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MCUXpresso SDK API Reference Manual

NXP Semiconductors



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Chapter 1

Introduction

The MCUXpresso Software Development Kit (MCUXpresso SDK) is a collection of software enablement for NXP Microcontrollers that includes peripheral drivers, multicore support and integrated RTOS support for FreeRTOS™. In addition to the base enablement, the MCUXpresso SDK is augmented with demo applications, driver example projects, and API documentation to help users quickly leverage the support provided by MCUXpresso SDK. The [MCUXpresso SDK Web Builder](#) is available to provide access to all MCUXpresso SDK packages. See the *MCUXpresso Software Development Kit (SDK) Release Notes* (document MCUXSDKRN) in the Supported Devices section at [MCUXpresso-SDK: Software Development Kit for MCUXpresso](#) for details.

The MCUXpresso SDK is built with the following runtime software components:

- Arm® and DSP standard libraries, and CMSIS-compliant device header files which provide direct access to the peripheral registers.
- Peripheral drivers that provide stateless, high-performance, ease-of-use APIs. Communication drivers provide higher-level transactional APIs for a higher-performance option.
- RTOS wrapper driver built on top of MCUXpresso SDK peripheral drivers and leverage native RTOS services to better comply to the RTOS cases.
- Real time operation systems (RTOS) for FreeRTOS OS.
- Stacks and middleware in source or object formats including:
- CMSIS-DSP, a suite of common signal processing functions.
- The MCUXpresso SDK comes complete with software examples demonstrating the usage of the peripheral drivers, RTOS wrapper drivers, middleware, and RTOSes.

The peripheral drivers and RTOS driver wrappers can be used across multiple devices within the product family without modification. The configuration items for each driver are encapsulated into C language data structures. Device-specific configuration information is provided as part of the MCUXpresso SDK and need not be modified by the user. If necessary, the user is able to modify the peripheral driver and RTOS wrapper driver configuration during runtime. The driver examples demonstrate how to configure the drivers by passing the proper configuration data to the APIs. The folder structure is organized to reduce the total number of includes required to compile a project.

The rest of this document describes the API references in detail for the peripheral drivers and RTOS wrapper drivers. For the latest version of this and other MCUXpresso SDK documents, see the mcuxpresso.nxp.com/apidoc/.

Deliverable	Location
Demo Applications	<install_dir>/boards/<board_name>/demo_apps
Driver Examples	<install_dir>/boards/<board_name>/driver_examples
Documentation	<install_dir>/docs
Middleware	<install_dir>/middleware
Drivers	<install_dir>/<device_name>/drivers/
CMSIS Standard Arm Cortex-M Headers, math and DSP Libraries	<install_dir>/CMSIS
Device Startup and Linker	<install_dir>/<device_name>/<toolchain>/
MCUXpresso SDK Utilities	<install_dir>/devices/<device_name>/utilities
RTOS Kernel Code	<install_dir>/rtos

MCUXpresso SDK Folder Structure

Chapter 2

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Chapter 3

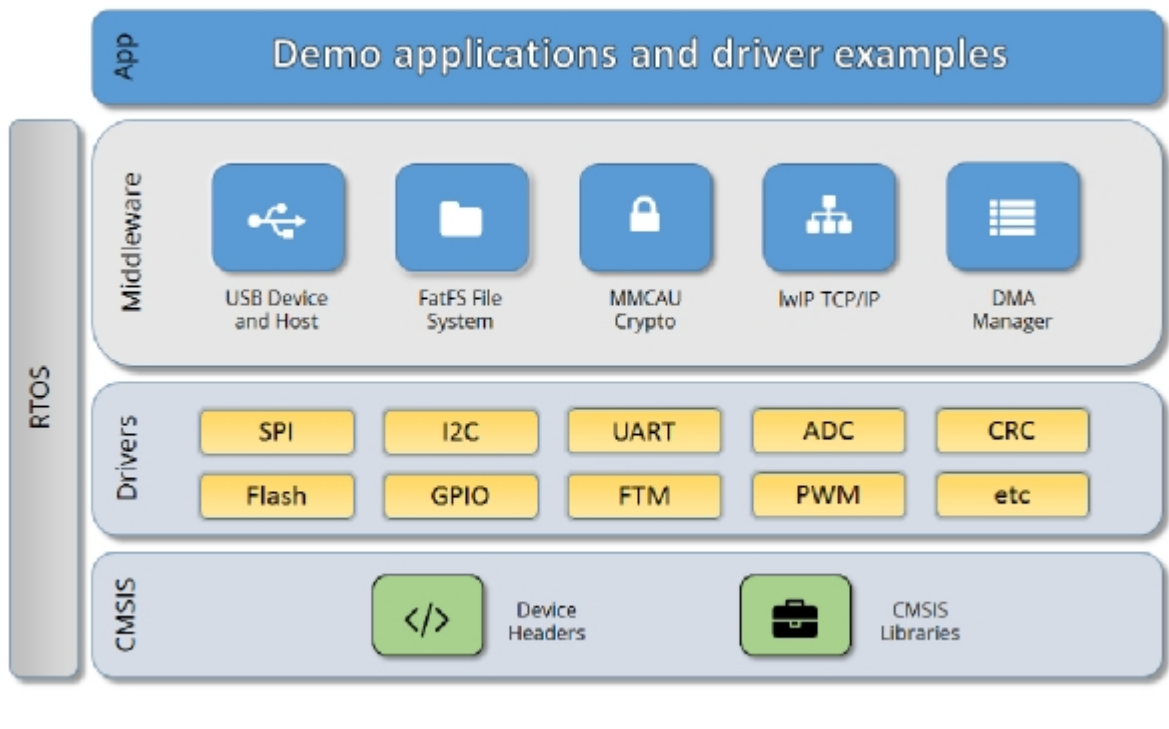
Architectural Overview

This chapter provides the architectural overview for the MCUXpresso Software Development Kit (MCUXpresso SDK). It describes each layer within the architecture and its associated components.

Overview

The MCUXpresso SDK architecture consists of five key components listed below.

1. The Arm Cortex Microcontroller Software Interface Standard (CMSIS) CORE compliance device-specific header files, SOC Header, and CMSIS math/DSP libraries.
2. Peripheral Drivers
3. Real-time Operating Systems (RTOS)
4. Stacks and Middleware that integrate with the MCUXpresso SDK
5. Demo Applications based on the MCUXpresso SDK



MCUXpresso SDK Block Diagram

MCU header files

Each supported MCU device in the MCUXpresso SDK has an overall System-on Chip (SoC) memory-

mapped header file. This header file contains the memory map and register base address for each peripheral and the IRQ vector table with associated vector numbers. The overall SoC header file provides access to the peripheral registers through pointers and predefined bit masks. In addition to the overall SoC memory-mapped header file, the MCUXpresso SDK includes a feature header file for each device. The feature header file allows NXP to deliver a single software driver for a given peripheral. The feature file ensures that the driver is properly compiled for the target SOC.

CMSIS Support

Along with the SoC header files and peripheral extension header files, the MCUXpresso SDK also includes common CMSIS header files for the Arm Cortex-M core and the math and DSP libraries from the latest CMSIS release. The CMSIS DSP library source code is also included for reference.

MCUXpresso SDK Peripheral Drivers

The MCUXpresso SDK peripheral drivers mainly consist of low-level functional APIs for the MCU product family on-chip peripherals and also of high-level transactional APIs for some bus drivers/DM-A driver/eDMA driver to quickly enable the peripherals and perform transfers.

All MCUXpresso SDK peripheral drivers only depend on the CMSIS headers, device feature files, `fsl_common.h`, and `fsl_clock.h` files so that users can easily pull selected drivers and their dependencies into projects. With the exception of the clock/power-relevant peripherals, each peripheral has its own driver. Peripheral drivers handle the peripheral clock gating/ungating inside the drivers during initialization and deinitialization respectively.

Low-level functional APIs provide common peripheral functionality, abstracting the hardware peripheral register accesses into a set of stateless basic functional operations. These APIs primarily focus on the control, configuration, and function of basic peripheral operations. The APIs hide the register access details and various MCU peripheral instantiation differences so that the application can be abstracted from the low-level hardware details. The API prototypes are intentionally similar to help ensure easy portability across supported MCUXpresso SDK devices.

Transactional APIs provide a quick method for customers to utilize higher-level functionality of the peripherals. The transactional APIs utilize interrupts and perform asynchronous operations without user intervention. Transactional APIs operate on high-level logic that requires data storage for internal operation context handling. However, the Peripheral Drivers do not allocate this memory space. Rather, the user passes in the memory to the driver for internal driver operation. Transactional APIs ensure the NVIC is enabled properly inside the drivers. The transactional APIs do not meet all customer needs, but provide a baseline for development of custom user APIs.

Note that the transactional drivers never disable an NVIC after use. This is due to the shared nature of interrupt vectors on devices. It is up to the user to ensure that NVIC interrupts are properly disabled after usage is complete.

Interrupt handling for transactional APIs

A double weak mechanism is introduced for drivers with transactional API. The double weak indicates two levels of weak vector entries. See the examples below:

```
PUBWEAK SPI0_IRQHandler
PUBWEAK SPI0_DriverIRQHandler
SPI0_IRQHandler
```

```
LDR    R0, =SPI0_DriverIRQHandler
BX     R0
```

The first level of the weak implementation are the functions defined in the vector table. In the devices/<DEVICE_NAME>/<TOOLCHAIN>/startup_<DEVICE_NAME>.s/.S file, the implementation of the first layer weak function calls the second layer of weak function. The implementation of the second layer weak function (ex. SPI0_DriverIRQHandler) jumps to itself (B). The MCUXpresso SDK drivers with transactional APIs provide the reimplement of the second layer function inside of the peripheral driver. If the MCUXpresso SDK drivers with transactional APIs are linked into the image, the SPI0_DriverIRQHandler is replaced with the function implemented in the MCUXpresso SDK SPI driver.

The reason for implementing the double weak functions is to provide a better user experience when using the transactional APIs. For drivers with a transactional function, call the transactional APIs and the drivers complete the interrupt-driven flow. Users are not required to redefine the vector entries out of the box. At the same time, if users are not satisfied by the second layer weak function implemented in the MCUXpresso SDK drivers, users can redefine the first layer weak function and implement their own interrupt handler functions to suit their implementation.

The limitation of the double weak mechanism is that it cannot be used for peripherals that share the same vector entry. For this use case, redefine the first layer weak function to enable the desired peripheral interrupt functionality. For example, if the MCU's UART0 and UART1 share the same vector entry, redefine the UART0_UART1_IRQHandler according to the use case requirements.

Feature Header Files

The peripheral drivers are designed to be reusable regardless of the peripheral functional differences from one MCU device to another. An overall Peripheral Feature Header File is provided for the MCUXpresso SDK-supported MCU device to define the features or configuration differences for each sub-family device.

Application

See the *Getting Started with MCUXpresso SDK* document (MCUXSDKGSUG).

Chapter 4

Clock Driver

4.1 Overview

The MCUXpresso SDK provides APIs for MCUXpresso SDK devices' clock operation.

The clock driver supports:

- Clock generator (PLL, FLL, and so on) configuration
- Clock mux and divider configuration
- Getting clock frequency

Files

- file [fsl_clock.h](#)

Data Structures

- struct [clock_usb_pll_config_t](#)
PLL configuration for USB. [More...](#)
- struct [clock_sys_pll_config_t](#)
PLL configuration for System. [More...](#)
- struct [clock_audio_pll_config_t](#)
PLL configuration for AUDIO and VIDEO. [More...](#)
- struct [clock_enet_pll_config_t](#)
PLL configuration for ENET. [More...](#)

Macros

- #define [FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL](#) 0
Configure whether driver controls clock.
- #define [CCSR_OFFSET](#) 0x0C
CCM registers offset.
- #define [PLL_SYS_OFFSET](#) 0x30
CCM Analog registers offset.
- #define [CCM_ANALOG_TUPLE](#)(reg, shift) (((reg)&0xFFFU) << 16U) | (shift)
CCM ANALOG tuple macros to map corresponding registers and bit fields.
- #define [CLKPN_FREQ](#) 0U
clockIPN frequency.
- #define [ADC_CLOCKS](#)
Clock ip name array for ADC.
- #define [AOI_CLOCKS](#)
Clock ip name array for AOI.
- #define [BEE_CLOCKS](#)
Clock ip name array for BEE.
- #define [CMP_CLOCKS](#)

- *Clock ip name array for CMP.*
• #define [DCDC_CLOCKS](#)
- *Clock ip name array for DCDC.*
• #define [DCP_CLOCKS](#)
- *Clock ip name array for DCP.*
• #define [DMAMUX_CLOCKS](#)
- *Clock ip name array for DMAMUX_CLOCKS.*
• #define [EDMA_CLOCKS](#)
- *Clock ip name array for DMA.*
• #define [ENC_CLOCKS](#)
- *Clock ip name array for ENC.*
• #define [ENET_CLOCKS](#)
- *Clock ip name array for ENET.*
• #define [EWM_CLOCKS](#)
- *Clock ip name array for EWM.*
• #define [FLEXCAN_CLOCKS](#)
- *Clock ip name array for FLEXCAN.*
• #define [FLEXCAN_PERIPH_CLOCKS](#)
- *Clock ip name array for FLEXCAN Peripheral clock.*
• #define [FLEXIO_CLOCKS](#)
- *Clock ip name array for FLEXIO.*
• #define [FLEXRAM_CLOCKS](#)
- *Clock ip name array for FLEXRAM.*
• #define [FLEXSPI_CLOCKS](#)
- *Clock ip name array for FLEXSPI.*
• #define [FLEXSPI_EXSC_CLOCKS](#)
- *Clock ip name array for FLEXSPI EXSC.*
• #define [GPIO_CLOCKS](#)
- *Clock ip name array for GPIO.*
• #define [GPT_CLOCKS](#)
- *Clock ip name array for GPT.*
• #define [KPP_CLOCKS](#)
- *Clock ip name array for KPP.*
• #define [LPI2C_CLOCKS](#)
- *Clock ip name array for LPI2C.*
• #define [LPSPI_CLOCKS](#)
- *Clock ip name array for LPSPI.*
• #define [LPUART_CLOCKS](#)
- *Clock ip name array for LPUART.*
• #define [OCRAM_EXSC_CLOCKS](#)
- *Clock ip name array for OCRAM EXSC.*
• #define [PIT_CLOCKS](#)
- *Clock ip name array for PIT.*
• #define [PWM_CLOCKS](#)
- *Clock ip name array for PWM.*
• #define [RTWDOG_CLOCKS](#)
- *Clock ip name array for RTWDOG.*
• #define [SAI_CLOCKS](#)
- *Clock ip name array for SAI.*
• #define [SEMC_CLOCKS](#)
- *Clock ip name array for SEMC.*

- #define `SEMC_EXSC_CLOCKS`
Clock ip name array for SEMC EXSC.
- #define `TMR_CLOCKS`
Clock ip name array for QTIMER.
- #define `TRNG_CLOCKS`
Clock ip name array for TRNG.
- #define `WDOG_CLOCKS`
Clock ip name array for WDOG.
- #define `USDHC_CLOCKS`
Clock ip name array for USDHC.
- #define `SPDIF_CLOCKS`
Clock ip name array for SPDIF.
- #define `XBARA_CLOCKS`
Clock ip name array for XBARA.
- #define `XBARB_CLOCKS`
Clock ip name array for XBARB.
- #define `kCLOCK_CoreSysClk kCLOCK_CpuClk`
For compatible with other platforms without CCM.
- #define `CLOCK_GetCoreSysClkFreq CLOCK_GetCpuClkFreq`
For compatible with other platforms without CCM.

Enumerations

- enum `clock_name_t` {
`kCLOCK_CpuClk` = 0x0U,
`kCLOCK_AhbClk` = 0x1U,
`kCLOCK_SemcClk` = 0x2U,
`kCLOCK_IpgClk` = 0x3U,
`kCLOCK_PerClk` = 0x4U,
`kCLOCK_OscClk` = 0x5U,
`kCLOCK_RtcClk` = 0x6U,
`kCLOCK_Usb1PllClk` = 0x7U,
`kCLOCK_Usb1PllPfd0Clk` = 0x8U,
`kCLOCK_Usb1PllPfd1Clk` = 0x9U,
`kCLOCK_Usb1PllPfd2Clk` = 0xAU,
`kCLOCK_Usb1PllPfd3Clk` = 0xBU,
`kCLOCK_Usb1SwClk` = 0x15U,
`kCLOCK_Usb1Sw60MClk` = 0x16U,
`kCLOCK_Usb1Sw80MClk` = 0x1BU,
`kCLOCK_SysPllClk` = 0xCU,
`kCLOCK_SysPllPfd0Clk` = 0xDU,
`kCLOCK_SysPllPfd1Clk` = 0xEU,
`kCLOCK_SysPllPfd2Clk` = 0xFU,
`kCLOCK_SysPllPfd3Clk` = 0x10U,
`kCLOCK_EnetPllClk` = 0x11U,
`kCLOCK_EnetPll25MClk` = 0x12U,
`kCLOCK_EnetPll500MClk` = 0x13U,
`kCLOCK_AudioPllClk` = 0x14U,

`kCLOCK_NoneName = CLOCK_SOURCE_NONE }`

Clock name used to get clock frequency.

- enum `clock_ip_name_t` { ,


```

kCLOCK_Aips_tz1 = (0U << 8U) | CCM_CCGR0_CG0_SHIFT,
kCLOCK_Aips_tz2 = (0U << 8U) | CCM_CCGR0_CG1_SHIFT,
kCLOCK_Mqs = (0U << 8U) | CCM_CCGR0_CG2_SHIFT,
kCLOCK_Sim_m_clk_r = (0U << 8U) | CCM_CCGR0_CG4_SHIFT,
kCLOCK_Dcp = (0U << 8U) | CCM_CCGR0_CG5_SHIFT,
kCLOCK_Lpuart3 = (0U << 8U) | CCM_CCGR0_CG6_SHIFT,
kCLOCK_Can1 = (0U << 8U) | CCM_CCGR0_CG7_SHIFT,
kCLOCK_Can1S = (0U << 8U) | CCM_CCGR0_CG8_SHIFT,
kCLOCK_Can2 = (0U << 8U) | CCM_CCGR0_CG9_SHIFT,
kCLOCK_Can2S = (0U << 8U) | CCM_CCGR0_CG10_SHIFT,
kCLOCK_Trace = (0U << 8U) | CCM_CCGR0_CG11_SHIFT,
kCLOCK_Gpt2 = (0U << 8U) | CCM_CCGR0_CG12_SHIFT,
kCLOCK_Gpt2S = (0U << 8U) | CCM_CCGR0_CG13_SHIFT,
kCLOCK_Lpuart2 = (0U << 8U) | CCM_CCGR0_CG14_SHIFT,
kCLOCK_Gpio2 = (0U << 8U) | CCM_CCGR0_CG15_SHIFT,
kCLOCK_Lpspi1 = (1U << 8U) | CCM_CCGR1_CG0_SHIFT,
kCLOCK_Lpspi2 = (1U << 8U) | CCM_CCGR1_CG1_SHIFT,
kCLOCK_Lpspi3 = (1U << 8U) | CCM_CCGR1_CG2_SHIFT,
kCLOCK_Lpspi4 = (1U << 8U) | CCM_CCGR1_CG3_SHIFT,
kCLOCK_Adc2 = (1U << 8U) | CCM_CCGR1_CG4_SHIFT,
kCLOCK_Enet = (1U << 8U) | CCM_CCGR1_CG5_SHIFT,
kCLOCK_Pit = (1U << 8U) | CCM_CCGR1_CG6_SHIFT,
kCLOCK_Adc1 = (1U << 8U) | CCM_CCGR1_CG8_SHIFT,
kCLOCK_SemcExsc = (1U << 8U) | CCM_CCGR1_CG9_SHIFT,
kCLOCK_Gpt1 = (1U << 8U) | CCM_CCGR1_CG10_SHIFT,
kCLOCK_Gpt1S = (1U << 8U) | CCM_CCGR1_CG11_SHIFT,
kCLOCK_Lpuart4 = (1U << 8U) | CCM_CCGR1_CG12_SHIFT,
kCLOCK_Gpio1 = (1U << 8U) | CCM_CCGR1_CG13_SHIFT,
kCLOCK_Csu = (1U << 8U) | CCM_CCGR1_CG14_SHIFT,
kCLOCK_Gpio5 = (1U << 8U) | CCM_CCGR1_CG15_SHIFT,
kCLOCK_OcramExsc = (2U << 8U) | CCM_CCGR2_CG0_SHIFT,
kCLOCK_IomuxcSnvs = (2U << 8U) | CCM_CCGR2_CG2_SHIFT,
kCLOCK_Lpi2c1 = (2U << 8U) | CCM_CCGR2_CG3_SHIFT,
kCLOCK_Lpi2c2 = (2U << 8U) | CCM_CCGR2_CG4_SHIFT,
kCLOCK_Lpi2c3 = (2U << 8U) | CCM_CCGR2_CG5_SHIFT,
kCLOCK_Ocotp = (2U << 8U) | CCM_CCGR2_CG6_SHIFT,
kCLOCK_Xbar1 = (2U << 8U) | CCM_CCGR2_CG11_SHIFT,
kCLOCK_Xbar2 = (2U << 8U) | CCM_CCGR2_CG12_SHIFT,
kCLOCK_Gpio3 = (2U << 8U) | CCM_CCGR2_CG13_SHIFT,
kCLOCK_Lpuart5 = (3U << 8U) | CCM_CCGR3_CG1_SHIFT,
kCLOCK_Semc = (3U << 8U) | CCM_CCGR3_CG2_SHIFT,
kCLOCK_Lpuart6 = (3U << 8U) | CCM_CCGR3_CG3_SHIFT,
kCLOCK_Aoi = (3U << 8U) | CCM_CCGR3_CG4_SHIFT,
kCLOCK_Ewm0 = (3U << 8U) | CCM_CCGR3_CG7_SHIFT,
kCLOCK_Wdog1 = (3U << 8U) | CCM_CCGR3_CG8_SHIFT,
kCLOCK_FlexRam = (3U << 8U) | CCM_CCGR3_CG9_SHIFT,
kCLOCK_Acmp1 = (3U << 8U) | CCM_CCGR3_CG10_SHIFT,
kCLOCK_Acmp2 = (3U << 8U) | CCM_CCGR3_CG11_SHIFT,
kCLOCK_Acmp3 = (3U << 8U) | CCM_CCGR3_CG12_SHIFT,

```

```
kCLOCK_Timer2 = (6U << 8U) | CCM_CCGR6_CG14_SHIFT }
```

CCM CCGR gate control for each module independently.

- enum `clock_osc_t` {
`kCLOCK_RcOsc = 0U,`
`kCLOCK_XtalOsc = 1U }`

OSC 24M source select.

- enum `clock_gate_value_t` {
`kCLOCK_ClockNotNeeded = 0U,`
`kCLOCK_ClockNeededRun = 1U,`
`kCLOCK_ClockNeededRunWait = 3U }`

Clock gate value.

- enum `clock_mode_t` {
`kCLOCK_ModeRun = 0U,`
`kCLOCK_ModeWait = 1U,`
`kCLOCK_ModeStop = 2U }`

System clock mode.

- enum `clock_mux_t` {
`kCLOCK_Pll3SwMux,`
`kCLOCK_PeriphMux,`
`kCLOCK_SemcAltMux,`
`kCLOCK_SemcMux,`
`kCLOCK_PrePeriphMux,`
`kCLOCK_TraceMux,`
`kCLOCK_PeriphClk2Mux,`
`kCLOCK_LpspiMux,`
`kCLOCK_FlexspiMux,`
`kCLOCK_Usdhc2Mux,`
`kCLOCK_Usdhc1Mux,`
`kCLOCK_Sai3Mux,`
`kCLOCK_Sai2Mux,`
`kCLOCK_Sai1Mux,`
`kCLOCK_PerclkMux,`
`kCLOCK_Flexio1Mux,`
`kCLOCK_CanMux,`
`kCLOCK_UartMux,`
`kCLOCK_SpdifMux,`
`kCLOCK_Lpi2cMux }`

MUX control names for clock mux setting.

- enum `clock_div_t` {

```
kCLOCK_ArmDiv,  
kCLOCK_PeriphClk2Div,  
kCLOCK_SemcDiv,  
kCLOCK_AhbDiv,  
kCLOCK_IpgDiv,  
kCLOCK_LpspiDiv,  
kCLOCK_FlexspiDiv,  
kCLOCK_PerclkDiv,  
kCLOCK_CanDiv,  
kCLOCK_TraceDiv,  
kCLOCK_Usdhc2Div,  
kCLOCK_Usdhc1Div,  
kCLOCK_UartDiv,  
kCLOCK_Flexio1Div,  
kCLOCK_Sai3PreDiv,  
kCLOCK_Sai3Div,  
kCLOCK_Flexio1PreDiv,  
kCLOCK_Sai1PreDiv,  
kCLOCK_Sai1Div,  
kCLOCK_Sai2PreDiv,  
kCLOCK_Sai2Div,  
kCLOCK_Spdif0PreDiv,  
kCLOCK_Spdif0Div,  
kCLOCK_Lpi2cDiv,  
kCLOCK_NonePreDiv = CLOCK_ROOT_NONE_PRE_DIV }
```

DIV control names for clock div setting.

- enum `clock_div_value_t` {

```

kCLOCK_ArmDivBy1 = 0,
kCLOCK_ArmDivBy2 = 1,
kCLOCK_ArmDivBy3 = 2,
kCLOCK_ArmDivBy4 = 3,
kCLOCK_ArmDivBy5 = 4,
kCLOCK_ArmDivBy6 = 5,
kCLOCK_ArmDivBy7 = 6,
kCLOCK_ArmDivBy8 = 7,
kCLOCK_PeriphClk2DivBy1 = 0,
kCLOCK_PeriphClk2DivBy2 = 1,
kCLOCK_PeriphClk2DivBy3 = 2,
kCLOCK_PeriphClk2DivBy4 = 3,
kCLOCK_PeriphClk2DivBy5 = 4,
kCLOCK_PeriphClk2DivBy6 = 5,
kCLOCK_PeriphClk2DivBy7 = 6,
kCLOCK_PeriphClk2DivBy8 = 7,
kCLOCK_SemcDivBy1 = 0,
kCLOCK_SemcDivBy2 = 1,
kCLOCK_SemcDivBy3 = 2,
kCLOCK_SemcDivBy4 = 3,
kCLOCK_SemcDivBy5 = 4,
kCLOCK_SemcDivBy6 = 5,
kCLOCK_SemcDivBy7 = 6,
kCLOCK_SemcDivBy8 = 7,
kCLOCK_AhbDivBy1 = 0,
kCLOCK_AhbDivBy2 = 1,
kCLOCK_AhbDivBy3 = 2,
kCLOCK_AhbDivBy4 = 3,
kCLOCK_AhbDivBy5 = 4,
kCLOCK_AhbDivBy6 = 5,
kCLOCK_AhbDivBy7 = 6,
kCLOCK_AhbDivBy8 = 7,
kCLOCK_IpgDivBy1 = 0,
kCLOCK_IpgDivBy2 = 1,
kCLOCK_IpgDivBy3 = 2,
kCLOCK_IpgDivBy4 = 3,
kCLOCK_LpspiDivBy1 = 0,
kCLOCK_LpspiDivBy2 = 1,
kCLOCK_LpspiDivBy3 = 2,
kCLOCK_LpspiDivBy4 = 3,
kCLOCK_LpspiDivBy5 = 4,
kCLOCK_LpspiDivBy6 = 5,
kCLOCK_LpspiDivBy7 = 6,
kCLOCK_LpspiDivBy8 = 7,
kCLOCK_FlexspiDivBy1 = 0,
kCLOCK_FlexspiDivBy2 = 1,
kCLOCK_FlexspiDivBy3 = 2,
kCLOCK_FlexspiDivBy4 = 3,
kCLOCK_FlexspiDivBy5 = 4,

```

`kCLOCK_MiscDivBy64 = 63 }`

Clock divider value.

- enum `clock_usb_src_t` {
`kCLOCK_Usb480M = 0,`
`kCLOCK_UsbSrcUnused = (int)0xFFFFFFFFFU }`
- USB clock source definition.*
- enum `clock_usb_phy_src_t` { `kCLOCK_Usbphy480M = 0 }`
- Source of the USB HS PHY.*
- enum `_clock_pll_clk_src` {
`kCLOCK_PllClkSrc24M = 0U,`
`kCLOCK_PllSrcClkPN = 1U }`
- PLL clock source, bypass cloco source also.*
- enum `clock_pll_t` {
`kCLOCK_PllSys = CCM_ANALOG_TUPLE(PLL_SYS_OFFSET, CCM_ANALOG_PLL_SYS_ENABLE_SHIFT),`
`kCLOCK_PllUsb1 = CCM_ANALOG_TUPLE(PLL_USB1_OFFSET, CCM_ANALOG_PLL_USB1_ENABLE_SHIFT),`
`kCLOCK_PllAudio = CCM_ANALOG_TUPLE(PLL_AUDIO_OFFSET, CCM_ANALOG_PLL_AUDIO_ENABLE_SHIFT),`
`kCLOCK_PllEnet = CCM_ANALOG_TUPLE(PLL_ENET_OFFSET, CCM_ANALOG_PLL_ENET_ENABLE_SHIFT),`
`kCLOCK_PllEnet500M = CCM_ANALOG_TUPLE(PLL_ENET_OFFSET, CCM_ANALOG_PLL_ENET_ENET_500M_REF_EN_SHIFT),`
`kCLOCK_PllEnet25M = CCM_ANALOG_TUPLE(PLL_ENET_OFFSET, CCM_ANALOG_PLL_ENET_ENET_25M_REF_EN_SHIFT) }`
- PLL name.*
- enum `clock_pfd_t` {
`kCLOCK_Pfd0 = 0U,`
`kCLOCK_Pfd1 = 1U,`
`kCLOCK_Pfd2 = 2U,`
`kCLOCK_Pfd3 = 3U }`
- PLL PFD name.*
- enum `clock_output1_selection_t` {
`kCLOCK_OutputPllUsb1Sw = 0U,`
`kCLOCK_OutputPllSys = 1U,`
`kCLOCK_OutputPllENET500M = 2U,`
`kCLOCK_OutputSemcClk = 5U,`
`kCLOCK_OutputAhbClk = 0xBU,`
`kCLOCK_OutputIpgClk = 0xCU,`
`kCLOCK_OutputPerClk = 0xDU,`
`kCLOCK_OutputPll4MainClk = 0xFU,`
`kCLOCK_DisableClockOutput1 = 0x10U }`
- The enumerator of clock output1's clock source, such as USB1 PLL, SYS PLL and so on.*
- enum `clock_output2_selection_t` {

```

kCLOCK_OutputUsdhc1Clk = 3U,
kCLOCK_OutputLpi2cClk = 6U,
kCLOCK_OutputOscClk = 0xEU,
kCLOCK_OutputLpspiClk = 0x10U,
kCLOCK_OutputUsdhc2Clk = 0x11U,
kCLOCK_OutputSai1Clk = 0x12U,
kCLOCK_OutputSai2Clk = 0x13U,
kCLOCK_OutputSai3Clk = 0x14U,
kCLOCK_OutputTraceClk = 0x16U,
kCLOCK_OutputCanClk = 0x17U,
kCLOCK_OutputFlexspiClk = 0x1BU,
kCLOCK_OutputUartClk = 0x1CU,
kCLOCK_OutputSpdif0Clk = 0x1DU,
kCLOCK_DisableClockOutput2 = 0x1FU }

```

The enumerator of clock output's clock source, such as USDHC1 clock root, LPI2C clock root and so on.

- enum `clock_output_divider_t` {


```

kCLOCK_DivideBy1 = 0U,
kCLOCK_DivideBy2,
kCLOCK_DivideBy3,
kCLOCK_DivideBy4,
kCLOCK_DivideBy5,
kCLOCK_DivideBy6,
kCLOCK_DivideBy7,
kCLOCK_DivideBy8 }

```

The enumerator of clock output's divider.

- enum `clock_root_t` {


```

kCLOCK_Usdhc1ClkRoot = 0U,
kCLOCK_Usdhc2ClkRoot,
kCLOCK_FlexspiClkRoot,
kCLOCK_LpspiClkRoot,
kCLOCK_TraceClkRoot,
kCLOCK_Sai1ClkRoot,
kCLOCK_Sai2ClkRoot,
kCLOCK_Sai3ClkRoot,
kCLOCK_Lpi2cClkRoot,
kCLOCK_CanClkRoot,
kCLOCK_UartClkRoot,
kCLOCK_SpdifClkRoot,
kCLOCK_Flexio1ClkRoot }

```

The enumerator of clock root.

Functions

- static void `CLOCK_SetMux` (`clock_mux_t` mux, `uint32_t` value)

Set CCM MUX node to certain value.
- static `uint32_t` `CLOCK_GetMux` (`clock_mux_t` mux)

- *Get CCM MUX value.*
- static void `CLOCK_SetDiv` (`clock_div_t` divider, `uint32_t` value)
 - *Set clock divider value.*
- static `uint32_t` `CLOCK_GetDiv` (`clock_div_t` divider)
 - *Get CCM DIV node value.*
- static void `CLOCK_ControlGate` (`clock_ip_name_t` name, `clock_gate_value_t` value)
 - *Control the clock gate for specific IP.*
- static void `CLOCK_EnableClock` (`clock_ip_name_t` name)
 - *Enable the clock for specific IP.*
- static void `CLOCK_DisableClock` (`clock_ip_name_t` name)
 - *Disable the clock for specific IP.*
- static void `CLOCK_SetMode` (`clock_mode_t` mode)
 - *Setting the low power mode that system will enter on next assertion of `dsm_request` signal.*
- static `uint32_t` `CLOCK_GetOscFreq` (void)
 - *Gets the OSC clock frequency.*
- `uint32_t` `CLOCK_GetAhbFreq` (void)
 - *Gets the AHB clock frequency.*
- `uint32_t` `CLOCK_GetSemcFreq` (void)
 - *Gets the SEMC clock frequency.*
- `uint32_t` `CLOCK_GetIpgFreq` (void)
 - *Gets the IPG clock frequency.*
- `uint32_t` `CLOCK_GetPerClkFreq` (void)
 - *Gets the PER clock frequency.*
- `uint32_t` `CLOCK_GetFreq` (`clock_name_t` name)
 - *Gets the clock frequency for a specific clock name.*
- static `uint32_t` `CLOCK_GetCpuClkFreq` (void)
 - *Get the CCM CPU/core/system frequency.*
- `uint32_t` `CLOCK_GetClockRootFreq` (`clock_root_t` clockRoot)
 - *Gets the frequency of selected clock root.*
- bool `CLOCK_EnableUsbhs0Clock` (`clock_usb_src_t` src, `uint32_t` freq)
 - *Enable USB HS clock.*

Variables

- volatile `uint32_t` `g_xtalFreq`
 - *External XTAL (24M OSC/SYSOSC) clock frequency.*
- volatile `uint32_t` `g_rtcXtalFreq`
 - *External RTC XTAL (32K OSC) clock frequency.*

Driver version

- #define `FSL_CLOCK_DRIVER_VERSION` (`MAKE_VERSION(2, 5, 1)`)
 - *CLOCK driver version 2.5.1.*
- #define `SDK_DEVICE_MAXIMUM_CPU_CLOCK_FREQUENCY` (500000000UL)
- #define `CCM_ANALOG_PLL_BYPASS_SHIFT` (16U)
- #define `CCM_ANALOG_PLL_BYPASS_SHIFT` (16U)
- #define `CCM_ANALOG_PLL_BYPASS_CLK_SRC_MASK` (0xC000U)
- #define `CCM_ANALOG_PLL_BYPASS_CLK_SRC_MASK` (0xC000U)
- #define `CCM_ANALOG_PLL_BYPASS_CLK_SRC_SHIFT` (14U)
- #define `CCM_ANALOG_PLL_BYPASS_CLK_SRC_SHIFT` (14U)

OSC operations

- void `CLOCK_InitExternalClk` (bool bypassXtalOsc)
Initialize the external 24MHz clock.
- void `CLOCK_DeinitExternalClk` (void)
Deinitialize the external 24MHz clock.
- void `CLOCK_SwitchOsc` (clock_osc_t osc)
Switch the OSC.
- static uint32_t `CLOCK_GetRtcFreq` (void)
Gets the RTC clock frequency.
- static void `CLOCK_SetXtalFreq` (uint32_t freq)
Set the XTAL (24M OSC) frequency based on board setting.
- static void `CLOCK_SetRtcXtalFreq` (uint32_t freq)
Set the RTC XTAL (32K OSC) frequency based on board setting.
- void `CLOCK_InitRcOsc24M` (void)
Initialize the RC oscillator 24MHz clock.
- void `CLOCK_DeinitRcOsc24M` (void)
Power down the RCOSC 24M clock.

4.2 Data Structure Documentation

4.2.1 struct clock_usb_pll_config_t

Data Fields

- uint8_t `loopDivider`
PLL loop divider.
- uint8_t `src`
Pll clock source, reference `_clock_pll_clk_src`.

Field Documentation

(1) uint8_t clock_usb_pll_config_t::loopDivider

0 - Fout=Fref*20; 1 - Fout=Fref*22

4.2.2 struct clock_sys_pll_config_t

Data Fields

- uint8_t `loopDivider`
PLL loop divider.
- uint32_t `numerator`
30 bit numerator of fractional loop divider.
- uint32_t `denominator`
30 bit denominator of fractional loop divider
- uint8_t `src`
Pll clock source, reference `_clock_pll_clk_src`.

- `uint16_t ss_stop`
Stop value to get frequency change.
- `uint8_t ss_enable`
Enable spread spectrum modulation.
- `uint16_t ss_step`
Step value to get frequency change step.

Field Documentation

(1) `uint8_t clock_sys_pll_config_t::loopDivider`

Intended to be 1 (528M). 0 - $F_{out}=F_{ref}*20$; 1 - $F_{out}=F_{ref}*22$

(2) `uint32_t clock_sys_pll_config_t::numerator`

(3) `uint16_t clock_sys_pll_config_t::ss_stop`

(4) `uint16_t clock_sys_pll_config_t::ss_step`

4.2.3 struct `clock_audio_pll_config_t`

Data Fields

- `uint8_t loopDivider`
PLL loop divider.
- `uint8_t postDivider`
Divider after the PLL, should only be 1, 2, 4, 8, 16.
- `uint32_t numerator`
30 bit numerator of fractional loop divider.
- `uint32_t denominator`
30 bit denominator of fractional loop divider
- `uint8_t src`
Pll clock source, reference `_clock_pll_clk_src`.

Field Documentation

(1) `uint8_t clock_audio_pll_config_t::loopDivider`

Valid range for DIV_SELECT divider value: 27~54.

(2) `uint8_t clock_audio_pll_config_t::postDivider`

(3) `uint32_t clock_audio_pll_config_t::numerator`

4.2.4 struct `clock_enet_pll_config_t`

Data Fields

- `bool enableClkOutput`

- *Power on and enable PLL clock output for ENET0 (ref_enetpll0).*
 • bool `enableClkOutput500M`
- *Power on and enable PLL clock output for ENET (ref_enetpll500M).*
 • bool `enableClkOutput25M`
- *Power on and enable PLL clock output for ENET1 (ref_enetpll1).*
 • uint8_t `loopDivider`
Controls the frequency of the ENET0 reference clock.
- uint8_t `src`
Pll clock source, reference `_clock_pll_clk_src`.

Field Documentation

- (1) `bool clock_enet_pll_config_t::enableClkOutput`
- (2) `bool clock_enet_pll_config_t::enableClkOutput500M`
- (3) `bool clock_enet_pll_config_t::enableClkOutput25M`
- (4) `uint8_t clock_enet_pll_config_t::loopDivider`

b00 25MHz b01 50MHz b10 100MHz (not 50% duty cycle) b11 125MHz

4.3 Macro Definition Documentation

4.3.1 #define FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL 0

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.

4.3.2 #define FSL_CLOCK_DRIVER_VERSION (MAKE_VERSION(2, 5, 1))

4.3.3 #define ADC_CLOCKS

Value:

```
{
    kCLOCK_IpInvalid, kCLOCK_Adc1, kCLOCK_Adc2 \
}
```

4.3.4 #define AOI_CLOCKS

Value:

```
{  
    kCLOCK_Aoi \  
}
```

4.3.5 #define BEE_CLOCKS

Value:

```
{  
    kCLOCK_Bee \  
}
```

4.3.6 #define CMP_CLOCKS

Value:

```
{  
    kCLOCK_IpInvalid, kCLOCK_Acmp1, kCLOCK_Acmp2, \  
    kCLOCK_Acmp3, kCLOCK_Acmp4 \  
}
```

4.3.7 #define DCDC_CLOCKS

Value:

```
{  
    kCLOCK_Dcdc \  
}
```

4.3.8 #define DCP_CLOCKS

Value:

```
{  
    kCLOCK_Dcp \  
}
```

4.3.9 #define DMAMUX_CLOCKS

Value:

```
{  
    kCLOCK_Dma \
```

4.3.10 #define EDMA_CLOCKS

Value:

```
{  
    kCLOCK_Dma \
```

4.3.11 #define ENC_CLOCKS

Value:

```
{  
    kCLOCK_IpInvalid, kCLOCK_Enc1, kCLOCK_Enc2 \
```

4.3.12 #define ENET_CLOCKS

Value:

```
{  
    kCLOCK_Enet \
```

4.3.13 #define EWM_CLOCKS

Value:

```
{  
    kCLOCK_Ewm0 \
```

4.3.14 #define FLEXCAN_CLOCKS

Value:

```
{
    kCLOCK_IpInvalid, kCLOCK_Can1, kCLOCK_Can2 \
}
```

4.3.15 #define FLEXCAN_PERIPH_CLOCKS

Value:

```
{
    kCLOCK_IpInvalid, kCLOCK_Can1S, kCLOCK_Can2S \
}
```

4.3.16 #define FLEXIO_CLOCKS

Value:

```
{
    kCLOCK_IpInvalid, kCLOCK_Flexio1 \
}
```

4.3.17 #define FLEXRAM_CLOCKS

Value:

```
{
    kCLOCK_FlexRam \
}
```

4.3.18 #define FLEXSPI_CLOCKS

Value:

```
{
    kCLOCK_FlexSpi \
}
```

4.3.19 #define FLEXSPI_EXSC_CLOCKS

Value:

```
{
    kCLOCK_FlexSpiExsc \
}
```

4.3.20 #define GPIO_CLOCKS

Value:

```
{
    kCLOCK_IpInvalid, kCLOCK_Gpio1, kCLOCK_Gpio2,
    kCLOCK_Gpio3, kCLOCK_IpInvalid, kCLOCK_Gpio5 \
}
```

4.3.21 #define GPT_CLOCKS

Value:

```
{
    kCLOCK_IpInvalid, kCLOCK_Gpt1, kCLOCK_Gpt2 \
}
```

4.3.22 #define KPP_CLOCKS

Value:

```
{
    kCLOCK_Kpp \
}
```

4.3.23 #define LPI2C_CLOCKS

Value:

```
{
    kCLOCK_IpInvalid, kCLOCK_Lpi2c1, kCLOCK_Lpi2c2,
    kCLOCK_Lpi2c3, kCLOCK_Lpi2c4 \
}
```

4.3.24 #define LPSPi_CLOCKS

Value:

```
{
    kCLOCK_IpInvalid, kCLOCK_Lpspi1, kCLOCK_Lpspi2,
    kCLOCK_Lpspi3, kCLOCK_Lpspi4 \
}
```

4.3.25 #define LPUART_CLOCKS

Value:

```
{
    kCLOCK_IpInvalid, kCLOCK_Lpuart1, kCLOCK_Lpuart2,
    kCLOCK_Lpuart3, kCLOCK_Lpuart4, kCLOCK_Lpuart5,
    \
    kCLOCK_Lpuart6, kCLOCK_Lpuart7,
    kCLOCK_Lpuart8 \
}
```

4.3.26 #define OCRAM_EXSC_CLOCKS

Value:

```
{
    kCLOCK_OcramExsc \
}
```

4.3.27 #define PIT_CLOCKS

Value:

```
{
    kCLOCK_Pit \
}
```

4.3.28 #define PWM_CLOCKS

Value:

```
{
    {kCLOCK_IpInvalid, kCLOCK_IpInvalid, kCLOCK_IpInvalid, kCLOCK_IpInvalid}, \
    {kCLOCK_Pwm1, kCLOCK_Pwm1, kCLOCK_Pwm1, kCLOCK_Pwm1}, \
    {
        \
        kCLOCK_Pwm2, kCLOCK_Pwm2, \
        kCLOCK_Pwm2, kCLOCK_Pwm2 \
    } \
}
```

4.3.29 #define RTWDOG_CLOCKS

Value:

```
{
    kCLOCK_Wdog3 \
}
```

4.3.30 #define SAI_CLOCKS

Value:

```
{
    kCLOCK_IpInvalid, kCLOCK_Sai1, kCLOCK_Sai2, \
    kCLOCK_Sai3 \
}
```

4.3.31 #define SEMC_CLOCKS

Value:

```
{
    kCLOCK_Semc \
}
```

4.3.32 #define SEMC_EXSC_CLOCKS

Value:

```
{
    kCLOCK_SemcExsc \
}
```


4.3.33 #define TMR_CLOCKS

Value:

```
{  
    kCLOCK_IpInvalid, kCLOCK_Timer1, kCLOCK_Timer2 \  
}
```

4.3.34 #define TRNG_CLOCKS

Value:

```
{  
    kCLOCK_Trng \  
}
```

4.3.35 #define WDOG_CLOCKS

Value:

```
{  
    kCLOCK_IpInvalid, kCLOCK_Wdog1, kCLOCK_Wdog2 \  
}
```

4.3.36 #define USDHC_CLOCKS

Value:

```
{  
    kCLOCK_IpInvalid, kCLOCK_Usdhc1, kCLOCK_Usdhc2 \  
}
```

4.3.37 #define SPDIF_CLOCKS

Value:

```
{  
    kCLOCK_Spdif \  
}
```

4.3.38 #define XBARA_CLOCKS

Value:

```
{
    kCLOCK_Xbar1 \
}
```

4.3.39 #define XBARB_CLOCKS

Value:

```
{
    kCLOCK_Xbar2 \
}
```

4.3.40 #define kCLOCK_CoreSysClk kCLOCK_CpuClk

4.3.41 #define CLOCK_GetCoreSysClkFreq CLOCK_GetCpuClkFreq

4.4 Enumeration Type Documentation

4.4.1 enum clock_name_t

Enumerator

kCLOCK_CpuClk CPU clock.
kCLOCK_AhbClk AHB clock.
kCLOCK_SemcClk SEMC clock.
kCLOCK_IpgClk IPG clock.
kCLOCK_PerClk PER clock.
kCLOCK_OscClk OSC clock selected by PMU_LOWPOWER_CTRL[OSC_SEL].
kCLOCK_RtcClk RTC clock. (RTCCLK)
kCLOCK_Usb1PllClk USB1PLLCLK.
kCLOCK_Usb1Pllpfd0Clk USB1PLLPDF0CLK.
kCLOCK_Usb1Pllpfd1Clk USB1PLLPFD1CLK.
kCLOCK_Usb1Pllpfd2Clk USB1PLLPFD2CLK.
kCLOCK_Usb1Pllpfd3Clk USB1PLLPFD3CLK.
kCLOCK_Usb1SwClk USB1PLLSWCLK.
kCLOCK_Usb1Sw60MClk USB1PLLSw60MCLK.
kCLOCK_Usb1Sw80MClk USB1PLLSw80MCLK.
kCLOCK_SysPllClk SYSPLLCLK.
kCLOCK_SysPllpfd0Clk SYSPLLPDF0CLK.

kCLOCK_SysPlIPfd1Clk SYSPLLPFD1CLK.
kCLOCK_SysPlIPfd2Clk SYSPLLPFD2CLK.
kCLOCK_SysPlIPfd3Clk SYSPLLPFD3CLK.
kCLOCK_EnetPlIClk Enet PLLCLK ref_enetpll.
kCLOCK_EnetPlI25MClk Enet PLLCLK ref_enetpll25M.
kCLOCK_EnetPlI500MClk Enet PLLCLK ref_enetpll500M.
kCLOCK_AudioPlIClk Audio PLLCLK.
kCLOCK_NoneName None Clock Name.

4.4.2 enum clock_ip_name_t

Enumerator

kCLOCK_Aips_tz1 CCGR0, CG0.
kCLOCK_Aips_tz2 CCGR0, CG1.
kCLOCK_Mqs CCGR0, CG2.
kCLOCK_Sim_m_clk_r CCGR0, CG4.
kCLOCK_Dcp CCGR0, CG5.
kCLOCK_Lpuart3 CCGR0, CG6.
kCLOCK_Can1 CCGR0, CG7.
kCLOCK_Can1S CCGR0, CG8.
kCLOCK_Can2 CCGR0, CG9.
kCLOCK_Can2S CCGR0, CG10.
kCLOCK_Trace CCGR0, CG11.
kCLOCK_Gpt2 CCGR0, CG12.
kCLOCK_Gpt2S CCGR0, CG13.
kCLOCK_Lpuart2 CCGR0, CG14.
kCLOCK_Gpio2 CCGR0, CG15.
kCLOCK_Lpspi1 CCGR1, CG0.
kCLOCK_Lpspi2 CCGR1, CG1.
kCLOCK_Lpspi3 CCGR1, CG2.
kCLOCK_Lpspi4 CCGR1, CG3.
kCLOCK_Adc2 CCGR1, CG4.
kCLOCK_Enet CCGR1, CG5.
kCLOCK_Pit CCGR1, CG6.
kCLOCK_Adc1 CCGR1, CG8.
kCLOCK_SemcExsc CCGR1, CG9.
kCLOCK_Gpt1 CCGR1, CG10.
kCLOCK_Gpt1S CCGR1, CG11.
kCLOCK_Lpuart4 CCGR1, CG12.
kCLOCK_Gpio1 CCGR1, CG13.
kCLOCK_Csu CCGR1, CG14.
kCLOCK_Gpio5 CCGR1, CG15.
kCLOCK_OcramExsc CCGR2, CG0.

kCLOCK_IomuxcSnvs CCGR2, CG2.
kCLOCK_Lpi2c1 CCGR2, CG3.
kCLOCK_Lpi2c2 CCGR2, CG4.
kCLOCK_Lpi2c3 CCGR2, CG5.
kCLOCK_Ocotp CCGR2, CG6.
kCLOCK_Xbar1 CCGR2, CG11.
kCLOCK_Xbar2 CCGR2, CG12.
kCLOCK_Gpio3 CCGR2, CG13.
kCLOCK_Lpuart5 CCGR3, CG1.
kCLOCK_Semc CCGR3, CG2.
kCLOCK_Lpuart6 CCGR3, CG3.
kCLOCK_Aoi CCGR3, CG4.
kCLOCK_Ewm0 CCGR3, CG7.
kCLOCK_Wdog1 CCGR3, CG8.
kCLOCK_FlexRam CCGR3, CG9.
kCLOCK_Acmp1 CCGR3, CG10.
kCLOCK_Acmp2 CCGR3, CG11.
kCLOCK_Acmp3 CCGR3, CG12.
kCLOCK_Acmp4 CCGR3, CG13.
kCLOCK_IomuxcSnvsGpr CCGR3, CG15.
kCLOCK_Sim_m7_clk_r CCGR4, CG0.
kCLOCK_Iomuxc CCGR4, CG1.
kCLOCK_IomuxcGpr CCGR4, CG2.
kCLOCK_Bee CCGR4, CG3.
kCLOCK_SimM7 CCGR4, CG4.
kCLOCK_SimM CCGR4, CG6.
kCLOCK_SimEms CCGR4, CG7.
kCLOCK_Pwm1 CCGR4, CG8.
kCLOCK_Pwm2 CCGR4, CG9.
kCLOCK_Enc1 CCGR4, CG12.
kCLOCK_Enc2 CCGR4, CG13.
kCLOCK_Rom CCGR5, CG0.
kCLOCK_Flexio1 CCGR5, CG1.
kCLOCK_Wdog3 CCGR5, CG2.
kCLOCK_Dma CCGR5, CG3.
kCLOCK_Kpp CCGR5, CG4.
kCLOCK_Wdog2 CCGR5, CG5.
kCLOCK_Aips_tz4 CCGR5, CG6.
kCLOCK_Spdif CCGR5, CG7.
kCLOCK_Sai1 CCGR5, CG9.
kCLOCK_Sai2 CCGR5, CG10.
kCLOCK_Sai3 CCGR5, CG11.
kCLOCK_Lpuart1 CCGR5, CG12.
kCLOCK_Lpuart7 CCGR5, CG13.
kCLOCK_SnvsHp CCGR5, CG14.

kCLOCK_SnvsLp CCGR5, CG15.
kCLOCK_UsbOh3 CCGR6, CG0.
kCLOCK_Usdhc1 CCGR6, CG1.
kCLOCK_Usdhc2 CCGR6, CG2.
kCLOCK_Dcdc CCGR6, CG3.
kCLOCK_Ipmux4 CCGR6, CG4.
kCLOCK_FlexSpi CCGR6, CG5.
kCLOCK_Trng CCGR6, CG6.
kCLOCK_Lpuart8 CCGR6, CG7.
kCLOCK_Timer4 CCGR6, CG8.
kCLOCK_Aips_tz3 CCGR6, CG9.
kCLOCK_SimPer CCGR6, CG10.
kCLOCK_Anadig CCGR6, CG11.
kCLOCK_Lpi2c4 CCGR6, CG12.
kCLOCK_Timer1 CCGR6, CG13.
kCLOCK_Timer2 CCGR6, CG14.

4.4.3 enum clock_osc_t

Enumerator

kCLOCK_RcOsc On chip OSC.
kCLOCK_XtalOsc 24M Xtal OSC

4.4.4 enum clock_gate_value_t

Enumerator

kCLOCK_ClockNotNeeded Clock is off during all modes.
kCLOCK_ClockNeededRun Clock is on in run mode, but off in WAIT and STOP modes.
kCLOCK_ClockNeededRunWait Clock is on during all modes, except STOP mode.

4.4.5 enum clock_mode_t

Enumerator

kCLOCK_ModeRun Remain in run mode.
kCLOCK_ModeWait Transfer to wait mode.
kCLOCK_ModeStop Transfer to stop mode.

4.4.6 enum clock_mux_t

These constants define the mux control names for clock mux setting.

- 0:7: REG offset to CCM_BASE in bytes.
- 8:15: Root clock setting bit field shift.
- 16:31: Root clock setting bit field width.

Enumerator

kCLOCK_Pll3SwMux pll3_sw_clk mux name
kCLOCK_PeriphMux periph mux name
kCLOCK_SemcAltMux semc mux name
kCLOCK_SemcMux semc mux name
kCLOCK_PrePeriphMux pre-periph mux name
kCLOCK_TraceMux trace mux name
kCLOCK_PeriphClk2Mux periph clock2 mux name
kCLOCK_LpspiMux lpspi mux name
kCLOCK_FlexspiMux flexspi mux name
kCLOCK_Usdhc2Mux usdhc2 mux name
kCLOCK_Usdhc1Mux usdhc1 mux name
kCLOCK_Sai3Mux sai3 mux name
kCLOCK_Sai2Mux sai2 mux name
kCLOCK_Sai1Mux sai1 mux name
kCLOCK_PerclkMux perclk mux name
kCLOCK_Flexio1Mux flexio1 mux name
kCLOCK_CanMux can mux name
kCLOCK_UartMux uart mux name
kCLOCK_SpdifMux spdif mux name
kCLOCK_Lpi2cMux lpi2c mux name

4.4.7 enum clock_div_t

These constants define div control names for clock div setting.

- 0:7: REG offset to CCM_BASE in bytes.
- 8:15: Root clock setting bit field shift.
- 16:31: Root clock setting bit field width.

Enumerator

kCLOCK_ArmDiv core div name
kCLOCK_PeriphClk2Div periph clock2 div name
kCLOCK_SemcDiv semc div name
kCLOCK_AhbDiv ahb div name

kCLOCK_IpgDiv ipg div name
kCLOCK_LpspiDiv lpspi div name
kCLOCK_FlexspiDiv flexspi div name
kCLOCK_PerclkDiv perclk div name
kCLOCK_CanDiv can div name
kCLOCK_TraceDiv trace div name
kCLOCK_Usdhc2Div usdhc2 div name
kCLOCK_Usdhc1Div usdhc1 div name
kCLOCK_UartDiv uart div name
kCLOCK_Flexio1Div flexio1 pre div name
kCLOCK_Sai3PreDiv sai3 pre div name
kCLOCK_Sai3Div sai3 div name
kCLOCK_Flexio1PreDiv flexio1 pre div name
kCLOCK_Sai1PreDiv sai1 pre div name
kCLOCK_Sai1Div sai1 div name
kCLOCK_Sai2PreDiv sai2 pre div name
kCLOCK_Sai2Div sai2 div name
kCLOCK_Spdif0PreDiv spdif pre div name
kCLOCK_Spdif0Div spdif div name
kCLOCK_Lpi2cDiv lpi2c div name
kCLOCK_NonePreDiv None Pre div.

4.4.8 enum clock_div_value_t

Enumerator

kCLOCK_ArmDivBy1 ARM clock divider set to divided by 1.
kCLOCK_ArmDivBy2 ARM clock divider set to divided by 2.
kCLOCK_ArmDivBy3 ARM clock divider set to divided by 3.
kCLOCK_ArmDivBy4 ARM clock divider set to divided by 4.
kCLOCK_ArmDivBy5 ARM clock divider set to divided by 5.
kCLOCK_ArmDivBy6 ARM clock divider set to divided by 6.
kCLOCK_ArmDivBy7 ARM clock divider set to divided by 7.
kCLOCK_ArmDivBy8 ARM clock divider set to divided by 8.
kCLOCK_PeriphClk2DivBy1 PeriphClk2 divider set to divided by 1.
kCLOCK_PeriphClk2DivBy2 PeriphClk2 divider set to divided by 2.
kCLOCK_PeriphClk2DivBy3 PeriphClk2 divider set to divided by 3.
kCLOCK_PeriphClk2DivBy4 PeriphClk2 divider set to divided by 4.
kCLOCK_PeriphClk2DivBy5 PeriphClk2 divider set to divided by 5.
kCLOCK_PeriphClk2DivBy6 PeriphClk2 divider set to divided by 6.
kCLOCK_PeriphClk2DivBy7 PeriphClk2 divider set to divided by 7.
kCLOCK_PeriphClk2DivBy8 PeriphClk2 divider set to divided by 8.
kCLOCK_SemcDivBy1 SEMC divider set to divided by 1.
kCLOCK_SemcDivBy2 SEMC divider set to divided by 2.

kCLOCK_SemcDivBy3 SEMC divider set to divided by 3.
kCLOCK_SemcDivBy4 SEMC divider set to divided by 4.
kCLOCK_SemcDivBy5 SEMC divider set to divided by 5.
kCLOCK_SemcDivBy6 SEMC divider set to divided by 6.
kCLOCK_SemcDivBy7 SEMC divider set to divided by 7.
kCLOCK_SemcDivBy8 SEMC divider set to divided by 8.
kCLOCK_AhbDivBy1 AHB divider set to divided by 1.
kCLOCK_AhbDivBy2 AHB divider set to divided by 2.
kCLOCK_AhbDivBy3 AHB divider set to divided by 3.
kCLOCK_AhbDivBy4 AHB divider set to divided by 4.
kCLOCK_AhbDivBy5 AHB divider set to divided by 5.
kCLOCK_AhbDivBy6 AHB divider set to divided by 6.
kCLOCK_AhbDivBy7 AHB divider set to divided by 7.
kCLOCK_AhbDivBy8 AHB divider set to divided by 8.
kCLOCK_IpgDivBy1 Ipg divider set to divided by 1.
kCLOCK_IpgDivBy2 Ipg divider set to divided by 2.
kCLOCK_IpgDivBy3 Ipg divider set to divided by 3.
kCLOCK_IpgDivBy4 Ipg divider set to divided by 4.
kCLOCK_LpspiDivBy1 LPSPI divider set to divided by 1.
kCLOCK_LpspiDivBy2 LPSPI divider set to divided by 2.
kCLOCK_LpspiDivBy3 LPSPI divider set to divided by 3.
kCLOCK_LpspiDivBy4 LPSPI divider set to divided by 4.
kCLOCK_LpspiDivBy5 LPSPI divider set to divided by 5.
kCLOCK_LpspiDivBy6 LPSPI divider set to divided by 6.
kCLOCK_LpspiDivBy7 LPSPI divider set to divided by 7.
kCLOCK_LpspiDivBy8 LPSPI divider set to divided by 8.
kCLOCK_FlexspiDivBy1 FLEXSPI divider set to divided by 1.
kCLOCK_FlexspiDivBy2 FLEXSPI divider set to divided by 2.
kCLOCK_FlexspiDivBy3 FLEXSPI divider set to divided by 3.
kCLOCK_FlexspiDivBy4 FLEXSPI divider set to divided by 4.
kCLOCK_FlexspiDivBy5 FLEXSPI divider set to divided by 5.
kCLOCK_FlexspiDivBy6 FLEXSPI divider set to divided by 6.
kCLOCK_FlexspiDivBy7 FLEXSPI divider set to divided by 7.
kCLOCK_FlexspiDivBy8 FLEXSPI divider set to divided by 8.
kCLOCK_TraceDivBy1 TRACE divider set to divided by 1.
kCLOCK_TraceDivBy2 TRACE divider set to divided by 2.
kCLOCK_TraceDivBy3 TRACE divider set to divided by 3.
kCLOCK_TraceDivBy4 TRACE divider set to divided by 4.
kCLOCK_Usdhc2DivBy1 USDHC2 divider set to divided by 1.
kCLOCK_Usdhc2DivBy2 USDHC2 divider set to divided by 2.
kCLOCK_Usdhc2DivBy3 USDHC2 divider set to divided by 3.
kCLOCK_Usdhc2DivBy4 USDHC2 divider set to divided by 4.
kCLOCK_Usdhc2DivBy5 USDHC2 divider set to divided by 5.
kCLOCK_Usdhc2DivBy6 USDHC2 divider set to divided by 6.
kCLOCK_Usdhc2DivBy7 USDHC2 divider set to divided by 7.

<i>kCLOCK_Usdhc2DivBy8</i>	USDHC2 divider set to divided by 8.
<i>kCLOCK_Usdhc1DivBy1</i>	USDHC1 divider set to divided by 1.
<i>kCLOCK_Usdhc1DivBy2</i>	USDHC1 divider set to divided by 2.
<i>kCLOCK_Usdhc1DivBy3</i>	USDHC1 divider set to divided by 3.
<i>kCLOCK_Usdhc1DivBy4</i>	USDHC1 divider set to divided by 4.
<i>kCLOCK_Usdhc1DivBy5</i>	USDHC1 divider set to divided by 5.
<i>kCLOCK_Usdhc1DivBy6</i>	USDHC1 divider set to divided by 6.
<i>kCLOCK_Usdhc1DivBy7</i>	USDHC1 divider set to divided by 7.
<i>kCLOCK_Usdhc1DivBy8</i>	USDHC1 divider set to divided by 8.
<i>kCLOCK_Flexio1DivBy1</i>	Flexio1 divider set to divided by 1.
<i>kCLOCK_Flexio1DivBy2</i>	Flexio1 divider set to divided by 2.
<i>kCLOCK_Flexio1DivBy3</i>	Flexio1 divider set to divided by 3.
<i>kCLOCK_Flexio1DivBy4</i>	Flexio1 divider set to divided by 4.
<i>kCLOCK_Flexio1DivBy5</i>	Flexio1 divider set to divided by 5.
<i>kCLOCK_Flexio1DivBy6</i>	Flexio1 divider set to divided by 6.
<i>kCLOCK_Flexio1DivBy7</i>	Flexio1 divider set to divided by 7.
<i>kCLOCK_Flexio1DivBy8</i>	Flexio1 divider set to divided by 8.
<i>kCLOCK_Sai3PreDivBy1</i>	SAI3ClkPred divider set to divided by 1.
<i>kCLOCK_Sai3PreDivBy2</i>	SAI3ClkPred divider set to divided by 2.
<i>kCLOCK_Sai3PreDivBy3</i>	SAI3ClkPred divider set to divided by 3.
<i>kCLOCK_Sai3PreDivBy4</i>	SAI3ClkPred divider set to divided by 4.
<i>kCLOCK_Sai3PreDivBy5</i>	SAI3ClkPred divider set to divided by 5.
<i>kCLOCK_Sai3PreDivBy6</i>	SAI3ClkPred divider set to divided by 6.
<i>kCLOCK_Sai3PreDivBy7</i>	SAI3ClkPred divider set to divided by 7.
<i>kCLOCK_Sai3PreDivBy8</i>	SAI3ClkPred divider set to divided by 8.
<i>kCLOCK_Flexio1PreDivBy1</i>	Flexio1 pred divider set to divided by 1.
<i>kCLOCK_Flexio1PreDivBy2</i>	Flexio1 pred divider set to divided by 2.
<i>kCLOCK_Flexio1PreDivBy3</i>	Flexio1 pred divider set to divided by 3.
<i>kCLOCK_Flexio1PreDivBy4</i>	Flexio1 pred divider set to divided by 4.
<i>kCLOCK_Flexio1PreDivBy5</i>	Flexio1 pred divider set to divided by 5.
<i>kCLOCK_Flexio1PreDivBy6</i>	Flexio1 pred divider set to divided by 6.
<i>kCLOCK_Flexio1PreDivBy7</i>	Flexio1 pred divider set to divided by 7.
<i>kCLOCK_Flexio1PreDivBy8</i>	Flexio1 pred divider set to divided by 8.
<i>kCLOCK_Sai1PreDivBy1</i>	SAI1 pred divider set to divided by 1.
<i>kCLOCK_Sai1PreDivBy2</i>	SAI1 pred divider set to divided by 2.
<i>kCLOCK_Sai1PreDivBy3</i>	SAI1 pred divider set to divided by 3.
<i>kCLOCK_Sai1PreDivBy4</i>	SAI1 pred divider set to divided by 4.
<i>kCLOCK_Sai1PreDivBy5</i>	SAI1 pred divider set to divided by 5.
<i>kCLOCK_Sai1PreDivBy6</i>	SAI1 pred divider set to divided by 6.
<i>kCLOCK_Sai1PreDivBy7</i>	SAI1 pred divider set to divided by 7.
<i>kCLOCK_Sai1PreDivBy8</i>	SAI1 pred divider set to divided by 8.
<i>kCLOCK_Sai2PreDivBy1</i>	SAI2ClkPred divider set to divided by 1.
<i>kCLOCK_Sai2PreDivBy2</i>	SAI2ClkPred divider set to divided by 2.
<i>kCLOCK_Sai2PreDivBy3</i>	SAI2ClkPred divider set to divided by 3.
<i>kCLOCK_Sai2PreDivBy4</i>	SAI2ClkPred divider set to divided by 4.

- kCLOCK_Sai2PreDivBy5* SAI2ClkPred divider set to divided by 5.
- kCLOCK_Sai2PreDivBy6* SAI2ClkPred divider set to divided by 6.
- kCLOCK_Sai2PreDivBy7* SAI2ClkPred divider set to divided by 7.
- kCLOCK_Sai2PreDivBy8* SAI2ClkPred divider set to divided by 8.
- kCLOCK_Spdif0PreDivBy1* SPDIF0ClkPred divider set to divided by 1.
- kCLOCK_Spdif0PreDivBy2* SPDIF0ClkPred divider set to divided by 2.
- kCLOCK_Spdif0PreDivBy3* SPDIF0ClkPred divider set to divided by 3.
- kCLOCK_Spdif0PreDivBy4* SPDIF0ClkPred divider set to divided by 4.
- kCLOCK_Spdif0PreDivBy5* SPDIF0ClkPred divider set to divided by 5.
- kCLOCK_Spdif0PreDivBy6* SPDIF0ClkPred divider set to divided by 6.
- kCLOCK_Spdif0PreDivBy7* SPDIF0ClkPred divider set to divided by 7.
- kCLOCK_Spdif0PreDivBy8* SPDIF0ClkPred divider set to divided by 8.
- kCLOCK_Spdif0DivBy1* SPDIF0ClkPodf divider set to divided by 1.
- kCLOCK_Spdif0DivBy2* SPDIF0ClkPodf divider set to divided by 2.
- kCLOCK_Spdif0DivBy3* SPDIF0ClkPodf divider set to divided by 3.
- kCLOCK_Spdif0DivBy4* SPDIF0ClkPodf divider set to divided by 4.
- kCLOCK_Spdif0DivBy5* SPDIF0ClkPodf divider set to divided by 5.
- kCLOCK_Spdif0DivBy6* SPDIF0ClkPodf divider set to divided by 6.
- kCLOCK_Spdif0DivBy7* SPDIF0ClkPodf divider set to divided by 7.
- kCLOCK_Spdif0DivBy8* SPDIF0ClkPodf divider set to divided by 8.
- kCLOCK_MiscDivBy1* Misc divider like LPI2C set to divided by 1.
- kCLOCK_MiscDivBy2* Misc divider like LPI2C set to divided by 2.
- kCLOCK_MiscDivBy3* Misc divider like LPI2C set to divided by 3.
- kCLOCK_MiscDivBy4* Misc divider like LPI2C set to divided by 4.
- kCLOCK_MiscDivBy5* Misc divider like LPI2C set to divided by 5.
- kCLOCK_MiscDivBy6* Misc divider like LPI2C set to divided by 6.
- kCLOCK_MiscDivBy7* Misc divider like LPI2C set to divided by 7.
- kCLOCK_MiscDivBy8* Misc divider like LPI2C set to divided by 8.
- kCLOCK_MiscDivBy9* Misc divider like LPI2C set to divided by 9.
- kCLOCK_MiscDivBy10* Misc divider like LPI2C set to divided by 10.
- kCLOCK_MiscDivBy11* Misc divider like LPI2C set to divided by 11.
- kCLOCK_MiscDivBy12* Misc divider like LPI2C set to divided by 12.
- kCLOCK_MiscDivBy13* Misc divider like LPI2C set to divided by 13.
- kCLOCK_MiscDivBy14* Misc divider like LPI2C set to divided by 14.
- kCLOCK_MiscDivBy15* Misc divider like LPI2C set to divided by 15.
- kCLOCK_MiscDivBy16* Misc divider like LPI2C set to divided by 16.
- kCLOCK_MiscDivBy17* Misc divider like LPI2C set to divided by 17.
- kCLOCK_MiscDivBy18* Misc divider like LPI2C set to divided by 18.
- kCLOCK_MiscDivBy19* Misc divider like LPI2C set to divided by 19.
- kCLOCK_MiscDivBy20* Misc divider like LPI2C set to divided by 20.
- kCLOCK_MiscDivBy21* Misc divider like LPI2C set to divided by 21.
- kCLOCK_MiscDivBy22* Misc divider like LPI2C set to divided by 22.
- kCLOCK_MiscDivBy23* Misc divider like LPI2C set to divided by 23.
- kCLOCK_MiscDivBy24* Misc divider like LPI2C set to divided by 24.
- kCLOCK_MiscDivBy25* Misc divider like LPI2C set to divided by 25.

<i>kCLOCK_MiscDivBy26</i>	Misc divider like LPI2C set to divided by 26.
<i>kCLOCK_MiscDivBy27</i>	Misc divider like LPI2C set to divided by 27.
<i>kCLOCK_MiscDivBy28</i>	Misc divider like LPI2C set to divided by 28.
<i>kCLOCK_MiscDivBy29</i>	Misc divider like LPI2C set to divided by 29.
<i>kCLOCK_MiscDivBy30</i>	Misc divider like LPI2C set to divided by 30.
<i>kCLOCK_MiscDivBy31</i>	Misc divider like LPI2C set to divided by 31.
<i>kCLOCK_MiscDivBy32</i>	Misc divider like LPI2C set to divided by 32.
<i>kCLOCK_MiscDivBy33</i>	Misc divider like LPI2C set to divided by 33.
<i>kCLOCK_MiscDivBy34</i>	Misc divider like LPI2C set to divided by 34.
<i>kCLOCK_MiscDivBy35</i>	Misc divider like LPI2C set to divided by 35.
<i>kCLOCK_MiscDivBy36</i>	Misc divider like LPI2C set to divided by 36.
<i>kCLOCK_MiscDivBy37</i>	Misc divider like LPI2C set to divided by 37.
<i>kCLOCK_MiscDivBy38</i>	Misc divider like LPI2C set to divided by 38.
<i>kCLOCK_MiscDivBy39</i>	Misc divider like LPI2C set to divided by 39.
<i>kCLOCK_MiscDivBy40</i>	Misc divider like LPI2C set to divided by 40.
<i>kCLOCK_MiscDivBy41</i>	Misc divider like LPI2C set to divided by 41.
<i>kCLOCK_MiscDivBy42</i>	Misc divider like LPI2C set to divided by 42.
<i>kCLOCK_MiscDivBy43</i>	Misc divider like LPI2C set to divided by 43.
<i>kCLOCK_MiscDivBy44</i>	Misc divider like LPI2C set to divided by 44.
<i>kCLOCK_MiscDivBy45</i>	Misc divider like LPI2C set to divided by 45.
<i>kCLOCK_MiscDivBy46</i>	Misc divider like LPI2C set to divided by 46.
<i>kCLOCK_MiscDivBy47</i>	Misc divider like LPI2C set to divided by 47.
<i>kCLOCK_MiscDivBy48</i>	Misc divider like LPI2C set to divided by 48.
<i>kCLOCK_MiscDivBy49</i>	Misc divider like LPI2C set to divided by 49.
<i>kCLOCK_MiscDivBy50</i>	Misc divider like LPI2C set to divided by 50.
<i>kCLOCK_MiscDivBy51</i>	Misc divider like LPI2C set to divided by 51.
<i>kCLOCK_MiscDivBy52</i>	Misc divider like LPI2C set to divided by 52.
<i>kCLOCK_MiscDivBy53</i>	Misc divider like LPI2C set to divided by 53.
<i>kCLOCK_MiscDivBy54</i>	Misc divider like LPI2C set to divided by 54.
<i>kCLOCK_MiscDivBy55</i>	Misc divider like LPI2C set to divided by 55.
<i>kCLOCK_MiscDivBy56</i>	Misc divider like LPI2C set to divided by 56.
<i>kCLOCK_MiscDivBy57</i>	Misc divider like LPI2C set to divided by 57.
<i>kCLOCK_MiscDivBy58</i>	Misc divider like LPI2C set to divided by 58.
<i>kCLOCK_MiscDivBy59</i>	Misc divider like LPI2C set to divided by 59.
<i>kCLOCK_MiscDivBy60</i>	Misc divider like LPI2C set to divided by 60.
<i>kCLOCK_MiscDivBy61</i>	Misc divider like LPI2C set to divided by 61.
<i>kCLOCK_MiscDivBy62</i>	Misc divider like LPI2C set to divided by 62.
<i>kCLOCK_MiscDivBy63</i>	Misc divider like LPI2C set to divided by 63.
<i>kCLOCK_MiscDivBy64</i>	Misc divider like LPI2C set to divided by 64.

4.4.9 enum clock_usb_src_t

Enumerator

kCLOCK_Usb480M Use 480M.

kCLOCK_UsbSrcUnused Used when the function does not care the clock source.

4.4.10 enum clock_usb_phy_src_t

Enumerator

kCLOCK_Usbphy480M Use 480M.

4.4.11 enum _clock_pll_clk_src

Enumerator

kCLOCK_PllClkSrc24M Pll clock source 24M.

kCLOCK_PllSrcClkPN Pll clock source CLK1_P and CLK1_N.

4.4.12 enum clock_pll_t

Enumerator

kCLOCK_PllSys PLL SYS.

kCLOCK_PllUsb1 PLL USB1.

kCLOCK_PllAudio PLL Audio.

kCLOCK_PllEnet PLL Enet0.

kCLOCK_PllEnet500M PLL ENET.

kCLOCK_PllEnet25M PLL Enet1.

4.4.13 enum clock_pfd_t

Enumerator

kCLOCK_Pfd0 PLL PFD0.

kCLOCK_Pfd1 PLL PFD1.

kCLOCK_Pfd2 PLL PFD2.

kCLOCK_Pfd3 PLL PFD3.

4.4.14 enum clock_output1_selection_t

Enumerator

kCLOCK_OutputPllUsb1Sw Selects USB1 PLL SW clock(Divided by 2) output.
kCLOCK_OutputPllSys Selects SYS PLL clock(Divided by 2) output.
kCLOCK_OutputPllENET500M Selects ENET PLL clock(Divided by 2) output.
kCLOCK_OutputSemcClk Selects semc clock root output.
kCLOCK_OutputAhbClk Selects AHB clock root output.
kCLOCK_OutputIpgClk Selects IPG clock root output.
kCLOCK_OutputPerClk Selects PERCLK clock root output.
kCLOCK_OutputPll4MainClk Selects PLL4 main clock output.
kCLOCK_DisableClockOutput1 Disables CLK01.

4.4.15 enum clock_output2_selection_t

Enumerator

kCLOCK_OutputUsdhc1Clk Selects USDHC1 clock root output.
kCLOCK_OutputLpi2cClk Selects LPI2C clock root output.
kCLOCK_OutputOscClk Selects OSC output.
kCLOCK_OutputLpspiClk Selects LPSPI clock root output.
kCLOCK_OutputUsdhc2Clk Selects USDHC2 clock root output.
kCLOCK_OutputSai1Clk Selects SAI1 clock root output.
kCLOCK_OutputSai2Clk Selects SAI2 clock root output.
kCLOCK_OutputSai3Clk Selects SAI3 clock root output.
kCLOCK_OutputTraceClk Selects Trace clock root output.
kCLOCK_OutputCanClk Selects CAN clock root output.
kCLOCK_OutputFlexspiClk Selects FLEXSPI clock root output.
kCLOCK_OutputUartClk Selects UART clock root output.
kCLOCK_OutputSpdif0Clk Selects SPDIF0 clock root output.
kCLOCK_DisableClockOutput2 Disables CLK02.

4.4.16 enum clock_output_divider_t

Enumerator

kCLOCK_DivideBy1 Output clock divided by 1.
kCLOCK_DivideBy2 Output clock divided by 2.
kCLOCK_DivideBy3 Output clock divided by 3.
kCLOCK_DivideBy4 Output clock divided by 4.
kCLOCK_DivideBy5 Output clock divided by 5.
kCLOCK_DivideBy6 Output clock divided by 6.

kCLOCK_DivideBy7 Output clock divided by 7.

kCLOCK_DivideBy8 Output clock divided by 8.

4.4.17 enum clock_root_t

Enumerator

kCLOCK_Usdhc1ClkRoot USDHC1 clock root.

kCLOCK_Usdhc2ClkRoot USDHC2 clock root.

kCLOCK_FlexspiClkRoot FLEXSPI clock root.

kCLOCK_LpspiClkRoot LPSPI clock root.

kCLOCK_TraceClkRoot Trace clock root.

kCLOCK_Sai1ClkRoot SAI1 clock root.

kCLOCK_Sai2ClkRoot SAI2 clock root.

kCLOCK_Sai3ClkRoot SAI3 clock root.

kCLOCK_Lpi2cClkRoot LPI2C clock root.

kCLOCK_CanClkRoot CAN clock root.

kCLOCK_UartClkRoot UART clock root.

kCLOCK_SpdifClkRoot SPDIF clock root.

kCLOCK_Flexio1ClkRoot FLEXIO1 clock root.

4.5 Function Documentation

4.5.1 static void CLOCK_SetMux (clock_mux_t mux, uint32_t value) [inline], [static]

Parameters

<i>mux</i>	Which mux node to set, see clock_mux_t .
<i>value</i>	Clock mux value to set, different mux has different value range.

4.5.2 static uint32_t CLOCK_GetMux (clock_mux_t mux) [inline], [static]

Parameters

<i>mux</i>	Which mux node to get, see clock_mux_t .
------------	--

Returns

Clock mux value.

4.5.3 static void CLOCK_SetDiv (clock_div_t *divider*, uint32_t *value*) [inline], [static]

Example, set the ARM clock divider to divide by 2:

```
CLOCK_SetDiv(kCLOCK_ArmDiv, kCLOCK_ArmDivBy2);
```

Example, set the LPI2C clock divider to divide by 5.

```
CLOCK_SetDiv(kCLOCK_Lpi2cDiv, kCLOCK_MiscDivBy5);
```

Only [kCLOCK_PerclkDiv](#), [kCLOCK_CanDiv](#), [kCLOCK_UartDiv](#), [kCLOCK_Sai3Div](#), [kCLOCK_Sai1-Div](#), [kCLOCK_Sai2Div](#), [kCLOCK_Lpi2cDiv](#) can use the divider [kCLOCK_MiscDivByxxx](#).

Parameters

<i>divider</i>	Which divider node to set.
<i>value</i>	Clock div value to set, different divider has different value range. See clock_div_value_t for details. Divided clock frequency = Undivided clock frequency / (value + 1)

4.5.4 static uint32_t CLOCK_GetDiv (clock_div_t *divider*) [inline], [static]

Parameters

<i>divider</i>	Which div node to get, see clock_div_t .
----------------	--

4.5.5 static void CLOCK_ControlGate (clock_ip_name_t *name*, clock_gate_value_t *value*) [inline], [static]

Parameters

<i>name</i>	Which clock to enable, see clock_ip_name_t .
-------------	--

<i>value</i>	Clock gate value to set, see clock_gate_value_t .
--------------	---

4.5.6 **static void CLOCK_EnableClock (clock_ip_name_t name) [inline], [static]**

Parameters

<i>name</i>	Which clock to enable, see clock_ip_name_t .
-------------	--

4.5.7 **static void CLOCK_DisableClock (clock_ip_name_t name) [inline], [static]**

Parameters

<i>name</i>	Which clock to disable, see clock_ip_name_t .
-------------	---

4.5.8 **static void CLOCK_SetMode (clock_mode_t mode) [inline], [static]**

Parameters

<i>mode</i>	Which mode to enter, see clock_mode_t .
-------------	---

4.5.9 **static uint32_t CLOCK_GetOscFreq (void) [inline], [static]**

This function will return the external XTAL OSC frequency if it is selected as the source of OSC, otherwise internal 24MHz RC OSC frequency will be returned.

Returns

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

4.5.10 **uint32_t CLOCK_GetAhbFreq (void)**

Returns

The AHB clock frequency value in hertz.

4.5.11 uint32_t CLOCK_GetSemcFreq (void)

Returns

The SEMC clock frequency value in hertz.

4.5.12 uint32_t CLOCK_GetIpgFreq (void)

Returns

The IPG clock frequency value in hertz.

4.5.13 uint32_t CLOCK_GetPerClkFreq (void)

Returns

The PER clock frequency value in hertz.

4.5.14 uint32_t CLOCK_GetFreq (clock_name_t *name*)

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

Parameters

<i>name</i>	Clock names defined in <code>clock_name_t</code>
-------------	--

Returns

Clock frequency value in hertz

4.5.15 static uint32_t CLOCK_GetCpuClkFreq (void) [inline], [static]

Returns

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

4.5.16 uint32_t CLOCK_GetClockRootFreq (clock_root_t *clockRoot*)

Parameters

<i>clockRoot</i>	The clock root used to get the frequency, please refer to clock_root_t .
------------------	--

Returns

The frequency of selected clock root.

4.5.17 void CLOCK_InitExternalClk (bool *bypassXtalOsc*)

This function supports two modes:

1. Use external crystal oscillator.
2. Bypass the external crystal oscillator, using input source clock directly.

After this function, please call `CLOCK_SetXtal0Freq` to inform clock driver the external clock frequency.

Parameters

<i>bypassXtalOsc</i>	Pass in true to bypass the external crystal oscillator.
----------------------	---

Note

This device does not support bypass external crystal oscillator, so the input parameter should always be false.

4.5.18 void CLOCK_DeinitExternalClk (void)

This function disables the external 24MHz clock.

After this function, please call `CLOCK_SetXtal0Freq` to set external clock frequency to 0.

4.5.19 void CLOCK_SwitchOsc (clock_osc_t *osc*)

This function switches the OSC source for SoC.

Parameters

<i>osc</i>	OSC source to switch to.
------------	--------------------------

4.5.20 static uint32_t CLOCK_GetRtcFreq (void) [inline], [static]

Returns

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

4.5.21 static void CLOCK_SetXtalFreq (uint32_t freq) [inline], [static]

Parameters

<i>freq</i>	The XTAL input clock frequency in Hz.
-------------	---------------------------------------

4.5.22 static void CLOCK_SetRtcXtalFreq (uint32_t freq) [inline], [static]

Parameters

<i>freq</i>	The RTC XTAL input clock frequency in Hz.
-------------	---

4.5.23 bool CLOCK_EnableUsbhs0Clock (clock_usb_src_t src, uint32_t freq)

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

Parameters

<i>src</i>	USB HS does not care about the clock source, here must be <code>kCLOCK_UsbSrc_Used</code> .
<i>freq</i>	USB HS does not care about the clock source, so this parameter is ignored.

Return values

<i>true</i>	The clock is set successfully.
<i>false</i>	The clock source is invalid to get proper USB HS clock.

4.6 Variable Documentation**4.6.1 volatile uint32_t g_xtalFreq**

The XTAL (24M OSC/SYSOSC) clock frequency in Hz, when the clock is setup, use the function `CLOCK_SetXtalFreq` to set the value in to clock driver. For example, if XTAL is 24MHz,

```
* CLOCK_InitExternalClk(false);  
* CLOCK_SetXtalFreq(24000000);  
*
```

4.6.2 volatile uint32_t g_rtcXtalFreq

The RTC XTAL (32K OSC) clock frequency in Hz, when the clock is setup, use the function `CLOCK_SetRtcXtalFreq` to set the value in to clock driver.

Chapter 5

ROMAPI Driver

The ROMAPI driver provides the functionalities to operate the external NOR Flash connected to the FLEXSPI controller.

The ROMAPI driver supports:

- Initialize serial NOR flash via FLEXSPI
- Program data to serial NOR flash via FLEXSPI.
- Erase serial NOR flash region via FLEXSPI.

Chapter 6

IOMUXC: IOMUX Controller

6.1 Overview

IOMUXC driver provides APIs for pin configuration. It also supports the miscellaneous functions integrated in IOMUXC.

Files

- file [fsl_iomuxc.h](#)

Driver version

- #define `FSL_IOMUXC_DRIVER_VERSION` (`MAKE_VERSION(2, 0, 2)`)
IOMUXC driver version 2.0.2.

Pin function ID

The pin function ID is a tuple of <muxRegister muxMode inputRegister inputDaisy configRegister>

- #define `IOMUXC_GPIO_EMC_00_SEMC_DATA00` 0x401F8014U, 0x0U, 0, 0, 0x401F8188U
- #define `IOMUXC_GPIO_EMC_00_QTIMER2_TIMER0` 0x401F8014U, 0x1U, 0x401F8420U, 0x0U, 0x401F8188U
- #define `IOMUXC_GPIO_EMC_00_LPUART4_CTS_B` 0x401F8014U, 0x2U, 0x401F83E0U, 0x0U, 0x401F8188U
- #define `IOMUXC_GPIO_EMC_00_SPDIF_SR_CLK` 0x401F8014U, 0x3U, 0, 0, 0x401F8188U
- #define `IOMUXC_GPIO_EMC_00_LPSPI2_SCK` 0x401F8014U, 0x4U, 0, 0, 0x401F8188U
- #define `IOMUXC_GPIO_EMC_00_GPIO2_IO00` 0x401F8014U, 0x5U, 0, 0, 0x401F8188U
- #define `IOMUXC_GPIO_EMC_00_FLEXCAN1_TX` 0x401F8014U, 0x6U, 0, 0, 0x401F8188U
- #define `IOMUXC_GPIO_EMC_00_PIT_TRIGGER02` 0x401F8014U, 0x7U, 0, 0, 0x401F8188U
- #define `IOMUXC_GPIO_EMC_01_SEMC_DATA01` 0x401F8018U, 0x0U, 0, 0, 0x401F818CU
- #define `IOMUXC_GPIO_EMC_01_QTIMER2_TIMER1` 0x401F8018U, 0x1U, 0x401F8424U, 0x0U, 0x401F818CU
- #define `IOMUXC_GPIO_EMC_01_LPUART4_RTS_B` 0x401F8018U, 0x2U, 0, 0, 0x401F818CU
- #define `IOMUXC_GPIO_EMC_01_SPDIF_OUT` 0x401F8018U, 0x3U, 0, 0, 0x401F818CU
- #define `IOMUXC_GPIO_EMC_01_LPSPI2_PCS0` 0x401F8018U, 0x4U, 0x401F83ACU, 0x0U, 0x401F818CU
- #define `IOMUXC_GPIO_EMC_01_GPIO2_IO01` 0x401F8018U, 0x5U, 0, 0, 0x401F818CU
- #define `IOMUXC_GPIO_EMC_01_FLEXCAN1_RX` 0x401F8018U, 0x6U, 0x401F8320U, 0x0U, 0x401F818CU
- #define `IOMUXC_GPIO_EMC_01_PIT_TRIGGER03` 0x401F8018U, 0x7U, 0, 0, 0x401F818CU
- #define `IOMUXC_GPIO_EMC_02_SEMC_DATA02` 0x401F801CU, 0x0U, 0, 0, 0x401F8190U
- #define `IOMUXC_GPIO_EMC_02_QTIMER2_TIMER2` 0x401F801CU, 0x1U, 0x401F8428U, 0x0U, 0x401F8190U

- #define **IOMUXC_GPIO_EMC_02_LPUART4_TX** 0x401F801CU, 0x2U, 0x401F83E8U, 0x0U, 0x401F8190U
- #define **IOMUXC_GPIO_EMC_02_SPDIF_LOCK** 0x401F801CU, 0x3U, 0, 0, 0x401F8190U
- #define **IOMUXC_GPIO_EMC_02_LPSPI2_SDO** 0x401F801CU, 0x4U, 0x401F83B8U, 0x0U, 0x401F8190U
- #define **IOMUXC_GPIO_EMC_02_GPIO2_IO02** 0x401F801CU, 0x5U, 0, 0, 0x401F8190U
- #define **IOMUXC_GPIO_EMC_02_LPI2C1_SCL** 0x401F801CU, 0x6U, 0x401F837CU, 0x0U, 0x401F8190U
- #define **IOMUXC_GPIO_EMC_03_SEMC_DATA03** 0x401F8020U, 0x0U, 0, 0, 0x401F8194U
- #define **IOMUXC_GPIO_EMC_03_QTIMER2_TIMER3** 0x401F8020U, 0x1U, 0x401F842CU, 0x0U, 0x401F8194U
- #define **IOMUXC_GPIO_EMC_03_LPUART4_RX** 0x401F8020U, 0x2U, 0x401F83E4U, 0x0U, 0x401F8194U
- #define **IOMUXC_GPIO_EMC_03_SPDIF_EXT_CLK** 0x401F8020U, 0x3U, 0, 0, 0x401F8194U
- #define **IOMUXC_GPIO_EMC_03_LPSPI2_SDI** 0x401F8020U, 0x4U, 0x401F83B4U, 0x0U, 0x401F8194U
- #define **IOMUXC_GPIO_EMC_03_GPIO2_IO03** 0x401F8020U, 0x5U, 0, 0, 0x401F8194U
- #define **IOMUXC_GPIO_EMC_03_LPI2C1_SDA** 0x401F8020U, 0x6U, 0x401F8380U, 0x0U, 0x401F8194U
- #define **IOMUXC_GPIO_EMC_04_SEMC_DATA04** 0x401F8024U, 0x0U, 0, 0, 0x401F8198U
- #define **IOMUXC_GPIO_EMC_04_XBAR1_INOUT04** 0x401F8024U, 0x1U, 0, 0, 0x401F8198U
- #define **IOMUXC_GPIO_EMC_04_SPDIF_OUT** 0x401F8024U, 0x2U, 0, 0, 0x401F8198U
- #define **IOMUXC_GPIO_EMC_04_SAI2_TX_BCLK** 0x401F8024U, 0x3U, 0x401F8464U, 0x1U, 0x401F8198U
- #define **IOMUXC_GPIO_EMC_04_FLEXIO1_FLEXIO16** 0x401F8024U, 0x4U, 0, 0, 0x401F8198U
- #define **IOMUXC_GPIO_EMC_04_GPIO2_IO04** 0x401F8024U, 0x5U, 0, 0, 0x401F8198U
- #define **IOMUXC_GPIO_EMC_05_SEMC_DATA05** 0x401F8028U, 0x0U, 0, 0, 0x401F819CU
- #define **IOMUXC_GPIO_EMC_05_XBAR1_INOUT05** 0x401F8028U, 0x1U, 0, 0, 0x401F819CU
- #define **IOMUXC_GPIO_EMC_05_SPDIF_IN** 0x401F8028U, 0x2U, 0x401F8488U, 0x0U, 0x401F819CU
- #define **IOMUXC_GPIO_EMC_05_SAI2_TX_SYNC** 0x401F8028U, 0x3U, 0x401F8468U, 0x1U, 0x401F819CU
- #define **IOMUXC_GPIO_EMC_05_FLEXIO1_FLEXIO17** 0x401F8028U, 0x4U, 0, 0, 0x401F819CU
- #define **IOMUXC_GPIO_EMC_05_GPIO2_IO05** 0x401F8028U, 0x5U, 0, 0, 0x401F819CU
- #define **IOMUXC_GPIO_EMC_06_SEMC_DATA06** 0x401F802CU, 0x0U, 0, 0, 0x401F81A0U
- #define **IOMUXC_GPIO_EMC_06_XBAR1_INOUT06** 0x401F802CU, 0x1U, 0, 0, 0x401F81A0U
- #define **IOMUXC_GPIO_EMC_06_LPUART3_TX** 0x401F802CU, 0x2U, 0x401F83DCU, 0x0U, 0x401F81A0U
- #define **IOMUXC_GPIO_EMC_06_SAI2_TX_DATA** 0x401F802CU, 0x3U, 0, 0, 0x401F81A0U
- #define **IOMUXC_GPIO_EMC_06_FLEXIO1_FLEXIO18** 0x401F802CU, 0x4U, 0, 0, 0x401F81A0U
- #define **IOMUXC_GPIO_EMC_06_GPIO2_IO06** 0x401F802CU, 0x5U, 0, 0, 0x401F81A0U
- #define **IOMUXC_GPIO_EMC_07_SEMC_DATA07** 0x401F8030U, 0x0U, 0, 0, 0x401F81A4U
- #define **IOMUXC_GPIO_EMC_07_XBAR1_INOUT07** 0x401F8030U, 0x1U, 0, 0, 0x401F81A4U

- A4U
- #define **IOMUXC_GPIO_EMC_07_LPUART3_RX** 0x401F8030U, 0x2U, 0x401F83D8U, 0x0U, 0x401F81A4U
- #define **IOMUXC_GPIO_EMC_07_SAI2_RX_SYNC** 0x401F8030U, 0x3U, 0x401F8460U, 0x1U, 0x401F81A4U
- #define **IOMUXC_GPIO_EMC_07_FLEXIO1_FLEXIO19** 0x401F8030U, 0x4U, 0, 0, 0x401F81A4U
- #define **IOMUXC_GPIO_EMC_07_GPIO2_IO07** 0x401F8030U, 0x5U, 0, 0, 0x401F81A4U
- #define **IOMUXC_GPIO_EMC_08_SEMC_DM00** 0x401F8034U, 0x0U, 0, 0, 0x401F81A8U
- #define **IOMUXC_GPIO_EMC_08_XBAR1_INOUT08** 0x401F8034U, 0x1U, 0, 0, 0x401F81A8U
- #define **IOMUXC_GPIO_EMC_08_FLEXCAN2_TX** 0x401F8034U, 0x2U, 0, 0, 0x401F81A8U
- #define **IOMUXC_GPIO_EMC_08_SAI2_RX_DATA** 0x401F8034U, 0x3U, 0x401F845CU, 0x1U, 0x401F81A8U
- #define **IOMUXC_GPIO_EMC_08_FLEXIO1_FLEXIO20** 0x401F8034U, 0x4U, 0, 0, 0x401F81A8U
- #define **IOMUXC_GPIO_EMC_08_GPIO2_IO08** 0x401F8034U, 0x5U, 0, 0, 0x401F81A8U
- #define **IOMUXC_GPIO_EMC_09_SEMC_WE** 0x401F8038U, 0x0U, 0, 0, 0x401F81ACU
- #define **IOMUXC_GPIO_EMC_09_XBAR1_INOUT09** 0x401F8038U, 0x1U, 0, 0, 0x401F81ACU
- #define **IOMUXC_GPIO_EMC_09_FLEXCAN2_RX** 0x401F8038U, 0x2U, 0x401F8324U, 0x1U, 0x401F81ACU
- #define **IOMUXC_GPIO_EMC_09_SAI2_RX_BCLK** 0x401F8038U, 0x3U, 0x401F8458U, 0x1U, 0x401F81ACU
- #define **IOMUXC_GPIO_EMC_09_FLEXIO1_FLEXIO21** 0x401F8038U, 0x4U, 0, 0, 0x401F81ACU
- #define **IOMUXC_GPIO_EMC_09_GPIO2_IO09** 0x401F8038U, 0x5U, 0, 0, 0x401F81ACU
- #define **IOMUXC_GPIO_EMC_10_SEMC_CAS** 0x401F803CU, 0x0U, 0, 0, 0x401F81B0U
- #define **IOMUXC_GPIO_EMC_10_XBAR1_INOUT10** 0x401F803CU, 0x1U, 0x401F84B0U, 0x0U, 0x401F81B0U
- #define **IOMUXC_GPIO_EMC_10_LPI2C4_SDA** 0x401F803CU, 0x2U, 0x401F8398U, 0x0U, 0x401F81B0U
- #define **IOMUXC_GPIO_EMC_10_SAI1_TX_SYNC** 0x401F803CU, 0x3U, 0x401F8450U, 0x0U, 0x401F81B0U
- #define **IOMUXC_GPIO_EMC_10_LPSPI2_SCK** 0x401F803CU, 0x4U, 0, 0, 0x401F81B0U
- #define **IOMUXC_GPIO_EMC_10_GPIO2_IO10** 0x401F803CU, 0x5U, 0, 0, 0x401F81B0U
- #define **IOMUXC_GPIO_EMC_10_FLEXPWM2_PWMX00** 0x401F803CU, 0x6U, 0, 0, 0x401F81B0U
- #define **IOMUXC_GPIO_EMC_11_SEMC_RAS** 0x401F8040U, 0x0U, 0, 0, 0x401F81B4U
- #define **IOMUXC_GPIO_EMC_11_XBAR1_INOUT11** 0x401F8040U, 0x1U, 0, 0, 0x401F81B4U
- #define **IOMUXC_GPIO_EMC_11_LPI2C4_SCL** 0x401F8040U, 0x2U, 0x401F8394U, 0x0U, 0x401F81B4U
- #define **IOMUXC_GPIO_EMC_11_SAI1_TX_BCLK** 0x401F8040U, 0x3U, 0x401F844CU, 0x0U, 0x401F81B4U
- #define **IOMUXC_GPIO_EMC_11_LPSPI2_PCS0** 0x401F8040U, 0x4U, 0x401F83ACU, 0x1U, 0x401F81B4U
- #define **IOMUXC_GPIO_EMC_11_GPIO2_IO11** 0x401F8040U, 0x5U, 0, 0, 0x401F81B4U
- #define **IOMUXC_GPIO_EMC_11_FLEXPWM2_PWMX01** 0x401F8040U, 0x6U, 0, 0, 0x401F81B4U
- #define **IOMUXC_GPIO_EMC_12_SEMC_CS0** 0x401F8044U, 0x0U, 0, 0, 0x401F81B8U

- #define **IOMUXC_GPIO_EMC_12_XBAR1_INOUT12** 0x401F8044U, 0x1U, 0x401F84B4U, 0x0U, 0x401F81B8U
- #define **IOMUXC_GPIO_EMC_12_LPUART6_TX** 0x401F8044U, 0x2U, 0x401F83F8U, 0x0U, 0x401F81B8U
- #define **IOMUXC_GPIO_EMC_12_SAI1_TX_DATA00** 0x401F8044U, 0x3U, 0, 0, 0x401F81B8U
- #define **IOMUXC_GPIO_EMC_12_LPSPI2_SDO** 0x401F8044U, 0x4U, 0x401F83B8U, 0x1U, 0x401F81B8U
- #define **IOMUXC_GPIO_EMC_12_GPIO2_IO12** 0x401F8044U, 0x5U, 0, 0, 0x401F81B8U
- #define **IOMUXC_GPIO_EMC_12_FLEXPWM2_PWMX02** 0x401F8044U, 0x6U, 0, 0, 0x401F81B8U
- #define **IOMUXC_GPIO_EMC_13_SEMC_BA0** 0x401F8048U, 0x0U, 0, 0, 0x401F81BCU
- #define **IOMUXC_GPIO_EMC_13_XBAR1_INOUT13** 0x401F8048U, 0x1U, 0x401F84B8U, 0x0U, 0x401F81BCU
- #define **IOMUXC_GPIO_EMC_13_LPUART6_RX** 0x401F8048U, 0x2U, 0x401F83F4U, 0x0U, 0x401F81BCU
- #define **IOMUXC_GPIO_EMC_13_SAI1_RX_DATA00** 0x401F8048U, 0x3U, 0x401F8438U, 0x0U, 0x401F81BCU
- #define **IOMUXC_GPIO_EMC_13_LPSPI2_SDI** 0x401F8048U, 0x4U, 0x401F83B4U, 0x1U, 0x401F81BCU
- #define **IOMUXC_GPIO_EMC_13_GPIO2_IO13** 0x401F8048U, 0x5U, 0, 0, 0x401F81BCU
- #define **IOMUXC_GPIO_EMC_13_FLEXPWM2_PWMX03** 0x401F8048U, 0x6U, 0, 0, 0x401F81BCU
- #define **IOMUXC_GPIO_EMC_13_CCM_PMIC_RDY** 0x401F8048U, 0x7U, 0x401F8300U, 0x0U, 0x401F81BCU
- #define **IOMUXC_GPIO_EMC_14_SEMC_BA1** 0x401F804CU, 0x0U, 0, 0, 0x401F81C0U
- #define **IOMUXC_GPIO_EMC_14_XBAR1_INOUT14** 0x401F804CU, 0x1U, 0x401F84A0U, 0x1U, 0x401F81C0U
- #define **IOMUXC_GPIO_EMC_14_LPUART6_CTS_B** 0x401F804CU, 0x2U, 0, 0, 0x401F81C0U
- #define **IOMUXC_GPIO_EMC_14_SAI1_RX_BCLK** 0x401F804CU, 0x3U, 0x401F8434U, 0x1U, 0x401F81C0U
- #define **IOMUXC_GPIO_EMC_14_LPSPI2_PCS1** 0x401F804CU, 0x4U, 0, 0, 0x401F81C0U
- #define **IOMUXC_GPIO_EMC_14_GPIO2_IO14** 0x401F804CU, 0x5U, 0, 0, 0x401F81C0U
- #define **IOMUXC_GPIO_EMC_14_FLEXCAN1_TX** 0x401F804CU, 0x6U, 0, 0, 0x401F81C0U
- #define **IOMUXC_GPIO_EMC_15_SEMC_ADDR10** 0x401F8050U, 0x0U, 0, 0, 0x401F81C4U
- #define **IOMUXC_GPIO_EMC_15_XBAR1_INOUT15** 0x401F8050U, 0x1U, 0x401F84A4U, 0x1U, 0x401F81C4U
- #define **IOMUXC_GPIO_EMC_15_LPUART6_RTS_B** 0x401F8050U, 0x2U, 0, 0, 0x401F81C4U
- #define **IOMUXC_GPIO_EMC_15_SAI1_RX_SYNC** 0x401F8050U, 0x3U, 0x401F8448U, 0x1U, 0x401F81C4U
- #define **IOMUXC_GPIO_EMC_15_WDOG1_B** 0x401F8050U, 0x4U, 0, 0, 0x401F81C4U
- #define **IOMUXC_GPIO_EMC_15_GPIO2_IO15** 0x401F8050U, 0x5U, 0, 0, 0x401F81C4U
- #define **IOMUXC_GPIO_EMC_15_FLEXCAN1_RX** 0x401F8050U, 0x6U, 0x401F8320U, 0x3U, 0x401F81C4U
- #define **IOMUXC_GPIO_EMC_16_SEMC_ADDR00** 0x401F8054U, 0x0U, 0, 0, 0x401F81C8U
- #define **IOMUXC_GPIO_EMC_16_MQS_RIGHT** 0x401F8054U, 0x2U, 0, 0, 0x401F81C8U
- #define **IOMUXC_GPIO_EMC_16_SAI2_MCLK** 0x401F8054U, 0x3U, 0x401F8454U, 0x1U, 0x401F81C8U
- #define **IOMUXC_GPIO_EMC_16_GPIO2_IO16** 0x401F8054U, 0x5U, 0, 0, 0x401F81C8U

- #define **IOMUXC_GPIO_EMC_16_SRC_BOOT_MODE00** 0x401F8054U, 0x6U, 0, 0, 0x401F81C8U
- #define **IOMUXC_GPIO_EMC_17_SEMC_ADDR01** 0x401F8058U, 0x0U, 0, 0, 0x401F81CCU
- #define **IOMUXC_GPIO_EMC_17_MQS_LEFT** 0x401F8058U, 0x2U, 0, 0, 0x401F81CCU
- #define **IOMUXC_GPIO_EMC_17_SAI3_MCLK** 0x401F8058U, 0x3U, 0x401F846CU, 0x1U, 0x401F81CCU
- #define **IOMUXC_GPIO_EMC_17_GPIO2_IO17** 0x401F8058U, 0x5U, 0, 0, 0x401F81CCU
- #define **IOMUXC_GPIO_EMC_17_SRC_BOOT_MODE01** 0x401F8058U, 0x6U, 0, 0, 0x401F81CCU
- #define **IOMUXC_GPIO_EMC_18_SEMC_ADDR02** 0x401F805CU, 0x0U, 0, 0, 0x401F81D0U
- #define **IOMUXC_GPIO_EMC_18_XBAR1_INOUT16** 0x401F805CU, 0x1U, 0x401F84A8U, 0x1U, 0x401F81D0U
- #define **IOMUXC_GPIO_EMC_18_LPI2C2_SDA** 0x401F805CU, 0x2U, 0x401F8388U, 0x1U, 0x401F81D0U
- #define **IOMUXC_GPIO_EMC_18_SAI1_RX_SYNC** 0x401F805CU, 0x3U, 0x401F8448U, 0x2U, 0x401F81D0U
- #define **IOMUXC_GPIO_EMC_18_FLEXIO1_FLEXIO22** 0x401F805CU, 0x4U, 0, 0, 0x401F81D0U
- #define **IOMUXC_GPIO_EMC_18_GPIO2_IO18** 0x401F805CU, 0x5U, 0, 0, 0x401F81D0U
- #define **IOMUXC_GPIO_EMC_18_SRC_BT_CFG00** 0x401F805CU, 0x6U, 0, 0, 0x401F81D0U
- #define **IOMUXC_GPIO_EMC_19_SEMC_ADDR03** 0x401F8060U, 0x0U, 0, 0, 0x401F81D4U
- #define **IOMUXC_GPIO_EMC_19_XBAR1_INOUT17** 0x401F8060U, 0x1U, 0x401F84ACU, 0x1U, 0x401F81D4U
- #define **IOMUXC_GPIO_EMC_19_LPI2C2_SCL** 0x401F8060U, 0x2U, 0x401F8384U, 0x1U, 0x401F81D4U
- #define **IOMUXC_GPIO_EMC_19_SAI1_RX_BCLK** 0x401F8060U, 0x3U, 0x401F8434U, 0x2U, 0x401F81D4U
- #define **IOMUXC_GPIO_EMC_19_FLEXIO1_FLEXIO23** 0x401F8060U, 0x4U, 0, 0, 0x401F81D4U
- #define **IOMUXC_GPIO_EMC_19_GPIO2_IO19** 0x401F8060U, 0x5U, 0, 0, 0x401F81D4U
- #define **IOMUXC_GPIO_EMC_19_SRC_BT_CFG01** 0x401F8060U, 0x6U, 0, 0, 0x401F81D4U
- #define **IOMUXC_GPIO_EMC_20_SEMC_ADDR04** 0x401F8064U, 0x0U, 0, 0, 0x401F81D8U
- #define **IOMUXC_GPIO_EMC_20_FLEXPWM1_PWMA03** 0x401F8064U, 0x1U, 0x401F8334U, 0x1U, 0x401F81D8U
- #define **IOMUXC_GPIO_EMC_20_LPUART2_CTS_B** 0x401F8064U, 0x2U, 0x401F83CCU, 0x1U, 0x401F81D8U
- #define **IOMUXC_GPIO_EMC_20_SAI1_MCLK** 0x401F8064U, 0x3U, 0x401F8430U, 0x3U, 0x401F81D8U
- #define **IOMUXC_GPIO_EMC_20_FLEXIO1_FLEXIO24** 0x401F8064U, 0x4U, 0, 0, 0x401F81D8U
- #define **IOMUXC_GPIO_EMC_20_GPIO2_IO20** 0x401F8064U, 0x5U, 0, 0, 0x401F81D8U
- #define **IOMUXC_GPIO_EMC_20_SRC_BT_CFG02** 0x401F8064U, 0x6U, 0, 0, 0x401F81D8U
- #define **IOMUXC_GPIO_EMC_21_SEMC_ADDR05** 0x401F8068U, 0x0U, 0, 0, 0x401F81DCU
- #define **IOMUXC_GPIO_EMC_21_FLEXPWM1_PWMB03** 0x401F8068U, 0x1U, 0x401F8344U, 0x1U, 0x401F81DCU
- #define **IOMUXC_GPIO_EMC_21_LPUART2_RTS_B** 0x401F8068U, 0x2U, 0, 0, 0x401F81DCU

- DCU
- #define **IOMUXC_GPIO_EMC_21_SAI1_RX_DATA00** 0x401F8068U, 0x3U, 0x401F8438U, 0x2U, 0x401F81DCU
 - #define **IOMUXC_GPIO_EMC_21_FLEXIO1_FLEXIO25** 0x401F8068U, 0x4U, 0, 0, 0x401F81DCU
 - #define **IOMUXC_GPIO_EMC_21_GPIO2_IO21** 0x401F8068U, 0x5U, 0, 0, 0x401F81DCU
 - #define **IOMUXC_GPIO_EMC_21_SRC_BT_CFG03** 0x401F8068U, 0x6U, 0, 0, 0x401F81DCU
 - #define **IOMUXC_GPIO_EMC_22_SEMC_ADDR06** 0x401F806CU, 0x0U, 0, 0, 0x401F81E0U
 - #define **IOMUXC_GPIO_EMC_22_FLEXPWM1_PWMA02** 0x401F806CU, 0x1U, 0x401F8330U, 0x1U, 0x401F81E0U
 - #define **IOMUXC_GPIO_EMC_22_LPUART2_TX** 0x401F806CU, 0x2U, 0x401F83D4U, 0x1U, 0x401F81E0U
 - #define **IOMUXC_GPIO_EMC_22_SAI1_TX_DATA03** 0x401F806CU, 0x3U, 0x401F843CU, 0x1U, 0x401F81E0U
 - #define **IOMUXC_GPIO_EMC_22_FLEXIO1_FLEXIO26** 0x401F806CU, 0x4U, 0, 0, 0x401F81E0U
 - #define **IOMUXC_GPIO_EMC_22_GPIO2_IO22** 0x401F806CU, 0x5U, 0, 0, 0x401F81E0U
 - #define **IOMUXC_GPIO_EMC_22_SRC_BT_CFG04** 0x401F806CU, 0x6U, 0, 0, 0x401F81E0U
 - #define **IOMUXC_GPIO_EMC_23_SEMC_ADDR07** 0x401F8070U, 0x0U, 0, 0, 0x401F81E4U
 - #define **IOMUXC_GPIO_EMC_23_FLEXPWM1_PWMB02** 0x401F8070U, 0x1U, 0x401F8340U, 0x1U, 0x401F81E4U
 - #define **IOMUXC_GPIO_EMC_23_LPUART2_RX** 0x401F8070U, 0x2U, 0x401F83D0U, 0x1U, 0x401F81E4U
 - #define **IOMUXC_GPIO_EMC_23_SAI1_TX_DATA02** 0x401F8070U, 0x3U, 0x401F8440U, 0x1U, 0x401F81E4U
 - #define **IOMUXC_GPIO_EMC_23_FLEXIO1_FLEXIO27** 0x401F8070U, 0x4U, 0, 0, 0x401F81E4U
 - #define **IOMUXC_GPIO_EMC_23_GPIO2_IO23** 0x401F8070U, 0x5U, 0, 0, 0x401F81E4U
 - #define **IOMUXC_GPIO_EMC_23_SRC_BT_CFG05** 0x401F8070U, 0x6U, 0, 0, 0x401F81E4U
 - #define **IOMUXC_GPIO_EMC_24_SEMC_ADDR08** 0x401F8074U, 0x0U, 0, 0, 0x401F81E8U
 - #define **IOMUXC_GPIO_EMC_24_FLEXPWM1_PWMA01** 0x401F8074U, 0x1U, 0x401F832CU, 0x1U, 0x401F81E8U
 - #define **IOMUXC_GPIO_EMC_24_LPUART8_CTS_B** 0x401F8074U, 0x2U, 0, 0, 0x401F81E8U
 - #define **IOMUXC_GPIO_EMC_24_SAI1_TX_DATA01** 0x401F8074U, 0x3U, 0x401F8444U, 0x1U, 0x401F81E8U
 - #define **IOMUXC_GPIO_EMC_24_FLEXIO1_FLEXIO28** 0x401F8074U, 0x4U, 0, 0, 0x401F81E8U
 - #define **IOMUXC_GPIO_EMC_24_GPIO2_IO24** 0x401F8074U, 0x5U, 0, 0, 0x401F81E8U
 - #define **IOMUXC_GPIO_EMC_24_SRC_BT_CFG06** 0x401F8074U, 0x6U, 0, 0, 0x401F81E8U
 - #define **IOMUXC_GPIO_EMC_25_SEMC_ADDR09** 0x401F8078U, 0x0U, 0, 0, 0x401F81ECU
 - #define **IOMUXC_GPIO_EMC_25_FLEXPWM1_PWMB01** 0x401F8078U, 0x1U, 0x401F833CU, 0x1U, 0x401F81ECU
 - #define **IOMUXC_GPIO_EMC_25_LPUART8_RTS_B** 0x401F8078U, 0x2U, 0, 0, 0x401F81ECU
 - #define **IOMUXC_GPIO_EMC_25_SAI1_TX_DATA00** 0x401F8078U, 0x3U, 0, 0, 0x401F81ECU
 - #define **IOMUXC_GPIO_EMC_25_FLEXIO1_FLEXIO29** 0x401F8078U, 0x4U, 0, 0, 0x401F81ECU

- #define **IOMUXC_GPIO_EMC_25_GPIO2_IO25** 0x401F8078U, 0x5U, 0, 0, 0x401F81ECU
- #define **IOMUXC_GPIO_EMC_25_SRC_BT_CFG07** 0x401F8078U, 0x6U, 0, 0, 0x401F81ECU
- #define **IOMUXC_GPIO_EMC_26_SEMC_ADDR11** 0x401F807CU, 0x0U, 0, 0, 0x401F81F0U
- #define **IOMUXC_GPIO_EMC_26_FLEXPWM1_PWMA00** 0x401F807CU, 0x1U, 0x401F8328U, 0x1U, 0x401F81F0U
- #define **IOMUXC_GPIO_EMC_26_LPUART8_TX** 0x401F807CU, 0x2U, 0x401F8408U, 0x1U, 0x401F81F0U
- #define **IOMUXC_GPIO_EMC_26_SAI1_TX_BCLK** 0x401F807CU, 0x3U, 0x401F844CU, 0x2U, 0x401F81F0U
- #define **IOMUXC_GPIO_EMC_26_FLEXIO1_FLEXIO30** 0x401F807CU, 0x4U, 0, 0, 0x401F81F0U
- #define **IOMUXC_GPIO_EMC_26_GPIO2_IO26** 0x401F807CU, 0x5U, 0, 0, 0x401F81F0U
- #define **IOMUXC_GPIO_EMC_26_SRC_BT_CFG08** 0x401F807CU, 0x6U, 0, 0, 0x401F81F0U
- #define **IOMUXC_GPIO_EMC_27_SEMC_ADDR12** 0x401F8080U, 0x0U, 0, 0, 0x401F81F4U
- #define **IOMUXC_GPIO_EMC_27_FLEXPWM1_PWMB00** 0x401F8080U, 0x1U, 0x401F8338U, 0x1U, 0x401F81F4U
- #define **IOMUXC_GPIO_EMC_27_LPUART8_RX** 0x401F8080U, 0x2U, 0x401F8404U, 0x1U, 0x401F81F4U
- #define **IOMUXC_GPIO_EMC_27_SAI1_TX_SYNC** 0x401F8080U, 0x3U, 0x401F8450U, 0x2U, 0x401F81F4U
- #define **IOMUXC_GPIO_EMC_27_FLEXIO1_FLEXIO31** 0x401F8080U, 0x4U, 0, 0, 0x401F81F4U
- #define **IOMUXC_GPIO_EMC_27_GPIO2_IO27** 0x401F8080U, 0x5U, 0, 0, 0x401F81F4U
- #define **IOMUXC_GPIO_EMC_27_SRC_BT_CFG09** 0x401F8080U, 0x6U, 0, 0, 0x401F81F4U
- #define **IOMUXC_GPIO_EMC_28_SEMC_DQS** 0x401F8084U, 0x0U, 0, 0, 0x401F81F8U
- #define **IOMUXC_GPIO_EMC_28_FLEXPWM2_PWMA03** 0x401F8084U, 0x1U, 0x401F8354U, 0x1U, 0x401F81F8U
- #define **IOMUXC_GPIO_EMC_28_XBAR1_INOUT18** 0x401F8084U, 0x2U, 0x401F84BCU, 0x0U, 0x401F81F8U
- #define **IOMUXC_GPIO_EMC_28_SAI3_MCLK** 0x401F8084U, 0x3U, 0x401F846CU, 0x2U, 0x401F81F8U
- #define **IOMUXC_GPIO_EMC_28_EWM_OUT_B** 0x401F8084U, 0x4U, 0, 0, 0x401F81F8U
- #define **IOMUXC_GPIO_EMC_28_GPIO2_IO28** 0x401F8084U, 0x5U, 0, 0, 0x401F81F8U
- #define **IOMUXC_GPIO_EMC_28_GPT2_CAPTURE2** 0x401F8084U, 0x6U, 0, 0, 0x401F81F8U
- #define **IOMUXC_GPIO_EMC_28_FLEXPWM1_PWMX00** 0x401F8084U, 0x7U, 0, 0, 0x401F81F8U
- #define **IOMUXC_GPIO_EMC_29_SEMC_CKE** 0x401F8088U, 0x0U, 0, 0, 0x401F81FCU
- #define **IOMUXC_GPIO_EMC_29_FLEXPWM2_PWMB03** 0x401F8088U, 0x1U, 0x401F8364U, 0x1U, 0x401F81FCU
- #define **IOMUXC_GPIO_EMC_29_XBAR1_INOUT19** 0x401F8088U, 0x2U, 0x401F84C0U, 0x0U, 0x401F81FCU
- #define **IOMUXC_GPIO_EMC_29_SAI3_RX_BCLK** 0x401F8088U, 0x3U, 0x401F8470U, 0x1U, 0x401F81FCU
- #define **IOMUXC_GPIO_EMC_29_WDOG2_RST_B_DEB** 0x401F8088U, 0x4U, 0, 0, 0x401F81FCU
- #define **IOMUXC_GPIO_EMC_29_GPIO2_IO29** 0x401F8088U, 0x5U, 0, 0, 0x401F81FCU
- #define **IOMUXC_GPIO_EMC_29_GPT2_COMPARE2** 0x401F8088U, 0x6U, 0, 0, 0x401F81FCU

- #define **IOMUXC_GPIO_EMC_29_FLEXPWM1_PWMX01** 0x401F8088U, 0x7U, 0, 0, 0x401F81FCU
- #define **IOMUXC_GPIO_EMC_30_SEMC_CLK** 0x401F808CU, 0x0U, 0, 0, 0x401F8200U
- #define **IOMUXC_GPIO_EMC_30_FLEXPWM2_PWMA02** 0x401F808CU, 0x1U, 0x401F8350U, 0x1U, 0x401F8200U
- #define **IOMUXC_GPIO_EMC_30_LPUART4_CTS_B** 0x401F808CU, 0x2U, 0x401F83E0U, 0x1U, 0x401F8200U
- #define **IOMUXC_GPIO_EMC_30_SAI3_RX_SYNC** 0x401F808CU, 0x3U, 0x401F8478U, 0x1U, 0x401F8200U
- #define **IOMUXC_GPIO_EMC_30_WDOG1_RST_B_DEB** 0x401F808CU, 0x4U, 0, 0, 0x401F8200U
- #define **IOMUXC_GPIO_EMC_30_GPIO2_IO30** 0x401F808CU, 0x5U, 0, 0, 0x401F8200U
- #define **IOMUXC_GPIO_EMC_30_GPT2_COMPARE3** 0x401F808CU, 0x6U, 0, 0, 0x401F8200U
- #define **IOMUXC_GPIO_EMC_30_FLEXPWM1_PWMX02** 0x401F808CU, 0x7U, 0, 0, 0x401F8200U
- #define **IOMUXC_GPIO_EMC_31_SEMC_DM01** 0x401F8090U, 0x0U, 0, 0, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_31_FLEXPWM2_PWMB02** 0x401F8090U, 0x1U, 0x401F8360U, 0x1U, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_31_LPUART4_RTS_B** 0x401F8090U, 0x2U, 0, 0, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_31_SAI3_RX_DATA** 0x401F8090U, 0x3U, 0x401F8474U, 0x1U, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_31_WDOG2_B** 0x401F8090U, 0x4U, 0, 0, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_31_GPIO2_IO31** 0x401F8090U, 0x5U, 0, 0, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_31_GPT2_CLK** 0x401F8090U, 0x6U, 0, 0, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_31_FLEXPWM1_PWMX03** 0x401F8090U, 0x7U, 0, 0, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_32_SEMC_DATA08** 0x401F8094U, 0x0U, 0, 0, 0x401F8208U
- #define **IOMUXC_GPIO_EMC_32_QTIMER1_TIMER0** 0x401F8094U, 0x1U, 0x401F8410U, 0x1U, 0x401F8208U
- #define **IOMUXC_GPIO_EMC_32_LPUART4_TX** 0x401F8094U, 0x2U, 0x401F83E8U, 0x2U, 0x401F8208U
- #define **IOMUXC_GPIO_EMC_32_SAI3_TX_DATA** 0x401F8094U, 0x3U, 0, 0, 0x401F8208U
- #define **IOMUXC_GPIO_EMC_32_LPSPi4_SCK** 0x401F8094U, 0x4U, 0x401F83C0U, 0x1U, 0x401F8208U
- #define **IOMUXC_GPIO_EMC_32_GPIO3_IO00** 0x401F8094U, 0x5U, 0, 0, 0x401F8208U
- #define **IOMUXC_GPIO_EMC_32_REF_24M_OUT** 0x401F8094U, 0x7U, 0, 0, 0x401F8208U
- #define **IOMUXC_GPIO_EMC_33_SEMC_DATA09** 0x401F8098U, 0x0U, 0, 0, 0x401F820CU
- #define **IOMUXC_GPIO_EMC_33_QTIMER1_TIMER1** 0x401F8098U, 0x1U, 0x401F8414U, 0x1U, 0x401F820CU
- #define **IOMUXC_GPIO_EMC_33_LPUART4_RX** 0x401F8098U, 0x2U, 0x401F83E4U, 0x2U, 0x401F820CU
- #define **IOMUXC_GPIO_EMC_33_SAI3_TX_BCLK** 0x401F8098U, 0x3U, 0x401F847CU, 0x1U, 0x401F820CU
- #define **IOMUXC_GPIO_EMC_33_LPSPi4_PCS0** 0x401F8098U, 0x4U, 0x401F83BCU, 0x1U, 0x401F820CU
- #define **IOMUXC_GPIO_EMC_33_GPIO3_IO01** 0x401F8098U, 0x5U, 0, 0, 0x401F820CU
- #define **IOMUXC_GPIO_EMC_34_SEMC_DATA10** 0x401F809CU, 0x0U, 0, 0, 0x401F8210U
- #define **IOMUXC_GPIO_EMC_34_QTIMER1_TIMER2** 0x401F809CU, 0x1U, 0x401F8418U, 0x1U, 0x401F8210U

- #define **IOMUXC_GPIO_EMC_34_LPUART7_TX** 0x401F809CU, 0x2U, 0x401F8400U, 0x1-U, 0x401F8210U
- #define **IOMUXC_GPIO_EMC_34_SAI3_TX_SYNC** 0x401F809CU, 0x3U, 0x401F8480U, 0x1U, 0x401F8210U
- #define **IOMUXC_GPIO_EMC_34_LPSPi4_SDO** 0x401F809CU, 0x4U, 0x401F83C8U, 0x1U, 0x401F8210U
- #define **IOMUXC_GPIO_EMC_34_GPIO3_IO02** 0x401F809CU, 0x5U, 0, 0, 0x401F8210U
- #define **IOMUXC_GPIO_EMC_34_ENET_CRs** 0x401F809CU, 0x6U, 0, 0, 0x401F8210U
- #define **IOMUXC_GPIO_EMC_35_SEMC_DATA11** 0x401F80A0U, 0x0U, 0, 0, 0x401F8214U
- #define **IOMUXC_GPIO_EMC_35_QTIMER1_TIMER3** 0x401F80A0U, 0x1U, 0x401F841C-U, 0x1U, 0x401F8214U
- #define **IOMUXC_GPIO_EMC_35_LPUART7_RX** 0x401F80A0U, 0x2U, 0x401F83FCU, 0x1-U, 0x401F8214U
- #define **IOMUXC_GPIO_EMC_35_USDHC2_WP** 0x401F80A0U, 0x3U, 0x401F849CU, 0x1U, 0x401F8214U
- #define **IOMUXC_GPIO_EMC_35_LPSPi4_SDI** 0x401F80A0U, 0x4U, 0x401F83C4U, 0x1U, 0x401F8214U
- #define **IOMUXC_GPIO_EMC_35_GPIO3_IO03** 0x401F80A0U, 0x5U, 0, 0, 0x401F8214U
- #define **IOMUXC_GPIO_EMC_35_ENET_COL** 0x401F80A0U, 0x6U, 0, 0, 0x401F8214U
- #define **IOMUXC_GPIO_EMC_36_SEMC_DATA12** 0x401F80A4U, 0x0U, 0, 0, 0x401F8218U
- #define **IOMUXC_GPIO_EMC_36_FLEXPWM2_PWMA01** 0x401F80A4U, 0x1U, 0x401-F834CU, 0x1U, 0x401F8218U
- #define **IOMUXC_GPIO_EMC_36_LPUART5_CTS_B** 0x401F80A4U, 0x2U, 0, 0, 0x401-F8218U
- #define **IOMUXC_GPIO_EMC_36_CCM_PMIC_RDY** 0x401F80A4U, 0x3U, 0x401F8300U, 0x3U, 0x401F8218U
- #define **IOMUXC_GPIO_EMC_36_LPSPi4_PCS1** 0x401F80A4U, 0x4U, 0, 0, 0x401F8218U
- #define **IOMUXC_GPIO_EMC_36_GPIO3_IO04** 0x401F80A4U, 0x5U, 0, 0, 0x401F8218U
- #define **IOMUXC_GPIO_EMC_36_ENET_RX_CLK** 0x401F80A4U, 0x6U, 0, 0, 0x401F8218U
- #define **IOMUXC_GPIO_EMC_36_USDHC1_WP** 0x401F80A4U, 0x7U, 0x401F8494U, 0x4U, 0x401F8218U
- #define **IOMUXC_GPIO_EMC_37_SEMC_DATA13** 0x401F80A8U, 0x0U, 0, 0, 0x401F821CU
- #define **IOMUXC_GPIO_EMC_37_FLEXPWM2_PWMB01** 0x401F80A8U, 0x1U, 0x401-F835CU, 0x1U, 0x401F821CU
- #define **IOMUXC_GPIO_EMC_37_LPUART5_RTS_B** 0x401F80A8U, 0x2U, 0, 0, 0x401F821-CU
- #define **IOMUXC_GPIO_EMC_37_MQS_RIGHT** 0x401F80A8U, 0x3U, 0, 0, 0x401F821CU
- #define **IOMUXC_GPIO_EMC_37_LPSPi4_PCS2** 0x401F80A8U, 0x4U, 0, 0, 0x401F821CU
- #define **IOMUXC_GPIO_EMC_37_GPIO3_IO05** 0x401F80A8U, 0x5U, 0, 0, 0x401F821CU
- #define **IOMUXC_GPIO_EMC_37_ENET_RDATA03** 0x401F80A8U, 0x6U, 0, 0, 0x401F821-CU
- #define **IOMUXC_GPIO_EMC_37_USDHC1_VSELECT** 0x401F80A8U, 0x7U, 0, 0, 0x401-F821CU
- #define **IOMUXC_GPIO_EMC_38_SEMC_DATA14** 0x401F80ACU, 0x0U, 0, 0, 0x401F8220U
- #define **IOMUXC_GPIO_EMC_38_FLEXPWM2_PWMA00** 0x401F80ACU, 0x1U, 0x401-F8348U, 0x1U, 0x401F8220U
- #define **IOMUXC_GPIO_EMC_38_LPUART5_TX** 0x401F80ACU, 0x2U, 0x401F83F0U, 0x1-U, 0x401F8220U
- #define **IOMUXC_GPIO_EMC_38_MQS_LEFT** 0x401F80ACU, 0x3U, 0, 0, 0x401F8220U
- #define **IOMUXC_GPIO_EMC_38_LPSPi4_PCS3** 0x401F80ACU, 0x4U, 0, 0, 0x401F8220U
- #define **IOMUXC_GPIO_EMC_38_GPIO3_IO06** 0x401F80ACU, 0x5U, 0, 0, 0x401F8220U
- #define **IOMUXC_GPIO_EMC_38_ENET_RDATA02** 0x401F80ACU, 0x6U, 0, 0, 0x401-

- F8220U
- #define **IOMUXC_GPIO_EMC_38_USDHC1_CD_B** 0x401F80ACU, 0x7U, 0x401F8490U, 0x3U, 0x401F8220U
 - #define **IOMUXC_GPIO_EMC_39_SEMC_DATA15** 0x401F80B0U, 0x0U, 0, 0, 0x401F8224U
 - #define **IOMUXC_GPIO_EMC_39_FLEXPWM2_PWMB00** 0x401F80B0U, 0x1U, 0x401F8358U, 0x1U, 0x401F8224U
 - #define **IOMUXC_GPIO_EMC_39_LPUART5_RX** 0x401F80B0U, 0x2U, 0x401F83ECU, 0x1U, 0x401F8224U
 - #define **IOMUXC_GPIO_EMC_39_USB_OTG1_OC** 0x401F80B0U, 0x3U, 0x401F848CU, 0x2U, 0x401F8224U
 - #define **IOMUXC_GPIO_EMC_39_WDOG1_B** 0x401F80B0U, 0x4U, 0, 0, 0x401F8224U
 - #define **IOMUXC_GPIO_EMC_39_GPIO3_IO07** 0x401F80B0U, 0x5U, 0, 0, 0x401F8224U
 - #define **IOMUXC_GPIO_EMC_39_ENET_TX_ER** 0x401F80B0U, 0x6U, 0, 0, 0x401F8224U
 - #define **IOMUXC_GPIO_EMC_39_GPT1_CLK** 0x401F80B0U, 0x7U, 0, 0, 0x401F8224U
 - #define **IOMUXC_GPIO_EMC_40_SEMC_CSX00** 0x401F80B4U, 0x0U, 0, 0, 0x401F8228U
 - #define **IOMUXC_GPIO_EMC_40_XBAR1_INOUT18** 0x401F80B4U, 0x1U, 0x401F84BCU, 0x1U, 0x401F8228U
 - #define **IOMUXC_GPIO_EMC_40_SPDIF_OUT** 0x401F80B4U, 0x2U, 0, 0, 0x401F8228U
 - #define **IOMUXC_GPIO_EMC_40_USB_OTG1_ID** 0x401F80B4U, 0x3U, 0x401F82FCU, 0x2U, 0x401F8228U
 - #define **IOMUXC_GPIO_EMC_40_ENET_MDIO** 0x401F80B4U, 0x4U, 0x401F8308U, 0x2U, 0x401F8228U
 - #define **IOMUXC_GPIO_EMC_40_GPIO3_IO08** 0x401F80B4U, 0x5U, 0, 0, 0x401F8228U
 - #define **IOMUXC_GPIO_EMC_40_ENET_TDATA03** 0x401F80B4U, 0x6U, 0, 0, 0x401F8228U
 - #define **IOMUXC_GPIO_EMC_40_GPT1_COMPARE3** 0x401F80B4U, 0x7U, 0, 0, 0x401F8228U
 - #define **IOMUXC_GPIO_EMC_41_SEMC_READY** 0x401F80B8U, 0x0U, 0x401F8484U, 0x1U, 0x401F822CU
 - #define **IOMUXC_GPIO_EMC_41_XBAR1_INOUT19** 0x401F80B8U, 0x1U, 0x401F84C0U, 0x1U, 0x401F822CU
 - #define **IOMUXC_GPIO_EMC_41_SPDIF_IN** 0x401F80B8U, 0x2U, 0x401F8488U, 0x1U, 0x401F822CU
 - #define **IOMUXC_GPIO_EMC_41_USB_OTG1_PWR** 0x401F80B8U, 0x3U, 0, 0, 0x401F822CU
 - #define **IOMUXC_GPIO_EMC_41_ENET_MDC** 0x401F80B8U, 0x4U, 0, 0, 0x401F822CU
 - #define **IOMUXC_GPIO_EMC_41_GPIO3_IO09** 0x401F80B8U, 0x5U, 0, 0, 0x401F822CU
 - #define **IOMUXC_GPIO_EMC_41_ENET_TDATA02** 0x401F80B8U, 0x6U, 0, 0, 0x401F822CU
 - #define **IOMUXC_GPIO_EMC_41_GPT1_COMPARE2** 0x401F80B8U, 0x7U, 0, 0, 0x401F822CU
 - #define **IOMUXC_GPIO_AD_B0_00_JTAG_TMS** 0x401F80BCU, 0x0U, 0, 0, 0x401F8230U
 - #define **IOMUXC_GPIO_AD_B0_00_GPIO1_IO00** 0x401F80BCU, 0x5U, 0, 0, 0x401F8230U
 - #define **IOMUXC_GPIO_AD_B0_00_GPT1_COMPARE1** 0x401F80BCU, 0x7U, 0, 0, 0x401F8230U
 - #define **IOMUXC_GPIO_AD_B0_01_JTAG_TCK** 0x401F80C0U, 0x0U, 0, 0, 0x401F8234U
 - #define **IOMUXC_GPIO_AD_B0_01_GPIO1_IO01** 0x401F80C0U, 0x5U, 0, 0, 0x401F8234U
 - #define **IOMUXC_GPIO_AD_B0_01_GPT1_CAPTURE2** 0x401F80C0U, 0x7U, 0, 0, 0x401F8234U
 - #define **IOMUXC_GPIO_AD_B0_02_JTAG_MOD** 0x401F80C4U, 0x0U, 0, 0, 0x401F8238U
 - #define **IOMUXC_GPIO_AD_B0_02_GPIO1_IO02** 0x401F80C4U, 0x5U, 0, 0, 0x401F8238U
 - #define **IOMUXC_GPIO_AD_B0_02_GPT1_CAPTURE1** 0x401F80C4U, 0x7U, 0, 0, 0x401F8238U

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F8238U
• #define IOMUXC_GPIO_AD_B0_03_JTAG_TDI 0x401F80C8U, 0x0U, 0, 0, 0x401F823CU
• #define IOMUXC_GPIO_AD_B0_03_USDHC2_CD_B 0x401F80C8U, 0x1U, 0x401F8498U,
  0x1U, 0x401F823CU
• #define IOMUXC_GPIO_AD_B0_03_WDOG1_B 0x401F80C8U, 0x2U, 0, 0, 0x401F823CU
• #define IOMUXC_GPIO_AD_B0_03_SAI1_MCLK 0x401F80C8U, 0x3U, 0x401F8430U, 0x1-
  U, 0x401F823CU
• #define IOMUXC_GPIO_AD_B0_03_USDHC1_WP 0x401F80C8U, 0x4U, 0x401F8494U, 0x0-
  U, 0x401F823CU
• #define IOMUXC_GPIO_AD_B0_03_GPIO1_IO03 0x401F80C8U, 0x5U, 0, 0, 0x401F823CU
• #define IOMUXC_GPIO_AD_B0_03_USB_OTG1_OC 0x401F80C8U, 0x6U, 0x401F848CU,
  0x0U, 0x401F823CU
• #define IOMUXC_GPIO_AD_B0_03_CCM_PMIC_RDY 0x401F80C8U, 0x7U, 0x401F8300U,
  0x2U, 0x401F823CU
• #define IOMUXC_GPIO_AD_B0_04_JTAG_TDO 0x401F80CCU, 0x0U, 0, 0, 0x401F8240U
• #define IOMUXC_GPIO_AD_B0_04_FLEXCAN1_TX 0x401F80CCU, 0x1U, 0, 0, 0x401-
  F8240U
• #define IOMUXC_GPIO_AD_B0_04_USDHC1_WP 0x401F80CCU, 0x2U, 0x401F8494U, 0x1-
  U, 0x401F8240U
• #define IOMUXC_GPIO_AD_B0_04_QTIMER2_TIMER0 0x401F80CCU, 0x3U, 0x401-
  F8420U, 0x1U, 0x401F8240U
• #define IOMUXC_GPIO_AD_B0_04_ENET_MDIO 0x401F80CCU, 0x4U, 0x401F8308U, 0x1-
  U, 0x401F8240U
• #define IOMUXC_GPIO_AD_B0_04_GPIO1_IO04 0x401F80CCU, 0x5U, 0, 0, 0x401F8240U
• #define IOMUXC_GPIO_AD_B0_04_USB_OTG1_PWR 0x401F80CCU, 0x6U, 0, 0, 0x401-
  F8240U
• #define IOMUXC_GPIO_AD_B0_04_EWM_OUT_B 0x401F80CCU, 0x7U, 0, 0, 0x401F8240U
• #define IOMUXC_GPIO_AD_B0_05_JTAG_TRSTB 0x401F80D0U, 0x0U, 0, 0, 0x401F8244U
• #define IOMUXC_GPIO_AD_B0_05_FLEXCAN1_RX 0x401F80D0U, 0x1U, 0x401F8320U,
  0x2U, 0x401F8244U
• #define IOMUXC_GPIO_AD_B0_05_USDHC1_CD_B 0x401F80D0U, 0x2U, 0x401F8490U,
  0x1U, 0x401F8244U
• #define IOMUXC_GPIO_AD_B0_05_QTIMER2_TIMER1 0x401F80D0U, 0x3U, 0x401-
  F8424U, 0x1U, 0x401F8244U
• #define IOMUXC_GPIO_AD_B0_05_ENET_MDC 0x401F80D0U, 0x4U, 0, 0, 0x401F8244U
• #define IOMUXC_GPIO_AD_B0_05_GPIO1_IO05 0x401F80D0U, 0x5U, 0, 0, 0x401F8244U
• #define IOMUXC_GPIO_AD_B0_05_USB_OTG1_ID 0x401F80D0U, 0x6U, 0x401F82FCU,
  0x0U, 0x401F8244U
• #define IOMUXC_GPIO_AD_B0_05_NMI_GLUE_NMI 0x401F80D0U, 0x7U, 0x401F840CU,
  0x0U, 0x401F8244U
• #define IOMUXC_GPIO_AD_B0_06_PIT_TRIGGER00 0x401F80D4U, 0x0U, 0, 0, 0x401-
  F8248U
• #define IOMUXC_GPIO_AD_B0_06_MQS_RIGHT 0x401F80D4U, 0x1U, 0, 0, 0x401F8248U
• #define IOMUXC_GPIO_AD_B0_06_LPUART1_TX 0x401F80D4U, 0x2U, 0, 0, 0x401F8248U
• #define IOMUXC_GPIO_AD_B0_06_QTIMER2_TIMER2 0x401F80D4U, 0x3U, 0x401-
  F8428U, 0x1U, 0x401F8248U
• #define IOMUXC_GPIO_AD_B0_06_FLEXPWM2_PWMA03 0x401F80D4U, 0x4U, 0x401-
  F8354U, 0x0U, 0x401F8248U
• #define IOMUXC_GPIO_AD_B0_06_GPIO1_IO06 0x401F80D4U, 0x5U, 0, 0, 0x401F8248U
• #define IOMUXC_GPIO_AD_B0_06_REF_32K_OUT 0x401F80D4U, 0x6U, 0, 0, 0x401F8248-
  U

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- #define **IOMUXC_GPIO_AD_B0_07_PIT_TRIGGER01** 0x401F80D8U, 0x0U, 0, 0, 0x401F824CU
- #define **IOMUXC_GPIO_AD_B0_07_MQS_LEFT** 0x401F80D8U, 0x1U, 0, 0, 0x401F824CU
- #define **IOMUXC_GPIO_AD_B0_07_LPUART1_RX** 0x401F80D8U, 0x2U, 0, 0, 0x401F824CU
- #define **IOMUXC_GPIO_AD_B0_07_QTIMER2_TIMER3** 0x401F80D8U, 0x3U, 0x401F842CU, 0x1U, 0x401F824CU
- #define **IOMUXC_GPIO_AD_B0_07_FLEXPWM2_PWMB03** 0x401F80D8U, 0x4U, 0x401F8364U, 0x0U, 0x401F824CU
- #define **IOMUXC_GPIO_AD_B0_07_GPIO1_IO07** 0x401F80D8U, 0x5U, 0, 0, 0x401F824CU
- #define **IOMUXC_GPIO_AD_B0_07_REF_24M_OUT** 0x401F80D8U, 0x6U, 0, 0, 0x401F824CU
- #define **IOMUXC_GPIO_AD_B0_08_ENET_TX_CLK** 0x401F80DCU, 0x0U, 0x401F831CU, 0x1U, 0x401F8250U
- #define **IOMUXC_GPIO_AD_B0_08_LPI2C3_SCL** 0x401F80DCU, 0x1U, 0x401F838CU, 0x1U, 0x401F8250U
- #define **IOMUXC_GPIO_AD_B0_08_LPUART1_CTS_B** 0x401F80DCU, 0x2U, 0, 0, 0x401F8250U
- #define **IOMUXC_GPIO_AD_B0_08_KPP_COL00** 0x401F80DCU, 0x3U, 0, 0, 0x401F8250U
- #define **IOMUXC_GPIO_AD_B0_08_ENET_REF_CLK1** 0x401F80DCU, 0x4U, 0x401F8304U, 0x1U, 0x401F8250U
- #define **IOMUXC_GPIO_AD_B0_08_GPIO1_IO08** 0x401F80DCU, 0x5U, 0, 0, 0x401F8250U
- #define **IOMUXC_GPIO_AD_B0_08_ARM_CM7_TXEV** 0x401F80DCU, 0x6U, 0, 0, 0x401F8250U
- #define **IOMUXC_GPIO_AD_B0_09_ENET_RDATA01** 0x401F80E0U, 0x0U, 0x401F8310U, 0x1U, 0x401F8254U
- #define **IOMUXC_GPIO_AD_B0_09_LPI2C3_SDA** 0x401F80E0U, 0x1U, 0x401F8390U, 0x1U, 0x401F8254U
- #define **IOMUXC_GPIO_AD_B0_09_LPUART1_RTS_B** 0x401F80E0U, 0x2U, 0, 0, 0x401F8254U
- #define **IOMUXC_GPIO_AD_B0_09_KPP_ROW00** 0x401F80E0U, 0x3U, 0, 0, 0x401F8254U
- #define **IOMUXC_GPIO_AD_B0_09_GPIO1_IO09** 0x401F80E0U, 0x5U, 0, 0, 0x401F8254U
- #define **IOMUXC_GPIO_AD_B0_09_ARM_CM7_RXEV** 0x401F80E0U, 0x6U, 0, 0, 0x401F8254U
- #define **IOMUXC_GPIO_AD_B0_10_ENET_RDATA00** 0x401F80E4U, 0x0U, 0x401F830CU, 0x1U, 0x401F8258U
- #define **IOMUXC_GPIO_AD_B0_10_LPSPI1_SCK** 0x401F80E4U, 0x1U, 0x401F83A0U, 0x1U, 0x401F8258U
- #define **IOMUXC_GPIO_AD_B0_10_LPUART5_TX** 0x401F80E4U, 0x2U, 0x401F83F0U, 0x0U, 0x401F8258U
- #define **IOMUXC_GPIO_AD_B0_10_KPP_COL01** 0x401F80E4U, 0x3U, 0, 0, 0x401F8258U
- #define **IOMUXC_GPIO_AD_B0_10_FLEXPWM2_PWMA02** 0x401F80E4U, 0x4U, 0x401F8350U, 0x0U, 0x401F8258U
- #define **IOMUXC_GPIO_AD_B0_10_GPIO1_IO10** 0x401F80E4U, 0x5U, 0, 0, 0x401F8258U
- #define **IOMUXC_GPIO_AD_B0_10_ARM_CM7_TRACE_CLK** 0x401F80E4U, 0x6U, 0, 0, 0x401F8258U
- #define **IOMUXC_GPIO_AD_B0_11_ENET_RX_EN** 0x401F80E8U, 0x0U, 0x401F8314U, 0x1U, 0x401F825CU
- #define **IOMUXC_GPIO_AD_B0_11_LPSPI1_PCS0** 0x401F80E8U, 0x1U, 0x401F839CU, 0x1U, 0x401F825CU
- #define **IOMUXC_GPIO_AD_B0_11_LPUART5_RX** 0x401F80E8U, 0x2U, 0x401F83ECU,

- 0x0U, 0x401F825CU
- #define **IOMUXC_GPIO_AD_B0_11_KPP_ROW01** 0x401F80E8U, 0x3U, 0, 0, 0x401F825CU
- #define **IOMUXC_GPIO_AD_B0_11_FLEXPWM2_PWMB02** 0x401F80E8U, 0x4U, 0x401F8360U, 0x0U, 0x401F825CU
- #define **IOMUXC_GPIO_AD_B0_11_GPIO1_IO11** 0x401F80E8U, 0x5U, 0, 0, 0x401F825CU
- #define **IOMUXC_GPIO_AD_B0_11_ARM_CM7_TRACE_SWO** 0x401F80E8U, 0x6U, 0, 0, 0x401F825CU
- #define **IOMUXC_GPIO_AD_B0_12_ENET_RX_ER** 0x401F80ECU, 0x0U, 0x401F8318U, 0x1U, 0x401F8260U
- #define **IOMUXC_GPIO_AD_B0_12_LPSP11_SDO** 0x401F80ECU, 0x1U, 0x401F83A8U, 0x1U, 0x401F8260U
- #define **IOMUXC_GPIO_AD_B0_12_LPUART3_CTS_B** 0x401F80ECU, 0x2U, 0, 0, 0x401F8260U
- #define **IOMUXC_GPIO_AD_B0_12_KPP_COL02** 0x401F80ECU, 0x3U, 0, 0, 0x401F8260U
- #define **IOMUXC_GPIO_AD_B0_12_FLEXPWM2_PWMA01** 0x401F80ECU, 0x4U, 0x401F834CU, 0x0U, 0x401F8260U
- #define **IOMUXC_GPIO_AD_B0_12_GPIO1_IO12** 0x401F80ECU, 0x5U, 0, 0, 0x401F8260U
- #define **IOMUXC_GPIO_AD_B0_12_ARM_CM7_TRACE00** 0x401F80ECU, 0x6U, 0, 0, 0x401F8260U
- #define **IOMUXC_GPIO_AD_B0_12_SNV5_HP_VIO_5_CTL** 0x401F80ECU, 0x7U, 0, 0, 0x401F8260U
- #define **IOMUXC_GPIO_AD_B0_13_ENET_TX_EN** 0x401F80F0U, 0x0U, 0, 0, 0x401F8264U
- #define **IOMUXC_GPIO_AD_B0_13_LPSP11_SDI** 0x401F80F0U, 0x1U, 0x401F83A4U, 0x1U, 0x401F8264U
- #define **IOMUXC_GPIO_AD_B0_13_LPUART3_RTS_B** 0x401F80F0U, 0x2U, 0, 0, 0x401F8264U
- #define **IOMUXC_GPIO_AD_B0_13_KPP_ROW02** 0x401F80F0U, 0x3U, 0, 0, 0x401F8264U
- #define **IOMUXC_GPIO_AD_B0_13_FLEXPWM2_PWMB01** 0x401F80F0U, 0x4U, 0x401F835CU, 0x0U, 0x401F8264U
- #define **IOMUXC_GPIO_AD_B0_13_GPIO1_IO13** 0x401F80F0U, 0x5U, 0, 0, 0x401F8264U
- #define **IOMUXC_GPIO_AD_B0_13_ARM_CM7_TRACE01** 0x401F80F0U, 0x6U, 0, 0, 0x401F8264U
- #define **IOMUXC_GPIO_AD_B0_13_SNV5_HP_VIO_5_B** 0x401F80F0U, 0x7U, 0, 0, 0x401F8264U
- #define **IOMUXC_GPIO_AD_B0_14_ENET_TDATA00** 0x401F80F4U, 0x0U, 0, 0, 0x401F8268U
- #define **IOMUXC_GPIO_AD_B0_14_FLEXPWM2_TX** 0x401F80F4U, 0x1U, 0, 0, 0x401F8268U
- #define **IOMUXC_GPIO_AD_B0_14_LPUART3_TX** 0x401F80F4U, 0x2U, 0x401F83DCU, 0x1U, 0x401F8268U
- #define **IOMUXC_GPIO_AD_B0_14_KPP_COL03** 0x401F80F4U, 0x3U, 0, 0, 0x401F8268U
- #define **IOMUXC_GPIO_AD_B0_14_FLEXPWM2_PWMA00** 0x401F80F4U, 0x4U, 0x401F8348U, 0x0U, 0x401F8268U
- #define **IOMUXC_GPIO_AD_B0_14_GPIO1_IO14** 0x401F80F4U, 0x5U, 0, 0, 0x401F8268U
- #define **IOMUXC_GPIO_AD_B0_14_ARM_CM7_TRACE02** 0x401F80F4U, 0x6U, 0, 0, 0x401F8268U
- #define **IOMUXC_GPIO_AD_B0_14_WDOG1_ANY** 0x401F80F4U, 0x7U, 0, 0, 0x401F8268U
- #define **IOMUXC_GPIO_AD_B0_15_ENET_TDATA01** 0x401F80F8U, 0x0U, 0, 0, 0x401F826CU
- #define **IOMUXC_GPIO_AD_B0_15_FLEXPWM2_RX** 0x401F80F8U, 0x1U, 0x401F8324U, 0x2U, 0x401F826CU

- #define **IOMUXC_GPIO_AD_B0_15_LPUART3_RX** 0x401F80F8U, 0x2U, 0x401F83D8U, 0x1U, 0x401F826CU
- #define **IOMUXC_GPIO_AD_B0_15_KPP_ROW03** 0x401F80F8U, 0x3U, 0, 0, 0x401F826CU
- #define **IOMUXC_GPIO_AD_B0_15_FLEXPWM2_PWMB00** 0x401F80F8U, 0x4U, 0x401F8358U, 0x0U, 0x401F826CU
- #define **IOMUXC_GPIO_AD_B0_15_GPIO1_IO15** 0x401F80F8U, 0x5U, 0, 0, 0x401F826CU
- #define **IOMUXC_GPIO_AD_B0_15_ARM_CM7_TRACE03** 0x401F80F8U, 0x6U, 0, 0, 0x401F826CU
- #define **IOMUXC_GPIO_AD_B1_00_SEMC_READY** 0x401F80FCU, 0x0U, 0x401F8484U, 0x0U, 0x401F8270U
- #define **IOMUXC_GPIO_AD_B1_00_FLEXSPI_A_DATA03** 0x401F80FCU, 0x1U, 0x401F8374U, 0x1U, 0x401F8270U
- #define **IOMUXC_GPIO_AD_B1_00_FLEXCAN2_TX** 0x401F80FCU, 0x2U, 0, 0, 0x401F8270U
- #define **IOMUXC_GPIO_AD_B1_00_SAI1_MCLK** 0x401F80FCU, 0x3U, 0x401F8430U, 0x2U, 0x401F8270U
- #define **IOMUXC_GPIO_AD_B1_00_FLEXIO1_FLEXIO15** 0x401F80FCU, 0x4U, 0, 0, 0x401F8270U
- #define **IOMUXC_GPIO_AD_B1_00_GPIO1_IO16** 0x401F80FCU, 0x5U, 0, 0, 0x401F8270U
- #define **IOMUXC_GPIO_AD_B1_00_ENET_1588_EVENT2_OUT** 0x401F80FCU, 0x6U, 0, 0, 0x401F8270U
- #define **IOMUXC_GPIO_AD_B1_00_KPP_COL04** 0x401F80FCU, 0x7U, 0, 0, 0x401F8270U
- #define **IOMUXC_GPIO_AD_B1_01_SEMC_CSX00** 0x401F8100U, 0x0U, 0, 0, 0x401F8274U
- #define **IOMUXC_GPIO_AD_B1_01_FLEXSPI_A_SCLK** 0x401F8100U, 0x1U, 0x401F8378U, 0x1U, 0x401F8274U
- #define **IOMUXC_GPIO_AD_B1_01_FLEXCAN2_RX** 0x401F8100U, 0x2U, 0x401F8324U, 0x3U, 0x401F8274U
- #define **IOMUXC_GPIO_AD_B1_01_SAI1_TX_BCLK** 0x401F8100U, 0x3U, 0x401F844CU, 0x1U, 0x401F8274U
- #define **IOMUXC_GPIO_AD_B1_01_FLEXIO1_FLEXIO14** 0x401F8100U, 0x4U, 0, 0, 0x401F8274U
- #define **IOMUXC_GPIO_AD_B1_01_GPIO1_IO17** 0x401F8100U, 0x5U, 0, 0, 0x401F8274U
- #define **IOMUXC_GPIO_AD_B1_01_ENET_1588_EVENT2_IN** 0x401F8100U, 0x6U, 0, 0, 0x401F8274U
- #define **IOMUXC_GPIO_AD_B1_01_KPP_ROW04** 0x401F8100U, 0x7U, 0, 0, 0x401F8274U
- #define **IOMUXC_GPIO_AD_B1_02_SEMC_CSX01** 0x401F8104U, 0x0U, 0, 0, 0x401F8278U
- #define **IOMUXC_GPIO_AD_B1_02_FLEXSPI_A_DATA00** 0x401F8104U, 0x1U, 0x401F8368U, 0x1U, 0x401F8278U
- #define **IOMUXC_GPIO_AD_B1_02_LPSPi4_SCK** 0x401F8104U, 0x2U, 0x401F83C0U, 0x0U, 0x401F8278U
- #define **IOMUXC_GPIO_AD_B1_02_SAI1_TX_SYNC** 0x401F8104U, 0x3U, 0x401F8450U, 0x1U, 0x401F8278U
- #define **IOMUXC_GPIO_AD_B1_02_FLEXIO1_FLEXIO13** 0x401F8104U, 0x4U, 0, 0, 0x401F8278U
- #define **IOMUXC_GPIO_AD_B1_02_GPIO1_IO18** 0x401F8104U, 0x5U, 0, 0, 0x401F8278U
- #define **IOMUXC_GPIO_AD_B1_02_ENET_1588_EVENT3_OUT** 0x401F8104U, 0x6U, 0, 0, 0x401F8278U
- #define **IOMUXC_GPIO_AD_B1_02_KPP_COL05** 0x401F8104U, 0x7U, 0, 0, 0x401F8278U
- #define **IOMUXC_GPIO_AD_B1_03_SEMC_CSX02** 0x401F8108U, 0x0U, 0, 0, 0x401F827CU
- #define **IOMUXC_GPIO_AD_B1_03_FLEXSPI_A_DATA02** 0x401F8108U, 0x1U, 0x401F8370U, 0x1U, 0x401F827CU

- #define **IOMUXC_GPIO_AD_B1_03_LPSP14_PCS0** 0x401F8108U, 0x2U, 0x401F83BCU, 0x0U, 0x401F827CU
- #define **IOMUXC_GPIO_AD_B1_03_SAI1_TX_DATA00** 0x401F8108U, 0x3U, 0, 0, 0x401F827CU
- #define **IOMUXC_GPIO_AD_B1_03_FLEXIO1_FLEXIO12** 0x401F8108U, 0x4U, 0, 0, 0x401F827CU
- #define **IOMUXC_GPIO_AD_B1_03_GPIO1_IO19** 0x401F8108U, 0x5U, 0, 0, 0x401F827CU
- #define **IOMUXC_GPIO_AD_B1_03_ENET_1588_EVENT3_IN** 0x401F8108U, 0x6U, 0, 0, 0x401F827CU
- #define **IOMUXC_GPIO_AD_B1_03_KPP_ROW05** 0x401F8108U, 0x7U, 0, 0, 0x401F827CU
- #define **IOMUXC_GPIO_AD_B1_04_SEMC_CSX03** 0x401F810CU, 0x0U, 0, 0, 0x401F8280U
- #define **IOMUXC_GPIO_AD_B1_04_FLEXSPI_A_DATA01** 0x401F810CU, 0x1U, 0x401F836CU, 0x1U, 0x401F8280U
- #define **IOMUXC_GPIO_AD_B1_04_LPSP14_SDO** 0x401F810CU, 0x2U, 0x401F83C8U, 0x0U, 0x401F8280U
- #define **IOMUXC_GPIO_AD_B1_04_SAI1_RX_SYNC** 0x401F810CU, 0x3U, 0x401F8448U, 0x0U, 0x401F8280U
- #define **IOMUXC_GPIO_AD_B1_04_FLEXIO1_FLEXIO11** 0x401F810CU, 0x4U, 0, 0, 0x401F8280U
- #define **IOMUXC_GPIO_AD_B1_04_GPIO1_IO20** 0x401F810CU, 0x5U, 0, 0, 0x401F8280U
- #define **IOMUXC_GPIO_AD_B1_04_LPSP11_PCS1** 0x401F810CU, 0x6U, 0, 0, 0x401F8280U
- #define **IOMUXC_GPIO_AD_B1_04_KPP_COL06** 0x401F810CU, 0x7U, 0, 0, 0x401F8280U
- #define **IOMUXC_GPIO_AD_B1_05_USDHC1_WP** 0x401F8110U, 0x0U, 0x401F8494U, 0x2U, 0x401F8284U
- #define **IOMUXC_GPIO_AD_B1_05_FLEXSPI_A_SS0_B** 0x401F8110U, 0x1U, 0, 0, 0x401F8284U
- #define **IOMUXC_GPIO_AD_B1_05_LPSP14_SDI** 0x401F8110U, 0x2U, 0x401F83C4U, 0x0U, 0x401F8284U
- #define **IOMUXC_GPIO_AD_B1_05_SAI1_RX_DATA00** 0x401F8110U, 0x3U, 0x401F8438U, 0x1U, 0x401F8284U
- #define **IOMUXC_GPIO_AD_B1_05_FLEXIO1_FLEXIO10** 0x401F8110U, 0x4U, 0, 0, 0x401F8284U
- #define **IOMUXC_GPIO_AD_B1_05_GPIO1_IO21** 0x401F8110U, 0x5U, 0, 0, 0x401F8284U
- #define **IOMUXC_GPIO_AD_B1_05_LPSP11_PCS2** 0x401F8110U, 0x6U, 0, 0, 0x401F8284U
- #define **IOMUXC_GPIO_AD_B1_05_KPP_ROW06** 0x401F8110U, 0x7U, 0, 0, 0x401F8284U
- #define **IOMUXC_GPIO_AD_B1_06_USDHC1_RESET_B** 0x401F8114U, 0x0U, 0, 0, 0x401F8288U
- #define **IOMUXC_GPIO_AD_B1_06_FLEXPWM1_PWMA00** 0x401F8114U, 0x1U, 0x401F8328U, 0x0U, 0x401F8288U
- #define **IOMUXC_GPIO_AD_B1_06_LPUART2_CTS_B** 0x401F8114U, 0x2U, 0x401F83CCU, 0x0U, 0x401F8288U
- #define **IOMUXC_GPIO_AD_B1_06_SAI1_RX_BCLK** 0x401F8114U, 0x3U, 0x401F8434U, 0x0U, 0x401F8288U
- #define **IOMUXC_GPIO_AD_B1_06_FLEXIO1_FLEXIO09** 0x401F8114U, 0x4U, 0, 0, 0x401F8288U
- #define **IOMUXC_GPIO_AD_B1_06_GPIO1_IO22** 0x401F8114U, 0x5U, 0, 0, 0x401F8288U
- #define **IOMUXC_GPIO_AD_B1_06_LPSP11_PCS3** 0x401F8114U, 0x6U, 0, 0, 0x401F8288U
- #define **IOMUXC_GPIO_AD_B1_06_KPP_COL07** 0x401F8114U, 0x7U, 0, 0, 0x401F8288U
- #define **IOMUXC_GPIO_AD_B1_07_USDHC1_VSELECT** 0x401F8118U, 0x0U, 0, 0, 0x401F828CU
- #define **IOMUXC_GPIO_AD_B1_07_FLEXPWM1_PWMB00** 0x401F8118U, 0x1U, 0x401F828CU, 0x0U, 0x401F828CU

- F8338U, 0x0U, 0x401F828CU
- #define **IOMUXC_GPIO_AD_B1_07_LPUART2_RTS_B** 0x401F8118U, 0x2U, 0, 0, 0x401F828CU
- #define **IOMUXC_GPIO_AD_B1_07_SAI1_TX_DATA01** 0x401F8118U, 0x3U, 0x401F8444U, 0x0U, 0x401F828CU
- #define **IOMUXC_GPIO_AD_B1_07_FLEXIO1_FLEXIO08** 0x401F8118U, 0x4U, 0, 0, 0x401F828CU
- #define **IOMUXC_GPIO_AD_B1_07_GPIO1_IO23** 0x401F8118U, 0x5U, 0, 0, 0x401F828CU
- #define **IOMUXC_GPIO_AD_B1_07_LPSPi3_PCS3** 0x401F8118U, 0x6U, 0, 0, 0x401F828CU
- #define **IOMUXC_GPIO_AD_B1_07_KPP_ROW07** 0x401F8118U, 0x7U, 0, 0, 0x401F828CU
- #define **IOMUXC_GPIO_AD_B1_08_LPI2C2_SCL** 0x401F811CU, 0x0U, 0x401F8384U, 0x0U, 0x401F8290U
- #define **IOMUXC_GPIO_AD_B1_08_FLEXPWM1_PWMA01** 0x401F811CU, 0x1U, 0x401F832CU, 0x0U, 0x401F8290U
- #define **IOMUXC_GPIO_AD_B1_08_LPUART2_TX** 0x401F811CU, 0x2U, 0x401F83D4U, 0x0U, 0x401F8290U
- #define **IOMUXC_GPIO_AD_B1_08_SAI1_TX_DATA02** 0x401F811CU, 0x3U, 0x401F8440U, 0x0U, 0x401F8290U
- #define **IOMUXC_GPIO_AD_B1_08_FLEXIO1_FLEXIO07** 0x401F811CU, 0x4U, 0, 0, 0x401F8290U
- #define **IOMUXC_GPIO_AD_B1_08_GPIO1_IO24** 0x401F811CU, 0x5U, 0, 0, 0x401F8290U
- #define **IOMUXC_GPIO_AD_B1_08_LPSPi3_PCS2** 0x401F811CU, 0x6U, 0, 0, 0x401F8290U
- #define **IOMUXC_GPIO_AD_B1_08_XBAR1_INOUT12** 0x401F811CU, 0x7U, 0x401F84B4U, 0x1U, 0x401F8290U
- #define **IOMUXC_GPIO_AD_B1_09_LPI2C2_SDA** 0x401F8120U, 0x0U, 0x401F8388U, 0x0U, 0x401F8294U
- #define **IOMUXC_GPIO_AD_B1_09_FLEXPWM1_PWMB01** 0x401F8120U, 0x1U, 0x401F833CU, 0x0U, 0x401F8294U
- #define **IOMUXC_GPIO_AD_B1_09_LPUART2_RX** 0x401F8120U, 0x2U, 0x401F83D0U, 0x0U, 0x401F8294U
- #define **IOMUXC_GPIO_AD_B1_09_SAI1_TX_DATA03** 0x401F8120U, 0x3U, 0x401F843CU, 0x0U, 0x401F8294U
- #define **IOMUXC_GPIO_AD_B1_09_FLEXIO1_FLEXIO06** 0x401F8120U, 0x4U, 0, 0, 0x401F8294U
- #define **IOMUXC_GPIO_AD_B1_09_GPIO1_IO25** 0x401F8120U, 0x5U, 0, 0, 0x401F8294U
- #define **IOMUXC_GPIO_AD_B1_09_LPSPi3_PCS1** 0x401F8120U, 0x6U, 0, 0, 0x401F8294U
- #define **IOMUXC_GPIO_AD_B1_09_XBAR1_INOUT13** 0x401F8120U, 0x7U, 0x401F84B8U, 0x1U, 0x401F8294U
- #define **IOMUXC_GPIO_AD_B1_10_USB_OTG1_PWR** 0x401F8124U, 0x0U, 0, 0, 0x401F8298U
- #define **IOMUXC_GPIO_AD_B1_10_FLEXPWM1_PWMA02** 0x401F8124U, 0x1U, 0x401F8330U, 0x0U, 0x401F8298U
- #define **IOMUXC_GPIO_AD_B1_10_LPUART4_TX** 0x401F8124U, 0x2U, 0x401F83E8U, 0x1U, 0x401F8298U
- #define **IOMUXC_GPIO_AD_B1_10_USDHC1_CD_B** 0x401F8124U, 0x3U, 0x401F8490U, 0x2U, 0x401F8298U
- #define **IOMUXC_GPIO_AD_B1_10_FLEXIO1_FLEXIO05** 0x401F8124U, 0x4U, 0, 0, 0x401F8298U
- #define **IOMUXC_GPIO_AD_B1_10_GPIO1_IO26** 0x401F8124U, 0x5U, 0, 0, 0x401F8298U
- #define **IOMUXC_GPIO_AD_B1_10_GPT2_CAPTURE1** 0x401F8124U, 0x6U, 0, 0, 0x401F8298U

- #define **IOMUXC_GPIO_AD_B1_11_USB_OTG1_ID** 0x401F8128U, 0x0U, 0x401F82FCU, 0x1U, 0x401F829CU
- #define **IOMUXC_GPIO_AD_B1_11_FLEXPWM1_PWMB02** 0x401F8128U, 0x1U, 0x401F8340U, 0x0U, 0x401F829CU
- #define **IOMUXC_GPIO_AD_B1_11_LPUART4_RX** 0x401F8128U, 0x2U, 0x401F83E4U, 0x1U, 0x401F829CU
- #define **IOMUXC_GPIO_AD_B1_11_USDHC1_WP** 0x401F8128U, 0x3U, 0x401F8494U, 0x3U, 0x401F829CU
- #define **IOMUXC_GPIO_AD_B1_11_FLEXIO1_FLEXIO04** 0x401F8128U, 0x4U, 0, 0, 0x401F829CU
- #define **IOMUXC_GPIO_AD_B1_11_GPIO1_IO27** 0x401F8128U, 0x5U, 0, 0, 0x401F829CU
- #define **IOMUXC_GPIO_AD_B1_11_GPT2_COMPARE1** 0x401F8128U, 0x6U, 0, 0, 0x401F829CU
- #define **IOMUXC_GPIO_AD_B1_12_USB_OTG1_OC** 0x401F812CU, 0x0U, 0x401F848CU, 0x1U, 0x401F82A0U
- #define **IOMUXC_GPIO_AD_B1_12_ACMP1_OUT** 0x401F812CU, 0x1U, 0, 0, 0x401F82A0U
- #define **IOMUXC_GPIO_AD_B1_12_LPSPi3_SCK** 0x401F812CU, 0x2U, 0, 0, 0x401F82A0U
- #define **IOMUXC_GPIO_AD_B1_12_USDHC2_CD_B** 0x401F812CU, 0x3U, 0x401F8498U, 0x2U, 0x401F82A0U
- #define **IOMUXC_GPIO_AD_B1_12_FLEXIO1_FLEXIO03** 0x401F812CU, 0x4U, 0, 0, 0x401F82A0U
- #define **IOMUXC_GPIO_AD_B1_12_GPIO1_IO28** 0x401F812CU, 0x5U, 0, 0, 0x401F82A0U
- #define **IOMUXC_GPIO_AD_B1_12_FLEXPWM1_PWMA03** 0x401F812CU, 0x6U, 0x401F8334U, 0x0U, 0x401F82A0U
- #define **IOMUXC_GPIO_AD_B1_13_LPI2C1_HREQ** 0x401F8130U, 0x0U, 0, 0, 0x401F82A4U
- #define **IOMUXC_GPIO_AD_B1_13_ACMP2_OUT** 0x401F8130U, 0x1U, 0, 0, 0x401F82A4U
- #define **IOMUXC_GPIO_AD_B1_13_LPSPi3_PCS0** 0x401F8130U, 0x2U, 0, 0, 0x401F82A4U
- #define **IOMUXC_GPIO_AD_B1_13_USDHC2_WP** 0x401F8130U, 0x3U, 0x401F849CU, 0x0U, 0x401F82A4U
- #define **IOMUXC_GPIO_AD_B1_13_FLEXIO1_FLEXIO02** 0x401F8130U, 0x4U, 0, 0, 0x401F82A4U
- #define **IOMUXC_GPIO_AD_B1_13_GPIO1_IO29** 0x401F8130U, 0x5U, 0, 0, 0x401F82A4U
- #define **IOMUXC_GPIO_AD_B1_13_FLEXPWM1_PWMB03** 0x401F8130U, 0x6U, 0x401F8344U, 0x0U, 0x401F82A4U
- #define **IOMUXC_GPIO_AD_B1_14_LPI2C1_SCL** 0x401F8134U, 0x0U, 0x401F837CU, 0x1U, 0x401F82A8U
- #define **IOMUXC_GPIO_AD_B1_14_ACMP3_OUT** 0x401F8134U, 0x1U, 0, 0, 0x401F82A8U
- #define **IOMUXC_GPIO_AD_B1_14_LPSPi3_SDO** 0x401F8134U, 0x2U, 0, 0, 0x401F82A8U
- #define **IOMUXC_GPIO_AD_B1_14_ENET_1588_EVENT0_OUT** 0x401F8134U, 0x3U, 0, 0, 0x401F82A8U
- #define **IOMUXC_GPIO_AD_B1_14_FLEXIO1_FLEXIO01** 0x401F8134U, 0x4U, 0, 0, 0x401F82A8U
- #define **IOMUXC_GPIO_AD_B1_14_GPIO1_IO30** 0x401F8134U, 0x5U, 0, 0, 0x401F82A8U
- #define **IOMUXC_GPIO_AD_B1_15_LPI2C1_SDA** 0x401F8138U, 0x0U, 0x401F8380U, 0x1U, 0x401F82ACU
- #define **IOMUXC_GPIO_AD_B1_15_ACMP4_OUT** 0x401F8138U, 0x1U, 0, 0, 0x401F82ACU
- #define **IOMUXC_GPIO_AD_B1_15_LPSPi3_SDI** 0x401F8138U, 0x2U, 0, 0, 0x401F82ACU
- #define **IOMUXC_GPIO_AD_B1_15_ENET_1588_EVENT0_IN** 0x401F8138U, 0x3U, 0, 0, 0x401F82ACU
- #define **IOMUXC_GPIO_AD_B1_15_FLEXIO1_FLEXIO00** 0x401F8138U, 0x4U, 0, 0, 0x401F82ACU

- F82ACU
- #define **IOMUXC_GPIO_AD_B1_15_GPIO1_IO31** 0x401F8138U, 0x5U, 0, 0, 0x401F82ACU
 - #define **IOMUXC_GPIO_SD_B0_00_USDHC1_DATA2** 0x401F813CU, 0x0U, 0, 0, 0x401F82B0U
 - #define **IOMUXC_GPIO_SD_B0_00_QTIMER1_TIMER0** 0x401F813CU, 0x1U, 0x401F8410U, 0x0U, 0x401F82B0U
 - #define **IOMUXC_GPIO_SD_B0_00_SAI1_MCLK** 0x401F813CU, 0x2U, 0x401F8430U, 0x0U, 0x401F82B0U
 - #define **IOMUXC_GPIO_SD_B0_00_SAI2_MCLK** 0x401F813CU, 0x3U, 0x401F8454U, 0x0U, 0x401F82B0U
 - #define **IOMUXC_GPIO_SD_B0_00_LPI2C3_SCL** 0x401F813CU, 0x4U, 0x401F838CU, 0x0U, 0x401F82B0U
 - #define **IOMUXC_GPIO_SD_B0_00_GPIO3_IO13** 0x401F813CU, 0x5U, 0, 0, 0x401F82B0U
 - #define **IOMUXC_GPIO_SD_B0_00_FLEXSPI_A_SS1_B** 0x401F813CU, 0x6U, 0, 0, 0x401F82B0U
 - #define **IOMUXC_GPIO_SD_B0_00_XBAR1_INOUT14** 0x401F813CU, 0x7U, 0x401F84A0U, 0x0U, 0x401F82B0U
 - #define **IOMUXC_GPIO_SD_B0_01_USDHC1_DATA3** 0x401F8140U, 0x0U, 0, 0, 0x401F82B4U
 - #define **IOMUXC_GPIO_SD_B0_01_QTIMER1_TIMER1** 0x401F8140U, 0x1U, 0x401F8414U, 0x0U, 0x401F82B4U
 - #define **IOMUXC_GPIO_SD_B0_01_REF_24M_OUT** 0x401F8140U, 0x2U, 0, 0, 0x401F82B4U
 - #define **IOMUXC_GPIO_SD_B0_01_SAI2_RX_SYNC** 0x401F8140U, 0x3U, 0x401F8460U, 0x0U, 0x401F82B4U
 - #define **IOMUXC_GPIO_SD_B0_01_LPI2C3_SDA** 0x401F8140U, 0x4U, 0x401F8390U, 0x0U, 0x401F82B4U
 - #define **IOMUXC_GPIO_SD_B0_01_GPIO3_IO14** 0x401F8140U, 0x5U, 0, 0, 0x401F82B4U
 - #define **IOMUXC_GPIO_SD_B0_01_FLEXSPI_B_SS1_B** 0x401F8140U, 0x6U, 0, 0, 0x401F82B4U
 - #define **IOMUXC_GPIO_SD_B0_01_XBAR1_INOUT15** 0x401F8140U, 0x7U, 0x401F84A4U, 0x0U, 0x401F82B4U
 - #define **IOMUXC_GPIO_SD_B0_02_USDHC1_CMD** 0x401F8144U, 0x0U, 0, 0, 0x401F82B8U
 - #define **IOMUXC_GPIO_SD_B0_02_QTIMER1_TIMER2** 0x401F8144U, 0x1U, 0x401F8418U, 0x0U, 0x401F82B8U
 - #define **IOMUXC_GPIO_SD_B0_02_LPUART7_CTS_B** 0x401F8144U, 0x2U, 0, 0, 0x401F82B8U
 - #define **IOMUXC_GPIO_SD_B0_02_SAI2_RX_BCLK** 0x401F8144U, 0x3U, 0x401F8458U, 0x0U, 0x401F82B8U
 - #define **IOMUXC_GPIO_SD_B0_02_LPSPI1_SCK** 0x401F8144U, 0x4U, 0x401F83A0U, 0x0U, 0x401F82B8U
 - #define **IOMUXC_GPIO_SD_B0_02_GPIO3_IO15** 0x401F8144U, 0x5U, 0, 0, 0x401F82B8U
 - #define **IOMUXC_GPIO_SD_B0_02_ENET_MDIO** 0x401F8144U, 0x6U, 0x401F8308U, 0x0U, 0x401F82B8U
 - #define **IOMUXC_GPIO_SD_B0_02_XBAR1_INOUT16** 0x401F8144U, 0x7U, 0x401F84A8U, 0x0U, 0x401F82B8U
 - #define **IOMUXC_GPIO_SD_B0_03_USDHC1_CLK** 0x401F8148U, 0x0U, 0, 0, 0x401F82BCU
 - #define **IOMUXC_GPIO_SD_B0_03_QTIMER1_TIMER3** 0x401F8148U, 0x1U, 0x401F841CU, 0x0U, 0x401F82BCU

- #define **IOMUXC_GPIO_SD_B0_03_LPUART7_RTS_B** 0x401F8148U, 0x2U, 0, 0, 0x401F82BCU
- #define **IOMUXC_GPIO_SD_B0_03_SAI2_RX_DATA** 0x401F8148U, 0x3U, 0x401F845CU, 0x0U, 0x401F82BCU
- #define **IOMUXC_GPIO_SD_B0_03_LPSP1_PCS0** 0x401F8148U, 0x4U, 0x401F839CU, 0x0U, 0x401F82BCU
- #define **IOMUXC_GPIO_SD_B0_03_GPIO3_IO16** 0x401F8148U, 0x5U, 0, 0, 0x401F82BCU
- #define **IOMUXC_GPIO_SD_B0_03_ENET_MDC** 0x401F8148U, 0x6U, 0, 0, 0x401F82BCU
- #define **IOMUXC_GPIO_SD_B0_04_USDHC1_DATA0** 0x401F814CU, 0x0U, 0, 0, 0x401F82C0U
- #define **IOMUXC_GPIO_SD_B0_04_FLEXCAN2_TX** 0x401F814CU, 0x1U, 0, 0, 0x401F82C0U
- #define **IOMUXC_GPIO_SD_B0_04_LPUART7_TX** 0x401F814CU, 0x2U, 0x401F8400U, 0x0U, 0x401F82C0U
- #define **IOMUXC_GPIO_SD_B0_04_SAI2_TX_DATA** 0x401F814CU, 0x3U, 0, 0, 0x401F82C0U
- #define **IOMUXC_GPIO_SD_B0_04_LPSP1_SDO** 0x401F814CU, 0x4U, 0x401F83A8U, 0x0U, 0x401F82C0U
- #define **IOMUXC_GPIO_SD_B0_04_GPIO3_IO17** 0x401F814CU, 0x5U, 0, 0, 0x401F82C0U
- #define **IOMUXC_GPIO_SD_B0_04_FLEXSPI_B_SS0_B** 0x401F814CU, 0x6U, 0, 0, 0x401F82C0U
- #define **IOMUXC_GPIO_SD_B0_05_USDHC1_DATA1** 0x401F8150U, 0x0U, 0, 0, 0x401F82C4U
- #define **IOMUXC_GPIO_SD_B0_05_FLEXCAN2_RX** 0x401F8150U, 0x1U, 0x401F8324U, 0x0U, 0x401F82C4U
- #define **IOMUXC_GPIO_SD_B0_05_LPUART7_RX** 0x401F8150U, 0x2U, 0x401F83FCU, 0x0U, 0x401F82C4U
- #define **IOMUXC_GPIO_SD_B0_05_SAI2_TX_BCLK** 0x401F8150U, 0x3U, 0x401F8464U, 0x0U, 0x401F82C4U
- #define **IOMUXC_GPIO_SD_B0_05_LPSP1_SDI** 0x401F8150U, 0x4U, 0x401F83A4U, 0x0U, 0x401F82C4U
- #define **IOMUXC_GPIO_SD_B0_05_GPIO3_IO18** 0x401F8150U, 0x5U, 0, 0, 0x401F82C4U
- #define **IOMUXC_GPIO_SD_B0_05_FLEXSPI_B_DQS** 0x401F8150U, 0x6U, 0, 0, 0x401F82C4U
- #define **IOMUXC_GPIO_SD_B0_06_USDHC1_CD_B** 0x401F8154U, 0x0U, 0x401F8490U, 0x0U, 0x401F82C8U
- #define **IOMUXC_GPIO_SD_B0_06_USDHC1_RESET_B** 0x401F8154U, 0x1U, 0, 0, 0x401F82C8U
- #define **IOMUXC_GPIO_SD_B0_06_REF_32K_OUT** 0x401F8154U, 0x2U, 0, 0, 0x401F82C8U
- #define **IOMUXC_GPIO_SD_B0_06_SAI2_TX_SYNC** 0x401F8154U, 0x3U, 0x401F8468U, 0x0U, 0x401F82C8U
- #define **IOMUXC_GPIO_SD_B0_06_WDOG1_B** 0x401F8154U, 0x4U, 0, 0, 0x401F82C8U
- #define **IOMUXC_GPIO_SD_B0_06_GPIO3_IO19** 0x401F8154U, 0x5U, 0, 0, 0x401F82C8U
- #define **IOMUXC_GPIO_SD_B0_06_XBAR1_INOUT17** 0x401F8154U, 0x6U, 0x401F84ACU, 0x0U, 0x401F82C8U
- #define **IOMUXC_GPIO_SD_B1_00_USDHC2_DATA2** 0x401F8158U, 0x0U, 0, 0, 0x401F82CCU
- #define **IOMUXC_GPIO_SD_B1_00_FLEXSPI_B_DATA03** 0x401F8158U, 0x1U, 0, 0, 0x401F82CCU

- #define **IOMUXC_GPIO_SD_B1_00_LPUART6_TX** 0x401F8158U, 0x2U, 0x401F83F8U, 0x1U, 0x401F82CCU
- #define **IOMUXC_GPIO_SD_B1_00_XBAR1_INOUT10** 0x401F8158U, 0x3U, 0x401F84B0U, 0x1U, 0x401F82CCU
- #define **IOMUXC_GPIO_SD_B1_00_FLEXCAN1_TX** 0x401F8158U, 0x4U, 0, 0, 0x401F82CCU
- #define **IOMUXC_GPIO_SD_B1_00_GPIO3_IO20** 0x401F8158U, 0x5U, 0, 0, 0x401F82CCU
- #define **IOMUXC_GPIO_SD_B1_01_USDHC2_DATA3** 0x401F815CU, 0x0U, 0, 0, 0x401F82D0U
- #define **IOMUXC_GPIO_SD_B1_01_FLEXSPI_B_SCLK** 0x401F815CU, 0x1U, 0, 0, 0x401F82D0U
- #define **IOMUXC_GPIO_SD_B1_01_LPUART6_RX** 0x401F815CU, 0x2U, 0x401F83F4U, 0x1U, 0x401F82D0U
- #define **IOMUXC_GPIO_SD_B1_01_FLEXSPI_A_SS1_B** 0x401F815CU, 0x3U, 0, 0, 0x401F82D0U
- #define **IOMUXC_GPIO_SD_B1_01_FLEXCAN1_RX** 0x401F815CU, 0x4U, 0x401F8320U, 0x1U, 0x401F82D0U
- #define **IOMUXC_GPIO_SD_B1_01_GPIO3_IO21** 0x401F815CU, 0x5U, 0, 0, 0x401F82D0U
- #define **IOMUXC_GPIO_SD_B1_02_USDHC2_CMD** 0x401F8160U, 0x0U, 0, 0, 0x401F82D4U
- #define **IOMUXC_GPIO_SD_B1_02_FLEXSPI_B_DATA00** 0x401F8160U, 0x1U, 0, 0, 0x401F82D4U
- #define **IOMUXC_GPIO_SD_B1_02_LPUART8_TX** 0x401F8160U, 0x2U, 0x401F8408U, 0x0U, 0x401F82D4U
- #define **IOMUXC_GPIO_SD_B1_02_LPI2C4_SCL** 0x401F8160U, 0x3U, 0x401F8394U, 0x1U, 0x401F82D4U
- #define **IOMUXC_GPIO_SD_B1_02_ENET_1588_EVENT1_OUT** 0x401F8160U, 0x4U, 0, 0, 0x401F82D4U
- #define **IOMUXC_GPIO_SD_B1_02_GPIO3_IO22** 0x401F8160U, 0x5U, 0, 0, 0x401F82D4U
- #define **IOMUXC_GPIO_SD_B1_02_CCM_CLKO1** 0x401F8160U, 0x6U, 0, 0, 0x401F82D4U
- #define **IOMUXC_GPIO_SD_B1_03_USDHC2_CLK** 0x401F8164U, 0x0U, 0, 0, 0x401F82D8U
- #define **IOMUXC_GPIO_SD_B1_03_FLEXSPI_B_DATA02** 0x401F8164U, 0x1U, 0, 0, 0x401F82D8U
- #define **IOMUXC_GPIO_SD_B1_03_LPUART8_RX** 0x401F8164U, 0x2U, 0x401F8404U, 0x0U, 0x401F82D8U
- #define **IOMUXC_GPIO_SD_B1_03_LPI2C4_SDA** 0x401F8164U, 0x3U, 0x401F8398U, 0x1U, 0x401F82D8U
- #define **IOMUXC_GPIO_SD_B1_03_ENET_1588_EVENT1_IN** 0x401F8164U, 0x4U, 0, 0, 0x401F82D8U
- #define **IOMUXC_GPIO_SD_B1_03_GPIO3_IO23** 0x401F8164U, 0x5U, 0, 0, 0x401F82D8U
- #define **IOMUXC_GPIO_SD_B1_03_CCM_CLKO2** 0x401F8164U, 0x6U, 0, 0, 0x401F82D8U
- #define **IOMUXC_GPIO_SD_B1_04_USDHC2_DATA0** 0x401F8168U, 0x0U, 0, 0, 0x401F82DCU
- #define **IOMUXC_GPIO_SD_B1_04_FLEXSPI_B_DATA01** 0x401F8168U, 0x1U, 0, 0, 0x401F82DCU
- #define **IOMUXC_GPIO_SD_B1_04_ENET_TX_CLK** 0x401F8168U, 0x2U, 0x401F831CU, 0x0U, 0x401F82DCU
- #define **IOMUXC_GPIO_SD_B1_04_ENET_REF_CLK1** 0x401F8168U, 0x3U, 0x401F8304U, 0x0U, 0x401F82DCU
- #define **IOMUXC_GPIO_SD_B1_04_EWM_OUT_B** 0x401F8168U, 0x4U, 0, 0, 0x401F82DCU
- #define **IOMUXC_GPIO_SD_B1_04_GPIO3_IO24** 0x401F8168U, 0x5U, 0, 0, 0x401F82DCU

- #define **IOMUXC_GPIO_SD_B1_04_CCM_WAIT** 0x401F8168U, 0x6U, 0, 0, 0x401F82DCU
- #define **IOMUXC_GPIO_SD_B1_05_USDHC2_DATA1** 0x401F816CU, 0x0U, 0, 0, 0x401F82E0U
- #define **IOMUXC_GPIO_SD_B1_05_FLEXSPI_A_DQS** 0x401F816CU, 0x1U, 0, 0, 0x401F82E0U
- #define **IOMUXC_GPIO_SD_B1_05_ENET_RDATA01** 0x401F816CU, 0x2U, 0x401F8310U, 0x0U, 0x401F82E0U
- #define **IOMUXC_GPIO_SD_B1_05_SAI3_MCLK** 0x401F816CU, 0x3U, 0x401F846CU, 0x0U, 0x401F82E0U
- #define **IOMUXC_GPIO_SD_B1_05_FLEXSPI_B_SS0_B** 0x401F816CU, 0x4U, 0, 0, 0x401F82E0U
- #define **IOMUXC_GPIO_SD_B1_05_GPIO3_IO25** 0x401F816CU, 0x5U, 0, 0, 0x401F82E0U
- #define **IOMUXC_GPIO_SD_B1_05_CCM_PMIC_RDY** 0x401F816CU, 0x6U, 0x401F8300U, 0x1U, 0x401F82E0U
- #define **IOMUXC_GPIO_SD_B1_06_USDHC2_CD_B** 0x401F8170U, 0x0U, 0x401F8498U, 0x0U, 0x401F82E4U
- #define **IOMUXC_GPIO_SD_B1_06_FLEXSPI_A_DATA03** 0x401F8170U, 0x1U, 0x401F8374U, 0x0U, 0x401F82E4U
- #define **IOMUXC_GPIO_SD_B1_06_ENET_RDATA00** 0x401F8170U, 0x2U, 0x401F830CU, 0x0U, 0x401F82E4U
- #define **IOMUXC_GPIO_SD_B1_06_SAI3_TX_BCLK** 0x401F8170U, 0x3U, 0x401F847CU, 0x0U, 0x401F82E4U
- #define **IOMUXC_GPIO_SD_B1_06_LPSP12_PCS0** 0x401F8170U, 0x4U, 0x401F83ACU, 0x2U, 0x401F82E4U
- #define **IOMUXC_GPIO_SD_B1_06_GPIO3_IO26** 0x401F8170U, 0x5U, 0, 0, 0x401F82E4U
- #define **IOMUXC_GPIO_SD_B1_06_CCM_STOP** 0x401F8170U, 0x6U, 0, 0, 0x401F82E4U
- #define **IOMUXC_GPIO_SD_B1_07_USDHC2_RESET_B** 0x401F8174U, 0x0U, 0, 0, 0x401F82E8U
- #define **IOMUXC_GPIO_SD_B1_07_FLEXSPI_A_SCLK** 0x401F8174U, 0x1U, 0x401F8378U, 0x0U, 0x401F82E8U
- #define **IOMUXC_GPIO_SD_B1_07_ENET_RX_EN** 0x401F8174U, 0x2U, 0x401F8314U, 0x0U, 0x401F82E8U
- #define **IOMUXC_GPIO_SD_B1_07_SAI3_TX_SYNC** 0x401F8174U, 0x3U, 0x401F8480U, 0x0U, 0x401F82E8U
- #define **IOMUXC_GPIO_SD_B1_07_LPSP12_SCK** 0x401F8174U, 0x4U, 0, 0, 0x401F82E8U
- #define **IOMUXC_GPIO_SD_B1_07_GPIO3_IO27** 0x401F8174U, 0x5U, 0, 0, 0x401F82E8U
- #define **IOMUXC_GPIO_SD_B1_08_USDHC2_DATA4** 0x401F8178U, 0x0U, 0, 0, 0x401F82ECU
- #define **IOMUXC_GPIO_SD_B1_08_FLEXSPI_A_DATA00** 0x401F8178U, 0x1U, 0x401F8368U, 0x0U, 0x401F82ECU
- #define **IOMUXC_GPIO_SD_B1_08_ENET_RX_ER** 0x401F8178U, 0x2U, 0x401F8318U, 0x0U, 0x401F82ECU
- #define **IOMUXC_GPIO_SD_B1_08_SAI3_TX_DATA** 0x401F8178U, 0x3U, 0, 0, 0x401F82ECU
- #define **IOMUXC_GPIO_SD_B1_08_LPSP12_SDO** 0x401F8178U, 0x4U, 0x401F83B8U, 0x2U, 0x401F82ECU
- #define **IOMUXC_GPIO_SD_B1_08_GPIO3_IO28** 0x401F8178U, 0x5U, 0, 0, 0x401F82ECU
- #define **IOMUXC_GPIO_SD_B1_09_USDHC2_DATA5** 0x401F817CU, 0x0U, 0, 0, 0x401F82F0U
- #define **IOMUXC_GPIO_SD_B1_09_FLEXSPI_A_DATA02** 0x401F817CU, 0x1U, 0x401-

- ```

F8370U, 0x0U, 0x401F82F0U
• #define IOMUXC_GPIO_SD_B1_09_ENET_TX_EN 0x401F817CU, 0x2U, 0, 0, 0x401F82F0U
• #define IOMUXC_GPIO_SD_B1_09_SAI3_RX_BCLK 0x401F817CU, 0x3U, 0x401F8470U,
0x0U, 0x401F82F0U
• #define IOMUXC_GPIO_SD_B1_09_LPSPi2_SDI 0x401F817CU, 0x4U, 0x401F83B4U, 0x2U,
0x401F82F0U
• #define IOMUXC_GPIO_SD_B1_09_GPIO3_IO29 0x401F817CU, 0x5U, 0, 0, 0x401F82F0U
• #define IOMUXC_GPIO_SD_B1_10_USDHC2_DATA6 0x401F8180U, 0x0U, 0, 0, 0x401F82-
F4U
• #define IOMUXC_GPIO_SD_B1_10_FLEXSPI_A_DATA01 0x401F8180U, 0x1U, 0x401F836-
CU, 0x0U, 0x401F82F4U
• #define IOMUXC_GPIO_SD_B1_10_ENET_TDATA00 0x401F8180U, 0x2U, 0, 0, 0x401F82-
F4U
• #define IOMUXC_GPIO_SD_B1_10_SAI3_RX_SYNC 0x401F8180U, 0x3U, 0x401F8478U,
0x0U, 0x401F82F4U
• #define IOMUXC_GPIO_SD_B1_10_LPSPi2_PCS2 0x401F8180U, 0x4U, 0, 0, 0x401F82F4U
• #define IOMUXC_GPIO_SD_B1_10_GPIO3_IO30 0x401F8180U, 0x5U, 0, 0, 0x401F82F4U
• #define IOMUXC_GPIO_SD_B1_11_USDHC2_DATA7 0x401F8184U, 0x0U, 0, 0, 0x401F82-
F8U
• #define IOMUXC_GPIO_SD_B1_11_FLEXSPI_A_SS0_B 0x401F8184U, 0x1U, 0, 0, 0x401-
F82F8U
• #define IOMUXC_GPIO_SD_B1_11_ENET_TDATA01 0x401F8184U, 0x2U, 0, 0, 0x401F82-
F8U
• #define IOMUXC_GPIO_SD_B1_11_SAI3_RX_DATA 0x401F8184U, 0x3U, 0x401F8474U,
0x0U, 0x401F82F8U
• #define IOMUXC_GPIO_SD_B1_11_LPSPi2_PCS3 0x401F8184U, 0x4U, 0, 0, 0x401F82F8U
• #define IOMUXC_GPIO_SD_B1_11_GPIO3_IO31 0x401F8184U, 0x5U, 0, 0, 0x401F82F8U
• #define IOMUXC_SNVS_WAKEUP_GPIO5_IO00 0x400A8000U, 0x5U, 0, 0, 0x400A8018U
• #define IOMUXC_SNVS_WAKEUP_NMI_GLUE_NMI 0x400A8000U, 0x7U, 0x401F840CU,
0x1U, 0x400A8018U
• #define IOMUXC_SNVS_PMIC_ON_REQ_SNVS_LP_PMIC_ON_REQ 0x400A8004U, 0x0-
U, 0, 0, 0x400A801CU
• #define IOMUXC_SNVS_PMIC_ON_REQ_GPIO5_IO01 0x400A8004U, 0x5U, 0, 0, 0x400-
A801CU
• #define IOMUXC_SNVS_PMIC_STBY_REQ_CCM_PMIC_VSTBY_REQ 0x400A8008U,
0x0U, 0, 0, 0x400A8020U
• #define IOMUXC_SNVS_PMIC_STBY_REQ_GPIO5_IO02 0x400A8008U, 0x5U, 0, 0, 0x400-
A8020U
• #define IOMUXC_SNVS_TEST_MODE 0, 0, 0, 0, 0x400A800CU
• #define IOMUXC_SNVS_POR_B 0, 0, 0, 0, 0x400A8010U
• #define IOMUXC_SNVS_ONOFF 0, 0, 0, 0, 0x400A8014U

```

## Configuration

- static void [IOMUXC\\_SetPinMux](#) (uint32\_t muxRegister, uint32\_t muxMode, uint32\_t inputRegister, uint32\_t inputDaisy, uint32\_t configRegister, uint32\_t inputOnfield)  
*Sets the IOMUXC pin mux mode.*
- static void [IOMUXC\\_SetPinConfig](#) (uint32\_t muxRegister, uint32\_t muxMode, uint32\_t inputRegister, uint32\_t inputDaisy, uint32\_t configRegister, uint32\_t configValue)  
*Sets the IOMUXC pin configuration.*
- static void [IOMUXC\\_EnableMode](#) (IOMUXC\_GPR\_Type \*base, uint32\_t mode, bool enable)

- *Sets IOMUXC general configuration for some mode.*  
 static void [IOMUXC\\_SetSaiMClkClockSource](#) (IOMUXC\_GPR\_Type \*base, iomuxc\_gpr\_saimclk\_t mclk, uint8\_t clkSrc)
- *Sets IOMUXC general configuration for SAI MCLK selection.*  
 static void [IOMUXC\\_MQSEnterSoftwareReset](#) (IOMUXC\_GPR\_Type \*base, bool enable)
- *Enters or exit MQS software reset.*  
 static void [IOMUXC\\_MQSEnable](#) (IOMUXC\_GPR\_Type \*base, bool enable)
- *Enables or disables MQS.*  
 static void [IOMUXC\\_MQSConfig](#) (IOMUXC\_GPR\_Type \*base, iomuxc\_mqs\_pwm\_oversample\_rate\_t rate, uint8\_t divider)
- *Configure MQS PWM oversampling rate compared with mclk and divider ratio control for mclk from hmclk.*

## 6.2 Macro Definition Documentation

### 6.2.1 #define FSL\_IOMUXC\_DRIVER\_VERSION (MAKE\_VERSION(2, 0, 2))

## 6.3 Function Documentation

### 6.3.1 static void IOMUXC\_SetPinMux ( uint32\_t muxRegister, uint32\_t muxMode, uint32\_t inputRegister, uint32\_t inputDaisy, uint32\_t configRegister, uint32\_t inputOnfield ) [inline], [static]

Note

The first five parameters can be filled with the pin function ID macros.

This is an example to set the PTA6 as the lpuart0\_tx:

```
* IOMUXC_SetPinMux (IOMUXC_PTA6_LPUART0_TX, 0);
*
```

This is an example to set the PTA0 as GPIOA0:

```
* IOMUXC_SetPinMux (IOMUXC_PTA0_GPIOA0, 0);
*
```

Parameters

|                    |                       |
|--------------------|-----------------------|
| <i>muxRegister</i> | The pin mux register. |
| <i>muxMode</i>     | The pin mux mode.     |

|                       |                            |
|-----------------------|----------------------------|
| <i>inputRegister</i>  | The select input register. |
| <i>inputDaisy</i>     | The input daisy.           |
| <i>configRegister</i> | The config register.       |
| <i>inputOnfield</i>   | Software input on field.   |

**6.3.2 static void IOMUXC\_SetPinConfig ( uint32\_t muxRegister, uint32\_t muxMode, uint32\_t inputRegister, uint32\_t inputDaisy, uint32\_t configRegister, uint32\_t configValue ) [inline], [static]**

Note

The previous five parameters can be filled with the pin function ID macros.

This is an example to set pin configuration for IOMUXC\_PTA3\_LPI2C0\_SCL5:

```
* IOMUXC_SetPinConfig(IOMUXC_PTA3_LPI2C0_SCL5, IOMUXC_SW_PAD_CTL_PAD_PUS_MASK |
 IOMUXC_SW_PAD_CTL_PAD_PUS(2U))
*
```

Parameters

|                       |                            |
|-----------------------|----------------------------|
| <i>muxRegister</i>    | The pin mux register.      |
| <i>muxMode</i>        | The pin mux mode.          |
| <i>inputRegister</i>  | The select input register. |
| <i>inputDaisy</i>     | The input daisy.           |
| <i>configRegister</i> | The config register.       |
| <i>configValue</i>    | The pin config value.      |

**6.3.3 static void IOMUXC\_EnableMode ( IOMUXC\_GPR\_Type \* base, uint32\_t mode, bool enable ) [inline], [static]**

Parameters

|               |                                                                       |
|---------------|-----------------------------------------------------------------------|
| <i>base</i>   | The IOMUXC GPR base address.                                          |
| <i>mode</i>   | The mode for setting. the mode is the logical OR of "iomuxc_gpr_mode" |
| <i>enable</i> | True enable false disable.                                            |

**6.3.4 static void IOMUXC\_SetSaiMClkClockSource ( IOMUXC\_GPR\_Type \* *base*, iomuxc\_gpr\_saimclk\_t *mclk*, uint8\_t *clkSrc* ) [inline], [static]**

Parameters

|               |                                                                                      |
|---------------|--------------------------------------------------------------------------------------|
| <i>base</i>   | The IOMUXC GPR base address.                                                         |
| <i>mclk</i>   | The SAI MCLK.                                                                        |
| <i>clkSrc</i> | The clock source. Take refer to register setting details for the clock source in RM. |

**6.3.5 static void IOMUXC\_MQSEnterSoftwareReset ( IOMUXC\_GPR\_Type \* *base*, bool *enable* ) [inline], [static]**

Parameters

|               |                                   |
|---------------|-----------------------------------|
| <i>base</i>   | The IOMUXC GPR base address.      |
| <i>enable</i> | Enter or exit MQS software reset. |

**6.3.6 static void IOMUXC\_MQSEnable ( IOMUXC\_GPR\_Type \* *base*, bool *enable* ) [inline], [static]**

Parameters

|               |                              |
|---------------|------------------------------|
| <i>base</i>   | The IOMUXC GPR base address. |
| <i>enable</i> | Enable or disable the MQS.   |

**6.3.7 static void IOMUXC\_MQSConfig ( IOMUXC\_GPR\_Type \* *base*, iomuxc\_mqs\_pwm\_oversample\_rate\_t *rate*, uint8\_t *divider* ) [inline], [static]**

Parameters

|                |                                                                                                 |
|----------------|-------------------------------------------------------------------------------------------------|
| <i>base</i>    | The IOMUXC GPR base address.                                                                    |
| <i>rate</i>    | The MQS PWM oversampling rate, refer to "iomuxc_mqs_pwm_oversample_rate_t".                     |
| <i>divider</i> | The divider ratio control for mclk from hmclk. $mclk\ freq = 1 / (divider + 1) * hmclk\ freq$ . |

## Chapter 7

# ADC\_ETC: ADC External Trigger Control

### 7.1 Overview

The MCUXpresso SDK provides a peripheral driver for the ADC\_ETC module of MCUXpresso SDK devices.

### 7.2 Typical use case

#### 7.2.1 Software trigger Configuration

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/adc-etc`

#### 7.2.2 Hardware trigger Configuration

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/adc-etc`

### Data Structures

- struct `adc_etc_config_t`  
*ADC\_ETC configuration. [More...](#)*
- struct `adc_etc_trigger_chain_config_t`  
*ADC\_ETC trigger chain configuration. [More...](#)*
- struct `adc_etc_trigger_config_t`  
*ADC\_ETC trigger configuration. [More...](#)*

### Macros

- #define `FSL_ADC_ETC_DRIVER_VERSION` (`MAKE_VERSION(2, 2, 1)`)  
*ADC\_ETC driver version.*
- #define `ADC_ETC_DMA_CTRL_TRGn_REQ_MASK` `0xFF0000U`  
*The mask of status flags cleared by writing 1.*

### Enumerations

- enum `_adc_etc_status_flag_mask`  
*ADC\_ETC customized status flags mask.*
- enum `adc_etc_external_trigger_source_t`  
*External triggers sources.*
- enum `adc_etc_interrupt_enable_t`  
*Interrupt enable/disable mask.*



- enum [adc\\_etc\\_dma\\_mode\\_selection\\_t](#)  
*DMA mode selection.*

## Initialization

- void [ADC\\_ETC\\_Init](#) (ADC\_ETC\_Type \*base, const [adc\\_etc\\_config\\_t](#) \*config)  
*Initialize the ADC\_ETC module.*
- void [ADC\\_ETC\\_Deinit](#) (ADC\_ETC\_Type \*base)  
*De-Initialize the ADC\_ETC module.*
- void [ADC\\_ETC\\_GetDefaultConfig](#) ([adc\\_etc\\_config\\_t](#) \*config)  
*Gets an available pre-defined settings for the ADC\_ETC's configuration.*
- void [ADC\\_ETC\\_SetTriggerConfig](#) (ADC\_ETC\_Type \*base, uint32\_t triggerGroup, const [adc\\_etc\\_trigger\\_config\\_t](#) \*config)  
*Set the external XBAR trigger configuration.*
- void [ADC\\_ETC\\_SetTriggerChainConfig](#) (ADC\_ETC\_Type \*base, uint32\_t triggerGroup, uint32\_t chainGroup, const [adc\\_etc\\_trigger\\_chain\\_config\\_t](#) \*config)  
*Set the external XBAR trigger chain configuration.*
- uint32\_t [ADC\\_ETC\\_GetInterruptStatusFlags](#) (ADC\_ETC\_Type \*base, [adc\\_etc\\_external\\_trigger\\_source\\_t](#) sourceIndex)  
*Gets the interrupt status flags of external XBAR and TSC triggers.*
- void [ADC\\_ETC\\_ClearInterruptStatusFlags](#) (ADC\_ETC\_Type \*base, [adc\\_etc\\_external\\_trigger\\_source\\_t](#) sourceIndex, uint32\_t mask)  
*Clears the ADC\_ETC's interrupt status falgs.*
- static void [ADC\\_ETC\\_EnableDMA](#) (ADC\_ETC\_Type \*base, uint32\_t triggerGroup)  
*Enable the DMA corresponding to each trigger source.*
- static void [ADC\\_ETC\\_DisableDMA](#) (ADC\_ETC\_Type \*base, uint32\_t triggerGroup)  
*Disable the DMA corresponding to each trigger sources.*
- static uint32\_t [ADC\\_ETC\\_GetDMAStatusFlags](#) (ADC\_ETC\_Type \*base)  
*Get the DMA request status falgs.*
- static void [ADC\\_ETC\\_ClearDMAStatusFlags](#) (ADC\_ETC\_Type \*base, uint32\_t mask)  
*Clear the DMA request status falgs.*
- static void [ADC\\_ETC\\_DoSoftwareReset](#) (ADC\_ETC\_Type \*base, bool enable)  
*When enable, all logical will be reset.*
- static void [ADC\\_ETC\\_DoSoftwareTrigger](#) (ADC\_ETC\_Type \*base, uint32\_t triggerGroup)  
*Do software trigger corresponding to each XBAR trigger sources.*
- uint32\_t [ADC\\_ETC\\_GetADCCConversionValue](#) (ADC\_ETC\_Type \*base, uint32\_t triggerGroup, uint32\_t chainGroup)  
*Get ADC conversion result from external XBAR sources.*

## 7.3 Data Structure Documentation

### 7.3.1 struct [adc\\_etc\\_config\\_t](#)

### 7.3.2 struct [adc\\_etc\\_trigger\\_chain\\_config\\_t](#)

### 7.3.3 struct [adc\\_etc\\_trigger\\_config\\_t](#)

## 7.4 Macro Definition Documentation

### 7.4.1 #define FSL\_ADC\_ETC\_DRIVER\_VERSION (MAKE\_VERSION(2, 2, 1))

Version 2.2.1.

### 7.4.2 #define ADC\_ETC\_DMA\_CTRL\_TRGn\_REQ\_MASK 0xFF0000U

## 7.5 Function Documentation

### 7.5.1 void ADC\_ETC\_Init ( ADC\_ETC\_Type \* *base*, const adc\_etc\_config\_t \* *config* )

Parameters

|               |                                          |
|---------------|------------------------------------------|
| <i>base</i>   | ADC_ETC peripheral base address.         |
| <i>config</i> | Pointer to "adc_etc_config_t" structure. |

### 7.5.2 void ADC\_ETC\_Deinit ( ADC\_ETC\_Type \* *base* )

Parameters

|             |                                  |
|-------------|----------------------------------|
| <i>base</i> | ADC_ETC peripheral base address. |
|-------------|----------------------------------|

### 7.5.3 void ADC\_ETC\_GetDefaultConfig ( adc\_etc\_config\_t \* *config* )

This function initializes the ADC\_ETC's configuration structure with available settings. The default values are:

```
* config->enableTSCBypass = true;
* config->enableTSC0Trigger = false;
* config->enableTSC1Trigger = false;
* config->TSC0triggerPriority = 0U;
* config->TSC1triggerPriority = 0U;
* config->clockPreDivider = 0U;
* config->XBARtriggerMask = 0U;
*
```

Parameters

---

|               |                                          |
|---------------|------------------------------------------|
| <i>config</i> | Pointer to "adc_etc_config_t" structure. |
|---------------|------------------------------------------|

#### 7.5.4 void ADC\_ETC\_SetTriggerConfig ( ADC\_ETC\_Type \* *base*, uint32\_t *triggerGroup*, const adc\_etc\_trigger\_config\_t \* *config* )

Parameters

|                     |                                                  |
|---------------------|--------------------------------------------------|
| <i>base</i>         | ADC_ETC peripheral base address.                 |
| <i>triggerGroup</i> | Trigger group index.                             |
| <i>config</i>       | Pointer to "adc_etc_trigger_config_t" structure. |

#### 7.5.5 void ADC\_ETC\_SetTriggerChainConfig ( ADC\_ETC\_Type \* *base*, uint32\_t *triggerGroup*, uint32\_t *chainGroup*, const adc\_etc\_trigger\_chain\_config\_t \* *config* )

For example, if *triggerGroup* is set to 0U and *chainGroup* is set to 1U, which means Trigger0 source's chain1 would be configurated.

Parameters

|                     |                                                        |
|---------------------|--------------------------------------------------------|
| <i>base</i>         | ADC_ETC peripheral base address.                       |
| <i>triggerGroup</i> | Trigger group index. Available number is 0~7.          |
| <i>chainGroup</i>   | Trigger chain group index. Available number is 0~7.    |
| <i>config</i>       | Pointer to "adc_etc_trigger_chain_config_t" structure. |

#### 7.5.6 uint32\_t ADC\_ETC\_GetInterruptStatusFlags ( ADC\_ETC\_Type \* *base*, adc\_etc\_external\_trigger\_source\_t *sourceIndex* )

Parameters

|             |                                  |
|-------------|----------------------------------|
| <i>base</i> | ADC_ETC peripheral base address. |
|-------------|----------------------------------|

|                    |                       |
|--------------------|-----------------------|
| <i>sourceIndex</i> | trigger source index. |
|--------------------|-----------------------|

Returns

Status flags mask of trigger. Refer to "\_adc\_etc\_status\_flag\_mask".

**7.5.7 void ADC\_ETC\_ClearInterruptStatusFlags ( ADC\_ETC\_Type \* *base*,  
adc\_etc\_external\_trigger\_source\_t *sourceIndex*, uint32\_t *mask* )**

Parameters

|                    |                                                                     |
|--------------------|---------------------------------------------------------------------|
| <i>base</i>        | ADC_ETC peripheral base address.                                    |
| <i>sourceIndex</i> | trigger source index.                                               |
| <i>mask</i>        | Status flags mask of trigger. Refer to "_adc_etc_status_flag_mask". |

**7.5.8 static void ADC\_ETC\_EnableDMA ( ADC\_ETC\_Type \* *base*, uint32\_t  
*triggerGroup* ) [inline], [static]**

Parameters

|                     |                                               |
|---------------------|-----------------------------------------------|
| <i>base</i>         | ADC_ETC peripheral base address.              |
| <i>triggerGroup</i> | Trigger group index. Available number is 0~7. |

**7.5.9 static void ADC\_ETC\_DisableDMA ( ADC\_ETC\_Type \* *base*, uint32\_t  
*triggerGroup* ) [inline], [static]**

Parameters

|                     |                                               |
|---------------------|-----------------------------------------------|
| <i>base</i>         | ADC_ETC peripheral base address.              |
| <i>triggerGroup</i> | Trigger group index. Available number is 0~7. |

**7.5.10 static uint32\_t ADC\_ETC\_GetDMAStatusFlags ( ADC\_ETC\_Type \* *base* )  
[inline], [static]**

Only external XBAR sources support DMA request.

## Parameters

|             |                                  |
|-------------|----------------------------------|
| <i>base</i> | ADC_ETC peripheral base address. |
|-------------|----------------------------------|

## Returns

Mask of external XBAR trigger's DMA request asserted flags. Available range is trigger0:0x01 to trigger7:0x80.

### 7.5.11 `static void ADC_ETC_ClearDMAStatusFlags ( ADC_ETC_Type * base, uint32_t mask ) [inline], [static]`

Only external XBAR sources support DMA request.

## Parameters

|             |                                                                                                                |
|-------------|----------------------------------------------------------------------------------------------------------------|
| <i>base</i> | ADC_ETC peripheral base address.                                                                               |
| <i>mask</i> | Mask of external XBAR trigger's DMA request asserted flags. Available range is trigger0:0x01 to trigger7:0x80. |

### 7.5.12 `static void ADC_ETC_DoSoftwareReset ( ADC_ETC_Type * base, bool enable ) [inline], [static]`

## Parameters

|               |                                    |
|---------------|------------------------------------|
| <i>base</i>   | ADC_ETC peripheral base address.   |
| <i>enable</i> | Enable/Disable the software reset. |

### 7.5.13 `static void ADC_ETC_DoSoftwareTrigger ( ADC_ETC_Type * base, uint32_t triggerGroup ) [inline], [static]`

Each XBAR trigger sources can be configured as HW or SW trigger mode. In hardware trigger mode, trigger source is from XBAR. In software mode, trigger source is from software trigger. TSC trigger sources can only work in hardware trigger mode.

## Parameters

|                     |                                               |
|---------------------|-----------------------------------------------|
| <i>base</i>         | ADC_ETC peripheral base address.              |
| <i>triggerGroup</i> | Trigger group index. Available number is 0~7. |

#### 7.5.14 uint32\_t ADC\_ETC\_GetADCConversionValue ( ADC\_ETC\_Type \* *base*, uint32\_t *triggerGroup*, uint32\_t *chainGroup* )

For example, if *triggerGroup* is set to 0U and *chainGroup* is set to 1U, which means the API would return Trigger0 source's chain1 conversion result.

## Parameters

|                     |                                                     |
|---------------------|-----------------------------------------------------|
| <i>base</i>         | ADC_ETC peripheral base address.                    |
| <i>triggerGroup</i> | Trigger group index. Available number is 0~7.       |
| <i>chainGroup</i>   | Trigger chain group index. Available number is 0~7. |

## Returns

ADC conversion result value.

# Chapter 8

## AIPSTZ: AHB to IP Bridge

### 8.1 Overview

The MCUXpresso SDK provides a driver for the AHB-to-IP Bridge (AIPSTZ) of MCUXpresso SDK devices.

### Enumerations

- enum `aipstz_master_privilege_level_t` {  
    [kAIPSTZ\\_MasterBufferedWriteEnable](#) = (1U << 3),  
    [kAIPSTZ\\_MasterTrustedForReadEnable](#) = (1U << 2),  
    [kAIPSTZ\\_MasterTrustedForWriteEnable](#) = (1U << 1),  
    [kAIPSTZ\\_MasterForceUserModeEnable](#) = 1U }  
    *List of AIPSTZ privilege configuration.*
- enum `aipstz_master_t`  
    *List of AIPSTZ masters.*
- enum `aipstz_peripheral_access_control_t`  
    *List of AIPSTZ peripheral access control configuration.*
- enum `aipstz_peripheral_t`  
    *List of AIPSTZ peripherals.*

### Driver version

- #define `FSL_AIPSTZ_DRIVER_VERSION` (MAKE\_VERSION(2, 0, 1))  
    *Version 2.0.1.*

### Initialization and deinitialization

- void `AIPSTZ_SetMasterPrivilegeLevel` (AIPSTZ\_Type \*base, `aipstz_master_t` master, uint32\_t privilegeConfig)  
    *Configure the privilege level for master.*
- void `AIPSTZ_SetPeripheralAccessControl` (AIPSTZ\_Type \*base, `aipstz_peripheral_t` peripheral, uint32\_t accessControl)  
    *Configure the access for peripheral.*

## 8.2 Enumeration Type Documentation

### 8.2.1 enum `aipstz_master_privilege_level_t`

Enumerator

**`kAIPSTZ_MasterBufferedWriteEnable`** Write accesses from this master are allowed to be buffered.

- kAIPSTZ\_MasterTrustedForReadEnable*** This master is trusted for read accesses.
- kAIPSTZ\_MasterTrustedForWriteEnable*** This master is trusted for write accesses.
- kAIPSTZ\_MasterForceUserModeEnable*** Accesses from this master are forced to user-mode.

### 8.2.2 enum aipstz\_master\_t

Organized by width for the 8-15 bits and shift for lower 8 bits.

### 8.2.3 enum aipstz\_peripheral\_access\_control\_t

### 8.2.4 enum aipstz\_peripheral\_t

Organized by register offset for higher 32 bits, width for the 8-15 bits and shift for lower 8 bits.

## 8.3 Function Documentation

### 8.3.1 void AIPSTZ\_SetMasterPriviledgeLevel ( AIPSTZ\_Type \* *base*, aipstz\_master\_t *master*, uint32\_t *privilegeConfig* )

Parameters

|                        |                                                                              |
|------------------------|------------------------------------------------------------------------------|
| <i>base</i>            | AIPSTZ peripheral base pointer                                               |
| <i>master</i>          | Masters for AIPSTZ.                                                          |
| <i>privilegeConfig</i> | Configuration is ORed from <a href="#">aipstz_master_privilege_level_t</a> . |

### 8.3.2 void AIPSTZ\_SetPeripheralAccessControl ( AIPSTZ\_Type \* *base*, aipstz\_peripheral\_t *peripheral*, uint32\_t *accessControl* )

Parameters

|                   |                                |
|-------------------|--------------------------------|
| <i>base</i>       | AIPSTZ peripheral base pointer |
| <i>peripheral</i> | Peripheral for AIPSTZ.         |



|                      |                                                                                 |
|----------------------|---------------------------------------------------------------------------------|
| <i>accessControl</i> | Configuration is ORed from <a href="#">aipstz_peripheral_access_control_t</a> . |
|----------------------|---------------------------------------------------------------------------------|

## Chapter 9

# AOI: Crossbar AND/OR/INVERT Driver

### 9.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Crossbar AND/OR/INVERT (AOI) block of MCUXpresso SDK devices.

The AOI module supports a configurable number of event outputs, where each event output represents a user-programmed combinational boolean function based on four event inputs. The key features of this module include:

- Four dedicated inputs for each event output
- User-programmable combinational boolean function evaluation for each event output
- Memory-mapped device connected to a slave peripheral (IPS) bus
- Configurable number of event outputs

### 9.2 Function groups

#### 9.2.1 AOI Initialization

To initialize the AOI driver, call the [AOI\\_Init\(\)](#) function and pass a baseaddr pointer.

See the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/aoi`.

#### 9.2.2 AOI Get Set Operation

The AOI module provides a universal boolean function generator using a four-term sum of products expression with each product term containing true or complement values of the four selected event inputs (A, B, C, D). The AOI is a highly programmable module for creating combinational boolean outputs for use as hardware triggers. Each selected input term in each product term can be configured to produce a logical 0 or 1 or pass the true or complement of the selected event input. To configure the selected AOI module event, call the API of the [AOI\\_SetEventLogicConfig\(\)](#) function. To get the current event state configure, call the API of [AOI\\_GetEventLogicConfig\(\)](#) function. The AOI module does not support any special modes of operation. See the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/aoi`.

### 9.3 Typical use case

The AOI module is designed to be integrated in conjunction with one or more inter-peripheral crossbar switch (XBAR) modules. A crossbar switch is typically used to select the 4\*n AOI inputs from among available peripheral outputs and GPIO signals. The n EVENTn outputs from the AOI module are typically

used as additional inputs to a second crossbar switch, adding to it the ability to connect to its outputs an arbitrary 4-input boolean function of its other inputs.

This is an example to initialize and configure the AOI driver for a possible use case. Because the AOI module function is directly connected with an XBAR (Inter-peripheral crossbar) module, other peripheral drivers (PIT, CMP, and XBAR) are used to show full functionality of AOI module.

For example: Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver-examples/aoi`

## Data Structures

- struct `aoi_event_config_t`  
*AOI event configuration structure. [More...](#)*

## Macros

- #define `AOI_AOI0`  
*AOI peripheral address.*

## Enumerations

- enum `aoi_input_config_t` {  
`kAOI_LogicZero = 0x0U,`  
`kAOI_InputSignal = 0x1U,`  
`kAOI_InvInputSignal = 0x2U,`  
`kAOI_LogicOne = 0x3U }`  
*AOI input configurations.*
- enum `aoi_event_t` {  
`kAOI_Event0 = 0x0U,`  
`kAOI_Event1 = 0x1U,`  
`kAOI_Event2 = 0x2U,`  
`kAOI_Event3 = 0x3U }`  
*AOI event indexes, where an event is the collection of the four product terms (0, 1, 2, and 3) and the four signal inputs (A, B, C, and D).*

## Driver version

- #define `FSL_AOI_DRIVER_VERSION` (`MAKE_VERSION(2, 0, 1)`)  
*Version 2.0.1.*

## AOI Initialization

- void `AOI_Init` (`AOI_Type *base`)  
*Initializes an AOI instance for operation.*
- void `AOI_Deinit` (`AOI_Type *base`)  
*Deinitializes an AOI instance for operation.*

## AOI Get Set Operation

- void [AOI\\_GetEventLogicConfig](#) (AOI\_Type \*base, [aoi\\_event\\_t](#) event, [aoi\\_event\\_config\\_t](#) \*config)  
*Gets the Boolean evaluation associated.*
- void [AOI\\_SetEventLogicConfig](#) (AOI\_Type \*base, [aoi\\_event\\_t](#) event, const [aoi\\_event\\_config\\_t](#) \*eventConfig)  
*Configures an AOI event.*

## 9.4 Data Structure Documentation

### 9.4.1 struct [aoi\\_event\\_config\\_t](#)

Defines structure [\\_aoi\\_event\\_config](#) and use the [AOI\\_SetEventLogicConfig\(\)](#) function to make whole event configuration.

#### Data Fields

- [aoi\\_input\\_config\\_t](#) PT0AC  
*Product term 0 input A.*
- [aoi\\_input\\_config\\_t](#) PT0BC  
*Product term 0 input B.*
- [aoi\\_input\\_config\\_t](#) PT0CC  
*Product term 0 input C.*
- [aoi\\_input\\_config\\_t](#) PT0DC  
*Product term 0 input D.*
- [aoi\\_input\\_config\\_t](#) PT1AC  
*Product term 1 input A.*
- [aoi\\_input\\_config\\_t](#) PT1BC  
*Product term 1 input B.*
- [aoi\\_input\\_config\\_t](#) PT1CC  
*Product term 1 input C.*
- [aoi\\_input\\_config\\_t](#) PT1DC  
*Product term 1 input D.*
- [aoi\\_input\\_config\\_t](#) PT2AC  
*Product term 2 input A.*
- [aoi\\_input\\_config\\_t](#) PT2BC  
*Product term 2 input B.*
- [aoi\\_input\\_config\\_t](#) PT2CC  
*Product term 2 input C.*
- [aoi\\_input\\_config\\_t](#) PT2DC  
*Product term 2 input D.*
- [aoi\\_input\\_config\\_t](#) PT3AC  
*Product term 3 input A.*
- [aoi\\_input\\_config\\_t](#) PT3BC  
*Product term 3 input B.*
- [aoi\\_input\\_config\\_t](#) PT3CC  
*Product term 3 input C.*
- [aoi\\_input\\_config\\_t](#) PT3DC  
*Product term 3 input D.*

## 9.5 Macro Definition Documentation

### 9.5.1 #define FSL\_AOI\_DRIVER\_VERSION (MAKE\_VERSION(2, 0, 1))

## 9.6 Enumeration Type Documentation

### 9.6.1 enum aoi\_input\_config\_t

The selection item represents the Boolean evaluations.

Enumerator

- kAOI\_LogicZero* Forces the input to logical zero.
- kAOI\_InputSignal* Passes the input signal.
- kAOI\_InvInputSignal* Inverts the input signal.
- kAOI\_LogicOne* Forces the input to logical one.

### 9.6.2 enum aoi\_event\_t

Enumerator

- kAOI\_Event0* Event 0 index.
- kAOI\_Event1* Event 1 index.
- kAOI\_Event2* Event 2 index.
- kAOI\_Event3* Event 3 index.

## 9.7 Function Documentation

### 9.7.1 void AOI\_Init ( AOI\_Type \* *base* )

This function un-gates the AOI clock.

Parameters

|             |                         |
|-------------|-------------------------|
| <i>base</i> | AOI peripheral address. |
|-------------|-------------------------|

### 9.7.2 void AOI\_Deinit ( AOI\_Type \* *base* )

This function shutdowns AOI module.

## Parameters

|             |                         |
|-------------|-------------------------|
| <i>base</i> | AOI peripheral address. |
|-------------|-------------------------|

### 9.7.3 void AOI\_GetEventLogicConfig ( AOI\_Type \* *base*, aoi\_event\_t *event*, aoi\_event\_config\_t \* *config* )

This function returns the Boolean evaluation associated.

Example:

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

## Parameters

|               |                                                           |
|---------------|-----------------------------------------------------------|
| <i>base</i>   | AOI peripheral address.                                   |
| <i>event</i>  | Index of the event which will be set of type aoi_event_t. |
| <i>config</i> | Selected input configuration .                            |

### 9.7.4 void AOI\_SetEventLogicConfig ( AOI\_Type \* *base*, aoi\_event\_t *event*, const aoi\_event\_config\_t \* *eventConfig* )

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

Example:

```
aoi_event_config_t demoEventLogicStruct;

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

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

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

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

```
demoEventLogicStruct.PT3DC = kAOI_LogicOne;
AOI_SetEventLogicConfig(AOI, kAOI_Event0, demoEventLogicStruct);
```

### Parameters

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

# Chapter 10

## BEE: Bus Encryption Engine

### 10.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Bus Encryption Engine (BEE) module.

The BEE module is implemented as an on-the-fly decryption engine. The main features of the BEE module are:

- Standard AXI interconnection
- On-the-fly AES-128 decryption, supporting ECB and CTR mode
- Aliased memory space support. Address remapping for up to two individual regions
- Independent AES Key management for those two individual regions
- Bus access pattern optimization with the aid of local store and forward buffer
- Non-secured access filtering based on security label of the access
- Illegal access check and filtering.

The known hardware limitations of the BEE module are as follows:

- Only supports 128 bits data width AXI interconnection
- Only supports 16-byte burst access size. For a single transaction, the minimum supported access size is limited to 4 bytes.
- Granularity of the address bias is 128 KB per step

### 10.2 BEE Driver Initialization and Configuration

The function [BEE\\_Init\(\)](#) initializes the BEE to default values. The function [BEE\\_GetDefaultConfig\(\)](#) loads default values to the BEE configuration structure. The default values are described below.

See the driver examples codes located at <SDK\_ROOT>/boards/<BOARD>/driver\_examples/bee. The function [BEE\\_Deinit\(\)](#) performs a hardware reset of BEE module and disables clocks. Configuration and keys from software for both regions are cleared.

### 10.3 Enable & Disable BEE

The function [BEE\\_Enable\(\)](#) enables decryption using BEE. The function [BEE\\_Disable\(\)](#) disables decryption using BEE.

### 10.4 Set BEE region config and key

The function [BEE\\_SetConfig\(\)](#) sets BEE settings according to given configuration structure. The structure is described below.

See the driver examples codes located at <SDK\_ROOT>/boards/<BOARD>/driver\_examples/bee. The function [BEE\\_SetRegionKey\(\)](#) loads given AES key to BEE register for the given region. The key must be 32-bit aligned and stored in little-endian format. Note that eFuse BEE\_KEYx\_SEL must be set



accordingly to be able to load and use the key loaded in BEE registers. Otherwise, the key cannot be loaded and BEE uses the key from OTPMK or SW\_GP2.

The function [BEE\\_SetRegionNonce\(\)](#) loads given AES nonce (used only for AES CTR mode) to BEE register for the given region. The nonce must be 32-bit aligned and stored in little-endian format.

## 10.5 Status

Provides functions to get and clear the BEE status.

The function [BEE\\_GetStatusFlags\(\)](#) returns status of BEE peripheral. The function [BEE\\_ClearStatusFlags\(\)](#) clears the BEE status flags.

### 10.5.1 BEE example

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/bee`

## Data Structures

- struct [bee\\_region\\_config\\_t](#)  
*BEE region configuration structure. [More...](#)*

## Enumerations

- enum [bee\\_aes\\_mode\\_t](#) {  
  [kBEE\\_AesEcbMode](#) = 0U,  
  [kBEE\\_AesCtrMode](#) = 1U }  
*BEE aes mode.*
- enum [bee\\_region\\_t](#) {  
  [kBEE\\_Region0](#) = 0U,  
  [kBEE\\_Region1](#) = 1U }  
*BEE region.*
- enum [bee\\_ac\\_prot\\_enable](#) {  
  [kBEE\\_AccessProtDisabled](#) = 0U,  
  [kBEE\\_AccessProtEnabled](#) = 1U }  
*BEE ac prot enable.*
- enum [bee\\_endian\\_swap\\_enable](#) {  
  [kBEE\\_EndianSwapDisabled](#) = 1U,  
  [kBEE\\_EndianSwapEnabled](#) = 0U }  
*BEE endian swap enable.*
- enum [bee\\_security\\_level](#) {  
  [kBEE\\_SecurityLevel0](#) = 0U,  
  [kBEE\\_SecurityLevel1](#) = 1U,  
  [kBEE\\_SecurityLevel2](#) = 2U,  
  [kBEE\\_SecurityLevel3](#) = 3U }  
*BEE security level.*

- enum `bee_status_flags_t` {  
`kBEE_DisableAbortFlag` = 1U,  
`kBEE_Reg0ReadSecViolation` = 2U,  
`kBEE_ReadIllegalAccess` = 4U,  
`kBEE_Reg1ReadSecViolation` = 8U,  
`kBEE_Reg0AccessViolation` = 16U,  
`kBEE_Reg1AccessViolation` = 32U,  
`kBEE_IdleFlag` = `BEE_STATUS_BEE_IDLE_MASK` }  
*BEE status flags.*

## Functions

- void `BEE_Init` (`BEE_Type *base`)  
*Resets BEE module to factory default values.*
- void `BEE_Deinit` (`BEE_Type *base`)  
*Resets BEE module, clears keys for both regions and disables clock to the BEE.*
- static void `BEE_Enable` (`BEE_Type *base`)  
*Enables BEE decryption.*
- static void `BEE_Disable` (`BEE_Type *base`)  
*Disables BEE decryption.*
- void `BEE_GetDefaultConfig` (`bee_region_config_t *config`)  
*Loads default values to the BEE region configuration structure.*
- void `BEE_SetConfig` (`BEE_Type *base`, const `bee_region_config_t *config`)  
*Sets BEE configuration.*
- `status_t` `BEE_SetRegionKey` (`BEE_Type *base`, `bee_region_t` region, const `uint8_t *key`, `size_t keySize`)  
*Loads the AES key for selected region into BEE key registers.*
- `status_t` `BEE_SetRegionNonce` (`BEE_Type *base`, `bee_region_t` region, const `uint8_t *nonce`, `size_t nonceSize`)  
*Loads the nonce for selected region into BEE nonce registers.*
- `uint32_t` `BEE_GetStatusFlags` (`BEE_Type *base`)  
*Gets the BEE status flags.*
- void `BEE_ClearStatusFlags` (`BEE_Type *base`, `uint32_t mask`)  
*Clears the BEE status flags.*

## Driver version

- `#define` `FSL_BEE_DRIVER_VERSION` (`MAKE_VERSION(2, 0, 2)`)  
*BEE driver version.*

## 10.6 Data Structure Documentation

### 10.6.1 struct `bee_region_config_t`

#### Data Fields

- `bee_aes_mode_t` `region0Mode`  
*AES mode used for encryption/decryption for region 0.*

- [bee\\_aes\\_mode\\_t region1Mode](#)  
*AES mode used for encryption/decryption for region 1.*
- [uint32\\_t region0AddrOffset](#)  
*Region 0 address offset.*
- [uint32\\_t region1AddrOffset](#)  
*Region 1 address offset.*
- [bee\\_security\\_level region0SecLevel](#)  
*Region 0 security level.*
- [bee\\_security\\_level region1SecLevel](#)  
*Region 1 security level.*
- [uint32\\_t region1Bot](#)  
*Region 1 bottom address.*
- [uint32\\_t region1Top](#)  
*Region 1 top address.*
- [bee\\_ac\\_prot\\_enable accessPermission](#)  
*Access permission control enable/disable.*
- [bee\\_endian\\_swap\\_enable endianSwapEn](#)  
*Endian swap enable/disable.*

## 10.7 Macro Definition Documentation

### 10.7.1 #define FSL\_BEE\_DRIVER\_VERSION (MAKE\_VERSION(2, 0, 2))

Version 2.0.2.

Current version: 2.0.2

Change log:

- 2.0.2
  - Bug Fixes
    - \* Fixed MISRA issue.
- 2.0.1
  - Bug Fixes
    - \* Fixed bug in key user key loading sequence. BEE must be enabled during loading of user key.
    - \* Fixed typos in comments.
  - New Features
    - \* Added configuration setting for endian swap, access permission and region security level.
  - Improvements
    - \* Setting of AES nonce was moved from [BEE\\_SetRegionKey\(\)](#) into separate [BEE\\_SetRegionNonce\(\)](#) function.
      - Changed handling of region settings. Both regions are configured simultaneously by [BEE\\_SetConfig\(\)](#) function. Configuration of FAC start and end address using IOM-UXC\_GPRs was moved to application.
    - \* Default value for region address offset was changed to 0.
- 2.0.0
  - Initial version

## 10.8 Enumeration Type Documentation

### 10.8.1 enum bee\_aes\_mode\_t

Enumerator

*kBEE\_AesEcbMode* AES ECB Mode.

*kBEE\_AesCtrMode* AES CTR Mode.

### 10.8.2 enum bee\_region\_t

Enumerator

*kBEE\_Region0* BEE region 0.

*kBEE\_Region1* BEE region 1.

### 10.8.3 enum bee\_ac\_prot\_enable

Enumerator

*kBEE\_AccessProtDisabled* BEE access permission control disabled.

*kBEE\_AccessProtEnabled* BEE access permission control enabled.

### 10.8.4 enum bee\_endian\_swap\_enable

Enumerator

*kBEE\_EndianSwapDisabled* BEE endian swap disabled.

*kBEE\_EndianSwapEnabled* BEE endian swap enabled.

### 10.8.5 enum bee\_security\_level

Enumerator

*kBEE\_SecurityLevel0* BEE security level 0.

*kBEE\_SecurityLevel1* BEE security level 1.

*kBEE\_SecurityLevel2* BEE security level 2.

*kBEE\_SecurityLevel3* BEE security level 3.

## 10.8.6 enum bee\_status\_flags\_t

Enumerator

*kBEE\_DisableAbortFlag* Disable abort flag.  
*kBEE\_Reg0ReadSecViolation* Region-0 read channel security violation.  
*kBEE\_ReadIllegalAccess* Read channel illegal access detected.  
*kBEE\_Reg1ReadSecViolation* Region-1 read channel security violation.  
*kBEE\_Reg0AccessViolation* Protected region-0 access violation.  
*kBEE\_Reg1AccessViolation* Protected region-1 access violation.  
*kBEE\_IdleFlag* Idle flag.

## 10.9 Function Documentation

### 10.9.1 void BEE\_Init ( BEE\_Type \* *base* )

This function performs hardware reset of BEE module. Attributes and keys from software for both regions are cleared.

Parameters

|             |                         |
|-------------|-------------------------|
| <i>base</i> | BEE peripheral address. |
|-------------|-------------------------|

### 10.9.2 void BEE\_Deinit ( BEE\_Type \* *base* )

This function performs hardware reset of BEE module and disables clocks. Attributes and keys from software for both regions are cleared.

Parameters

|             |                         |
|-------------|-------------------------|
| <i>base</i> | BEE peripheral address. |
|-------------|-------------------------|

### 10.9.3 static void BEE\_Enable ( BEE\_Type \* *base* ) [inline], [static]

This function enables decryption using BEE.

Parameters

---

|             |                         |
|-------------|-------------------------|
| <i>base</i> | BEE peripheral address. |
|-------------|-------------------------|

#### 10.9.4 static void BEE\_Disable ( BEE\_Type \* *base* ) [inline], [static]

This function disables decryption using BEE.

Parameters

|             |                         |
|-------------|-------------------------|
| <i>base</i> | BEE peripheral address. |
|-------------|-------------------------|

#### 10.9.5 void BEE\_GetDefaultConfig ( bee\_region\_config\_t \* *config* )

Loads default values to the BEE region configuration structure. The default values are as follows:

```
* config->region0Mode = kBEE_AesCtrMode;
* config->region1Mode = kBEE_AesCtrMode;
* config->region0AddrOffset = 0U;
* config->region1AddrOffset = 0U;
* config->region0SecLevel = kBEE_SecurityLevel3;
* config->region1SecLevel = kBEE_SecurityLevel3;
* config->region1Bot = 0U;
* config->region1Top = 0U;
* config->accessPermission = kBEE_AccessProtDisabled;
* config->endianSwapEn = kBEE_EndianSwapEnabled;
*
```

Parameters

|               |                                             |
|---------------|---------------------------------------------|
| <i>config</i> | Configuration structure for BEE peripheral. |
|---------------|---------------------------------------------|

#### 10.9.6 void BEE\_SetConfig ( BEE\_Type \* *base*, const bee\_region\_config\_t \* *config* )

This function sets BEE peripheral and BEE region settings according to given configuration structure.

Parameters

|             |                         |
|-------------|-------------------------|
| <i>base</i> | BEE peripheral address. |
|-------------|-------------------------|

|               |                                  |
|---------------|----------------------------------|
| <i>config</i> | Configuration structure for BEE. |
|---------------|----------------------------------|

### 10.9.7 **status\_t BEE\_SetRegionKey ( BEE\_Type \* *base*, bee\_region\_t *region*, const uint8\_t \* *key*, size\_t *keySize* )**

This function loads given AES key to BEE register for the given region. The key must be 32-bit aligned and stored in little-endian format.

Please note, that eFuse BEE\_KEYx\_SEL must be set accordingly to be able to load and use key loaded in BEE registers. Otherwise, key cannot be loaded and BEE will use key from OTPMK or SW\_GP2.

Parameters

|                |                                               |
|----------------|-----------------------------------------------|
| <i>base</i>    | BEE peripheral address.                       |
| <i>region</i>  | Selection of the BEE region to be configured. |
| <i>key</i>     | AES key (in little-endian format).            |
| <i>keySize</i> | Size of AES key.                              |

### 10.9.8 **status\_t BEE\_SetRegionNonce ( BEE\_Type \* *base*, bee\_region\_t *region*, const uint8\_t \* *nonce*, size\_t *nonceSize* )**

This function loads given nonce (only AES CTR mode) to BEE register for the given region. The nonce must be 32-bit aligned and stored in little-endian format.

Parameters

|                  |                                               |
|------------------|-----------------------------------------------|
| <i>base</i>      | BEE peripheral address.                       |
| <i>region</i>    | Selection of the BEE region to be configured. |
| <i>nonce</i>     | AES nonce (in little-endian format).          |
| <i>nonceSize</i> | Size of AES nonce.                            |

### 10.9.9 **uint32\_t BEE\_GetStatusFlags ( BEE\_Type \* *base* )**

This function returns status of BEE peripheral.

Parameters

|             |                         |
|-------------|-------------------------|
| <i>base</i> | BEE peripheral address. |
|-------------|-------------------------|

Returns

The status flags. This is the logical OR of members of the enumeration [bee\\_status\\_flags\\_t](#)

**10.9.10 void BEE\_ClearStatusFlags ( BEE\_Type \* *base*, uint32\_t *mask* )**

Parameters

|             |                                                                                                                  |
|-------------|------------------------------------------------------------------------------------------------------------------|
| <i>base</i> | BEE peripheral base address.                                                                                     |
| <i>mask</i> | The status flags to clear. This is a logical OR of members of the enumeration <a href="#">bee_status_flags_t</a> |



# Chapter 11

## CACHE: ARMV7-M7 CACHE Memory Controller

### 11.1 Overview

The MCUXpresso SDK provides a peripheral driver for the CACHE Controller of MCUXpresso SDK devices.

The CACHE driver is created to help the user more easily operate the cache memory. The APIs for basic operations are including the following three levels:

1L. The L1 cache driver API. This level provides the level 1 caches controller drivers. The L1 caches are mainly integrated in the Core memory system, Cortex-M7 L1 caches, etc. For our Cortex-M4 series platforms, the L1 cache is the local memory controller (LMEM) which is not integrated in the Cortex-M4 processor memory system.

2L. The L2 cache driver API. This level provides the level 2 cache controller drivers. The L2 cache could be integrated in the CORE memory system or an external L2 cache memory, PL310, etc.

3L. The combined cache driver API. This level provides many APIs for combined L1 and L2 cache maintain operations. This is provided for MCUXpresso SDK drivers (DMA, ENET, USDHC, etc) which should do the cache maintenance in their transactional APIs.

### 11.2 Function groups

#### 11.2.1 L1 CACHE Operation

The L1 CACHE has both code cache and data cache. This function group provides independent two groups API for both code cache and data cache. There are Enable/Disable APIs for code cache and data cache control and cache maintenance operations as Invalidate/Clean/CleanInvalidate by all and by address range.

#### 11.2.2 L2 CACHE Operation

The L2 CACHE does not divide the cache to data and code. Instead, this function group provides one group cache maintenance operations as Enable/Disable/Invalidate/Clean/CleanInvalidate by all and by address range. Except the maintenance operation APIs, the L2 CACHE has it's initialization/configure API. The user can use the default configure parameter by calling `L2CACHE_GetDefaultConfig()` or changing the parameters as they wish. Then, call `L2CACHE_Init` to do the L2 CACHE initialization. After initialization, the L2 cache can then be enabled.

Note: For the core external l2 Cache, the SoC usually has the control bit to select the SRAM to use as L2 Cache or normal SRAM. Make sure this selection is right when you use the L2 CACHE feature.

## Driver version

- #define **FSL\_CACHE\_DRIVER\_VERSION** (MAKE\_VERSION(2, 0, 4))  
*cache driver version 2.0.4.*

## Control for cortex-m7 L1 cache

- static void **L1CACHE\_EnableICache** (void)  
*Enables cortex-m7 L1 instruction cache.*
- static void **L1CACHE\_DisableICache** (void)  
*Disables cortex-m7 L1 instruction cache.*
- static void **L1CACHE\_InvalidateICache** (void)  
*Invalidate cortex-m7 L1 instruction cache.*
- void **L1CACHE\_InvalidateICacheByRange** (uint32\_t address, uint32\_t size\_byte)  
*Invalidate cortex-m7 L1 instruction cache by range.*
- static void **L1CACHE\_EnableDCache** (void)  
*Enables cortex-m7 L1 data cache.*
- static void **L1CACHE\_DisableDCache** (void)  
*Disables cortex-m7 L1 data cache.*
- static void **L1CACHE\_InvalidateDCache** (void)  
*Invalidates cortex-m7 L1 data cache.*
- static void **L1CACHE\_CleanDCache** (void)  
*Cleans cortex-m7 L1 data cache.*
- static void **L1CACHE\_CleanInvalidateDCache** (void)  
*Cleans and Invalidates cortex-m7 L1 data cache.*
- static void **L1CACHE\_InvalidateDCacheByRange** (uint32\_t address, uint32\_t size\_byte)  
*Invalidates cortex-m7 L1 data cache by range.*
- static void **L1CACHE\_CleanDCacheByRange** (uint32\_t address, uint32\_t size\_byte)  
*Cleans cortex-m7 L1 data cache by range.*
- static void **L1CACHE\_CleanInvalidateDCacheByRange** (uint32\_t address, uint32\_t size\_byte)  
*Cleans and Invalidates cortex-m7 L1 data cache by range.*

## Unified Cache Control for all caches (cortex-m7 L1 cache + I2 pl310)

Mainly used for many drivers for easy cache operation.

- void **ICACHE\_InvalidateByRange** (uint32\_t address, uint32\_t size\_byte)  
*Invalidates all instruction caches by range.*
- void **DCACHE\_InvalidateByRange** (uint32\_t address, uint32\_t size\_byte)  
*Invalidates all data caches by range.*
- void **DCACHE\_CleanByRange** (uint32\_t address, uint32\_t size\_byte)  
*Cleans all data caches by range.*
- void **DCACHE\_CleanInvalidateByRange** (uint32\_t address, uint32\_t size\_byte)  
*Cleans and Invalidates all data caches by range.*

## 11.3 Macro Definition Documentation

### 11.3.1 #define FSL\_CACHE\_DRIVER\_VERSION (MAKE\_VERSION(2, 0, 4))

## 11.4 Function Documentation

11.4.1 void L1CACHE\_InvalidateICacheByRange ( uint32\_t *address*, uint32\_t *size\_byte* )

## Parameters

|                  |                                                    |
|------------------|----------------------------------------------------|
| <i>address</i>   | The start address of the memory to be invalidated. |
| <i>size_byte</i> | The memory size.                                   |

## Note

The start address and *size\_byte* should be 32-byte(FSL\_FEATURE\_L1ICACHE\_LINESIZE\_BYTE) aligned. The startAddr here will be forced to align to L1 I-cache line size if startAddr is not aligned. For the *size\_byte*, application should make sure the alignment or make sure the right operation order if the *size\_byte* is not aligned.

#### 11.4.2 static void L1CACHE\_InvalidateDCacheByRange ( uint32\_t *address*, uint32\_t *size\_byte* ) [inline], [static]

## Parameters

|                  |                                                    |
|------------------|----------------------------------------------------|
| <i>address</i>   | The start address of the memory to be invalidated. |
| <i>size_byte</i> | The memory size.                                   |

## Note

The start address and *size\_byte* should be 32-byte(FSL\_FEATURE\_L1DCACHE\_LINESIZE\_BYTE) aligned. The startAddr here will be forced to align to L1 D-cache line size if startAddr is not aligned. For the *size\_byte*, application should make sure the alignment or make sure the right operation order if the *size\_byte* is not aligned.

#### 11.4.3 static void L1CACHE\_CleanDCacheByRange ( uint32\_t *address*, uint32\_t *size\_byte* ) [inline], [static]

## Parameters

|                  |                                                |
|------------------|------------------------------------------------|
| <i>address</i>   | The start address of the memory to be cleaned. |
| <i>size_byte</i> | The memory size.                               |

## Note

The start address and *size\_byte* should be 32-byte(FSL\_FEATURE\_L1DCACHE\_LINESIZE\_BYTE) aligned. The startAddr here will be forced to align to L1 D-cache line size if startAddr is not aligned. For the *size\_byte*, application should make sure the alignment or make sure the right operation order if the *size\_byte* is not aligned.

11.4.4 `static void L1CACHE_CleanInvalidateDCacheByRange ( uint32_t address,  
uint32_t size_byte ) [inline], [static]`

## Parameters

|                  |                                                              |
|------------------|--------------------------------------------------------------|
| <i>address</i>   | The start address of the memory to be clean and invalidated. |
| <i>size_byte</i> | The memory size.                                             |

## Note

The start address and *size\_byte* should be 32-byte(FSL\_FEATURE\_L1DCACHE\_LINESIZE\_BYTE) aligned. The startAddr here will be forced to align to L1 D-cache line size if startAddr is not aligned. For the *size\_byte*, application should make sure the alignment or make sure the right operation order if the *size\_byte* is not aligned.

#### 11.4.5 void ICACHE\_InvalidateByRange ( uint32\_t *address*, uint32\_t *size\_byte* )

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

## Parameters

|                  |                                       |
|------------------|---------------------------------------|
| <i>address</i>   | The physical address.                 |
| <i>size_byte</i> | size of the memory to be invalidated. |

## Note

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

#### 11.4.6 void DCACHE\_InvalidateByRange ( uint32\_t *address*, uint32\_t *size\_byte* )

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

## Parameters

|                |                       |
|----------------|-----------------------|
| <i>address</i> | The physical address. |
|----------------|-----------------------|

|                  |                                       |
|------------------|---------------------------------------|
| <i>size_byte</i> | size of the memory to be invalidated. |
|------------------|---------------------------------------|

## Note

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

#### 11.4.7 void DCACHE\_CleanByRange ( uint32\_t address, uint32\_t size\_byte )

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

## Parameters

|                  |                                   |
|------------------|-----------------------------------|
| <i>address</i>   | The physical address.             |
| <i>size_byte</i> | size of the memory to be cleaned. |

## Note

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

#### 11.4.8 void DCACHE\_CleanInvalidateByRange ( uint32\_t address, uint32\_t size\_byte )

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

## Parameters

|                  |                                                   |
|------------------|---------------------------------------------------|
| <i>address</i>   | The physical address.                             |
| <i>size_byte</i> | size of the memory to be cleaned and invalidated. |

## Note

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

# Chapter 12

## CMP: Analog Comparator Driver

### 12.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Analog Comparator (CMP) module of MCU-Xpresso SDK devices.

The CMP driver is a basic comparator with advanced features. The APIs for the basic comparator enable the CMP to compare the two voltages of the two input channels and create the output of the comparator result. The APIs for advanced features can be used as the plug-in functions based on the basic comparator. They can process the comparator's output with hardware support.

### 12.2 Typical use case

#### 12.2.1 Polling Configuration

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/cmp`

#### 12.2.2 Interrupt Configuration

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/cmp`

### Data Structures

- struct `cmp_config_t`  
*Configures the comparator. [More...](#)*
- struct `cmp_filter_config_t`  
*Configures the filter. [More...](#)*
- struct `cmp_dac_config_t`  
*Configures the internal DAC. [More...](#)*

### Enumerations

- enum `_cmp_interrupt_enable` {  
    `kCMP_OutputRisingInterruptEnable` = `CMP_SCR_IER_MASK`,  
    `kCMP_OutputFallingInterruptEnable` = `CMP_SCR_IEF_MASK` }  
*Interrupt enable/disable mask.*
- enum `_cmp_status_flags` {  
    `kCMP_OutputRisingEventFlag` = `CMP_SCR_CFR_MASK`,  
    `kCMP_OutputFallingEventFlag` = `CMP_SCR_CFF_MASK`,  
    `kCMP_OutputAssertEventFlag` = `CMP_SCR_COUT_MASK` }  
*Status flags' mask.*



- enum `cmp_hysteresis_mode_t` {  
`kCMP_HysteresisLevel0 = 0U`,  
`kCMP_HysteresisLevel1 = 1U`,  
`kCMP_HysteresisLevel2 = 2U`,  
`kCMP_HysteresisLevel3 = 3U` }  
*CMP Hysteresis mode.*
- enum `cmp_reference_voltage_source_t` {  
`kCMP_VrefSourceVin1 = 0U`,  
`kCMP_VrefSourceVin2 = 1U` }  
*CMP Voltage Reference source.*

## Driver version

- `#define FSL_CMP_DRIVER_VERSION (MAKE_VERSION(2, 0, 2))`  
*CMP driver version 2.0.2.*

## Initialization

- void `CMP_Init` (`CMP_Type *base`, const `cmp_config_t *config`)  
*Initializes the CMP.*
- void `CMP_Deinit` (`CMP_Type *base`)  
*De-initializes the CMP module.*
- static void `CMP_Enable` (`CMP_Type *base`, bool enable)  
*Enables/disables the CMP module.*
- void `CMP_GetDefaultConfig` (`cmp_config_t *config`)  
*Initializes the CMP user configuration structure.*
- void `CMP_SetInputChannels` (`CMP_Type *base`, `uint8_t positiveChannel`, `uint8_t negativeChannel`)  
*Sets the input channels for the comparator.*

## Advanced Features

- void `CMP_EnableDMA` (`CMP_Type *base`, bool enable)  
*Enables/disables the DMA request for rising/falling events.*
- static void `CMP_EnableWindowMode` (`CMP_Type *base`, bool enable)  
*Enables/disables the window mode.*
- void `CMP_SetFilterConfig` (`CMP_Type *base`, const `cmp_filter_config_t *config`)  
*Configures the filter.*
- void `CMP_SetDACConfig` (`CMP_Type *base`, const `cmp_dac_config_t *config`)  
*Configures the internal DAC.*
- void `CMP_EnableInterrupts` (`CMP_Type *base`, `uint32_t mask`)  
*Enables the interrupts.*
- void `CMP_DisableInterrupts` (`CMP_Type *base`, `uint32_t mask`)  
*Disables the interrupts.*

## Results

- `uint32_t CMP_GetStatusFlags` (`CMP_Type *base`)  
*Gets the status flags.*
- void `CMP_ClearStatusFlags` (`CMP_Type *base`, `uint32_t mask`)  
*Clears the status flags.*

## 12.3 Data Structure Documentation

### 12.3.1 struct cmp\_config\_t

#### Data Fields

- 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.*

#### Field Documentation

- (1) **bool cmp\_config\_t::enableCmp**
- (2) **cmp\_hysteresis\_mode\_t cmp\_config\_t::hysteresisMode**
- (3) **bool cmp\_config\_t::enableHighSpeed**
- (4) **bool cmp\_config\_t::enableInvertOutput**
- (5) **bool cmp\_config\_t::useUnfilteredOutput**
- (6) **bool cmp\_config\_t::enablePinOut**

### 12.3.2 struct cmp\_filter\_config\_t

#### Data Fields

- bool [enableSample](#)  
*Using the external SAMPLE as a sampling clock input or using a divided bus clock.*
- uint8\_t [filterCount](#)  
*Filter Sample Count.*
- uint8\_t [filterPeriod](#)  
*Filter Sample Period.*

#### Field Documentation

- (1) **bool cmp\_filter\_config\_t::enableSample**

(2) `uint8_t cmp_filter_config_t::filterCount`

Available range is 1-7; 0 disables the filter.

(3) `uint8_t cmp_filter_config_t::filterPeriod`

The divider to the bus clock. Available range is 0-255.

### 12.3.3 struct `cmp_dac_config_t`

#### Data Fields

- `cmp_reference_voltage_source_t referenceVoltageSource`  
*Supply voltage reference source.*
- `uint8_t DACValue`  
*Value for the DAC Output Voltage.*

#### Field Documentation

(1) `cmp_reference_voltage_source_t cmp_dac_config_t::referenceVoltageSource`

(2) `uint8_t cmp_dac_config_t::DACValue`

Available range is 0-63.

## 12.4 Macro Definition Documentation

### 12.4.1 #define `FSL_CMP_DRIVER_VERSION (MAKE_VERSION(2, 0, 2))`

## 12.5 Enumeration Type Documentation

### 12.5.1 enum `_cmp_interrupt_enable`

Enumerator

- `kCMP_OutputRisingInterruptEnable` Comparator interrupt enable rising.
- `kCMP_OutputFallingInterruptEnable` Comparator interrupt enable falling.

### 12.5.2 enum `_cmp_status_flags`

Enumerator

- `kCMP_OutputRisingEventFlag` Rising-edge on the comparison output has occurred.
- `kCMP_OutputFallingEventFlag` Falling-edge on the comparison output has occurred.
- `kCMP_OutputAssertEventFlag` Return the current value of the analog comparator output.

### 12.5.3 enum cmp\_hysteresis\_mode\_t

Enumerator

- kCMP\_HysteresisLevel0* Hysteresis level 0.
- kCMP\_HysteresisLevel1* Hysteresis level 1.
- kCMP\_HysteresisLevel2* Hysteresis level 2.
- kCMP\_HysteresisLevel3* Hysteresis level 3.

### 12.5.4 enum cmp\_reference\_voltage\_source\_t

Enumerator

- kCMP\_VrefSourceVin1* Vin1 is selected as a resistor ladder network supply reference Vin.
- kCMP\_VrefSourceVin2* Vin2 is selected as a resistor ladder network supply reference Vin.

## 12.6 Function Documentation

### 12.6.1 void CMP\_Init ( CMP\_Type \* *base*, const cmp\_config\_t \* *config* )

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

|               |                                         |
|---------------|-----------------------------------------|
| <i>base</i>   | CMP peripheral base address.            |
| <i>config</i> | Pointer to the configuration structure. |

### 12.6.2 void CMP\_Deinit ( CMP\_Type \* *base* )

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

|             |                              |
|-------------|------------------------------|
| <i>base</i> | CMP peripheral base address. |
|-------------|------------------------------|

### 12.6.3 static void CMP\_Enable ( CMP\_Type \* *base*, bool *enable* ) [inline], [static]

Parameters

|               |                                 |
|---------------|---------------------------------|
| <i>base</i>   | CMP peripheral base address.    |
| <i>enable</i> | Enables or disables the module. |

### 12.6.4 void CMP\_GetDefaultConfig ( cmp\_config\_t \* *config* )

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

|               |                                         |
|---------------|-----------------------------------------|
| <i>config</i> | Pointer to the configuration structure. |
|---------------|-----------------------------------------|

### 12.6.5 void CMP\_SetInputChannels ( CMP\_Type \* *base*, uint8\_t *positiveChannel*, uint8\_t *negativeChannel* )

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

---

|                         |                                                             |
|-------------------------|-------------------------------------------------------------|
| <i>base</i>             | CMP peripheral base address.                                |
| <i>positive-Channel</i> | Positive side input channel number. Available range is 0-7. |
| <i>negative-Channel</i> | Negative side input channel number. Available range is 0-7. |

### 12.6.6 void CMP\_EnableDMA ( CMP\_Type \* *base*, bool *enable* )

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

|               |                                  |
|---------------|----------------------------------|
| <i>base</i>   | CMP peripheral base address.     |
| <i>enable</i> | Enables or disables the feature. |

### 12.6.7 static void CMP\_EnableWindowMode ( CMP\_Type \* *base*, bool *enable* ) [inline], [static]

Parameters

|               |                                  |
|---------------|----------------------------------|
| <i>base</i>   | CMP peripheral base address.     |
| <i>enable</i> | Enables or disables the feature. |

### 12.6.8 void CMP\_SetFilterConfig ( CMP\_Type \* *base*, const cmp\_filter\_config\_t \* *config* )

Parameters

|               |                                         |
|---------------|-----------------------------------------|
| <i>base</i>   | CMP peripheral base address.            |
| <i>config</i> | Pointer to the configuration structure. |

### 12.6.9 void CMP\_SetDACConfig ( CMP\_Type \* *base*, const cmp\_dac\_config\_t \* *config* )

Parameters

|               |                                                                      |
|---------------|----------------------------------------------------------------------|
| <i>base</i>   | CMP peripheral base address.                                         |
| <i>config</i> | Pointer to the configuration structure. "NULL" disables the feature. |

### 12.6.10 void CMP\_EnableInterrupts ( CMP\_Type \* *base*, uint32\_t *mask* )

Parameters

|             |                                                         |
|-------------|---------------------------------------------------------|
| <i>base</i> | CMP peripheral base address.                            |
| <i>mask</i> | Mask value for interrupts. See "_cmp_interrupt_enable". |

### 12.6.11 void CMP\_DisableInterrupts ( CMP\_Type \* *base*, uint32\_t *mask* )

Parameters

|             |                                                         |
|-------------|---------------------------------------------------------|
| <i>base</i> | CMP peripheral base address.                            |
| <i>mask</i> | Mask value for interrupts. See "_cmp_interrupt_enable". |

### 12.6.12 uint32\_t CMP\_GetStatusFlags ( CMP\_Type \* *base* )

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | CMP peripheral base address. |
|-------------|------------------------------|

Returns

Mask value for the asserted flags. See "\_cmp\_status\_flags".

### 12.6.13 void CMP\_ClearStatusFlags ( CMP\_Type \* *base*, uint32\_t *mask* )

## Parameters

|             |                                                    |
|-------------|----------------------------------------------------|
| <i>base</i> | CMP peripheral base address.                       |
| <i>mask</i> | Mask value for the flags. See "_cmp_status_flags". |



# Chapter 13

## Common Driver

### 13.1 Overview

The MCUXpresso SDK provides a driver for the common module of MCUXpresso SDK devices.

#### Macros

- #define `FSL_DRIVER_TRANSFER_DOUBLE_WEAK_IRQ` 1  
*Macro to use the default weak IRQ handler in drivers.*
- #define `MAKE_STATUS`(group, code) (((group)\*100L) + (code))  
*Construct a status code value from a group and code number.*
- #define `MAKE_VERSION`(major, minor, bugfix) (((major) \* 65536L) + ((minor) \* 256L) + (bugfix))  
*Construct the version number for drivers.*
- #define `DEBUG_CONSOLE_DEVICE_TYPE_NONE` 0U  
*No debug console.*
- #define `DEBUG_CONSOLE_DEVICE_TYPE_UART` 1U  
*Debug console based on UART.*
- #define `DEBUG_CONSOLE_DEVICE_TYPE_LPUART` 2U  
*Debug console based on LPUART.*
- #define `DEBUG_CONSOLE_DEVICE_TYPE_LPSCI` 3U  
*Debug console based on LPSCI.*
- #define `DEBUG_CONSOLE_DEVICE_TYPE_USBCDC` 4U  
*Debug console based on USBCDC.*
- #define `DEBUG_CONSOLE_DEVICE_TYPE_FLEXCOMM` 5U  
*Debug console based on FLEXCOMM.*
- #define `DEBUG_CONSOLE_DEVICE_TYPE_IUART` 6U  
*Debug console based on i.MX UART.*
- #define `DEBUG_CONSOLE_DEVICE_TYPE_VUSART` 7U  
*Debug console based on LPC\_VUSART.*
- #define `DEBUG_CONSOLE_DEVICE_TYPE_MINI_USART` 8U  
*Debug console based on LPC\_USART.*
- #define `DEBUG_CONSOLE_DEVICE_TYPE_SWO` 9U  
*Debug console based on SWO.*
- #define `DEBUG_CONSOLE_DEVICE_TYPE_QSCI` 10U  
*Debug console based on QSCI.*
- #define `ARRAY_SIZE`(x) (sizeof(x) / sizeof((x)[0]))  
*Computes the number of elements in an array.*

#### Typedefs

- typedef int32\_t `status_t`  
*Type used for all status and error return values.*

## Enumerations

- enum `_status_groups` {
  - `kStatusGroup_Generic` = 0,
  - `kStatusGroup_FLASH` = 1,
  - `kStatusGroup_LPSPI` = 4,
  - `kStatusGroup_FLEXIO_SPI` = 5,
  - `kStatusGroup_DSPI` = 6,
  - `kStatusGroup_FLEXIO_UART` = 7,
  - `kStatusGroup_FLEXIO_I2C` = 8,
  - `kStatusGroup_LPI2C` = 9,
  - `kStatusGroup_UART` = 10,
  - `kStatusGroup_I2C` = 11,
  - `kStatusGroup_LPSCI` = 12,
  - `kStatusGroup_LPUART` = 13,
  - `kStatusGroup_SPI` = 14,
  - `kStatusGroup_XRDC` = 15,
  - `kStatusGroup_SEMA42` = 16,
  - `kStatusGroup_SDHC` = 17,
  - `kStatusGroup_SDMMC` = 18,
  - `kStatusGroup_SAI` = 19,
  - `kStatusGroup_MCG` = 20,
  - `kStatusGroup_SCG` = 21,
  - `kStatusGroup_SDSPI` = 22,
  - `kStatusGroup_FLEXIO_I2S` = 23,
  - `kStatusGroup_FLEXIO_MCULCD` = 24,
  - `kStatusGroup_FLASHIAP` = 25,
  - `kStatusGroup_FLEXCOMM_I2C` = 26,
  - `kStatusGroup_I2S` = 27,
  - `kStatusGroup_IUART` = 28,
  - `kStatusGroup_CSI` = 29,
  - `kStatusGroup_MIPI_DSI` = 30,
  - `kStatusGroup_SDRAMC` = 35,
  - `kStatusGroup_POWER` = 39,
  - `kStatusGroup_ENET` = 40,
  - `kStatusGroup_PHY` = 41,
  - `kStatusGroup_TRGMUX` = 42,
  - `kStatusGroup_SMARTCARD` = 43,
  - `kStatusGroup_LMEM` = 44,
  - `kStatusGroup_QSPI` = 45,
  - `kStatusGroup_DMA` = 50,
  - `kStatusGroup_EDMA` = 51,
  - `kStatusGroup_DMAMGR` = 52,
  - `kStatusGroup_FLEXCAN` = 53,
  - `kStatusGroup_LTC` = 54,
  - `kStatusGroup_FLEXIO_CAMERA` = 55,
  - `kStatusGroup_LPC_SPI` = 56,
  - `kStatusGroup_LPC_USMCI` = 57,
  - `kStatusGroup_DMIC` = 58,
  - `kStatusGroup_SDIF` = 59,

```
kStatusGroup_BMA = 164 }
```

*Status group numbers.*

- enum {
  - kStatus\_Success = MAKE\_STATUS(kStatusGroup\_Generic, 0),
  - kStatus\_Fail = MAKE\_STATUS(kStatusGroup\_Generic, 1),
  - kStatus\_ReadOnly = MAKE\_STATUS(kStatusGroup\_Generic, 2),
  - kStatus\_OutOfRange = MAKE\_STATUS(kStatusGroup\_Generic, 3),
  - kStatus\_InvalidArgument = MAKE\_STATUS(kStatusGroup\_Generic, 4),
  - kStatus\_Timeout = MAKE\_STATUS(kStatusGroup\_Generic, 5),
  - kStatus\_NoTransferInProgress,
  - kStatus\_Busy = MAKE\_STATUS(kStatusGroup\_Generic, 7),
  - kStatus\_NoData }

*Generic status return codes.*

## Functions

- void \* **SDK\_Malloc** (size\_t size, size\_t alignbytes)
  - Allocate memory with given alignment and aligned size.*
- void **SDK\_Free** (void \*ptr)
  - Free memory.*
- void **SDK\_DelayAtLeastUs** (uint32\_t delayTime\_us, uint32\_t coreClock\_Hz)
  - Delay at least for some time.*

## Driver version

- #define **FSL\_COMMON\_DRIVER\_VERSION** (MAKE\_VERSION(2, 3, 2))
  - common driver version.*

## Min/max macros

- #define **MIN**(a, b) (((a) < (b)) ? (a) : (b))
- #define **MAX**(a, b) (((a) > (b)) ? (a) : (b))

## UINT16\_MAX/UINT32\_MAX value

- #define **UINT16\_MAX** ((uint16\_t)-1)
- #define **UINT32\_MAX** ((uint32\_t)-1)

## Suppress fallthrough warning macro

- #define **SUPPRESS\_FALL\_THROUGH\_WARNING**()

## 13.2 Macro Definition Documentation

### 13.2.1 #define FSL\_DRIVER\_TRANSFER\_DOUBLE\_WEAK\_IRQ 1

### 13.2.2 #define MAKE\_STATUS( group, code ) (((group)\*100L) + (code))

**13.2.3 #define MAKE\_VERSION( *major, minor, bugfix* ) (((major) \* 65536L) + ((minor) \* 256L) + (bugfix))**

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 |

**13.2.4 #define FSL\_COMMON\_DRIVER\_VERSION (MAKE\_VERSION(2, 3, 2))**

**13.2.5 #define DEBUG\_CONSOLE\_DEVICE\_TYPE\_NONE 0U**

**13.2.6 #define DEBUG\_CONSOLE\_DEVICE\_TYPE\_UART 1U**

**13.2.7 #define DEBUG\_CONSOLE\_DEVICE\_TYPE\_LPUART 2U**

**13.2.8 #define DEBUG\_CONSOLE\_DEVICE\_TYPE\_LPSCI 3U**

**13.2.9 #define DEBUG\_CONSOLE\_DEVICE\_TYPE\_USBCDC 4U**

**13.2.10 #define DEBUG\_CONSOLE\_DEVICE\_TYPE\_FLEXCOMM 5U**

**13.2.11 #define DEBUG\_CONSOLE\_DEVICE\_TYPE\_IUART 6U**

**13.2.12 #define DEBUG\_CONSOLE\_DEVICE\_TYPE\_VUSART 7U**

**13.2.13 #define DEBUG\_CONSOLE\_DEVICE\_TYPE\_MINI\_USART 8U**

**13.2.14 #define DEBUG\_CONSOLE\_DEVICE\_TYPE\_SWO 9U**

**13.2.15 #define DEBUG\_CONSOLE\_DEVICE\_TYPE\_QSCI 10U**

**13.2.16 #define ARRAY\_SIZE( x ) (sizeof(x) / sizeof((x)[0]))**

### 13.3 Typedef Documentation

**13.3.1 typedef int32\_t status\_t**

## 13.4 Enumeration Type Documentation

### 13.4.1 enum \_status\_groups

Enumerator

*kStatusGroup\_Generic* Group number for generic status codes.  
*kStatusGroup\_FLASH* Group number for FLASH status codes.  
*kStatusGroup\_LPSPI* Group number for LPSPI status codes.  
*kStatusGroup\_FLEXIO\_SPI* Group number for FLEXIO SPI status codes.  
*kStatusGroup\_DSPI* Group number for DSPI status codes.  
*kStatusGroup\_FLEXIO\_UART* Group number for FLEXIO UART status codes.  
*kStatusGroup\_FLEXIO\_I2C* Group number for FLEXIO I2C status codes.  
*kStatusGroup\_LPI2C* Group number for LPI2C status codes.  
*kStatusGroup\_UART* Group number for UART status codes.  
*kStatusGroup\_I2C* Group number for I2C status codes.  
*kStatusGroup\_LPSCI* Group number for LPSCI status codes.  
*kStatusGroup\_LPUART* Group number for LPUART status codes.  
*kStatusGroup\_SPI* Group number for SPI status code.  
*kStatusGroup\_XRDC* Group number for XRDC status code.  
*kStatusGroup\_SEMA42* Group number for SEMA42 status code.  
*kStatusGroup\_SDHC* Group number for SDHC status code.  
*kStatusGroup\_SDMMC* Group number for SDMMC status code.  
*kStatusGroup\_SAI* Group number for SAI status code.  
*kStatusGroup\_MCG* Group number for MCG status codes.  
*kStatusGroup\_SCG* Group number for SCG status codes.  
*kStatusGroup\_SDSPI* Group number for SDSPI status codes.  
*kStatusGroup\_FLEXIO\_I2S* Group number for FLEXIO I2S status codes.  
*kStatusGroup\_FLEXIO\_MCULCD* Group number for FLEXIO LCD status codes.  
*kStatusGroup\_FLASHIAP* Group number for FLASHIAP status codes.  
*kStatusGroup\_FLEXCOMM\_I2C* Group number for FLEXCOMM I2C status codes.  
*kStatusGroup\_I2S* Group number for I2S status codes.  
*kStatusGroup\_IUART* Group number for IUART status codes.  
*kStatusGroup\_CSI* Group number for CSI status codes.  
*kStatusGroup\_MIPI\_DSI* Group number for MIPI DSI status codes.  
*kStatusGroup\_SDRAMC* Group number for SDRAMC status codes.  
*kStatusGroup\_POWER* Group number for POWER status codes.  
*kStatusGroup\_ENET* Group number for ENET status codes.  
*kStatusGroup\_PHY* Group number for PHY status codes.  
*kStatusGroup\_TRGMUX* Group number for TRGMUX status codes.  
*kStatusGroup\_SMARTCARD* Group number for SMARTCARD status codes.  
*kStatusGroup\_LMEM* Group number for LMEM status codes.  
*kStatusGroup\_QSPI* Group number for QSPI status codes.  
*kStatusGroup\_DMA* Group number for DMA status codes.  
*kStatusGroup\_EDMA* Group number for EDMA status codes.  
*kStatusGroup\_DMAMGR* Group number for DMAMGR status codes.

*kStatusGroup\_FLEXCAN* Group number for FlexCAN status codes.

*kStatusGroup\_LTC* Group number for LTC status codes.

*kStatusGroup\_FLEXIO\_CAMERA* Group number for FLEXIO CAMERA status codes.

*kStatusGroup\_LPC\_SPI* Group number for LPC\_SPI status codes.

*kStatusGroup\_LPC\_USART* Group number for LPC\_USART status codes.

*kStatusGroup\_DMIC* Group number for DMIC status codes.

*kStatusGroup\_SDIF* Group number for SDIF status codes.

*kStatusGroup\_SPIFI* Group number for SPIFI status codes.

*kStatusGroup\_OTP* Group number for OTP status codes.

*kStatusGroup\_MCAN* Group number for MCAN status codes.

*kStatusGroup\_CAAM* Group number for CAAM status codes.

*kStatusGroup\_ECSPi* Group number for ECSPi status codes.

*kStatusGroup\_USDHC* Group number for USDHC status codes.

*kStatusGroup\_LPC\_I2C* Group number for LPC\_I2C status codes.

*kStatusGroup\_DCP* Group number for DCP status codes.

*kStatusGroup\_MSCAN* Group number for MSCAN status codes.

*kStatusGroup\_ESAI* Group number for ESAI status codes.

*kStatusGroup\_FLEXSPI* Group number for FLEXSPI status codes.

*kStatusGroup\_MMDC* Group number for MMDC status codes.

*kStatusGroup\_PDM* Group number for MIC status codes.

*kStatusGroup\_SDMA* Group number for SDMA status codes.

*kStatusGroup\_ICS* Group number for ICS status codes.

*kStatusGroup\_SPDIF* Group number for SPDIF status codes.

*kStatusGroup\_LPC\_MINISPI* Group number for LPC\_MINISPI status codes.

*kStatusGroup\_HASHCRYPT* Group number for Hashcrypt status codes.

*kStatusGroup\_LPC\_SPI\_SSP* Group number for LPC\_SPI\_SSP status codes.

*kStatusGroup\_I3C* Group number for I3C status codes.

*kStatusGroup\_LPC\_I2C\_1* Group number for LPC\_I2C\_1 status codes.

*kStatusGroup\_NOTIFIER* Group number for NOTIFIER status codes.

*kStatusGroup\_DebugConsole* Group number for debug console status codes.

*kStatusGroup\_SEMC* Group number for SEMC status codes.

*kStatusGroup\_ApplicationRangeStart* Starting number for application groups.

*kStatusGroup\_IAP* Group number for IAP status codes.

*kStatusGroup\_SFA* Group number for SFA status codes.

*kStatusGroup\_SPC* Group number for SPC status codes.

*kStatusGroup\_PUF* Group number for PUF status codes.

*kStatusGroup\_TOUCH\_PANEL* Group number for touch panel status codes.

*kStatusGroup\_HAL\_GPIO* Group number for HAL GPIO status codes.

*kStatusGroup\_HAL\_UART* Group number for HAL UART status codes.

*kStatusGroup\_HAL\_TIMER* Group number for HAL TIMER status codes.

*kStatusGroup\_HAL\_SPI* Group number for HAL SPI status codes.

*kStatusGroup\_HAL\_I2C* Group number for HAL I2C status codes.

*kStatusGroup\_HAL\_FLASH* Group number for HAL FLASH status codes.

*kStatusGroup\_HAL\_PWM* Group number for HAL PWM status codes.

*kStatusGroup\_HAL\_RNG* Group number for HAL RNG status codes.

*kStatusGroup\_HAL\_I2S* Group number for HAL I2S status codes.

*kStatusGroup\_TIMERMANAGER* Group number for TiMER MANAGER status codes.

*kStatusGroup\_SERIALMANAGER* Group number for SERIAL MANAGER status codes.

*kStatusGroup\_LED* Group number for LED status codes.

*kStatusGroup\_BUTTON* Group number for BUTTON status codes.

*kStatusGroup\_EXTERN\_EEPROM* Group number for EXTERN EEPROM status codes.

*kStatusGroup\_SHELL* Group number for SHELL status codes.

*kStatusGroup\_MEM\_MANAGER* Group number for MEM MANAGER status codes.

*kStatusGroup\_LIST* Group number for List status codes.

*kStatusGroup\_OSA* Group number for OSA status codes.

*kStatusGroup\_COMMON\_TASK* Group number for Common task status codes.

*kStatusGroup\_MSG* Group number for messaging status codes.

*kStatusGroup\_SDK\_OCOTP* Group number for OCOTP status codes.

*kStatusGroup\_SDK\_FLEXSPINOR* Group number for FLEXSPINOR status codes.

*kStatusGroup\_CODEC* Group number for codec status codes.

*kStatusGroup\_ASRC* Group number for codec status ASRC.

*kStatusGroup\_OTFAD* Group number for codec status codes.

*kStatusGroup\_SDIOSLV* Group number for SDIOSLV status codes.

*kStatusGroup\_MECC* Group number for MECC status codes.

*kStatusGroup\_ENET\_QOS* Group number for ENET\_QOS status codes.

*kStatusGroup\_LOG* Group number for LOG status codes.

*kStatusGroup\_I3CBUS* Group number for I3CBUS status codes.

*kStatusGroup\_QSCI* Group number for QSCI status codes.

*kStatusGroup\_SNT* Group number for SNT status codes.

*kStatusGroup\_QUEUEDSPI* Group number for QSPI status codes.

*kStatusGroup\_POWER\_MANAGER* Group number for POWER\_MANAGER status codes.

*kStatusGroup\_IPED* Group number for IPED status codes.

*kStatusGroup\_CSS\_PKC* Group number for CSS PKC status codes.

*kStatusGroup\_HOSTIF* Group number for HOSTIF status codes.

*kStatusGroup\_CLIF* Group number for CLIF status codes.

*kStatusGroup\_BMA* Group number for BMA status codes.

### 13.4.2 anonymous enum

Enumerator

*kStatus\_Success* Generic status for Success.

*kStatus\_Fail* Generic status for Fail.

*kStatus\_ReadOnly* Generic status for read only failure.

*kStatus\_OutOfRange* Generic status for out of range access.

*kStatus\_InvalidArgument* Generic status for invalid argument check.

*kStatus\_Timeout* Generic status for timeout.

*kStatus\_NoTransferInProgress* Generic status for no transfer in progress.

*kStatus\_Busy* Generic status for module is busy.

*kStatus\_NoData* Generic status for no data is found for the operation.

## 13.5 Function Documentation

### 13.5.1 void\* SDK\_Malloc ( size\_t size, size\_t alignbytes )

This is provided to support the dynamically allocated memory used in cache-able region.

Parameters

|                   |                                |
|-------------------|--------------------------------|
| <i>size</i>       | The length required to malloc. |
| <i>alignbytes</i> | The alignment size.            |

Return values

|            |                   |
|------------|-------------------|
| <i>The</i> | allocated memory. |
|------------|-------------------|

### 13.5.2 void SDK\_Free ( void \* ptr )

Parameters

|            |                           |
|------------|---------------------------|
| <i>ptr</i> | The memory to be release. |
|------------|---------------------------|

### 13.5.3 void SDK\_DelayAtLeastUs ( uint32\_t delayTime\_us, uint32\_t coreClock\_Hz )

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

|                     |                                    |
|---------------------|------------------------------------|
| <i>delayTime_us</i> | Delay time in unit of microsecond. |
| <i>coreClock_Hz</i> | Core clock frequency with Hz.      |



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# Chapter 14

## DCDC: DCDC Converter

### 14.1 Overview

The MCUXpresso SDK provides a peripheral driver for the DCDC Converter (DCDC) module of MCU-Xpresso SDK devices.

The DCDC converter module is a synchronous buck mode DCDC converter. It can produce single outputs for SoC peripherals and external devices with high conversion efficiency. The converter can be operated in continuous or pulsed mode.

As a module to provide the power for hardware system, the DCDC starts working when the system is powered up before the software takes over the SoC. Some important configuration is done by the board settings. Before the software can access the DCDC's registers, the DCDC is already working normally with the default settings.

However, if the application needs to improve the DCDC's performance or change the default settings, the DCDC driver would help. The DCDC's register cannot be accessed by software before its initialization (open the clock gate). The user can configure the hardware according to the application guide from reference manual.

### 14.2 Function groups

#### 14.2.1 Initialization and deinitialization

This function group is to enable/disable the operations to DCDC module through the driver.

#### 14.2.2 Status

Provides functions to get the DCDC status.

#### 14.2.3 Misc control

Provides functions to set the DCDC's miscellaneous control.

#### Set point mode control

Provides functions to initialize/de-initialize DCDC module in set point mode.

## 14.3 Application guideline

### 14.3.1 Continuous conduction mode

### 14.3.2 Discontinuous conduction mode

/\*!

## Data Structures

- struct `dcdc_detection_config_t`  
*Configuration for DCDC detection. [More...](#)*
- struct `dcdc_loop_control_config_t`  
*Configuration for the loop control. [More...](#)*
- struct `dcdc_low_power_config_t`  
*Configuration for DCDC low power. [More...](#)*
- struct `dcdc_internal_regulator_config_t`  
*Configuration for DCDC internal regulator. [More...](#)*
- struct `dcdc_min_power_config_t`  
*Configuration for min power setting. [More...](#)*

## Macros

- `#define FSL_DCDC_DRIVER_VERSION (MAKE_VERSION(2, 3, 0))`  
*DCDC driver version.*

## Enumerations

- enum `_dcdc_status_flags_t` { `kDCDC_LockedOKStatus = (1U << 0U)` }  
*DCDC status flags.*
- enum `dcdc_comparator_current_bias_t` {  
`kDCDC_ComparatorCurrentBias50nA = 0U,`  
`kDCDC_ComparatorCurrentBias100nA = 1U,`  
`kDCDC_ComparatorCurrentBias200nA = 2U,`  
`kDCDC_ComparatorCurrentBias400nA = 3U` }  
*The current bias of low power comparator.*
- enum `dcdc_over_current_threshold_t` {  
`kDCDC_OverCurrentThresholdAlt0 = 0U,`  
`kDCDC_OverCurrentThresholdAlt1 = 1U,`  
`kDCDC_OverCurrentThresholdAlt2 = 2U,`  
`kDCDC_OverCurrentThresholdAlt3 = 3U` }  
*The threshold of over current detection.*
- enum `dcdc_peak_current_threshold_t` {  
`kDCDC_PeakCurrentThresholdAlt0 = 0U,`  
`kDCDC_PeakCurrentThresholdAlt1 = 1U,`  
`kDCDC_PeakCurrentThresholdAlt2 = 2U,`  
`kDCDC_PeakCurrentThresholdAlt3 = 3U,`  
`kDCDC_PeakCurrentThresholdAlt4 = 4U,`

`kDCDC_PeakCurrentThresholdAlt5 = 5U }`

*The threshold if peak current detection.*

- enum `dcdc_count_charging_time_period_t` {  
`kDCDC_CountChargingTimePeriod8Cycle = 0U,`  
`kDCDC_CountChargingTimePeriod16Cycle = 1U }`

*The period of counting the charging times in power save mode.*

- enum `dcdc_count_charging_time_threshold_t` {  
`kDCDC_CountChargingTimeThreshold32 = 0U,`  
`kDCDC_CountChargingTimeThreshold64 = 1U,`  
`kDCDC_CountChargingTimeThreshold16 = 2U,`  
`kDCDC_CountChargingTimeThreshold8 = 3U }`

*The threshold of the counting number of charging times.*

- enum `dcdc_clock_source_t` {  
`kDCDC_ClockAutoSwitch = 0U,`  
`kDCDC_ClockInternalOsc = 1U,`  
`kDCDC_ClockExternalOsc = 2U }`

*Oscillator clock option.*

## Initialization and deinitialization

- void `DCDC_Init` (`DCDC_Type *base`)  
*Enable the access to DCDC registers.*
- void `DCDC_Deinit` (`DCDC_Type *base`)  
*Disable the access to DCDC registers.*

## Status

- uint32\_t `DCDC_GetstatusFlags` (`DCDC_Type *base`)  
*Get DCDC status flags.*

## Misc control

- static void `DCDC_EnableOutputRangeComparator` (`DCDC_Type *base`, bool enable)  
*Enable the output range comparator.*
- void `DCDC_SetClockSource` (`DCDC_Type *base`, `dcdc_clock_source_t` clockSource)  
*Configure the DCDC clock source.*
- void `DCDC_GetDefaultDetectionConfig` (`dcdc_detection_config_t *config`)  
*Get the default setting for detection configuration.*
- void `DCDC_SetDetectionConfig` (`DCDC_Type *base`, const `dcdc_detection_config_t *config`)  
*Configure the DCDC detection.*
- void `DCDC_GetDefaultLowPowerConfig` (`dcdc_low_power_config_t *config`)  
*Get the default setting for low power configuration.*
- void `DCDC_SetLowPowerConfig` (`DCDC_Type *base`, const `dcdc_low_power_config_t *config`)  
*Configure the DCDC low power.*
- void `DCDC_ResetCurrentAlertSignal` (`DCDC_Type *base`, bool enable)  
*Reset current alert signal.*
- static void `DCDC_SetBandgapVoltageTrimValue` (`DCDC_Type *base`, uint32\_t trimValue)  
*Set the bangap trim value to trim bandgap voltage.*
- void `DCDC_GetDefaultLoopControlConfig` (`dcdc_loop_control_config_t *config`)

- *Get the default setting for loop control configuration.*
- void [DCDC\\_SetLoopControlConfig](#) (DCDC\_Type \*base, const [dcdc\\_loop\\_control\\_config\\_t](#) \*config)
- *Configure the DCDC loop control.*
- void [DCDC\\_SetMinPowerConfig](#) (DCDC\_Type \*base, const [dcdc\\_min\\_power\\_config\\_t](#) \*config)
- *Configure for the min power.*
- static void [DCDC\\_SetLPComparatorBiasValue](#) (DCDC\_Type \*base, [dcdc\\_comparator\\_current\\_bias\\_t](#) biasVaule)
- *Set the current bias of low power comparator.*
- static void [DCDC\\_LockTargetVoltage](#) (DCDC\_Type \*base)
- *Lock target voltage.*
- void [DCDC\\_AdjustTargetVoltage](#) (DCDC\_Type \*base, uint32\_t VDDRun, uint32\_t VDDStandby)
- *Adjust the target voltage of VDD\_SOC in run mode and low power mode.*
- void [DCDC\\_AdjustRunTargetVoltage](#) (DCDC\_Type \*base, uint32\_t VDDRun)
- *Adjust the target voltage of VDD\_SOC in run mode.*
- void [DCDC\\_AdjustLowPowerTargetVoltage](#) (DCDC\_Type \*base, uint32\_t VDDStandby)
- *Adjust the target voltage of VDD\_SOC in low power mode.*
- void [DCDC\\_SetInternalRegulatorConfig](#) (DCDC\_Type \*base, const [dcdc\\_internal\\_regulator\\_config\\_t](#) \*config)
- *Configure the DCDC internal regulator.*
- static void [DCDC\\_EnableImproveTransition](#) (DCDC\_Type \*base, bool enable)
- *Enable/Disable to improve the transition from heavy load to light load.*

## Application guideline

- void [DCDC\\_BootIntoDCM](#) (DCDC\_Type \*base)
- *Boot DCDC into DCM(discontinuous conduction mode).*
- void [DCDC\\_BootIntoCCM](#) (DCDC\_Type \*base)
- *Boot DCDC into CCM(continous conduction mode).*

## 14.4 Data Structure Documentation

### 14.4.1 struct [dcdc\\_detection\\_config\\_t](#)

#### Data Fields

- bool [enableXtalokDetection](#)
- *Enable xtalok detection circuit.*
- bool [powerDownOverVoltageDetection](#)
- *Power down over-voltage detection comparator.*
- bool [powerDownLowVlotageDetection](#)
- *Power down low-voltage detection comparator.*
- bool [powerDownOverCurrentDetection](#)
- *Power down over-current detection.*
- bool [powerDownPeakCurrentDetection](#)
- *Power down peak-current detection.*
- bool [powerDownZeroCrossDetection](#)
- *Power down the zero cross detection function for discontinuous conductor mode.*
- [dcdc\\_over\\_current\\_threshold\\_t](#) [OverCurrentThreshold](#)
- *The threshold of over current detection.*

- [dcdc\\_peak\\_current\\_threshold\\_t](#) [PeakCurrentThreshold](#)  
*The threshold of peak current detection.*

#### Field Documentation

- (1) `bool dcdc_detection_config_t::enableXtalokDetection`
- (2) `bool dcdc_detection_config_t::powerDownOverVoltageDetection`
- (3) `bool dcdc_detection_config_t::powerDownLowVoltageDetection`
- (4) `bool dcdc_detection_config_t::powerDownOverCurrentDetection`
- (5) `bool dcdc_detection_config_t::powerDownPeakCurrentDetection`
- (6) `bool dcdc_detection_config_t::powerDownZeroCrossDetection`
- (7) `dc_dc_over_current_threshold_t dcdc_detection_config_t::OverCurrentThreshold`
- (8) `dc_dc_peak_current_threshold_t dcdc_detection_config_t::PeakCurrentThreshold`

#### 14.4.2 struct dcdc\_loop\_control\_config\_t

#### Data Fields

- `bool enableCommonHysteresis`  
*Enable hysteresis in switching converter common mode analog comparators.*
- `bool enableCommonThresholdDetection`  
*Increase the threshold detection for common mode analog comparator.*
- `bool enableInvertHysteresisSign`  
*Invert the sign of the hysteresis in DC-DC analog comparators.*
- `bool enableRCThresholdDetection`  
*Increase the threshold detection for RC scale circuit.*
- `uint32_t enableRCScaleCircuit`  
*Available range is 0~7.*
- `uint32_t complementFeedForwardStep`  
*Available range is 0~7.*

#### Field Documentation

- (1) `bool dcdc_loop_control_config_t::enableCommonHysteresis`

This feature will improve transient supply ripple and efficiency.

- (2) `bool dcdc_loop_control_config_t::enableCommonThresholdDetection`
- (3) `bool dcdc_loop_control_config_t::enableInvertHysteresisSign`
- (4) `bool dcdc_loop_control_config_t::enableRCThresholdDetection`

**(5) uint32\_t dc\_dc\_loop\_control\_config\_t::enableRCScaleCircuit**

Enable analog circuit of DC-DC converter to respond faster under transient load conditions.

**(6) uint32\_t dc\_dc\_loop\_control\_config\_t::complementFeedForwardStep**

Two's complement feed forward step in duty cycle in the switching DC-DC converter. Each time this field makes a transition from 0x0, the loop filter of the DC-DC converter is stepped once by a value proportional to the change. This can be used to force a certain control loop behavior, such as improving response under known heavy load transients.

**14.4.3 struct dc\_dc\_low\_power\_config\_t****Data Fields**

- bool [enableOverloadDetection](#)  
*Enable the overload detection in power save mode, if current is larger than the overloading threshold (typical value is 50 mA), DCDC will switch to the run mode automatically.*
- bool [enableAdjustHystereticValue](#)  
*Adjust hysteretic value in low power from 12.5mV to 25mV.*
- [dc\\_dc\\_count\\_charging\\_time\\_period\\_t countChargingTimePeriod](#)  
*The period of counting the charging times in power save mode.*
- [dc\\_dc\\_count\\_charging\\_time\\_threshold\\_t countChargingTimeThreshold](#)  
*the threshold of the counting number of charging times during the period that lp\_overload\_freq\_sel sets in power save mode.*

**Field Documentation****(1) bool dc\_dc\_low\_power\_config\_t::enableOverloadDetection****(2) bool dc\_dc\_low\_power\_config\_t::enableAdjustHystereticValue****(3) dc\_dc\_count\_charging\_time\_period\_t dc\_dc\_low\_power\_config\_t::countChargingTimePeriod****(4) dc\_dc\_count\_charging\_time\_threshold\_t dc\_dc\_low\_power\_config\_t::countChargingTimeThreshold****14.4.4 struct dc\_dc\_internal\_regulator\_config\_t****Data Fields**

- bool [enableLoadResistor](#)  
*control the load resistor of the internal regulator of DCDC, the load resistor is connected as default "true", and need set to "false" to disconnect the load resistor.*
- uint32\_t [feedbackPoint](#)  
*Available range is 0~3.*

### Field Documentation

- (1) `bool dcdc_internal_regulator_config_t::enableLoadResistor`
- (2) `uint32_t dcdc_internal_regulator_config_t::feedbackPoint`

Select the feedback point of the internal regulator.

## 14.4.5 struct dcdc\_min\_power\_config\_t

### Data Fields

- `bool enableUseHalfFreqForContinuous`  
*Set DCDC clock to half frequency for the continuous mode.*

### Field Documentation

- (1) `bool dcdc_min_power_config_t::enableUseHalfFreqForContinuous`

## 14.5 Macro Definition Documentation

### 14.5.1 #define FSL\_DCDC\_DRIVER\_VERSION (MAKE\_VERSION(2, 3, 0))

Version 2.3.0.

## 14.6 Enumeration Type Documentation

### 14.6.1 enum \_dcdc\_status\_flags\_t

Enumerator

*kDCDC\_LockedOKStatus* Indicate DCDC status. 1'b1: DCDC already settled 1'b0: DCDC is settling.

### 14.6.2 enum dcdc\_comparator\_current\_bias\_t

Enumerator

*kDCDC\_ComparatorCurrentBias50nA* The current bias of low power comparator is 50nA.  
*kDCDC\_ComparatorCurrentBias100nA* The current bias of low power comparator is 100nA.  
*kDCDC\_ComparatorCurrentBias200nA* The current bias of low power comparator is 200nA.  
*kDCDC\_ComparatorCurrentBias400nA* The current bias of low power comparator is 400nA.

### 14.6.3 enum dc\_dc\_over\_current\_threshold\_t

Enumerator

- kDCDC\_OverCurrentThresholdAlt0* 1A in the run mode, 0.25A in the power save mode.
- kDCDC\_OverCurrentThresholdAlt1* 2A in the run mode, 0.25A in the power save mode.
- kDCDC\_OverCurrentThresholdAlt2* 1A in the run mode, 0.2A in the power save mode.
- kDCDC\_OverCurrentThresholdAlt3* 2A in the run mode, 0.2A in the power save mode.

### 14.6.4 enum dc\_dc\_peak\_current\_threshold\_t

Enumerator

- kDCDC\_PeakCurrentThresholdAlt0* 150mA peak current threshold.
- kDCDC\_PeakCurrentThresholdAlt1* 250mA peak current threshold.
- kDCDC\_PeakCurrentThresholdAlt2* 350mA peak current threshold.
- kDCDC\_PeakCurrentThresholdAlt3* 450mA peak current threshold.
- kDCDC\_PeakCurrentThresholdAlt4* 550mA peak current threshold.
- kDCDC\_PeakCurrentThresholdAlt5* 650mA peak current threshold.

### 14.6.5 enum dc\_dc\_count\_charging\_time\_period\_t

Enumerator

- kDCDC\_CountChargingTimePeriod8Cycle* Eight 32k cycle.
- kDCDC\_CountChargingTimePeriod16Cycle* Sixteen 32k cycle.

### 14.6.6 enum dc\_dc\_count\_charging\_time\_threshold\_t

Enumerator

- kDCDC\_CountChargingTimeThreshold32* 0x0: 32.
- kDCDC\_CountChargingTimeThreshold64* 0x1: 64.
- kDCDC\_CountChargingTimeThreshold16* 0x2: 16.
- kDCDC\_CountChargingTimeThreshold8* 0x3: 8.

### 14.6.7 enum dc\_dc\_clock\_source\_t

Enumerator

- kDCDC\_ClockAutoSwitch* Automatic clock switch from internal oscillator to external clock.
- kDCDC\_ClockInternalOsc* Use internal oscillator.
- kDCDC\_ClockExternalOsc* Use external 24M crystal oscillator.



## 14.7 Function Documentation

### 14.7.1 void DCDC\_Init ( DCDC\_Type \* *base* )

Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | DCDC peripheral base address. |
|-------------|-------------------------------|

### 14.7.2 void DCDC\_Deinit ( DCDC\_Type \* *base* )

Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | DCDC peripheral base address. |
|-------------|-------------------------------|

### 14.7.3 uint32\_t DCDC\_GetstatusFlags ( DCDC\_Type \* *base* )

Parameters

|             |                          |
|-------------|--------------------------|
| <i>base</i> | peripheral base address. |
|-------------|--------------------------|

Returns

Mask of asserted status flags. See to "\_dcdc\_status\_flags\_t".

### 14.7.4 static void DCDC\_EnableOutputRangeComparator ( DCDC\_Type \* *base*, bool *enable* ) [inline], [static]

The output range comparator is disabled by default.

Parameters

|               |                               |
|---------------|-------------------------------|
| <i>base</i>   | DCDC peripheral base address. |
| <i>enable</i> | Enable the feature or not.    |

### 14.7.5 void DCDC\_SetClockSource ( DCDC\_Type \* *base*, dcdc\_clock\_source\_t *clockSource* )

## Parameters

|                    |                                                      |
|--------------------|------------------------------------------------------|
| <i>base</i>        | DCDC peripheral base address.                        |
| <i>clockSource</i> | Clock source for DCDC. See to "dcdc_clock_source_t". |

### 14.7.6 void DCDC\_GetDefaultDetectionConfig ( dcdc\_detection\_config\_t \* config )

The default configuration are set according to responding registers' setting when powered on. They are:

```
* config->enableXtalokDetection = false;
* config->powerDownOverVoltageDetection = true;
* config->powerDownLowVoltageDetection = false;
* config->powerDownOverCurrentDetection = true;
* config->powerDownPeakCurrentDetection = true;
* config->powerDownZeroCrossDetection = true;
* config->OverCurrentThreshold = kDCDC_OverCurrentThresholdAlt0;
* config->PeakCurrentThreshold = kDCDC_PeakCurrentThresholdAlt0;
*
```

## Parameters

|               |                                                                      |
|---------------|----------------------------------------------------------------------|
| <i>config</i> | Pointer to configuration structure. See to "dcdc_detection_config_t" |
|---------------|----------------------------------------------------------------------|

### 14.7.7 void DCDC\_SetDetectionConfig ( DCDC\_Type \* base, const dcdc\_detection\_config\_t \* config )

## Parameters

|               |                                                                      |
|---------------|----------------------------------------------------------------------|
| <i>base</i>   | DCDC peripheral base address.                                        |
| <i>config</i> | Pointer to configuration structure. See to "dcdc_detection_config_t" |

### 14.7.8 void DCDC\_GetDefaultLowPowerConfig ( dcdc\_low\_power\_config\_t \* config )

The default configuration are set according to responding registers' setting when powered on. They are:

```
* config->enableOverloadDetection = true;
* config->enableAdjustHystereticValue = false;
* config->countChargingTimePeriod = kDCDC_CountChargingTimePeriod8Cycle
;
* config->countChargingTimeThreshold = kDCDC_CountChargingTimeThreshold32
;
*
```

Parameters

|               |                                                                      |
|---------------|----------------------------------------------------------------------|
| <i>config</i> | Pointer to configuration structure. See to "dcdc_low_power_config_t" |
|---------------|----------------------------------------------------------------------|

#### 14.7.9 void DCDC\_SetLowPowerConfig ( DCDC\_Type \* *base*, const dcdc\_low\_power\_config\_t \* *config* )

Parameters

|               |                                                                       |
|---------------|-----------------------------------------------------------------------|
| <i>base</i>   | DCDC peripheral base address.                                         |
| <i>config</i> | Pointer to configuration structure. See to "dcdc_low_power_config_t". |

#### 14.7.10 void DCDC\_ResetCurrentAlertSignal ( DCDC\_Type \* *base*, bool *enable* )

Alert signal is generate by peak current detection.

Parameters

|               |                                                                                    |
|---------------|------------------------------------------------------------------------------------|
| <i>base</i>   | DCDC peripheral base address.                                                      |
| <i>enable</i> | Switcher to reset signal. True means reset signal. False means don't reset signal. |

#### 14.7.11 static void DCDC\_SetBandgapVoltageTrimValue ( DCDC\_Type \* *base*, uint32\_t *trimValue* ) [inline], [static]

Parameters

|                  |                                                   |
|------------------|---------------------------------------------------|
| <i>base</i>      | DCDC peripheral base address.                     |
| <i>trimValue</i> | The bangap trim value. Available range is 0U-31U. |

#### 14.7.12 void DCDC\_GetDefaultLoopControlConfig ( dcdc\_loop\_control\_config\_t \* *config* )

The default configuration are set according to responding registers' setting when powered on. They are:

```
* config->enableCommonHysteresis = false;
* config->enableCommonThresholdDetection = false;
* config->enableInvertHysteresisSign = false;
* config->enableRCThresholdDetection = false;
```

```
* config->enableRCScaleCircuit = 0U;
* config->complementFeedForwardStep = 0U;
*
```

## Parameters

|               |                                                                         |
|---------------|-------------------------------------------------------------------------|
| <i>config</i> | Pointer to configuration structure. See to "dcdc_loop_control_config_t" |
|---------------|-------------------------------------------------------------------------|

#### 14.7.13 void DCDC\_SetLoopControlConfig ( DCDC\_Type \* *base*, const dcdc\_loop\_control\_config\_t \* *config* )

## Parameters

|               |                                                                          |
|---------------|--------------------------------------------------------------------------|
| <i>base</i>   | DCDC peripheral base address.                                            |
| <i>config</i> | Pointer to configuration structure. See to "dcdc_loop_control_config_t". |

#### 14.7.14 void DCDC\_SetMinPowerConfig ( DCDC\_Type \* *base*, const dcdc\_min\_power\_config\_t \* *config* )

## Parameters

|               |                                                                       |
|---------------|-----------------------------------------------------------------------|
| <i>base</i>   | DCDC peripheral base address.                                         |
| <i>config</i> | Pointer to configuration structure. See to "dcdc_min_power_config_t". |

#### 14.7.15 static void DCDC\_SetLPComparatorBiasValue ( DCDC\_Type \* *base*, dcdc\_comparator\_current\_bias\_t *biasVaule* ) [inline], [static]

## Parameters

|                  |                                                                                      |
|------------------|--------------------------------------------------------------------------------------|
| <i>base</i>      | DCDC peripheral base address.                                                        |
| <i>biasVaule</i> | The current bias of low power comparator. Refer to "dcdc_comparator_current_bias_t". |

#### 14.7.16 static void DCDC\_LockTargetVoltage ( DCDC\_Type \* *base* ) [inline], [static]

## Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | DCDC peripheral base address. |
|-------------|-------------------------------|

#### 14.7.17 void DCDC\_AdjustTargetVoltage ( DCDC\_Type \* *base*, uint32\_t *VDDRun*, uint32\_t *VDDStandby* )

**Deprecated** Do not use this function. It has been superseded by [DCDC\\_AdjustRunTargetVoltage](#) and [DCDC\\_AdjustLowPowerTargetVoltage](#)

This function is to adjust the target voltage of DCDC output. Change them and finally wait until the output is stabled. Set the target value of run mode the same as low power mode before entering power save mode, because DCDC will switch back to run mode if it detects the current loading is larger than about 50 mA(typical value).

## Parameters

|                   |                                                                                                    |
|-------------------|----------------------------------------------------------------------------------------------------|
| <i>base</i>       | DCDC peripheral base address.                                                                      |
| <i>VDDRun</i>     | Target value in run mode. 25 mV each step from 0x00 to 0x1F. 00 is for 0.8V, 0x1F is for 1.575V.   |
| <i>VDDStandby</i> | Target value in low power mode. 25 mV each step from 0x00 to 0x4. 00 is for 0.9V, 0x4 is for 1.0V. |

#### 14.7.18 void DCDC\_AdjustRunTargetVoltage ( DCDC\_Type \* *base*, uint32\_t *VDDRun* )

This function is to adjust the target voltage of DCDC output. Change them and finally wait until the output is stabled. Set the target value of run mode the same as low power mode before entering power save mode, because DCDC will switch back to run mode if it detects the current loading is larger than about 50 mA(typical value).

## Parameters

|               |                                                                                                  |
|---------------|--------------------------------------------------------------------------------------------------|
| <i>base</i>   | DCDC peripheral base address.                                                                    |
| <i>VDDRun</i> | Target value in run mode. 25 mV each step from 0x00 to 0x1F. 00 is for 0.8V, 0x1F is for 1.575V. |

### 14.7.19 void DCDC\_AdjustLowPowerTargetVoltage ( DCDC\_Type \* *base*, uint32\_t *VDDStandby* )

This function is to adjust the target voltage of DCDC output. Change them and finally wait until the output is stabled. Set the target value of run mode the same as low power mode before entering power save mode, because DCDC will switch back to run mode if it detects the current loading is larger than about 50 mA(typical value).

Parameters

|                   |                                                                                                    |
|-------------------|----------------------------------------------------------------------------------------------------|
| <i>base</i>       | DCDC peripheral base address.                                                                      |
| <i>VDDStandby</i> | Target value in low power mode. 25 mV each step from 0x00 to 0x4. 00 is for 0.9V, 0x4 is for 1.0V. |

### 14.7.20 void DCDC\_SetInternalRegulatorConfig ( DCDC\_Type \* *base*, const *dcdc\_internal\_regulator\_config\_t* \* *config* )

Parameters

|               |                                                                                |
|---------------|--------------------------------------------------------------------------------|
| <i>base</i>   | DCDC peripheral base address.                                                  |
| <i>config</i> | Pointer to configuration structure. See to "dcdc_internal_regulator_config_t". |

### 14.7.21 static void DCDC\_EnableImproveTransition ( DCDC\_Type \* *base*, bool *enable* ) [inline], [static]

It is valid while zero cross detection is enabled. If output exceeds the threshold, DCDC would return CCM from DCM.

Parameters

|               |                               |
|---------------|-------------------------------|
| <i>base</i>   | DCDC peripheral base address. |
| <i>enable</i> | Enable the feature or not.    |

### 14.7.22 void DCDC\_BootIntoDCM ( DCDC\_Type \* *base* )

`pwd_zcd=0x0; pwd_cmp_offset=0x0; dcdc_loopctrl_en_rcscale= 0x5; DCM_set_ctrl=1'b1;`

Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | DCDC peripheral base address. |
|-------------|-------------------------------|

#### 14.7.23 void DCDC\_BootIntoCCM ( DCDC\_Type \* *base* )

`pwd_zcd=0x1; pwd_cmp_offset=0x0; dcdc_loopctrl_en_rcscale=0x3;`

Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | DCDC peripheral base address. |
|-------------|-------------------------------|

# Chapter 15

## DCP: Data Co-Processor

### 15.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Data Co-Processor (DCP) module. For security purposes, the Data Co-Processor (DCP) provides hardware acceleration for the cryptographic algorithms. The features of DCP are: Encryption Algorithms: AES-128 (ECB and CBC modes), Hashing Algorithms: SHA-1 and SHA-256, modified CRC-32, Key selection from the SNVS, DCP internal key storage, or general memory, Internal Memory for storing up to four AES-128 keys-when a key is written to a key slot it can be read only by the DCP AES-128 engine, IP slave interface, and DMA.

The driver comprises two sets of API functions.

In the first set, blocking APIs are provided, for selected subset of operations supported by DCP hardware. The DCP operations are complete (and results are made available for further usage) when a function returns. When called, these functions do not return until a DCP operation is complete. These functions use main CPU for simple polling loops to determine operation complete or error status.

The DCP work packets (descriptors) are placed on the system stack during the blocking API calls. The driver uses critical section (implemented as global interrupt enable/disable) for a short time whenever it needs to pass DCP work packets to DCP channel for processing. Therefore, the driver functions are designed to be re-entrant and as a consequence, one CPU thread can call one blocking API, such as AES Encrypt, while other CPU thread can call another blocking API, such as SHA-256 Update. The blocking functions provide typical interface to upper layer or application software.

In the second set, non-blocking variants of the first set APIs are provided. Internally, the blocking APIs are implemented as a non-blocking operation start, followed by a blocking wait (CPU polling DCP work packet's status word) for an operation completion. The non-blocking functions allow upper layer to inject an application specific operation after the DCP operation start and DCP channel complete events. RTOS event wait and RTOS event set can be an example of such an operation.

### 15.2 DCP Driver Initialization and Configuration

Initialize DCP after Power On Reset or reset cycle Refer to the driver examples codes located at <SDK\_ROOT>/boards/<BOARD>/driver\_examples/dcp

The DCP Driver is initialized by calling the [DCP\\_Init\(\)](#) function. It enables the DCP module clock and configures DCP for operation.

### Key Management

The DCP implements four different key storage mechanisms: OTP-key, OTP-Unique key, Payload key, and SRAM-based keys that can be used by the software to securely store keys on a semi-permanent basis (kDCP\_KeySlot0 ~ kDCP\_KeySlot3). Once the function [DCP\\_AES\\_SetKey\(\)](#) is called, it sets the AES key for encryption/decryption with the [dcp\\_handle\\_t](#) structure. In case the SRAM-based key is selected,



the function copies and holds the key in memory. In case the OTP key is used, please make sure to set DCP related IOMUXC\_GPRs before DCP initialization, since the software reset of DCP must be issued to take these setting in effect. Refer to the DCP\_OTPKeySelect() function in BEE driver example.

### 15.3 Comments about API usage in RTOS

DCP transactional (encryption or hash) APIs can be called from multiple threads.

### 15.4 Comments about API usage in interrupt handler

Assuming the host processor receiving interrupt has the ownership of the DCP module, it can request Encrypt/Decrypt/Hash/public\_key operations in an interrupt routine. Additionally, as the DCP accesses system memory for its operation with data (such as message, plaintext, ciphertext, or keys) all data should remain valid until the DCP operation completes.

### 15.5 Comments about DCACHE

Input and output buffers passed to DCP API should be in non-cached memory or handled properly (DCACHE Clean and Invalidate) while using DCACHE.

## 15.6 DCP Driver Examples

### 15.6.1 Simple examples

Encrypt plaintext by AES engine Refer to the driver examples codes located at <SDK\_ROOT>/boards/<BOARD>/driver\_examples/DCP

Compute hash (CRC-32) The CRC-32 algorithm implements a 32-bit CRC algorithm similar to the one used by Ethernet and many other protocols. The CRC differs from the Unix cksum() function in these four ways: The CRC initial value is 0xFFFFFFFF instead of 0x00000000, final XOR value is 0x00000000 instead of 0xFFFFFFFF, the logic pads the zeros to a 32-bit boundary for the trailing bytes, and it does not post-pend the file length. Refer to the driver examples codes located at <SDK\_ROOT>/boards/<BOARD>/driver\_examples/DCP

Compute hash (SHA-256) Refer to the driver examples codes located at <SDK\_ROOT>/boards/<BOARD>/driver\_examples/DCP

## Modules

- [DCP AES blocking driver](#)
- [DCP AES non-blocking driver](#)
- [DCP HASH driver](#)

## Data Structures

- struct [dcp\\_work\\_packet\\_t](#)  
*DCP's work packet. [More...](#)*
- struct [dcp\\_handle\\_t](#)  
*Specify DCP's key resource and DCP channel. [More...](#)*

- struct `dcp_context_t`  
*DCP's context buffer, used by DCP for context switching between channels. [More...](#)*
- struct `dcp_config_t`  
*DCP's configuration structure. [More...](#)*

## Enumerations

- enum `_dcp_status` { `kStatus_DCP_Again` = MAKE\_STATUS(kStatusGroup\_DCP, 0) }  
*DCP status return codes.*
- enum `_dcp_ch_enable_t` {  
`kDCP_chDisable` = 0U,  
`kDCP_ch0Enable` = 1U,  
`kDCP_ch1Enable` = 2U,  
`kDCP_ch2Enable` = 4U,  
`kDCP_ch3Enable` = 8U,  
`kDCP_chEnableAll` = 15U }  
*DCP channel enable.*
- enum `_dcp_ch_int_enable_t` {  
`kDCP_chIntDisable` = 0U,  
`kDCP_ch0IntEnable` = 1U,  
`kDCP_ch1IntEnable` = 2U,  
`kDCP_ch2IntEnable` = 4U,  
`kDCP_ch3IntEnable` = 8U }  
*DCP interrupt enable.*
- enum `dcp_channel_t` {  
`kDCP_Channel0` = (1u << 16),  
`kDCP_Channel1` = (1u << 17),  
`kDCP_Channel2` = (1u << 18),  
`kDCP_Channel3` = (1u << 19) }  
*DCP channel selection.*
- enum `dcp_key_slot_t` {  
`kDCP_KeySlot0` = 0U,  
`kDCP_KeySlot1` = 1U,  
`kDCP_KeySlot2` = 2U,  
`kDCP_KeySlot3` = 3U,  
`kDCP_OtpKey` = 4U,  
`kDCP_OtpUniqueKey` = 5U,  
`kDCP_PayloadKey` = 6U }  
*DCP key slot selection.*
- enum `dcp_swap_t`  
*DCP key, input & output swap options.*

## Functions

- void `DCP_Init` (DCP\_Type \*base, const `dcp_config_t` \*config)  
*Enables clock to and enables DCP.*
- void `DCP_Deinit` (DCP\_Type \*base)  
*Disable DCP clock.*

- void [DCP\\_GetDefaultConfig](#) ([dcp\\_config\\_t](#) \*config)  
*Gets the default configuration structure.*
- [status\\_t DCP\\_WaitForChannelComplete](#) ([DCP\\_Type](#) \*base, [dcp\\_handle\\_t](#) \*handle)  
*Poll and wait on DCP channel.*

## Driver version

- #define [FSL\\_DCP\\_DRIVER\\_VERSION](#) ([MAKE\\_VERSION](#)(2, 1, 6))  
*DCP driver version.*

## 15.7 Data Structure Documentation

### 15.7.1 struct [dcp\\_work\\_packet\\_t](#)

### 15.7.2 struct [dcp\\_handle\\_t](#)

#### Data Fields

- [dcp\\_channel\\_t](#) channel  
*Specify DCP channel.*
- [dcp\\_key\\_slot\\_t](#) keySlot  
*For operations with key (such as AES encryption/decryption), specify DCP key slot.*
- [uint32\\_t](#) [swapConfig](#)  
*For configuration of key, input, output byte/word swap options.*

#### Field Documentation

(1) [dcp\\_channel\\_t](#) [dcp\\_handle\\_t::channel](#)

(2) [dcp\\_key\\_slot\\_t](#) [dcp\\_handle\\_t::keySlot](#)

### 15.7.3 struct [dcp\\_context\\_t](#)

### 15.7.4 struct [dcp\\_config\\_t](#)

#### Data Fields

- bool [gatherResidualWrites](#)  
*Enable the ragged writes to the unaligned buffers.*
- bool [enableContextCaching](#)  
*Enable the caching of contexts between the operations.*
- bool [enableContextSwitching](#)  
*Enable automatic context switching for the channels.*
- [uint8\\_t](#) [enableChannel](#)  
*DCP channel enable.*
- [uint8\\_t](#) [enableChannelInterrupt](#)  
*Per-channel interrupt enable.*

### Field Documentation

- (1) `bool dcp_config_t::gatherResidualWrites`
- (2) `bool dcp_config_t::enableContextCaching`
- (3) `bool dcp_config_t::enableContextSwitching`
- (4) `uint8_t dcp_config_t::enableChannel`
- (5) `uint8_t dcp_config_t::enableChannelInterrupt`

## 15.8 Macro Definition Documentation

### 15.8.1 `#define FSL_DCP_DRIVER_VERSION (MAKE_VERSION(2, 1, 6))`

Version 2.1.6.

Current version: 2.1.6

Change log:

- Version 2.1.6
  - Bug Fix
    - \* MISRA C-2012 issue fix.
- Version 2.1.5
  - Improvements
    - \* Add support for DCACHE.
- Version 2.1.4
  - Bug Fix
    - \* Fix CRC-32 computation issue on the code's block boundary size.
- Version 2.1.3
  - Bug Fix
    - \* MISRA C-2012 issue fixed: rule 10.1, 10.3, 10.4, 11.9, 14.4, 16.4 and 17.7.
- Version 2.1.2
  - Fix sign-compare warning in `dcp_reverse_and_copy`.
- Version 2.1.1
  - Add DCP status clearing when channel operation is complete
- 2.1.0
  - Add byte/word swap feature for key, input and output data
- Version 2.0.0
  - Initial version

## 15.9 Enumeration Type Documentation

### 15.9.1 enum \_dcp\_status

Enumerator

*kStatus\_DCP\_Again* Non-blocking function shall be called again.

### 15.9.2 enum \_dcp\_ch\_enable\_t

Enumerator

*kDCP\_chDisable* DCP channel disable.  
*kDCP\_ch0Enable* DCP channel 0 enable.  
*kDCP\_ch1Enable* DCP channel 1 enable.  
*kDCP\_ch2Enable* DCP channel 2 enable.  
*kDCP\_ch3Enable* DCP channel 3 enable.  
*kDCP\_chEnableAll* DCP channel enable all.

### 15.9.3 enum \_dcp\_ch\_int\_enable\_t

Enumerator

*kDCP\_chIntDisable* DCP interrupts disable.  
*kDCP\_ch0IntEnable* DCP channel 0 interrupt enable.  
*kDCP\_ch1IntEnable* DCP channel 1 interrupt enable.  
*kDCP\_ch2IntEnable* DCP channel 2 interrupt enable.  
*kDCP\_ch3IntEnable* DCP channel 3 interrupt enable.

### 15.9.4 enum dcp\_channel\_t

Enumerator

*kDCP\_Channel0* DCP channel 0.  
*kDCP\_Channel1* DCP channel 1.  
*kDCP\_Channel2* DCP channel 2.  
*kDCP\_Channel3* DCP channel 3.

### 15.9.5 enum dcp\_key\_slot\_t

Enumerator

*kDCP\_KeySlot0* DCP key slot 0.

***kDCP\_KeySlot1*** DCP key slot 1.  
***kDCP\_KeySlot2*** DCP key slot 2.  
***kDCP\_KeySlot3*** DCP key slot 3.  
***kDCP\_OtpKey*** DCP OTP key.  
***kDCP\_OtpUniqueKey*** DCP unique OTP key.  
***kDCP\_PayloadKey*** DCP payload key.

### 15.9.6 enum dcp\_swap\_t

## 15.10 Function Documentation

### 15.10.1 void DCP\_Init ( DCP\_Type \* *base*, const dcp\_config\_t \* *config* )

Enable DCP clock and configure DCP.

Parameters

|               |                                     |
|---------------|-------------------------------------|
| <i>base</i>   | DCP base address                    |
| <i>config</i> | Pointer to configuration structure. |

### 15.10.2 void DCP\_Deinit ( DCP\_Type \* *base* )

Reset DCP and Disable DCP clock.

Parameters

|             |                  |
|-------------|------------------|
| <i>base</i> | DCP base address |
|-------------|------------------|

### 15.10.3 void DCP\_GetDefaultConfig ( dcp\_config\_t \* *config* )

This function initializes the DCP configuration structure to a default value. The default values are as follows. `dcpConfig->gatherResidualWrites = true;` `dcpConfig->enableContextCaching = true;` `dcpConfig->enableContextSwitching = true;` `dcpConfig->enableChannnel = kDCP_chEnableAll;` `dcpConfig->enableChannelInterrupt = kDCP_chIntDisable;`

Parameters

|     |               |                                     |
|-----|---------------|-------------------------------------|
| out | <i>config</i> | Pointer to configuration structure. |
|-----|---------------|-------------------------------------|

#### 15.10.4 `status_t DCP_WaitForChannelComplete ( DCP_Type * base, dcp_handle_t * handle )`

Polls the specified DCP channel until current it completes activity.

Parameters

|               |                              |
|---------------|------------------------------|
| <i>base</i>   | DCP peripheral base address. |
| <i>handle</i> | Specifies DCP channel.       |

Returns

`kStatus_Success` When data processing completes without error.

`kStatus_Fail` When error occurs.

## 15.11 DCP AES blocking driver

### 15.11.1 Overview

This section describes the programming interface of the DCP AES blocking driver.

#### Macros

- #define `DCP_AES_BLOCK_SIZE` 16  
*AES block size in bytes.*

#### Functions

- `status_t DCP_AES_SetKey` (DCP\_Type \*base, `dcp_handle_t` \*handle, const uint8\_t \*key, size\_t keySize)  
*Set AES key to `dcp_handle_t` struct and optionally to DCP.*
- `status_t DCP_AES_EncryptEcb` (DCP\_Type \*base, `dcp_handle_t` \*handle, const uint8\_t \*plaintext, uint8\_t \*ciphertext, size\_t size)  
*Encrypts AES on one or multiple 128-bit block(s).*
- `status_t DCP_AES_DecryptEcb` (DCP\_Type \*base, `dcp_handle_t` \*handle, const uint8\_t \*ciphertext, uint8\_t \*plaintext, size\_t size)  
*Decrypts AES on one or multiple 128-bit block(s).*
- `status_t DCP_AES_EncryptCbc` (DCP\_Type \*base, `dcp_handle_t` \*handle, const uint8\_t \*plaintext, uint8\_t \*ciphertext, size\_t size, const uint8\_t iv[16])  
*Encrypts AES using CBC block mode.*
- `status_t DCP_AES_DecryptCbc` (DCP\_Type \*base, `dcp_handle_t` \*handle, const uint8\_t \*ciphertext, uint8\_t \*plaintext, size\_t size, const uint8\_t iv[16])  
*Decrypts AES using CBC block mode.*

### 15.11.2 Function Documentation

#### 15.11.2.1 `status_t DCP_AES_SetKey ( DCP_Type * base, dcp_handle_t * handle, const uint8_t * key, size_t keySize )`

Sets the AES key for encryption/decryption with the `dcp_handle_t` structure. The `dcp_handle_t` input argument specifies keySlot. If the keySlot is `kDCP_OtpKey`, the function will check the `OTP_KEY_READY` bit and will return it's ready to use status. For other keySlot selections, the function will copy and hold the key in `dcp_handle_t` struct. If the keySlot is one of the four DCP SRAM-based keys (one of `kDCP_KeySlot0`, `kDCP_KeySlot1`, `kDCP_KeySlot2`, `kDCP_KeySlot3`), this function will also load the supplied key to the specified keySlot in DCP.



## Parameters

|                |                                        |
|----------------|----------------------------------------|
| <i>base</i>    | DCP peripheral base address.           |
| <i>handle</i>  | Handle used for the request.           |
| <i>key</i>     | 0-mod-4 aligned pointer to AES key.    |
| <i>keySize</i> | AES key size in bytes. Shall equal 16. |

## Returns

status from set key operation

**15.11.2.2** `status_t DCP_AES_EncryptEcb ( DCP_Type * base, dcp_handle_t * handle, const uint8_t * plaintext, uint8_t * ciphertext, size_t size )`

Encrypts AES. The source plaintext and destination ciphertext can overlap in system memory.

## Parameters

|     |                   |                                                                       |
|-----|-------------------|-----------------------------------------------------------------------|
|     | <i>base</i>       | DCP peripheral base address                                           |
|     | <i>handle</i>     | Handle used for this request.                                         |
|     | <i>plaintext</i>  | Input plain text to encrypt                                           |
| out | <i>ciphertext</i> | Output cipher text                                                    |
|     | <i>size</i>       | Size of input and output data in bytes. Must be multiple of 16 bytes. |

## Returns

Status from encrypt operation

**15.11.2.3** `status_t DCP_AES_DecryptEcb ( DCP_Type * base, dcp_handle_t * handle, const uint8_t * ciphertext, uint8_t * plaintext, size_t size )`

Decrypts AES. The source ciphertext and destination plaintext can overlap in system memory.

## Parameters

---

|     |                   |                                                                       |
|-----|-------------------|-----------------------------------------------------------------------|
|     | <i>base</i>       | DCP peripheral base address                                           |
|     | <i>handle</i>     | Handle used for this request.                                         |
|     | <i>ciphertext</i> | Input plain text to encrypt                                           |
| out | <i>plaintext</i>  | Output cipher text                                                    |
|     | <i>size</i>       | Size of input and output data in bytes. Must be multiple of 16 bytes. |

Returns

Status from decrypt operation

**15.11.2.4** `status_t DCP_AES_EncryptCbc ( DCP_Type * base, dcp_handle_t * handle,  
const uint8_t * plaintext, uint8_t * ciphertext, size_t size, const uint8_t iv[16] )`

Encrypts AES using CBC block mode. The source plaintext and destination ciphertext can overlap in system memory.

Parameters

|     |                   |                                                                       |
|-----|-------------------|-----------------------------------------------------------------------|
|     | <i>base</i>       | DCP peripheral base address                                           |
|     | <i>handle</i>     | Handle used for this request.                                         |
|     | <i>plaintext</i>  | Input plain text to encrypt                                           |
| out | <i>ciphertext</i> | Output cipher text                                                    |
|     | <i>size</i>       | Size of input and output data in bytes. Must be multiple of 16 bytes. |
|     | <i>iv</i>         | Input initial vector to combine with the first input block.           |

Returns

Status from encrypt operation

**15.11.2.5** `status_t DCP_AES_DecryptCbc ( DCP_Type * base, dcp_handle_t * handle,  
const uint8_t * ciphertext, uint8_t * plaintext, size_t size, const uint8_t iv[16] )`

Decrypts AES using CBC block mode. The source ciphertext and destination plaintext can overlap in system memory.

## Parameters

|     |                   |                                                                       |
|-----|-------------------|-----------------------------------------------------------------------|
|     | <i>base</i>       | DCP peripheral base address                                           |
|     | <i>handle</i>     | Handle used for this request.                                         |
|     | <i>ciphertext</i> | Input cipher text to decrypt                                          |
| out | <i>plaintext</i>  | Output plain text                                                     |
|     | <i>size</i>       | Size of input and output data in bytes. Must be multiple of 16 bytes. |
|     | <i>iv</i>         | Input initial vector to combine with the first input block.           |

## Returns

Status from decrypt operation

## 15.12 DCP AES non-blocking driver

### 15.12.1 Overview

This section describes the programming interface of the DCP AES non-blocking driver.

### Functions

- `status_t DCP_AES_EncryptEcbNonBlocking` (DCP\_Type \*base, `dcp_handle_t` \*handle, `dcp_work_packet_t` \*dcpPacket, const uint8\_t \*plaintext, uint8\_t \*ciphertext, size\_t size)  
*Encrypts AES using the ECB block mode.*
- `status_t DCP_AES_DecryptEcbNonBlocking` (DCP\_Type \*base, `dcp_handle_t` \*handle, `dcp_work_packet_t` \*dcpPacket, const uint8\_t \*ciphertext, uint8\_t \*plaintext, size\_t size)  
*Decrypts AES using ECB block mode.*
- `status_t DCP_AES_EncryptCbcNonBlocking` (DCP\_Type \*base, `dcp_handle_t` \*handle, `dcp_work_packet_t` \*dcpPacket, const uint8\_t \*plaintext, uint8\_t \*ciphertext, size\_t size, const uint8\_t \*iv)  
*Encrypts AES using CBC block mode.*
- `status_t DCP_AES_DecryptCbcNonBlocking` (DCP\_Type \*base, `dcp_handle_t` \*handle, `dcp_work_packet_t` \*dcpPacket, const uint8\_t \*ciphertext, uint8\_t \*plaintext, size\_t size, const uint8\_t \*iv)  
*Decrypts AES using CBC block mode.*

### 15.12.2 Function Documentation

#### 15.12.2.1 `status_t DCP_AES_EncryptEcbNonBlocking` ( DCP\_Type \* *base*, `dcp_handle_t` \* *handle*, `dcp_work_packet_t` \* *dcpPacket*, const uint8\_t \* *plaintext*, uint8\_t \* *ciphertext*, size\_t *size* )

Puts AES ECB encrypt work packet to DCP channel.

Parameters

|     |                   |                                                                       |
|-----|-------------------|-----------------------------------------------------------------------|
|     | <i>base</i>       | DCP peripheral base address                                           |
|     | <i>handle</i>     | Handle used for this request.                                         |
| out | <i>dcpPacket</i>  | Memory for the DCP work packet.                                       |
|     | <i>plaintext</i>  | Input plain text to encrypt.                                          |
| out | <i>ciphertext</i> | Output cipher text                                                    |
|     | <i>size</i>       | Size of input and output data in bytes. Must be multiple of 16 bytes. |

Returns

- kStatus\_Success The work packet has been scheduled at DCP channel.
- kStatus\_DCP\_Again The DCP channel is busy processing previous request.

**15.12.2.2** `status_t DCP_AES_DecryptEcbNonBlocking ( DCP_Type * base, dcp_handle_t * handle, dcp_work_packet_t * dcpPacket, const uint8_t * ciphertext, uint8_t * plaintext, size_t size )`

Puts AES ECB decrypt dcpPacket to DCP input job ring.

Parameters

|     |                   |                                                                       |
|-----|-------------------|-----------------------------------------------------------------------|
|     | <i>base</i>       | DCP peripheral base address                                           |
|     | <i>handle</i>     | Handle used for this request.                                         |
| out | <i>dcpPacket</i>  | Memory for the DCP work packet.                                       |
|     | <i>ciphertext</i> | Input cipher text to decrypt                                          |
| out | <i>plaintext</i>  | Output plain text                                                     |
|     | <i>size</i>       | Size of input and output data in bytes. Must be multiple of 16 bytes. |

Returns

kStatus\_Success The work packet has been scheduled at DCP channel.  
 kStatus\_DCP\_Again The DCP channel is busy processing previous request.

**15.12.2.3** `status_t DCP_AES_EncryptCbcNonBlocking ( DCP_Type * base, dcp_handle_t * handle, dcp_work_packet_t * dcpPacket, const uint8_t * plaintext, uint8_t * ciphertext, size_t size, const uint8_t * iv )`

Puts AES CBC encrypt dcpPacket to DCP input job ring.

Parameters

|     |                   |                                                                       |
|-----|-------------------|-----------------------------------------------------------------------|
|     | <i>base</i>       | DCP peripheral base address                                           |
|     | <i>handle</i>     | Handle used for this request. Specifies jobRing.                      |
| out | <i>dcpPacket</i>  | Memory for the DCP work packet.                                       |
|     | <i>plaintext</i>  | Input plain text to encrypt                                           |
| out | <i>ciphertext</i> | Output cipher text                                                    |
|     | <i>size</i>       | Size of input and output data in bytes. Must be multiple of 16 bytes. |
|     | <i>iv</i>         | Input initial vector to combine with the first input block.           |

Returns

kStatus\_Success The work packet has been scheduled at DCP channel.  
 kStatus\_DCP\_Again The DCP channel is busy processing previous request.

**15.12.2.4** `status_t DCP_AES_DecryptCbcNonBlocking ( DCP_Type * base, dcp_handle_t * handle, dcp_work_packet_t * dcpPacket, const uint8_t * ciphertext, uint8_t * plaintext, size_t size, const uint8_t * iv )`

Puts AES CBC decrypt dcpPacket to DCP input job ring.

Parameters

|     |                   |                                                                       |
|-----|-------------------|-----------------------------------------------------------------------|
|     | <i>base</i>       | DCP peripheral base address                                           |
|     | <i>handle</i>     | Handle used for this request. Specifies jobRing.                      |
| out | <i>dcpPacket</i>  | Memory for the DCP work packet.                                       |
|     | <i>ciphertext</i> | Input cipher text to decrypt                                          |
| out | <i>plaintext</i>  | Output plain text                                                     |
|     | <i>size</i>       | Size of input and output data in bytes. Must be multiple of 16 bytes. |
|     | <i>iv</i>         | Input initial vector to combine with the first input block.           |

Returns

kStatus\_Success The work packet has been scheduled at DCP channel.

kStatus\_DCP\_Again The DCP channel is busy processing previous request.

## 15.13 DCP HASH driver

### 15.13.1 Overview

This section describes the programming interface of the DCP HASH driver.

#### Data Structures

- struct `dcp_hash_ctx_t`  
*Storage type used to save hash context. [More...](#)*

#### Macros

- #define `DCP_SHA_BLOCK_SIZE` 128U  
*DCP HASH Context size.*
- #define `DCP_HASH_BLOCK_SIZE` `DCP_SHA_BLOCK_SIZE`  
*DCP hash block size.*
- #define `DCP_HASH_CTX_SIZE` 64  
*DCP HASH Context size.*

#### Enumerations

- enum `dcp_hash_algo_t` {  
  `kDCP_Sha1`,  
  `kDCP_Sha256`,  
  `kDCP_Crc32` }  
*Supported cryptographic block cipher functions for HASH creation.*

#### Functions

- `status_t DCP_HASH_Init` (`DCP_Type *base`, `dcp_handle_t *handle`, `dcp_hash_ctx_t *ctx`, `dcp_hash_algo_t algo`)  
*Initialize HASH context.*
- `status_t DCP_HASH_Update` (`DCP_Type *base`, `dcp_hash_ctx_t *ctx`, `const uint8_t *input`, `size_t inputSize`)  
*Add data to current HASH.*
- `status_t DCP_HASH_Finish` (`DCP_Type *base`, `dcp_hash_ctx_t *ctx`, `uint8_t *output`, `size_t *outputSize`)  
*Finalize hashing.*
- `status_t DCP_HASH` (`DCP_Type *base`, `dcp_handle_t *handle`, `dcp_hash_algo_t algo`, `const uint8_t *input`, `size_t inputSize`, `uint8_t *output`, `size_t *outputSize`)  
*Create HASH on given data.*



## 15.13.2 Data Structure Documentation

### 15.13.2.1 struct dcp\_hash\_ctx\_t

## 15.13.3 Macro Definition Documentation

### 15.13.3.1 #define DCP\_SHA\_BLOCK\_SIZE 128U

internal buffer block size

### 15.13.3.2 #define DCP\_HASH\_CTX\_SIZE 64

## 15.13.4 Enumeration Type Documentation

### 15.13.4.1 enum dcp\_hash\_algo\_t

Enumerator

*kDCP\_Sha1* SHA\_1.  
*kDCP\_Sha256* SHA\_256.  
*kDCP\_Crc32* CRC\_32.

## 15.13.5 Function Documentation

### 15.13.5.1 status\_t DCP\_HASH\_Init ( DCP\_Type \* *base*, dcp\_handle\_t \* *handle*, dcp\_hash\_ctx\_t \* *ctx*, dcp\_hash\_algo\_t *algo* )

This function initializes the HASH.

Parameters

|     |               |                                                   |
|-----|---------------|---------------------------------------------------|
|     | <i>base</i>   | DCP peripheral base address                       |
|     | <i>handle</i> | Specifies the DCP channel used for hashing.       |
| out | <i>ctx</i>    | Output hash context                               |
|     | <i>algo</i>   | Underlying algorithm to use for hash computation. |

Returns

Status of initialization

### 15.13.5.2 `status_t DCP_HASH_Update ( DCP_Type * base, dcp_hash_ctx_t * ctx, const uint8_t * input, size_t inputSize )`

Add data to current HASH. This can be called repeatedly with an arbitrary amount of data to be hashed. The functions blocks. If it returns `kStatus_Success`, the running hash has been updated (DCP has processed the input data), so the memory at the input pointer can be released back to system. The DCP context buffer is updated with the running hash and with all necessary information to support possible context switch.

Parameters

|                |                  |                             |
|----------------|------------------|-----------------------------|
|                | <i>base</i>      | DCP peripheral base address |
| <i>in, out</i> | <i>ctx</i>       | HASH context                |
|                | <i>input</i>     | Input data                  |
|                | <i>inputSize</i> | Size of input data in bytes |

Returns

Status of the hash update operation

### 15.13.5.3 `status_t DCP_HASH_Finish ( DCP_Type * base, dcp_hash_ctx_t * ctx, uint8_t * output, size_t * outputSize )`

Outputs the final hash (computed by [DCP\\_HASH\\_Update\(\)](#)) and erases the context.

Parameters

|                |                   |                                                                                                                                                                                         |
|----------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                | <i>base</i>       | DCP peripheral base address                                                                                                                                                             |
| <i>in, out</i> | <i>ctx</i>        | Input hash context                                                                                                                                                                      |
| <i>out</i>     | <i>output</i>     | Output hash data                                                                                                                                                                        |
| <i>in, out</i> | <i>outputSize</i> | Optional parameter (can be passed as NULL). On function entry, it specifies the size of <code>output[]</code> buffer. On function return, it stores the number of updated output bytes. |

Returns

Status of the hash finish operation

### 15.13.5.4 `status_t DCP_HASH ( DCP_Type * base, dcp_handle_t * handle, dcp_hash_algo_t algo, const uint8_t * input, size_t inputSize, uint8_t * output, size_t * outputSize )`

Perform the full SHA or CRC32 in one function call. The function is blocking.

## Parameters

|     |                   |                                                               |
|-----|-------------------|---------------------------------------------------------------|
|     | <i>base</i>       | DCP peripheral base address                                   |
|     | <i>handle</i>     | Handle used for the request.                                  |
|     | <i>algo</i>       | Underlying algorithm to use for hash computation.             |
|     | <i>input</i>      | Input data                                                    |
|     | <i>inputSize</i>  | Size of input data in bytes                                   |
| out | <i>output</i>     | Output hash data                                              |
| out | <i>outputSize</i> | Output parameter storing the size of the output hash in bytes |

## Returns

Status of the one call hash operation.

## Chapter 16

# DMAMUX: Direct Memory Access Multiplexer Driver

### 16.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Direct Memory Access Multiplexer (DMAMUX) of MCUXpresso SDK devices.

### 16.2 Typical use case

#### 16.2.1 DMAMUX Operation

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/dmamux`

#### Driver version

- `#define FSL_DMAMUX_DRIVER_VERSION (MAKE_VERSION(2, 0, 5))`  
*DMAMUX driver version 2.0.5.*

#### DMAMUX Initialization and de-initialization

- void `DMAMUX_Init` (DMAMUX\_Type \*base)  
*Initializes the DMAMUX peripheral.*
- void `DMAMUX_Deinit` (DMAMUX\_Type \*base)  
*Deinitializes the DMAMUX peripheral.*

#### DMAMUX Channel Operation

- static void `DMAMUX_EnableChannel` (DMAMUX\_Type \*base, uint32\_t channel)  
*Enables the DMAMUX channel.*
- static void `DMAMUX_DisableChannel` (DMAMUX\_Type \*base, uint32\_t channel)  
*Disables the DMAMUX channel.*
- static void `DMAMUX_SetSource` (DMAMUX\_Type \*base, uint32\_t channel, uint32\_t source)  
*Configures the DMAMUX channel source.*
- static void `DMAMUX_EnablePeriodTrigger` (DMAMUX\_Type \*base, uint32\_t channel)  
*Enables the DMAMUX period trigger.*
- static void `DMAMUX_DisablePeriodTrigger` (DMAMUX\_Type \*base, uint32\_t channel)  
*Disables the DMAMUX period trigger.*
- static void `DMAMUX_EnableAlwaysOn` (DMAMUX\_Type \*base, uint32\_t channel, bool enable)  
*Enables the DMA channel to be always ON.*

### 16.3 Macro Definition Documentation

#### 16.3.1 `#define FSL_DMAMUX_DRIVER_VERSION (MAKE_VERSION(2, 0, 5))`

## 16.4 Function Documentation

### 16.4.1 void DMAMUX\_Init ( DMAMUX\_Type \* *base* )

This function un gates the DMAMUX clock.

Parameters

|             |                                 |
|-------------|---------------------------------|
| <i>base</i> | DMAMUX peripheral base address. |
|-------------|---------------------------------|

#### 16.4.2 void DMAMUX\_Deinit ( DMAMUX\_Type \* *base* )

This function gates the DMAMUX clock.

Parameters

|             |                                 |
|-------------|---------------------------------|
| <i>base</i> | DMAMUX peripheral base address. |
|-------------|---------------------------------|

#### 16.4.3 static void DMAMUX\_EnableChannel ( DMAMUX\_Type \* *base*, uint32\_t *channel* ) [inline], [static]

This function enables the DMAMUX channel.

Parameters

|                |                                 |
|----------------|---------------------------------|
| <i>base</i>    | DMAMUX peripheral base address. |
| <i>channel</i> | DMAMUX channel number.          |

#### 16.4.4 static void DMAMUX\_DisableChannel ( DMAMUX\_Type \* *base*, uint32\_t *channel* ) [inline], [static]

This function disables the DMAMUX channel.

Note

The user must disable the DMAMUX channel before configuring it.

Parameters

|             |                                 |
|-------------|---------------------------------|
| <i>base</i> | DMAMUX peripheral base address. |
|-------------|---------------------------------|

|                |                        |
|----------------|------------------------|
| <i>channel</i> | DMAMUX channel number. |
|----------------|------------------------|

**16.4.5 static void DMAMUX\_SetSource ( DMAMUX\_Type \* *base*, uint32\_t *channel*, uint32\_t *source* ) [inline], [static]**

Parameters

|                |                                                            |
|----------------|------------------------------------------------------------|
| <i>base</i>    | DMAMUX peripheral base address.                            |
| <i>channel</i> | DMAMUX channel number.                                     |
| <i>source</i>  | Channel source, which is used to trigger the DMA transfer. |

**16.4.6 static void DMAMUX\_EnablePeriodTrigger ( DMAMUX\_Type \* *base*, uint32\_t *channel* ) [inline], [static]**

This function enables the DMAMUX period trigger feature.

Parameters

|                |                                 |
|----------------|---------------------------------|
| <i>base</i>    | DMAMUX peripheral base address. |
| <i>channel</i> | DMAMUX channel number.          |

**16.4.7 static void DMAMUX\_DisablePeriodTrigger ( DMAMUX\_Type \* *base*, uint32\_t *channel* ) [inline], [static]**

This function disables the DMAMUX period trigger.

Parameters

|                |                                 |
|----------------|---------------------------------|
| <i>base</i>    | DMAMUX peripheral base address. |
| <i>channel</i> | DMAMUX channel number.          |

**16.4.8 static void DMAMUX\_EnableAlwaysOn ( DMAMUX\_Type \* *base*, uint32\_t *channel*, bool *enable* ) [inline], [static]**

This function enables the DMAMUX channel always ON feature.

## Parameters

|                |                                                                                  |
|----------------|----------------------------------------------------------------------------------|
| <i>base</i>    | DMAMUX peripheral base address.                                                  |
| <i>channel</i> | DMAMUX channel number.                                                           |
| <i>enable</i>  | Switcher of the always ON feature. "true" means enabled, "false" means disabled. |



## Chapter 17

# eDMA: Enhanced Direct Memory Access (eDMA) Controller Driver

### 17.1 Overview

The MCUXpresso SDK provides a peripheral driver for the enhanced Direct Memory Access (eDMA) of MCUXpresso SDK devices.

### 17.2 Typical use case

#### 17.2.1 eDMA Operation

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/edma`

### Data Structures

- struct `edma_config_t`  
*eDMA global configuration structure. [More...](#)*
- struct `edma_transfer_config_t`  
*eDMA transfer configuration [More...](#)*
- struct `edma_channel_Preemption_config_t`  
*eDMA channel priority configuration [More...](#)*
- struct `edma_minor_offset_config_t`  
*eDMA minor offset configuration [More...](#)*
- struct `edma_tcd_t`  
*eDMA TCD. [More...](#)*
- struct `edma_handle_t`  
*eDMA transfer handle structure [More...](#)*

### Macros

- #define `DMA_DCHPRI_INDEX(channel)` (((channel) & ~0x03U) | (3U - ((channel)&0x03U)))  
*Compute the offset unit from DCHPRI3.*

### Typedefs

- typedef void(\* `edma_callback` )(struct `_edma_handle` \*handle, void \*userData, bool transferDone, uint32\_t tcds)  
*Define callback function for eDMA.*

## Enumerations

- enum `edma_transfer_size_t` {
  - `kEDMA_TransferSize1Bytes` = 0x0U,
  - `kEDMA_TransferSize2Bytes` = 0x1U,
  - `kEDMA_TransferSize4Bytes` = 0x2U,
  - `kEDMA_TransferSize8Bytes` = 0x3U,
  - `kEDMA_TransferSize16Bytes` = 0x4U,
  - `kEDMA_TransferSize32Bytes` = 0x5U }

*eDMA transfer configuration*
- enum `edma_modulo_t` {
  - `kEDMA_ModuloDisable` = 0x0U,
  - `kEDMA_Modulo2bytes`,
  - `kEDMA_Modulo4bytes`,
  - `kEDMA_Modulo8bytes`,
  - `kEDMA_Modulo16bytes`,
  - `kEDMA_Modulo32bytes`,
  - `kEDMA_Modulo64bytes`,
  - `kEDMA_Modulo128bytes`,
  - `kEDMA_Modulo256bytes`,
  - `kEDMA_Modulo512bytes`,
  - `kEDMA_Modulo1Kbytes`,
  - `kEDMA_Modulo2Kbytes`,
  - `kEDMA_Modulo4Kbytes`,
  - `kEDMA_Modulo8Kbytes`,
  - `kEDMA_Modulo16Kbytes`,
  - `kEDMA_Modulo32Kbytes`,
  - `kEDMA_Modulo64Kbytes`,
  - `kEDMA_Modulo128Kbytes`,
  - `kEDMA_Modulo256Kbytes`,
  - `kEDMA_Modulo512Kbytes`,
  - `kEDMA_Modulo1Mbytes`,
  - `kEDMA_Modulo2Mbytes`,
  - `kEDMA_Modulo4Mbytes`,
  - `kEDMA_Modulo8Mbytes`,
  - `kEDMA_Modulo16Mbytes`,
  - `kEDMA_Modulo32Mbytes`,
  - `kEDMA_Modulo64Mbytes`,
  - `kEDMA_Modulo128Mbytes`,
  - `kEDMA_Modulo256Mbytes`,
  - `kEDMA_Modulo512Mbytes`,
  - `kEDMA_Modulo1Gbytes`,
  - `kEDMA_Modulo2Gbytes` }

*eDMA modulo configuration*
- enum `edma_bandwidth_t` {

```
kEDMA_BandwidthStallNone = 0x0U,
kEDMA_BandwidthStall4Cycle = 0x2U,
kEDMA_BandwidthStall8Cycle = 0x3U }
```

*Bandwidth control.*

- enum `edma_channel_link_type_t` {
 

```
kEDMA_LinkNone = 0x0U,
kEDMA_MinorLink,
kEDMA_MajorLink }
```

*Channel link type.*

- enum {
 

```
kEDMA_DoneFlag = 0x1U,
kEDMA_ErrorFlag = 0x2U,
kEDMA_InterruptFlag = 0x4U }
```

*\_edma\_channel\_status\_flags eDMA channel status flags.*

- enum {
 

```
kEDMA_DestinationBusErrorFlag = DMA_ES_DBE_MASK,
kEDMA_SourceBusErrorFlag = DMA_ES_SBE_MASK,
kEDMA_ScatterGatherErrorFlag = DMA_ES_SGE_MASK,
kEDMA_NbytesErrorFlag = DMA_ES_NCE_MASK,
kEDMA_DestinationOffsetErrorFlag = DMA_ES_DOE_MASK,
kEDMA_DestinationAddressErrorFlag = DMA_ES_DAE_MASK,
kEDMA_SourceOffsetErrorFlag = DMA_ES_SOE_MASK,
kEDMA_SourceAddressErrorFlag = DMA_ES_SAE_MASK,
kEDMA_ErrorChannelFlag = DMA_ES_ERRCHN_MASK,
kEDMA_ChannelPriorityErrorFlag = DMA_ES_CPE_MASK,
kEDMA_TransferCanceledFlag = DMA_ES_ECX_MASK,
kEDMA_ValidFlag = (int)DMA_ES_VLD_MASK }
```

*\_edma\_error\_status\_flags eDMA channel error status flags.*

- enum `edma_interrupt_enable_t` {
 

```
kEDMA_ErrorInterruptEnable = 0x1U,
kEDMA_MajorInterruptEnable = DMA_CSR_INTMAJOR_MASK,
kEDMA_HalfInterruptEnable = DMA_CSR_INTHALF_MASK }
```

*eDMA interrupt source*

- enum `edma_transfer_type_t` {
 

```
kEDMA_MemoryToMemory = 0x0U,
kEDMA_PeripheralToMemory,
kEDMA_MemoryToPeripheral,
kEDMA_PeripheralToPeripheral }
```

*eDMA transfer type*

- enum {
 

```
kStatus_EDMA_QueueFull = MAKE_STATUS(kStatusGroup_EDMA, 0),
kStatus_EDMA_Busy = MAKE_STATUS(kStatusGroup_EDMA, 1) }
```

*\_edma\_transfer\_status eDMA transfer status*

## Driver version

- #define `FSL_EDMA_DRIVER_VERSION` (`MAKE_VERSION(2, 4, 3)`)

*eDMA driver version*

## eDMA initialization and de-initialization

- void [EDMA\\_Init](#) (DMA\_Type \*base, const [edma\\_config\\_t](#) \*config)  
*Initializes the eDMA peripheral.*
- void [EDMA\\_Deinit](#) (DMA\_Type \*base)  
*Deinitializes the eDMA peripheral.*
- void [EDMA\\_InstallTCD](#) (DMA\_Type \*base, uint32\_t channel, [edma\\_tcd\\_t](#) \*tcd)  
*Push content of TCD structure into hardware TCD register.*
- void [EDMA\\_GetDefaultConfig](#) ([edma\\_config\\_t](#) \*config)  
*Gets the eDMA default configuration structure.*
- static void [EDMA\\_EnableContinuousChannelLinkMode](#) (DMA\_Type \*base, bool enable)  
*Enable/Disable continuous channel link mode.*
- static void [EDMA\\_EnableMinorLoopMapping](#) (DMA\_Type \*base, bool enable)  
*Enable/Disable minor loop mapping.*

## eDMA Channel Operation

- void [EDMA\\_ResetChannel](#) (DMA\_Type \*base, uint32\_t channel)  
*Sets all TCD registers to default values.*
- void [EDMA\\_SetTransferConfig](#) (DMA\_Type \*base, uint32\_t channel, const [edma\\_transfer\\_config\\_t](#) \*config, [edma\\_tcd\\_t](#) \*nextTcd)  
*Configures the eDMA transfer attribute.*
- void [EDMA\\_SetMinorOffsetConfig](#) (DMA\_Type \*base, uint32\_t channel, const [edma\\_minor\\_offset\\_config\\_t](#) \*config)  
*Configures the eDMA minor offset feature.*
- void [EDMA\\_SetChannelPreemptionConfig](#) (DMA\_Type \*base, uint32\_t channel, const [edma\\_channel\\_preemption\\_config\\_t](#) \*config)  
*Configures the eDMA channel preemption feature.*
- void [EDMA\\_SetChannelLink](#) (DMA\_Type \*base, uint32\_t channel, [edma\\_channel\\_link\\_type\\_t](#) linkType, uint32\_t linkedChannel)  
*Sets the channel link for the eDMA transfer.*
- void [EDMA\\_SetBandWidth](#) (DMA\_Type \*base, uint32\_t channel, [edma\\_bandwidth\\_t](#) bandWidth)  
*Sets the bandwidth for the eDMA transfer.*
- void [EDMA\\_SetModulo](#) (DMA\_Type \*base, uint32\_t channel, [edma\\_modulo\\_t](#) srcModulo, [edma\\_modulo\\_t](#) destModulo)  
*Sets the source modulo and the destination modulo for the eDMA transfer.*
- static void [EDMA\\_EnableAsyncRequest](#) (DMA\_Type \*base, uint32\_t channel, bool enable)  
*Enables an async request for the eDMA transfer.*
- static void [EDMA\\_EnableAutoStopRequest](#) (DMA\_Type \*base, uint32\_t channel, bool enable)  
*Enables an auto stop request for the eDMA transfer.*
- void [EDMA\\_EnableChannelInterrupts](#) (DMA\_Type \*base, uint32\_t channel, uint32\_t mask)  
*Enables the interrupt source for the eDMA transfer.*
- void [EDMA\\_DisableChannelInterrupts](#) (DMA\_Type \*base, uint32\_t channel, uint32\_t mask)  
*Disables the interrupt source for the eDMA transfer.*
- void [EDMA\\_SetMajorOffsetConfig](#) (DMA\_Type \*base, uint32\_t channel, int32\_t sourceOffset, int32\_t destOffset)  
*Configures the eDMA channel TCD major offset feature.*

## eDMA TCD Operation

- void [EDMA\\_TcdReset](#) ([edma\\_tcd\\_t](#) \*tcd)  
*Sets all fields to default values for the TCD structure.*
- void [EDMA\\_TcdSetTransferConfig](#) ([edma\\_tcd\\_t](#) \*tcd, const [edma\\_transfer\\_config\\_t](#) \*config, [edma\\_tcd\\_t](#) \*nextTcd)  
*Configures the eDMA TCD transfer attribute.*
- void [EDMA\\_TcdSetMinorOffsetConfig](#) ([edma\\_tcd\\_t](#) \*tcd, const [edma\\_minor\\_offset\\_config\\_t](#) \*config)  
*Configures the eDMA TCD minor offset feature.*
- void [EDMA\\_TcdSetChannelLink](#) ([edma\\_tcd\\_t](#) \*tcd, [edma\\_channel\\_link\\_type\\_t](#) linkType, uint32\_t linkedChannel)  
*Sets the channel link for the eDMA TCD.*
- static void [EDMA\\_TcdSetBandWidth](#) ([edma\\_tcd\\_t](#) \*tcd, [edma\\_bandwidth\\_t](#) bandWidth)  
*Sets the bandwidth for the eDMA TCD.*
- void [EDMA\\_TcdSetModulo](#) ([edma\\_tcd\\_t](#) \*tcd, [edma\\_modulo\\_t](#) srcModulo, [edma\\_modulo\\_t](#) destModulo)  
*Sets the source modulo and the destination modulo for the eDMA TCD.*
- static void [EDMA\\_TcdEnableAutoStopRequest](#) ([edma\\_tcd\\_t](#) \*tcd, bool enable)  
*Sets the auto stop request for the eDMA TCD.*
- void [EDMA\\_TcdEnableInterrupts](#) ([edma\\_tcd\\_t](#) \*tcd, uint32\_t mask)  
*Enables the interrupt source for the eDMA TCD.*
- void [EDMA\\_TcdDisableInterrupts](#) ([edma\\_tcd\\_t](#) \*tcd, uint32\_t mask)  
*Disables the interrupt source for the eDMA TCD.*
- void [EDMA\\_TcdSetMajorOffsetConfig](#) ([edma\\_tcd\\_t](#) \*tcd, int32\_t sourceOffset, int32\_t destOffset)  
*Configures the eDMA TCD major offset feature.*

## eDMA Channel Transfer Operation

- static void [EDMA\\_EnableChannelRequest](#) ([DMA\\_Type](#) \*base, uint32\_t channel)  
*Enables the eDMA hardware channel request.*
- static void [EDMA\\_DisableChannelRequest](#) ([DMA\\_Type](#) \*base, uint32\_t channel)  
*Disables the eDMA hardware channel request.*
- static void [EDMA\\_TriggerChannelStart](#) ([DMA\\_Type](#) \*base, uint32\_t channel)  
*Starts the eDMA transfer by using the software trigger.*

## eDMA Channel Status Operation

- uint32\_t [EDMA\\_GetRemainingMajorLoopCount](#) ([DMA\\_Type](#) \*base, uint32\_t channel)  
*Gets the remaining major loop count from the eDMA current channel TCD.*
- static uint32\_t [EDMA\\_GetErrorStatusFlags](#) ([DMA\\_Type](#) \*base)  
*Gets the eDMA channel error status flags.*
- uint32\_t [EDMA\\_GetChannelStatusFlags](#) ([DMA\\_Type](#) \*base, uint32\_t channel)  
*Gets the eDMA channel status flags.*
- void [EDMA\\_ClearChannelStatusFlags](#) ([DMA\\_Type](#) \*base, uint32\_t channel, uint32\_t mask)  
*Clears the eDMA channel status flags.*

## eDMA Transactional Operation

- void [EDMA\\_CreateHandle](#) ([edma\\_handle\\_t](#) \*handle, [DMA\\_Type](#) \*base, uint32\_t channel)  
*Creates the eDMA handle.*

- void `EDMA_InstallTCDMemory` (`edma_handle_t *handle`, `edma_tcd_t *tcdPool`, `uint32_t tcdSize`)  
*Installs the TCDs memory pool into the eDMA handle.*
- void `EDMA_SetCallback` (`edma_handle_t *handle`, `edma_callback` callback, `void *userData`)  
*Installs a callback function for the eDMA transfer.*
- void `EDMA_PrepareTransferConfig` (`edma_transfer_config_t *config`, `void *srcAddr`, `uint32_t srcWidth`, `int16_t srcOffset`, `void *destAddr`, `uint32_t destWidth`, `int16_t destOffset`, `uint32_t bytesEachRequest`, `uint32_t transferBytes`)  
*Prepares the eDMA transfer structure configurations.*
- void `EDMA_PrepareTransfer` (`edma_transfer_config_t *config`, `void *srcAddr`, `uint32_t srcWidth`, `void *destAddr`, `uint32_t destWidth`, `uint32_t bytesEachRequest`, `uint32_t transferBytes`, `edma_transfer_type_t transferType`)  
*Prepares the eDMA transfer structure.*
- `status_t` `EDMA_SubmitTransfer` (`edma_handle_t *handle`, `const edma_transfer_config_t *config`)  
*Submits the eDMA transfer request.*
- void `EDMA_StartTransfer` (`edma_handle_t *handle`)  
*eDMA starts transfer.*
- void `EDMA_StopTransfer` (`edma_handle_t *handle`)  
*eDMA stops transfer.*
- void `EDMA_AbortTransfer` (`edma_handle_t *handle`)  
*eDMA aborts transfer.*
- static `uint32_t` `EDMA_GetUnusedTCDDNumber` (`edma_handle_t *handle`)  
*Get unused TCD slot number.*
- static `uint32_t` `EDMA_GetNextTCDDAddress` (`edma_handle_t *handle`)  
*Get the next tcd address.*
- void `EDMA_HandleIRQ` (`edma_handle_t *handle`)  
*eDMA IRQ handler for the current major loop transfer completion.*

## 17.3 Data Structure Documentation

### 17.3.1 struct `edma_config_t`

#### Data Fields

- bool `enableContinuousLinkMode`  
*Enable (true) continuous link mode.*
- bool `enableHaltOnError`  
*Enable (true) transfer halt on error.*
- bool `enableRoundRobinArbitration`  
*Enable (true) round robin channel arbitration method or fixed priority arbitration is used for channel selection.*
- bool `enableDebugMode`  
*Enable(true) eDMA debug mode.*

#### Field Documentation

##### (1) bool `edma_config_t::enableContinuousLinkMode`

Upon minor loop completion, the channel activates again if that channel has a minor loop channel link enabled and the link channel is itself.

**(2) bool edma\_config\_t::enableHaltOnError**

Any error causes the HALT bit to set. Subsequently, all service requests are ignored until the HALT bit is cleared.

**(3) bool edma\_config\_t::enableDebugMode**

When in debug mode, the eDMA stalls the start of a new channel. Executing channels are allowed to complete.

**17.3.2 struct edma\_transfer\_config\_t**

This structure configures the source/destination transfer attribute.

**Data Fields**

- uint32\_t [srcAddr](#)  
*Source data address.*
- uint32\_t [destAddr](#)  
*Destination data address.*
- [edma\\_transfer\\_size\\_t srcTransferSize](#)  
*Source data transfer size.*
- [edma\\_transfer\\_size\\_t destTransferSize](#)  
*Destination data transfer size.*
- int16\_t [srcOffset](#)  
*Sign-extended offset applied to the current source address to form the next-state value as each source read is completed.*
- int16\_t [destOffset](#)  
*Sign-extended offset applied to the current destination address to form the next-state value as each destination write is completed.*
- uint32\_t [minorLoopBytes](#)  
*Bytes to transfer in a minor loop.*
- uint32\_t [majorLoopCounts](#)  
*Major loop iteration count.*

**Field Documentation****(1) uint32\_t edma\_transfer\_config\_t::srcAddr****(2) uint32\_t edma\_transfer\_config\_t::destAddr****(3) edma\_transfer\_size\_t edma\_transfer\_config\_t::srcTransferSize****(4) edma\_transfer\_size\_t edma\_transfer\_config\_t::destTransferSize****(5) int16\_t edma\_transfer\_config\_t::srcOffset**



(6) `int16_t edma_transfer_config_t::destOffset`

(7) `uint32_t edma_transfer_config_t::majorLoopCounts`

### 17.3.3 struct edma\_channel\_Preemption\_config\_t

#### Data Fields

- `bool enableChannelPreemption`  
*If true: a channel can be suspended by other channel with higher priority.*
- `bool enablePreemptAbility`  
*If true: a channel can suspend other channel with low priority.*
- `uint8_t channelPriority`  
*Channel priority.*

### 17.3.4 struct edma\_minor\_offset\_config\_t

#### Data Fields

- `bool enableSrcMinorOffset`  
*Enable(true) or Disable(false) source minor loop offset.*
- `bool enableDestMinorOffset`  
*Enable(true) or Disable(false) destination minor loop offset.*
- `uint32_t minorOffset`  
*Offset for a minor loop mapping.*

#### Field Documentation

(1) `bool edma_minor_offset_config_t::enableSrcMinorOffset`

(2) `bool edma_minor_offset_config_t::enableDestMinorOffset`

(3) `uint32_t edma_minor_offset_config_t::minorOffset`

### 17.3.5 struct edma\_tcd\_t

This structure is same as TCD register which is described in reference manual, and is used to configure the scatter/gather feature as a next hardware TCD.

#### Data Fields

- `__IO uint32_t SADDR`  
*SADDR register, used to save source address.*
- `__IO uint16_t SOFF`  
*SOFF register, save offset bytes every transfer.*
- `__IO uint16_t ATTR`



- *ATTR register, source/destination transfer size and modulo.*  
\_\_IO uint32\_t **NBYTES**
- *Nbytes register, minor loop length in bytes.*  
\_\_IO uint32\_t **SLAST**
- *SLAST register.*  
\_\_IO uint32\_t **DADDR**
- *DADDR register, used for destination address.*  
\_\_IO uint16\_t **DOFF**
- *DOFF register, used for destination offset.*  
\_\_IO uint16\_t **CITER**
- *CITER register, current minor loop numbers, for unfinished minor loop.*  
\_\_IO uint32\_t **DLAST\_SGA**
- *DLASTSGA register, next tcd address used in scatter-gather mode.*  
\_\_IO uint16\_t **CSR**
- *CSR register, for TCD control status.*  
\_\_IO uint16\_t **BITER**
- *BITER register, begin minor loop count.*

### Field Documentation

(1) \_\_IO uint16\_t edma\_tcd\_t::CITER

(2) \_\_IO uint16\_t edma\_tcd\_t::BITER

### 17.3.6 struct edma\_handle\_t

#### Data Fields

- **edma\_callback callback**  
*Callback function for major count exhausted.*
- void \* **userData**  
*Callback function parameter.*
- DMA\_Type \* **base**  
*eDMA peripheral base address.*
- **edma\_tcd\_t \* tcdPool**  
*Pointer to memory stored TCDs.*
- uint8\_t **channel**  
*eDMA channel number.*
- volatile int8\_t **header**  
*The first TCD index.*
- volatile int8\_t **tail**  
*The last TCD index.*
- volatile int8\_t **tcdUsed**  
*The number of used TCD slots.*
- volatile int8\_t **tcdSize**  
*The total number of TCD slots in the queue.*
- uint8\_t **flags**  
*The status of the current channel.*

### Field Documentation

(1) **edma\_callback edma\_handle\_t::callback**

(2) **void\* edma\_handle\_t::userData**

(3) **DMA\_Type\* edma\_handle\_t::base**

(4) **edma\_tcd\_t\* edma\_handle\_t::tcdPool**

(5) **uint8\_t edma\_handle\_t::channel**

(6) **volatile int8\_t edma\_handle\_t::header**

Should point to the next TCD to be loaded into the eDMA engine.

(7) **volatile int8\_t edma\_handle\_t::tail**

Should point to the next TCD to be stored into the memory pool.

(8) **volatile int8\_t edma\_handle\_t::tcdUsed**

Should reflect the number of TCDs can be used/loaded in the memory.

(9) **volatile int8\_t edma\_handle\_t::tcdSize**

(10) **uint8\_t edma\_handle\_t::flags**

## 17.4 Macro Definition Documentation

### 17.4.1 #define FSL\_EDMA\_DRIVER\_VERSION (MAKE\_VERSION(2, 4, 3))

Version 2.4.3.

## 17.5 Typedef Documentation

### 17.5.1 typedef void(\* edma\_callback)(struct \_edma\_handle \*handle, void \*userData, bool transferDone, uint32\_t tcDs)

This callback function is called in the EDMA interrupt handle. In normal mode, run into callback function means the transfer users need is done. In scatter gather mode, run into callback function means a transfer control block (tcd) is finished. Not all transfer finished, users can get the finished tcd numbers using interface EDMA\_GetUnusedTCDNumber.

Parameters

---

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>handle</i>       | EDMA handle pointer, users shall not touch the values inside.                                                                                                                                                                                                                                                                                                                                                                                   |
| <i>userData</i>     | The callback user parameter pointer. Users can use this parameter to involve things users need to change in EDMA callback function.                                                                                                                                                                                                                                                                                                             |
| <i>transferDone</i> | If the current loaded transfer done. In normal mode it means if all transfer done. In scatter gather mode, this parameter shows is the current transfer block in EDMA register is done. As the load of core is different, it will be different if the new tcd loaded into EDMA registers while this callback called. If true, it always means new tcd still not loaded into registers, while false means new tcd already loaded into registers. |
| <i>tcds</i>         | How many tcds are done from the last callback. This parameter only used in scatter gather mode. It tells user how many tcds are finished between the last callback and this.                                                                                                                                                                                                                                                                    |

## 17.6 Enumeration Type Documentation

### 17.6.1 enum edma\_transfer\_size\_t

Enumerator

- kEDMA\_TransferSize1Bytes* Source/Destination data transfer size is 1 byte every time.
- kEDMA\_TransferSize2Bytes* Source/Destination data transfer size is 2 bytes every time.
- kEDMA\_TransferSize4Bytes* Source/Destination data transfer size is 4 bytes every time.
- kEDMA\_TransferSize8Bytes* Source/Destination data transfer size is 8 bytes every time.
- kEDMA\_TransferSize16Bytes* Source/Destination data transfer size is 16 bytes every time.
- kEDMA\_TransferSize32Bytes* Source/Destination data transfer size is 32 bytes every time.

### 17.6.2 enum edma\_modulo\_t

Enumerator

- kEDMA\_ModuloDisable* Disable modulo.
- kEDMA\_Modulo2bytes* Circular buffer size is 2 bytes.
- kEDMA\_Modulo4bytes* Circular buffer size is 4 bytes.
- kEDMA\_Modulo8bytes* Circular buffer size is 8 bytes.
- kEDMA\_Modulo16bytes* Circular buffer size is 16 bytes.
- kEDMA\_Modulo32bytes* Circular buffer size is 32 bytes.
- kEDMA\_Modulo64bytes* Circular buffer size is 64 bytes.
- kEDMA\_Modulo128bytes* Circular buffer size is 128 bytes.
- kEDMA\_Modulo256bytes* Circular buffer size is 256 bytes.
- kEDMA\_Modulo512bytes* Circular buffer size is 512 bytes.
- kEDMA\_Modulo1Kbytes* Circular buffer size is 1 K bytes.
- kEDMA\_Modulo2Kbytes* Circular buffer size is 2 K bytes.
- kEDMA\_Modulo4Kbytes* Circular buffer size is 4 K bytes.

*kEDMA\_Modulo8Kbytes* Circular buffer size is 8 K bytes.  
*kEDMA\_Modulo16Kbytes* Circular buffer size is 16 K bytes.  
*kEDMA\_Modulo32Kbytes* Circular buffer size is 32 K bytes.  
*kEDMA\_Modulo64Kbytes* Circular buffer size is 64 K bytes.  
*kEDMA\_Modulo128Kbytes* Circular buffer size is 128 K bytes.  
*kEDMA\_Modulo256Kbytes* Circular buffer size is 256 K bytes.  
*kEDMA\_Modulo512Kbytes* Circular buffer size is 512 K bytes.  
*kEDMA\_Modulo1Mbytes* Circular buffer size is 1 M bytes.  
*kEDMA\_Modulo2Mbytes* Circular buffer size is 2 M bytes.  
*kEDMA\_Modulo4Mbytes* Circular buffer size is 4 M bytes.  
*kEDMA\_Modulo8Mbytes* Circular buffer size is 8 M bytes.  
*kEDMA\_Modulo16Mbytes* Circular buffer size is 16 M bytes.  
*kEDMA\_Modulo32Mbytes* Circular buffer size is 32 M bytes.  
*kEDMA\_Modulo64Mbytes* Circular buffer size is 64 M bytes.  
*kEDMA\_Modulo128Mbytes* Circular buffer size is 128 M bytes.  
*kEDMA\_Modulo256Mbytes* Circular buffer size is 256 M bytes.  
*kEDMA\_Modulo512Mbytes* Circular buffer size is 512 M bytes.  
*kEDMA\_Modulo1Gbytes* Circular buffer size is 1 G bytes.  
*kEDMA\_Modulo2Gbytes* Circular buffer size is 2 G bytes.

### 17.6.3 enum edma\_bandwidth\_t

Enumerator

*kEDMA\_BandwidthStallNone* No eDMA engine stalls.  
*kEDMA\_BandwidthStall4Cycle* eDMA engine stalls for 4 cycles after each read/write.  
*kEDMA\_BandwidthStall8Cycle* eDMA engine stalls for 8 cycles after each read/write.

### 17.6.4 enum edma\_channel\_link\_type\_t

Enumerator

*kEDMA\_LinkNone* No channel link.  
*kEDMA\_MinorLink* Channel link after each minor loop.  
*kEDMA\_MajorLink* Channel link while major loop count exhausted.

### 17.6.5 anonymous enum

Enumerator

*kEDMA\_DoneFlag* DONE flag, set while transfer finished, CITER value exhausted.  
*kEDMA\_ErrorFlag* eDMA error flag, an error occurred in a transfer  
*kEDMA\_InterruptFlag* eDMA interrupt flag, set while an interrupt occurred of this channel

### 17.6.6 anonymous enum

Enumerator

- kEDMA\_DestinationBusErrorFlag* Bus error on destination address.
- kEDMA\_SourceBusErrorFlag* Bus error on the source address.
- kEDMA\_ScatterGatherErrorFlag* Error on the Scatter/Gather address, not 32byte aligned.
- kEDMA\_NbytesErrorFlag* NBYTES/CITER configuration error.
- kEDMA\_DestinationOffsetErrorFlag* Destination offset not aligned with destination size.
- kEDMA\_DestinationAddressErrorFlag* Destination address not aligned with destination size.
- kEDMA\_SourceOffsetErrorFlag* Source offset not aligned with source size.
- kEDMA\_SourceAddressErrorFlag* Source address not aligned with source size.
- kEDMA\_ErrorChannelFlag* Error channel number of the cancelled channel number.
- kEDMA\_ChannelPriorityErrorFlag* Channel priority is not unique.
- kEDMA\_TransferCanceledFlag* Transfer cancelled.
- kEDMA\_ValidFlag* No error occurred, this bit is 0. Otherwise, it is 1.

### 17.6.7 enum edma\_interrupt\_enable\_t

Enumerator

- kEDMA\_ErrorInterruptEnable* Enable interrupt while channel error occurs.
- kEDMA\_MajorInterruptEnable* Enable interrupt while major count exhausted.
- kEDMA\_HalfInterruptEnable* Enable interrupt while major count to half value.

### 17.6.8 enum edma\_transfer\_type\_t

Enumerator

- kEDMA\_MemoryToMemory* Transfer from memory to memory.
- kEDMA\_PeripheralToMemory* Transfer from peripheral to memory.
- kEDMA\_MemoryToPeripheral* Transfer from memory to peripheral.
- kEDMA\_PeripheralToPeripheral* Transfer from Peripheral to peripheral.

### 17.6.9 anonymous enum

Enumerator

- kStatus\_EDMA\_QueueFull* TCD queue is full.
- kStatus\_EDMA\_Busy* Channel is busy and can't handle the transfer request.

## **17.7 Function Documentation**

### **17.7.1 void EDMA\_Init ( DMA\_Type \* *base*, const edma\_config\_t \* *config* )**

This function un-gates the eDMA clock and configures the eDMA peripheral according to the configuration structure.

## Parameters

|               |                                                                |
|---------------|----------------------------------------------------------------|
| <i>base</i>   | eDMA peripheral base address.                                  |
| <i>config</i> | A pointer to the configuration structure, see "edma_config_t". |

## Note

This function enables the minor loop map feature.

### 17.7.2 void EDMA\_Deinit ( DMA\_Type \* *base* )

This function gates the eDMA clock.

## Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | eDMA peripheral base address. |
|-------------|-------------------------------|

### 17.7.3 void EDMA\_InstallTCD ( DMA\_Type \* *base*, uint32\_t *channel*, edma\_tcd\_t \* *tcd* )

## Parameters

|                |                               |
|----------------|-------------------------------|
| <i>base</i>    | EDMA peripheral base address. |
| <i>channel</i> | EDMA channel number.          |
| <i>tcd</i>     | Point to TCD structure.       |

### 17.7.4 void EDMA\_GetDefaultConfig ( edma\_config\_t \* *config* )

This function sets the configuration structure to default values. The default configuration is set to the following values.

```
* config.enableContinuousLinkMode = false;
* config.enableHaltOnError = true;
* config.enableRoundRobinArbitration = false;
* config.enableDebugMode = false;
*
```

## Parameters

|               |                                                |
|---------------|------------------------------------------------|
| <i>config</i> | A pointer to the eDMA configuration structure. |
|---------------|------------------------------------------------|

### 17.7.5 static void EDMA\_EnableContinuousChannelLinkMode ( DMA\_Type \* *base*, bool *enable* ) [inline], [static]

## Note

Do not use continuous link mode with a channel linking to itself if there is only one minor loop iteration per service request, for example, if the channel's NBYTES value is the same as either the source or destination size. The same data transfer profile can be achieved by simply increasing the NBYTES value, which provides more efficient, faster processing.

## Parameters

|               |                                   |
|---------------|-----------------------------------|
| <i>base</i>   | EDMA peripheral base address.     |
| <i>enable</i> | true is enable, false is disable. |

### 17.7.6 static void EDMA\_EnableMinorLoopMapping ( DMA\_Type \* *base*, bool *enable* ) [inline], [static]

The TCDn.word2 is redefined to include individual enable fields, an offset field, and the NBYTES field.

## Parameters

|               |                                   |
|---------------|-----------------------------------|
| <i>base</i>   | EDMA peripheral base address.     |
| <i>enable</i> | true is enable, false is disable. |

### 17.7.7 void EDMA\_ResetChannel ( DMA\_Type \* *base*, uint32\_t *channel* )

This function sets TCD registers for this channel to default values.

## Parameters

---



|                |                               |
|----------------|-------------------------------|
| <i>base</i>    | eDMA peripheral base address. |
| <i>channel</i> | eDMA channel number.          |

## Note

This function must not be called while the channel transfer is ongoing or it causes unpredictable results.

This function enables the auto stop request feature.

### 17.7.8 void EDMA\_SetTransferConfig ( DMA\_Type \* *base*, uint32\_t *channel*, const edma\_transfer\_config\_t \* *config*, edma\_tcd\_t \* *nextTcd* )

This function configures the transfer attribute, including source address, destination address, transfer size, address offset, and so on. It also configures the scatter gather feature if the user supplies the TCD address.

Example:

```
* edma_transfer_t config;
* edma_tcd_t tcd;
* config.srcAddr = ..;
* config.destAddr = ..;
* ...
* EDMA_SetTransferConfig(DMA0, channel, &config, &stcd);
*
```

## Parameters

|                |                                                                                               |
|----------------|-----------------------------------------------------------------------------------------------|
| <i>base</i>    | eDMA peripheral base address.                                                                 |
| <i>channel</i> | eDMA channel number.                                                                          |
| <i>config</i>  | Pointer to eDMA transfer configuration structure.                                             |
| <i>nextTcd</i> | Point to TCD structure. It can be NULL if users do not want to enable scatter/gather feature. |

## Note

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

### 17.7.9 void EDMA\_SetMinorOffsetConfig ( DMA\_Type \* *base*, uint32\_t *channel*, const edma\_minor\_offset\_config\_t \* *config* )

The minor offset means that the signed-extended value is added to the source address or destination address after each minor loop.

Parameters

|                |                                                        |
|----------------|--------------------------------------------------------|
| <i>base</i>    | eDMA peripheral base address.                          |
| <i>channel</i> | eDMA channel number.                                   |
| <i>config</i>  | A pointer to the minor offset configuration structure. |

**17.7.10 void EDMA\_SetChannelPreemptionConfig ( DMA\_Type \* *base*, uint32\_t *channel*, const edma\_channel\_Preemption\_config\_t \* *config* )**

This function configures the channel preemption attribute and the priority of the channel.

Parameters

|                |                                                              |
|----------------|--------------------------------------------------------------|
| <i>base</i>    | eDMA peripheral base address.                                |
| <i>channel</i> | eDMA channel number                                          |
| <i>config</i>  | A pointer to the channel preemption configuration structure. |

**17.7.11 void EDMA\_SetChannelLink ( DMA\_Type \* *base*, uint32\_t *channel*, edma\_channel\_link\_type\_t *linkType*, uint32\_t *linkedChannel* )**

This function configures either the minor link or the major link mode. The minor link means that the channel link is triggered every time CITER decreases by 1. The major link means that the channel link is triggered when the CITER is exhausted.

Parameters

|                 |                                                                                                                                                                                  |
|-----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>     | eDMA peripheral base address.                                                                                                                                                    |
| <i>channel</i>  | eDMA channel number.                                                                                                                                                             |
| <i>linkType</i> | A channel link type, which can be one of the following: <ul style="list-style-type: none"> <li>• kEDMA_LinkNone</li> <li>• kEDMA_MinorLink</li> <li>• kEDMA_MajorLink</li> </ul> |

|                      |                            |
|----------------------|----------------------------|
| <i>linkedChannel</i> | The linked channel number. |
|----------------------|----------------------------|

Note

Users should ensure that DONE flag is cleared before calling this interface, or the configuration is invalid.

**17.7.12 void EDMA\_SetBandWidth ( DMA\_Type \* *base*, uint32\_t *channel*, edma\_bandwidth\_t *bandWidth* )**

Because the eDMA processes the minor loop, it continuously generates read/write sequences until the minor count is exhausted. The bandwidth forces the eDMA to stall after the completion of each read/write access to control the bus request bandwidth seen by the crossbar switch.

Parameters

|                  |                                                                                                                                                                                                               |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>      | eDMA peripheral base address.                                                                                                                                                                                 |
| <i>channel</i>   | eDMA channel number.                                                                                                                                                                                          |
| <i>bandWidth</i> | A bandwidth setting, which can be one of the following: <ul style="list-style-type: none"> <li>• kEDMABandwidthStallNone</li> <li>• kEDMABandwidthStall4Cycle</li> <li>• kEDMABandwidthStall8Cycle</li> </ul> |

**17.7.13 void EDMA\_SetModulo ( DMA\_Type \* *base*, uint32\_t *channel*, edma\_modulo\_t *srcModulo*, edma\_modulo\_t *destModulo* )**

This function defines a specific address range specified to be the value after (SADDR + SOFF)/(DADDR + DOFF) calculation is performed or the original register value. It provides the ability to implement a circular data queue easily.

Parameters

|                |                               |
|----------------|-------------------------------|
| <i>base</i>    | eDMA peripheral base address. |
| <i>channel</i> | eDMA channel number.          |

|                   |                             |
|-------------------|-----------------------------|
| <i>srcModulo</i>  | A source modulo value.      |
| <i>destModulo</i> | A destination modulo value. |

**17.7.14 static void EDMA\_EnableAsyncRequest ( DMA\_Type \* *base*, uint32\_t *channel*, bool *enable* ) [inline], [static]**

Parameters

|                |                                                  |
|----------------|--------------------------------------------------|
| <i>base</i>    | eDMA peripheral base address.                    |
| <i>channel</i> | eDMA channel number.                             |
| <i>enable</i>  | The command to enable (true) or disable (false). |

**17.7.15 static void EDMA\_EnableAutoStopRequest ( DMA\_Type \* *base*, uint32\_t *channel*, bool *enable* ) [inline], [static]**

If enabling the auto stop request, the eDMA hardware automatically disables the hardware channel request.

Parameters

|                |                                                  |
|----------------|--------------------------------------------------|
| <i>base</i>    | eDMA peripheral base address.                    |
| <i>channel</i> | eDMA channel number.                             |
| <i>enable</i>  | The command to enable (true) or disable (false). |

**17.7.16 void EDMA\_EnableChannelInterrupts ( DMA\_Type \* *base*, uint32\_t *channel*, uint32\_t *mask* )**

Parameters

|                |                                                                                                                  |
|----------------|------------------------------------------------------------------------------------------------------------------|
| <i>base</i>    | eDMA peripheral base address.                                                                                    |
| <i>channel</i> | eDMA channel number.                                                                                             |
| <i>mask</i>    | The mask of interrupt source to be set. Users need to use the defined <code>edma_interrupt_enable_t</code> type. |

**17.7.17 void EDMA\_DisableChannelInterrupts ( DMA\_Type \* *base*, uint32\_t *channel*, uint32\_t *mask* )**

Parameters

|                |                                                                                                        |
|----------------|--------------------------------------------------------------------------------------------------------|
| <i>base</i>    | eDMA peripheral base address.                                                                          |
| <i>channel</i> | eDMA channel number.                                                                                   |
| <i>mask</i>    | The mask of the interrupt source to be set. Use the defined <code>edma_interrupt_enable_t</code> type. |

### 17.7.18 void EDMA\_SetMajorOffsetConfig ( DMA\_Type \* *base*, uint32\_t *channel*, int32\_t *sourceOffset*, int32\_t *destOffset* )

Adjustment value added to the source address at the completion of the major iteration count

Parameters

|                     |                                                                                     |
|---------------------|-------------------------------------------------------------------------------------|
| <i>base</i>         | eDMA peripheral base address.                                                       |
| <i>channel</i>      | edma channel number.                                                                |
| <i>sourceOffset</i> | source address offset will be applied to source address after major loop done.      |
| <i>destOffset</i>   | destination address offset will be applied to source address after major loop done. |

### 17.7.19 void EDMA\_TcdReset ( edma\_tcd\_t \* *tcd* )

This function sets all fields for this TCD structure to default value.

Parameters

|            |                               |
|------------|-------------------------------|
| <i>tcd</i> | Pointer to the TCD structure. |
|------------|-------------------------------|

Note

This function enables the auto stop request feature.

### 17.7.20 void EDMA\_TcdSetTransferConfig ( edma\_tcd\_t \* *tcd*, const edma\_transfer\_config\_t \* *config*, edma\_tcd\_t \* *nextTcd* )

The TCD is a transfer control descriptor. The content of the TCD is the same as the hardware TCD registers. The TCD is used in the scatter-gather mode. This function configures the TCD transfer attribute, including source address, destination address, transfer size, address offset, and so on. It also configures the scatter gather feature if the user supplies the next TCD address. Example:

```

* edma_transfer_t config = {
* ...
* }
* edma_tcd_t tcd __aligned(32);
* edma_tcd_t nextTcd __aligned(32);
* EDMA_TcdSetTransferConfig(&tcd, &config, &nextTcd);
*

```

## Parameters

|                |                                                                                                          |
|----------------|----------------------------------------------------------------------------------------------------------|
| <i>tcd</i>     | Pointer to the TCD structure.                                                                            |
| <i>config</i>  | Pointer to eDMA transfer configuration structure.                                                        |
| <i>nextTcd</i> | Pointer to the next TCD structure. It can be NULL if users do not want to enable scatter/gather feature. |

## Note

TCD address should be 32 bytes aligned or it causes an eDMA error.

If the nextTcd is not NULL, the scatter gather feature is enabled and DREQ bit is cleared in the previous transfer configuration, which is set in the EDMA\_TcdReset.

### 17.7.21 void EDMA\_TcdSetMinorOffsetConfig ( edma\_tcd\_t \* *tcd*, const edma\_minor\_offset\_config\_t \* *config* )

A minor offset is a signed-extended value added to the source address or a destination address after each minor loop.

## Parameters

|               |                                                        |
|---------------|--------------------------------------------------------|
| <i>tcd</i>    | A point to the TCD structure.                          |
| <i>config</i> | A pointer to the minor offset configuration structure. |

### 17.7.22 void EDMA\_TcdSetChannelLink ( edma\_tcd\_t \* *tcd*, edma\_channel\_link\_type\_t *linkType*, uint32\_t *linkedChannel* )

This function configures either a minor link or a major link. The minor link means the channel link is triggered every time CITER decreases by 1. The major link means that the channel link is triggered when the CITER is exhausted.

## Note

Users should ensure that DONE flag is cleared before calling this interface, or the configuration is invalid.

## Parameters

|                      |                                                                                                                                                               |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>tcd</i>           | Point to the TCD structure.                                                                                                                                   |
| <i>linkType</i>      | Channel link type, it can be one of: <ul style="list-style-type: none"> <li>• kEDMA_LinkNone</li> <li>• kEDMA_MinorLink</li> <li>• kEDMA_MajorLink</li> </ul> |
| <i>linkedChannel</i> | The linked channel number.                                                                                                                                    |

### 17.7.23 static void EDMA\_TcdSetBandWidth ( edma\_tcd\_t \* *tcd*, edma\_bandwidth\_t *bandWidth* ) [inline], [static]

Because the eDMA processes the minor loop, it continuously generates read/write sequences until the minor count is exhausted. The bandwidth forces the eDMA to stall after the completion of each read/write access to control the bus request bandwidth seen by the crossbar switch.

## Parameters

|                  |                                                                                                                                                                                                               |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>tcd</i>       | A pointer to the TCD structure.                                                                                                                                                                               |
| <i>bandWidth</i> | A bandwidth setting, which can be one of the following: <ul style="list-style-type: none"> <li>• kEDMABandwidthStallNone</li> <li>• kEDMABandwidthStall4Cycle</li> <li>• kEDMABandwidthStall8Cycle</li> </ul> |

### 17.7.24 void EDMA\_TcdSetModulo ( edma\_tcd\_t \* *tcd*, edma\_modulo\_t *srcModulo*, edma\_modulo\_t *destModulo* )

This function defines a specific address range specified to be the value after (SADDR + SOFF)/(DADDR + DOFF) calculation is performed or the original register value. It provides the ability to implement a circular data queue easily.

## Parameters

|            |                                 |
|------------|---------------------------------|
| <i>tcd</i> | A pointer to the TCD structure. |
|------------|---------------------------------|

|                   |                             |
|-------------------|-----------------------------|
| <i>srcModulo</i>  | A source modulo value.      |
| <i>destModulo</i> | A destination modulo value. |

### 17.7.25 static void EDMA\_TcdEnableAutoStopRequest ( edma\_tcd\_t \* *tcd*, bool *enable* ) [inline], [static]

If enabling the auto stop request, the eDMA hardware automatically disables the hardware channel request.

Parameters

|               |                                                  |
|---------------|--------------------------------------------------|
| <i>tcd</i>    | A pointer to the TCD structure.                  |
| <i>enable</i> | The command to enable (true) or disable (false). |

### 17.7.26 void EDMA\_TcdEnableInterrupts ( edma\_tcd\_t \* *tcd*, uint32\_t *mask* )

Parameters

|             |                                                                                                     |
|-------------|-----------------------------------------------------------------------------------------------------|
| <i>tcd</i>  | Point to the TCD structure.                                                                         |
| <i>mask</i> | The mask of interrupt source to be set. Users need to use the defined edma_interrupt_enable_t type. |

### 17.7.27 void EDMA\_TcdDisableInterrupts ( edma\_tcd\_t \* *tcd*, uint32\_t *mask* )

Parameters

|             |                                                                                                     |
|-------------|-----------------------------------------------------------------------------------------------------|
| <i>tcd</i>  | Point to the TCD structure.                                                                         |
| <i>mask</i> | The mask of interrupt source to be set. Users need to use the defined edma_interrupt_enable_t type. |

### 17.7.28 void EDMA\_TcdSetMajorOffsetConfig ( edma\_tcd\_t \* *tcd*, int32\_t *sourceOffset*, int32\_t *destOffset* )

Adjustment value added to the source address at the completion of the major iteration count



Parameters

|                     |                                                                                     |
|---------------------|-------------------------------------------------------------------------------------|
| <i>tcd</i>          | A point to the TCD structure.                                                       |
| <i>sourceOffset</i> | source address offset will be applied to source address after major loop done.      |
| <i>destOffset</i>   | destination address offset will be applied to source address after major loop done. |

### 17.7.29 static void EDMA\_EnableChannelRequest ( DMA\_Type \* *base*, uint32\_t *channel* ) [inline], [static]

This function enables the hardware channel request.

Parameters

|                |                               |
|----------------|-------------------------------|
| <i>base</i>    | eDMA peripheral base address. |
| <i>channel</i> | eDMA channel number.          |

### 17.7.30 static void EDMA\_DisableChannelRequest ( DMA\_Type \* *base*, uint32\_t *channel* ) [inline], [static]

This function disables the hardware channel request.

Parameters

|                |                               |
|----------------|-------------------------------|
| <i>base</i>    | eDMA peripheral base address. |
| <i>channel</i> | eDMA channel number.          |

### 17.7.31 static void EDMA\_TriggerChannelStart ( DMA\_Type \* *base*, uint32\_t *channel* ) [inline], [static]

This function starts a minor loop transfer.

Parameters

|                |                               |
|----------------|-------------------------------|
| <i>base</i>    | eDMA peripheral base address. |
| <i>channel</i> | eDMA channel number.          |

**17.7.32** `uint32_t EDMA_GetRemainingMajorLoopCount ( DMA_Type * base,  
uint32_t channel )`

This function checks the TCD (Task Control Descriptor) status for a specified eDMA channel and returns the number of major loop count that has not finished.

Parameters

|                |                               |
|----------------|-------------------------------|
| <i>base</i>    | eDMA peripheral base address. |
| <i>channel</i> | eDMA channel number.          |

Returns

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

Note

1. This function can only be used to get unfinished major loop count of transfer without the next TCD, or it might be inaccuracy.
1. The unfinished/remaining transfer bytes cannot be obtained directly from registers while the channel is running. Because to calculate the remaining bytes, the initial NBYTES configured in DMA\_TCDn\_NBYTES\_MLNO register is needed while the eDMA IP does not support getting it while a channel is active. In another word, the NBYTES value reading is always the actual (decrementing) NBYTES value the dma\_engine is working with while a channel is running. Consequently, to get the remaining transfer bytes, a software-saved initial value of NBYTES (for example copied before enabling the channel) is needed. The formula to calculate it is shown below: RemainingBytes = RemainingMajorLoopCount \* NBYTES(initially configured)

**17.7.33 static uint32\_t EDMA\_GetErrorStatusFlags ( DMA\_Type \* *base* )  
[inline], [static]**

Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | eDMA peripheral base address. |
|-------------|-------------------------------|

Returns

The mask of error status flags. Users need to use the \_edma\_error\_status\_flags type to decode the return variables.

**17.7.34 uint32\_t EDMA\_GetChannelStatusFlags ( DMA\_Type \* *base*, uint32\_t *channel* )**

## Parameters

|                |                               |
|----------------|-------------------------------|
| <i>base</i>    | eDMA peripheral base address. |
| <i>channel</i> | eDMA channel number.          |

## Returns

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

### 17.7.35 void EDMA\_ClearChannelStatusFlags ( DMA\_Type \* *base*, uint32\_t *channel*, uint32\_t *mask* )

## Parameters

|                |                                                                                                                       |
|----------------|-----------------------------------------------------------------------------------------------------------------------|
| <i>base</i>    | eDMA peripheral base address.                                                                                         |
| <i>channel</i> | eDMA channel number.                                                                                                  |
| <i>mask</i>    | The mask of channel status to be cleared. Users need to use the defined <code>_edma_channel_status_flags</code> type. |

### 17.7.36 void EDMA\_CreateHandle ( edma\_handle\_t \* *handle*, DMA\_Type \* *base*, uint32\_t *channel* )

This function is called if using the transactional API for eDMA. This function initializes the internal state of the eDMA handle.

## Parameters

|                |                                                                               |
|----------------|-------------------------------------------------------------------------------|
| <i>handle</i>  | eDMA handle pointer. The eDMA handle stores callback function and parameters. |
| <i>base</i>    | eDMA peripheral base address.                                                 |
| <i>channel</i> | eDMA channel number.                                                          |

### 17.7.37 void EDMA\_InstallTCMemory ( edma\_handle\_t \* *handle*, edma\_tcd\_t \* *tcdPool*, uint32\_t *tcdSize* )

This function is called after the `EDMA_CreateHandle` to use scatter/gather feature. This function shall only be used while users need to use scatter gather mode. Scatter gather mode enables EDMA to load a new transfer control block (tcd) in hardware, and automatically reconfigure that DMA channel for a

new transfer. Users need to prepare tcd memory and also configure tcDs using interface EDMA\_Submit-Transfer.

## Parameters

|                |                                                           |
|----------------|-----------------------------------------------------------|
| <i>handle</i>  | eDMA handle pointer.                                      |
| <i>tcdPool</i> | A memory pool to store TCDs. It must be 32 bytes aligned. |
| <i>tcdSize</i> | The number of TCD slots.                                  |

### 17.7.38 void EDMA\_SetCallback ( edma\_handle\_t \* *handle*, edma\_callback *callback*, void \* *userData* )

This callback is called in the eDMA IRQ handler. Use the callback to do something after the current major loop transfer completes. This function will be called every time one tcd finished transfer.

## Parameters

|                 |                                        |
|-----------------|----------------------------------------|
| <i>handle</i>   | eDMA handle pointer.                   |
| <i>callback</i> | eDMA callback function pointer.        |
| <i>userData</i> | A parameter for the callback function. |

### 17.7.39 void EDMA\_PrepareTransferConfig ( edma\_transfer\_config\_t \* *config*, void \* *srcAddr*, uint32\_t *srcWidth*, int16\_t *srcOffset*, void \* *destAddr*, uint32\_t *destWidth*, int16\_t *destOffset*, uint32\_t *bytesEachRequest*, uint32\_t *transferBytes* )

This function prepares the transfer configuration structure according to the user input.

## Parameters

|                         |                                                           |
|-------------------------|-----------------------------------------------------------|
| <i>config</i>           | The user configuration structure of type edma_transfer_t. |
| <i>srcAddr</i>          | eDMA transfer source address.                             |
| <i>srcWidth</i>         | eDMA transfer source address width(bytes).                |
| <i>srcOffset</i>        | source address offset.                                    |
| <i>destAddr</i>         | eDMA transfer destination address.                        |
| <i>destWidth</i>        | eDMA transfer destination address width(bytes).           |
| <i>destOffset</i>       | destination address offset.                               |
| <i>bytesEachRequest</i> | eDMA transfer bytes per channel request.                  |
| <i>transferBytes</i>    | eDMA transfer bytes to be transferred.                    |

## Note

The data address and the data width must be consistent. For example, if the SRC is 4 bytes, the source address must be 4 bytes aligned, or it results in source address error (SAE).

**17.7.40 void EDMA\_PrepareTransfer ( edma\_transfer\_config\_t \* config, void \* srcAddr, uint32\_t srcWidth, void \* destAddr, uint32\_t destWidth, uint32\_t bytesEachRequest, uint32\_t transferBytes, edma\_transfer\_type\_t transferType )**

This function prepares the transfer configuration structure according to the user input.

## Parameters

|                         |                                                           |
|-------------------------|-----------------------------------------------------------|
| <i>config</i>           | The user configuration structure of type edma_transfer_t. |
| <i>srcAddr</i>          | eDMA transfer source address.                             |
| <i>srcWidth</i>         | eDMA transfer source address width(bytes).                |
| <i>destAddr</i>         | eDMA transfer destination address.                        |
| <i>destWidth</i>        | eDMA transfer destination address width(bytes).           |
| <i>bytesEachRequest</i> | eDMA transfer bytes per channel request.                  |
| <i>transferBytes</i>    | eDMA transfer bytes to be transferred.                    |
| <i>transferType</i>     | eDMA transfer type.                                       |

## Note

The data address and the data width must be consistent. For example, if the SRC is 4 bytes, the source address must be 4 bytes aligned, or it results in source address error (SAE).

**17.7.41 status\_t EDMA\_SubmitTransfer ( edma\_handle\_t \* handle, const edma\_transfer\_config\_t \* config )**

This function submits the eDMA transfer request according to the transfer configuration structure. In scatter gather mode, call this function will add a configured tcd to the circular list of tcd pool. The tcd pools is setup by call function EDMA\_InstallTCDMemory before.

## Parameters

|               |                                                   |
|---------------|---------------------------------------------------|
| <i>handle</i> | eDMA handle pointer.                              |
| <i>config</i> | Pointer to eDMA transfer configuration structure. |

## Return values

|                                |                                                                     |
|--------------------------------|---------------------------------------------------------------------|
| <i>kStatus_EDMA_Success</i>    | It means submit transfer request succeed.                           |
| <i>kStatus_EDMA_Queue-Full</i> | It means TCD queue is full. Submit transfer request is not allowed. |
| <i>kStatus_EDMA_Busy</i>       | It means the given channel is busy, need to submit request later.   |

**17.7.42 void EDMA\_StartTransfer ( edma\_handle\_t \* *handle* )**

This function enables the channel request. Users can call this function after submitting the transfer request or before submitting the transfer request.

## Parameters

|               |                      |
|---------------|----------------------|
| <i>handle</i> | eDMA handle pointer. |
|---------------|----------------------|

**17.7.43 void EDMA\_StopTransfer ( edma\_handle\_t \* *handle* )**

This function disables the channel request to pause the transfer. Users can call [EDMA\\_StartTransfer\(\)](#) again to resume the transfer.

## Parameters

|               |                      |
|---------------|----------------------|
| <i>handle</i> | eDMA handle pointer. |
|---------------|----------------------|

**17.7.44 void EDMA\_AbortTransfer ( edma\_handle\_t \* *handle* )**

This function disables the channel request and clear transfer status bits. Users can submit another transfer after calling this API.



Parameters

|               |                     |
|---------------|---------------------|
| <i>handle</i> | DMA handle pointer. |
|---------------|---------------------|

**17.7.45** `static uint32_t EDMA_GetUnusedTCDNumber ( edma_handle_t * handle )`  
**[inline], [static]**

This function gets current tcd index which is run. If the TCD pool pointer is NULL, it will return 0.

Parameters

|               |                     |
|---------------|---------------------|
| <i>handle</i> | DMA handle pointer. |
|---------------|---------------------|

Returns

The unused tcd slot number.

**17.7.46** `static uint32_t EDMA_GetNextTCDAddress ( edma_handle_t * handle )`  
**[inline], [static]**

This function gets the next tcd address. If this is last TCD, return 0.

Parameters

|               |                     |
|---------------|---------------------|
| <i>handle</i> | DMA handle pointer. |
|---------------|---------------------|

Returns

The next TCD address.

**17.7.47** `void EDMA_HandleIRQ ( edma_handle_t * handle )`

This function clears the channel major interrupt flag and calls the callback function if it is not NULL.

Note: For the case using TCD queue, when the major iteration count is exhausted, additional operations are performed. These include the final address adjustments and reloading of the BITER field into the CITER. Assertion of an optional interrupt request also occurs at this time, as does a possible fetch of a new TCD from memory using the scatter/gather address pointer included in the descriptor (if scatter/gather is enabled).

For instance, when the time interrupt of TCD[0] happens, the TCD[1] has already been loaded into the eDMA engine. As *sga* and *sga\_index* are calculated based on the *DLAST\_SGA* bitfield lies in the *TCD\_CSR* register, the *sga\_index* in this case should be 2 (*DLAST\_SGA* of TCD[1] stores the address of TCD[2]). Thus, the "tcdUsed" updated should be (*tcdUsed* - 2U) which indicates the number of TCDs can be loaded in the memory pool (because TCD[0] and TCD[1] have been loaded into the eDMA engine at this point already.).

For the last two continuous ISRs in a scatter/gather process, they both load the last TCD (The last ISR does not load a new TCD) from the memory pool to the eDMA engine when major loop completes. Therefore, ensure that the header and *tcdUsed* updated are identical for them. *tcdUsed* are both 0 in this case as no TCD to be loaded.

See the "eDMA basic data flow" in the eDMA Functional description section of the Reference Manual for further details.

Parameters

|               |                      |
|---------------|----------------------|
| <i>handle</i> | eDMA handle pointer. |
|---------------|----------------------|

# Chapter 18

## ENC: Quadrature Encoder/Decoder

### 18.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Quadrature Encoder/Decoder (ENC) module of MCUXpresso SDK devices.

This section describes the programming interface of the ENC Peripheral driver. The ENC driver configures the ENC module and provides a functional interface for the user to build the ENC application.

### 18.2 Function groups

#### 18.2.1 Initialization and De-initialization

This function group initializes default configuration structure for the ENC counter and initializes ENC counter with the normal configuration and de-initialize ENC module. Some APIs are also created to control the features.

#### 18.2.2 Status

This function group get/clear the ENC status.

#### 18.2.3 Interrupts

This function group enable/disable the ENC interrupts.

#### 18.2.4 Value Operation

This function group get the counter/hold value of positions.

### 18.3 Typical use case

#### 18.3.1 Polling Configuration

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/enc`

### Data Structures

- struct [enc\\_config\\_t](#)

- Define user configuration structure for ENC module. [More...](#)
- struct `enc_self_test_config_t`  
Define configuration structure for self test module. [More...](#)

## Enumerations

- enum `_enc_interrupt_enable` {  
`kENC_HOMETransitionInterruptEnable = (1U << 0U),`  
`kENC_INDEXPulseInterruptEnable = (1U << 1U),`  
`kENC_WatchdogTimeoutInterruptEnable = (1U << 2U),`  
`kENC_PositionCompareInterruptEnable = (1U << 3U),`  
`kENC_PositionRollOverInterruptEnable = (1U << 5U),`  
`kENC_PositionRollUnderInterruptEnable = (1U << 6U) }`  
*Interrupt enable/disable mask.*
- enum `_enc_status_flags` {  
`kENC_HOMETransitionFlag = (1U << 0U),`  
`kENC_INDEXPulseFlag = (1U << 1U),`  
`kENC_WatchdogTimeoutFlag = (1U << 2U),`  
`kENC_PositionCompareFlag = (1U << 3U),`  
`kENC_PositionRollOverFlag = (1U << 5U),`  
`kENC_PositionRollUnderFlag = (1U << 6U),`  
`kENC_LastCountDirectionFlag = (1U << 7U) }`  
*Status flag mask.*
- enum `_enc_signal_status_flags` {  
`kENC_RawHOMESTatusFlag = ENC_IMR_HOME_MASK,`  
`kENC_RawINDEXStatusFlag = ENC_IMR_INDEX_MASK,`  
`kENC_RawPHBStatusFlag = ENC_IMR_PHB_MASK,`  
`kENC_RawPHAEXStatusFlag = ENC_IMR_PHA_MASK,`  
`kENC_FilteredHOMESTatusFlag = ENC_IMR_FHOM_MASK,`  
`kENC_FilteredINDEXStatusFlag = ENC_IMR_FIND_MASK,`  
`kENC_FilteredPHBStatusFlag = ENC_IMR_FPHB_MASK,`  
`kENC_FilteredPHAStatusFlag = ENC_IMR_FPHA_MASK }`  
*Signal status flag mask.*
- enum `enc_home_trigger_mode_t` {  
`kENC_HOMETriggerDisabled = 0U,`  
`kENC_HOMETriggerOnRisingEdge,`  
`kENC_HOMETriggerOnFallingEdge }`  
*Define HOME signal's trigger mode.*
- enum `enc_index_trigger_mode_t` {  
`kENC_INDEXTriggerDisabled = 0U,`  
`kENC_INDEXTriggerOnRisingEdge,`  
`kENC_INDEXTriggerOnFallingEdge }`  
*Define INDEX signal's trigger mode.*
- enum `enc_decoder_work_mode_t` {  
`kENC_DecoderWorkAsNormalMode = 0U,`  
`kENC_DecoderWorkAsSignalPhaseCountMode }`  
*Define type for decoder work mode.*

- enum `enc_position_match_mode_t` {  
`kENC_POSMATCHOnPositionCounterEqualToComapreValue` = 0U,  
`kENC_POSMATCHOnReadingAnyPositionCounter` }  
*Define type for the condition of POSMATCH pulses.*
- enum `enc_revolution_count_condition_t` {  
`kENC_RevolutionCountOnINDEXPulse` = 0U,  
`kENC_RevolutionCountOnRollOverModulus` }  
*Define type for determining how the revolution counter (REV) is incremented/decremented.*
- enum `enc_self_test_direction_t` {  
`kENC_SelfTestDirectionPositive` = 0U,  
`kENC_SelfTestDirectionNegative` }  
*Define type for direction of self test generated signal.*

## Initialization and De-initialization

- void `ENC_Init` (ENC\_Type \*base, const `enc_config_t` \*config)  
*Initialization for the ENC module.*
- void `ENC_Deinit` (ENC\_Type \*base)  
*De-initialization for the ENC module.*
- void `ENC_GetDefaultConfig` (`enc_config_t` \*config)  
*Get an available pre-defined settings for ENC's configuration.*
- void `ENC_DoSoftwareLoadInitialPositionValue` (ENC\_Type \*base)  
*Load the initial position value to position counter.*
- void `ENC_SetSelfTestConfig` (ENC\_Type \*base, const `enc_self_test_config_t` \*config)  
*Enable and configure the self test function.*
- void `ENC_EnableWatchdog` (ENC\_Type \*base, bool enable)  
*Enable watchdog for ENC module.*
- void `ENC_SetInitialPositionValue` (ENC\_Type \*base, uint32\_t value)  
*Set initial position value for ENC module.*

## Status

- uint32\_t `ENC_GetStatusFlags` (ENC\_Type \*base)  
*Get the status flags.*
- void `ENC_ClearStatusFlags` (ENC\_Type \*base, uint32\_t mask)  
*Clear the status flags.*
- static uint16\_t `ENC_GetSignalStatusFlags` (ENC\_Type \*base)  
*Get the signals' real-time status.*

## Interrupts

- void `ENC_EnableInterrupts` (ENC\_Type \*base, uint32\_t mask)  
*Enable the interrupts.*
- void `ENC_DisableInterrupts` (ENC\_Type \*base, uint32\_t mask)  
*Disable the interrupts.*
- uint32\_t `ENC_GetEnabledInterrupts` (ENC\_Type \*base)  
*Get the enabled interrupts' flags.*

## Value Operation

- uint32\_t `ENC_GetPositionValue` (ENC\_Type \*base)

- `uint32_t ENC_GetHoldPositionValue` (ENC\_Type \*base)  
*Get the current position counter's value.*
- `static uint16_t ENC_GetPositionDifferenceValue` (ENC\_Type \*base)  
*Get the hold position counter's value.*
- `static uint16_t ENC_GetHoldPositionDifferenceValue` (ENC\_Type \*base)  
*Get the position difference counter's value.*
- `static uint16_t ENC_GetHoldPositionDifferenceValue` (ENC\_Type \*base)  
*Get the hold position difference counter's value.*
- `static uint16_t ENC_GetRevolutionValue` (ENC\_Type \*base)  
*Get the position revolution counter's value.*
- `static uint16_t ENC_GetHoldRevolutionValue` (ENC\_Type \*base)  
*Get the hold position revolution counter's value.*

## 18.4 Data Structure Documentation

### 18.4.1 struct enc\_config\_t

#### Data Fields

- `bool enableReverseDirection`  
*Enable reverse direction counting.*
- `enc_decoder_work_mode_t decoderWorkMode`  
*Enable signal phase count mode.*
- `enc_home_trigger_mode_t HOMETriggerMode`  
*Enable HOME to initialize position counters.*
- `enc_index_trigger_mode_t INDEXTriggerMode`  
*Enable INDEX to initialize position counters.*
- `bool enableTRIGGERClearPositionCounter`  
*Clear POSD, REV, UPOS and LPOS on rising edge of TRIGGER, or not.*
- `bool enableTRIGGERClearHoldPositionCounter`  
*Enable update of hold registers on rising edge of TRIGGER, or not.*
- `bool enableWatchdog`  
*Enable the watchdog to detect if the target is moving or not.*
- `uint16_t watchdogTimeoutValue`  
*Watchdog timeout count value.*
- `uint16_t filterCount`  
*Input Filter Sample Count.*
- `uint16_t filterSamplePeriod`  
*Input Filter Sample Period.*
- `enc_position_match_mode_t positionMatchMode`  
*The condition of POSMATCH pulses.*
- `uint32_t positionCompareValue`  
*Position compare value.*
- `enc_revolution_count_condition_t revolutionCountCondition`  
*Revolution Counter Modulus Enable.*
- `bool enableModuloCountMode`  
*Enable Modulo Counting.*
- `uint32_t positionModulusValue`  
*Position modulus value.*
- `uint32_t positionInitialValue`  
*Position initial value.*

## Field Documentation

- (1) **bool enc\_config\_t::enableReverseDirection**
- (2) **enc\_decoder\_work\_mode\_t enc\_config\_t::decoderWorkMode**
- (3) **enc\_home\_trigger\_mode\_t enc\_config\_t::HOMETriggerMode**
- (4) **enc\_index\_trigger\_mode\_t enc\_config\_t::INDEXTriggerMode**
- (5) **bool enc\_config\_t::enableTRIGGERClearPositionCounter**
- (6) **bool enc\_config\_t::enableWatchdog**
- (7) **uint16\_t enc\_config\_t::watchdogTimeoutValue**

It stores the timeout count for the quadrature decoder module watchdog timer. This field is only available when "enableWatchdog" = true. The available value is a 16-bit unsigned number.

- (8) **uint16\_t enc\_config\_t::filterCount**

This value should be chosen to reduce the probability of noisy samples causing an incorrect transition to be recognized. The value represent the number of consecutive samples that must agree prior to the input filter accepting an input transition. A value of 0x0 represents 3 samples. A value of 0x7 represents 10 samples. The Available range is 0 - 7.

- (9) **uint16\_t enc\_config\_t::filterSamplePeriod**

This value should be set such that the sampling period is larger than the period of the expected noise. This value represents the sampling period (in IPBus clock cycles) of the decoder input signals. The available range is 0 - 255.

- (10) **enc\_position\_match\_mode\_t enc\_config\_t::positionMatchMode**
- (11) **uint32\_t enc\_config\_t::positionCompareValue**

The available value is a 32-bit number.

- (12) **enc\_revolution\_count\_condition\_t enc\_config\_t::revolutionCountCondition**

- (13) **bool enc\_config\_t::enableModuloCountMode**

- (14) **uint32\_t enc\_config\_t::positionModulusValue**

This value would be available only when "enableModuloCountMode" = true. The available value is a 32-bit number.

- (15) **uint32\_t enc\_config\_t::positionInitialValue**

The available value is a 32-bit number.

## 18.4.2 struct enc\_self\_test\_config\_t

The self test module provides a quadrature test signal to the inputs of the quadrature decoder module. This is a factory test feature. It is also useful to customers' software development and testing.

### Data Fields

- [enc\\_self\\_test\\_direction\\_t](#) `signalDirection`  
*Direction of self test generated signal.*
- [uint16\\_t](#) `signalCount`  
*Hold the number of quadrature advances to generate.*
- [uint16\\_t](#) `signalPeriod`  
*Hold the period of quadrature phase in IPBus clock cycles.*

### Field Documentation

(1) `enc_self_test_direction_t enc_self_test_config_t::signalDirection`

(2) `uint16_t enc_self_test_config_t::signalCount`

The available range is 0 - 255.

(3) `uint16_t enc_self_test_config_t::signalPeriod`

The available range is 0 - 31.

## 18.5 Enumeration Type Documentation

### 18.5.1 enum \_enc\_interrupt\_enable

Enumerator

- kENC\_HOMETransitionInterruptEnable*** HOME interrupt enable.
- kENC\_INDEXPulseInterruptEnable*** INDEX pulse interrupt enable.
- kENC\_WatchdogTimeoutInterruptEnable*** Watchdog timeout interrupt enable.
- kENC\_PositionCompareInterruptEnable*** Position compare interrupt enable.
- kENC\_PositionRollOverInterruptEnable*** Roll-over interrupt enable.
- kENC\_PositionRollUnderInterruptEnable*** Roll-under interrupt enable.

### 18.5.2 enum \_enc\_status\_flags

These flags indicate the counter's events.

Enumerator

- kENC\_HOMETransitionFlag*** HOME signal transition interrupt request.



***kENC\_INDEXPulseFlag*** INDEX Pulse Interrupt Request.  
***kENC\_WatchdogTimeoutFlag*** Watchdog timeout interrupt request.  
***kENC\_PositionCompareFlag*** Position compare interrupt request.  
***kENC\_PositionRollOverFlag*** Roll-over interrupt request.  
***kENC\_PositionRollUnderFlag*** Roll-under interrupt request.  
***kENC\_LastCountDirectionFlag*** Last count was in the up direction, or the down direction.

### 18.5.3 enum \_enc\_signal\_status\_flags

These flags indicate the counter's signal.

Enumerator

***kENC\_RawHOMESTATUSFlag*** Raw HOME input.  
***kENC\_RawINDEXSTATUSFlag*** Raw INDEX input.  
***kENC\_RawPHBSTATUSFlag*** Raw PHASEB input.  
***kENC\_RawPHAEXSTATUSFlag*** Raw PHASEA input.  
***kENC\_FilteredHOMESTATUSFlag*** The filtered version of HOME input.  
***kENC\_FilteredINDEXSTATUSFlag*** The filtered version of INDEX input.  
***kENC\_FilteredPHBSTATUSFlag*** The filtered version of PHASEB input.  
***kENC\_FilteredPHASTATUSFlag*** The filtered version of PHASEA input.

### 18.5.4 enum enc\_home\_trigger\_mode\_t

The ENC would count the trigger from HOME signal line.

Enumerator

***kENC\_HOMETRIGGERDISABLED*** HOME signal's trigger is disabled.  
***kENC\_HOMETRIGGERONRISINGEDGE*** Use positive going edge-to-trigger initialization of position counters.  
***kENC\_HOMETRIGGERONFALLINGEDGE*** Use negative going edge-to-trigger initialization of position counters.

### 18.5.5 enum enc\_index\_trigger\_mode\_t

The ENC would count the trigger from INDEX signal line.

Enumerator

***kENC\_INDEXTRIGGERDISABLED*** INDEX signal's trigger is disabled.

***kENC\_INDEXTriggerOnRisingEdge*** Use positive going edge-to-trigger initialization of position counters.

***kENC\_INDEXTriggerOnFallingEdge*** Use negative going edge-to-trigger initialization of position counters.

### 18.5.6 enum enc\_decoder\_work\_mode\_t

The normal work mode uses the standard quadrature decoder with PHASEA and PHASEB. When in signal phase count mode, a positive transition of the PHASEA input generates a count signal while the PHASEB input and the reverse direction control the counter direction. If the reverse direction is not enabled, PHASEB = 0 means counting up and PHASEB = 1 means counting down. Otherwise, the direction is reversed.

Enumerator

***kENC\_DecoderWorkAsNormalMode*** Use standard quadrature decoder with PHASEA and PHASEB.

***kENC\_DecoderWorkAsSignalPhaseCountMode*** PHASEA input generates a count signal while PHASEB input control the direction.

### 18.5.7 enum enc\_position\_match\_mode\_t

Enumerator

***kENC\_POSMATCHOnPositionCounterEqualToCompareValue*** POSMATCH pulses when a match occurs between the position counters (POS) and the compare value (COMP).

***kENC\_POSMATCHOnReadingAnyPositionCounter*** POSMATCH pulses when any position counter register is read.

### 18.5.8 enum enc\_revolution\_count\_condition\_t

Enumerator

***kENC\_RevolutionCountOnINDEXPulse*** Use INDEX pulse to increment/decrement revolution counter.

***kENC\_RevolutionCountOnRollOverModulus*** Use modulus counting roll-over/under to increment/decrement revolution counter.

### 18.5.9 enum enc\_self\_test\_direction\_t

Enumerator

*kENC\_SelfTestDirectionPositive* Self test generates the signal in positive direction.

*kENC\_SelfTestDirectionNegative* Self test generates the signal in negative direction.

## 18.6 Function Documentation

### 18.6.1 void ENC\_Init ( ENC\_Type \* base, const enc\_config\_t \* config )

This function is to make the initialization for the ENC module. It should be called firstly before any operation to the ENC with the operations like:

- Enable the clock for ENC module.
- Configure the ENC's working attributes.

Parameters

|               |                                                            |
|---------------|------------------------------------------------------------|
| <i>base</i>   | ENC peripheral base address.                               |
| <i>config</i> | Pointer to configuration structure. See to "enc_config_t". |

### 18.6.2 void ENC\_Deinit ( ENC\_Type \* base )

This function is to make the de-initialization for the ENC module. It could be called when ENC is no longer used with the operations like:

- Disable the clock for ENC module.

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | ENC peripheral base address. |
|-------------|------------------------------|

### 18.6.3 void ENC\_GetDefaultConfig ( enc\_config\_t \* config )

This function initializes the ENC configuration structure with an available settings, the default value are:

```
* config->enableReverseDirection = false;
* config->decoderWorkMode = kENC_DecoderWorkAsNormalMode
;
* config->HOMETriggerMode = kENC_HOMETriggerDisabled;
* config->INDEXTriggerMode = kENC_INDEXTriggerDisabled;
* config->enableTRIGGERClearPositionCounter = false;
* config->enableTRIGGERClearHoldPositionCounter = false;
* config->enableWatchdog = false;
* config->watchdogTimeoutValue = 0U;
* config->filterCount = 0U;
```

```

* config->filterSamplePeriod = 0U;
* config->positionMatchMode =
 kENC_POSMATCHOnPositionCounterEqualToComapreValue;
* config->positionCompareValue = 0xFFFFFFFFFU;
* config->revolutionCountCondition =
 kENC_RevolutionCountOnINDEXPulse;
* config->enableModuloCountMode = false;
* config->positionModulusValue = 0U;
* config->positionInitialValue = 0U;
* config->prescalerValue = kENC_ClockDiv1;
* config->enablePeriodMeasurementFunction = true;
*

```

Parameters

|               |                                                                          |
|---------------|--------------------------------------------------------------------------|
| <i>config</i> | Pointer to a variable of configuration structure. See to "enc_config_t". |
|---------------|--------------------------------------------------------------------------|

**18.6.4 void ENC\_DoSoftwareLoadInitialPositionValue ( ENC\_Type \* *base* )**

This function is to transfer the initial position value (UNIT and LINIT) contents to position counter (UP-OS and LPOS), so that to provide the consistent operation the position counter registers.

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | ENC peripheral base address. |
|-------------|------------------------------|

**18.6.5 void ENC\_SetSelfTestConfig ( ENC\_Type \* *base*, const enc\_self\_test\_config\_t \* *config* )**

This function is to enable and configuration the self test function. It controls and sets the frequency of a quadrature signal generator. It provides a quadrature test signal to the inputs of the quadrature decoder module. It is a factory test feature; however, it may be useful to customers' software development and testing.

Parameters

|               |                                                                                              |
|---------------|----------------------------------------------------------------------------------------------|
| <i>base</i>   | ENC peripheral base address.                                                                 |
| <i>config</i> | Pointer to configuration structure. See to "enc_self_test_config_t". Pass "NULL" to disable. |

**18.6.6 void ENC\_EnableWatchdog ( ENC\_Type \* *base*, bool *enable* )**

Parameters

|               |                                  |
|---------------|----------------------------------|
| <i>base</i>   | ENC peripheral base address      |
| <i>enable</i> | Enables or disables the watchdog |

### 18.6.7 void ENC\_SetInitialPositionValue ( ENC\_Type \* *base*, uint32\_t *value* )

Parameters

|              |                             |
|--------------|-----------------------------|
| <i>base</i>  | ENC peripheral base address |
| <i>value</i> | Positive initial value      |

### 18.6.8 uint32\_t ENC\_GetStatusFlags ( ENC\_Type \* *base* )

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | ENC peripheral base address. |
|-------------|------------------------------|

Returns

Mask value of status flags. For available mask, see to "\_enc\_status\_flags".

### 18.6.9 void ENC\_ClearStatusFlags ( ENC\_Type \* *base*, uint32\_t *mask* )

Parameters

|             |                                                                                           |
|-------------|-------------------------------------------------------------------------------------------|
| <i>base</i> | ENC peripheral base address.                                                              |
| <i>mask</i> | Mask value of status flags to be cleared. For available mask, see to "_enc_status_flags". |

### 18.6.10 static uint16\_t ENC\_GetSignalStatusFlags ( ENC\_Type \* *base* ) [inline], [static]

## Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | ENC peripheral base address. |
|-------------|------------------------------|

## Returns

Mask value of signals' real-time status. For available mask, see to "\_enc\_signal\_status\_flags"

### 18.6.11 void ENC\_EnableInterrupts ( ENC\_Type \* *base*, uint32\_t *mask* )

## Parameters

|             |                                                                                             |
|-------------|---------------------------------------------------------------------------------------------|
| <i>base</i> | ENC peripheral base address.                                                                |
| <i>mask</i> | Mask value of interrupts to be enabled. For available mask, see to "_enc_interrupt_enable". |

### 18.6.12 void ENC\_DisableInterrupts ( ENC\_Type \* *base*, uint32\_t *mask* )

## Parameters

|             |                                                                                              |
|-------------|----------------------------------------------------------------------------------------------|
| <i>base</i> | ENC peripheral base address.                                                                 |
| <i>mask</i> | Mask value of interrupts to be disabled. For available mask, see to "_enc_interrupt_enable". |

### 18.6.13 uint32\_t ENC\_GetEnabledInterrupts ( ENC\_Type \* *base* )

## Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | ENC peripheral base address. |
|-------------|------------------------------|

## Returns

Mask value of enabled interrupts.

### 18.6.14 uint32\_t ENC\_GetPositionValue ( ENC\_Type \* *base* )

## Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | ENC peripheral base address. |
|-------------|------------------------------|

## Returns

Current position counter's value.

### 18.6.15 `uint32_t ENC_GetHoldPositionValue ( ENC_Type * base )`

When any of the counter registers is read, the contents of each counter register is written to the corresponding hold register. Taking a snapshot of the counters' values provides a consistent view of a system position and a velocity to be attained.

## Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | ENC peripheral base address. |
|-------------|------------------------------|

## Returns

Hold position counter's value.

### 18.6.16 `static uint16_t ENC_GetPositionDifferenceValue ( ENC_Type * base )` `[inline], [static]`

## Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | ENC peripheral base address. |
|-------------|------------------------------|

## Returns

The position difference counter's value.

### 18.6.17 `static uint16_t ENC_GetHoldPositionDifferenceValue ( ENC_Type * base )` `[inline], [static]`

When any of the counter registers is read, the contents of each counter register is written to the corresponding hold register. Taking a snapshot of the counters' values provides a consistent view of a system position and a velocity to be attained.

## Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | ENC peripheral base address. |
|-------------|------------------------------|

## Returns

Hold position difference counter's value.

**18.6.18** `static uint16_t ENC_GetRevolutionValue ( ENC_Type * base ) [inline], [static]`

## Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | ENC peripheral base address. |
|-------------|------------------------------|

## Returns

The position revolution counter's value.

**18.6.19** `static uint16_t ENC_GetHoldRevolutionValue ( ENC_Type * base ) [inline], [static]`

When any of the counter registers is read, the contents of each counter register is written to the corresponding hold register. Taking a snapshot of the counters' values provides a consistent view of a system position and a velocity to be attained.

## Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | ENC peripheral base address. |
|-------------|------------------------------|

## Returns

Hold position revolution counter's value.



## Chapter 19

# ENET: Ethernet MAC Driver

### 19.1 Overview

The MCUXpresso SDK provides a peripheral driver for the 10/100 Mbps Ethernet MAC (ENET) module of MCUXpresso SDK devices.

### ENET: Ethernet MAC Driver {EthernetMACDriver}

### 19.2 Operations of Ethernet MAC Driver

#### 19.2.1 MII interface Operation

The MII interface is the interface connected with MAC and PHY. the Serial management interface - MII management interface should be set before any access to the external PHY chip register. Call [ENET\\_SetSMI\(\)](#) to initialize the MII management interface. Use [ENET\\_StartSMIRead\(\)](#), [ENET\\_StartSMIWrite\(\)](#), and [ENET\\_ReadSMIData\(\)](#) to read/write to PHY registers. This function group sets up the MII and serial management SMI interface, gets data from the SMI interface, and starts the SMI read and write command. Use [ENET\\_SetMII\(\)](#) to configure the MII before successfully getting data from the external PHY.

#### 19.2.2 MAC address filter

This group sets/gets the ENET mac address and the multicast group address filter. [ENET\\_AddMulticastGroup\(\)](#) should be called to add the ENET MAC to the multicast group. The IEEE 1588 feature requires receiving the PTP message.

#### 19.2.3 Other Basic control Operations

This group has the receive active API [ENET\\_ActiveRead\(\)](#) for single and multiple rings. The [ENET\\_AVBConfigure\(\)](#) is provided to configure the AVB features to support the AVB frames transmission. Note that due to the AVB frames transmission scheme being a credit-based TX scheme, it is only supported with the Enhanced buffer descriptors. Because of this, the AVB configuration should only be done with the Enhanced buffer descriptor. When the AVB feature is required, make sure the the "ENET\_ENHANCEDBUFFERDESCRIPTOR\_MODE" is defined before using this feature.

#### 19.2.4 Transactional Operation

For ENET receive, the [ENET\\_GetRxFrameSize\(\)](#) function needs to be called to get the received data size. Then, call the [ENET\\_ReadFrame\(\)](#) function to get the received data. If the received error occurs, call the

[ENET\\_GetRxErrBeforeReadFrame\(\)](#) function after [ENET\\_GetRxFrameSize\(\)](#) and before [ENET\\_ReadFrame\(\)](#) functions to get the detailed error information.

For ENET transmit, call the [ENET\\_SendFrame\(\)](#) function to send the data out. The transmit data error information is only accessible for the IEEE 1588 enhanced buffer descriptor mode. When the `ENET_ENHANCEDBUFFERDESCRIPTOR_MODE` is defined, the [ENET\\_GetTxErrAfterSendFrame\(\)](#) can be used to get the detail transmit error information. The transmit error information can only be updated by uDMA after the data is transmitted. The [ENET\\_GetTxErrAfterSendFrame\(\)](#) function is recommended to be called on the transmit interrupt handler.

If send/read frame with zero-copy mechanism is needed, there're special APIs like [ENET\\_GetRxBuffer\(\)](#), [ENET\\_ReleaseRxBuffer\(\)](#), [ENET\\_SendFrameZeroCopy\(\)](#) and [ENET\\_SetTxBuffer\(\)](#). The send frame zero-copy APIs can't be used mixed with [ENET\\_SendFrame\(\)](#) for the same ENET peripheral, same as read frame zero-copy APIs.

## 19.2.5 PTP IEEE 1588 Feature Operation

This function group configures the PTP IEEE 1588 feature, starts/stops/gets/sets/adjusts the PTP IEEE 1588 timer, gets the receive/transmit frame timestamp, and PTP IEEE 1588 timer channel feature setting.

The [ENET\\_Ptp1588Configure\(\)](#) function needs to be called when the `ENET_ENHANCEDBUFFERDESCRIPTOR_MODE` is defined and the IEEE 1588 feature is required.

## 19.3 Typical use case

### 19.3.1 ENET Initialization, receive, and transmit operations

For the `ENET_ENHANCEDBUFFERDESCRIPTOR_MODE` undefined use case, use the legacy type buffer descriptor transmit/receive the frame as follows. Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/enet` For the `ENET_ENHANCEDBUFFERDESCRIPTOR_MODE` defined use case, add the PTP IEEE 1588 configuration to enable the PTP IEEE 1588 feature. The initialization occurs as follows. Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/enet`

### Modules

- [ENET CMSIS Driver](#)

### Data Structures

- struct [enet\\_rx\\_bd\\_struct\\_t](#)  
*Defines the receive buffer descriptor structure for the little endian system. [More...](#)*
- struct [enet\\_tx\\_bd\\_struct\\_t](#)  
*Defines the enhanced transmit buffer descriptor structure for the little endian system. [More...](#)*
- struct [enet\\_data\\_error\\_stats\\_t](#)  
*Defines the ENET data error statistics structure. [More...](#)*
- struct [enet\\_rx\\_frame\\_error\\_t](#)

- Defines the Rx frame error structure. [More...](#)
- struct `enet_transfer_stats_t`  
Defines the ENET transfer statistics structure. [More...](#)
- struct `enet_frame_info_t`  
Defines the frame info structure. [More...](#)
- struct `enet_tx_dirty_ring_t`  
Defines the ENET transmit dirty addresses ring/queue structure. [More...](#)
- struct `enet_buffer_config_t`  
Defines the receive buffer descriptor configuration structure. [More...](#)
- struct `enet_intcoalesce_config_t`  
Defines the interrupt coalescing configure structure. [More...](#)
- struct `enet_config_t`  
Defines the basic configuration structure for the ENET device. [More...](#)
- struct `enet_tx_bd_ring_t`  
Defines the ENET transmit buffer descriptor ring/queue structure. [More...](#)
- struct `enet_rx_bd_ring_t`  
Defines the ENET receive buffer descriptor ring/queue structure. [More...](#)
- struct `enet_handle_t`  
Defines the ENET handler structure. [More...](#)

## Macros

- #define `ENET_BUFFDESCRIPTOR_RX_ERR_MASK`  
Defines the receive error status flag mask.

## Typedefs

- typedef void `(*enet_rx_alloc_callback_t)(ENET_Type *base, void *userData, uint8_t ringId)`  
Defines the ENET Rx memory buffer alloc function pointer.
- typedef void `(*enet_rx_free_callback_t)(ENET_Type *base, void *buffer, void *userData, uint8_t ringId)`  
Defines the ENET Rx memory buffer free function pointer.
- typedef void `(*enet_callback_t)(ENET_Type *base, enet_handle_t *handle, enet_event_t event, enet_frame_info_t *frameInfo, void *userData)`  
ENET callback function.
- typedef void `(*enet_isr_t)(ENET_Type *base, enet_handle_t *handle)`  
Define interrupt IRQ handler.

## Enumerations

- enum {  
`kStatus_ENET_InitMemoryFail`,  
`kStatus_ENET_RxFrameError` = MAKE\_STATUS(kStatusGroup\_ENET, 1U),  
`kStatus_ENET_RxFrameFail` = MAKE\_STATUS(kStatusGroup\_ENET, 2U),  
`kStatus_ENET_RxFrameEmpty` = MAKE\_STATUS(kStatusGroup\_ENET, 3U),  
`kStatus_ENET_RxFrameDrop` = MAKE\_STATUS(kStatusGroup\_ENET, 4U),  
`kStatus_ENET_TxFrameOverLen` = MAKE\_STATUS(kStatusGroup\_ENET, 5U),  
`kStatus_ENET_TxFrameBusy` = MAKE\_STATUS(kStatusGroup\_ENET, 6U),  
`kStatus_ENET_TxFrameFail` = MAKE\_STATUS(kStatusGroup\_ENET, 7U) }

- Defines the status return codes for transaction.*

  - enum `enet_mii_mode_t` {  
`kENET_MiiMode = 0U`,  
`kENET_RmiiMode = 1U` }

*Defines the MII/RMII/RGMII mode for data interface between the MAC and the PHY.*
- enum `enet_mii_speed_t` {  
`kENET_MiiSpeed10M = 0U`,  
`kENET_MiiSpeed100M = 1U` }

*Defines the 10/100/1000 Mbps speed for the MII data interface.*
- enum `enet_mii_duplex_t` {  
`kENET_MiiHalfDuplex = 0U`,  
`kENET_MiiFullDuplex` }

*Defines the half or full duplex for the MII data interface.*
- enum `enet_mii_write_t` {  
`kENET_MiiWriteNoCompliant = 0U`,  
`kENET_MiiWriteValidFrame` }

*Define the MII opcode for normal MDIO\_CLAUSES\_22 Frame.*
- enum `enet_mii_read_t` {  
`kENET_MiiReadValidFrame = 2U`,  
`kENET_MiiReadNoCompliant = 3U` }

*Defines the read operation for the MII management frame.*
- enum `enet_mii_extend_opcode` {  
`kENET_MiiAddrWrite_C45 = 0U`,  
`kENET_MiiWriteFrame_C45 = 1U`,  
`kENET_MiiReadFrame_C45 = 3U` }

*Define the MII opcode for extended MDIO\_CLAUSES\_45 Frame.*
- enum `enet_special_control_flag_t` {  
`kENET_ControlFlowControlEnable = 0x0001U`,  
`kENET_ControlRxPayloadCheckEnable = 0x0002U`,  
`kENET_ControlRxPadRemoveEnable = 0x0004U`,  
`kENET_ControlRxBroadCastRejectEnable = 0x0008U`,  
`kENET_ControlMacAddrInsert = 0x0010U`,  
`kENET_ControlStoreAndFwdDisable = 0x0020U`,  
`kENET_ControlSMIPreambleDisable = 0x0040U`,  
`kENET_ControlPromiscuousEnable = 0x0080U`,  
`kENET_ControlMIILoopEnable = 0x0100U`,  
`kENET_ControlVLANTagEnable = 0x0200U` }

*Defines a special configuration for ENET MAC controller.*
- enum `enet_interrupt_enable_t` {

```

kENET_BabrInterrupt = ENET_EIR_BABR_MASK,
kENET_BabtInterrupt = ENET_EIR_BABT_MASK,
kENET_GraceStopInterrupt = ENET_EIR_GRA_MASK,
kENET_TxFrameInterrupt = ENET_EIR_TXF_MASK,
kENET_TxBufferInterrupt = ENET_EIR_TXB_MASK,
kENET_RxFrameInterrupt = ENET_EIR_RXF_MASK,
kENET_RxBufferInterrupt = ENET_EIR_RXB_MASK,
kENET_MiiInterrupt = ENET_EIR_MII_MASK,
kENET_EBusERInterrupt = ENET_EIR_EBERR_MASK,
kENET_LateCollisionInterrupt = ENET_EIR_LC_MASK,
kENET_RetryLimitInterrupt = ENET_EIR_RL_MASK,
kENET_UnderrunInterrupt = ENET_EIR_UN_MASK,
kENET_PayloadRxInterrupt = ENET_EIR_PLR_MASK,
kENET_WakeupInterrupt = ENET_EIR_WAKEUP_MASK,
kENET_TsAvailInterrupt = ENET_EIR_TS_AVAIL_MASK,
kENET_TsTimerInterrupt = ENET_EIR_TS_TIMER_MASK }

```

*List of interrupts supported by the peripheral.*

- enum `enet_event_t` {
  - `kENET_RxEvent`,
  - `kENET_TxEvent`,
  - `kENET_ErrEvent`,
  - `kENET_WakeUpEvent`,
  - `kENET_TimeStampEvent`,
  - `kENET_TimeStampAvailEvent` }

*Defines the common interrupt event for callback use.*
- enum `enet_tx_accelerator_t` {
  - `kENET_TxAccelIsShift16Enabled` = `ENET_TACC_SHIFT16_MASK`,
  - `kENET_TxAccelIpCheckEnabled` = `ENET_TACC_IPCHK_MASK`,
  - `kENET_TxAccelProtoCheckEnabled` = `ENET_TACC_PROCHK_MASK` }

*Defines the transmit accelerator configuration.*
- enum `enet_rx_accelerator_t` {
  - `kENET_RxAccelPadRemoveEnabled` = `ENET_RACC_PADREM_MASK`,
  - `kENET_RxAccelIpCheckEnabled` = `ENET_RACC_IPDIS_MASK`,
  - `kENET_RxAccelProtoCheckEnabled` = `ENET_RACC_PRODIS_MASK`,
  - `kENET_RxAccelMacCheckEnabled` = `ENET_RACC_LINEDIS_MASK`,
  - `kENET_RxAccelIsShift16Enabled` = `ENET_RACC_SHIFT16_MASK` }

*Defines the receive accelerator configuration.*

## Functions

- `uint32_t ENET_GetInstance` (`ENET_Type *base`)  
*Get the ENET instance from peripheral base address.*

## Variables

- const `clock_ip_name_t s_enetClock` []  
*Pointers to enet clocks for each instance.*

## Driver version

- #define `FSL_ENET_DRIVER_VERSION` (`MAKE_VERSION(2, 5, 4)`)  
*Defines the driver version.*

## Control and status region bit masks of the receive buffer descriptor.

Defines the queue number.

- #define `ENET_BUFFDESCRIPTOR_RX_EMPTY_MASK` `0x8000U`  
*Empty bit mask.*
- #define `ENET_BUFFDESCRIPTOR_RX_SOFTOWNER1_MASK` `0x4000U`  
*Software owner one mask.*
- #define `ENET_BUFFDESCRIPTOR_RX_WRAP_MASK` `0x2000U`  
*Next buffer descriptor is the start address.*
- #define `ENET_BUFFDESCRIPTOR_RX_SOFTOWNER2_Mask` `0x1000U`  
*Software owner two mask.*
- #define `ENET_BUFFDESCRIPTOR_RX_LAST_MASK` `0x0800U`  
*Last BD of the frame mask.*
- #define `ENET_BUFFDESCRIPTOR_RX_MISS_MASK` `0x0100U`  
*Received because of the promiscuous mode.*
- #define `ENET_BUFFDESCRIPTOR_RX_BROADCAST_MASK` `0x0080U`  
*Broadcast packet mask.*
- #define `ENET_BUFFDESCRIPTOR_RX_MULTICAST_MASK` `0x0040U`  
*Multicast packet mask.*
- #define `ENET_BUFFDESCRIPTOR_RX_LENVIOLATE_MASK` `0x0020U`  
*Length violation mask.*
- #define `ENET_BUFFDESCRIPTOR_RX_NOOCTET_MASK` `0x0010U`  
*Non-octet aligned frame mask.*
- #define `ENET_BUFFDESCRIPTOR_RX_CRC_MASK` `0x0004U`  
*CRC error mask.*
- #define `ENET_BUFFDESCRIPTOR_RX_OVERRUN_MASK` `0x0002U`  
*FIFO overrun mask.*
- #define `ENET_BUFFDESCRIPTOR_RX_TRUNC_MASK` `0x0001U`  
*Frame is truncated mask.*

## Control and status bit masks of the transmit buffer descriptor.

- #define `ENET_BUFFDESCRIPTOR_TX_READY_MASK` `0x8000U`  
*Ready bit mask.*
- #define `ENET_BUFFDESCRIPTOR_TX_SOFTOWNER1_MASK` `0x4000U`  
*Software owner one mask.*
- #define `ENET_BUFFDESCRIPTOR_TX_WRAP_MASK` `0x2000U`  
*Wrap buffer descriptor mask.*
- #define `ENET_BUFFDESCRIPTOR_TX_SOFTOWNER2_MASK` `0x1000U`  
*Software owner two mask.*
- #define `ENET_BUFFDESCRIPTOR_TX_LAST_MASK` `0x0800U`  
*Last BD of the frame mask.*
- #define `ENET_BUFFDESCRIPTOR_TX_TRANSMITCRC_MASK` `0x0400U`  
*Transmit CRC mask.*

## Defines some Ethernet parameters.

- #define `ENET_FRAME_MAX_FRAMELEN` 1518U  
*Default maximum Ethernet frame size without VLAN tag.*
- #define `ENET_FRAME_VLAN_TAGLEN` 4U  
*Ethernet single VLAN tag size.*
- #define `ENET_FRAME_CRC_LEN` 4U  
*CRC size in a frame.*
- #define `ENET_FRAME_TX_LEN_LIMITATION(x)` (((x)->RCR & ENET\_RCR\_MAX\_FL\_MASK) >> ENET\_RCR\_MAX\_FL\_SHIFT) - `ENET_FRAME_CRC_LEN`
- #define `ENET_FIFO_MIN_RX_FULL` 5U  
*ENET minimum receive FIFO full.*
- #define `ENET_RX_MIN_BUFFERSIZE` 256U  
*ENET minimum buffer size.*
- #define `ENET_PHY_MAXADDRESS` (ENET\_MMFR\_PA\_MASK >> ENET\_MMFR\_PA\_SHIFT)  
*Maximum PHY address.*
- #define `ENET_TX_INTERRUPT` ((uint32\_t)kENET\_TxFrameInterrupt | (uint32\_t)kENET\_TxBufferInterrupt)  
*Enet Tx interrupt flag.*
- #define `ENET_RX_INTERRUPT` ((uint32\_t)kENET\_RxFrameInterrupt | (uint32\_t)kENET\_RxBufferInterrupt)  
*Enet Rx interrupt flag.*
- #define `ENET_TS_INTERRUPT` ((uint32\_t)kENET\_TsTimerInterrupt | (uint32\_t)kENET\_TsAvailInterrupt)  
*Enet timestamp interrupt flag.*
- #define `ENET_ERR_INTERRUPT`  
*Enet error interrupt flag.*

## Initialization and De-initialization

- void `ENET_GetDefaultConfig` (`enet_config_t` \*config)  
*Gets the ENET default configuration structure.*
- `status_t` `ENET_Up` (`ENET_Type` \*base, `enet_handle_t` \*handle, const `enet_config_t` \*config, const `enet_buffer_config_t` \*bufferConfig, `uint8_t` \*macAddr, `uint32_t` srcClock\_Hz)  
*Initializes the ENET module.*
- `status_t` `ENET_Init` (`ENET_Type` \*base, `enet_handle_t` \*handle, const `enet_config_t` \*config, const `enet_buffer_config_t` \*bufferConfig, `uint8_t` \*macAddr, `uint32_t` srcClock\_Hz)  
*Initializes the ENET module.*
- void `ENET_Down` (`ENET_Type` \*base)  
*Stops the ENET module.*
- void `ENET_Deinit` (`ENET_Type` \*base)  
*Deinitializes the ENET module.*
- static void `ENET_Reset` (`ENET_Type` \*base)  
*Resets the ENET module.*

## MII interface operation

- void `ENET_SetMII` (`ENET_Type` \*base, `enet_mii_speed_t` speed, `enet_mii_duplex_t` duplex)  
*Sets the ENET MII speed and duplex.*



- void [ENET\\_SetSMI](#) (ENET\_Type \*base, uint32\_t srcClock\_Hz, bool isPreambleDisabled)  
*Sets the ENET SMI(serial management interface)- MII management interface.*
- static bool [ENET\\_GetSMI](#) (ENET\_Type \*base)  
*Gets the ENET SMI- MII management interface configuration.*
- static uint32\_t [ENET\\_ReadSMIData](#) (ENET\_Type \*base)  
*Reads data from the PHY register through an SMI interface.*
- void [ENET\\_StartSMIRead](#) (ENET\_Type \*base, uint32\_t phyAddr, uint32\_t phyReg, [enet\\_mii\\_read\\_t](#) operation)  
*Starts an SMI (Serial Management Interface) read command.*
- void [ENET\\_StartSMIWrite](#) (ENET\_Type \*base, uint32\_t phyAddr, uint32\_t phyReg, [enet\\_mii\\_write\\_t](#) operation, uint32\_t data)  
*Starts an SMI write command.*
- void [ENET\\_StartExtC45SMIWriteReg](#) (ENET\_Type \*base, uint32\_t phyAddr, uint32\_t phyReg)  
*Starts the extended IEEE802.3 Clause 45 MDIO format SMI write register command.*
- void [ENET\\_StartExtC45SMIWriteData](#) (ENET\_Type \*base, uint32\_t phyAddr, uint32\_t phyReg, uint32\_t data)  
*Starts the extended IEEE802.3 Clause 45 MDIO format SMI write data command.*
- void [ENET\\_StartExtC45SMIReadData](#) (ENET\_Type \*base, uint32\_t phyAddr, uint32\_t phyReg)  
*Starts the extended IEEE802.3 Clause 45 MDIO format SMI read data command.*

## MAC Address Filter

- void [ENET\\_SetMacAddr](#) (ENET\_Type \*base, uint8\_t \*macAddr)  
*Sets the ENET module Mac address.*
- void [ENET\\_GetMacAddr](#) (ENET\_Type \*base, uint8\_t \*macAddr)  
*Gets the ENET module Mac address.*
- void [ENET\\_AddMulticastGroup](#) (ENET\_Type \*base, uint8\_t \*address)  
*Adds the ENET device to a multicast group.*
- void [ENET\\_LeaveMulticastGroup](#) (ENET\_Type \*base, uint8\_t \*address)  
*Moves the ENET device from a multicast group.*

## Other basic operation

- static void [ENET\\_ActiveRead](#) (ENET\_Type \*base)  
*Activates frame reception for multiple rings.*
- static void [ENET\\_EnableSleepMode](#) (ENET\_Type \*base, bool enable)  
*Enables/disables the MAC to enter sleep mode.*
- static void [ENET\\_GetAccelFunction](#) (ENET\_Type \*base, uint32\_t \*txAccelOption, uint32\_t \*rxAccelOption)  
*Gets ENET transmit and receive accelerator functions from MAC controller.*

## Interrupts.

- static void [ENET\\_EnableInterrupts](#) (ENET\_Type \*base, uint32\_t mask)  
*Enables the ENET interrupt.*
- static void [ENET\\_DisableInterrupts](#) (ENET\_Type \*base, uint32\_t mask)  
*Disables the ENET interrupt.*
- static uint32\_t [ENET\\_GetInterruptStatus](#) (ENET\_Type \*base)  
*Gets the ENET interrupt status flag.*
- static void [ENET\\_ClearInterruptStatus](#) (ENET\_Type \*base, uint32\_t mask)



- *Clears the ENET interrupt events status flag.*
- void [ENET\\_SetRxISRHandler](#) (ENET\_Type \*base, [enet\\_isr\\_t](#) ISRHandler)  
*Set the second level Rx IRQ handler.*
- void [ENET\\_SetTxISRHandler](#) (ENET\_Type \*base, [enet\\_isr\\_t](#) ISRHandler)  
*Set the second level Tx IRQ handler.*
- void [ENET\\_SetErrISRHandler](#) (ENET\_Type \*base, [enet\\_isr\\_t](#) ISRHandler)  
*Set the second level Err IRQ handler.*

## Transactional operation

- void [ENET\\_SetCallback](#) (enet\_handle\_t \*handle, [enet\\_callback\\_t](#) callback, void \*userData)  
*Sets the callback function.*
- void [ENET\\_GetRxErrBeforeReadFrame](#) (enet\_handle\_t \*handle, [enet\\_data\\_error\\_stats\\_t](#) \*eError-Static, uint8\_t ringId)  
*Gets the error statistics of a received frame for ENET specified ring.*
- void [ENET\\_GetStatistics](#) (ENET\_Type \*base, [enet\\_transfer\\_stats\\_t](#) \*statistics)  
*Gets statistical data in transfer.*
- [status\\_t](#) [ENET\\_GetRxFrameSize](#) (enet\_handle\_t \*handle, uint32\_t \*length, uint8\_t ringId)  
*Gets the size of the read frame for specified ring.*
- [status\\_t](#) [ENET\\_ReadFrame](#) (ENET\_Type \*base, enet\_handle\_t \*handle, uint8\_t \*data, uint32\_t length, uint8\_t ringId, uint32\_t \*ts)  
*Reads a frame from the ENET device.*
- [status\\_t](#) [ENET\\_SendFrame](#) (ENET\_Type \*base, enet\_handle\_t \*handle, const uint8\_t \*data, uint32\_t length, uint8\_t ringId, bool tsFlag, void \*context)  
*Transmits an ENET frame for specified ring.*
- [status\\_t](#) [ENET\\_SetTxReclaim](#) (enet\_handle\_t \*handle, bool isEnabled, uint8\_t ringId)  
*Enable or disable tx descriptors reclaim mechanism.*
- void [ENET\\_ReclaimTxDescriptor](#) (ENET\_Type \*base, enet\_handle\_t \*handle, uint8\_t ringId)  
*Reclaim tx descriptors.*
- [status\\_t](#) [ENET\\_GetRxBuffer](#) (ENET\_Type \*base, enet\_handle\_t \*handle, void \*\*buffer, uint32\_t \*length, uint8\_t ringId, bool \*isLastBuff, uint32\_t \*ts)  
*Get a receive buffer pointer of the ENET device for specified ring.*
- void [ENET\\_ReleaseRxBuffer](#) (ENET\_Type \*base, enet\_handle\_t \*handle, void \*buffer, uint8\_t ringId)  
*Release receive buffer descriptor to DMA.*
- [status\\_t](#) [ENET\\_GetRxFrame](#) (ENET\_Type \*base, enet\_handle\_t \*handle, [enet\\_rx\\_frame\\_struct\\_t](#) \*rxFrame, uint8\_t ringId)  
*Receives one frame in specified BD ring with zero copy.*
- [status\\_t](#) [ENET\\_StartTxFrame](#) (ENET\_Type \*base, enet\_handle\_t \*handle, [enet\\_tx\\_frame\\_struct\\_t](#) \*txFrame, uint8\_t ringId)  
*Sends one frame in specified BD ring with zero copy.*
- [status\\_t](#) [ENET\\_SendFrameZeroCopy](#) (ENET\_Type \*base, enet\_handle\_t \*handle, const uint8\_t \*data, uint32\_t length, uint8\_t ringId, bool tsFlag, void \*context)  
*Transmits an ENET frame for specified ring with zero-copy.*
- void [ENET\\_TransmitIRQHandler](#) (ENET\_Type \*base, enet\_handle\_t \*handle)  
*The transmit IRQ handler.*
- void [ENET\\_ReceiveIRQHandler](#) (ENET\_Type \*base, enet\_handle\_t \*handle)  
*The receive IRQ handler.*
- void [ENET\\_ErrorIRQHandler](#) (ENET\_Type \*base, enet\_handle\_t \*handle)  
*Some special IRQ handler including the error, mii, wakeup irq handler.*

- void [ENET\\_Ptp1588IRQHandler](#) (ENET\_Type \*base)  
*the common IRQ handler for the 1588 irq handler.*
- void [ENET\\_CommonFrame0IRQHandler](#) (ENET\_Type \*base)  
*the common IRQ handler for the tx/rx/error etc irq handler.*

## 19.4 Data Structure Documentation

### 19.4.1 struct enet\_rx\_bd\_struct\_t

#### Data Fields

- uint16\_t [length](#)  
*Buffer descriptor data length.*
- uint16\_t [control](#)  
*Buffer descriptor control and status.*
- uint8\_t \* [buffer](#)  
*Data buffer pointer.*

#### Field Documentation

(1) uint16\_t enet\_rx\_bd\_struct\_t::length

(2) uint16\_t enet\_rx\_bd\_struct\_t::control

(3) uint8\_t\* enet\_rx\_bd\_struct\_t::buffer

### 19.4.2 struct enet\_tx\_bd\_struct\_t

#### Data Fields

- uint16\_t [length](#)  
*Buffer descriptor data length.*
- uint16\_t [control](#)  
*Buffer descriptor control and status.*
- uint8\_t \* [buffer](#)  
*Data buffer pointer.*

#### Field Documentation

(1) uint16\_t enet\_tx\_bd\_struct\_t::length

(2) uint16\_t enet\_tx\_bd\_struct\_t::control

(3) uint8\_t\* enet\_tx\_bd\_struct\_t::buffer

### 19.4.3 struct enet\_data\_error\_stats\_t

#### Data Fields

- uint32\_t [statsRxLenGreaterErr](#)  
*Receive length greater than RCR[MAX\_FL].*
- uint32\_t [statsRxAlignErr](#)  
*Receive non-octet alignment/.*
- uint32\_t [statsRxFcsErr](#)  
*Receive CRC error.*
- uint32\_t [statsRxOverRunErr](#)  
*Receive over run.*
- uint32\_t [statsRxTruncateErr](#)  
*Receive truncate.*

#### Field Documentation

- (1) uint32\_t enet\_data\_error\_stats\_t::statsRxLenGreaterErr
- (2) uint32\_t enet\_data\_error\_stats\_t::statsRxFcsErr
- (3) uint32\_t enet\_data\_error\_stats\_t::statsRxOverRunErr
- (4) uint32\_t enet\_data\_error\_stats\_t::statsRxTruncateErr

### 19.4.4 struct enet\_rx\_frame\_error\_t

#### Data Fields

- bool [statsRxTruncateErr](#): 1  
*Receive truncate.*
- bool [statsRxOverRunErr](#): 1  
*Receive over run.*
- bool [statsRxFcsErr](#): 1  
*Receive CRC error.*
- bool [statsRxAlignErr](#): 1  
*Receive non-octet alignment.*
- bool [statsRxLenGreaterErr](#): 1  
*Receive length greater than RCR[MAX\_FL].*

#### Field Documentation

- (1) bool enet\_rx\_frame\_error\_t::statsRxTruncateErr
- (2) bool enet\_rx\_frame\_error\_t::statsRxOverRunErr
- (3) bool enet\_rx\_frame\_error\_t::statsRxFcsErr
- (4) bool enet\_rx\_frame\_error\_t::statsRxAlignErr

(5) `bool enet_rx_frame_error_t::statsRxLenGreaterErr`

### 19.4.5 struct `enet_transfer_stats_t`

#### Data Fields

- `uint32_t statsRxFrameCount`  
*Rx frame number.*
- `uint32_t statsRxFrameOk`  
*Good Rx frame number.*
- `uint32_t statsRxCrcErr`  
*Rx frame number with CRC error.*
- `uint32_t statsRxAlignErr`  
*Rx frame number with alignment error.*
- `uint32_t statsRxDropInvalidSFD`  
*Dropped frame number due to invalid SFD.*
- `uint32_t statsRxFifoOverflowErr`  
*Rx FIFO overflow count.*
- `uint32_t statsTxFrameCount`  
*Tx frame number.*
- `uint32_t statsTxFrameOk`  
*Good Tx frame number.*
- `uint32_t statsTxCrcAlignErr`  
*The transmit frame is error.*
- `uint32_t statsTxFifoUnderRunErr`  
*Tx FIFO underrun count.*

#### Field Documentation

- (1) `uint32_t enet_transfer_stats_t::statsRxFrameCount`
- (2) `uint32_t enet_transfer_stats_t::statsRxFrameOk`
- (3) `uint32_t enet_transfer_stats_t::statsRxCrcErr`
- (4) `uint32_t enet_transfer_stats_t::statsRxAlignErr`
- (5) `uint32_t enet_transfer_stats_t::statsRxDropInvalidSFD`
- (6) `uint32_t enet_transfer_stats_t::statsRxFifoOverflowErr`
- (7) `uint32_t enet_transfer_stats_t::statsTxFrameCount`
- (8) `uint32_t enet_transfer_stats_t::statsTxFrameOk`
- (9) `uint32_t enet_transfer_stats_t::statsTxCrcAlignErr`
- (10) `uint32_t enet_transfer_stats_t::statsTxFifoUnderRunErr`

## 19.4.6 struct enet\_frame\_info\_t

### Data Fields

- void \* `context`  
*User specified data.*

## 19.4.7 struct enet\_tx\_dirty\_ring\_t

### Data Fields

- `enet_frame_info_t * txDirtyBase`  
*Dirty buffer descriptor base address pointer.*
- `uint16_t txGenIdx`  
*tx generate index.*
- `uint16_t txConsumIdx`  
*tx consume index.*
- `uint16_t txRingLen`  
*tx ring length.*
- `bool isFull`  
*tx ring is full flag.*

### Field Documentation

- (1) `enet_frame_info_t* enet_tx_dirty_ring_t::txDirtyBase`
- (2) `uint16_t enet_tx_dirty_ring_t::txGenIdx`
- (3) `uint16_t enet_tx_dirty_ring_t::txConsumIdx`
- (4) `uint16_t enet_tx_dirty_ring_t::txRingLen`
- (5) `bool enet_tx_dirty_ring_t::isFull`

## 19.4.8 struct enet\_buffer\_config\_t

Note that for the internal DMA requirements, the buffers have a corresponding alignment requirements.

1. The aligned receive and transmit buffer size must be evenly divisible by ENET\_BUFF\_ALIGNMENT. when the data buffers are in cacheable region when cache is enabled, all those size should be aligned to the maximum value of "ENET\_BUFF\_ALIGNMENT" and the cache line size.
2. The aligned transmit and receive buffer descriptor start address must be at least 64 bit aligned. However, it's recommended to be evenly divisible by ENET\_BUFF\_ALIGNMENT. buffer descriptors should be put in non-cacheable region when cache is enabled.
3. The aligned transmit and receive data buffer start address must be evenly divisible by ENET\_BUFF\_ALIGNMENT. Receive buffers should be continuous with the total size equal to "rxBdNumber \* rxBuffSizeAlign". Transmit buffers should be continuous with the total size equal to "txBdNumber

\* `txBuffSizeAlign`". when the data buffers are in cacheable region when cache is enabled, all those size should be aligned to the maximum value of "ENET\_BUFF\_ALIGNMENT" and the cache line size.

## Data Fields

- `uint16_t rxBdNumber`  
*Receive buffer descriptor number.*
- `uint16_t txBdNumber`  
*Transmit buffer descriptor number.*
- `uint16_t rxBuffSizeAlign`  
*Aligned receive data buffer size.*
- `uint16_t txBuffSizeAlign`  
*Aligned transmit data buffer size.*
- volatile `enet_rx_bd_struct_t * rxBdStartAddrAlign`  
*Aligned receive buffer descriptor start address: should be non-cacheable.*
- volatile `enet_tx_bd_struct_t * txBdStartAddrAlign`  
*Aligned transmit buffer descriptor start address: should be non-cacheable.*
- `uint8_t * rxBufferAlign`  
*Receive data buffer start address.*
- `uint8_t * txBufferAlign`  
*Transmit data buffer start address.*
- `bool rxMaintainEnable`  
*Receive buffer cache maintain.*
- `bool txMaintainEnable`  
*Transmit buffer cache maintain.*
- `enet_frame_info_t * txFrameInfo`  
*Transmit frame information start address.*

## Field Documentation

- (1) `uint16_t enet_buffer_config_t::rxBdNumber`
- (2) `uint16_t enet_buffer_config_t::txBdNumber`
- (3) `uint16_t enet_buffer_config_t::rxBuffSizeAlign`
- (4) `uint16_t enet_buffer_config_t::txBuffSizeAlign`
- (5) `volatile enet_rx_bd_struct_t* enet_buffer_config_t::rxBdStartAddrAlign`
- (6) `volatile enet_tx_bd_struct_t* enet_buffer_config_t::txBdStartAddrAlign`
- (7) `uint8_t* enet_buffer_config_t::rxBufferAlign`
- (8) `uint8_t* enet_buffer_config_t::txBufferAlign`
- (9) `bool enet_buffer_config_t::rxMaintainEnable`

(10) `bool enet_buffer_config_t::txMaintainEnable`

(11) `enet_frame_info_t* enet_buffer_config_t::txFrameInfo`

### 19.4.9 struct `enet_intcoalesce_config_t`

#### Data Fields

- `uint8_t txCoalesceFrameCount` [FSL\_FEATURE\_ENET\_QUEUE]  
*Transmit interrupt coalescing frame count threshold.*
- `uint16_t txCoalesceTimeCount` [FSL\_FEATURE\_ENET\_QUEUE]  
*Transmit interrupt coalescing timer count threshold.*
- `uint8_t rxCoalesceFrameCount` [FSL\_FEATURE\_ENET\_QUEUE]  
*Receive interrupt coalescing frame count threshold.*
- `uint16_t rxCoalesceTimeCount` [FSL\_FEATURE\_ENET\_QUEUE]  
*Receive interrupt coalescing timer count threshold.*

#### Field Documentation

(1) `uint8_t enet_intcoalesce_config_t::txCoalesceFrameCount`[FSL\_FEATURE\_ENET\_QUEUE]

(2) `uint16_t enet_intcoalesce_config_t::txCoalesceTimeCount`[FSL\_FEATURE\_ENET\_QUEUE]

(3) `uint8_t enet_intcoalesce_config_t::rxCoalesceFrameCount`[FSL\_FEATURE\_ENET\_QUEUE]

(4) `uint16_t enet_intcoalesce_config_t::rxCoalesceTimeCount`[FSL\_FEATURE\_ENET\_QUEUE]

### 19.4.10 struct `enet_config_t`

Note:

1. `macSpecialConfig` is used for a special control configuration, A logical OR of "`enet_special_control_flag_t`". For a special configuration for MAC, set this parameter to 0.
2. `txWatermark` is used for a cut-through operation. It is in steps of 64 bytes: 0/1 - 64 bytes written to TX FIFO before transmission of a frame begins. 2 - 128 bytes written to TX FIFO .... 3 - 192 bytes written to TX FIFO .... The maximum of `txWatermark` is 0x2F - 4032 bytes written to TX FIFO .... `txWatermark` allows minimizing the transmit latency to set the `txWatermark` to 0 or 1 or for larger bus access latency 3 or larger due to contention for the system bus.
3. `rxFifoFullThreshold` is similar to the `txWatermark` for cut-through operation in RX. It is in 64-bit words. The minimum is `ENET_FIFO_MIN_RX_FULL` and the maximum is 0xFF. If the end of the frame is stored in FIFO and the frame size is smaller than the `txWatermark`, the frame is still transmitted. The rule is the same for `rxFifoFullThreshold` in the receive direction.
4. When "`kENET_ControlFlowControlEnable`" is set in the `macSpecialConfig`, ensure that the `pauseDuration`, `rxFifoEmptyThreshold`, and `rxFifoStatEmptyThreshold` are set for flow control enabled case.
5. When "`kENET_ControlStoreAndFwdDisabled`" is set in the `macSpecialConfig`, ensure that the `rxFifoFullThreshold` and `txFifoWatermark` are set for store and forward disable.

6. The rxAccelerConfig and txAccelerConfig default setting with 0 - accelerator are disabled. The "enet\_tx\_accelerator\_t" and "enet\_rx\_accelerator\_t" are recommended to be used to enable the transmit and receive accelerator. After the accelerators are enabled, the store and forward feature should be enabled. As a result, kENET\_ControlStoreAndFwdDisabled should not be set.
7. The intCoalesceCfg can be used in the rx or tx enabled cases to decrease the CPU loading.

## Data Fields

- uint32\_t [macSpecialConfig](#)  
*Mac special configuration.*
- uint32\_t [interrupt](#)  
*Mac interrupt source.*
- uint16\_t [rxMaxFrameLen](#)  
*Receive maximum frame length.*
- [enet\\_mii\\_mode\\_t](#) [miiMode](#)  
*MII mode.*
- [enet\\_mii\\_speed\\_t](#) [miiSpeed](#)  
*MII Speed.*
- [enet\\_mii\\_duplex\\_t](#) [miiDuplex](#)  
*MII duplex.*
- uint8\_t [rxAccelerConfig](#)  
*Receive accelerator, A logical OR of "enet\_rx\_accelerator\_t".*
- uint8\_t [txAccelerConfig](#)  
*Transmit accelerator, A logical OR of "enet\_tx\_accelerator\_t".*
- uint16\_t [pauseDuration](#)  
*For flow control enabled case: Pause duration.*
- uint8\_t [rxFifoEmptyThreshold](#)  
*For flow control enabled case: when RX FIFO level reaches this value, it makes MAC generate XOFF pause frame.*
- uint8\_t [rxFifoStatEmptyThreshold](#)  
*For flow control enabled case: number of frames in the receive FIFO, independent of size, that can be accept.*
- uint8\_t [rxFifoFullThreshold](#)  
*For store and forward disable case, the data required in RX FIFO to notify the MAC receive ready status.*
- uint8\_t [txFifoWatermark](#)  
*For store and forward disable case, the data required in TX FIFO before a frame transmit start.*
- [enet\\_intcoalesce\\_config\\_t](#) \* [intCoalesceCfg](#)  
*If the interrupt coalesce is not required in the ring n(0,1,2), please set to NULL.*
- uint8\_t [ringNum](#)  
*Number of used rings.*
- [enet\\_rx\\_alloc\\_callback\\_t](#) [rxBuffAlloc](#)  
*Callback function to alloc memory, must be provided for zero-copy Rx.*
- [enet\\_rx\\_free\\_callback\\_t](#) [rxBuffFree](#)  
*Callback function to free memory, must be provided for zero-copy Rx.*
- [enet\\_callback\\_t](#) [callback](#)  
*General callback function.*
- void \* [userData](#)



*Callback function parameter.*

### Field Documentation

**(1) uint32\_t enet\_config\_t::macSpecialConfig**

A logical OR of "enet\_special\_control\_flag\_t".

**(2) uint32\_t enet\_config\_t::interrupt**

A logical OR of "enet\_interrupt\_enable\_t".

**(3) uint16\_t enet\_config\_t::rxMaxFrameLen**

**(4) enet\_mii\_mode\_t enet\_config\_t::miiMode**

**(5) enet\_mii\_speed\_t enet\_config\_t::miiSpeed**

**(6) enet\_mii\_duplex\_t enet\_config\_t::miiDuplex**

**(7) uint8\_t enet\_config\_t::rxAccelerConfig**

**(8) uint8\_t enet\_config\_t::txAccelerConfig**

**(9) uint16\_t enet\_config\_t::pauseDuration**

**(10) uint8\_t enet\_config\_t::rxFifoEmptyThreshold**

**(11) uint8\_t enet\_config\_t::rxFifoStatEmptyThreshold**

If the limit is reached, reception continues and a pause frame is triggered.

**(12) uint8\_t enet\_config\_t::rxFifoFullThreshold**

**(13) uint8\_t enet\_config\_t::txFifoWatermark**

**(14) enet\_intcoalesce\_config\_t\* enet\_config\_t::intCoalesceCfg**

**(15) uint8\_t enet\_config\_t::ringNum**

default with 1 – single ring.

**(16) enet\_rx\_alloc\_callback\_t enet\_config\_t::rxBuffAlloc**

**(17) enet\_rx\_free\_callback\_t enet\_config\_t::rxBuffFree**

**(18) enet\_callback\_t enet\_config\_t::callback**

**(19) void\* enet\_config\_t::userData**

### 19.4.11 struct enet\_tx\_bd\_ring\_t

#### Data Fields

- volatile [enet\\_tx\\_bd\\_struct\\_t](#) \* [txBdBase](#)  
*Buffer descriptor base address pointer.*
- uint16\_t [txGenIdx](#)  
*The current available transmit buffer descriptor pointer.*
- uint16\_t [txConsumIdx](#)  
*Transmit consume index.*
- volatile uint16\_t [txDescUsed](#)  
*Transmit descriptor used number.*
- uint16\_t [txRingLen](#)  
*Transmit ring length.*

#### Field Documentation

- (1) volatile [enet\\_tx\\_bd\\_struct\\_t](#)\* [enet\\_tx\\_bd\\_ring\\_t::txBdBase](#)
- (2) uint16\_t [enet\\_tx\\_bd\\_ring\\_t::txGenIdx](#)
- (3) uint16\_t [enet\\_tx\\_bd\\_ring\\_t::txConsumIdx](#)
- (4) volatile uint16\_t [enet\\_tx\\_bd\\_ring\\_t::txDescUsed](#)
- (5) uint16\_t [enet\\_tx\\_bd\\_ring\\_t::txRingLen](#)

### 19.4.12 struct enet\_rx\_bd\_ring\_t

#### Data Fields

- volatile [enet\\_rx\\_bd\\_struct\\_t](#) \* [rxBdBase](#)  
*Buffer descriptor base address pointer.*
- uint16\_t [rxGenIdx](#)  
*The current available receive buffer descriptor pointer.*
- uint16\_t [rxRingLen](#)  
*Receive ring length.*

#### Field Documentation

- (1) volatile [enet\\_rx\\_bd\\_struct\\_t](#)\* [enet\\_rx\\_bd\\_ring\\_t::rxBdBase](#)
- (2) uint16\_t [enet\\_rx\\_bd\\_ring\\_t::rxGenIdx](#)
- (3) uint16\_t [enet\\_rx\\_bd\\_ring\\_t::rxRingLen](#)

## 19.4.13 struct \_enet\_handle

### Data Fields

- [enet\\_rx\\_bd\\_ring\\_t rxBdRing](#) [FSL\_FEATURE\_ENET\_QUEUE]  
*Receive buffer descriptor.*
- [enet\\_tx\\_bd\\_ring\\_t txBdRing](#) [FSL\_FEATURE\_ENET\_QUEUE]  
*Transmit buffer descriptor.*
- [uint16\\_t rxBuffSizeAlign](#) [FSL\_FEATURE\_ENET\_QUEUE]  
*Receive buffer size alignment.*
- [uint16\\_t txBuffSizeAlign](#) [FSL\_FEATURE\_ENET\_QUEUE]  
*Transmit buffer size alignment.*
- [bool rxMaintainEnable](#) [FSL\_FEATURE\_ENET\_QUEUE]  
*Receive buffer cache maintain.*
- [bool txMaintainEnable](#) [FSL\_FEATURE\_ENET\_QUEUE]  
*Transmit buffer cache maintain.*
- [uint8\\_t ringNum](#)  
*Number of used rings.*
- [enet\\_callback\\_t callback](#)  
*Callback function.*
- [void \\* userData](#)  
*Callback function parameter.*
- [enet\\_tx\\_dirty\\_ring\\_t txDirtyRing](#) [FSL\_FEATURE\_ENET\_QUEUE]  
*Ring to store tx frame information.*
- [bool txReclaimEnable](#) [FSL\_FEATURE\_ENET\_QUEUE]  
*Tx reclaim enable flag.*
- [enet\\_rx\\_alloc\\_callback\\_t rxBuffAlloc](#)  
*Callback function to alloc memory for zero copy Rx.*
- [enet\\_rx\\_free\\_callback\\_t rxBuffFree](#)  
*Callback function to free memory for zero copy Rx.*
- [uint8\\_t multicastCount](#) [64]  
*Multicast collisions counter.*

### Field Documentation

- (1) [enet\\_rx\\_bd\\_ring\\_t enet\\_handle\\_t::rxBdRing](#)[FSL\_FEATURE\_ENET\_QUEUE]
- (2) [enet\\_tx\\_bd\\_ring\\_t enet\\_handle\\_t::txBdRing](#)[FSL\_FEATURE\_ENET\_QUEUE]
- (3) [uint16\\_t enet\\_handle\\_t::rxBuffSizeAlign](#)[FSL\_FEATURE\_ENET\_QUEUE]
- (4) [uint16\\_t enet\\_handle\\_t::txBuffSizeAlign](#)[FSL\_FEATURE\_ENET\_QUEUE]
- (5) [bool enet\\_handle\\_t::rxMaintainEnable](#)[FSL\_FEATURE\_ENET\_QUEUE]
- (6) [bool enet\\_handle\\_t::txMaintainEnable](#)[FSL\_FEATURE\_ENET\_QUEUE]
- (7) [uint8\\_t enet\\_handle\\_t::ringNum](#)
- (8) [enet\\_callback\\_t enet\\_handle\\_t::callback](#)

- (9) `void* enet_handle_t::userData`
- (10) `enet_tx_dirty_ring_t enet_handle_t::txDirtyRing[FSL_FEATURE_ENET_QUEUE]`
- (11) `bool enet_handle_t::txReclaimEnable[FSL_FEATURE_ENET_QUEUE]`
- (12) `enet_rx_alloc_callback_t enet_handle_t::rxBuffAlloc`
- (13) `enet_rx_free_callback_t enet_handle_t::rxBuffFree`

## 19.5 Macro Definition Documentation

19.5.1 `#define FSL_ENET_DRIVER_VERSION (MAKE_VERSION(2, 5, 4))`

19.5.2 `#define ENET_BUFFDESCRIPTOR_RX_EMPTY_MASK 0x8000U`

19.5.3 `#define ENET_BUFFDESCRIPTOR_RX_SOFTOWNER1_MASK 0x4000U`

19.5.4 `#define ENET_BUFFDESCRIPTOR_RX_WRAP_MASK 0x2000U`

19.5.5 `#define ENET_BUFFDESCRIPTOR_RX_SOFTOWNER2_Mask 0x1000U`

19.5.6 `#define ENET_BUFFDESCRIPTOR_RX_LAST_MASK 0x0800U`

19.5.7 `#define ENET_BUFFDESCRIPTOR_RX_MISS_MASK 0x0100U`

19.5.8 `#define ENET_BUFFDESCRIPTOR_RX_BROADCAST_MASK 0x0080U`

19.5.9 `#define ENET_BUFFDESCRIPTOR_RX_MULTICAST_MASK 0x0040U`

19.5.10 `#define ENET_BUFFDESCRIPTOR_RX_LENVIOLATE_MASK 0x0020U`

19.5.11 `#define ENET_BUFFDESCRIPTOR_RX_NOOCTET_MASK 0x0010U`

19.5.12 `#define ENET_BUFFDESCRIPTOR_RX_CRC_MASK 0x0004U`

19.5.13 `#define ENET_BUFFDESCRIPTOR_RX_OVERRUN_MASK 0x0002U`

19.5.14 `#define ENET_BUFFDESCRIPTOR_RX_TRUNC_MASK 0x0001U`

19.5.15 `#define ENET_BUFFDESCRIPTOR_TX_READY_MASK 0x8000U`

19.5.16 **#define ENET\_BUFFDESCRIPTOR\_TX\_SOFTWENER1\_MASK 0x4000U**

19.5.17 **#define ENET\_BUFFDESCRIPTOR\_TX\_WRAP\_MASK 0x2000U**

19.5.18 **#define ENET\_BUFFDESCRIPTOR\_TX\_SOFTWENER2\_MASK 0x1000U**

19.5.19 **#define ENET\_BUFFDESCRIPTOR\_TX\_LAST\_MASK 0x0800U**

19.5.20 **#define ENET\_BUFFDESCRIPTOR\_TX\_TRANMITCRC\_MASK 0x0400U**

19.5.21 **#define ENET\_BUFFDESCRIPTOR\_RX\_ERR\_MASK**

**Value:**

```
(ENET_BUFFDESCRIPTOR_RX_TRUNC_MASK |
 ENET_BUFFDESCRIPTOR_RX_OVERRUN_MASK | \
 ENET_BUFFDESCRIPTOR_RX_LENVIOLATE_MASK |
 ENET_BUFFDESCRIPTOR_RX_NOOCTET_MASK |
 ENET_BUFFDESCRIPTOR_RX_CRC_MASK)
```

19.5.22 **#define ENET\_FRAME\_MAX\_FRAMELEN 1518U**

19.5.23 **#define ENET\_FRAME\_VLAN\_TAGLEN 4U**

19.5.24 **#define ENET\_FRAME\_CRC\_LEN 4U**

19.5.25 **#define ENET\_FIFO\_MIN\_RX\_FULL 5U**

19.5.26 **#define ENET\_RX\_MIN\_BUFFERSIZE 256U**

19.5.27 **#define ENET\_PHY\_MAXADDRESS (ENET\_MMFR\_PA\_MASK >>  
ENET\_MMFR\_PA\_SHIFT)**

19.5.28 **#define ENET\_TX\_INTERRUPT ((uint32\_t)kENET\_TxFrameInterrupt |  
(uint32\_t)kENET\_TxBufferInterrupt)**

19.5.29 **#define ENET\_RX\_INTERRUPT ((uint32\_t)kENET\_RxFrameInterrupt |  
(uint32\_t)kENET\_RxBufferInterrupt)**

**19.5.30 #define ENET\_TS\_INTERRUPT ((uint32\_t)kENET\_TsTimerInterrupt | (uint32\_t)kENET\_TsAvailInterrupt)**

**19.5.31 #define ENET\_ERR\_INTERRUPT**

**Value:**

```
((uint32_t)kENET_BabrInterrupt | (uint32_t)
 kENET_BabtInterrupt | (uint32_t)kENET_EBusERInterrupt | \
 (uint32_t)kENET_LateCollisionInterrupt | (uint32_t)
 kENET_RetryLimitInterrupt | \
 (uint32_t)kENET_UnderrunInterrupt | (uint32_t)
 kENET_PayloadRxInterrupt)
```

## 19.6 Typedef Documentation

**19.6.1 typedef void>(\* enet\_rx\_alloc\_callback\_t)(ENET\_Type \*base, void \*userData, uint8\_t ringId)**

**19.6.2 typedef void(\* enet\_rx\_free\_callback\_t)(ENET\_Type \*base, void \*buffer, void \*userData, uint8\_t ringId)**

**19.6.3 typedef void(\* enet\_callback\_t)(ENET\_Type \*base, enet\_handle\_t \*handle, enet\_event\_t event, enet\_frame\_info\_t \*frameInfo, void \*userData)**

**19.6.4 typedef void(\* enet\_isr\_t)(ENET\_Type \*base, enet\_handle\_t \*handle)**

## 19.7 Enumeration Type Documentation

### 19.7.1 anonymous enum

Enumerator

*kStatus\_ENET\_InitMemoryFail* Init fails since buffer memory is not enough.

*kStatus\_ENET\_RxFrameError* A frame received but data error happen.

*kStatus\_ENET\_RxFrameFail* Failed to receive a frame.

*kStatus\_ENET\_RxFrameEmpty* No frame arrive.

*kStatus\_ENET\_RxFrameDrop* Rx frame is dropped since no buffer memory.

*kStatus\_ENET\_TxFrameOverLen* Tx frame over length.

*kStatus\_ENET\_TxFrameBusy* Tx buffer descriptors are under process.

*kStatus\_ENET\_TxFrameFail* Transmit frame fail.

### 19.7.2 enum enet\_mii\_mode\_t

Enumerator

*kENET\_MiiMode* MII mode for data interface.

*kENET\_RmiiMode* RMII mode for data interface.

### 19.7.3 enum enet\_mii\_speed\_t

Notice: "kENET\_MiiSpeed1000M" only supported when mii mode is "kENET\_RgmiiMode".

Enumerator

*kENET\_MiiSpeed10M* Speed 10 Mbps.

*kENET\_MiiSpeed100M* Speed 100 Mbps.

### 19.7.4 enum enet\_mii\_duplex\_t

Enumerator

*kENET\_MiiHalfDuplex* Half duplex mode.

*kENET\_MiiFullDuplex* Full duplex mode.

### 19.7.5 enum enet\_mii\_write\_t

Enumerator

*kENET\_MiiWriteNoCompliant* Write frame operation, but not MII-compliant.

*kENET\_MiiWriteValidFrame* Write frame operation for a valid MII management frame.

### 19.7.6 enum enet\_mii\_read\_t

Enumerator

*kENET\_MiiReadValidFrame* Read frame operation for a valid MII management frame.

*kENET\_MiiReadNoCompliant* Read frame operation, but not MII-compliant.

### 19.7.7 enum enet\_mii\_extend\_opcode

Enumerator

- kENET\_MiiAddrWrite\_C45* Address Write operation.
- kENET\_MiiWriteFrame\_C45* Write frame operation for a valid MII management frame.
- kENET\_MiiReadFrame\_C45* Read frame operation for a valid MII management frame.

### 19.7.8 enum enet\_special\_control\_flag\_t

These control flags are provided for special user requirements. Normally, these control flags are unused for ENET initialization. For special requirements, set the flags to macSpecialConfig in the [enet\\_config\\_t](#). The *kENET\_ControlStoreAndFwdDisable* is used to disable the FIFO store and forward. FIFO store and forward means that the FIFO read/send is started when a complete frame is stored in TX/RX FIFO. If this flag is set, configure *rxFifoFullThreshold* and *txFifoWatermark* in the [enet\\_config\\_t](#).

Enumerator

- kENET\_ControlFlowControlEnable* Enable ENET flow control: pause frame.
- kENET\_ControlRxPayloadCheckEnable* Enable ENET receive payload length check.
- kENET\_ControlRxPadRemoveEnable* Padding is removed from received frames.
- kENET\_ControlRxBroadCastRejectEnable* Enable broadcast frame reject.
- kENET\_ControlMacAddrInsert* Enable MAC address insert.
- kENET\_ControlStoreAndFwdDisable* Enable FIFO store and forward.
- kENET\_ControlSMIPreambleDisable* Enable SMI preamble.
- kENET\_ControlPromiscuousEnable* Enable promiscuous mode.
- kENET\_ControlMIILoopEnable* Enable ENET MII loop back.
- kENET\_ControlVLANTagEnable* Enable normal VLAN (single vlan tag).

### 19.7.9 enum enet\_interrupt\_enable\_t

This enumeration uses one-bit encoding to allow a logical OR of multiple members. Members usually map to interrupt enable bits in one or more peripheral registers.

Enumerator

- kENET\_BabrInterrupt* Babbling receive error interrupt source.
- kENET\_BabtInterrupt* Babbling transmit error interrupt source.
- kENET\_GraceStopInterrupt* Graceful stop complete interrupt source.
- kENET\_TxFrameInterrupt* TX FRAME interrupt source.
- kENET\_TxBufferInterrupt* TX BUFFER interrupt source.
- kENET\_RxFrameInterrupt* RX FRAME interrupt source.
- kENET\_RxBufferInterrupt* RX BUFFER interrupt source.



*kENET\_MiiInterrupt* MII interrupt source.  
*kENET\_EBusERInterrupt* Ethernet bus error interrupt source.  
*kENET\_LateCollisionInterrupt* Late collision interrupt source.  
*kENET\_RetryLimitInterrupt* Collision Retry Limit interrupt source.  
*kENET\_UnderrunInterrupt* Transmit FIFO underrun interrupt source.  
*kENET\_PayloadRxInterrupt* Payload Receive error interrupt source.  
*kENET\_WakeupInterrupt* WAKEUP interrupt source.  
*kENET\_TsAvailInterrupt* TS AVAIL interrupt source for PTP.  
*kENET\_TsTimerInterrupt* TS WRAP interrupt source for PTP.

### 19.7.10 enum enet\_event\_t

Enumerator

*kENET\_RxEvent* Receive event.  
*kENET\_TxEvent* Transmit event.  
*kENET\_ErrEvent* Error event: BABR/BABT/EBERR/LC/RL/UN/PLR .  
*kENET\_WakeUpEvent* Wake up from sleep mode event.  
*kENET\_TimeStampEvent* Time stamp event.  
*kENET\_TimeStampAvailEvent* Time stamp available event.

### 19.7.11 enum enet\_tx\_accelerator\_t

Enumerator

*kENET\_TxAccelIsShift16Enabled* Transmit FIFO shift-16.  
*kENET\_TxAccelIpCheckEnabled* Insert IP header checksum.  
*kENET\_TxAccelProtoCheckEnabled* Insert protocol checksum.

### 19.7.12 enum enet\_rx\_accelerator\_t

Enumerator

*kENET\_RxAccelPadRemoveEnabled* Padding removal for short IP frames.  
*kENET\_RxAccelIpCheckEnabled* Discard with wrong IP header checksum.  
*kENET\_RxAccelProtoCheckEnabled* Discard with wrong protocol checksum.  
*kENET\_RxAccelMacCheckEnabled* Discard with Mac layer errors.  
*kENET\_RxAccelIsShift16Enabled* Receive FIFO shift-16.

## 19.8 Function Documentation

### 19.8.1 uint32\_t ENET\_GetInstance ( ENET\_Type \* base )

## Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | ENET peripheral base address. |
|-------------|-------------------------------|

## Returns

ENET instance.

### 19.8.2 void ENET\_GetDefaultConfig ( enet\_config\_t \* *config* )

The purpose of this API is to get the default ENET MAC controller configure structure for [ENET\\_Init\(\)](#). User may use the initialized structure unchanged in [ENET\\_Init\(\)](#), or modify some fields of the structure before calling [ENET\\_Init\(\)](#). Example:

```
enet_config_t config;
ENET_GetDefaultConfig(&config);
```

## Parameters

|               |                                                          |
|---------------|----------------------------------------------------------|
| <i>config</i> | The ENET mac controller configuration structure pointer. |
|---------------|----------------------------------------------------------|

### 19.8.3 status\_t ENET\_Up ( ENET\_Type \* *base*, enet\_handle\_t \* *handle*, const enet\_config\_t \* *config*, const enet\_buffer\_config\_t \* *bufferConfig*, uint8\_t \* *macAddr*, uint32\_t *srcClock\_Hz* )

This function initializes the module with the ENET configuration.

## Note

ENET has two buffer descriptors legacy buffer descriptors and enhanced IEEE 1588 buffer descriptors. The legacy descriptor is used by default. To use the IEEE 1588 feature, use the enhanced IEEE 1588 buffer descriptor by defining "ENET\_ENHANCEDBUFFERDESCRIPTOR\_MODE" and calling [ENET\\_Ptp1588Configure\(\)](#) to configure the 1588 feature and related buffers after calling [ENET\\_Up\(\)](#).

## Parameters

---

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>         | ENET peripheral base address.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <i>handle</i>       | ENET handler pointer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <i>config</i>       | ENET mac configuration structure pointer. The "enet_config_t" type mac configuration return from ENET_GetDefaultConfig can be used directly. It is also possible to verify the Mac configuration using other methods.                                                                                                                                                                                                                                                                                      |
| <i>bufferConfig</i> | ENET buffer configuration structure pointer. The buffer configuration should be prepared for ENET Initialization. It is the start address of "ringNum" enet_buffer_config structures. To support added multi-ring features in some soc and compatible with the previous enet driver version. For single ring supported, this bufferConfig is a buffer configure structure pointer, for multi-ring supported and used case, this bufferConfig pointer should be a buffer configure structure array pointer. |
| <i>macAddr</i>      | ENET mac address of Ethernet device. This MAC address should be provided.                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <i>srcClock_Hz</i>  | The internal module clock source for MII clock.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

Return values

|                                     |                                               |
|-------------------------------------|-----------------------------------------------|
| <i>kStatus_Success</i>              | Succeed to initialize the ethernet driver.    |
| <i>kStatus_ENET_Init-MemoryFail</i> | Init fails since buffer memory is not enough. |

**19.8.4 status\_t ENET\_Init ( ENET\_Type \* *base*, enet\_handle\_t \* *handle*, const enet\_config\_t \* *config*, const enet\_buffer\_config\_t \* *bufferConfig*, uint8\_t \* *macAddr*, uint32\_t *srcClock\_Hz* )**

This function ungates the module clock and initializes it with the ENET configuration.

Note

ENET has two buffer descriptors legacy buffer descriptors and enhanced IEEE 1588 buffer descriptors. The legacy descriptor is used by default. To use the IEEE 1588 feature, use the enhanced IEEE 1588 buffer descriptor by defining "ENET\_ENHANCEDBUFFERDESCRIPTOR\_MODE" and calling ENET\_Ptp1588Configure() to configure the 1588 feature and related buffers after calling [ENET\\_Init\(\)](#).

Parameters

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|---------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>         | ENET peripheral base address.                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <i>handle</i>       | ENET handler pointer.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <i>config</i>       | ENET mac configuration structure pointer. The "enet_config_t" type mac configuration return from ENET_GetDefaultConfig can be used directly. It is also possible to verify the Mac configuration using other methods.                                                                                                                                                                                                                                                                                      |
| <i>bufferConfig</i> | ENET buffer configuration structure pointer. The buffer configuration should be prepared for ENET Initialization. It is the start address of "ringNum" enet_buffer_config structures. To support added multi-ring features in some soc and compatible with the previous enet driver version. For single ring supported, this bufferConfig is a buffer configure structure pointer, for multi-ring supported and used case, this bufferConfig pointer should be a buffer configure structure array pointer. |
| <i>macAddr</i>      | ENET mac address of Ethernet device. This MAC address should be provided.                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <i>srcClock_Hz</i>  | The internal module clock source for MII clock.                                                                                                                                                                                                                                                                                                                                                                                                                                                            |

Return values

|                                     |                                               |
|-------------------------------------|-----------------------------------------------|
| <i>kStatus_Success</i>              | Succeed to initialize the ethernet driver.    |
| <i>kStatus_ENET_Init-MemoryFail</i> | Init fails since buffer memory is not enough. |

### 19.8.5 void ENET\_Down ( ENET\_Type \* *base* )

This function disables the ENET module.

Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | ENET peripheral base address. |
|-------------|-------------------------------|

### 19.8.6 void ENET\_Deinit ( ENET\_Type \* *base* )

This function gates the module clock, clears ENET interrupts, and disables the ENET module.

Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | ENET peripheral base address. |
|-------------|-------------------------------|

**19.8.7 static void ENET\_Reset ( ENET\_Type \* *base* ) [inline], [static]**

This function restores the ENET module to reset state. Note that this function sets all registers to reset state. As a result, the ENET module can't work after calling this function.

Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | ENET peripheral base address. |
|-------------|-------------------------------|

### 19.8.8 void ENET\_SetMII ( ENET\_Type \* *base*, enet\_mii\_speed\_t *speed*, enet\_mii\_duplex\_t *duplex* )

This API is provided to dynamically change the speed and dulpex for MAC.

Parameters

|               |                               |
|---------------|-------------------------------|
| <i>base</i>   | ENET peripheral base address. |
| <i>speed</i>  | The speed of the RMII mode.   |
| <i>duplex</i> | The duplex of the RMII mode.  |

### 19.8.9 void ENET\_SetSMI ( ENET\_Type \* *base*, uint32\_t *srcClock\_Hz*, bool *isPreambleDisabled* )

Parameters

|                            |                                                                                                                                                   |
|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>                | ENET peripheral base address.                                                                                                                     |
| <i>srcClock_Hz</i>         | This is the ENET module clock frequency. See clock distribution.                                                                                  |
| <i>isPreamble-Disabled</i> | The preamble disable flag. <ul style="list-style-type: none"> <li>• true Enables the preamble.</li> <li>• false Disables the preamble.</li> </ul> |

### 19.8.10 static bool ENET\_GetSMI ( ENET\_Type \* *base* ) [inline], [static]

This API is used to get the SMI configuration to check whether the MII management interface has been set.

Parameters

---

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | ENET peripheral base address. |
|-------------|-------------------------------|

Returns

The SMI setup status true or false.

**19.8.11 static uint32\_t ENET\_ReadSMIData ( ENET\_Type \* *base* ) [inline], [static]**

Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | ENET peripheral base address. |
|-------------|-------------------------------|

Returns

The data read from PHY

**19.8.12 void ENET\_StartSMIRead ( ENET\_Type \* *base*, uint32\_t *phyAddr*, uint32\_t *phyReg*, enet\_mii\_read\_t *operation* )**

Used for standard IEEE802.3 MDIO Clause 22 format.

Parameters

|                  |                                      |
|------------------|--------------------------------------|
| <i>base</i>      | ENET peripheral base address.        |
| <i>phyAddr</i>   | The PHY address.                     |
| <i>phyReg</i>    | The PHY register. Range from 0 ~ 31. |
| <i>operation</i> | The read operation.                  |

**19.8.13 void ENET\_StartSMIWrite ( ENET\_Type \* *base*, uint32\_t *phyAddr*, uint32\_t *phyReg*, enet\_mii\_write\_t *operation*, uint32\_t *data* )**

Used for standard IEEE802.3 MDIO Clause 22 format.

## Parameters

|                  |                                      |
|------------------|--------------------------------------|
| <i>base</i>      | ENET peripheral base address.        |
| <i>phyAddr</i>   | The PHY address.                     |
| <i>phyReg</i>    | The PHY register. Range from 0 ~ 31. |
| <i>operation</i> | The write operation.                 |
| <i>data</i>      | The data written to PHY.             |

### 19.8.14 void ENET\_StartExtC45SMIWriteReg ( ENET\_Type \* *base*, uint32\_t *phyAddr*, uint32\_t *phyReg* )

## Parameters

|                |                                                                                                                                                                                                        |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>    | ENET peripheral base address.                                                                                                                                                                          |
| <i>phyAddr</i> | The PHY address.                                                                                                                                                                                       |
| <i>phyReg</i>  | The PHY register. For MDIO IEEE802.3 Clause 45, the phyReg is a 21-bits combination of the devaddr (5 bits device address) and the regAddr (16 bits phy register): phyReg = (devaddr << 16)   regAddr. |

### 19.8.15 void ENET\_StartExtC45SMIWriteData ( ENET\_Type \* *base*, uint32\_t *phyAddr*, uint32\_t *phyReg*, uint32\_t *data* )

After writing MMFR register, we need to check whether the transmission is over. This is an example for whole procedure of clause 45 MDIO write.

```
* ENET_ClearInterruptStatus(base, ENET_EIR_MII_MASK);
* ENET_StartExtC45SMIWriteReg(base, phyAddr, phyReg);
* while ((ENET_GetInterruptStatus(base) & ENET_EIR_MII_MASK) == 0U)
* {
* }
* ENET_ClearInterruptStatus(base, ENET_EIR_MII_MASK);
* ENET_StartExtC45SMIWriteData(base, phyAddr, phyReg, data);
* while ((ENET_GetInterruptStatus(base) & ENET_EIR_MII_MASK) == 0U)
* {
* }
* ENET_ClearInterruptStatus(base, ENET_EIR_MII_MASK);
*
```



## Parameters

|                |                                                                                                                                                                                                        |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>    | ENET peripheral base address.                                                                                                                                                                          |
| <i>phyAddr</i> | The PHY address.                                                                                                                                                                                       |
| <i>phyReg</i>  | The PHY register. For MDIO IEEE802.3 Clause 45, the phyReg is a 21-bits combination of the devaddr (5 bits device address) and the regAddr (16 bits phy register): phyReg = (devaddr << 16)   regAddr. |
| <i>data</i>    | The data written to PHY.                                                                                                                                                                               |

### 19.8.16 void ENET\_StartExtC45SMIReadData ( ENET\_Type \* base, uint32\_t phyAddr, uint32\_t phyReg )

After writing MMFR register, we need to check whether the transmission is over. This is an example for whole procedure of clause 45 MDIO read.

```
*
* uint32_t data;
* ENET_ClearInterruptStatus(base, ENET_EIR_MII_MASK);
* ENET_StartExtC45SMIWriteReg(base, phyAddr, phyReg);
* while ((ENET_GetInterruptStatus(base) & ENET_EIR_MII_MASK) == 0U)
* {
* }
* ENET_ClearInterruptStatus(base, ENET_EIR_MII_MASK);
* ENET_StartExtC45SMIReadData(base, phyAddr, phyReg);
* while ((ENET_GetInterruptStatus(base) & ENET_EIR_MII_MASK) == 0U)
* {
* }
* ENET_ClearInterruptStatus(base, ENET_EIR_MII_MASK);
* data = ENET_ReadSMIData(base);
*
```

## Parameters

|                |                                                                                                                                                                                                        |
|----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>    | ENET peripheral base address.                                                                                                                                                                          |
| <i>phyAddr</i> | The PHY address.                                                                                                                                                                                       |
| <i>phyReg</i>  | The PHY register. For MDIO IEEE802.3 Clause 45, the phyReg is a 21-bits combination of the devaddr (5 bits device address) and the regAddr (16 bits phy register): phyReg = (devaddr << 16)   regAddr. |

### 19.8.17 void ENET\_SetMacAddr ( ENET\_Type \* base, uint8\_t \* macAddr )

Parameters

|                |                                                                                                   |
|----------------|---------------------------------------------------------------------------------------------------|
| <i>base</i>    | ENET peripheral base address.                                                                     |
| <i>macAddr</i> | The six-byte Mac address pointer. The pointer is allocated by application and input into the API. |

### 19.8.18 void ENET\_GetMacAddr ( ENET\_Type \* *base*, uint8\_t \* *macAddr* )

Parameters

|                |                                                                                                   |
|----------------|---------------------------------------------------------------------------------------------------|
| <i>base</i>    | ENET peripheral base address.                                                                     |
| <i>macAddr</i> | The six-byte Mac address pointer. The pointer is allocated by application and input into the API. |

### 19.8.19 void ENET\_AddMulticastGroup ( ENET\_Type \* *base*, uint8\_t \* *address* )

Parameters

|                |                                                                        |
|----------------|------------------------------------------------------------------------|
| <i>base</i>    | ENET peripheral base address.                                          |
| <i>address</i> | The six-byte multicast group address which is provided by application. |

### 19.8.20 void ENET\_LeaveMulticastGroup ( ENET\_Type \* *base*, uint8\_t \* *address* )

Parameters

|                |                                                                        |
|----------------|------------------------------------------------------------------------|
| <i>base</i>    | ENET peripheral base address.                                          |
| <i>address</i> | The six-byte multicast group address which is provided by application. |

### 19.8.21 static void ENET\_ActiveRead ( ENET\_Type \* *base* ) [inline], [static]

This function is to active the enet read process.

Note

This must be called after the MAC configuration and state are ready. It must be called after the [ENET\\_Init\(\)](#). This should be called when the frame reception is required.

Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | ENET peripheral base address. |
|-------------|-------------------------------|

### 19.8.22 static void ENET\_EnableSleepMode ( ENET\_Type \* *base*, bool *enable* ) [inline], [static]

This function is used to set the MAC enter sleep mode. When entering sleep mode, the magic frame wakeup interrupt should be enabled to wake up MAC from the sleep mode and reset it to normal mode.

Parameters

|               |                                                   |
|---------------|---------------------------------------------------|
| <i>base</i>   | ENET peripheral base address.                     |
| <i>enable</i> | True enable sleep mode, false disable sleep mode. |

### 19.8.23 static void ENET\_GetAccelFunction ( ENET\_Type \* *base*, uint32\_t \* *txAccelOption*, uint32\_t \* *rxAccelOption* ) [inline], [static]

Parameters

|                      |                                                                                                                                                |
|----------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>          | ENET peripheral base address.                                                                                                                  |
| <i>txAccelOption</i> | The transmit accelerator option. The "enet_tx_accelerator_t" is recommended to be used to as the mask to get the exact the accelerator option. |
| <i>rxAccelOption</i> | The receive accelerator option. The "enet_rx_accelerator_t" is recommended to be used to as the mask to get the exact the accelerator option.  |

### 19.8.24 static void ENET\_EnableInterrupts ( ENET\_Type \* *base*, uint32\_t *mask* ) [inline], [static]

This function enables the ENET interrupt according to the provided mask. The mask is a logical OR of enumeration members. See [enet\\_interrupt\\_enable\\_t](#). For example, to enable the TX frame interrupt and RX frame interrupt, do the following.

```
* ENET_EnableInterrupts(ENET, kENET_TxFrameInterrupt |
* kENET_RxFrameInterrupt);
*
```

## Parameters

|             |                                                                                                              |
|-------------|--------------------------------------------------------------------------------------------------------------|
| <i>base</i> | ENET peripheral base address.                                                                                |
| <i>mask</i> | ENET interrupts to enable. This is a logical OR of the enumeration <a href="#">enet_interrupt_enable_t</a> . |

### 19.8.25 static void ENET\_DisableInterrupts ( ENET\_Type \* *base*, uint32\_t *mask* ) [inline], [static]

This function disables the ENET interrupts according to the provided mask. The mask is a logical OR of enumeration members. See [enet\\_interrupt\\_enable\\_t](#). For example, to disable the TX frame interrupt and RX frame interrupt, do the following.

```
* ENET_DisableInterrupts(ENET, kENET_TxFrameInterrupt |
* kENET_RxFrameInterrupt);
```

## Parameters

|             |                                                                                                               |
|-------------|---------------------------------------------------------------------------------------------------------------|
| <i>base</i> | ENET peripheral base address.                                                                                 |
| <i>mask</i> | ENET interrupts to disable. This is a logical OR of the enumeration <a href="#">enet_interrupt_enable_t</a> . |

### 19.8.26 static uint32\_t ENET\_GetInterruptStatus ( ENET\_Type \* *base* ) [inline], [static]

## Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | ENET peripheral base address. |
|-------------|-------------------------------|

## Returns

The event status of the interrupt source. This is the logical OR of members of the enumeration [enet\\_interrupt\\_enable\\_t](#).

### 19.8.27 static void ENET\_ClearInterruptStatus ( ENET\_Type \* *base*, uint32\_t *mask* ) [inline], [static]

This function clears enabled ENET interrupts according to the provided mask. The mask is a logical OR of enumeration members. See the [enet\\_interrupt\\_enable\\_t](#). For example, to clear the TX frame interrupt and RX frame interrupt, do the following.

```
* ENET_ClearInterruptStatus (ENET,
* kENET_TxFrameInterrupt | kENET_RxFrameInterrupt);
```

## Parameters

|             |                                                                                                                                     |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i> | ENET peripheral base address.                                                                                                       |
| <i>mask</i> | ENET interrupt source to be cleared. This is the logical OR of members of the enumeration <a href="#">enet_interrupt_enable_t</a> . |

### 19.8.28 void ENET\_SetRxISRHandler ( ENET\_Type \* *base*, enet\_isr\_t *ISRHandler* )

## Parameters

|                   |                               |
|-------------------|-------------------------------|
| <i>base</i>       | ENET peripheral base address. |
| <i>ISRHandler</i> | The handler to install.       |

### 19.8.29 void ENET\_SetTxISRHandler ( ENET\_Type \* *base*, enet\_isr\_t *ISRHandler* )

## Parameters

|                   |                               |
|-------------------|-------------------------------|
| <i>base</i>       | ENET peripheral base address. |
| <i>ISRHandler</i> | The handler to install.       |

### 19.8.30 void ENET\_SetErrISRHandler ( ENET\_Type \* *base*, enet\_isr\_t *ISRHandler* )

## Parameters

|                   |                               |
|-------------------|-------------------------------|
| <i>base</i>       | ENET peripheral base address. |
| <i>ISRHandler</i> | The handler to install.       |

### 19.8.31 void ENET\_SetCallback ( enet\_handle\_t \* *handle*, enet\_callback\_t *callback*, void \* *userData* )

**Deprecated** Do not use this function. It has been superseded by the config param in [ENET\\_Init](#). This API is provided for the application callback required case when ENET interrupt is enabled. This API should be called after calling [ENET\\_Init](#).

## Parameters

|                 |                                                          |
|-----------------|----------------------------------------------------------|
| <i>handle</i>   | ENET handler pointer. Should be provided by application. |
| <i>callback</i> | The ENET callback function.                              |
| <i>userData</i> | The callback function parameter.                         |

### 19.8.32 void ENET\_GetRxErrBeforeReadFrame ( enet\_handle\_t \* *handle*, enet\_data\_error\_stats\_t \* *eErrorStatic*, uint8\_t *ringId* )

This API must be called after the ENET\_GetRxFrameSize and before the [ENET\\_ReadFrame\(\)](#). If the ENET\_GetRxFrameSize returns kStatus\_ENET\_RxFrameError, the ENET\_GetRxErrBeforeReadFrame can be used to get the exact error statistics. This is an example.

```
*
* status = ENET_GetRxFrameSize(&g_handle, &length, 0);
* if (status == kStatus_ENET_RxFrameError)
* {
* Comments: Get the error information of the received frame.
* ENET_GetRxErrBeforeReadFrame(&g_handle, &eErrStatic, 0);
* Comments: update the receive buffer.
* ENET_ReadFrame(EXAMPLE_ENET, &g_handle, NULL, 0);
* }
*
```

## Parameters

|                     |                                                                                             |
|---------------------|---------------------------------------------------------------------------------------------|
| <i>handle</i>       | The ENET handler structure pointer. This is the same handler pointer used in the ENET_Init. |
| <i>eErrorStatic</i> | The error statistics structure pointer.                                                     |
| <i>ringId</i>       | The ring index, range from 0 ~ (FSL_FEATURE_ENET_INSTANCE_QUEUE(x) - 1).                    |

### 19.8.33 void ENET\_GetStatistics ( ENET\_Type \* *base*, enet\_transfer\_stats\_t \* *statistics* )

## Parameters

|                   |                                   |
|-------------------|-----------------------------------|
| <i>base</i>       | ENET peripheral base address.     |
| <i>statistics</i> | The statistics structure pointer. |

### 19.8.34 `status_t ENET_GetRxFrameSize ( enet_handle_t * handle, uint32_t * length, uint8_t ringId )`

This function gets a received frame size from the ENET buffer descriptors.

#### Note

The FCS of the frame is automatically removed by MAC and the size is the length without the FCS. After calling `ENET_GetRxFrameSize`, `ENET_ReadFrame()` should be called to receive frame and update the BD if the result is not "kStatus\_ENET\_RxFrameEmpty".

#### Parameters

|               |                                                                                                   |
|---------------|---------------------------------------------------------------------------------------------------|
| <i>handle</i> | The ENET handler structure. This is the same handler pointer used in the <code>ENET_Init</code> . |
| <i>length</i> | The length of the valid frame received.                                                           |
| <i>ringId</i> | The ring index or ring number.                                                                    |

#### Return values

|                                   |                                                                                                                                                   |
|-----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>kStatus_ENET_RxFrame-Empty</i> | No frame received. Should not call <code>ENET_ReadFrame</code> to read frame.                                                                     |
| <i>kStatus_ENET_RxFrame-Error</i> | Data error happens. <code>ENET_ReadFrame</code> should be called with NULL data and NULL length to update the receive buffers.                    |
| <i>kStatus_Success</i>            | Receive a frame Successfully then the <code>ENET_ReadFrame</code> should be called with the right data buffer and the captured data length input. |

### 19.8.35 `status_t ENET_ReadFrame ( ENET_Type * base, enet_handle_t * handle, uint8_t * data, uint32_t length, uint8_t ringId, uint32_t * ts )`

This function reads a frame (both the data and the length) from the ENET buffer descriptors. User can get timestamp through `ts` pointer if the `ts` is not NULL.

#### Note

It doesn't store the timestamp in the receive timestamp queue. The `ENET_GetRxFrameSize` should be used to get the size of the prepared data buffer. This API uses `memcpy` to copy data from DMA buffer to application buffer, 4 bytes aligned data buffer in 32 bits platforms provided by user may let compiler use optimization instruction to reduce time consumption. This is an example:

```
* uint32_t length;
* enet_handle_t g_handle;
* Comments: Get the received frame size firstly.
* status = ENET_GetRxFrameSize(&g_handle, &length, 0);
* if (length != 0)
```

```

*
* {
* Comments: Allocate memory here with the size of "length"
* uint8_t *data = memory allocate interface;
* if (!data)
* {
* ENET_ReadFrame(ENET, &g_handle, NULL, 0, 0, NULL);
* Comments: Add the console warning log.
* }
* else
* {
* status = ENET_ReadFrame(ENET, &g_handle, data, length, 0, NULL);
* Comments: Call stack input API to deliver the data to stack
* }
* }
* else if (status == kStatus_ENET_RxFrameError)
* {
* Comments: Update the received buffer when a error frame is received.
* ENET_ReadFrame(ENET, &g_handle, NULL, 0, 0, NULL);
* }
*

```

Parameters

|               |                                                                                                    |
|---------------|----------------------------------------------------------------------------------------------------|
| <i>base</i>   | ENET peripheral base address.                                                                      |
| <i>handle</i> | The ENET handler structure. This is the same handler pointer used in the ENET_Init.                |
| <i>data</i>   | The data buffer provided by user to store the frame which memory size should be at least "length". |
| <i>length</i> | The size of the data buffer which is still the length of the received frame.                       |
| <i>ringId</i> | The ring index or ring number.                                                                     |
| <i>ts</i>     | The timestamp address to store received timestamp.                                                 |

Returns

The execute status, successful or failure.

**19.8.36 status\_t ENET\_SendFrame ( ENET\_Type \* base, enet\_handle\_t \* handle, const uint8\_t \* data, uint32\_t length, uint8\_t ringId, bool tsFlag, void \* context )**

Note

The CRC is automatically appended to the data. Input the data to send without the CRC. This API uses memcpy to copy data from DMA buffer to application buffer, 4 bytes aligned data buffer in 32 bits platforms provided by user may let compiler use optimization instruction to reduce time consumption.



Parameters

|                |                                                                                   |
|----------------|-----------------------------------------------------------------------------------|
| <i>base</i>    | ENET peripheral base address.                                                     |
| <i>handle</i>  | The ENET handler pointer. This is the same handler pointer used in the ENET_Init. |
| <i>data</i>    | The data buffer provided by user to send.                                         |
| <i>length</i>  | The length of the data to send.                                                   |
| <i>ringId</i>  | The ring index or ring number.                                                    |
| <i>tsFlag</i>  | Timestamp enable flag.                                                            |
| <i>context</i> | Used by user to handle some events after transmit over.                           |

Return values

|                                  |                                                                                                                                                                                                                                           |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>kStatus_Success</i>           | Send frame succeed.                                                                                                                                                                                                                       |
| <i>kStatus_ENET_TxFrame-Busy</i> | Transmit buffer descriptor is busy under transmission. The transmit busy happens when the data send rate is over the MAC capacity. The waiting mechanism is recommended to be added after each call return with kStatus-ENET_TxFrameBusy. |

**19.8.37 status\_t ENET\_SetTxReclaim ( enet\_handle\_t \* handle, bool isEnabled, uint8\_t ringId )**

Note

This function must be called when no pending send frame action. Set enable if you want to reclaim context or timestamp in interrupt.

Parameters

|                  |                                                                                   |
|------------------|-----------------------------------------------------------------------------------|
| <i>handle</i>    | The ENET handler pointer. This is the same handler pointer used in the ENET_Init. |
| <i>isEnabled</i> | Enable or disable flag.                                                           |
| <i>ringId</i>    | The ring index or ring number.                                                    |

Return values

|                        |                                       |
|------------------------|---------------------------------------|
| <i>kStatus_Success</i> | Succeed to enable/disable Tx reclaim. |
| <i>kStatus_Fail</i>    | Fail to enable/disable Tx reclaim.    |

**19.8.38** void ENET\_ReclaimTxDescriptor ( ENET\_Type \* *base*, enet\_handle\_t \* *handle*, uint8\_t *ringId* )

This function is used to update the tx descriptor status and store the tx timestamp when the 1588 feature is enabled. This is called by the transmit interrupt IRQ handler after the complete of a frame transmission.

Parameters

|               |                                                                                   |
|---------------|-----------------------------------------------------------------------------------|
| <i>base</i>   | ENET peripheral base address.                                                     |
| <i>handle</i> | The ENET handler pointer. This is the same handler pointer used in the ENET_Init. |
| <i>ringId</i> | The ring index or ring number.                                                    |

**19.8.39** `status_t ENET_GetRxBuffer ( ENET_Type * base, enet_handle_t * handle, void ** buffer, uint32_t * length, uint8_t ringId, bool * isLastBuff, uint32_t * ts )`

**Deprecated** Do not use this function. It has been superseded by [ENET\\_GetRxFrame](#).

This function can get the data address which stores frame. Then can analyze these data directly without doing any memory copy. When the frame locates in multiple BD buffer, need to repeat calling this function until isLastBuff=true (need to store the temp buf pointer everytime call this function). After finishing the analysis of this frame, call ENET\_ReleaseRxBuffer to release rxbuff memory to DMA. This is an example:

```
* uint32_t length;
* uint8_t *buf = NULL;
* uint32_t data_len = 0;
* bool isLastBuff = false;
* enet_handle_t g_handle;
* status_t status;
* status = ENET_GetRxFrameSize(&g_handle, &length, 0);
* if (length != 0)
* {
* ENET_GetRxBuffer(EXAMPLE_ENET, &g_handle, &buf, &data_len, 0, &isLastBuff, NULL
*);
* ENET_ReleaseRxBuffer(EXAMPLE_ENET, &g_handle, buf, 0);
* }
*
```

Parameters

|               |                                                                                                                                                           |
|---------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>   | ENET peripheral base address.                                                                                                                             |
| <i>handle</i> | The ENET handler structure. This is the same handler pointer used in the ENET_Init.                                                                       |
| <i>buffer</i> | The data buffer pointer to store the frame.                                                                                                               |
| <i>length</i> | The size of the data buffer. If isLastBuff=false, it represents data length of this buffer. If isLastBuff=true, it represents data length of total frame. |

|                   |                                                                            |
|-------------------|----------------------------------------------------------------------------|
| <i>ringId</i>     | The ring index, range from 0 ~ (FSL_FEATURE_ENET_INSTANCE_QUEUEEn(x) - 1). |
| <i>isLastBuff</i> | The flag represents whether this buffer is the last buffer to store frame. |
| <i>ts</i>         | The 1588 timestamp value, valid in last buffer.                            |

Return values

|                                  |                                                                                              |
|----------------------------------|----------------------------------------------------------------------------------------------|
| <i>kStatus_Success</i>           | Get receive buffer succeed.                                                                  |
| <i>kStatus_ENET_RxFrame-Fail</i> | Get receive buffer fails, it's owned by application, should wait app to release this buffer. |

#### 19.8.40 void ENET\_ReleaseRxBuffer ( ENET\_Type \* *base*, enet\_handle\_t \* *handle*, void \* *buffer*, uint8\_t *ringId* )

**Deprecated** Do not use this function. It has been superseded by [ENET\\_GetRxFrame](#).

This function can release specified BD owned by application, meanwhile it may rearrange the BD to let the no-owned BDs always in back of the index of DMA transfer. So for the situation that releasing order is not same as the getting order, the rearrangement makes all ready BDs can be used by DMA.

Note

This function can't be interrupted by ENET\_GetRxBuffer, so in application must make sure ENET\_GetRxBuffer is called before or after this function. And this function itself isn't thread safe due to BD content exchanging.

Parameters

|               |                                                                                       |
|---------------|---------------------------------------------------------------------------------------|
| <i>base</i>   | ENET peripheral base address.                                                         |
| <i>handle</i> | The ENET handler structure. This is the same handler pointer used in the ENET_Init.   |
| <i>buffer</i> | The buffer address to store frame, using it to find the correspond BD and release it. |
| <i>ringId</i> | The ring index, range from 0 ~ (FSL_FEATURE_ENET_INSTANCE_QUEUEEn(x) - 1).            |

#### 19.8.41 status\_t ENET\_GetRxFrame ( ENET\_Type \* *base*, enet\_handle\_t \* *handle*, enet\_rx\_frame\_struct\_t \* *rxFrame*, uint8\_t *ringId* )

This function will use the user-defined allocate and free callback. Every time application gets one frame through this function, driver will allocate new buffers for the BDs whose buffers have been taken by application.

Note

This function will drop current frame and update related BDs as available for DMA if new buffers allocating fails. Application must provide a memory pool including at least BD number + 1 buffers to make this function work normally. If user calls this function in Rx interrupt handler, be careful that this function makes Rx BD ready with allocating new buffer(normal) or updating current BD(out of memory). If there's always new Rx frame input, Rx interrupt will be triggered forever. Application need to disable Rx interrupt according to specific design in this case.

Parameters

|                |                                                                                   |
|----------------|-----------------------------------------------------------------------------------|
| <i>base</i>    | ENET peripheral base address.                                                     |
| <i>handle</i>  | The ENET handler pointer. This is the same handler pointer used in the ENET_Init. |
| <i>rxFrame</i> | The received frame information structure provided by user.                        |
| <i>ringId</i>  | The ring index or ring number.                                                    |

Return values

|                                   |                                                                 |
|-----------------------------------|-----------------------------------------------------------------|
| <i>kStatus_Success</i>            | Succeed to get one frame and allocate new memory for Rx buffer. |
| <i>kStatus_ENET_RxFrame-Empty</i> | There's no Rx frame in the BD.                                  |
| <i>kStatus_ENET_RxFrame-Error</i> | There's issue in this receiving.                                |
| <i>kStatus_ENET_RxFrame-Drop</i>  | There's no new buffer memory for BD, drop this frame.           |

**19.8.42 status\_t ENET\_StartTxFrame ( ENET\_Type \* *base*, enet\_handle\_t \* *handle*, enet\_tx\_frame\_struct\_t \* *txFrame*, uint8\_t *ringId* )**

This function supports scattered buffer transmit, user needs to provide the buffer array.

Note

Tx reclaim should be enabled to ensure the Tx buffer ownership can be given back to application after Tx is over.

## Parameters

|                |                                                                                   |
|----------------|-----------------------------------------------------------------------------------|
| <i>base</i>    | ENET peripheral base address.                                                     |
| <i>handle</i>  | The ENET handler pointer. This is the same handler pointer used in the ENET_Init. |
| <i>txFrame</i> | The Tx frame structure.                                                           |
| <i>ringId</i>  | The ring index or ring number.                                                    |

## Return values

|                                     |                                                                         |
|-------------------------------------|-------------------------------------------------------------------------|
| <i>kStatus_Success</i>              | Succeed to send one frame.                                              |
| <i>kStatus_ENET_TxFrame-Busy</i>    | The BD is not ready for Tx or the reclaim operation still not finishes. |
| <i>kStatus_ENET_TxFrame-OverLen</i> | The Tx frame length is over max ethernet frame length.                  |

**19.8.43** `status_t ENET_SendFrameZeroCopy ( ENET_Type * base, enet_handle_t * handle, const uint8_t * data, uint32_t length, uint8_t ringId, bool tsFlag, void * context )`

**Deprecated** Do not use this function. It has been superseded by [ENET\\_StartTxFrame](#).

## Note

The CRC is automatically appended to the data. Input the data to send without the CRC. The frame must store in continuous memory and need to check the buffer start address alignment based on your device, otherwise it has issue or can't get highest DMA transmit speed.

## Parameters

|               |                                                                                   |
|---------------|-----------------------------------------------------------------------------------|
| <i>base</i>   | ENET peripheral base address.                                                     |
| <i>handle</i> | The ENET handler pointer. This is the same handler pointer used in the ENET_Init. |
| <i>data</i>   | The data buffer provided by user to send.                                         |
| <i>length</i> | The length of the data to send.                                                   |

|                |                                                         |
|----------------|---------------------------------------------------------|
| <i>ringId</i>  | The ring index or ring number.                          |
| <i>tsFlag</i>  | Timestamp enable flag.                                  |
| <i>context</i> | Used by user to handle some events after transmit over. |

Return values

|                                  |                                                                                                                                                                                                                                                   |
|----------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>kStatus_Success</i>           | Send frame succeed.                                                                                                                                                                                                                               |
| <i>kStatus_ENET_TxFrame-Busy</i> | Transmit buffer descriptor is busy under transmission. The transmit busy happens when the data send rate is over the MAC capacity. The waiting mechanism is recommended to be added after each call return with <i>kStatus-ENET_TxFrameBusy</i> . |

**19.8.44 void ENET\_TransmitIRQHandler ( ENET\_Type \* *base*, enet\_handle\_t \* *handle* )**

Parameters

|               |                               |
|---------------|-------------------------------|
| <i>base</i>   | ENET peripheral base address. |
| <i>handle</i> | The ENET handler pointer.     |

**19.8.45 void ENET\_ReceiveIRQHandler ( ENET\_Type \* *base*, enet\_handle\_t \* *handle* )**

Parameters

|               |                               |
|---------------|-------------------------------|
| <i>base</i>   | ENET peripheral base address. |
| <i>handle</i> | The ENET handler pointer.     |

**19.8.46 void ENET\_ErrorIRQHandler ( ENET\_Type \* *base*, enet\_handle\_t \* *handle* )**

Parameters

|               |                               |
|---------------|-------------------------------|
| <i>base</i>   | ENET peripheral base address. |
| <i>handle</i> | The ENET handler pointer.     |

**19.8.47 void ENET\_Ptp1588IRQHandler ( ENET\_Type \* *base* )**

This is used for the 1588 timer interrupt.



Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | ENET peripheral base address. |
|-------------|-------------------------------|

#### 19.8.48 void ENET\_CommonFrame0IRQHandler ( ENET\_Type \* *base* )

This is used for the combined tx/rx/error interrupt for single/multi-ring (frame 0).

Parameters

|             |                               |
|-------------|-------------------------------|
| <i>base</i> | ENET peripheral base address. |
|-------------|-------------------------------|

### 19.9 Variable Documentation

#### 19.9.1 const clock\_ip\_name\_t s\_enetClock[]

## 19.10 ENET CMSIS Driver

This section describes the programming interface of the ENET Cortex Microcontroller Software Interface Standard (CMSIS) driver. This driver defines generic peripheral driver interfaces for middleware making it reusable across a wide range of supported microcontroller devices. The API connects microcontroller peripherals with middleware that implements for example communication stacks, file systems, or graphic user interfaces. More information and usage method see <http://www.keil.com/pack/doc/cmsis/Driver/html/index.html>.

The ENET CMSIS driver includes transactional APIs.

Transactional APIs are transaction target high-level APIs. The transactional APIs can be used to enable the peripheral quickly and also in the application if the code size and performance of transactional APIs satisfy the requirements. If the code size and performance are critical requirements, see the transactional API implementation and write custom code accessing the hardware registers.

### 19.10.1 Typical use case

```
void ENET_SignalEvent_t(uint32_t event)
{
 if (event == ARM_ETH_MAC_EVENT_RX_FRAME)
 {
 uint32_t size;
 uint32_t len;

 /* Get the Frame size */
 size = EXAMPLE_ENET.GetRxFrameSize();
 /* Call ENET_ReadFrame when there is a received frame. */
 if (size != 0)
 {
 /* Received valid frame. Deliver the rx buffer with the size equal to length. */
 uint8_t *data = (uint8_t *)malloc(size);
 if (data)
 {
 len = EXAMPLE_ENET.ReadFrame(data, size);
 if (size == len)
 {
 /* Increase the received frame numbers. */
 if (g_rxIndex < ENET_EXAMPLE_LOOP_COUNT)
 {
 g_rxIndex++;
 }
 }
 free(data);
 }
 }
 }
 if (event == ARM_ETH_MAC_EVENT_TX_FRAME)
 {
 g_testTxNum ++;
 }
}

/* Initialize the ENET module. */
EXAMPLE_ENET.Initialize(ENET_SignalEvent_t);
EXAMPLE_ENET.PowerControl(ARM_POWER_FULL);
EXAMPLE_ENET.SetMacAddress((ARM_ETH_MAC_ADDR *)g_macAddr);
EXAMPLE_ENET.Control(ARM_ETH_MAC_CONFIGURE, linkInfo.speed << ARM_ETH_MAC_SPEED_Pos |
 linkInfo.duplex << ARM_ETH_MAC_DUPLEX_Pos | ARM_ETH_MAC_ADDRESS_BROADCAST);
EXAMPLE_ENET_PHY.PowerControl(ARM_POWER_FULL);
```

```

EXAMPLE_ENET_PHY.SetMode(ARM_ETH_PHY_AUTO_NEGOTIATE);
EXAMPLE_ENET.Control(ARM_ETH_MAC_CONTROL_RX, 1);
EXAMPLE_ENET.Control(ARM_ETH_MAC_CONTROL_TX, 1);
if (EXAMPLE_ENET_PHY.GetLinkState() == ARM_ETH_LINK_UP)
{
 linkInfo = EXAMPLE_ENET_PHY.GetLinkInfo();
}
else
{
 PRINTF("\r\nPHY Link down, please check the cable connection and link partner setting.\r\n");
}

/* Build broadcast for sending. */
ENET_BuildBroadCastFrame();

while (1)
{
 /* Check the total number of received number. */
 if (g_rxCheckIdx != g_rxIndex)
 {
 PRINTF("The %d frame has been successfully received!\r\n", g_rxIndex);
 g_rxCheckIdx = g_rxIndex;
 }
 if (g_testTxNum && (g_txCheckIdx != g_testTxNum))
 {
 g_txCheckIdx = g_testTxNum;
 PRINTF("The %d frame transmitted success!\r\n", g_txCheckIdx);
 }
 /* Get the Frame size */
 if (txnumber < ENET_EXAMPLE_LOOP_COUNT)
 {
 txnumber++;
 /* Send a multicast frame when the PHY is link up. */
 if (EXAMPLE_ENET.SendFrame(&g_frame[0], ENET_DATA_LENGTH, ARM_ETH_MAC_TX_FRAME_EVENT) ==
ARM_DRIVER_OK)
 {
 for (uint32_t count = 0; count < 0x3FF; count++)
 {
 __ASM("nop");
 }
 }
 else
 {
 PRINTF(" \r\nTransmit frame failed!\r\n");
 }
 }
}

```

## Chapter 20

# EWM: External Watchdog Monitor Driver

### 20.1 Overview

The MCUXpresso SDK provides a peripheral driver for the External Watchdog (EWM) Driver module of MCUXpresso SDK devices.

### 20.2 Typical use case

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/ewm`

### Data Structures

- struct `ewm_config_t`  
*Data structure for EWM configuration. [More...](#)*

### Enumerations

- enum `ewm_lpo_clock_source_t` {  
    `kEWM_LpoClockSource0` = 0U,  
    `kEWM_LpoClockSource1` = 1U,  
    `kEWM_LpoClockSource2` = 2U,  
    `kEWM_LpoClockSource3` = 3U }  
*Describes EWM clock source.*
- enum `_ewm_interrupt_enable_t` { `kEWM_InterruptEnable` = EWM\_CTRL\_INTEN\_MASK }  
*EWM interrupt configuration structure with default settings all disabled.*
- enum `_ewm_status_flags_t` { `kEWM_RunningFlag` = EWM\_CTRL\_EWMEN\_MASK }  
*EWM status flags.*

### Driver version

- #define `FSL_EWM_DRIVER_VERSION` (MAKE\_VERSION(2, 0, 3))  
*EWM driver version 2.0.3.*

### EWM initialization and de-initialization

- void `EWM_Init` (EWM\_Type \*base, const `ewm_config_t` \*config)  
*Initializes the EWM peripheral.*
- void `EWM_Deinit` (EWM\_Type \*base)  
*Deinitializes the EWM peripheral.*
- void `EWM_GetDefaultConfig` (`ewm_config_t` \*config)  
*Initializes the EWM configuration structure.*

## EWM functional Operation

- static void [EWM\\_EnableInterrupts](#) (EWM\_Type \*base, uint32\_t mask)  
*Enables the EWM interrupt.*
- static void [EWM\\_DisableInterrupts](#) (EWM\_Type \*base, uint32\_t mask)  
*Disables the EWM interrupt.*
- static uint32\_t [EWM\\_GetStatusFlags](#) (EWM\_Type \*base)  
*Gets all status flags.*
- void [EWM\\_Refresh](#) (EWM\_Type \*base)  
*Services the EWM.*

## 20.3 Data Structure Documentation

### 20.3.1 struct ewm\_config\_t

This structure is used to configure the EWM.

#### Data Fields

- bool [enableEwm](#)  
*Enable EWM module.*
- bool [enableEwmInput](#)  
*Enable EWM\_in input.*
- bool [setInputAssertLogic](#)  
*EWM\_in signal assertion state.*
- bool [enableInterrupt](#)  
*Enable EWM interrupt.*
- [ewm\\_lpo\\_clock\\_source\\_t](#) [clockSource](#)  
*Clock source select.*
- uint8\_t [prescaler](#)  
*Clock prescaler value.*
- uint8\_t [compareLowValue](#)  
*Compare low-register value.*
- uint8\_t [compareHighValue](#)  
*Compare high-register value.*

## 20.4 Macro Definition Documentation

### 20.4.1 #define FSL\_EWM\_DRIVER\_VERSION (MAKE\_VERSION(2, 0, 3))

## 20.5 Enumeration Type Documentation

### 20.5.1 enum ewm\_lpo\_clock\_source\_t

Enumerator

- kEWM\_LpoClockSource0* EWM clock sourced from lpo\_clk[0].
- kEWM\_LpoClockSource1* EWM clock sourced from lpo\_clk[1].
- kEWM\_LpoClockSource2* EWM clock sourced from lpo\_clk[2].

*kEWM\_LpoClockSource3* EWM clock sourced from lpo\_clk[3].

### 20.5.2 enum \_ewm\_interrupt\_enable\_t

This structure contains the settings for all of EWM interrupt configurations.

Enumerator

*kEWM\_InterruptEnable* Enable the EWM to generate an interrupt.

### 20.5.3 enum \_ewm\_status\_flags\_t

This structure contains the constants for the EWM status flags for use in the EWM functions.

Enumerator

*kEWM\_RunningFlag* Running flag, set when EWM is enabled.

## 20.6 Function Documentation

### 20.6.1 void EWM\_Init ( EWM\_Type \* *base*, const ewm\_config\_t \* *config* )

This function is used to initialize the EWM. After calling, the EWM runs immediately according to the configuration. Note that, except for the interrupt enable control bit, other control bits and registers are write once after a CPU reset. Modifying them more than once generates a bus transfer error.

This is an example.

```
* ewm_config_t config;
* EWM_GetDefaultConfig(&config);
* config.compareHighValue = 0xAAU;
* EWM_Init(ewm_base, &config);
*
```

Parameters

|               |                              |
|---------------|------------------------------|
| <i>base</i>   | EWM peripheral base address  |
| <i>config</i> | The configuration of the EWM |

### 20.6.2 void EWM\_Deinit ( EWM\_Type \* *base* )

This function is used to shut down the EWM.

## Parameters

|             |                             |
|-------------|-----------------------------|
| <i>base</i> | EWM peripheral base address |
|-------------|-----------------------------|

### 20.6.3 void EWM\_GetDefaultConfig ( ewm\_config\_t \* config )

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

```
* ewmConfig->enableEwm = true;
* ewmConfig->enableEwmInput = false;
* ewmConfig->setInputAssertLogic = false;
* ewmConfig->enableInterrupt = false;
* ewmConfig->ewm_lpo_clock_source_t = kEWM_LpoClockSource0;
* ewmConfig->prescaler = 0;
* ewmConfig->compareLowValue = 0;
* ewmConfig->compareHighValue = 0xFEU;
*
```

## Parameters

|               |                                             |
|---------------|---------------------------------------------|
| <i>config</i> | Pointer to the EWM configuration structure. |
|---------------|---------------------------------------------|

## See Also

[ewm\\_config\\_t](#)

### 20.6.4 static void EWM\_EnableInterrupts ( EWM\_Type \* base, uint32\_t mask ) [inline], [static]

This function enables the EWM interrupt.

## Parameters

|             |                                                                                                                                                                       |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i> | EWM peripheral base address                                                                                                                                           |
| <i>mask</i> | The interrupts to enable The parameter can be combination of the following source if defined <ul style="list-style-type: none"> <li>• kEWM_InterruptEnable</li> </ul> |

### 20.6.5 static void EWM\_DisableInterrupts ( EWM\_Type \* base, uint32\_t mask ) [inline], [static]

This function enables the EWM interrupt.

## Parameters

|             |                                                                                                                                                                        |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i> | EWM peripheral base address                                                                                                                                            |
| <i>mask</i> | The interrupts to disable The parameter can be combination of the following source if defined <ul style="list-style-type: none"> <li>• kEWM_InterruptEnable</li> </ul> |

### 20.6.6 static uint32\_t EWM\_GetStatusFlags ( EWM\_Type \* *base* ) [inline], [static]

This function gets all status flags.

This is an example for getting the running flag.

```
* uint32_t status;
* status = EWM_GetStatusFlags(ewm_base) & kEWM_RunningFlag;
*
```

## Parameters

|             |                             |
|-------------|-----------------------------|
| <i>base</i> | EWM peripheral base address |
|-------------|-----------------------------|

## Returns

State of the status flag: asserted (true) or not-asserted (false).

## See Also

[\\_ewm\\_status\\_flags\\_t](#)

- True: a related status flag has been set.
- False: a related status flag is not set.

### 20.6.7 void EWM\_Refresh ( EWM\_Type \* *base* )

This function resets the EWM counter to zero.



## Parameters

|             |                             |
|-------------|-----------------------------|
| <i>base</i> | EWM peripheral base address |
|-------------|-----------------------------|

---

## Chapter 21

# FlexCAN: Flex Controller Area Network Driver

### 21.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Flex Controller Area Network (FlexCAN) module of MCUXpresso SDK devices.

### Modules

- [FlexCAN Driver](#)

## 21.2 FlexCAN Driver

### 21.2.1 Overview

This section describes the programming interface of the FlexCAN driver. The FlexCAN driver configures FlexCAN module and provides functional and transactional interfaces to build the FlexCAN application.

### 21.2.2 Typical use case

#### 21.2.2.1 Message Buffer Send Operation

Refer to the driver examples codes located at <SDK\_ROOT>/boards/<BOARD>/driver\_examples/flexcan

#### 21.2.2.2 Message Buffer Receive Operation

Refer to the driver examples codes located at <SDK\_ROOT>/boards/<BOARD>/driver\_examples/flexcan

#### 21.2.2.3 Receive FIFO Operation

Refer to the driver examples codes located at <SDK\_ROOT>/boards/<BOARD>/driver\_examples/flexcan

## Data Structures

- struct [flexcan\\_frame\\_t](#)  
*FlexCAN message frame structure. [More...](#)*
- struct [flexcan\\_timing\\_config\\_t](#)  
*FlexCAN protocol timing characteristic configuration structure. [More...](#)*
- struct [flexcan\\_config\\_t](#)  
*FlexCAN module configuration structure. [More...](#)*
- struct [flexcan\\_rx\\_mb\\_config\\_t](#)  
*FlexCAN Receive Message Buffer configuration structure. [More...](#)*
- struct [flexcan\\_rx\\_fifo\\_config\\_t](#)  
*FlexCAN Legacy Rx FIFO configuration structure. [More...](#)*
- struct [flexcan\\_mb\\_transfer\\_t](#)  
*FlexCAN Message Buffer transfer. [More...](#)*
- struct [flexcan\\_fifo\\_transfer\\_t](#)  
*FlexCAN Rx FIFO transfer. [More...](#)*
- struct [flexcan\\_handle\\_t](#)  
*FlexCAN handle structure. [More...](#)*

## Macros

- #define `FLEXCAN_ID_STD(id)` (((uint32\_t)((uint32\_t)(id)) << CAN\_ID\_STD\_SHIFT)) & CAN\_ID\_STD\_MASK)  
*FlexCAN frame length helper macro.*
- #define `FLEXCAN_ID_EXT(id)`  
*Extend Frame ID helper macro.*
- #define `FLEXCAN_RX_MB_STD_MASK(id, rtr, ide)`  
*FlexCAN Rx Message Buffer Mask helper macro.*
- #define `FLEXCAN_RX_MB_EXT_MASK(id, rtr, ide)`  
*Extend Rx Message Buffer Mask helper macro.*
- #define `FLEXCAN_RX_FIFO_STD_MASK_TYPE_A(id, rtr, ide)`  
*FlexCAN Legacy Rx FIFO Mask helper macro.*
- #define `FLEXCAN_RX_FIFO_STD_MASK_TYPE_B_HIGH(id, rtr, ide)`  
*Standard Rx FIFO Mask helper macro Type B upper part helper macro.*
- #define `FLEXCAN_RX_FIFO_STD_MASK_TYPE_B_LOW(id, rtr, ide)`  
*Standard Rx FIFO Mask helper macro Type B lower part helper macro.*
- #define `FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_HIGH(id)` (((uint32\_t)(id)&0x7F8) << 21)  
*Standard Rx FIFO Mask helper macro Type C upper part helper macro.*
- #define `FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_HIGH(id)` (((uint32\_t)(id)&0x7F8) << 13)  
*Standard Rx FIFO Mask helper macro Type C mid-upper part helper macro.*
- #define `FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_LOW(id)` (((uint32\_t)(id)&0x7F8) << 5)  
*Standard Rx FIFO Mask helper macro Type C mid-lower part helper macro.*
- #define `FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_LOW(id)` (((uint32\_t)(id)&0x7F8) >> 3)  
*Standard Rx FIFO Mask helper macro Type C lower part helper macro.*
- #define `FLEXCAN_RX_FIFO_EXT_MASK_TYPE_A(id, rtr, ide)`  
*Extend Rx FIFO Mask helper macro Type A helper macro.*
- #define `FLEXCAN_RX_FIFO_EXT_MASK_TYPE_B_HIGH(id, rtr, ide)`  
*Extend Rx FIFO Mask helper macro Type B upper part helper macro.*
- #define `FLEXCAN_RX_FIFO_EXT_MASK_TYPE_B_LOW(id, rtr, ide)`  
*Extend Rx FIFO Mask helper macro Type B lower part helper macro.*
- #define `FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_HIGH(id)` ((FLEXCAN\_ID\_EXT(id) & 0x1FE00000) << 3)  
*Extend Rx FIFO Mask helper macro Type C upper part helper macro.*
- #define `FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_HIGH(id)`  
*Extend Rx FIFO Mask helper macro Type C mid-upper part helper macro.*
- #define `FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_LOW(id)`  
*Extend Rx FIFO Mask helper macro Type C mid-lower part helper macro.*
- #define `FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_LOW(id)` ((FLEXCAN\_ID\_EXT(id) & 0x1FE00000) >> 21)  
*Extend Rx FIFO Mask helper macro Type C lower part helper macro.*
- #define `FLEXCAN_RX_FIFO_STD_FILTER_TYPE_A(id, rtr, ide)` `FLEXCAN_RX_FIFO_STD_MASK_TYPE_A(id, rtr, ide)`  
*FlexCAN Rx FIFO Filter helper macro.*
- #define `FLEXCAN_RX_FIFO_STD_FILTER_TYPE_B_HIGH(id, rtr, ide)`  
*Standard Rx FIFO Filter helper macro Type B upper part helper macro.*
- #define `FLEXCAN_RX_FIFO_STD_FILTER_TYPE_B_LOW(id, rtr, ide)`

- *Standard Rx FIFO Filter helper macro Type B lower part helper macro.*  
 • #define `FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_HIGH(id)`
- *Standard Rx FIFO Filter helper macro Type C upper part helper macro.*  
 • #define `FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_MID_HIGH(id)`
- *Standard Rx FIFO Filter helper macro Type C mid-upper part helper macro.*  
 • #define `FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_MID_LOW(id)`
- *Standard Rx FIFO Filter helper macro Type C mid-lower part helper macro.*  
 • #define `FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_LOW(id)`
- *Standard Rx FIFO Filter helper macro Type C lower part helper macro.*  
 • #define `FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_A(id, rtr, ide) FLEXCAN_RX_FIFO_EXT_MASK_TYPE_A(id, rtr, ide)`
- *Extend Rx FIFO Filter helper macro Type A helper macro.*  
 • #define `FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_B_HIGH(id, rtr, ide)`
- *Extend Rx FIFO Filter helper macro Type B upper part helper macro.*  
 • #define `FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_B_LOW(id, rtr, ide)`
- *Extend Rx FIFO Filter helper macro Type B lower part helper macro.*  
 • #define `FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_HIGH(id)`
- *Extend Rx FIFO Filter helper macro Type C upper part helper macro.*  
 • #define `FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_MID_HIGH(id)`
- *Extend Rx FIFO Filter helper macro Type C mid-upper part helper macro.*  
 • #define `FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_MID_LOW(id)`
- *Extend Rx FIFO Filter helper macro Type C mid-lower part helper macro.*  
 • #define `FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_LOW(id) FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_LOW(id)`
- *Extend Rx FIFO Filter helper macro Type C lower part helper macro.*  
 • #define `FLEXCAN_ERROR_AND_STATUS_INIT_FLAG`
- *FlexCAN interrupt/status flag helper macro.*  
 • #define `FLEXCAN_CALLBACK(x) void(x)(CAN_Type * base, flexcan_handle_t * handle, status_t status, uint32_t result, void *userData)`
- *FlexCAN transfer callback function.*

## Enumerations

- enum {
  - `kStatus_FLEXCAN_TxBusy = MAKE_STATUS(kStatusGroup_FLEXCAN, 0),`
  - `kStatus_FLEXCAN_TxIdle = MAKE_STATUS(kStatusGroup_FLEXCAN, 1),`
  - `kStatus_FLEXCAN_TxSwitchToRx,`
  - `kStatus_FLEXCAN_RxBusy = MAKE_STATUS(kStatusGroup_FLEXCAN, 3),`
  - `kStatus_FLEXCAN_RxIdle = MAKE_STATUS(kStatusGroup_FLEXCAN, 4),`
  - `kStatus_FLEXCAN_RxOverflow = MAKE_STATUS(kStatusGroup_FLEXCAN, 5),`
  - `kStatus_FLEXCAN_RxFifoBusy = MAKE_STATUS(kStatusGroup_FLEXCAN, 6),`
  - `kStatus_FLEXCAN_RxFifoIdle = MAKE_STATUS(kStatusGroup_FLEXCAN, 7),`
  - `kStatus_FLEXCAN_RxFifoOverflow = MAKE_STATUS(kStatusGroup_FLEXCAN, 8),`
  - `kStatus_FLEXCAN_RxFifoWarning = MAKE_STATUS(kStatusGroup_FLEXCAN, 9),`
  - `kStatus_FLEXCAN_ErrorStatus = MAKE_STATUS(kStatusGroup_FLEXCAN, 10),`
  - `kStatus_FLEXCAN_WakeUp = MAKE_STATUS(kStatusGroup_FLEXCAN, 11),`
  - `kStatus_FLEXCAN_UnHandled = MAKE_STATUS(kStatusGroup_FLEXCAN, 12),`

- ```
kStatus_FLEXCAN_RxRemote = MAKE_STATUS(kStatusGroup_FLEXCAN, 13) }
```
- FlexCAN Enhanced Rx FIFO base address helper macro.*
- enum flexcan_frame_format_t {
kFLEXCAN_FrameFormatStandard = 0x0U,
kFLEXCAN_FrameFormatExtend = 0x1U }
- FlexCAN frame format.*
- enum flexcan_frame_type_t {
kFLEXCAN_FrameTypeData = 0x0U,
kFLEXCAN_FrameTypeRemote = 0x1U }
- FlexCAN frame type.*
- enum flexcan_clock_source_t {
kFLEXCAN_ClkSrcOsc = 0x0U,
kFLEXCAN_ClkSrcPeri = 0x1U,
kFLEXCAN_ClkSrc0 = 0x0U,
kFLEXCAN_ClkSrc1 = 0x1U }
- FlexCAN clock source.*
- enum flexcan_wake_up_source_t {
kFLEXCAN_WakeupSrcUnfiltered = 0x0U,
kFLEXCAN_WakeupSrcFiltered = 0x1U }
- FlexCAN wake up source.*
- enum flexcan_rx_fifo_filter_type_t {
kFLEXCAN_RxFifoFilterTypeA = 0x0U,
kFLEXCAN_RxFifoFilterTypeB,
kFLEXCAN_RxFifoFilterTypeC,
kFLEXCAN_RxFifoFilterTypeD = 0x3U }
- FlexCAN Rx Fifo Filter type.*
- enum flexcan_rx_fifo_priority_t {
kFLEXCAN_RxFifoPrioLow = 0x0U,
kFLEXCAN_RxFifoPrioHigh = 0x1U }
- FlexCAN Enhanced/Legacy Rx FIFO priority.*
- enum _flexcan_interrupt_enable {
kFLEXCAN_BusOffInterruptEnable = CAN_CTRL1_BOFFMSK_MASK,
kFLEXCAN_ErrorInterruptEnable = CAN_CTRL1_ERRMSK_MASK,
kFLEXCAN_TxWarningInterruptEnable = CAN_CTRL1_TWRNMSK_MASK,
kFLEXCAN_RxWarningInterruptEnable = CAN_CTRL1_RWRNMSK_MASK,
kFLEXCAN_WakeUpInterruptEnable = CAN_MCR_WAKMSK_MASK }
- FlexCAN interrupt enable enumerations.*
- enum _flexcan_flags {
kFLEXCAN_SynchFlag = CAN_ESR1_SYNCH_MASK,
kFLEXCAN_TxWarningIntFlag = CAN_ESR1_TWRNINT_MASK,
kFLEXCAN_RxWarningIntFlag = CAN_ESR1_RWRNINT_MASK,
kFLEXCAN_IdleFlag = CAN_ESR1_IDLE_MASK,
kFLEXCAN_FaultConfinementFlag = CAN_ESR1_FLTCONF_MASK,
kFLEXCAN_TransmittingFlag = CAN_ESR1_TX_MASK,
kFLEXCAN_ReceivingFlag = CAN_ESR1_RX_MASK,
kFLEXCAN_BusOffIntFlag = CAN_ESR1_BOFFINT_MASK,
kFLEXCAN_ErrorIntFlag = CAN_ESR1_ERRINT_MASK,

```
kFLEXCAN_WakeUpIntFlag = CAN_ESR1_WAKINT_MASK }
```

FlexCAN status flags.

- enum `_flexcan_error_flags` {
 - `kFLEXCAN_TxErrorWarningFlag` = `CAN_ESR1_TXWRN_MASK`,
 - `kFLEXCAN_RxErrorWarningFlag` = `CAN_ESR1_RXWRN_MASK`,
 - `kFLEXCAN_StuffingError` = `CAN_ESR1_STFERR_MASK`,
 - `kFLEXCAN_FormError` = `CAN_ESR1_FRMERR_MASK`,
 - `kFLEXCAN_CrcError` = `CAN_ESR1_CRCERR_MASK`,
 - `kFLEXCAN_AckError` = `CAN_ESR1_ACKERR_MASK`,
 - `kFLEXCAN_Bit0Error` = `CAN_ESR1_BIT0ERR_MASK`,
 - `kFLEXCAN_Bit1Error` = `CAN_ESR1_BIT1ERR_MASK` }

FlexCAN error status flags.

- enum {
 - `kFLEXCAN_RxFifoOverflowFlag` = `CAN_IFLAG1_BUF7I_MASK`,
 - `kFLEXCAN_RxFifoWarningFlag` = `CAN_IFLAG1_BUF6I_MASK`,
 - `kFLEXCAN_RxFifoFrameAvlFlag` = `CAN_IFLAG1_BUF5I_MASK` }

FlexCAN Legacy Rx FIFO status flags.

Driver version

- #define `FSL_FLEXCAN_DRIVER_VERSION` (`MAKE_VERSION`(2, 8, 6))
FlexCAN driver version.

Initialization and deinitialization

- void `FLEXCAN_EnterFreezeMode` (`CAN_Type *base`)
Enter FlexCAN Freeze Mode.
- void `FLEXCAN_ExitFreezeMode` (`CAN_Type *base`)
Exit FlexCAN Freeze Mode.
- uint32_t `FLEXCAN_GetInstance` (`CAN_Type *base`)
Get the FlexCAN instance from peripheral base address.
- bool `FLEXCAN_CalculateImprovedTimingValues` (`CAN_Type *base`, uint32_t bitRate, uint32_t sourceClock_Hz, `flexcan_timing_config_t *pTimingConfig`)
Calculates the improved timing values by specific bit Rates for classical CAN.
- void `FLEXCAN_Init` (`CAN_Type *base`, const `flexcan_config_t *pConfig`, uint32_t sourceClock_Hz)
Initializes a FlexCAN instance.
- void `FLEXCAN_Deinit` (`CAN_Type *base`)
De-initializes a FlexCAN instance.
- void `FLEXCAN_GetDefaultConfig` (`flexcan_config_t *pConfig`)
Gets the default configuration structure.

Configuration.

- void `FLEXCAN_SetTimingConfig` (`CAN_Type *base`, const `flexcan_timing_config_t *pConfig`)

- *Sets the FlexCAN protocol timing characteristic.*
- void [FLEXCAN_SetRxMbGlobalMask](#) (CAN_Type *base, uint32_t mask)
Sets the FlexCAN receive message buffer global mask.
- void [FLEXCAN_SetRxFifoGlobalMask](#) (CAN_Type *base, uint32_t mask)
Sets the FlexCAN receive FIFO global mask.
- void [FLEXCAN_SetRxIndividualMask](#) (CAN_Type *base, uint8_t maskIdx, uint32_t mask)
Sets the FlexCAN receive individual mask.
- void [FLEXCAN_SetTxMbConfig](#) (CAN_Type *base, uint8_t mbIdx, bool enable)
Configures a FlexCAN transmit message buffer.
- void [FLEXCAN_SetRxMbConfig](#) (CAN_Type *base, uint8_t mbIdx, const flexcan_rx_mb_config_t *pRxMbConfig, bool enable)
Configures a FlexCAN Receive Message Buffer.
- void [FLEXCAN_SetRxFifoConfig](#) (CAN_Type *base, const flexcan_rx_fifo_config_t *pRxFifoConfig, bool enable)
Configures the FlexCAN Legacy Rx FIFO.

Status

- static uint32_t [FLEXCAN_GetStatusFlags](#) (CAN_Type *base)
Gets the FlexCAN module interrupt flags.
- static void [FLEXCAN_ClearStatusFlags](#) (CAN_Type *base, uint32_t mask)
Clears status flags with the provided mask.
- static void [FLEXCAN_GetBusErrCount](#) (CAN_Type *base, uint8_t *txErrBuf, uint8_t *rxErrBuf)
Gets the FlexCAN Bus Error Counter value.
- static uint64_t [FLEXCAN_GetMbStatusFlags](#) (CAN_Type *base, uint64_t mask)
Gets the FlexCAN Message Buffer interrupt flags.
- static void [FLEXCAN_ClearMbStatusFlags](#) (CAN_Type *base, uint64_t mask)
Clears the FlexCAN Message Buffer interrupt flags.

Interrupts

- static void [FLEXCAN_EnableInterrupts](#) (CAN_Type *base, uint32_t mask)
Enables FlexCAN interrupts according to the provided mask.
- static void [FLEXCAN_DisableInterrupts](#) (CAN_Type *base, uint32_t mask)
Disables FlexCAN interrupts according to the provided mask.
- static void [FLEXCAN_EnableMbInterrupts](#) (CAN_Type *base, uint64_t mask)
Enables FlexCAN Message Buffer interrupts.
- static void [FLEXCAN_DisableMbInterrupts](#) (CAN_Type *base, uint64_t mask)
Disables FlexCAN Message Buffer interrupts.

Bus Operations

- static void [FLEXCAN_Enable](#) (CAN_Type *base, bool enable)
Enables or disables the FlexCAN module operation.
- [status_t FLEXCAN_WriteTxMb](#) (CAN_Type *base, uint8_t mbIdx, const flexcan_frame_t *pTxFrame)
Writes a FlexCAN Message to the Transmit Message Buffer.

- `status_t FLEXCAN_ReadRxMb` (CAN_Type *base, uint8_t mbIdx, `flexcan_frame_t` *pRxFrame)
Reads a FlexCAN Message from Receive Message Buffer.
- `status_t FLEXCAN_ReadRxFifo` (CAN_Type *base, `flexcan_frame_t` *pRxFrame)
Reads a FlexCAN Message from Legacy Rx FIFO.

Transactional

- `status_t FLEXCAN_TransferSendBlocking` (CAN_Type *base, uint8_t mbIdx, `flexcan_frame_t` *pTxFrame)
Performs a polling send transaction on the CAN bus.
- `status_t FLEXCAN_TransferReceiveBlocking` (CAN_Type *base, uint8_t mbIdx, `flexcan_frame_t` *pRxFrame)
Performs a polling receive transaction on the CAN bus.
- `status_t FLEXCAN_TransferReceiveFifoBlocking` (CAN_Type *base, `flexcan_frame_t` *pRxFrame)
Performs a polling receive transaction from Legacy Rx FIFO on the CAN bus.
- `void FLEXCAN_TransferCreateHandle` (CAN_Type *base, `flexcan_handle_t` *handle, `flexcan_transfer_callback_t` callback, void *userData)
Initializes the FlexCAN handle.
- `status_t FLEXCAN_TransferSendNonBlocking` (CAN_Type *base, `flexcan_handle_t` *handle, `flexcan_mb_transfer_t` *pMbXfer)
Sends a message using IRQ.
- `status_t FLEXCAN_TransferReceiveNonBlocking` (CAN_Type *base, `flexcan_handle_t` *handle, `flexcan_mb_transfer_t` *pMbXfer)
Receives a message using IRQ.
- `status_t FLEXCAN_TransferReceiveFifoNonBlocking` (CAN_Type *base, `flexcan_handle_t` *handle, `flexcan_fifo_transfer_t` *pFifoXfer)
Receives a message from Rx FIFO using IRQ.
- `uint32_t FLEXCAN_GetTimeStamp` (`flexcan_handle_t` *handle, uint8_t mbIdx)
Gets the detail index of Mailbox's Timestamp by handle.
- `void FLEXCAN_TransferAbortSend` (CAN_Type *base, `flexcan_handle_t` *handle, uint8_t mbIdx)
Aborts the interrupt driven message send process.
- `void FLEXCAN_TransferAbortReceive` (CAN_Type *base, `flexcan_handle_t` *handle, uint8_t mbIdx)
Aborts the interrupt driven message receive process.
- `void FLEXCAN_TransferAbortReceiveFifo` (CAN_Type *base, `flexcan_handle_t` *handle)
Aborts the interrupt driven message receive from Rx FIFO process.
- `void FLEXCAN_TransferHandleIRQ` (CAN_Type *base, `flexcan_handle_t` *handle)
FlexCAN IRQ handle function.

21.2.3 Data Structure Documentation

21.2.3.1 struct flexcan_frame_t

Field Documentation

- (1) `uint32_t flexcan_frame_t::timestamp`
- (2) `uint32_t flexcan_frame_t::length`
- (3) `uint32_t flexcan_frame_t::type`
- (4) `uint32_t flexcan_frame_t::format`
- (5) `uint32_t flexcan_frame_t::__pad0__`
- (6) `uint32_t flexcan_frame_t::idhit`
- (7) `uint32_t flexcan_frame_t::id`
- (8) `uint32_t flexcan_frame_t::dataWord0`
- (9) `uint32_t flexcan_frame_t::dataWord1`
- (10) `uint8_t flexcan_frame_t::dataByte3`
- (11) `uint8_t flexcan_frame_t::dataByte2`
- (12) `uint8_t flexcan_frame_t::dataByte1`
- (13) `uint8_t flexcan_frame_t::dataByte0`
- (14) `uint8_t flexcan_frame_t::dataByte7`
- (15) `uint8_t flexcan_frame_t::dataByte6`
- (16) `uint8_t flexcan_frame_t::dataByte5`
- (17) `uint8_t flexcan_frame_t::dataByte4`

21.2.3.2 struct flexcan_timing_config_t

Data Fields

- `uint16_t preDivider`
Classic CAN or CAN FD nominal phase bit rate prescaler.
- `uint8_t rJumpwidth`
Classic CAN or CAN FD nominal phase Re-sync Jump Width.
- `uint8_t phaseSeg1`
Classic CAN or CAN FD nominal phase Segment 1.
- `uint8_t phaseSeg2`
Classic CAN or CAN FD nominal phase Segment 2.
- `uint8_t propSeg`
Classic CAN or CAN FD nominal phase Propagation Segment.

Field Documentation

- (1) `uint16_t flexcan_timing_config_t::preDivider`
- (2) `uint8_t flexcan_timing_config_t::rJumpwidth`
- (3) `uint8_t flexcan_timing_config_t::phaseSeg1`
- (4) `uint8_t flexcan_timing_config_t::phaseSeg2`
- (5) `uint8_t flexcan_timing_config_t::propSeg`

21.2.3.3 struct flexcan_config_t

Deprecated Do not use the baudRate. It has been superceded bitRate

Do not use the baudRateFD. It has been superceded bitRateFD

Data Fields

- `flexcan_clock_source_t clkSrc`
Clock source for FlexCAN Protocol Engine.
- `flexcan_wake_up_source_t wakeupSrc`
Wake up source selection.
- `uint8_t maxMbNum`
The maximum number of Message Buffers used by user.
- `bool enableLoopBack`
Enable or Disable Loop Back Self Test Mode.
- `bool enableTimerSync`
Enable or Disable Timer Synchronization.
- `bool enableSelfWakeup`
Enable or Disable Self Wakeup Mode.
- `bool enableIndividMask`
Enable or Disable Rx Individual Mask and Queue feature.
- `bool disableSelfReception`
Enable or Disable Self Reflection.
- `bool enableListenOnlyMode`
Enable or Disable Listen Only Mode.
- `bool enableSupervisorMode`
Enable or Disable Supervisor Mode, enable this mode will make registers allow only Supervisor access.
- `uint32_t baudRate`
FlexCAN bit rate in bps, for classical CAN or CANFD nominal phase.
- `uint32_t bitRate`
FlexCAN bit rate in bps, for classical CAN or CANFD nominal phase.

Field Documentation

- (1) `uint32_t flexcan_config_t::baudRate`
- (2) `uint32_t flexcan_config_t::bitRate`
- (3) `flexcan_clock_source_t flexcan_config_t::clkSrc`

- (4) `flexcan_wake_up_source_t flexcan_config_t::wakeupSrc`
- (5) `uint8_t flexcan_config_t::maxMbNum`
- (6) `bool flexcan_config_t::enableLoopBack`
- (7) `bool flexcan_config_t::enableTimerSync`
- (8) `bool flexcan_config_t::enableSelfWakeup`
- (9) `bool flexcan_config_t::enableIndividMask`
- (10) `bool flexcan_config_t::disableSelfReception`
- (11) `bool flexcan_config_t::enableListenOnlyMode`
- (12) `bool flexcan_config_t::enableSupervisorMode`

21.2.3.4 struct flexcan_rx_mb_config_t

This structure is used as the parameter of `FLEXCAN_SetRxMbConfig()` function. The `FLEXCAN_SetRxMbConfig()` function is used to configure FlexCAN Receive Message Buffer. The function abort previous receiving process, clean the Message Buffer and activate the Rx Message Buffer using given Message Buffer setting.

Data Fields

- `uint32_t id`
CAN Message Buffer Frame Identifier, should be set using `FLEXCAN_ID_EXT()` or `FLEXCAN_ID_STD()` macro.
- `flexcan_frame_format_t format`
CAN Frame Identifier format(Standard of Extend).
- `flexcan_frame_type_t type`
CAN Frame Type(Data or Remote).

Field Documentation

- (1) `uint32_t flexcan_rx_mb_config_t::id`
- (2) `flexcan_frame_format_t flexcan_rx_mb_config_t::format`
- (3) `flexcan_frame_type_t flexcan_rx_mb_config_t::type`

21.2.3.5 struct flexcan_rx_fifo_config_t

Data Fields

- `uint32_t * idFilterTable`
Pointer to the FlexCAN Legacy Rx FIFO identifier filter table.

- `uint8_t idFilterNum`
The FlexCAN Legacy Rx FIFO Filter elements quantity.
- `flexcan_rx_fifo_filter_type_t idFilterType`
The FlexCAN Legacy Rx FIFO Filter type.
- `flexcan_rx_fifo_priority_t priority`
The FlexCAN Legacy Rx FIFO receive priority.

Field Documentation

- (1) `uint32_t* flexcan_rx_fifo_config_t::idFilterTable`
- (2) `uint8_t flexcan_rx_fifo_config_t::idFilterNum`
- (3) `flexcan_rx_fifo_filter_type_t flexcan_rx_fifo_config_t::idFilterType`
- (4) `flexcan_rx_fifo_priority_t flexcan_rx_fifo_config_t::priority`

21.2.3.6 struct flexcan_mb_transfer_t

Data Fields

- `flexcan_frame_t * frame`
The buffer of CAN Message to be transfer.
- `uint8_t mbIdx`
The index of Message buffer used to transfer Message.

Field Documentation

- (1) `flexcan_frame_t* flexcan_mb_transfer_t::frame`
- (2) `uint8_t flexcan_mb_transfer_t::mbIdx`

21.2.3.7 struct flexcan_fifo_transfer_t

Data Fields

- `flexcan_frame_t * frame`
The buffer of CAN Message to be received from Rx FIFO.

Field Documentation

- (1) `flexcan_frame_t* flexcan_fifo_transfer_t::frame`

21.2.3.8 struct _flexcan_handle

FlexCAN handle structure definition.

Data Fields

- `flexcan_transfer_callback_t callback`

- *Callback function.*
- void * `userData`
FlexCAN callback function parameter.
- `flexcan_frame_t` *volatile `mbFrameBuf` [CAN_WORD1_COUNT]
The buffer for received CAN data from Message Buffers.
- `flexcan_frame_t` *volatile `rxFifoFrameBuf`
The buffer for received CAN data from Legacy Rx FIFO.
- volatile uint8_t `mbState` [CAN_WORD1_COUNT]
Message Buffer transfer state.
- volatile uint8_t `rxFifoState`
Rx FIFO transfer state.
- volatile uint32_t `timestamp` [CAN_WORD1_COUNT]
Mailbox transfer timestamp.

Field Documentation

- (1) `flexcan_transfer_callback_t flexcan_handle_t::callback`
- (2) `void* flexcan_handle_t::userData`
- (3) `flexcan_frame_t* volatile flexcan_handle_t::mbFrameBuf`[CAN_WORD1_COUNT]
- (4) `flexcan_frame_t* volatile flexcan_handle_t::rxFifoFrameBuf`
- (5) `volatile uint8_t flexcan_handle_t::mbState`[CAN_WORD1_COUNT]
- (6) `volatile uint8_t flexcan_handle_t::rxFifoState`
- (7) `volatile uint32_t flexcan_handle_t::timestamp`[CAN_WORD1_COUNT]

21.2.4 Macro Definition Documentation

21.2.4.1 `#define FSL_FLEXCAN_DRIVER_VERSION (MAKE_VERSION(2, 8, 6))`

21.2.4.2 `#define FLEXCAN_ID_STD(id) (((uint32_t)((uint32_t)(id)) << CAN_ID_STD_SHIFT)) & CAN_ID_STD_MASK)`

FlexCAN Frame ID helper macro. Standard Frame ID helper macro.

21.2.4.3 `#define FLEXCAN_ID_EXT(id)`

Value:

```
((uint32_t)((uint32_t)(id) << CAN_ID_EXT_SHIFT)) & \
(CAN_ID_EXT_MASK | CAN_ID_STD_MASK)
```

21.2.4.4 #define FLEXCAN_RX_MB_STD_MASK(*id*, *rtr*, *ide*)**Value:**

```
((uint32_t)((uint32_t)(rtr) << 31) | (uint32_t)((uint32_t)(ide) << 30)) | \
  FLEXCAN_ID_STD(id)
```

Standard Rx Message Buffer Mask helper macro.

21.2.4.5 #define FLEXCAN_RX_MB_EXT_MASK(*id*, *rtr*, *ide*)**Value:**

```
((uint32_t)((uint32_t)(rtr) << 31) | (uint32_t)((uint32_t)(ide) << 30)) | \
  FLEXCAN_ID_EXT(id)
```

21.2.4.6 #define FLEXCAN_RX_FIFO_STD_MASK_TYPE_A(*id*, *rtr*, *ide*)**Value:**

```
((uint32_t)((uint32_t)(rtr) << 31) | (uint32_t)((uint32_t)(ide) << 30)) | \
  (FLEXCAN_ID_STD(id) << 1)
```

Standard Rx FIFO Mask helper macro Type A helper macro.

21.2.4.7 #define FLEXCAN_RX_FIFO_STD_MASK_TYPE_B_HIGH(*id*, *rtr*, *ide*)**Value:**

```
((uint32_t)((uint32_t)(rtr) << 31) | (uint32_t)((uint32_t)(ide) << 30)) | \
  (((uint32_t)(id) & 0x7FF) << 19)
```

21.2.4.8 #define FLEXCAN_RX_FIFO_STD_MASK_TYPE_B_LOW(*id*, *rtr*, *ide*)**Value:**

```
((uint32_t)((uint32_t)(rtr) << 15) | (uint32_t)((uint32_t)(ide) << 14)) | \
  (((uint32_t)(id) & 0x7FF) << 3)
```

21.2.4.9 `#define FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_HIGH(id) (((uint32_t)(id)&0x7F8) << 21)`

21.2.4.10 `#define FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_HIGH(id) (((uint32_t)(id)&0x7F8) << 13)`

21.2.4.11 `#define FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_LOW(id) (((uint32_t)(id)&0x7F8) << 5)`

21.2.4.12 `#define FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_LOW(id) (((uint32_t)(id)&0x7F8) >> 3)`

21.2.4.13 `#define FLEXCAN_RX_FIFO_EXT_MASK_TYPE_A(id, rtr, ide)`

Value:

```
((uint32_t)((uint32_t)rtr << 31) | (uint32_t)((uint32_t)ide << 30)) | \
(FLEXCAN_ID_EXT(id) << 1)
```

21.2.4.14 `#define FLEXCAN_RX_FIFO_EXT_MASK_TYPE_B_HIGH(id, rtr, ide)`

Value:

```
((uint32_t)((uint32_t)rtr << 31) | (uint32_t)((uint32_t)ide << 30)) | \
(FLEXCAN_ID_EXT(id) & 0x1FFF8000) << 1
```

21.2.4.15 `#define FLEXCAN_RX_FIFO_EXT_MASK_TYPE_B_LOW(id, rtr, ide)`

Value:

```
((uint32_t)((uint32_t)rtr << 15) | (uint32_t)((uint32_t)ide << 14)) | \
(FLEXCAN_ID_EXT(id) & 0x1FFF8000) >> 15
```

21.2.4.16 `#define FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_HIGH(id) ((FLEXCAN_ID_EXT(id) & 0x1FE00000) << 3)`

21.2.4.17 `#define FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_HIGH(id)`

Value:

```
(FLEXCAN_ID_EXT(id) & 0x1FE00000) >> 5
```


21.2.4.18 #define FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_LOW(*id*)

Value:

```
((FLEXCAN_ID_EXT(id) & 0x1FE00000) >> 13) \
```

21.2.4.19 #define FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_LOW(*id*)
((FLEXCAN_ID_EXT(id) & 0x1FE00000) >> 21)

21.2.4.20 #define FLEXCAN_RX_FIFO_STD_FILTER_TYPE_A(*id*, *rtr*, *ide*)
FLEXCAN_RX_FIFO_STD_MASK_TYPE_A(id, rtr, ide)

Standard Rx FIFO Filter helper macro Type A helper macro.

21.2.4.21 #define FLEXCAN_RX_FIFO_STD_FILTER_TYPE_B_HIGH(*id*, *rtr*, *ide*)

Value:

```
FLEXCAN_RX_FIFO_STD_MASK_TYPE_B_HIGH( id, rtr, ide) \
```

21.2.4.22 #define FLEXCAN_RX_FIFO_STD_FILTER_TYPE_B_LOW(*id*, *rtr*, *ide*)

Value:

```
FLEXCAN_RX_FIFO_STD_MASK_TYPE_B_LOW( id, rtr, ide) \
```

21.2.4.23 #define FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_HIGH(*id*)

Value:

```
FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_HIGH( id) \
```

21.2.4.24 #define FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_MID_HIGH(*id*)

Value:

```
FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_HIGH( id) \
```

21.2.4.25 #define FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_MID_LOW(*id*)

Value:

```
FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_LOW(      \
      id)
```

21.2.4.26 #define FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_LOW(*id*)

Value:

```
FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_LOW(         \
      id)
```

21.2.4.27 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_A(*id*, *rtr*, *ide*) FLEXCAN_RX_FIFO_EXT_MASK_TYPE_A(id, rtr, ide)

21.2.4.28 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_B_HIGH(*id*, *rtr*, *ide*)

Value:

```
FLEXCAN_RX_FIFO_EXT_MASK_TYPE_B_HIGH(       \
      id, rtr, ide)
```

21.2.4.29 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_B_LOW(*id*, *rtr*, *ide*)

Value:

```
FLEXCAN_RX_FIFO_EXT_MASK_TYPE_B_LOW(       \
      id, rtr, ide)
```

21.2.4.30 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_HIGH(*id*)

Value:

```
FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_HIGH(      \
      id)
```

21.2.4.31 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_MID_HIGH(id)**Value:**

```
FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_HIGH(
    id) \
```

21.2.4.32 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_MID_LOW(id)**Value:**

```
FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_LOW(
    id) \
```

21.2.4.33 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_LOW(id) FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_LOW(id)**21.2.4.34 #define FLEXCAN_ERROR_AND_STATUS_INIT_FLAG****Value:**

```
((uint32_t)kFLEXCAN_TxWarningIntFlag | (uint32_t)
    kFLEXCAN_RxWarningIntFlag | (uint32_t)
    kFLEXCAN_BusOffIntFlag | \
    (uint32_t)kFLEXCAN_ErrorIntFlag | FLEXCAN_MEMORY_ERROR_INIT_FLAG)
```

21.2.4.35 #define FLEXCAN_CALLBACK(x) void(x)(CAN_Type * base, flexcan_handle_t * handle, status_t status, uint32_t result, void *userData)

The FlexCAN transfer callback returns a value from the underlying layer. If the status equals to kStatus_FLEXCAN_ErrorStatus, the result parameter is the Content of FlexCAN status register which can be used to get the working status(or error status) of FlexCAN module. If the status equals to other FlexCAN Message Buffer transfer status, the result is the index of Message Buffer that generate transfer event. If the status equals to other FlexCAN Message Buffer transfer status, the result is meaningless and should be Ignored.

21.2.5 Enumeration Type Documentation**21.2.5.1 anonymous enum**

FlexCAN transfer status.

Enumerator

kStatus_FLEXCAN_TxBusy Tx Message Buffer is Busy.
kStatus_FLEXCAN_TxIdle Tx Message Buffer is Idle.
kStatus_FLEXCAN_TxSwitchToRx Remote Message is send out and Message buffer changed to Receive one.
kStatus_FLEXCAN_RxBusy Rx Message Buffer is Busy.
kStatus_FLEXCAN_RxIdle Rx Message Buffer is Idle.
kStatus_FLEXCAN_RxOverflow Rx Message Buffer is Overflowed.
kStatus_FLEXCAN_RxFifoBusy Rx Message FIFO is Busy.
kStatus_FLEXCAN_RxFifoIdle Rx Message FIFO is Idle.
kStatus_FLEXCAN_RxFifoOverflow Rx Message FIFO is overflowed.
kStatus_FLEXCAN_RxFifoWarning Rx Message FIFO is almost overflowed.
kStatus_FLEXCAN_ErrorStatus FlexCAN Module Error and Status.
kStatus_FLEXCAN_WakeUp FlexCAN is waken up from STOP mode.
kStatus_FLEXCAN_UnHandled UnHadled Interrupt asserted.
kStatus_FLEXCAN_RxRemote Rx Remote Message Received in Mail box.

21.2.5.2 enum flexcan_frame_format_t

Enumerator

kFLEXCAN_FrameFormatStandard Standard frame format attribute.
kFLEXCAN_FrameFormatExtend Extend frame format attribute.

21.2.5.3 enum flexcan_frame_type_t

Enumerator

kFLEXCAN_FrameTypeData Data frame type attribute.
kFLEXCAN_FrameTypeRemote Remote frame type attribute.

21.2.5.4 enum flexcan_clock_source_t

Deprecated Do not use the *kFLEXCAN_ClkSrcOs*. It has been superceded *kFLEXCAN_ClkSrc0*
 Do not use the *kFLEXCAN_ClkSrcPeri*. It has been superceded *kFLEXCAN_ClkSrc1*

Enumerator

kFLEXCAN_ClkSrcOsc FlexCAN Protocol Engine clock from Oscillator.
kFLEXCAN_ClkSrcPeri FlexCAN Protocol Engine clock from Peripheral Clock.
kFLEXCAN_ClkSrc0 FlexCAN Protocol Engine clock selected by user as SRC == 0.
kFLEXCAN_ClkSrc1 FlexCAN Protocol Engine clock selected by user as SRC == 1.

21.2.5.5 enum flexcan_wake_up_source_t

Enumerator

kFLEXCAN_WakeupSrcUnfiltered FlexCAN uses unfiltered Rx input to detect edge.

kFLEXCAN_WakeupSrcFiltered FlexCAN uses filtered Rx input to detect edge.

21.2.5.6 enum flexcan_rx_fifo_filter_type_t

Enumerator

kFLEXCAN_RxFifoFilterTypeA One full ID (standard and extended) per ID Filter element.

kFLEXCAN_RxFifoFilterTypeB Two full standard IDs or two partial 14-bit ID slices per ID Filter Table element.

kFLEXCAN_RxFifoFilterTypeC Four partial 8-bit Standard or extended ID slices per ID Filter Table element.

kFLEXCAN_RxFifoFilterTypeD All frames rejected.

21.2.5.7 enum flexcan_rx_fifo_priority_t

The matching process starts from the Rx MB(or Enhanced/Legacy Rx FIFO) with higher priority. If no MB(or Enhanced/Legacy Rx FIFO filter) is satisfied, the matching process goes on with the Enhanced/Legacy Rx FIFO(or Rx MB) with lower priority.

Enumerator

kFLEXCAN_RxFifoPrioLow Matching process start from Rx Message Buffer first.

kFLEXCAN_RxFifoPrioHigh Matching process start from Enhanced/Legacy Rx FIFO first.

21.2.5.8 enum _flexcan_interrupt_enable

This provides constants for the FlexCAN interrupt enable enumerations for use in the FlexCAN functions.

Note

FlexCAN Message Buffers and Legacy Rx FIFO interrupts not included in.

Enumerator

kFLEXCAN_BusOffInterruptEnable Bus Off interrupt, use bit 15.

kFLEXCAN_ErrorInterruptEnable CAN Error interrupt, use bit 14.

kFLEXCAN_TxWarningInterruptEnable Tx Warning interrupt, use bit 11.

kFLEXCAN_RxWarningInterruptEnable Rx Warning interrupt, use bit 10.

kFLEXCAN_WakeUpInterruptEnable Self Wake Up interrupt, use bit 26.

21.2.5.9 enum _flexcan_flags

This provides constants for the FlexCAN status flags for use in the FlexCAN functions.

Note

The CPU read action clears the bits corresponding to the FLEXCAN_ErrorFlag macro, therefore user need to read status flags and distinguish which error is occur using [_flexcan_error_flags](#) enumerations.

Enumerator

kFLEXCAN_SynchFlag CAN Synchronization Status.
kFLEXCAN_TxWarningIntFlag Tx Warning Interrupt Flag.
kFLEXCAN_RxWarningIntFlag Rx Warning Interrupt Flag.
kFLEXCAN_IdleFlag FlexCAN In IDLE Status.
kFLEXCAN_FaultConfinementFlag FlexCAN Fault Confinement State.
kFLEXCAN_TransmittingFlag FlexCAN In Transmission Status.
kFLEXCAN_ReceivingFlag FlexCAN In Reception Status.
kFLEXCAN_BusOffIntFlag Bus Off Interrupt Flag.
kFLEXCAN_ErrorIntFlag CAN Error Interrupt Flag.
kFLEXCAN_WakeUpIntFlag Self Wake-Up Interrupt Flag.

21.2.5.10 enum _flexcan_error_flags

The FlexCAN Error Status enumerations is used to report current error of the FlexCAN bus. This enumerations should be used with KFlexCAN_ErrorFlag in [_flexcan_flags](#) enumerations to determine which error is generated.

Enumerator

kFLEXCAN_TxErrorWarningFlag Tx Error Warning Status.
kFLEXCAN_RxErrorWarningFlag Rx Error Warning Status.
kFLEXCAN_StuffingError Stuffing Error.
kFLEXCAN_FormError Form Error.
kFLEXCAN_CrcError Cyclic Redundancy Check Error.
kFLEXCAN_AckError Received no ACK on transmission.
kFLEXCAN_Bit0Error Unable to send dominant bit.
kFLEXCAN_Bit1Error Unable to send recessive bit.

21.2.5.11 anonymous enum

The FlexCAN Legacy Rx FIFO Status enumerations are used to determine the status of the Rx FIFO. Because Rx FIFO occupy the MB0 ~ MB7 (Rx Fifo filter also occupies more Message Buffer space), Rx FIFO status flags are mapped to the corresponding Message Buffer status flags.

Enumerator

- kFLEXCAN_RxFifoOverflowFlag*** Rx FIFO overflow flag.
kFLEXCAN_RxFifoWarningFlag Rx FIFO almost full flag.
kFLEXCAN_RxFifoFrameAvlFlag Frames available in Rx FIFO flag.

21.2.6 Function Documentation

21.2.6.1 void FLEXCAN_EnterFreezeMode (CAN_Type * *base*)

This function makes the FlexCAN work under Freeze Mode.

Parameters

<i>base</i>	FlexCAN peripheral base address.
-------------	----------------------------------

21.2.6.2 void FLEXCAN_ExitFreezeMode (CAN_Type * *base*)

This function makes the FlexCAN leave Freeze Mode.

Parameters

<i>base</i>	FlexCAN peripheral base address.
-------------	----------------------------------

21.2.6.3 uint32_t FLEXCAN_GetInstance (CAN_Type * *base*)

Parameters

<i>base</i>	FlexCAN peripheral base address.
-------------	----------------------------------

Returns

FlexCAN instance.

21.2.6.4 bool FLEXCAN_CalculateImprovedTimingValues (CAN_Type * *base*, uint32_t *bitRate*, uint32_t *sourceClock_Hz*, flexcan_timing_config_t * *pTimingConfig*)

This function use to calculates the Classical CAN timing values according to the given bit rate. The Calculated timing values will be set in CTRL1/CBT/ENCBT register. The calculation is based on the recommendation of the CiA 301 v4.2.0 and previous version document.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>bitRate</i>	The classical CAN speed in bps defined by user, should be less than or equal to 1-Mbps.
<i>sourceClock_Hz</i>	The Source clock frequency in Hz.
<i>pTimingConfig</i>	Pointer to the FlexCAN timing configuration structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration.

21.2.6.5 void FLEXCAN_Init (CAN_Type * *base*, const flexcan_config_t * *pConfig*, uint32_t *sourceClock_Hz*)

This function initializes the FlexCAN module with user-defined settings. This example shows how to set up the `flexcan_config_t` parameters and how to call the `FLEXCAN_Init` function by passing in these parameters.

```
* flexcan_config_t flexcanConfig;
* flexcanConfig.clkSrc           = kFLEXCAN_ClkSrc0;
* flexcanConfig.bitRate         = 1000000U;
* flexcanConfig.maxMbNum        = 16;
* flexcanConfig.enableLoopBack  = false;
* flexcanConfig.enableSelfWakeup = false;
* flexcanConfig.enableIndividMask = false;
* flexcanConfig.enableDoze      = false;
* flexcanConfig.disableSelfReception = false;
* flexcanConfig.enableListenOnlyMode = false;
* flexcanConfig.timingConfig    = timingConfig;
* FLEXCAN_Init(CAN0, &flexcanConfig, 4000000U);
*
```

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>pConfig</i>	Pointer to the user-defined configuration structure.
<i>sourceClock_Hz</i>	FlexCAN Protocol Engine clock source frequency in Hz.

21.2.6.6 void FLEXCAN_Deinit (CAN_Type * *base*)

This function disables the FlexCAN module clock and sets all register values to the reset value.

Parameters

<i>base</i>	FlexCAN peripheral base address.
-------------	----------------------------------

21.2.6.7 void FLEXCAN_GetDefaultConfig (flexcan_config_t * pConfig)

This function initializes the FlexCAN configuration structure to default values. The default values are as follows. flexcanConfig->clkSrc = kFLEXCAN_ClkSrc0; flexcanConfig->bitRate = 1000000U; flexcanConfig->bitRateFD = 2000000U; flexcanConfig->maxMbNum = 16; flexcanConfig->enableLoopBack = false; flexcanConfig->enableSelfWakeup = false; flexcanConfig->enableIndividMask = false; flexcanConfig->disableSelfReception = false; flexcanConfig->enableListenOnlyMode = false; flexcanConfig->enableDoze = false; flexcanConfig->enableMemoryErrorControl = true; flexcanConfig->enableNonCorrectableErrorEnterFreeze = true; flexcanConfig.timingConfig = timingConfig;

Parameters

<i>pConfig</i>	Pointer to the FlexCAN configuration structure.
----------------	---

21.2.6.8 void FLEXCAN_SetTimingConfig (CAN_Type * base, const flexcan_timing_config_t * pConfig)

This function gives user settings to classical CAN or CANFD nominal phase timing characteristic. The function is for an experienced user. For less experienced users, call the [FLEXCAN_GetDefaultConfig\(\)](#) and get the default timing characteristics, then call [FLEXCAN_Init\(\)](#) and fill the bit rate field.

Note

Calling [FLEXCAN_SetTimingConfig\(\)](#) overrides the bit rate set in [FLEXCAN_Init\(\)](#).

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>pConfig</i>	Pointer to the timing configuration structure.

21.2.6.9 void FLEXCAN_SetRxMbGlobalMask (CAN_Type * base, uint32_t mask)

This function sets the global mask for the FlexCAN message buffer in a matching process. The configuration is only effective when the Rx individual mask is disabled in the [FLEXCAN_Init\(\)](#).

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>mask</i>	Rx Message Buffer Global Mask value.

21.2.6.10 void FLEXCAN_SetRxFifoGlobalMask (CAN_Type * *base*, uint32_t *mask*)

This function sets the global mask for FlexCAN FIFO in a matching process.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>mask</i>	Rx Fifo Global Mask value.

21.2.6.11 void FLEXCAN_SetRxIndividualMask (CAN_Type * *base*, uint8_t *maskIdx*, uint32_t *mask*)

This function sets the individual mask for the FlexCAN matching process. The configuration is only effective when the Rx individual mask is enabled in the [FLEXCAN_Init\(\)](#). If the Rx FIFO is disabled, the individual mask is applied to the corresponding Message Buffer. If the Rx FIFO is enabled, the individual mask for Rx FIFO occupied Message Buffer is applied to the Rx Filter with the same index. Note that only the first 32 individual masks can be used as the Rx FIFO filter mask.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>maskIdx</i>	The Index of individual Mask.
<i>mask</i>	Rx Individual Mask value.

21.2.6.12 void FLEXCAN_SetTxMbConfig (CAN_Type * *base*, uint8_t *mbIdx*, bool *enable*)

This function aborts the previous transmission, cleans the Message Buffer, and configures it as a Transmit Message Buffer.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>mbIdx</i>	The Message Buffer index.
<i>enable</i>	Enable/disable Tx Message Buffer. <ul style="list-style-type: none"> • true: Enable Tx Message Buffer. • false: Disable Tx Message Buffer.

21.2.6.13 void FLEXCAN_SetRxMbConfig (CAN_Type * *base*, uint8_t *mbIdx*, const flexcan_rx_mb_config_t * *pRxMbConfig*, bool *enable*)

This function cleans a FlexCAN build-in Message Buffer and configures it as a Receive Message Buffer.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>mbIdx</i>	The Message Buffer index.
<i>pRxMbConfig</i>	Pointer to the FlexCAN Message Buffer configuration structure.
<i>enable</i>	Enable/disable Rx Message Buffer. <ul style="list-style-type: none"> • true: Enable Rx Message Buffer. • false: Disable Rx Message Buffer.

21.2.6.14 void FLEXCAN_SetRxFifoConfig (CAN_Type * *base*, const flexcan_rx_fifo_config_t * *pRxFifoConfig*, bool *enable*)

This function configures the FlexCAN Rx FIFO with given configuration.

Note

Legacy Rx FIFO only can receive classic CAN message.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>pRxFifoConfig</i>	Pointer to the FlexCAN Legacy Rx FIFO configuration structure. Can be NULL when enable parameter is false.

<i>enable</i>	Enable/disable Legacy Rx FIFO. <ul style="list-style-type: none"> • true: Enable Legacy Rx FIFO. • false: Disable Legacy Rx FIFO.
---------------	---

21.2.6.15 `static uint32_t FLEXCAN_GetStatusFlags (CAN_Type * base) [inline], [static]`

This function gets all FlexCAN status flags. The flags are returned as the logical OR value of the enumerators `_flexcan_flags`. To check the specific status, compare the return value with enumerators in `_flexcan_flags`.

Parameters

<i>base</i>	FlexCAN peripheral base address.
-------------	----------------------------------

Returns

FlexCAN status flags which are ORed by the enumerators in the `_flexcan_flags`.

21.2.6.16 `static void FLEXCAN_ClearStatusFlags (CAN_Type * base, uint32_t mask) [inline], [static]`

This function clears the FlexCAN status flags with a provided mask. An automatically cleared flag can't be cleared by this function.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>mask</i>	The status flags to be cleared, it is logical OR value of <code>_flexcan_flags</code> .

21.2.6.17 `static void FLEXCAN_GetBusErrCount (CAN_Type * base, uint8_t * txErrBuf, uint8_t * rxErrBuf) [inline], [static]`

This function gets the FlexCAN Bus Error Counter value for both Tx and Rx direction. These values may be needed in the upper layer error handling.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>txErrBuf</i>	Buffer to store Tx Error Counter value.
<i>rxErrBuf</i>	Buffer to store Rx Error Counter value.

21.2.6.18 `static uint64_t FLEXCAN_GetMbStatusFlags (CAN_Type * base, uint64_t mask) [inline], [static]`

This function gets the interrupt flags of a given Message Buffers.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>mask</i>	The ORed FlexCAN Message Buffer mask.

Returns

The status of given Message Buffers.

21.2.6.19 `static void FLEXCAN_ClearMbStatusFlags (CAN_Type * base, uint64_t mask) [inline], [static]`

This function clears the interrupt flags of a given Message Buffers.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>mask</i>	The ORed FlexCAN Message Buffer mask.

21.2.6.20 `static void FLEXCAN_EnableInterrupts (CAN_Type * base, uint32_t mask) [inline], [static]`

This function enables the FlexCAN interrupts according to the provided mask. The mask is a logical OR of enumeration members, see [_flexcan_interrupt_enable](#).

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>mask</i>	The interrupts to enable. Logical OR of _flexcan_interrupt_enable .

**21.2.6.21 static void FLEXCAN_DisableInterrupts (CAN_Type * *base*, uint32_t *mask*)
[inline], [static]**

This function disables the FlexCAN interrupts according to the provided mask. The mask is a logical OR of enumeration members, see [_flexcan_interrupt_enable](#).

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>mask</i>	The interrupts to disable. Logical OR of _flexcan_interrupt_enable .

**21.2.6.22 static void FLEXCAN_EnableMblInterrupts (CAN_Type * *base*, uint64_t *mask*)
[inline], [static]**

This function enables the interrupts of given Message Buffers.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>mask</i>	The ORed FlexCAN Message Buffer mask.

**21.2.6.23 static void FLEXCAN_DisableMblInterrupts (CAN_Type * *base*, uint64_t *mask*)
[inline], [static]**

This function disables the interrupts of given Message Buffers.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>mask</i>	The ORed FlexCAN Message Buffer mask.

**21.2.6.24 static void FLEXCAN_Enable (CAN_Type * *base*, bool *enable*) [inline],
[static]**

This function enables or disables the FlexCAN module.

Parameters

<i>base</i>	FlexCAN base pointer.
<i>enable</i>	true to enable, false to disable.

21.2.6.25 `status_t FLEXCAN_WriteTxMb (CAN_Type * base, uint8_t mbIdx, const flexcan_frame_t * pTxFrame)`

This function writes a CAN Message to the specified Transmit Message Buffer and changes the Message Buffer state to start CAN Message transmit. After that the function returns immediately.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>mbIdx</i>	The FlexCAN Message Buffer index.
<i>pTxFrame</i>	Pointer to CAN message frame to be sent.

Return values

<i>kStatus_Success</i>	- Write Tx Message Buffer Successfully.
<i>kStatus_Fail</i>	- Tx Message Buffer is currently in use.

21.2.6.26 `status_t FLEXCAN_ReadRxMb (CAN_Type * base, uint8_t mbIdx, flexcan_frame_t * pRxFrame)`

This function reads a CAN message from a specified Receive Message Buffer. The function fills a receive CAN message frame structure with just received data and activates the Message Buffer again. The function returns immediately.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>mbIdx</i>	The FlexCAN Message Buffer index.
<i>pRxFrame</i>	Pointer to CAN message frame structure for reception.

Return values

<i>kStatus_Success</i>	- Rx Message Buffer is full and has been read successfully.
<i>kStatus_FLEXCAN_Rx-Overflow</i>	- Rx Message Buffer is already overflowed and has been read successfully.
<i>kStatus_Fail</i>	- Rx Message Buffer is empty.

21.2.6.27 **status_t FLEXCAN_ReadRxFifo (CAN_Type * *base*, flexcan_frame_t * *pRxFrame*)**

This function reads a CAN message from the FlexCAN Legacy Rx FIFO.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>pRxFrame</i>	Pointer to CAN message frame structure for reception.

Return values

<i>kStatus_Success</i>	- Read Message from Rx FIFO successfully.
<i>kStatus_Fail</i>	- Rx FIFO is not enabled.

21.2.6.28 **status_t FLEXCAN_TransferSendBlocking (CAN_Type * *base*, uint8_t *mbIdx*, flexcan_frame_t * *pTxFrame*)**

Note

A transfer handle does not need to be created before calling this API.

Parameters

<i>base</i>	FlexCAN peripheral base pointer.
<i>mbIdx</i>	The FlexCAN Message Buffer index.
<i>pTxFrame</i>	Pointer to CAN message frame to be sent.

Return values

<i>kStatus_Success</i>	- Write Tx Message Buffer Successfully.
<i>kStatus_Fail</i>	- Tx Message Buffer is currently in use.

21.2.6.29 **status_t FLEXCAN_TransferReceiveBlocking (CAN_Type * *base*, uint8_t *mbIdx*, flexcan_frame_t * *pRxFrame*)**

Note

A transfer handle does not need to be created before calling this API.

Parameters

<i>base</i>	FlexCAN peripheral base pointer.
<i>mbIdx</i>	The FlexCAN Message Buffer index.
<i>pRxFrame</i>	Pointer to CAN message frame structure for reception.

Return values

<i>kStatus_Success</i>	- Rx Message Buffer is full and has been read successfully.
<i>kStatus_FLEXCAN_Rx-Overflow</i>	- Rx Message Buffer is already overflowed and has been read successfully.
<i>kStatus_Fail</i>	- Rx Message Buffer is empty.

21.2.6.30 `status_t FLEXCAN_TransferReceiveFifoBlocking (CAN_Type * base, flexcan_frame_t * pRxFrame)`

Note

A transfer handle does not need to be created before calling this API.

Parameters

<i>base</i>	FlexCAN peripheral base pointer.
<i>pRxFrame</i>	Pointer to CAN message frame structure for reception.

Return values

<i>kStatus_Success</i>	- Read Message from Rx FIFO successfully.
<i>kStatus_Fail</i>	- Rx FIFO is not enabled.

21.2.6.31 `void FLEXCAN_TransferCreateHandle (CAN_Type * base, flexcan_handle_t * handle, flexcan_transfer_callback_t callback, void * userData)`

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

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>handle</i>	FlexCAN handle pointer.
<i>callback</i>	The callback function.
<i>userData</i>	The parameter of the callback function.

21.2.6.32 `status_t FLEXCAN_TransferSendNonBlocking (CAN_Type * base, flexcan_handle_t * handle, flexcan_mb_transfer_t * pMbXfer)`

This function sends a message using IRQ. This is a non-blocking function, which returns right away. When messages have been sent out, the send callback function is called.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>handle</i>	FlexCAN handle pointer.
<i>pMbXfer</i>	FlexCAN Message Buffer transfer structure. See the flexcan_mb_transfer_t .

Return values

<i>kStatus_Success</i>	Start Tx Message Buffer sending process successfully.
<i>kStatus_Fail</i>	Write Tx Message Buffer failed.
<i>kStatus_FLEXCAN_Tx-Busy</i>	Tx Message Buffer is in use.

21.2.6.33 `status_t FLEXCAN_TransferReceiveNonBlocking (CAN_Type * base, flexcan_handle_t * handle, flexcan_mb_transfer_t * pMbXfer)`

This function receives a message using IRQ. This is non-blocking function, which returns right away. When the message has been received, the receive callback function is called.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>handle</i>	FlexCAN handle pointer.
<i>pMbXfer</i>	FlexCAN Message Buffer transfer structure. See the flexcan_mb_transfer_t .

Return values

<i>kStatus_Success</i>	- Start Rx Message Buffer receiving process successfully.
<i>kStatus_FLEXCAN_Rx-Busy</i>	- Rx Message Buffer is in use.

21.2.6.34 **status_t FLEXCAN_TransferReceiveFifoNonBlocking (CAN_Type * base, flexcan_handle_t * handle, flexcan_fifo_transfer_t * pFifoXfer)**

This function receives a message using IRQ. This is a non-blocking function, which returns right away. When all messages have been received, the receive callback function is called.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>handle</i>	FlexCAN handle pointer.
<i>pFifoXfer</i>	FlexCAN Rx FIFO transfer structure. See the flexcan_fifo_transfer_t .

Return values

<i>kStatus_Success</i>	- Start Rx FIFO receiving process successfully.
<i>kStatus_FLEXCAN_Rx-FifoBusy</i>	- Rx FIFO is currently in use.

21.2.6.35 **uint32_t FLEXCAN_GetTimeStamp (flexcan_handle_t * handle, uint8_t mblIdx)**

This function can only be used when calling non-blocking Data transfer (TX/RX) API, After TX/RX data transfer done (User can get the status by handler's callback function), we can get the detail index of Mailbox's timestamp by handle, Detail non-blocking data transfer API (TX/RX) contain. -FLEXCAN_TransferSendNonBlocking -FLEXCAN_TransferFDSEndNonBlocking -FLEXCAN_TransferReceiveNonBlocking -FLEXCAN_TransferFDReceiveNonBlocking -FLEXCAN_TransferReceiveFifoNonBlocking

Parameters

<i>handle</i>	FlexCAN handle pointer.
<i>mblIdx</i>	The FlexCAN Message Buffer index.

Return values

<i>the</i>	index of mailbox 's timestamp stored in the handle.
------------	---

21.2.6.36 void FLEXCAN_TransferAbortSend (CAN_Type * *base*, flexcan_handle_t * *handle*, uint8_t *mbIdx*)

This function aborts the interrupt driven message send process.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>handle</i>	FlexCAN handle pointer.
<i>mbIdx</i>	The FlexCAN Message Buffer index.

21.2.6.37 void FLEXCAN_TransferAbortReceive (CAN_Type * *base*, flexcan_handle_t * *handle*, uint8_t *mbIdx*)

This function aborts the interrupt driven message receive process.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>handle</i>	FlexCAN handle pointer.
<i>mbIdx</i>	The FlexCAN Message Buffer index.

21.2.6.38 void FLEXCAN_TransferAbortReceiveFifo (CAN_Type * *base*, flexcan_handle_t * *handle*)

This function aborts the interrupt driven message receive from Rx FIFO process.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>handle</i>	FlexCAN handle pointer.

21.2.6.39 void FLEXCAN_TransferHandleIRQ (CAN_Type * *base*, flexcan_handle_t * *handle*)

This function handles the FlexCAN Error, the Message Buffer, and the Rx FIFO IRQ request.

Parameters

<i>base</i>	FlexCAN peripheral base address.
<i>handle</i>	FlexCAN handle pointer.

Chapter 22

FlexIO: FlexIO Driver

22.1 Overview

The MCUXpresso SDK provides a generic driver and multiple protocol-specific FlexIO drivers for the FlexIO module of MCUXpresso SDK devices.

Modules

- [FlexIO Camera Driver](#)
- [FlexIO Driver](#)
- [FlexIO I2C Master Driver](#)
- [FlexIO I2S Driver](#)
- [FlexIO MCU Interface LCD Driver](#)
- [FlexIO SPI Driver](#)
- [FlexIO UART Driver](#)

22.2 FlexIO Driver

22.2.1 Overview

Data Structures

- struct `flexio_config_t`
Define FlexIO user configuration structure. [More...](#)
- struct `flexio_timer_config_t`
Define FlexIO timer configuration structure. [More...](#)
- struct `flexio_shifter_config_t`
Define FlexIO shifter configuration structure. [More...](#)

Macros

- #define `FLEXIO_TIMER_TRIGGER_SEL_PININPUT(x)` `((uint32_t)(x) << 1U)`
Calculate FlexIO timer trigger.

Typedefs

- typedef void(* `flexio_isr_t`)(void *base, void *handle)
typedef for FlexIO simulated driver interrupt handler.

Enumerations

- enum `flexio_timer_trigger_polarity_t` {
 `kFLEXIO_TimerTriggerPolarityActiveHigh` = 0x0U,
 `kFLEXIO_TimerTriggerPolarityActiveLow` = 0x1U }
Define time of timer trigger polarity.
- enum `flexio_timer_trigger_source_t` {
 `kFLEXIO_TimerTriggerSourceExternal` = 0x0U,
 `kFLEXIO_TimerTriggerSourceInternal` = 0x1U }
Define type of timer trigger source.
- enum `flexio_pin_config_t` {
 `kFLEXIO_PinConfigOutputDisabled` = 0x0U,
 `kFLEXIO_PinConfigOpenDrainOrBidirection` = 0x1U,
 `kFLEXIO_PinConfigBidirectionOutputData` = 0x2U,
 `kFLEXIO_PinConfigOutput` = 0x3U }
Define type of timer/shifter pin configuration.
- enum `flexio_pin_polarity_t` {
 `kFLEXIO_PinActiveHigh` = 0x0U,
 `kFLEXIO_PinActiveLow` = 0x1U }
Definition of pin polarity.

- enum flexio_timer_mode_t {
 - kFLEXIO_TimerModeDisabled = 0x0U,
 - kFLEXIO_TimerModeDual8BitBaudBit = 0x1U,
 - kFLEXIO_TimerModeDual8BitPWM = 0x2U,
 - kFLEXIO_TimerModeSingle16Bit = 0x3U }

Define type of timer work mode.
- enum flexio_timer_output_t {
 - kFLEXIO_TimerOutputOneNotAffectedByReset = 0x0U,
 - kFLEXIO_TimerOutputZeroNotAffectedByReset = 0x1U,
 - kFLEXIO_TimerOutputOneAffectedByReset = 0x2U,
 - kFLEXIO_TimerOutputZeroAffectedByReset = 0x3U }

Define type of timer initial output or timer reset condition.
- enum flexio_timer_decrement_source_t {
 - kFLEXIO_TimerDecSrcOnFlexIOClockShiftTimerOutput = 0x0U,
 - kFLEXIO_TimerDecSrcOnTriggerInputShiftTimerOutput = 0x1U,
 - kFLEXIO_TimerDecSrcOnPinInputShiftPinInput = 0x2U,
 - kFLEXIO_TimerDecSrcOnTriggerInputShiftTriggerInput = 0x3U }

Define type of timer decrement.
- enum flexio_timer_reset_condition_t {
 - kFLEXIO_TimerResetNever = 0x0U,
 - kFLEXIO_TimerResetOnTimerPinEqualToTimerOutput = 0x2U,
 - kFLEXIO_TimerResetOnTimerTriggerEqualToTimerOutput = 0x3U,
 - kFLEXIO_TimerResetOnTimerPinRisingEdge = 0x4U,
 - kFLEXIO_TimerResetOnTimerTriggerRisingEdge = 0x6U,
 - kFLEXIO_TimerResetOnTimerTriggerBothEdge = 0x7U }

Define type of timer reset condition.
- enum flexio_timer_disable_condition_t {
 - kFLEXIO_TimerDisableNever = 0x0U,
 - kFLEXIO_TimerDisableOnPreTimerDisable = 0x1U,
 - kFLEXIO_TimerDisableOnTimerCompare = 0x2U,
 - kFLEXIO_TimerDisableOnTimerCompareTriggerLow = 0x3U,
 - kFLEXIO_TimerDisableOnPinBothEdge = 0x4U,
 - kFLEXIO_TimerDisableOnPinBothEdgeTriggerHigh = 0x5U,
 - kFLEXIO_TimerDisableOnTriggerFallingEdge = 0x6U }

Define type of timer disable condition.
- enum flexio_timer_enable_condition_t {
 - kFLEXIO_TimerEnabledAlways = 0x0U,
 - kFLEXIO_TimerEnableOnPrevTimerEnable = 0x1U,
 - kFLEXIO_TimerEnableOnTriggerHigh = 0x2U,
 - kFLEXIO_TimerEnableOnTriggerHighPinHigh = 0x3U,
 - kFLEXIO_TimerEnableOnPinRisingEdge = 0x4U,
 - kFLEXIO_TimerEnableOnPinRisingEdgeTriggerHigh = 0x5U,
 - kFLEXIO_TimerEnableOnTriggerRisingEdge = 0x6U,
 - kFLEXIO_TimerEnableOnTriggerBothEdge = 0x7U }

Define type of timer enable condition.
- enum flexio_timer_stop_bit_condition_t {

```

kFLEXIO_TimerStopBitDisabled = 0x0U,
kFLEXIO_TimerStopBitEnableOnTimerCompare = 0x1U,
kFLEXIO_TimerStopBitEnableOnTimerDisable = 0x2U,
kFLEXIO_TimerStopBitEnableOnTimerCompareDisable = 0x3U }

```

Define type of timer stop bit generate condition.

- enum flexio_timer_start_bit_condition_t {
kFLEXIO_TimerStartBitDisabled = 0x0U,
kFLEXIO_TimerStartBitEnabled = 0x1U }

Define type of timer start bit generate condition.

- enum flexio_shifter_timer_polarity_t {
kFLEXIO_ShifterTimerPolarityOnPositive = 0x0U,
kFLEXIO_ShifterTimerPolarityOnNegative = 0x1U }

Define type of timer polarity for shifter control.

- enum flexio_shifter_mode_t {
kFLEXIO_ShifterDisabled = 0x0U,
kFLEXIO_ShifterModeReceive = 0x1U,
kFLEXIO_ShifterModeTransmit = 0x2U,
kFLEXIO_ShifterModeMatchStore = 0x4U,
kFLEXIO_ShifterModeMatchContinuous = 0x5U,
kFLEXIO_ShifterModeState = 0x6U,
kFLEXIO_ShifterModeLogic = 0x7U }

Define type of shifter working mode.

- enum flexio_shifter_input_source_t {
kFLEXIO_ShifterInputFromPin = 0x0U,
kFLEXIO_ShifterInputFromNextShifterOutput = 0x1U }

Define type of shifter input source.

- enum flexio_shifter_stop_bit_t {
kFLEXIO_ShifterStopBitDisable = 0x0U,
kFLEXIO_ShifterStopBitLow = 0x2U,
kFLEXIO_ShifterStopBitHigh = 0x3U }

Define of STOP bit configuration.

- enum flexio_shifter_start_bit_t {
kFLEXIO_ShifterStartBitDisabledLoadDataOnEnable = 0x0U,
kFLEXIO_ShifterStartBitDisabledLoadDataOnShift = 0x1U,
kFLEXIO_ShifterStartBitLow = 0x2U,
kFLEXIO_ShifterStartBitHigh = 0x3U }

Define type of START bit configuration.

- enum flexio_shifter_buffer_type_t {
kFLEXIO_ShifterBuffer = 0x0U,
kFLEXIO_ShifterBufferBitSwapped = 0x1U,
kFLEXIO_ShifterBufferByteSwapped = 0x2U,
kFLEXIO_ShifterBufferBitByteSwapped = 0x3U,
kFLEXIO_ShifterBufferNibbleByteSwapped = 0x4U,
kFLEXIO_ShifterBufferHalfWordSwapped = 0x5U,
kFLEXIO_ShifterBufferNibbleSwapped = 0x6U }

Define FlexIO shifter buffer type.

Variables

- 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.

Driver version

- #define `FSL_FLEXIO_DRIVER_VERSION` (MAKE_VERSION(2, 0, 4))
FlexIO driver version.

FlexIO Initialization and De-initialization

- void `FLEXIO_GetDefaultConfig` (`flexio_config_t *userConfig`)
Gets the default configuration to configure the FlexIO module.
- void `FLEXIO_Init` (FLEXIO_Type *base, const `flexio_config_t *userConfig`)
Configures the FlexIO with a FlexIO configuration.
- void `FLEXIO_Deinit` (FLEXIO_Type *base)
Gates the FlexIO clock.
- uint32_t `FLEXIO_GetInstance` (FLEXIO_Type *base)
Get instance number for FLEXIO module.

FlexIO Basic Operation

- void `FLEXIO_Reset` (FLEXIO_Type *base)
Resets the FlexIO module.
- static void `FLEXIO_Enable` (FLEXIO_Type *base, bool enable)
Enables the FlexIO module operation.
- static uint32_t `FLEXIO_ReadPinInput` (FLEXIO_Type *base)
Reads the input data on each of the FlexIO pins.
- static uint8_t `FLEXIO_GetShifterState` (FLEXIO_Type *base)
Gets the current state pointer for state mode use.
- void `FLEXIO_SetShifterConfig` (FLEXIO_Type *base, uint8_t index, const `flexio_shifter_config_t *shifterConfig`)
Configures the shifter with the shifter configuration.
- void `FLEXIO_SetTimerConfig` (FLEXIO_Type *base, uint8_t index, const `flexio_timer_config_t *timerConfig`)
Configures the timer with the timer configuration.

FlexIO Interrupt Operation

- static void `FLEXIO_EnableShifterStatusInterrupts` (FLEXIO_Type *base, uint32_t mask)
Enables the shifter status interrupt.
- static void `FLEXIO_DisableShifterStatusInterrupts` (FLEXIO_Type *base, uint32_t mask)

- *Disables the shifter status interrupt.*
- static void [FLEXIO_EnableShifterErrorInterrupts](#) (FLEXIO_Type *base, uint32_t mask)
Enables the shifter error interrupt.
- static void [FLEXIO_DisableShifterErrorInterrupts](#) (FLEXIO_Type *base, uint32_t mask)
Disables the shifter error interrupt.
- static void [FLEXIO_EnableTimerStatusInterrupts](#) (FLEXIO_Type *base, uint32_t mask)
Enables the timer status interrupt.
- static void [FLEXIO_DisableTimerStatusInterrupts](#) (FLEXIO_Type *base, uint32_t mask)
Disables the timer status interrupt.

FlexIO Status Operation

- static uint32_t [FLEXIO_GetShifterStatusFlags](#) (FLEXIO_Type *base)
Gets the shifter status flags.
- static void [FLEXIO_ClearShifterStatusFlags](#) (FLEXIO_Type *base, uint32_t mask)
Clears the shifter status flags.
- static uint32_t [FLEXIO_GetShifterErrorFlags](#) (FLEXIO_Type *base)
Gets the shifter error flags.
- static void [FLEXIO_ClearShifterErrorFlags](#) (FLEXIO_Type *base, uint32_t mask)
Clears the shifter error flags.
- static uint32_t [FLEXIO_GetTimerStatusFlags](#) (FLEXIO_Type *base)
Gets the timer status flags.
- static void [FLEXIO_ClearTimerStatusFlags](#) (FLEXIO_Type *base, uint32_t mask)
Clears the timer status flags.

FlexIO DMA Operation

- static void [FLEXIO_EnableShifterStatusDMA](#) (FLEXIO_Type *base, uint32_t mask, bool enable)
Enables/disables the shifter status DMA.
- 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.
- status_t [FLEXIO_RegisterHandleIRQ](#) (void *base, void *handle, flexio_isr_t isr)
Registers the handle and the interrupt handler for the FlexIO-simulated peripheral.
- status_t [FLEXIO_UnregisterHandleIRQ](#) (void *base)
Unregisters the handle and the interrupt handler for the FlexIO-simulated peripheral.

22.2.2 Data Structure Documentation

22.2.2.1 struct flexio_config_t

Data Fields

- 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.

Field Documentation

(1) bool flexio_config_t::enableFastAccess

22.2.2.2 struct flexio_timer_config_t

Data Fields

- 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.

Field Documentation

- (1) `uint32_t flexio_timer_config_t::triggerSelect`
- (2) `flexio_timer_trigger_polarity_t flexio_timer_config_t::triggerPolarity`
- (3) `flexio_timer_trigger_source_t flexio_timer_config_t::triggerSource`
- (4) `flexio_pin_config_t flexio_timer_config_t::pinConfig`
- (5) `uint32_t flexio_timer_config_t::pinSelect`
- (6) `flexio_pin_polarity_t flexio_timer_config_t::pinPolarity`
- (7) `flexio_timer_mode_t flexio_timer_config_t::timerMode`
- (8) `flexio_timer_output_t flexio_timer_config_t::timerOutput`
- (9) `flexio_timer_decrement_source_t flexio_timer_config_t::timerDecrement`
- (10) `flexio_timer_reset_condition_t flexio_timer_config_t::timerReset`
- (11) `flexio_timer_disable_condition_t flexio_timer_config_t::timerDisable`
- (12) `flexio_timer_enable_condition_t flexio_timer_config_t::timerEnable`
- (13) `flexio_timer_stop_bit_condition_t flexio_timer_config_t::timerStop`
- (14) `flexio_timer_start_bit_condition_t flexio_timer_config_t::timerStart`
- (15) `uint32_t flexio_timer_config_t::timerCompare`

22.2.2.3 struct flexio_shifter_config_t

Data Fields

- `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.

Field Documentation

- (1) `uint32_t flexio_shifter_config_t::timerSelect`
- (2) `flexio_shifter_timer_polarity_t flexio_shifter_config_t::timerPolarity`
- (3) `flexio_pin_config_t flexio_shifter_config_t::pinConfig`
- (4) `uint32_t flexio_shifter_config_t::pinSelect`
- (5) `flexio_pin_polarity_t flexio_shifter_config_t::pinPolarity`
- (6) `flexio_shifter_mode_t flexio_shifter_config_t::shifterMode`
- (7) `uint32_t flexio_shifter_config_t::parallelWidth`
- (8) `flexio_shifter_input_source_t flexio_shifter_config_t::inputSource`
- (9) `flexio_shifter_stop_bit_t flexio_shifter_config_t::shifterStop`
- (10) `flexio_shifter_start_bit_t flexio_shifter_config_t::shifterStart`

22.2.3 Macro Definition Documentation

22.2.3.1 `#define FSL_FLEXIO_DRIVER_VERSION (MAKE_VERSION(2, 0, 4))`

22.2.3.2 `#define FLEXIO_TIMER_TRIGGER_SEL_PININPUT(x) ((uint32_t)(x) << 1U)`

22.2.4 Typedef Documentation

22.2.4.1 `typedef void(* flexio_isr_t)(void *base, void *handle)`

22.2.5 Enumeration Type Documentation

22.2.5.1 `enum flexio_timer_trigger_polarity_t`

Enumerator

- `kFLEXIO_TimerTriggerPolarityActiveHigh` Active high.
- `kFLEXIO_TimerTriggerPolarityActiveLow` Active low.

22.2.5.2 enum flexio_timer_trigger_source_t

Enumerator

kFLEXIO_TimerTriggerSourceExternal External trigger selected.

kFLEXIO_TimerTriggerSourceInternal Internal trigger selected.

22.2.5.3 enum flexio_pin_config_t

Enumerator

kFLEXIO_PinConfigOutputDisabled Pin output disabled.

kFLEXIO_PinConfigOpenDrainOrBidirection Pin open drain or bidirectional output enable.

kFLEXIO_PinConfigBidirectionOutputData Pin bidirectional output data.

kFLEXIO_PinConfigOutput Pin output.

22.2.5.4 enum flexio_pin_polarity_t

Enumerator

kFLEXIO_PinActiveHigh Active high.

kFLEXIO_PinActiveLow Active low.

22.2.5.5 enum flexio_timer_mode_t

Enumerator

kFLEXIO_TimerModeDisabled Timer Disabled.

kFLEXIO_TimerModeDual8BitBaudBit Dual 8-bit counters baud/bit mode.

kFLEXIO_TimerModeDual8BitPWM Dual 8-bit counters PWM mode.

kFLEXIO_TimerModeSingle16Bit Single 16-bit counter mode.

22.2.5.6 enum flexio_timer_output_t

Enumerator

kFLEXIO_TimerOutputOneNotAffectedByReset Logic one when enabled and is not affected by timer reset.

kFLEXIO_TimerOutputZeroNotAffectedByReset Logic zero when enabled and is not affected by timer reset.

kFLEXIO_TimerOutputOneAffectedByReset Logic one when enabled and on timer reset.

kFLEXIO_TimerOutputZeroAffectedByReset Logic zero when enabled and on timer reset.

22.2.5.7 enum flexio_timer_decrement_source_t

Enumerator

- kFLEXIO_TimerDecSrcOnFlexIOClockShiftTimerOutput* Decrement counter on FlexIO clock, Shift clock equals Timer output.
- kFLEXIO_TimerDecSrcOnTriggerInputShiftTimerOutput* Decrement counter on Trigger input (both edges), Shift clock equals Timer output.
- kFLEXIO_TimerDecSrcOnPinInputShiftPinInput* Decrement counter on Pin input (both edges), Shift clock equals Pin input.
- kFLEXIO_TimerDecSrcOnTriggerInputShiftTriggerInput* Decrement counter on Trigger input (both edges), Shift clock equals Trigger input.

22.2.5.8 enum flexio_timer_reset_condition_t

Enumerator

- kFLEXIO_TimerResetNever* Timer never reset.
- kFLEXIO_TimerResetOnTimerPinEqualToTimerOutput* Timer reset on Timer Pin equal to Timer Output.
- kFLEXIO_TimerResetOnTimerTriggerEqualToTimerOutput* Timer reset on Timer Trigger equal to Timer Output.
- kFLEXIO_TimerResetOnTimerPinRisingEdge* Timer reset on Timer Pin rising edge.
- kFLEXIO_TimerResetOnTimerTriggerRisingEdge* Timer reset on Trigger rising edge.
- kFLEXIO_TimerResetOnTimerTriggerBothEdge* Timer reset on Trigger rising or falling edge.

22.2.5.9 enum flexio_timer_disable_condition_t

Enumerator

- kFLEXIO_TimerDisableNever* Timer never disabled.
- kFLEXIO_TimerDisableOnPreTimerDisable* Timer disabled on Timer N-1 disable.
- kFLEXIO_TimerDisableOnTimerCompare* Timer disabled on Timer compare.
- kFLEXIO_TimerDisableOnTimerCompareTriggerLow* Timer disabled on Timer compare and Trigger Low.
- kFLEXIO_TimerDisableOnPinBothEdge* Timer disabled on Pin rising or falling edge.
- kFLEXIO_TimerDisableOnPinBothEdgeTriggerHigh* Timer disabled on Pin rising or falling edge provided Trigger is high.
- kFLEXIO_TimerDisableOnTriggerFallingEdge* Timer disabled on Trigger falling edge.

22.2.5.10 enum flexio_timer_enable_condition_t

Enumerator

- kFLEXIO_TimerEnabledAlways* Timer always enabled.

kFLEXIO_TimerEnableOnPrevTimerEnable Timer enabled on Timer N-1 enable.
kFLEXIO_TimerEnableOnTriggerHigh Timer enabled on Trigger high.
kFLEXIO_TimerEnableOnTriggerHighPinHigh Timer enabled on Trigger high and Pin high.
kFLEXIO_TimerEnableOnPinRisingEdge Timer enabled on Pin rising edge.
kFLEXIO_TimerEnableOnPinRisingEdgeTriggerHigh Timer enabled on Pin rising edge and Trigger high.
kFLEXIO_TimerEnableOnTriggerRisingEdge Timer enabled on Trigger rising edge.
kFLEXIO_TimerEnableOnTriggerBothEdge Timer enabled on Trigger rising or falling edge.

22.2.5.11 enum flexio_timer_stop_bit_condition_t

Enumerator

kFLEXIO_TimerStopBitDisabled Stop bit disabled.
kFLEXIO_TimerStopBitEnableOnTimerCompare Stop bit is enabled on timer compare.
kFLEXIO_TimerStopBitEnableOnTimerDisable Stop bit is enabled on timer disable.
kFLEXIO_TimerStopBitEnableOnTimerCompareDisable Stop bit is enabled on timer compare and timer disable.

22.2.5.12 enum flexio_timer_start_bit_condition_t

Enumerator

kFLEXIO_TimerStartBitDisabled Start bit disabled.
kFLEXIO_TimerStartBitEnabled Start bit enabled.

22.2.5.13 enum flexio_shifter_timer_polarity_t

Enumerator

kFLEXIO_ShifterTimerPolarityOnPositive Shift on positive edge of shift clock.
kFLEXIO_ShifterTimerPolarityOnNegative Shift on negative edge of shift clock.

22.2.5.14 enum flexio_shifter_mode_t

Enumerator

kFLEXIO_ShifterDisabled Shifter is disabled.
kFLEXIO_ShifterModeReceive Receive mode.
kFLEXIO_ShifterModeTransmit Transmit mode.
kFLEXIO_ShifterModeMatchStore Match store mode.
kFLEXIO_ShifterModeMatchContinuous Match continuous mode.

kFLEXIO_ShifterModeState SHIFTBUF contents are used for storing programmable state attributes.

kFLEXIO_ShifterModeLogic SHIFTBUF contents are used for implementing programmable logic look up table.

22.2.5.15 enum flexio_shifter_input_source_t

Enumerator

kFLEXIO_ShifterInputFromPin Shifter input from pin.

kFLEXIO_ShifterInputFromNextShifterOutput Shifter input from Shifter N+1.

22.2.5.16 enum flexio_shifter_stop_bit_t

Enumerator

kFLEXIO_ShifterStopBitDisable Disable shifter stop bit.

kFLEXIO_ShifterStopBitLow Set shifter stop bit to logic low level.

kFLEXIO_ShifterStopBitHigh Set shifter stop bit to logic high level.

22.2.5.17 enum flexio_shifter_start_bit_t

Enumerator

kFLEXIO_ShifterStartBitDisabledLoadDataOnEnable Disable shifter start bit, transmitter loads data on enable.

kFLEXIO_ShifterStartBitDisabledLoadDataOnShift Disable shifter start bit, transmitter loads data on first shift.

kFLEXIO_ShifterStartBitLow Set shifter start bit to logic low level.

kFLEXIO_ShifterStartBitHigh Set shifter start bit to logic high level.

22.2.5.18 enum flexio_shifter_buffer_type_t

Enumerator

kFLEXIO_ShifterBuffer Shifter Buffer N Register.

kFLEXIO_ShifterBufferBitSwapped Shifter Buffer N Bit Byte Swapped Register.

kFLEXIO_ShifterBufferByteSwapped Shifter Buffer N Byte Swapped Register.

kFLEXIO_ShifterBufferBitByteSwapped Shifter Buffer N Bit Swapped Register.

kFLEXIO_ShifterBufferNibbleByteSwapped Shifter Buffer N Nibble Byte Swapped Register.

kFLEXIO_ShifterBufferHalfWordSwapped Shifter Buffer N Half Word Swapped Register.

kFLEXIO_ShifterBufferNibbleSwapped Shifter Buffer N Nibble Swapped Register.

22.2.6 Function Documentation

22.2.6.1 void FLEXIO_GetDefaultConfig (flexio_config_t * userConfig)

The configuration can be used directly to call the FLEXIO_Configure().

Example:

```
flexio_config_t config;
FLEXIO_GetDefaultConfig(&config);
```

Parameters

<i>userConfig</i>	pointer to flexio_config_t structure
-------------------	--

22.2.6.2 void FLEXIO_Init (FLEXIO_Type * base, const flexio_config_t * userConfig)

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

<i>base</i>	FlexIO peripheral base address
<i>userConfig</i>	pointer to flexio_config_t structure

22.2.6.3 void FLEXIO_Deinit (FLEXIO_Type * base)

Call this API to stop the FlexIO clock.

Note

After calling this API, call the FLEXIO_Init to use the FlexIO module.

Parameters

<i>base</i>	FlexIO peripheral base address
-------------	--------------------------------

22.2.6.4 uint32_t FLEXIO_GetInstance (FLEXIO_Type * *base*)

Parameters

<i>base</i>	FLEXIO peripheral base address.
-------------	---------------------------------

22.2.6.5 void FLEXIO_Reset (FLEXIO_Type * *base*)

Parameters

<i>base</i>	FlexIO peripheral base address
-------------	--------------------------------

22.2.6.6 static void FLEXIO_Enable (FLEXIO_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	FlexIO peripheral base address
<i>enable</i>	true to enable, false to disable.

22.2.6.7 static uint32_t FLEXIO_ReadPinInput (FLEXIO_Type * *base*) [inline], [static]

Parameters

<i>base</i>	FlexIO peripheral base address
-------------	--------------------------------

Returns

FlexIO pin input data

22.2.6.8 static uint8_t FLEXIO_GetShifterState (FLEXIO_Type * *base*) [inline], [static]

Parameters

<i>base</i>	FlexIO peripheral base address
-------------	--------------------------------

Returns

current State pointer

22.2.6.9 void FLEXIO_SetShifterConfig (FLEXIO_Type * *base*, uint8_t *index*, const flexio_shifter_config_t * *shifterConfig*)

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

<i>base</i>	FlexIO peripheral base address
<i>index</i>	Shifter index
<i>shifterConfig</i>	Pointer to flexio_shifter_config_t structure

22.2.6.10 void FLEXIO_SetTimerConfig (FLEXIO_Type * *base*, uint8_t *index*, const flexio_timer_config_t * *timerConfig*)

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,
```

```

.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

<i>base</i>	FlexIO peripheral base address
<i>index</i>	Timer index
<i>timerConfig</i>	Pointer to the flexio_timer_config_t structure

22.2.6.11 static void FLEXIO_EnableShifterStatusInterrupts (FLEXIO_Type * *base*, uint32_t *mask*) [inline], [static]

The interrupt generates when the corresponding SSF is set.

Parameters

<i>base</i>	FlexIO peripheral base address
<i>mask</i>	The shifter status mask which can be calculated by $(1 \ll \text{shifter index})$

Note

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

22.2.6.12 static void FLEXIO_DisableShifterStatusInterrupts (FLEXIO_Type * *base*, uint32_t *mask*) [inline], [static]

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

Parameters

<i>base</i>	FlexIO peripheral base address
<i>mask</i>	The shifter status mask which can be calculated by $(1 \ll \text{shifter index})$

Note

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

22.2.6.13 static void FLEXIO_EnableShifterErrorInterrupts (FLEXIO_Type * *base*, uint32_t *mask*) [inline], [static]

The interrupt generates when the corresponding SEF is set.

Parameters

<i>base</i>	FlexIO peripheral base address
<i>mask</i>	The shifter error mask which can be calculated by $(1 \ll \text{shifter index})$

Note

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

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

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

Parameters

<i>base</i>	FlexIO peripheral base address
<i>mask</i>	The shifter error mask which can be calculated by $(1 \ll \text{shifter index})$

Note

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

22.2.6.15 `static void FLEXIO_EnableTimerStatusInterrupts (FLEXIO_Type * base,
uint32_t mask) [inline], [static]`

The interrupt generates when the corresponding SSF is set.

Parameters

<i>base</i>	FlexIO peripheral base address
<i>mask</i>	The timer status mask which can be calculated by $(1 \ll \text{timer index})$

Note

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

22.2.6.16 `static void FLEXIO_DisableTimerStatusInterrupts (FLEXIO_Type * base, uint32_t mask) [inline], [static]`

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

Parameters

<i>base</i>	FlexIO peripheral base address
<i>mask</i>	The timer status mask which can be calculated by $(1 \ll \text{timer index})$

Note

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

22.2.6.17 `static uint32_t FLEXIO_GetShifterStatusFlags (FLEXIO_Type * base) [inline], [static]`

Parameters

<i>base</i>	FlexIO peripheral base address
-------------	--------------------------------

Returns

Shifter status flags

22.2.6.18 `static void FLEXIO_ClearShifterStatusFlags (FLEXIO_Type * base, uint32_t mask) [inline], [static]`

Parameters

<i>base</i>	FlexIO peripheral base address
<i>mask</i>	The shifter status mask which can be calculated by $(1 \ll \text{shifter index})$

Note

For clearing multiple shifter status flags, for example, two shifter status flags, can calculate the mask by using $((1 \ll \text{shifter index0}) | (1 \ll \text{shifter index1}))$

22.2.6.19 `static uint32_t FLEXIO_GetShifterErrorFlags (FLEXIO_Type * base)` `[inline], [static]`

Parameters

<i>base</i>	FlexIO peripheral base address
-------------	--------------------------------

Returns

Shifter error flags

22.2.6.20 `static void FLEXIO_ClearShifterErrorFlags (FLEXIO_Type * base, uint32_t` `mask) [inline], [static]`

Parameters

<i>base</i>	FlexIO peripheral base address
<i>mask</i>	The shifter error mask which can be calculated by $(1 \ll \text{shifter index})$

Note

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

22.2.6.21 `static uint32_t FLEXIO_GetTimerStatusFlags (FLEXIO_Type * base)` `[inline], [static]`

Parameters

<i>base</i>	FlexIO peripheral base address
-------------	--------------------------------

Returns

Timer status flags

22.2.6.22 `static void FLEXIO_ClearTimerStatusFlags (FLEXIO_Type * base, uint32_t mask) [inline], [static]`

Parameters

<i>base</i>	FlexIO peripheral base address
<i>mask</i>	The timer status mask which can be calculated by $(1 \ll \text{timer index})$

Note

For clearing multiple timer status flags, for example, two timer status flags, can calculate the mask by using $((1 \ll \text{timer index0}) | (1 \ll \text{timer index1}))$

22.2.6.23 `static void FLEXIO_EnableShifterStatusDMA (FLEXIO_Type * base, uint32_t mask, bool enable) [inline], [static]`

The DMA request generates when the corresponding SSF is set.

Note

For multiple shifter status DMA enables, for example, calculate the mask by using $((1 \ll \text{shifter index0}) | (1 \ll \text{shifter index1}))$

Parameters

<i>base</i>	FlexIO peripheral base address
<i>mask</i>	The shifter status mask which can be calculated by $(1 \ll \text{shifter index})$

<i>enable</i>	True to enable, false to disable.
---------------	-----------------------------------

22.2.6.24 `uint32_t FLEXIO_GetShifterBufferAddress (FLEXIO_Type * base, flexio_shifter_buffer_type_t type, uint8_t index)`

Parameters

<i>base</i>	FlexIO peripheral base address
<i>type</i>	Shifter type of flexio_shifter_buffer_type_t
<i>index</i>	Shifter index

Returns

Corresponding shifter buffer index

22.2.6.25 `status_t FLEXIO_RegisterHandleIRQ (void * base, void * handle, flexio_isr_t isr)`

Parameters

<i>base</i>	Pointer to the FlexIO simulated peripheral type.
<i>handle</i>	Pointer to the handler for FlexIO simulated peripheral.
<i>isr</i>	FlexIO simulated peripheral interrupt handler.

Return values

<i>kStatus_Success</i>	Successfully create the handle.
<i>kStatus_OutOfRange</i>	The FlexIO type/handle/ISR table out of range.

22.2.6.26 `status_t FLEXIO_UnregisterHandleIRQ (void * base)`

Parameters

<i>base</i>	Pointer to the FlexIO simulated peripheral type.
-------------	--

Return values

<i>kStatus_Success</i>	Successfully create the handle.
<i>kStatus_OutOfRange</i>	The FlexIO type/handle/ISR table out of range.

22.2.7 Variable Documentation

22.2.7.1 `FLEXIO_Type* const s_flexioBases[]`

22.2.7.2 `const clock_ip_name_t s_flexioClocks[]`

22.3 FlexIO Camera Driver

22.3.1 Overview

The MCUXpresso SDK provides a driver for the camera function using Flexible I/O.

FlexIO Camera driver includes functional APIs and eDMA transactional APIs. Functional APIs target low level APIs. Users can use functional APIs for FlexIO Camera initialization/configuration/operation purpose. Using the functional API requires knowledge of the FlexIO Camera peripheral and how to organize functional APIs to meet the requirements of the application. All functional API use the [FLEXIO_CAMERA_Type](#) * as the first parameter. FlexIO Camera functional operation groups provide the functional APIs set.

eDMA transactional APIs target high-level APIs. Users can use the transactional API to enable the peripheral quickly and can also use in the application if the code size and performance of transactional APIs satisfy requirements. If the code size and performance are critical requirements, see the transactional API implementation and write custom code. All transactional APIs use the `flexio_camera_edma_handle_t` as the second parameter. Users need to initialize the handle by calling the [FLEXIO_CAMERA_Transfer>CreateHandleEDMA\(\)](#) API.

eDMA transactional APIs support asynchronous receive. This means that the functions [FLEXIO_CAMERA_TransferReceiveEDMA\(\)](#) set up an interrupt for data receive. When the receive is complete, the upper layer is notified through a callback function with the status `kStatus_FLEXIO_CAMERA_RxIdle`.

22.3.2 Typical use case

22.3.2.1 FlexIO Camera Receive using eDMA method

```
volatile uint32_t isEDMAGetOnePictureFinish = false;
edma_handle_t g_edmaHandle;
flexio_camera_edma_handle_t g_cameraEdmaHandle;
edma_config_t edmaConfig;
FLEXIO_CAMERA_Type g_FlexioCameraDevice = {.flexioBase = FLEXIO0,
                                           .datPinStartIdx = 24U, /* fxio_pin 24 -31 are used. */
                                           .pclkPinIdx = 1U,      /* fxio_pin 1 is used as pclk pin. */
                                           .hrefPinIdx = 18U,     /* flexio_pin 18 is used as href pin. */
                                           .shifterStartIdx = 0U, /* Shifter 0 = 7 are used. */
                                           .shifterCount = 8U,
                                           .timerIdx = 0U};

flexio_camera_config_t cameraConfig;

/* Configure DMAMUX */
DMAMUX_Init(DMAMUX0);
/* Configure DMA */
EDMA_GetDefaultConfig(&edmaConfig);
EDMA_Init(DMA0, &edmaConfig);

DMAMUX_SetSource(DMAMUX0, DMA_CHN_FLEXIO_TO_FRAMEBUFF, (g_FlexioCameraDevice.
    shifterStartIdx + 1U));
DMAMUX_EnableChannel(DMAMUX0, DMA_CHN_FLEXIO_TO_FRAMEBUFF);
EDMA_CreateHandle(&g_edmaHandle, DMA0, DMA_CHN_FLEXIO_TO_FRAMEBUFF);

FLEXIO_CAMERA_GetDefaultConfig(&cameraConfig);
FLEXIO_CAMERA_Init(&g_FlexioCameraDevice, &cameraConfig);
/* Clear all the flag. */
```

```

FLEXIO_CAMERA_ClearStatusFlags(&g_FlexioCameraDevice,
                                kFLEXIO_CAMERA_RxDataRegFullFlag |
                                kFLEXIO_CAMERA_RxErrorFlag);
FLEXIO_ClearTimerStatusFlags(FLEXIO0, 0xFF);
FLEXIO_CAMERA_TransferCreateHandleEDMA(&g_FlexioCameraDevice, &
                                         g_cameraEdmaHandle, FLEXIO_CAMERA_UserCallback, NULL,
                                         &g_edmaHandle);
cameraTransfer.dataAddress = (uint32_t)u16CameraFrameBuffer;
cameraTransfer.dataNum = sizeof(u16CameraFrameBuffer);
FLEXIO_CAMERA_TransferReceiveEDMA(&g_FlexioCameraDevice, &
                                    g_cameraEdmaHandle, &cameraTransfer);
while (!isEDMAGetOnePictureFinish)
{
    ;
}

/* A callback function is also needed */
void FLEXIO_CAMERA_UserCallback(FLEXIO_CAMERA_Type *base,
                                flexio_camera_edma_handle_t *handle,
                                status_t status,
                                void *userData)
{
    userData = userData;
    /* eDMA Transfer finished */
    if (kStatus_FLEXIO_CAMERA_RxIdle == status)
    {
        isEDMAGetOnePictureFinish = true;
    }
}

```

Modules

- [FlexIO eDMA Camera Driver](#)

Data Structures

- struct [FLEXIO_CAMERA_Type](#)
Define structure of configuring the FlexIO Camera device. [More...](#)
- struct [flexio_camera_config_t](#)
Define FlexIO Camera user configuration structure. [More...](#)
- struct [flexio_camera_transfer_t](#)
Define FlexIO Camera transfer structure. [More...](#)

Macros

- #define [FLEXIO_CAMERA_PARALLEL_DATA_WIDTH](#) (8U)
Define the Camera CPI interface is constantly 8-bit width.

Enumerations

- enum {
 [kStatus_FLEXIO_CAMERA_RxBusy](#) = MAKE_STATUS(kStatusGroup_FLEXIO_CAMERA,


```

0),
kStatus_FLEXIO_CAMERA_RxIdle = MAKE_STATUS(kStatusGroup_FLEXIO_CAMERA, 1)
}

```

Error codes for the Camera driver.

- enum `_flexio_camera_status_flags` {
 - `kFLEXIO_CAMERA_RxDataRegFullFlag = 0x1U`,
 - `kFLEXIO_CAMERA_RxErrorFlag = 0x2U` }

Define FlexIO Camera status mask.

Driver version

- #define `FSL_FLEXIO_CAMERA_DRIVER_VERSION` (`MAKE_VERSION(2, 1, 3)`)
FlexIO Camera driver version 2.1.3.

Initialization and configuration

- void `FLEXIO_CAMERA_Init` (`FLEXIO_CAMERA_Type *base`, const `flexio_camera_config_t *config`)
Ungates the FlexIO clock, resets the FlexIO module, and configures the FlexIO Camera.
- void `FLEXIO_CAMERA_Deinit` (`FLEXIO_CAMERA_Type *base`)
Resets the FLEXIO_CAMERA shifer and timer config.
- void `FLEXIO_CAMERA_GetDefaultConfig` (`flexio_camera_config_t *config`)
Gets the default configuration to configure the FlexIO Camera.
- static void `FLEXIO_CAMERA_Enable` (`FLEXIO_CAMERA_Type *base`, bool enable)
Enables/disables the FlexIO Camera module operation.

Status

- uint32_t `FLEXIO_CAMERA_GetStatusFlags` (`FLEXIO_CAMERA_Type *base`)
Gets the FlexIO Camera status flags.
- void `FLEXIO_CAMERA_ClearStatusFlags` (`FLEXIO_CAMERA_Type *base`, uint32_t mask)
Clears the receive buffer full flag manually.

Interrupts

- void `FLEXIO_CAMERA_EnableInterrupt` (`FLEXIO_CAMERA_Type *base`)
Switches on the interrupt for receive buffer full event.
- void `FLEXIO_CAMERA_DisableInterrupt` (`FLEXIO_CAMERA_Type *base`)
Switches off the interrupt for receive buffer full event.

DMA support

- static void `FLEXIO_CAMERA_EnableRxDMA` (`FLEXIO_CAMERA_Type *base`, bool enable)

Enables/disables the FlexIO Camera receive DMA.

- static uint32_t `FLEXIO_CAMERA_GetRxBufferAddress` (`FLEXIO_CAMERA_Type *base`)
Gets the data from the receive buffer.

22.3.3 Data Structure Documentation

22.3.3.1 struct FLEXIO_CAMERA_Type

Data Fields

- FLEXIO_Type * `flexioBase`
FlexIO module base address.
- uint32_t `datPinStartIdx`
First data pin (D0) index for flexio_camera.
- uint32_t `pclkPinIdx`
Pixel clock pin (PCLK) index for flexio_camera.
- uint32_t `hrefPinIdx`
Horizontal sync pin (HREF) index for flexio_camera.
- uint32_t `shifterStartIdx`
First shifter index used for flexio_camera data FIFO.
- uint32_t `shifterCount`
The count of shifters that are used as flexio_camera data FIFO.
- uint32_t `timerIdx`
Timer index used for flexio_camera in FlexIO.

Field Documentation

(1) `FLEXIO_Type* FLEXIO_CAMERA_Type::flexioBase`

(2) `uint32_t FLEXIO_CAMERA_Type::datPinStartIdx`

Then the successive following `FLEXIO_CAMERA_DATA_WIDTH-1` pins are used as D1-D7.

(3) `uint32_t FLEXIO_CAMERA_Type::pclkPinIdx`

(4) `uint32_t FLEXIO_CAMERA_Type::hrefPinIdx`

(5) `uint32_t FLEXIO_CAMERA_Type::shifterStartIdx`

(6) `uint32_t FLEXIO_CAMERA_Type::shifterCount`

(7) `uint32_t FLEXIO_CAMERA_Type::timerIdx`

22.3.3.2 struct flexio_camera_config_t

Data Fields

- bool `enablecamera`
Enable/disable FlexIO Camera 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.*

Field Documentation

(1) bool `flexio_camera_config_t::enablecamera`

(2) bool `flexio_camera_config_t::enableFastAccess`

22.3.3.3 struct `flexio_camera_transfer_t`

Data Fields

- uint32_t `dataAddress`
Transfer buffer.
- uint32_t `dataNum`
Transfer num.

22.3.4 Macro Definition Documentation

22.3.4.1 `#define FSL_FLEXIO_CAMERA_DRIVER_VERSION (MAKE_VERSION(2, 1, 3))`

22.3.4.2 `#define FLEXIO_CAMERA_PARALLEL_DATA_WIDTH (8U)`

22.3.5 Enumeration Type Documentation

22.3.5.1 anonymous enum

Enumerator

kStatus_FLEXIO_CAMERA_RxBusy Receiver is busy.
kStatus_FLEXIO_CAMERA_RxIdle Camera receiver is idle.

22.3.5.2 enum `_flexio_camera_status_flags`

Enumerator

kFLEXIO_CAMERA_RxDataRegFullFlag Receive buffer full flag.
kFLEXIO_CAMERA_RxErrorFlag Receive buffer error flag.

22.3.6 Function Documentation

22.3.6.1 void FLEXIO_CAMERA_Init (FLEXIO_CAMERA_Type * *base*, const flexio_camera_config_t * *config*)

Parameters

<i>base</i>	Pointer to FLEXIO_CAMERA_Type structure
<i>config</i>	Pointer to flexio_camera_config_t structure

22.3.6.2 void FLEXIO_CAMERA_Deinit (FLEXIO_CAMERA_Type * *base*)

Note

After calling this API, call FLEXIO_CAMERA_Init to use the FlexIO Camera module.

Parameters

<i>base</i>	Pointer to FLEXIO_CAMERA_Type structure
-------------	---

22.3.6.3 void FLEXIO_CAMERA_GetDefaultConfig (flexio_camera_config_t * *config*)

The configuration can be used directly for calling the [FLEXIO_CAMERA_Init\(\)](#). Example:

```
flexio_camera_config_t config;
FLEXIO_CAMERA_GetDefaultConfig(&userConfig);
```

Parameters

<i>config</i>	Pointer to the flexio_camera_config_t structure
---------------	---

22.3.6.4 static void FLEXIO_CAMERA_Enable (FLEXIO_CAMERA_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	Pointer to the FLEXIO_CAMERA_Type
<i>enable</i>	True to enable, false does not have any effect.

22.3.6.5 `uint32_t FLEXIO_CAMERA_GetStatusFlags (FLEXIO_CAMERA_Type * base)`

Parameters

<i>base</i>	Pointer to FLEXIO_CAMERA_Type structure
-------------	---

Returns

FlexIO shifter status flags

- FLEXIO_SHIFTSTAT_SSF_MASK
- 0

22.3.6.6 `void FLEXIO_CAMERA_ClearStatusFlags (FLEXIO_CAMERA_Type * base, uint32_t mask)`

Parameters

<i>base</i>	Pointer to the device.
<i>mask</i>	status flag The parameter can be any combination of the following values: <ul style="list-style-type: none"> • kFLEXIO_CAMERA_RxDataRegFullFlag • kFLEXIO_CAMERA_RxErrorFlag

22.3.6.7 `void FLEXIO_CAMERA_EnableInterrupt (FLEXIO_CAMERA_Type * base)`

Parameters

<i>base</i>	Pointer to the device.
-------------	------------------------

22.3.6.8 `void FLEXIO_CAMERA_DisableInterrupt (FLEXIO_CAMERA_Type * base)`

Parameters

<i>base</i>	Pointer to the device.
-------------	------------------------

22.3.6.9 static void FLEXIO_CAMERA_EnableRxDMA (FLEXIO_CAMERA_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	Pointer to FLEXIO_CAMERA_Type structure
<i>enable</i>	True to enable, false to disable.

The FlexIO Camera mode can't work without the DMA or eDMA support, Usually, it needs at least two DMA or eDMA channels, one for transferring data from Camera, such as 0V7670 to FlexIO buffer, another is for transferring data from FlexIO buffer to LCD.

22.3.6.10 static uint32_t FLEXIO_CAMERA_GetRxBufferAddress (FLEXIO_CAMERA_Type * *base*) [inline], [static]

Parameters

<i>base</i>	Pointer to the device.
-------------	------------------------

Returns

data Pointer to the buffer that keeps the data with count of `base->shifterCount` .

22.3.7 FlexIO eDMA Camera Driver

22.3.7.1 Overview

Data Structures

- struct `flexio_camera_edma_handle_t`
Camera eDMA handle. [More...](#)

Typedefs

- typedef void(* `flexio_camera_edma_transfer_callback_t`)(`FLEXIO_CAMERA_Type` *base, `flexio_camera_edma_handle_t` *handle, `status_t` status, void *userData)
Camera transfer callback function.

Driver version

- #define `FSL_FLEXIO_CAMERA_EDMA_DRIVER_VERSION` (`MAKE_VERSION(2, 1, 3)`)
FlexIO Camera EDMA driver version 2.1.3.

eDMA transactional

- `status_t FLEXIO_CAMERA_TransferCreateHandleEDMA` (`FLEXIO_CAMERA_Type` *base, `flexio_camera_edma_handle_t` *handle, `flexio_camera_edma_transfer_callback_t` callback, void *userData, `edma_handle_t` *rxEdmaHandle)
Initializes the Camera handle, which is used in transactional functions.
- `status_t FLEXIO_CAMERA_TransferReceiveEDMA` (`FLEXIO_CAMERA_Type` *base, `flexio_camera_edma_handle_t` *handle, `flexio_camera_transfer_t` *xfer)
Receives data using eDMA.
- void `FLEXIO_CAMERA_TransferAbortReceiveEDMA` (`FLEXIO_CAMERA_Type` *base, `flexio_camera_edma_handle_t` *handle)
Aborts the receive data which used the eDMA.
- `status_t FLEXIO_CAMERA_TransferGetReceiveCountEDMA` (`FLEXIO_CAMERA_Type` *base, `flexio_camera_edma_handle_t` *handle, `size_t` *count)
Gets the remaining bytes to be received.

22.3.7.2 Data Structure Documentation

22.3.7.2.1 struct `flexio_camera_edma_handle`

Forward declaration of the handle typedef.

Data Fields

- `flexio_camera_edma_transfer_callback_t` callback

- *Callback function.*
- void * [userData](#)
Camera callback function parameter.
- size_t [rxSize](#)
Total bytes to be received.
- [edma_handle_t](#) * [rxEdmaHandle](#)
The eDMA RX channel used.
- uint8_t [nbytes](#)
eDMA minor byte transfer count initially configured.
- volatile uint8_t [rxState](#)
RX transfer state.

Field Documentation

- (1) [flexio_camera_edma_transfer_callback_t](#) [flexio_camera_edma_handle_t::callback](#)
- (2) void* [flexio_camera_edma_handle_t::userData](#)
- (3) size_t [flexio_camera_edma_handle_t::rxSize](#)
- (4) [edma_handle_t](#)* [flexio_camera_edma_handle_t::rxEdmaHandle](#)
- (5) uint8_t [flexio_camera_edma_handle_t::nbytes](#)

22.3.7.3 Macro Definition Documentation

22.3.7.3.1 #define FSL_FLEXIO_CAMERA_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 1, 3))

22.3.7.4 Typedef Documentation

22.3.7.4.1 typedef void(* [flexio_camera_edma_transfer_callback_t](#))([FLEXIO_CAMERA_Type](#) *[base](#), [flexio_camera_edma_handle_t](#) *[handle](#), [status_t](#) [status](#), void *[userData](#))

22.3.7.5 Function Documentation

22.3.7.5.1 [status_t](#) [FLEXIO_CAMERA_TransferCreateHandleEDMA](#) ([FLEXIO_CAMERA_Type](#) * [base](#), [flexio_camera_edma_handle_t](#) * [handle](#), [flexio_camera_edma_transfer_callback_t](#) [callback](#), void * [userData](#), [edma_handle_t](#) * [rxEdmaHandle](#))

Parameters

<i>base</i>	Pointer to the FLEXIO_CAMERA_Type .
-------------	---

<i>handle</i>	Pointer to flexio_camera_edma_handle_t structure.
<i>callback</i>	The callback function.
<i>userData</i>	The parameter of the callback function.
<i>rxEdmaHandle</i>	User requested DMA handle for RX DMA transfer.

Return values

<i>kStatus_Success</i>	Successfully create the handle.
<i>kStatus_OutOfRange</i>	The FlexIO Camera eDMA type/handle table out of range.

22.3.7.5.2 status_t FLEXIO_CAMERA_TransferReceiveEDMA (FLEXIO_CAMERA_Type * base, flexio_camera_edma_handle_t * handle, flexio_camera_transfer_t * xfer)

This function receives data using eDMA. This is a non-blocking function, which returns right away. When all data is received, the receive callback function is called.

Parameters

<i>base</i>	Pointer to the FLEXIO_CAMERA_Type .
<i>handle</i>	Pointer to the flexio_camera_edma_handle_t structure.
<i>xfer</i>	Camera eDMA transfer structure, see flexio_camera_transfer_t .

Return values

<i>kStatus_Success</i>	if succeeded, others failed.
<i>kStatus_CAMERA_Rx-Busy</i>	Previous transfer on going.

22.3.7.5.3 void FLEXIO_CAMERA_TransferAbortReceiveEDMA (FLEXIO_CAMERA_Type * base, flexio_camera_edma_handle_t * handle)

This function aborts the receive data which used the eDMA.

Parameters

<i>base</i>	Pointer to the FLEXIO_CAMERA_Type .
-------------	---

<i>handle</i>	Pointer to the flexio_camera_edma_handle_t structure.
---------------	---

22.3.7.5.4 `status_t FLEXIO_CAMERA_TransferGetReceiveCountEDMA (FLEXIO_CAMERA_Type * base, flexio_camera_edma_handle_t * handle, size_t * count)`

This function gets the number of bytes still not received.

Parameters

<i>base</i>	Pointer to the FLEXIO_CAMERA_Type .
<i>handle</i>	Pointer to the flexio_camera_edma_handle_t structure.
<i>count</i>	Number of bytes sent so far by the non-blocking transaction.

Return values

<i>kStatus_Success</i>	Succeed get the transfer count.
<i>kStatus_InvalidArgument</i>	The count parameter is invalid.

22.4 FlexIO I2C Master Driver

22.4.1 Overview

The MCUXpresso SDK provides a peripheral driver for I2C master function using Flexible I/O module of MCUXpresso SDK devices.

The FlexIO I2C master driver includes functional APIs and transactional APIs.

Functional APIs target low level APIs. Functional APIs can be used for the FlexIO I2C master initialization/configuration/operation for the optimization/customization purpose. Using the functional APIs requires the knowledge of the FlexIO I2C master peripheral and how to organize functional APIs to meet the application requirements. The FlexIO I2C master functional operation groups provide the functional APIs set.

Transactional APIs target high-level APIs. The transactional APIs can be used to enable the peripheral quickly and also in the application if the code size and performance of transactional APIs satisfy the requirements. If the code size and performance are critical requirements, see the transactional API implementation and write custom code using the functional APIs or accessing the hardware registers.

Transactional APIs support an asynchronous transfer. This means that the functions [FLEXIO_I2C_MasterTransferNonBlocking\(\)](#) set up the interrupt non-blocking transfer. When the transfer completes, the upper layer is notified through a callback function with the `kStatus_Success` status.

22.4.2 Typical use case

22.4.2.1 FlexIO I2C master transfer using an interrupt method

```
flexio_i2c_master_handle_t g_m_handle;
flexio_i2c_master_config_t masterConfig;
flexio_i2c_master_transfer_t masterXfer;
volatile bool completionFlag = false;
const uint8_t sendData[] = {.....};
FLEXIO_I2C_Type i2cDev;

void FLEXIO_I2C_MasterCallback(FLEXIO_I2C_Type *base, status_t status, void *
    userData)
{
    userData = userData;

    if (kStatus_Success == status)
    {
        completionFlag = true;
    }
}

void main(void)
{
    //...

    FLEXIO_I2C_MasterGetDefaultConfig(&masterConfig);

    FLEXIO_I2C_MasterInit(&i2cDev, &user_config);
    FLEXIO_I2C_MasterTransferCreateHandle(&i2cDev, &g_m_handle,
        FLEXIO_I2C_MasterCallback, NULL);
}
```

```

// Prepares to send.
masterXfer.slaveAddress = g_accel_address[0];
masterXfer.direction = kI2C_Read;
masterXfer.subaddress = &who_am_i_reg;
masterXfer.subaddressSize = 1;
masterXfer.data = &who_am_i_value;
masterXfer.dataSize = 1;
masterXfer.flags = kI2C_TransferDefaultFlag;

// Sends out.
FLEXIO_I2C_MasterTransferNonBlocking(&i2cDev, &g_m_handle, &
    masterXfer);

// Wait for sending is complete.
while (!completionFlag)
{
}

// ...
}

```

Data Structures

- struct [FLEXIO_I2C_Type](#)
Define FlexIO I2C master access structure typedef. [More...](#)
- struct [flexio_i2c_master_config_t](#)
Define FlexIO I2C master user configuration structure. [More...](#)
- struct [flexio_i2c_master_transfer_t](#)
Define FlexIO I2C master transfer structure. [More...](#)
- struct [flexio_i2c_master_handle_t](#)
Define FlexIO I2C master handle structure. [More...](#)

Macros

- `#define I2C_RETRY_TIMES 0U` /* Define to zero means keep waiting until the flag is assert/deassert. */
Retry times for waiting flag.

Typedefs

- 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.

Enumerations

- enum {
[kStatus_FLEXIO_I2C_Busy](#) = MAKE_STATUS(kStatusGroup_FLEXIO_I2C, 0),
[kStatus_FLEXIO_I2C_Idle](#) = MAKE_STATUS(kStatusGroup_FLEXIO_I2C, 1),
[kStatus_FLEXIO_I2C_Nak](#) = MAKE_STATUS(kStatusGroup_FLEXIO_I2C, 2),

- ```
kStatus_FLEXIO_I2C_Timeout = MAKE_STATUS(kStatusGroup_FLEXIO_I2C, 3) }
```
- FlexIO I2C transfer status.*
- enum `_flexio_i2c_master_interrupt` {  
`kFLEXIO_I2C_TxEmptyInterruptEnable` = 0x1U,  
`kFLEXIO_I2C_RxFullInterruptEnable` = 0x2U }
- Define FlexIO I2C master interrupt mask.*
- enum `_flexio_i2c_master_status_flags` {  
`kFLEXIO_I2C_TxEmptyFlag` = 0x1U,  
`kFLEXIO_I2C_RxFullFlag` = 0x2U,  
`kFLEXIO_I2C_ReceiveNakFlag` = 0x4U }
- Define FlexIO I2C master status mask.*
- enum `flexio_i2c_direction_t` {  
`kFLEXIO_I2C_Write` = 0x0U,  
`kFLEXIO_I2C_Read` = 0x1U }
- Direction of master transfer.*

## Driver version

- #define `FSL_FLEXIO_I2C_MASTER_DRIVER_VERSION` (`MAKE_VERSION(2, 4, 0)`)

## Initialization and deinitialization

- status\_t `FLEXIO_I2C_CheckForBusyBus` (`FLEXIO_I2C_Type *base`)  
*Make sure the bus isn't already pulled down.*
- 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.*
- void `FLEXIO_I2C_MasterDeinit` (`FLEXIO_I2C_Type *base`)  
*De-initializes the FlexIO I2C master peripheral.*
- void `FLEXIO_I2C_MasterGetDefaultConfig` (`flexio_i2c_master_config_t *masterConfig`)  
*Gets the default configuration to configure the FlexIO module.*
- static void `FLEXIO_I2C_MasterEnable` (`FLEXIO_I2C_Type *base`, `bool enable`)  
*Enables/disables the FlexIO module operation.*

## Status

- uint32\_t `FLEXIO_I2C_MasterGetStatusFlags` (`FLEXIO_I2C_Type *base`)  
*Gets the FlexIO I2C master status flags.*
- void `FLEXIO_I2C_MasterClearStatusFlags` (`FLEXIO_I2C_Type *base`, `uint32_t mask`)  
*Clears the FlexIO I2C master status flags.*

## Interrupts

- void `FLEXIO_I2C_MasterEnableInterrupts` (`FLEXIO_I2C_Type *base`, `uint32_t mask`)

*Enables the FlexIO i2c master interrupt requests.*

- void `FLEXIO_I2C_MasterDisableInterrupts` (`FLEXIO_I2C_Type *base`, `uint32_t mask`)  
*Disables the FlexIO I2C master interrupt requests.*

## Bus Operations

- void `FLEXIO_I2C_MasterSetBaudRate` (`FLEXIO_I2C_Type *base`, `uint32_t baudRate_Bps`, `uint32_t srcClock_Hz`)  
*Sets the FlexIO I2C master transfer baudrate.*
- void `FLEXIO_I2C_MasterStart` (`FLEXIO_I2C_Type *base`, `uint8_t address`, `flexio_i2c_direction_t direction`)  
*Sends START + 7-bit address to the bus.*
- void `FLEXIO_I2C_MasterStop` (`FLEXIO_I2C_Type *base`)  
*Sends the stop signal on the bus.*
- void `FLEXIO_I2C_MasterRepeatedStart` (`FLEXIO_I2C_Type *base`)  
*Sends the repeated start signal on the bus.*
- void `FLEXIO_I2C_MasterAbortStop` (`FLEXIO_I2C_Type *base`)  
*Sends the stop signal when transfer is still on-going.*
- void `FLEXIO_I2C_MasterEnableAck` (`FLEXIO_I2C_Type *base`, `bool enable`)  
*Configures the sent ACK/NAK for the following byte.*
- `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.*
- static void `FLEXIO_I2C_MasterWriteByte` (`FLEXIO_I2C_Type *base`, `uint32_t data`)  
*Writes one byte of data to the I2C bus.*
- static `uint8_t FLEXIO_I2C_MasterReadByte` (`FLEXIO_I2C_Type *base`)  
*Reads one byte of data from the I2C bus.*
- `status_t FLEXIO_I2C_MasterWriteBlocking` (`FLEXIO_I2C_Type *base`, `const uint8_t *txBuff`, `uint8_t txSize`)  
*Sends a buffer of data in bytes.*
- `status_t FLEXIO_I2C_MasterReadBlocking` (`FLEXIO_I2C_Type *base`, `uint8_t *rxBuff`, `uint8_t rxSize`)  
*Receives a buffer of bytes.*
- `status_t FLEXIO_I2C_MasterTransferBlocking` (`FLEXIO_I2C_Type *base`, `flexio_i2c_master_transfer_t *xfer`)  
*Performs a master polling transfer on the I2C bus.*

## Transactional

- `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.*
- `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.*
- `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.*

- void `FLEXIO_I2C_MasterTransferAbort` (`FLEXIO_I2C_Type *base`, `flexio_i2c_master_handle_t *handle`)  
*Aborts an interrupt non-blocking transfer early.*
- void `FLEXIO_I2C_MasterTransferHandleIRQ` (`void *i2cType`, `void *i2cHandle`)  
*Master interrupt handler.*

## 22.4.3 Data Structure Documentation

### 22.4.3.1 struct FLEXIO\_I2C\_Type

#### Data Fields

- `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.*

#### Field Documentation

- (1) `FLEXIO_Type* FLEXIO_I2C_Type::flexioBase`
- (2) `uint8_t FLEXIO_I2C_Type::SDAPinIndex`
- (3) `uint8_t FLEXIO_I2C_Type::SCLPinIndex`
- (4) `uint8_t FLEXIO_I2C_Type::shifterIndex[2]`
- (5) `uint8_t FLEXIO_I2C_Type::timerIndex[3]`
- (6) `uint32_t FLEXIO_I2C_Type::baudrate`

### 22.4.3.2 struct flexio\_i2c\_master\_config\_t

#### Data Fields

- 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.

#### Field Documentation

- (1) bool flexio\_i2c\_master\_config\_t::enableMaster
- (2) bool flexio\_i2c\_master\_config\_t::enableInDoze
- (3) bool flexio\_i2c\_master\_config\_t::enableInDebug
- (4) bool flexio\_i2c\_master\_config\_t::enableFastAccess
- (5) uint32\_t flexio\_i2c\_master\_config\_t::baudRate\_Bps

#### 22.4.3.3 struct flexio\_i2c\_master\_transfer\_t

#### Data Fields

- 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.
- uint8\_t [subaddressSize](#)  
Size of command buffer.
- uint8\_t volatile \* [data](#)  
Transfer buffer.
- volatile size\_t [dataSize](#)  
Transfer size.

#### Field Documentation

- (1) uint32\_t flexio\_i2c\_master\_transfer\_t::flags
- (2) uint8\_t flexio\_i2c\_master\_transfer\_t::slaveAddress
- (3) flexio\_i2c\_direction\_t flexio\_i2c\_master\_transfer\_t::direction
- (4) uint32\_t flexio\_i2c\_master\_transfer\_t::subaddress

Transferred MSB first.

- (5) uint8\_t flexio\_i2c\_master\_transfer\_t::subaddressSize



(6) `uint8_t volatile* flexio_i2c_master_transfer_t::data`

(7) `volatile size_t flexio_i2c_master_transfer_t::dataSize`

#### 22.4.3.4 struct `flexio_i2c_master_handle`

FlexIO I2C master handle typedef.

#### Data Fields

- [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.*
- `void *` [userData](#)  
*Callback parameter passed to callback function.*
- `bool` [needRestart](#)  
*Whether master needs to send re-start signal.*

#### Field Documentation

(1) `flexio_i2c_master_transfer_t flexio_i2c_master_handle_t::transfer`

(2) `size_t flexio_i2c_master_handle_t::transferSize`

(3) `uint8_t flexio_i2c_master_handle_t::state`

(4) `flexio_i2c_master_transfer_callback_t flexio_i2c_master_handle_t::completionCallback`

Callback function called at transfer event.

(5) `void* flexio_i2c_master_handle_t::userData`

(6) `bool flexio_i2c_master_handle_t::needRestart`

#### 22.4.4 Macro Definition Documentation

22.4.4.1 `#define I2C_RETRY_TIMES 0U /* Define to zero means keep waiting until the flag is assert/deassert. */`

#### 22.4.5 Typedef Documentation

**22.4.5.1** `typedef void(* flexio_i2c_master_transfer_callback_t)(FLEXIO_I2C_Type *base, flexio_i2c_master_handle_t *handle, status_t status, void *userData)`

## 22.4.6 Enumeration Type Documentation

### 22.4.6.1 anonymous enum

Enumerator

*kStatus\_FLEXIO\_I2C\_Busy* I2C is busy doing transfer.  
*kStatus\_FLEXIO\_I2C\_Idle* I2C is busy doing transfer.  
*kStatus\_FLEXIO\_I2C\_Nak* NAK received during transfer.  
*kStatus\_FLEXIO\_I2C\_Timeout* Timeout polling status flags.

### 22.4.6.2 enum flexio\_i2c\_master\_interrupt

Enumerator

*kFLEXIO\_I2C\_TxEmptyInterruptEnable* Tx buffer empty interrupt enable.  
*kFLEXIO\_I2C\_RxFullInterruptEnable* Rx buffer full interrupt enable.

### 22.4.6.3 enum flexio\_i2c\_master\_status\_flags

Enumerator

*kFLEXIO\_I2C\_TxEmptyFlag* Tx shifter empty flag.  
*kFLEXIO\_I2C\_RxFullFlag* Rx shifter full/Transfer complete flag.  
*kFLEXIO\_I2C\_ReceiveNakFlag* Receive NAK flag.

### 22.4.6.4 enum flexio\_i2c\_direction\_t

Enumerator

*kFLEXIO\_I2C\_Write* Master send to slave.  
*kFLEXIO\_I2C\_Read* Master receive from slave.

## 22.4.7 Function Documentation

### 22.4.7.1 status\_t FLEXIO\_I2C\_CheckForBusyBus ( FLEXIO\_I2C\_Type \* base )

Check the FLEXIO pin status to see whether either of SDA and SCL pin is pulled down.

## Parameters

|             |                                                        |
|-------------|--------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure.. |
|-------------|--------------------------------------------------------|

## Return values

|                                |  |
|--------------------------------|--|
| <i>kStatus_Success</i>         |  |
| <i>kStatus_FLEXIO_I2C_Busy</i> |  |

### 22.4.7.2 status\_t FLEXIO\_I2C\_MasterInit ( FLEXIO\_I2C\_Type \* *base*, flexio\_i2c\_master\_config\_t \* *masterConfig*, uint32\_t *srcClock\_Hz* )

## 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

|                     |                                                                  |
|---------------------|------------------------------------------------------------------|
| <i>base</i>         | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure.            |
| <i>masterConfig</i> | Pointer to <a href="#">flexio_i2c_master_config_t</a> structure. |
| <i>srcClock_Hz</i>  | FlexIO source clock in Hz.                                       |

## Return values

|                                |                                                |
|--------------------------------|------------------------------------------------|
| <i>kStatus_Success</i>         | Initialization successful                      |
| <i>kStatus_InvalidArgument</i> | The source clock exceed upper range limitation |

### 22.4.7.3 void FLEXIO\_I2C\_MasterDeinit ( FLEXIO\_I2C\_Type \* *base* )

Calling this API Resets the FlexIO I2C master shifer and timer config, module can't work unless the FLEXIO\_I2C\_MasterInit is called.

## Parameters

|             |                                                       |
|-------------|-------------------------------------------------------|
| <i>base</i> | pointer to <a href="#">FLEXIO_I2C_Type</a> structure. |
|-------------|-------------------------------------------------------|

#### 22.4.7.4 void FLEXIO\_I2C\_MasterGetDefaultConfig ( flexio\_i2c\_master\_config\_t \* masterConfig )

The configuration can be used directly for calling the [FLEXIO\\_I2C\\_MasterInit\(\)](#).

Example:

```
flexio_i2c_master_config_t config;
FLEXIO_I2C_MasterGetDefaultConfig(&config);
```

## Parameters

|                     |                                                                  |
|---------------------|------------------------------------------------------------------|
| <i>masterConfig</i> | Pointer to <a href="#">flexio_i2c_master_config_t</a> structure. |
|---------------------|------------------------------------------------------------------|

#### 22.4.7.5 static void FLEXIO\_I2C\_MasterEnable ( FLEXIO\_I2C\_Type \* base, bool enable ) [inline], [static]

## Parameters

|               |                                                             |
|---------------|-------------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure.       |
| <i>enable</i> | Pass true to enable module, false does not have any effect. |

#### 22.4.7.6 uint32\_t FLEXIO\_I2C\_MasterGetStatusFlags ( FLEXIO\_I2C\_Type \* base )

## Parameters

|             |                                                      |
|-------------|------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure |
|-------------|------------------------------------------------------|

## Returns

Status flag, use status flag to AND [\\_flexio\\_i2c\\_master\\_status\\_flags](#) can get the related status.

#### 22.4.7.7 void FLEXIO\_I2C\_MasterClearStatusFlags ( FLEXIO\_I2C\_Type \* base, uint32\_t mask )

## Parameters

|             |                                                                                                                                                                                             |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure.                                                                                                                                       |
| <i>mask</i> | Status flag. The parameter can be any combination of the following values: <ul style="list-style-type: none"> <li>• kFLEXIO_I2C_RxFullFlag</li> <li>• kFLEXIO_I2C_ReceiveNakFlag</li> </ul> |

#### 22.4.7.8 void FLEXIO\_I2C\_MasterEnableInterrupts ( FLEXIO\_I2C\_Type \* *base*, uint32\_t *mask* )

## Parameters

|             |                                                                                                                                                                |
|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure.                                                                                                          |
| <i>mask</i> | Interrupt source. Currently only one interrupt request source: <ul style="list-style-type: none"> <li>• kFLEXIO_I2C_TransferCompleteInterruptEnable</li> </ul> |

#### 22.4.7.9 void FLEXIO\_I2C\_MasterDisableInterrupts ( FLEXIO\_I2C\_Type \* *base*, uint32\_t *mask* )

## Parameters

|             |                                                       |
|-------------|-------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure. |
| <i>mask</i> | Interrupt source.                                     |

#### 22.4.7.10 void FLEXIO\_I2C\_MasterSetBaudRate ( FLEXIO\_I2C\_Type \* *base*, uint32\_t *baudRate\_Bps*, uint32\_t *srcClock\_Hz* )

## Parameters

|                     |                                                      |
|---------------------|------------------------------------------------------|
| <i>base</i>         | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure |
| <i>baudRate_Bps</i> | the baud rate value in HZ                            |

|                    |                    |
|--------------------|--------------------|
| <i>srcClock_Hz</i> | source clock in HZ |
|--------------------|--------------------|

**22.4.7.11 void FLEXIO\_I2C\_MasterStart ( FLEXIO\_I2C\_Type \* *base*, uint8\_t *address*, flexio\_i2c\_direction\_t *direction* )**

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

|                  |                                                                                                                                                                                                         |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>      | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure.                                                                                                                                                   |
| <i>address</i>   | 7-bit address.                                                                                                                                                                                          |
| <i>direction</i> | transfer direction. This parameter is one of the values in flexio_i2c_direction_t: <ul style="list-style-type: none"> <li>• kFLEXIO_I2C_Write: Transmit</li> <li>• kFLEXIO_I2C_Read: Receive</li> </ul> |

**22.4.7.12 void FLEXIO\_I2C\_MasterStop ( FLEXIO\_I2C\_Type \* *base* )**

Parameters

|             |                                                       |
|-------------|-------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure. |
|-------------|-------------------------------------------------------|

**22.4.7.13 void FLEXIO\_I2C\_MasterRepeatedStart ( FLEXIO\_I2C\_Type \* *base* )**

Parameters

|             |                                                       |
|-------------|-------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure. |
|-------------|-------------------------------------------------------|

**22.4.7.14 void FLEXIO\_I2C\_MasterAbortStop ( FLEXIO\_I2C\_Type \* *base* )**

## Parameters

|             |                                                       |
|-------------|-------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure. |
|-------------|-------------------------------------------------------|

**22.4.7.15 void FLEXIO\_I2C\_MasterEnableAck ( FLEXIO\_I2C\_Type \* *base*, bool *enable* )**

## Parameters

|               |                                                          |
|---------------|----------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure.    |
| <i>enable</i> | True to configure send ACK, false configure to send NAK. |

**22.4.7.16 status\_t FLEXIO\_I2C\_MasterSetTransferCount ( FLEXIO\_I2C\_Type \* *base*, uint16\_t *count* )**

## 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

|              |                                                                                      |
|--------------|--------------------------------------------------------------------------------------|
| <i>base</i>  | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure.                                |
| <i>count</i> | Number of bytes need to be transferred from a start signal to a re-start/stop signal |

## Return values

|                                |                                    |
|--------------------------------|------------------------------------|
| <i>kStatus_Success</i>         | Successfully configured the count. |
| <i>kStatus_InvalidArgument</i> | Input argument is invalid.         |

**22.4.7.17 static void FLEXIO\_I2C\_MasterWriteByte ( FLEXIO\_I2C\_Type \* *base*, uint32\_t *data* ) [inline], [static]**

## 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

|             |                                                       |
|-------------|-------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure. |
| <i>data</i> | a byte of data.                                       |

#### 22.4.7.18 static uint8\_t FLEXIO\_I2C\_MasterReadByte ( FLEXIO\_I2C\_Type \* *base* ) [inline], [static]

## 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

|             |                                                       |
|-------------|-------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure. |
|-------------|-------------------------------------------------------|

## Returns

data byte read.

#### 22.4.7.19 status\_t FLEXIO\_I2C\_MasterWriteBlocking ( FLEXIO\_I2C\_Type \* *base*, const uint8\_t \* *txBuff*, uint8\_t *txSize* )

## Note

This function blocks via polling until all bytes have been sent.

## Parameters

|               |                                                       |
|---------------|-------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure. |
| <i>txBuff</i> | The data bytes to send.                               |
| <i>txSize</i> | The number of data bytes to send.                     |

## Return values

|                                    |                                  |
|------------------------------------|----------------------------------|
| <i>kStatus_Success</i>             | Successfully write data.         |
| <i>kStatus_FLEXIO_I2C_-Nak</i>     | Receive NAK during writing data. |
| <i>kStatus_FLEXIO_I2C_-Timeout</i> | Timeout polling status flags.    |



**22.4.7.20** `status_t FLEXIO_I2C_MasterReadBlocking ( FLEXIO_I2C_Type * base,  
uint8_t * rxBuff, uint8_t rxSize )`

Note

This function blocks via polling until all bytes have been received.

Parameters

|               |                                                       |
|---------------|-------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure. |
| <i>rxBuff</i> | The buffer to store the received bytes.               |
| <i>rxSize</i> | The number of data bytes to be received.              |

Return values

|                                   |                               |
|-----------------------------------|-------------------------------|
| <i>kStatus_Success</i>            | Successfully read data.       |
| <i>kStatus_FLEXIO_I2C_Timeout</i> | Timeout polling status flags. |

**22.4.7.21** `status_t FLEXIO_I2C_MasterTransferBlocking ( FLEXIO_I2C_Type * base,  
flexio_i2c_master_transfer_t * xfer )`

Note

The API does not return until the transfer succeeds or fails due to receiving NAK.

Parameters

|             |                                                                    |
|-------------|--------------------------------------------------------------------|
| <i>base</i> | pointer to <a href="#">FLEXIO_I2C_Type</a> structure.              |
| <i>xfer</i> | pointer to <a href="#">flexio_i2c_master_transfer_t</a> structure. |

Returns

status of `status_t`.

**22.4.7.22** `status_t FLEXIO_I2C_MasterTransferCreateHandle ( FLEXIO_I2C_Type * base,  
flexio_i2c_master_handle_t * handle, flexio_i2c_master_transfer_callback_t  
callback, void * userData )`

## Parameters

|                 |                                                                                           |
|-----------------|-------------------------------------------------------------------------------------------|
| <i>base</i>     | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure.                                     |
| <i>handle</i>   | Pointer to <code>flexio_i2c_master_handle_t</code> structure to store the transfer state. |
| <i>callback</i> | Pointer to user callback function.                                                        |
| <i>userData</i> | User param passed to the callback function.                                               |

## Return values

|                           |                                                |
|---------------------------|------------------------------------------------|
| <i>kStatus_Success</i>    | Successfully create the handle.                |
| <i>kStatus_OutOfRange</i> | The FlexIO type/handle/isr table out of range. |

**22.4.7.23** `status_t FLEXIO_I2C_MasterTransferNonBlocking ( FLEXIO_I2C_Type * base, flexio_i2c_master_handle_t * handle, flexio_i2c_master_transfer_t * xfer )`

## 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

|               |                                                                                              |
|---------------|----------------------------------------------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure                                         |
| <i>handle</i> | Pointer to <code>flexio_i2c_master_handle_t</code> structure which stores the transfer state |
| <i>xfer</i>   | pointer to <a href="#">flexio_i2c_master_transfer_t</a> structure                            |

## Return values

|                                |                                                      |
|--------------------------------|------------------------------------------------------|
| <i>kStatus_Success</i>         | Successfully start a transfer.                       |
| <i>kStatus_FLEXIO_I2C_Busy</i> | FlexIO I2C is not idle, is running another transfer. |

**22.4.7.24** `status_t FLEXIO_I2C_MasterTransferGetCount ( FLEXIO_I2C_Type * base, flexio_i2c_master_handle_t * handle, size_t * count )`

## Parameters

|               |                                                                                               |
|---------------|-----------------------------------------------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure.                                         |
| <i>handle</i> | Pointer to <code>flexio_i2c_master_handle_t</code> structure which stores the transfer state. |
| <i>count</i>  | Number of bytes transferred so far by the non-blocking transaction.                           |

## Return values

|                                     |                                                                |
|-------------------------------------|----------------------------------------------------------------|
| <i>kStatus_InvalidArgument</i>      | count is Invalid.                                              |
| <i>kStatus_NoTransferInProgress</i> | There is not a non-blocking transaction currently in progress. |
| <i>kStatus_Success</i>              | Successfully return the count.                                 |

#### 22.4.7.25 void FLEXIO\_I2C\_MasterTransferAbort ( FLEXIO\_I2C\_Type \* *base*, flexio\_i2c\_master\_handle\_t \* *handle* )

## Note

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

## Parameters

|               |                                                                                              |
|---------------|----------------------------------------------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure                                         |
| <i>handle</i> | Pointer to <code>flexio_i2c_master_handle_t</code> structure which stores the transfer state |

#### 22.4.7.26 void FLEXIO\_I2C\_MasterTransferHandleIRQ ( void \* *i2cType*, void \* *i2cHandle* )

## Parameters

|                  |                                                                   |
|------------------|-------------------------------------------------------------------|
| <i>i2cType</i>   | Pointer to <a href="#">FLEXIO_I2C_Type</a> structure              |
| <i>i2cHandle</i> | Pointer to <a href="#">flexio_i2c_master_transfer_t</a> structure |

## 22.5 FlexIO I2S Driver

### 22.5.1 Overview

The MCUXpresso SDK provides a peripheral driver for I2S function using Flexible I/O module of MCU-Xpresso SDK devices.

The FlexIO I2S driver includes functional APIs and transactional APIs.

Functional APIs are feature/property target low level APIs.

Functional APIs can be used for FlexIO I2S initialization/configuration/operation for optimization/customization purpose. Using the functional API requires the knowledge of the FlexIO I2S peripheral and how to organize functional APIs to meet the application requirements. All functional API use the peripheral base address as the first parameter. FlexIO I2S functional operation groups provide the functional APIs set.

Transactional APIs are transaction target high level APIs. The transactional APIs can be used to enable the peripheral and also in the application if the code size and performance of transactional APIs can satisfy requirements. If the code size and performance are critical requirements, see the transactional API implementation and write custom code. All transactional APIs use the `sai_handle_t` as the first parameter. Initialize the handle by calling the `FlexIO_I2S_TransferTxCreateHandle()` or `FlexIO_I2S_TransferRxCreateHandle()` API.

Transactional APIs support asynchronous transfer. This means that the functions [FLEXIO\\_I2S\\_TransferSendNonBlocking\(\)](#) and [FLEXIO\\_I2S\\_TransferReceiveNonBlocking\(\)](#) set up an interrupt for data transfer. When the transfer completes, the upper layer is notified through a callback function with the `kStatus_FLEXIO_I2S_TxIdle` and `kStatus_FLEXIO_I2S_RxIdle` status.

### 22.5.2 Typical use case

#### 22.5.2.1 FlexIO I2S send/receive using an interrupt method

```
sai_handle_t g_saiTxHandle;
sai_config_t user_config;
sai_transfer_t sendXfer;
volatile bool txFinished;
volatile bool rxFinished;
const uint8_t sendData[] = [.....];

void FLEXIO_I2S_UserCallback(sai_handle_t *handle, status_t status, void *userData)
{
 userData = userData;

 if (kStatus_FLEXIO_I2S_TxIdle == status)
 {
 txFinished = true;
 }
}

void main(void)
{
 //...

 FLEXIO_I2S_TxGetDefaultConfig(&user_config);
```

```

FLEXIO_I2S_TxInit(FLEXIO I2S0, &user_config);
FLEXIO_I2S_TransferTxCreateHandle(FLEXIO I2S0, &g_saiHandle,
 FLEXIO_I2S_UserCallback, NULL);

//Configures the SAI format.
FLEXIO_I2S_TransferTxSetTransferFormat(FLEXIO I2S0, &g_saiHandle, mclkSource, mclk);

// Prepares to send.
sendXfer.data = sendData
sendXfer.dataSize = sizeof(sendData)/sizeof(sendData[0]);
txFinished = false;

// Sends out.
FLEXIO_I2S_TransferSendNonBlocking(FLEXIO I2S0, &g_saiHandle, &
 sendXfer);

// Waiting to send is finished.
while (!txFinished)
{
}

// ...
}

```

### 22.5.2.2 FLEXIO\_I2S send/receive using a DMA method

```

sai_handle_t g_saiHandle;
dma_handle_t g_saiTxDmaHandle;
dma_handle_t g_saiRxDmaHandle;
sai_config_t user_config;
sai_transfer_t sendXfer;
volatile bool txFinished;
uint8_t sendData[] = ...;

void FLEXIO_I2S_UserCallback(sai_handle_t *handle, status_t status, void *userData)
{
 userData = userData;

 if (kStatus_FLEXIO_I2S_TxIdle == status)
 {
 txFinished = true;
 }
}

void main(void)
{
 //...

 FLEXIO_I2S_TxGetDefaultConfig(&user_config);
 FLEXIO_I2S_TxInit(FLEXIO I2S0, &user_config);

 // Sets up the DMA.
 DMAMUX_Init(DMAMUX0);
 DMAMUX_SetSource(DMAMUX0, FLEXIO_I2S_TX_DMA_CHANNEL, FLEXIO_I2S_TX_DMA_REQUEST);
 DMAMUX_EnableChannel(DMAMUX0, FLEXIO_I2S_TX_DMA_CHANNEL);

 DMA_Init(DMA0);

 /* Creates the DMA handle. */
 DMA_TransferTxCreateHandle(&g_saiTxDmaHandle, DMA0, FLEXIO_I2S_TX_DMA_CHANNEL);

 FLEXIO_I2S_TransferTxCreateHandleDMA(FLEXIO I2S0, &g_saiTxDmaHandle, FLEXIO_I2S_UserCallback, NULL);

 // Prepares to send.
 sendXfer.data = sendData

```

```

sendXfer.dataSize = sizeof(sendData)/sizeof(sendData[0]);
txFinished = false;

// Sends out.
FLEXIO_I2S_TransferSendDMA(&g_saiHandle, &sendXfer);

// Waiting to send is finished.
while (!txFinished)
{
}

// ...
}

```

## Modules

- [FlexIO eDMA I2S Driver](#)

## Data Structures

- struct [FLEXIO\\_I2S\\_Type](#)  
*Define FlexIO I2S access structure typedef. [More...](#)*
- struct [flexio\\_i2s\\_config\\_t](#)  
*FlexIO I2S configure structure. [More...](#)*
- struct [flexio\\_i2s\\_format\\_t](#)  
*FlexIO I2S audio format, FlexIO I2S only support the same format in Tx and Rx. [More...](#)*
- struct [flexio\\_i2s\\_transfer\\_t](#)  
*Define FlexIO I2S transfer structure. [More...](#)*
- struct [flexio\\_i2s\\_handle\\_t](#)  
*Define FlexIO I2S handle structure. [More...](#)*

## Macros

- `#define I2S_RETRY_TIMES 0U` /\* Define to zero means keep waiting until the flag is assert/deassert. \*/  
*Retry times for waiting flag.*
- `#define FLEXIO_I2S_XFER_QUEUE_SIZE (4U)`  
*FlexIO I2S transfer queue size, user can refine it according to use case.*

## Typedefs

- 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.*

## Enumerations

- enum {
  - kStatus\_FLEXIO\_I2S\_Idle = MAKE\_STATUS(kStatusGroup\_FLEXIO\_I2S, 0),
  - kStatus\_FLEXIO\_I2S\_TxBusy = MAKE\_STATUS(kStatusGroup\_FLEXIO\_I2S, 1),
  - kStatus\_FLEXIO\_I2S\_RxBusy = MAKE\_STATUS(kStatusGroup\_FLEXIO\_I2S, 2),
  - kStatus\_FLEXIO\_I2S\_Error = MAKE\_STATUS(kStatusGroup\_FLEXIO\_I2S, 3),
  - kStatus\_FLEXIO\_I2S\_QueueFull = MAKE\_STATUS(kStatusGroup\_FLEXIO\_I2S, 4),
  - kStatus\_FLEXIO\_I2S\_Timeout }

*FlexIO I2S transfer status.*
- enum flexio\_i2s\_master\_slave\_t {
  - kFLEXIO\_I2S\_Master = 0x0U,
  - kFLEXIO\_I2S\_Slave = 0x1U }

*Master or slave mode.*
- enum {
  - kFLEXIO\_I2S\_TxDataRegEmptyInterruptEnable = 0x1U,
  - kFLEXIO\_I2S\_RxDataRegFullInterruptEnable = 0x2U }

*\_flexio\_i2s\_interrupt\_enable Define FlexIO FlexIO I2S interrupt mask.*
- enum {
  - kFLEXIO\_I2S\_TxDataRegEmptyFlag = 0x1U,
  - kFLEXIO\_I2S\_RxDataRegFullFlag = 0x2U }

*\_flexio\_i2s\_status\_flags Define FlexIO FlexIO I2S status mask.*
- enum flexio\_i2s\_sample\_rate\_t {
  - kFLEXIO\_I2S\_SampleRate8KHz = 8000U,
  - kFLEXIO\_I2S\_SampleRate11025Hz = 11025U,
  - kFLEXIO\_I2S\_SampleRate12KHz = 12000U,
  - kFLEXIO\_I2S\_SampleRate16KHz = 16000U,
  - kFLEXIO\_I2S\_SampleRate22050Hz = 22050U,
  - kFLEXIO\_I2S\_SampleRate24KHz = 24000U,
  - kFLEXIO\_I2S\_SampleRate32KHz = 32000U,
  - kFLEXIO\_I2S\_SampleRate44100Hz = 44100U,
  - kFLEXIO\_I2S\_SampleRate48KHz = 48000U,
  - kFLEXIO\_I2S\_SampleRate96KHz = 96000U }

*Audio sample rate.*
- enum flexio\_i2s\_word\_width\_t {
  - kFLEXIO\_I2S\_WordWidth8bits = 8U,
  - kFLEXIO\_I2S\_WordWidth16bits = 16U,
  - kFLEXIO\_I2S\_WordWidth24bits = 24U,
  - kFLEXIO\_I2S\_WordWidth32bits = 32U }

*Audio word width.*

## Driver version

- #define FSL\_FLEXIO\_I2S\_DRIVER\_VERSION (MAKE\_VERSION(2, 2, 0))
 

*FlexIO I2S driver version 2.2.0.*

## Initialization and deinitialization

- void `FLEXIO_I2S_Init` (`FLEXIO_I2S_Type *base`, const `flexio_i2s_config_t *config`)  
*Initializes the FlexIO I2S.*
- void `FLEXIO_I2S_GetDefaultConfig` (`flexio_i2s_config_t *config`)  
*Sets the FlexIO I2S configuration structure to default values.*
- void `FLEXIO_I2S_Deinit` (`FLEXIO_I2S_Type *base`)  
*De-initializes the FlexIO I2S.*
- static void `FLEXIO_I2S_Enable` (`FLEXIO_I2S_Type *base`, bool enable)  
*Enables/disables the FlexIO I2S module operation.*

## Status

- uint32\_t `FLEXIO_I2S_GetStatusFlags` (`FLEXIO_I2S_Type *base`)  
*Gets the FlexIO I2S status flags.*

## Interrupts

- void `FLEXIO_I2S_EnableInterrupts` (`FLEXIO_I2S_Type *base`, uint32\_t mask)  
*Enables the FlexIO I2S interrupt.*
- void `FLEXIO_I2S_DisableInterrupts` (`FLEXIO_I2S_Type *base`, uint32\_t mask)  
*Disables the FlexIO I2S interrupt.*

## DMA Control

- static void `FLEXIO_I2S_TxEnableDMA` (`FLEXIO_I2S_Type *base`, bool enable)  
*Enables/disables the FlexIO I2S Tx DMA requests.*
- static void `FLEXIO_I2S_RxEnableDMA` (`FLEXIO_I2S_Type *base`, bool enable)  
*Enables/disables the FlexIO I2S Rx DMA requests.*
- static uint32\_t `FLEXIO_I2S_TxGetDataRegisterAddress` (`FLEXIO_I2S_Type *base`)  
*Gets the FlexIO I2S send data register address.*
- static uint32\_t `FLEXIO_I2S_RxGetDataRegisterAddress` (`FLEXIO_I2S_Type *base`)  
*Gets the FlexIO I2S receive data register address.*

## Bus Operations

- 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.*
- void `FLEXIO_I2S_SlaveSetFormat` (`FLEXIO_I2S_Type *base`, `flexio_i2s_format_t *format`)  
*Configures the FlexIO I2S audio format in slave mode.*
- `status_t` `FLEXIO_I2S_WriteBlocking` (`FLEXIO_I2S_Type *base`, uint8\_t bitWidth, uint8\_t \*tx-Data, size\_t size)  
*Sends data using a blocking method.*
- static void `FLEXIO_I2S_WriteData` (`FLEXIO_I2S_Type *base`, uint8\_t bitWidth, uint32\_t data)



*Writes data into a data register.*

- `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.*

- `static uint32_t FLEXIO_I2S_ReadData` (`FLEXIO_I2S_Type *base`)

*Reads a data from the data register.*

## Transactional

- `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.*

- `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.*

- `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.*

- `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.*

- `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.*

- `void FLEXIO_I2S_TransferAbortSend` (`FLEXIO_I2S_Type *base`, `flexio_i2s_handle_t *handle`)

*Aborts the current send.*

- `void FLEXIO_I2S_TransferAbortReceive` (`FLEXIO_I2S_Type *base`, `flexio_i2s_handle_t *handle`)

*Aborts the current receive.*

- `status_t FLEXIO_I2S_TransferGetSendCount` (`FLEXIO_I2S_Type *base`, `flexio_i2s_handle_t *handle`, `size_t *count`)

*Gets the remaining bytes to be sent.*

- `status_t FLEXIO_I2S_TransferGetReceiveCount` (`FLEXIO_I2S_Type *base`, `flexio_i2s_handle_t *handle`, `size_t *count`)

*Gets the remaining bytes to be received.*

- `void FLEXIO_I2S_TransferTxHandleIRQ` (`void *i2sBase`, `void *i2sHandle`)

*Tx interrupt handler.*

- `void FLEXIO_I2S_TransferRxHandleIRQ` (`void *i2sBase`, `void *i2sHandle`)

*Rx interrupt handler.*

## 22.5.3 Data Structure Documentation

### 22.5.3.1 struct FLEXIO\_I2S\_Type

#### Data Fields

- `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.*

### 22.5.3.2 struct flexio\_i2s\_config\_t

#### Data Fields

- 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.*

### 22.5.3.3 struct flexio\_i2s\_format\_t

#### Data Fields

- uint8\_t `bitWidth`  
*Bit width of audio data, always 8/16/24/32 bits.*
- uint32\_t `sampleRate_Hz`  
*Sample rate of the audio data.*

### 22.5.3.4 struct flexio\_i2s\_transfer\_t

#### Data Fields

- uint8\_t \* [data](#)  
*Data buffer start pointer.*
- size\_t [dataSize](#)  
*Bytes to be transferred.*

#### Field Documentation

(1) size\_t flexio\_i2s\_transfer\_t::dataSize

### 22.5.3.5 struct \_flexio\_i2s\_handle

#### Data Fields

- 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](#) [FLEXIO\_I2S\_XFER\_QUEUE\_SIZE]  
*Transfer queue storing queued transfer.*
- size\_t [transferSize](#) [FLEXIO\_I2S\_XFER\_QUEUE\_SIZE]  
*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.*

## 22.5.4 Macro Definition Documentation

22.5.4.1 #define FSL\_FLEXIO\_I2S\_DRIVER\_VERSION (MAKE\_VERSION(2, 2, 0))

22.5.4.2 #define I2S\_RETRY\_TIMES 0U /\* Define to zero means keep waiting until the flag is assert/deassert. \*/

22.5.4.3 #define FLEXIO\_I2S\_XFER\_QUEUE\_SIZE (4U)

## 22.5.5 Enumeration Type Documentation

### 22.5.5.1 anonymous enum

Enumerator

*kStatus\_FLEXIO\_I2S\_Idle* FlexIO I2S is in idle state.  
*kStatus\_FLEXIO\_I2S\_TxBusy* FlexIO I2S Tx is busy.  
*kStatus\_FLEXIO\_I2S\_RxBusy* FlexIO I2S Rx is busy.  
*kStatus\_FLEXIO\_I2S\_Error* FlexIO I2S error occurred.  
*kStatus\_FLEXIO\_I2S\_QueueFull* FlexIO I2S transfer queue is full.  
*kStatus\_FLEXIO\_I2S\_Timeout* FlexIO I2S timeout polling status flags.

### 22.5.5.2 enum flexio\_i2s\_master\_slave\_t

Enumerator

*kFLEXIO\_I2S\_Master* Master mode.  
*kFLEXIO\_I2S\_Slave* Slave mode.

### 22.5.5.3 anonymous enum

Enumerator

*kFLEXIO\_I2S\_TxDataRegEmptyInterruptEnable* Transmit buffer empty interrupt enable.  
*kFLEXIO\_I2S\_RxDataRegFullInterruptEnable* Receive buffer full interrupt enable.

### 22.5.5.4 anonymous enum

Enumerator

*kFLEXIO\_I2S\_TxDataRegEmptyFlag* Transmit buffer empty flag.  
*kFLEXIO\_I2S\_RxDataRegFullFlag* Receive buffer full flag.

### 22.5.5.5 enum flexio\_i2s\_sample\_rate\_t

Enumerator

*kFLEXIO\_I2S\_SampleRate8KHz* Sample rate 8000Hz.  
*kFLEXIO\_I2S\_SampleRate11025Hz* Sample rate 11025Hz.  
*kFLEXIO\_I2S\_SampleRate12KHz* Sample rate 12000Hz.  
*kFLEXIO\_I2S\_SampleRate16KHz* Sample rate 16000Hz.  
*kFLEXIO\_I2S\_SampleRate22050Hz* Sample rate 22050Hz.  
*kFLEXIO\_I2S\_SampleRate24KHz* Sample rate 24000Hz.

*kFLEXIO\_I2S\_SampleRate32KHz* Sample rate 32000Hz.  
*kFLEXIO\_I2S\_SampleRate44100Hz* Sample rate 44100Hz.  
*kFLEXIO\_I2S\_SampleRate48KHz* Sample rate 48000Hz.  
*kFLEXIO\_I2S\_SampleRate96KHz* Sample rate 96000Hz.

### 22.5.5.6 enum flexio\_i2s\_word\_width\_t

Enumerator

*kFLEXIO\_I2S\_WordWidth8bits* Audio data width 8 bits.  
*kFLEXIO\_I2S\_WordWidth16bits* Audio data width 16 bits.  
*kFLEXIO\_I2S\_WordWidth24bits* Audio data width 24 bits.  
*kFLEXIO\_I2S\_WordWidth32bits* Audio data width 32 bits.

## 22.5.6 Function Documentation

### 22.5.6.1 void FLEXIO\_I2S\_Init ( FLEXIO\_I2S\_Type \* *base*, const flexio\_i2s\_config\_t \* *config* )

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

|               |                                 |
|---------------|---------------------------------|
| <i>base</i>   | FlexIO I2S base pointer         |
| <i>config</i> | FlexIO I2S configure structure. |

### 22.5.6.2 void FLEXIO\_I2S\_GetDefaultConfig ( flexio\_i2s\_config\_t \* *config* )

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

|               |                                           |
|---------------|-------------------------------------------|
| <i>config</i> | pointer to master configuration structure |
|---------------|-------------------------------------------|

**22.5.6.3 void FLEXIO\_I2S\_Deinit ( FLEXIO\_I2S\_Type \* *base* )**

Calling this API resets the FlexIO I2S shifter and timer config. After calling this API, call the FLEXIO\_I2S\_Init to use the FlexIO I2S module.

## Parameters

|             |                         |
|-------------|-------------------------|
| <i>base</i> | FlexIO I2S base pointer |
|-------------|-------------------------|

**22.5.6.4 static void FLEXIO\_I2S\_Enable ( FLEXIO\_I2S\_Type \* *base*, bool *enable* )  
[inline], [static]**

## Parameters

|               |                                                 |
|---------------|-------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2S_Type</a>      |
| <i>enable</i> | True to enable, false dose not have any effect. |

**22.5.6.5 uint32\_t FLEXIO\_I2S\_GetStatusFlags ( FLEXIO\_I2S\_Type \* *base* )**

## Parameters

|             |                                                      |
|-------------|------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure |
|-------------|------------------------------------------------------|

## Returns

Status flag, which are ORed by the enumerators in the `_flexio_i2s_status_flags`.

**22.5.6.6 void FLEXIO\_I2S\_EnableInterrupts ( FLEXIO\_I2S\_Type \* *base*, uint32\_t *mask* )**

This function enables the FlexIO UART interrupt.

Parameters

|             |                                                      |
|-------------|------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure |
| <i>mask</i> | interrupt source                                     |

**22.5.6.7 void FLEXIO\_I2S\_DisableInterrupts ( FLEXIO\_I2S\_Type \* *base*, uint32\_t *mask* )**

This function enables the FlexIO UART interrupt.

Parameters

|             |                                                      |
|-------------|------------------------------------------------------|
| <i>base</i> | pointer to <a href="#">FLEXIO_I2S_Type</a> structure |
| <i>mask</i> | interrupt source                                     |

**22.5.6.8 static void FLEXIO\_I2S\_TxEnableDMA ( FLEXIO\_I2S\_Type \* *base*, bool *enable* ) [inline], [static]**

Parameters

|               |                                                 |
|---------------|-------------------------------------------------|
| <i>base</i>   | FlexIO I2S base pointer                         |
| <i>enable</i> | True means enable DMA, false means disable DMA. |

**22.5.6.9 static void FLEXIO\_I2S\_RxEnableDMA ( FLEXIO\_I2S\_Type \* *base*, bool *enable* ) [inline], [static]**

Parameters

|               |                                                 |
|---------------|-------------------------------------------------|
| <i>base</i>   | FlexIO I2S base pointer                         |
| <i>enable</i> | True means enable DMA, false means disable DMA. |

**22.5.6.10 static uint32\_t FLEXIO\_I2S\_TxGetDataRegisterAddress ( FLEXIO\_I2S\_Type \* *base* ) [inline], [static]**

This function returns the I2S data register address, mainly used by DMA/eDMA.

## Parameters

|             |                                                      |
|-------------|------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure |
|-------------|------------------------------------------------------|

## Returns

FlexIO i2s send data register address.

**22.5.6.11** `static uint32_t FLEXIO_I2S_RxGetDataRegisterAddress ( FLEXIO_I2S_Type * base ) [inline], [static]`

This function returns the I2S data register address, mainly used by DMA/eDMA.

## Parameters

|             |                                                      |
|-------------|------------------------------------------------------|
| <i>base</i> | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure |
|-------------|------------------------------------------------------|

## Returns

FlexIO i2s receive data register address.

**22.5.6.12** `void FLEXIO_I2S_MasterSetFormat ( FLEXIO_I2S_Type * base, flexio_i2s_format_t * format, uint32_t srcClock_Hz )`

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

|                    |                                                      |
|--------------------|------------------------------------------------------|
| <i>base</i>        | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure |
| <i>format</i>      | Pointer to FlexIO I2S audio data format structure.   |
| <i>srcClock_Hz</i> | I2S master clock source frequency in Hz.             |

**22.5.6.13** `void FLEXIO_I2S_SlaveSetFormat ( FLEXIO_I2S_Type * base, flexio_i2s_format_t * format )`

Audio format can be changed in run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred.



## Parameters

|               |                                                      |
|---------------|------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure |
| <i>format</i> | Pointer to FlexIO I2S audio data format structure.   |

**22.5.6.14** `status_t FLEXIO_I2S_WriteBlocking ( FLEXIO_I2S_Type * base, uint8_t bitWidth, uint8_t * txData, size_t size )`

## Note

This function blocks via polling until data is ready to be sent.

## Parameters

|                 |                                                         |
|-----------------|---------------------------------------------------------|
| <i>base</i>     | FlexIO I2S base pointer.                                |
| <i>bitWidth</i> | How many bits in a audio word, usually 8/16/24/32 bits. |
| <i>txData</i>   | Pointer to the data to be written.                      |
| <i>size</i>     | Bytes to be written.                                    |

## Return values

|                                   |                               |
|-----------------------------------|-------------------------------|
| <i>kStatus_Success</i>            | Successfully write data.      |
| <i>kStatus_FLEXIO_I2C_Timeout</i> | Timeout polling status flags. |

**22.5.6.15** `static void FLEXIO_I2S_WriteData ( FLEXIO_I2S_Type * base, uint8_t bitWidth, uint32_t data ) [inline], [static]`

## Parameters

|                 |                                                         |
|-----------------|---------------------------------------------------------|
| <i>base</i>     | FlexIO I2S base pointer.                                |
| <i>bitWidth</i> | How many bits in a audio word, usually 8/16/24/32 bits. |
| <i>data</i>     | Data to be written.                                     |

**22.5.6.16** `status_t FLEXIO_I2S_ReadBlocking ( FLEXIO_I2S_Type * base, uint8_t bitWidth, uint8_t * rxData, size_t size )`

## Note

This function blocks via polling until data is ready to be sent.

## Parameters

|                 |                                                         |
|-----------------|---------------------------------------------------------|
| <i>base</i>     | FlexIO I2S base pointer                                 |
| <i>bitWidth</i> | How many bits in a audio word, usually 8/16/24/32 bits. |
| <i>rxData</i>   | Pointer to the data to be read.                         |
| <i>size</i>     | Bytes to be read.                                       |

## Return values

|                                   |                               |
|-----------------------------------|-------------------------------|
| <i>kStatus_Success</i>            | Successfully read data.       |
| <i>kStatus_FLEXIO_I2C_Timeout</i> | Timeout polling status flags. |

**22.5.6.17** `static uint32_t FLEXIO_I2S_ReadData ( FLEXIO_I2S_Type * base )`  
**[inline], [static]**

## Parameters

|             |                         |
|-------------|-------------------------|
| <i>base</i> | FlexIO I2S base pointer |
|-------------|-------------------------|

## Returns

Data read from data register.

**22.5.6.18** `void FLEXIO_I2S_TransferTxCreateHandle ( FLEXIO_I2S_Type * base,`  
`flexio_i2s_handle_t * handle, flexio_i2s_callback_t callback, void * userData )`

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

|                 |                                                                       |
|-----------------|-----------------------------------------------------------------------|
| <i>base</i>     | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure                  |
| <i>handle</i>   | Pointer to flexio_i2s_handle_t structure to store the transfer state. |
| <i>callback</i> | FlexIO I2S callback function, which is called while finished a block. |
| <i>userData</i> | User parameter for the FlexIO I2S callback.                           |

**22.5.6.19 void FLEXIO\_I2S\_TransferSetFormat ( FLEXIO\_I2S\_Type \* *base*, flexio\_i2s\_handle\_t \* *handle*, flexio\_i2s\_format\_t \* *format*, uint32\_t *srcClock\_Hz* )**

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

|                    |                                                                                              |
|--------------------|----------------------------------------------------------------------------------------------|
| <i>base</i>        | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure.                                        |
| <i>handle</i>      | FlexIO I2S handle pointer.                                                                   |
| <i>format</i>      | Pointer to audio data format structure.                                                      |
| <i>srcClock_Hz</i> | FlexIO I2S bit clock source frequency in Hz. This parameter should be 0 while in slave mode. |

**22.5.6.20 void FLEXIO\_I2S\_TransferRxCreateHandle ( FLEXIO\_I2S\_Type \* *base*, flexio\_i2s\_handle\_t \* *handle*, flexio\_i2s\_callback\_t *callback*, void \* *userData* )**

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

|                 |                                                                       |
|-----------------|-----------------------------------------------------------------------|
| <i>base</i>     | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure.                 |
| <i>handle</i>   | Pointer to flexio_i2s_handle_t structure to store the transfer state. |
| <i>callback</i> | FlexIO I2S callback function, which is called while finished a block. |
| <i>userData</i> | User parameter for the FlexIO I2S callback.                           |

**22.5.6.21 status\_t FLEXIO\_I2S\_TransferSendNonBlocking ( FLEXIO\_I2S\_Type \* *base*, flexio\_i2s\_handle\_t \* *handle*, flexio\_i2s\_transfer\_t \* *xfer* )**

## 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

|               |                                                                          |
|---------------|--------------------------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure.                    |
| <i>handle</i> | Pointer to flexio_i2s_handle_t structure which stores the transfer state |
| <i>xfer</i>   | Pointer to <a href="#">flexio_i2s_transfer_t</a> structure               |

## Return values

|                                   |                                                                                    |
|-----------------------------------|------------------------------------------------------------------------------------|
| <i>kStatus_Success</i>            | Successfully start the data transmission.                                          |
| <i>kStatus_FLEXIO_I2S_Tx-Busy</i> | Previous transmission still not finished, data not all written to TX register yet. |
| <i>kStatus_InvalidArgument</i>    | The input parameter is invalid.                                                    |

### 22.5.6.22 status\_t FLEXIO\_I2S\_TransferReceiveNonBlocking ( FLEXIO\_I2S\_Type \* base, flexio\_i2s\_handle\_t \* handle, flexio\_i2s\_transfer\_t \* xfer )

## 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

|               |                                                                          |
|---------------|--------------------------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure.                    |
| <i>handle</i> | Pointer to flexio_i2s_handle_t structure which stores the transfer state |
| <i>xfer</i>   | Pointer to <a href="#">flexio_i2s_transfer_t</a> structure               |

## Return values

|                        |                                      |
|------------------------|--------------------------------------|
| <i>kStatus_Success</i> | Successfully start the data receive. |
|------------------------|--------------------------------------|

|                                   |                                      |
|-----------------------------------|--------------------------------------|
| <i>kStatus_FLEXIO_I2S_-RxBusy</i> | Previous receive still not finished. |
| <i>kStatus_InvalidArgument</i>    | The input parameter is invalid.      |

#### 22.5.6.23 void FLEXIO\_I2S\_TransferAbortSend ( FLEXIO\_I2S\_Type \* *base*, flexio\_i2s\_handle\_t \* *handle* )

##### Note

This API can be called at any time when interrupt non-blocking transfer initiates to abort the transfer in a early time.

##### Parameters

|               |                                                                          |
|---------------|--------------------------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure.                    |
| <i>handle</i> | Pointer to flexio_i2s_handle_t structure which stores the transfer state |

#### 22.5.6.24 void FLEXIO\_I2S\_TransferAbortReceive ( FLEXIO\_I2S\_Type \* *base*, flexio\_i2s\_handle\_t \* *handle* )

##### Note

This API can be called at any time when interrupt non-blocking transfer initiates to abort the transfer in a early time.

##### Parameters

|               |                                                                          |
|---------------|--------------------------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure.                    |
| <i>handle</i> | Pointer to flexio_i2s_handle_t structure which stores the transfer state |

#### 22.5.6.25 status\_t FLEXIO\_I2S\_TransferGetSendCount ( FLEXIO\_I2S\_Type \* *base*, flexio\_i2s\_handle\_t \* *handle*, size\_t \* *count* )

##### Parameters

|               |                                                                          |
|---------------|--------------------------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure.                    |
| <i>handle</i> | Pointer to flexio_i2s_handle_t structure which stores the transfer state |
| <i>count</i>  | Bytes sent.                                                              |

Return values

|                                     |                                                                |
|-------------------------------------|----------------------------------------------------------------|
| <i>kStatus_Success</i>              | Succeed get the transfer count.                                |
| <i>kStatus_NoTransferInProgress</i> | There is not a non-blocking transaction currently in progress. |

#### 22.5.6.26 `status_t FLEXIO_I2S_TransferGetReceiveCount ( FLEXIO_I2S_Type * base, flexio_i2s_handle_t * handle, size_t * count )`

Parameters

|               |                                                                          |
|---------------|--------------------------------------------------------------------------|
| <i>base</i>   | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure.                    |
| <i>handle</i> | Pointer to flexio_i2s_handle_t structure which stores the transfer state |
| <i>count</i>  | Bytes received.                                                          |

Returns

count Bytes received.

Return values

|                                     |                                                                |
|-------------------------------------|----------------------------------------------------------------|
| <i>kStatus_Success</i>              | Succeed get the transfer count.                                |
| <i>kStatus_NoTransferInProgress</i> | There is not a non-blocking transaction currently in progress. |

#### 22.5.6.27 `void FLEXIO_I2S_TransferTxHandleIRQ ( void * i2sBase, void * i2sHandle )`

Parameters

|                |                                                       |
|----------------|-------------------------------------------------------|
| <i>i2sBase</i> | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure. |
|----------------|-------------------------------------------------------|

|                  |                                          |
|------------------|------------------------------------------|
| <i>i2sHandle</i> | Pointer to flexio_i2s_handle_t structure |
|------------------|------------------------------------------|

#### 22.5.6.28 void FLEXIO\_I2S\_TransferRxHandleIRQ ( void \* *i2sBase*, void \* *i2sHandle* )

Parameters

|                  |                                                       |
|------------------|-------------------------------------------------------|
| <i>i2sBase</i>   | Pointer to <a href="#">FLEXIO_I2S_Type</a> structure. |
| <i>i2sHandle</i> | Pointer to flexio_i2s_handle_t structure.             |

## 22.5.7 FlexIO eDMA I2S Driver

### 22.5.7.1 Overview

#### Data Structures

- struct `flexio_i2s_edma_handle_t`  
*FlexIO I2S DMA transfer handle, users should not touch the content of the handle. [More...](#)*

#### Typedefs

- typedef void(\* `flexio_i2s_edma_callback_t`)(`FLEXIO_I2S_Type` \*base, `flexio_i2s_edma_handle_t` \*handle, `status_t` status, void \*userData)  
*FlexIO I2S eDMA transfer callback function for finish and error.*

#### Driver version

- #define `FSL_FLEXIO_I2S_EDMA_DRIVER_VERSION` (`MAKE_VERSION(2, 1, 7)`)  
*FlexIO I2S EDMA driver version 2.1.7.*

#### eDMA Transactional

- void `FLEXIO_I2S_TransferTxCreateHandleEDMA` (`FLEXIO_I2S_Type` \*base, `flexio_i2s_edma_handle_t` \*handle, `flexio_i2s_edma_callback_t` callback, void \*userData, `edma_handle_t` \*dmaHandle)  
*Initializes the FlexIO I2S eDMA handle.*
- void `FLEXIO_I2S_TransferRxCreateHandleEDMA` (`FLEXIO_I2S_Type` \*base, `flexio_i2s_edma_handle_t` \*handle, `flexio_i2s_edma_callback_t` callback, void \*userData, `edma_handle_t` \*dmaHandle)  
*Initializes the FlexIO I2S Rx eDMA handle.*
- void `FLEXIO_I2S_TransferSetFormatEDMA` (`FLEXIO_I2S_Type` \*base, `flexio_i2s_edma_handle_t` \*handle, `flexio_i2s_format_t` \*format, `uint32_t` srcClock\_Hz)  
*Configures the FlexIO I2S Tx audio format.*
- `status_t` `FLEXIO_I2S_TransferSendEDMA` (`FLEXIO_I2S_Type` \*base, `flexio_i2s_edma_handle_t` \*handle, `flexio_i2s_transfer_t` \*xfer)  
*Performs a non-blocking FlexIO I2S transfer using DMA.*
- `status_t` `FLEXIO_I2S_TransferReceiveEDMA` (`FLEXIO_I2S_Type` \*base, `flexio_i2s_edma_handle_t` \*handle, `flexio_i2s_transfer_t` \*xfer)  
*Performs a non-blocking FlexIO I2S receive using eDMA.*
- void `FLEXIO_I2S_TransferAbortSendEDMA` (`FLEXIO_I2S_Type` \*base, `flexio_i2s_edma_handle_t` \*handle)  
*Aborts a FlexIO I2S transfer using eDMA.*
- void `FLEXIO_I2S_TransferAbortReceiveEDMA` (`FLEXIO_I2S_Type` \*base, `flexio_i2s_edma_handle_t` \*handle)  
*Aborts a FlexIO I2S receive using eDMA.*



- `status_t FLEXIO_I2S_TransferGetSendCountEDMA` (`FLEXIO_I2S_Type *base`, `flexio_i2s_edma_handle_t *handle`, `size_t *count`)  
*Gets the remaining bytes to be sent.*
- `status_t FLEXIO_I2S_TransferGetReceiveCountEDMA` (`FLEXIO_I2S_Type *base`, `flexio_i2s_edma_handle_t *handle`, `size_t *count`)  
*Get the remaining bytes to be received.*

## 22.5.7.2 Data Structure Documentation

### 22.5.7.2.1 struct flexio\_i2s\_edma\_handle

#### Data Fields

- `edma_handle_t * dmaHandle`  
*DMA handler for FlexIO I2S send.*
- `uint8_t bytesPerFrame`  
*Bytes in a frame.*
- `uint8_t nbytes`  
*eDMA minor byte transfer count initially configured.*
- `uint32_t state`  
*Internal state for FlexIO I2S eDMA transfer.*
- `flexio_i2s_edma_callback_t callback`  
*Callback for users while transfer finish or error occurred.*
- `void * userData`  
*User callback parameter.*
- `edma_tcd_t tcd [FLEXIO_I2S_XFER_QUEUE_SIZE+1U]`  
*TCD pool for eDMA transfer.*
- `flexio_i2s_transfer_t queue [FLEXIO_I2S_XFER_QUEUE_SIZE]`  
*Transfer queue storing queued transfer.*
- `size_t transferSize [FLEXIO_I2S_XFER_QUEUE_SIZE]`  
*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.*

#### Field Documentation

- (1) `uint8_t flexio_i2s_edma_handle_t::nbytes`
- (2) `edma_tcd_t flexio_i2s_edma_handle_t::tcd[FLEXIO_I2S_XFER_QUEUE_SIZE+1U]`
- (3) `flexio_i2s_transfer_t flexio_i2s_edma_handle_t::queue[FLEXIO_I2S_XFER_QUEUE_SIZE]`
- (4) `volatile uint8_t flexio_i2s_edma_handle_t::queueUser`

## 22.5.7.3 Macro Definition Documentation

- 22.5.7.3.1 `#define FSL_FLEXIO_I2S_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 1, 7))`

## 22.5.7.4 Function Documentation

**22.5.7.4.1 void FLEXIO\_I2S\_TransferTxCreateHandleEDMA ( FLEXIO\_I2S\_Type \* *base*, flexio\_i2s\_edma\_handle\_t \* *handle*, flexio\_i2s\_edma\_callback\_t *callback*, void \* *userData*, edma\_handle\_t \* *dmaHandle* )**

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

|                  |                                                                               |
|------------------|-------------------------------------------------------------------------------|
| <i>base</i>      | FlexIO I2S peripheral base address.                                           |
| <i>handle</i>    | FlexIO I2S eDMA handle pointer.                                               |
| <i>callback</i>  | FlexIO I2S eDMA callback function called while finished a block.              |
| <i>userData</i>  | User parameter for callback.                                                  |
| <i>dmaHandle</i> | eDMA handle for FlexIO I2S. This handle is a static value allocated by users. |

**22.5.7.4.2 void FLEXIO\_I2S\_TransferRxCreateHandleEDMA ( FLEXIO\_I2S\_Type \* *base*, flexio\_i2s\_edma\_handle\_t \* *handle*, flexio\_i2s\_edma\_callback\_t *callback*, void \* *userData*, edma\_handle\_t \* *dmaHandle* )**

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

|                  |                                                                               |
|------------------|-------------------------------------------------------------------------------|
| <i>base</i>      | FlexIO I2S peripheral base address.                                           |
| <i>handle</i>    | FlexIO I2S eDMA handle pointer.                                               |
| <i>callback</i>  | FlexIO I2S eDMA callback function called while finished a block.              |
| <i>userData</i>  | User parameter for callback.                                                  |
| <i>dmaHandle</i> | eDMA handle for FlexIO I2S. This handle is a static value allocated by users. |

**22.5.7.4.3 void FLEXIO\_I2S\_TransferSetFormatEDMA ( FLEXIO\_I2S\_Type \* *base*, flexio\_i2s\_edma\_handle\_t \* *handle*, flexio\_i2s\_format\_t \* *format*, uint32\_t *srcClock\_Hz* )**

Audio format can be changed in run-time of FlexIO I2S. This function configures the sample rate and audio data format to be transferred. This function also sets the eDMA parameter according to format.

## Parameters

|                    |                                                                              |
|--------------------|------------------------------------------------------------------------------|
| <i>base</i>        | FlexIO I2S peripheral base address.                                          |
| <i>handle</i>      | FlexIO I2S eDMA handle pointer                                               |
| <i>format</i>      | Pointer to FlexIO I2S audio data format structure.                           |
| <i>srcClock_Hz</i> | FlexIO I2S clock source frequency in Hz, it should be 0 while in slave mode. |

#### 22.5.7.4.4 `status_t FLEXIO_I2S_TransferSendEDMA ( FLEXIO_I2S_Type * base, flexio_i2s_edma_handle_t * handle, flexio_i2s_transfer_t * xfer )`

## Note

This interface returned immediately after transfer initiates. Users should call `FLEXIO_I2S_GetTransferStatus` to poll the transfer status and check whether the FlexIO I2S transfer is finished.

## Parameters

|               |                                     |
|---------------|-------------------------------------|
| <i>base</i>   | FlexIO I2S peripheral base address. |
| <i>handle</i> | FlexIO I2S DMA handle pointer.      |
| <i>xfer</i>   | Pointer to DMA transfer structure.  |

## Return values

|                                |                                            |
|--------------------------------|--------------------------------------------|
| <i>kStatus_Success</i>         | Start a FlexIO I2S eDMA send successfully. |
| <i>kStatus_InvalidArgument</i> | The input arguments is invalid.            |
| <i>kStatus_TxBusy</i>          | FlexIO I2S is busy sending data.           |

#### 22.5.7.4.5 `status_t FLEXIO_I2S_TransferReceiveEDMA ( FLEXIO_I2S_Type * base, flexio_i2s_edma_handle_t * handle, flexio_i2s_transfer_t * xfer )`

## Note

This interface returned immediately after transfer initiates. Users should call `FLEXIO_I2S_GetReceiveRemainingBytes` to poll the transfer status and check whether the FlexIO I2S transfer is finished.

## Parameters

|               |                                     |
|---------------|-------------------------------------|
| <i>base</i>   | FlexIO I2S peripheral base address. |
| <i>handle</i> | FlexIO I2S DMA handle pointer.      |
| <i>xfer</i>   | Pointer to DMA transfer structure.  |

## Return values

|                                |                                               |
|--------------------------------|-----------------------------------------------|
| <i>kStatus_Success</i>         | Start a FlexIO I2S eDMA receive successfully. |
| <i>kStatus_InvalidArgument</i> | The input arguments is invalid.               |
| <i>kStatus_RxBusy</i>          | FlexIO I2S is busy receiving data.            |

#### 22.5.7.4.6 void FLEXIO\_I2S\_TransferAbortSendEDMA ( FLEXIO\_I2S\_Type \* *base*, flexio\_i2s\_edma\_handle\_t \* *handle* )

## Parameters

|               |                                     |
|---------------|-------------------------------------|
| <i>base</i>   | FlexIO I2S peripheral base address. |
| <i>handle</i> | FlexIO I2S DMA handle pointer.      |

#### 22.5.7.4.7 void FLEXIO\_I2S\_TransferAbortReceiveEDMA ( FLEXIO\_I2S\_Type \* *base*, flexio\_i2s\_edma\_handle\_t \* *handle* )

## Parameters

|               |                                     |
|---------------|-------------------------------------|
| <i>base</i>   | FlexIO I2S peripheral base address. |
| <i>handle</i> | FlexIO I2S DMA handle pointer.      |

#### 22.5.7.4.8 status\_t FLEXIO\_I2S\_TransferGetSendCountEDMA ( FLEXIO\_I2S\_Type \* *base*, flexio\_i2s\_edma\_handle\_t \* *handle*, size\_t \* *count* )

## Parameters

|             |                                     |
|-------------|-------------------------------------|
| <i>base</i> | FlexIO I2S peripheral base address. |
|-------------|-------------------------------------|

|               |                                |
|---------------|--------------------------------|
| <i>handle</i> | FlexIO I2S DMA handle pointer. |
| <i>count</i>  | Bytes sent.                    |

Return values

|                                     |                                                                |
|-------------------------------------|----------------------------------------------------------------|
| <i>kStatus_Success</i>              | Succeed get the transfer count.                                |
| <i>kStatus_NoTransferInProgress</i> | There is not a non-blocking transaction currently in progress. |

**22.5.7.4.9** `status_t FLEXIO_I2S_TransferGetReceiveCountEDMA ( FLEXIO_I2S_Type * base, flexio_i2s_edma_handle_t * handle, size_t * count )`

Parameters

|               |                                     |
|---------------|-------------------------------------|
| <i>base</i>   | FlexIO I2S peripheral base address. |
| <i>handle</i> | FlexIO I2S DMA handle pointer.      |
| <i>count</i>  | Bytes received.                     |

Return values

|                                     |                                                                |
|-------------------------------------|----------------------------------------------------------------|
| <i>kStatus_Success</i>              | Succeed get the transfer count.                                |
| <i>kStatus_NoTransferInProgress</i> | There is not a non-blocking transaction currently in progress. |

## 22.6 FlexIO MCU Interface LCD Driver

### 22.6.1 Overview

The MCUXpresso SDK provides a peripheral driver for LCD (8080 or 6800 interface) function using Flexible I/O module of MCUXpresso SDK devices.

The FlexIO LCD driver supports both 8-bit and 16-bit data bus, 8080 and 6800 interface. User could change the macro `FLEXIO_MCULCD_DATA_BUS_WIDTH` to choose 8-bit data bus or 16-bit data bus.

The FlexIO LCD driver supports three kinds of data transfer:

1. Send a data array. For example, send the LCD image data to the LCD controller.
2. Send a value many times. For example, send 0 many times to clean the LCD screen.
3. Read data into a data array. For example, read image from LCD controller.

The FlexIO LCD driver includes functional APIs and transactional APIs.

Functional APIs are feature/property target low level APIs. Functional APIs can be used for FlexIO LCD initialization/configuration/operation for optimization/customization purpose. Using the functional API requires the knowledge of the FlexIO LCD peripheral and how to organize functional APIs to meet the application requirements. All functional API use the peripheral base address as the first parameter. FlexIO LCD functional operation groups provide the functional APIs set.

Transactional APIs are transaction target high level APIs. The transactional APIs can be used to enable the peripheral and also in the application if the code size and performance of transactional APIs can satisfy requirements. If the code size and performance are critical requirements, see the transactional API implementation and write custom code.

Transactional APIs support asynchronous transfer. This means that the function `FLEXIO_MCULCD_-TransferNonBlocking` sets up an interrupt for data transfer. When the transfer completes, the upper layer is notified through a callback function with the `kStatus_FLEXIO_MCULCD_Idle` status.

### 22.6.2 Typical use case

#### 22.6.2.1 FlexIO LCD send/receive using functional APIs

This example shows how to send command, or write and read data using the functional APIs. The data bus is 16-bit.

```
uint16_t dataToSend[] = { ... };
uint16_t dataToReceive[] = { ... };

FLEXIO_MCULCD_Type flexioLcdDev;
flexio_MCULCD_transfer_t xfer;
flexio_MCULCD_config_t config;

FLEXIO_MCULCD_GetDefaultConfig(&config);
FLEXIO_MCULCD_Init(&flexioLcdDev, &config, 120000000);

// Method 1:
FLEXIO_MCULCD_StartTransfer(&flexioLcdDev);
```

```

FLEXIO_MCULCD_WriteCommandBlocking(&flexioLcdDev, command1);
FLEXIO_MCULCD_StopTransfer(&flexioLcdDev);

// Method 2:
xfer.command = command1;
xfer.dataCount = 0; // Only send command, no data transfer.
FLEXIO_MCULCD_TransferBlocking(&flexioLcdDev, &xfer);

// Method 1:
FLEXIO_MCULCD_StartTransfer(&flexioLcdDev);
FLEXIO_MCULCD_WriteCommandBlocking(&flexioLcdDev, command2);
FLEXIO_MCULCD_WriteDataArrayBlocking(&flexioLcdDev, dataToSend, sizeof(
 dataToSend));
FLEXIO_MCULCD_StopTransfer(&flexioLcdDev);

// Method 2:
xfer.command = command2;
xfer.mode = kFLEXIO_MCULCD_WriteArray;
xfer.dataAddrOrSameValue = (uint32_t)dataToSend;
xfer.dataCount = sizeof(dataToSend);
FLEXIO_MCULCD_TransferBlocking(&flexioLcdDev, &xfer);

// Method 1:
FLEXIO_MCULCD_StartTransfer(&flexioLcdDev);
FLEXIO_MCULCD_WriteCommandBlocking(&flexioLcdDev, command2);
FLEXIO_MCULCD_WriteSameValueBlocking(&flexioLcdDev, value, 1000); //
 Send value 1000 times
FLEXIO_MCULCD_StopTransfer(&flexioLcdDev);

// Method 2:
xfer.command = command2;
xfer.mode = kFLEXIO_MCULCD_WriteSameValue;
xfer.dataAddrOrSameValue = value;
xfer.dataCount = 1000;
FLEXIO_MCULCD_TransferBlocking(&flexioLcdDev, &xfer);

// Method 1:
FLEXIO_MCULCD_StartTransfer(&flexioLcdDev);
FLEXIO_MCULCD_WriteCommandBlocking(&flexioLcdDev, command3);
FLEXIO_MCULCD_ReadDataArrayBlocking(&flexioLcdDev, dataToReceive, sizeof(
 dataToReceive));
FLEXIO_MCULCD_StopTransfer(&flexioLcdDev);

// Method 2:
xfer.command = command3;
xfer.mode = kFLEXIO_MCULCD_ReadArray;
xfer.dataAddrOrSameValue = (uint32_t)dataToReceive;
xfer.dataCount = sizeof(dataToReceive);
FLEXIO_MCULCD_TransferBlocking(&flexioLcdDev, &xfer);

```

### 22.6.2.2 FlexIO LCD send/receive using interrupt transactional APIs

```

flexio_MCULCD_handle_t handle;
volatile bool completeFlag = false;

void flexioLcdCallback(FLEXIO_MCULCD_Type *base, flexio_MCULCD_handle_t *handle,
 status_t status, void *userData)
{
 if (kStatus_FLEXIO_MCULCD_Idle == status)
 {
 completeFlag = true;
 }
}

void main(void)

```

```

{
 // Init the FlexIO LCD driver.
 FLEXIO_MCULCD_Init(...);

 // Create the transactional handle.
 FLEXIO_MCULCD_TransferCreateHandle(&flexioLcdDev, &handle,
 flexioLcdCallback, NULL);

 xfer.command = command1;
 xfer.dataCount = 0; // Only send command, no data transfer.
 completeFlag = false;
 FLEXIO_MCULCD_TransferNonBlocking(&flexioLcdDev, &xfer);

 // When only send method, it is not necessary to wait for the callback,
 // because the command is sent using a blocking method internally. The
 // command has been sent out after the function FLEXIO_MCULCD_TransferNonBlocking
 // returns.
 while (!completeFlag)
 {
 }

 xfer.command = command2;
 xfer.mode = kFLEXIO_MCULCD_WriteArray;
 xfer.dataAddrOrSameValue = (uint32_t)dataToSend;
 xfer.dataCount = sizeof(dataToSend);
 completeFlag = false;
 FLEXIO_MCULCD_TransferNonBlocking(&flexioLcdDev, &handle, &xfer);

 while (!completeFlag)
 {
 }

 xfer.command = command2;
 xfer.mode = kFLEXIO_MCULCD_WriteSameValue;
 xfer.dataAddrOrSameValue = value;
 xfer.dataCount = 1000;
 completeFlag = false;
 FLEXIO_MCULCD_TransferNonBlocking(&flexioLcdDev, &handle, &xfer);

 while (!completeFlag)
 {
 }

 xfer.command = command3;
 xfer.mode = kFLEXIO_MCULCD_ReadArray;
 xfer.dataAddrOrSameValue = (uint32_t)dataToReceive;
 xfer.dataCount = sizeof(dataToReceive);
 completeFlag = false;
 FLEXIO_MCULCD_TransferNonBlocking(&flexioLcdDev, &handle, &xfer);

 while (!completeFlag)
 {
 }
}

```

## Modules

- [FlexIO eDMA MCU Interface LCD Driver](#)

*SDK provide eDMA transactional APIs to transfer data using eDMA, the eDMA method is similar with interrupt transactional method.*



## Data Structures

- struct [FLEXIO\\_MCULCD\\_Type](#)  
*Define FlexIO MCULCD access structure typedef. [More...](#)*
- struct [flexio\\_mculcd\\_config\\_t](#)  
*Define FlexIO MCULCD configuration structure. [More...](#)*
- struct [flexio\\_mculcd\\_transfer\\_t](#)  
*Define FlexIO MCULCD transfer structure. [More...](#)*
- struct [flexio\\_mculcd\\_handle\\_t](#)  
*Define FlexIO MCULCD handle structure. [More...](#)*

## Macros

- #define [FLEXIO\\_MCULCD\\_WAIT\\_COMPLETE\\_TIME](#) 512  
*The delay time to wait for FLEXIO transmit complete.*
- #define [FLEXIO\\_MCULCD\\_DATA\\_BUS\\_WIDTH](#) 16UL  
*The data bus width, must be 8 or 16.*

## Typedefs

- typedef void(\* [flexio\\_mculcd\\_pin\\_func\\_t](#))(bool set)  
*Function to set or clear the CS and RS pin.*
- typedef void(\* [flexio\\_mculcd\\_transfer\\_callback\\_t](#))([FLEXIO\\_MCULCD\\_Type](#) \*base, [flexio\\_mculcd\\_handle\\_t](#) \*handle, [status\\_t](#) status, void \*userData)  
*FlexIO MCULCD callback for finished transfer.*

## Enumerations

- enum {  
  [kStatus\\_FLEXIO\\_MCULCD\\_Idle](#) = MAKE\_STATUS(kStatusGroup\_FLEXIO\_MCULCD, 0),  
  [kStatus\\_FLEXIO\\_MCULCD\\_Busy](#) = MAKE\_STATUS(kStatusGroup\_FLEXIO\_MCULCD, 1),  
  [kStatus\\_FLEXIO\\_MCULCD\\_Error](#) = MAKE\_STATUS(kStatusGroup\_FLEXIO\_MCULCD, 2) }  
*FlexIO LCD transfer status.*
- enum [flexio\\_mculcd\\_pixel\\_format\\_t](#) {  
  [kFLEXIO\\_MCULCD\\_RGB565](#) = 0,  
  [kFLEXIO\\_MCULCD\\_BGR565](#),  
  [kFLEXIO\\_MCULCD\\_RGB888](#),  
  [kFLEXIO\\_MCULCD\\_BGR888](#) }  
*Define FlexIO MCULCD pixel format.*
- enum [flexio\\_mculcd\\_bus\\_t](#) {  
  [kFLEXIO\\_MCULCD\\_8080](#),  
  [kFLEXIO\\_MCULCD\\_6800](#) }  
*Define FlexIO MCULCD bus type.*
- enum [\\_flexio\\_mculcd\\_interrupt\\_enable](#) {  
  [kFLEXIO\\_MCULCD\\_TxEmptyInterruptEnable](#) = (1U << 0U),

- ```
kFLEXIO_MCULCD_RxFullInterruptEnable = (1U << 1U) }
```
- *Define FlexIO MCULCD interrupt mask.*
 - enum `_flexio_mculcd_status_flags` {


```
kFLEXIO_MCULCD_TxEmptyFlag = (1U << 0U),
kFLEXIO_MCULCD_RxFullFlag = (1U << 1U) }
```

Define FlexIO MCULCD status mask.
 - enum `_flexio_mculcd_dma_enable` {


```
kFLEXIO_MCULCD_TxDmaEnable = 0x1U,
kFLEXIO_MCULCD_RxDmaEnable = 0x2U }
```

Define FlexIO MCULCD DMA mask.
 - enum `flexio_mculcd_transfer_mode_t` {


```
kFLEXIO_MCULCD_ReadArray,
kFLEXIO_MCULCD_WriteArray,
kFLEXIO_MCULCD_WriteSameValue }
```

Transfer mode.

Driver version

- #define `FSL_FLEXIO_MCULCD_DRIVER_VERSION` (`MAKE_VERSION(2, 0, 6)`)
FlexIO MCULCD driver version.

FlexIO MCULCD Configuration

- `status_t FLEXIO_MCULCD_Init` (`FLEXIO_MCULCD_Type *base`, `flexio_mculcd_config_t *config`, `uint32_t srcClock_Hz`)
Ungates the FlexIO clock, resets the FlexIO module, configures the FlexIO MCULCD hardware, and configures the FlexIO MCULCD with FlexIO MCULCD configuration.
- void `FLEXIO_MCULCD_Deinit` (`FLEXIO_MCULCD_Type *base`)
Resets the FLEXIO_MCULCD timer and shifter configuration.
- void `FLEXIO_MCULCD_GetDefaultConfig` (`flexio_mculcd_config_t *config`)
Gets the default configuration to configure the FlexIO MCULCD.

Status

- `uint32_t FLEXIO_MCULCD_GetStatusFlags` (`FLEXIO_MCULCD_Type *base`)
Gets FlexIO MCULCD status flags.
- void `FLEXIO_MCULCD_ClearStatusFlags` (`FLEXIO_MCULCD_Type *base`, `uint32_t mask`)
Clears FlexIO MCULCD status flags.

Interrupts

- void `FLEXIO_MCULCD_EnableInterrupts` (`FLEXIO_MCULCD_Type *base`, `uint32_t mask`)
Enables the FlexIO MCULCD interrupt.
- void `FLEXIO_MCULCD_DisableInterrupts` (`FLEXIO_MCULCD_Type *base`, `uint32_t mask`)

Disables the FlexIO MCULCD interrupt.

DMA Control

- static void `FLEXIO_MCULCD_EnableTxDMA` (`FLEXIO_MCULCD_Type *base`, bool enable)
Enables/disables the FlexIO MCULCD transmit DMA.
- static void `FLEXIO_MCULCD_EnableRxDMA` (`FLEXIO_MCULCD_Type *base`, bool enable)
Enables/disables the FlexIO MCULCD receive DMA.
- static uint32_t `FLEXIO_MCULCD_GetTxDataRegisterAddress` (`FLEXIO_MCULCD_Type *base`)
Gets the FlexIO MCULCD transmit data register address.
- static uint32_t `FLEXIO_MCULCD_GetRxDataRegisterAddress` (`FLEXIO_MCULCD_Type *base`)
Gets the FlexIO MCULCD receive data register address.

Bus Operations

- `status_t FLEXIO_MCULCD_SetBaudRate` (`FLEXIO_MCULCD_Type *base`, uint32_t baudRate-_Bps, uint32_t srcClock_Hz)
Set desired baud rate.
- void `FLEXIO_MCULCD_SetSingleBeatWriteConfig` (`FLEXIO_MCULCD_Type *base`)
Configures the FLEXIO MCULCD to multiple beats write mode.
- void `FLEXIO_MCULCD_ClearSingleBeatWriteConfig` (`FLEXIO_MCULCD_Type *base`)
Clear the FLEXIO MCULCD multiple beats write mode configuration.
- void `FLEXIO_MCULCD_SetSingleBeatReadConfig` (`FLEXIO_MCULCD_Type *base`)
Configures the FLEXIO MCULCD to multiple beats read mode.
- void `FLEXIO_MCULCD_ClearSingleBeatReadConfig` (`FLEXIO_MCULCD_Type *base`)
Clear the FLEXIO MCULCD multiple beats read mode configuration.
- void `FLEXIO_MCULCD_SetMultiBeatsWriteConfig` (`FLEXIO_MCULCD_Type *base`)
Configures the FLEXIO MCULCD to multiple beats write mode.
- void `FLEXIO_MCULCD_ClearMultiBeatsWriteConfig` (`FLEXIO_MCULCD_Type *base`)
Clear the FLEXIO MCULCD multiple beats write mode configuration.
- void `FLEXIO_MCULCD_SetMultiBeatsReadConfig` (`FLEXIO_MCULCD_Type *base`)
Configures the FLEXIO MCULCD to multiple beats read mode.
- void `FLEXIO_MCULCD_ClearMultiBeatsReadConfig` (`FLEXIO_MCULCD_Type *base`)
Clear the FLEXIO MCULCD multiple beats read mode configuration.
- static void `FLEXIO_MCULCD_Enable` (`FLEXIO_MCULCD_Type *base`, bool enable)
Enables/disables the FlexIO MCULCD module operation.
- uint32_t `FLEXIO_MCULCD_ReadData` (`FLEXIO_MCULCD_Type *base`)
Read data from the FLEXIO MCULCD RX shifter buffer.
- static void `FLEXIO_MCULCD_WriteData` (`FLEXIO_MCULCD_Type *base`, uint32_t data)
Write data into the FLEXIO MCULCD TX shifter buffer.
- static void `FLEXIO_MCULCD_StartTransfer` (`FLEXIO_MCULCD_Type *base`)
Assert the nCS to start transfer.
- static void `FLEXIO_MCULCD_StopTransfer` (`FLEXIO_MCULCD_Type *base`)
De-assert the nCS to stop transfer.
- void `FLEXIO_MCULCD_WaitTransmitComplete` (void)
Wait for transmit data send out finished.

- void `FLEXIO_MCULCD_WriteCommandBlocking` (`FLEXIO_MCULCD_Type *base`, `uint32_t command`)
Send command in blocking way.
- void `FLEXIO_MCULCD_WriteDataArrayBlocking` (`FLEXIO_MCULCD_Type *base`, `const void *data`, `size_t size`)
Send data array in blocking way.
- void `FLEXIO_MCULCD_ReadDataArrayBlocking` (`FLEXIO_MCULCD_Type *base`, `void *data`, `size_t size`)
Read data into array in blocking way.
- void `FLEXIO_MCULCD_WriteSameValueBlocking` (`FLEXIO_MCULCD_Type *base`, `uint32_t sameValue`, `size_t size`)
Send the same value many times in blocking way.
- void `FLEXIO_MCULCD_TransferBlocking` (`FLEXIO_MCULCD_Type *base`, `flexio_mculcd_transfer_t *xfer`)
Performs a polling transfer.

Transactional

- `status_t FLEXIO_MCULCD_TransferCreateHandle` (`FLEXIO_MCULCD_Type *base`, `flexio_mculcd_handle_t *handle`, `flexio_mculcd_transfer_callback_t callback`, `void *userData`)
Initializes the FlexIO MCULCD handle, which is used in transactional functions.
- `status_t FLEXIO_MCULCD_TransferNonBlocking` (`FLEXIO_MCULCD_Type *base`, `flexio_mculcd_handle_t *handle`, `flexio_mculcd_transfer_t *xfer`)
Transfer data using IRQ.
- void `FLEXIO_MCULCD_TransferAbort` (`FLEXIO_MCULCD_Type *base`, `flexio_mculcd_handle_t *handle`)
Aborts the data transfer, which used IRQ.
- `status_t FLEXIO_MCULCD_TransferGetCount` (`FLEXIO_MCULCD_Type *base`, `flexio_mculcd_handle_t *handle`, `size_t *count`)
Gets the data transfer status which used IRQ.
- void `FLEXIO_MCULCD_TransferHandleIRQ` (`void *base`, `void *handle`)
FlexIO MCULCD IRQ handler function.

22.6.3 Data Structure Documentation

22.6.3.1 struct FLEXIO_MCULCD_Type

Data Fields

- `FLEXIO_Type * flexioBase`
FlexIO base pointer.
- `flexio_mculcd_bus_t busType`
The bus type, 8080 or 6800.
- `uint8_t dataPinStartIndex`
Start index of the data pin, the FlexIO pin `dataPinStartIndex` to `(dataPinStartIndex + FLEXIO_MCULCD_DATA_BUS_WIDTH - 1)` will be used for data transfer.

- `uint8_t ENWRPinIndex`
Pin select for WR(8080 mode), EN(6800 mode).
- `uint8_t RDPinIndex`
Pin select for RD(8080 mode), not used in 6800 mode.
- `uint8_t txShifterStartIndex`
Start index of shifters used for data write, it must be 0 or 4.
- `uint8_t txShifterEndIndex`
End index of shifters used for data write.
- `uint8_t rxShifterStartIndex`
Start index of shifters used for data read.
- `uint8_t rxShifterEndIndex`
End index of shifters used for data read, it must be 3 or 7.
- `uint8_t timerIndex`
Timer index used in FlexIO MCULCD.
- `flexio_mculcd_pin_func_t setCSPin`
Function to set or clear the CS pin.
- `flexio_mculcd_pin_func_t setRSPin`
Function to set or clear the RS pin.
- `flexio_mculcd_pin_func_t setRDWRPin`
Function to set or clear the RD/WR pin, only used in 6800 mode.

Field Documentation

- (1) `FLEXIO_Type* FLEXIO_MCULCD_Type::flexioBase`
- (2) `flexio_mculcd_bus_t FLEXIO_MCULCD_Type::busType`
- (3) `uint8_t FLEXIO_MCULCD_Type::dataPinStartIndex`
Only support data bus width 8 and 16.
- (4) `uint8_t FLEXIO_MCULCD_Type::ENWRPinIndex`
- (5) `uint8_t FLEXIO_MCULCD_Type::RDPinIndex`
- (6) `uint8_t FLEXIO_MCULCD_Type::txShifterStartIndex`
- (7) `uint8_t FLEXIO_MCULCD_Type::txShifterEndIndex`
- (8) `uint8_t FLEXIO_MCULCD_Type::rxShifterStartIndex`
- (9) `uint8_t FLEXIO_MCULCD_Type::rxShifterEndIndex`
- (10) `uint8_t FLEXIO_MCULCD_Type::timerIndex`
- (11) `flexio_mculcd_pin_func_t FLEXIO_MCULCD_Type::setCSPin`
- (12) `flexio_mculcd_pin_func_t FLEXIO_MCULCD_Type::setRSPin`
- (13) `flexio_mculcd_pin_func_t FLEXIO_MCULCD_Type::setRDWRPin`

22.6.3.2 struct flexio_mculcd_config_t

Data Fields

- bool [enable](#)
Enable/disable FlexIO MCULCD 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.

Field Documentation

- (1) **bool flexio_mculcd_config_t::enable**
- (2) **bool flexio_mculcd_config_t::enableInDoze**
- (3) **bool flexio_mculcd_config_t::enableInDebug**
- (4) **bool flexio_mculcd_config_t::enableFastAccess**
- (5) **uint32_t flexio_mculcd_config_t::baudRate_Bps**

22.6.3.3 struct flexio_mculcd_transfer_t

Data Fields

- uint32_t [command](#)
Command to send.
- [flexio_mculcd_transfer_mode_t mode](#)
Transfer mode.
- uint32_t [dataAddrOrSameValue](#)
When sending the same value for many times, this is the value to send.
- size_t [dataSize](#)
How many bytes to transfer.

Field Documentation

- (1) **uint32_t flexio_mculcd_transfer_t::command**
- (2) **flexio_mculcd_transfer_mode_t flexio_mculcd_transfer_t::mode**
- (3) **uint32_t flexio_mculcd_transfer_t::dataAddrOrSameValue**

When writing or reading array, this is the address of the data array.

(4) `size_t flexio_mculcd_transfer_t::dataSize`

22.6.3.4 struct `_flexio_mculcd_handle`

typedef for `flexio_mculcd_handle_t` in advance.

Data Fields

- `uint32_t dataAddrOrSameValue`
When sending the same value for many times, this is the value to send.
- `size_t dataCount`
Total count to be transferred.
- `volatile size_t remainingCount`
Remaining count to transfer.
- `volatile uint32_t state`
FlexIO MCULCD internal state.
- `flexio_mculcd_transfer_callback_t completionCallback`
FlexIO MCULCD transfer completed callback.
- `void * userData`
Callback parameter.

Field Documentation

(1) `uint32_t flexio_mculcd_handle_t::dataAddrOrSameValue`

When writing or reading array, this is the address of the data array.

(2) `size_t flexio_mculcd_handle_t::dataCount`

(3) `volatile size_t flexio_mculcd_handle_t::remainingCount`

(4) `volatile uint32_t flexio_mculcd_handle_t::state`

(5) `flexio_mculcd_transfer_callback_t flexio_mculcd_handle_t::completionCallback`

(6) `void* flexio_mculcd_handle_t::userData`

22.6.4 Macro Definition Documentation

22.6.4.1 `#define FSL_FLEXIO_MCULCD_DRIVER_VERSION (MAKE_VERSION(2, 0, 6))`

22.6.4.2 `#define FLEXIO_MCULCD_WAIT_COMPLETE_TIME 512`

Currently there is no method to detect whether the data has been sent out from the shifter, so the driver use a software delay for this. When the data is written to shifter buffer, the driver call the delay function to wait for the data shift out. If this value is too small, then the last few bytes might be lost when writing data using interrupt method or DMA method.

22.6.5 Typedef Documentation

22.6.5.1 typedef void(* flexio_mculcd_pin_func_t)(bool set)

22.6.5.2 typedef void(* flexio_mculcd_transfer_callback_t)(FLEXIO_MCULCD_Type *base, flexio_mculcd_handle_t *handle, status_t status, void *userData)

When transfer finished, the callback function is called and returns the `status` as `kStatus_FLEXIO_MCULCD_Idle`.

22.6.6 Enumeration Type Documentation

22.6.6.1 anonymous enum

Enumerator

kStatus_FLEXIO_MCULCD_Idle FlexIO LCD is idle.
kStatus_FLEXIO_MCULCD_Busy FlexIO LCD is busy.
kStatus_FLEXIO_MCULCD_Error FlexIO LCD error occurred.

22.6.6.2 enum flexio_mculcd_pixel_format_t

Enumerator

kFLEXIO_MCULCD_RGB565 RGB565, 16-bit.
kFLEXIO_MCULCD_BGR565 BGR565, 16-bit.
kFLEXIO_MCULCD_RGB888 RGB888, 24-bit.
kFLEXIO_MCULCD_BGR888 BGR888, 24-bit.

22.6.6.3 enum flexio_mculcd_bus_t

Enumerator

kFLEXIO_MCULCD_8080 Using Intel 8080 bus.
kFLEXIO_MCULCD_6800 Using Motorola 6800 bus.

22.6.6.4 enum _flexio_mculcd_interrupt_enable

Enumerator

kFLEXIO_MCULCD_TxEmptyInterruptEnable Transmit buffer empty interrupt enable.
kFLEXIO_MCULCD_RxFullInterruptEnable Receive buffer full interrupt enable.

22.6.6.5 enum `_flexio_mculcd_status_flags`

Enumerator

kFLEXIO_MCULCD_TxEmptyFlag Transmit buffer empty flag.

kFLEXIO_MCULCD_RxFullFlag Receive buffer full flag.

22.6.6.6 enum `_flexio_mculcd_dma_enable`

Enumerator

kFLEXIO_MCULCD_TxDmaEnable Tx DMA request source.

kFLEXIO_MCULCD_RxDmaEnable Rx DMA request source.

22.6.6.7 enum `flexio_mculcd_transfer_mode_t`

Enumerator

kFLEXIO_MCULCD_ReadArray Read data into an array.

kFLEXIO_MCULCD_WriteArray Write data from an array.

kFLEXIO_MCULCD_WriteSameValue Write the same value many times.

22.6.7 Function Documentation

22.6.7.1 `status_t FLEXIO_MCULCD_Init (FLEXIO_MCULCD_Type * base, flexio_mculcd_config_t * config, uint32_t srcClock_Hz)`

The configuration structure can be filled by the user, or be set with default values by the [FLEXIO_MCU-LCD_GetDefaultConfig](#).

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>config</i>	Pointer to the flexio_mculcd_config_t structure.
<i>srcClock_Hz</i>	FlexIO source clock in Hz.

Return values

<i>kStatus_Success</i>	Initialization success.
<i>kStatus_InvalidArgument</i>	Initialization failed because of invalid argument.

22.6.7.2 void FLEXIO_MCULCD_Deinit (FLEXIO_MCULCD_Type * *base*)

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type .
-------------	---

22.6.7.3 void FLEXIO_MCULCD_GetDefaultConfig (flexio_mculcd_config_t * *config*)

The default configuration value is:

```
* config->enable = true;
* config->enableInDoze = false;
* config->enableInDebug = true;
* config->enableFastAccess = true;
* config->baudRate_Bps = 96000000U;
*
```

Parameters

<i>config</i>	Pointer to the flexio_mculcd_config_t structure.
---------------	--

22.6.7.4 uint32_t FLEXIO_MCULCD_GetStatusFlags (FLEXIO_MCULCD_Type * *base*)

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
-------------	--

Returns

status flag; OR'ed value or the [_flexio_mculcd_status_flags](#).

Note

Don't use this function with DMA APIs.

22.6.7.5 void FLEXIO_MCULCD_ClearStatusFlags (FLEXIO_MCULCD_Type * *base*, uint32_t *mask*)

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>mask</i>	Status to clear, it is the OR'ed value of _flexio_mculcd_status_flags .

Note

Don't use this function with DMA APIs.

22.6.7.6 void FLEXIO_MCULCD_EnableInterrupts (FLEXIO_MCULCD_Type * *base*, uint32_t *mask*)

This function enables the FlexIO MCULCD interrupt.

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>mask</i>	Interrupts to enable, it is the OR'ed value of _flexio_mculcd_interrupt_enable .

22.6.7.7 void FLEXIO_MCULCD_DisableInterrupts (FLEXIO_MCULCD_Type * *base*, uint32_t *mask*)

This function disables the FlexIO MCULCD interrupt.

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>mask</i>	Interrupts to disable, it is the OR'ed value of _flexio_mculcd_interrupt_enable .

22.6.7.8 static void FLEXIO_MCULCD_EnableTxDMA (FLEXIO_MCULCD_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
-------------	--

<i>enable</i>	True means enable DMA, false means disable DMA.
---------------	---

22.6.7.9 static void FLEXIO_MCULCD_EnableRxDMA (FLEXIO_MCULCD_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>enable</i>	True means enable DMA, false means disable DMA.

22.6.7.10 static uint32_t FLEXIO_MCULCD_GetTxDataRegisterAddress (FLEXIO_MCULCD_Type * *base*) [inline], [static]

This function returns the MCULCD data register address, which is mainly used by DMA/eDMA.

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
-------------	--

Returns

FlexIO MCULCD transmit data register address.

22.6.7.11 static uint32_t FLEXIO_MCULCD_GetRxDataRegisterAddress (FLEXIO_MCULCD_Type * *base*) [inline], [static]

This function returns the MCULCD data register address, which is mainly used by DMA/eDMA.

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
-------------	--

Returns

FlexIO MCULCD receive data register address.

22.6.7.12 status_t FLEXIO_MCULCD_SetBaudRate (FLEXIO_MCULCD_Type * *base*, uint32_t *baudRate_Bps*, uint32_t *srcClock_Hz*)

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>baudRate_Bps</i>	Desired baud rate.
<i>srcClock_Hz</i>	FLEXIO clock frequency in Hz.

Return values

<i>kStatus_Success</i>	Set successfully.
<i>kStatus_InvalidArgument</i>	Could not set the baud rate.

22.6.7.13 void FLEXIO_MCULCD_SetSingleBeatWriteConfig (FLEXIO_MCULCD_Type * *base*)

At the beginning multiple beats write operation, the FLEXIO MCULCD is configured to multiple beats write mode using this function. After write operation, the configuration is cleared by [FLEXIO_MCULCD_ClearSingleBeatWriteConfig](#).

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type .
-------------	---

Note

This is an internal used function, upper layer should not use.

22.6.7.14 void FLEXIO_MCULCD_ClearSingleBeatWriteConfig (FLEXIO_MCULCD_Type * *base*)

Clear the write configuration set by [FLEXIO_MCULCD_SetSingleBeatWriteConfig](#).

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type .
-------------	---

Note

This is an internal used function, upper layer should not use.

22.6.7.15 void FLEXIO_MCULCD_SetSingleBeatReadConfig (FLEXIO_MCULCD_Type * *base*)

At the beginning or multiple beats read operation, the FLEXIO MCULCD is configured to multiple beats read mode using this function. After read operation, the configuration is cleared by [FLEXIO_MCULCD_ClearSingleBeatReadConfig](#).

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type .
-------------	---

Note

This is an internal used function, upper layer should not use.

22.6.7.16 void FLEXIO_MCULCD_ClearSingleBeatReadConfig (FLEXIO_MCULCD_Type * *base*)

Clear the read configuration set by [FLEXIO_MCULCD_SetSingleBeatReadConfig](#).

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type .
-------------	---

Note

This is an internal used function, upper layer should not use.

22.6.7.17 void FLEXIO_MCULCD_SetMultiBeatsWriteConfig (FLEXIO_MCULCD_Type * *base*)

At the beginning multiple beats write operation, the FLEXIO MCULCD is configured to multiple beats write mode using this function. After write operation, the configuration is cleared by [FLEXIO_MCULCD_ClearMultBeatsWriteConfig](#).

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type .
-------------	---

Note

This is an internal used function, upper layer should not use.

22.6.7.18 void FLEXIO_MCULCD_ClearMultiBeatsWriteConfig (FLEXIO_MCULCD_Type * *base*)

Clear the write configuration set by FLEXIO_MCULCD_SetMultBeatsWriteConfig.

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type .
-------------	---

Note

This is an internal used function, upper layer should not use.

22.6.7.19 void FLEXIO_MCULCD_SetMultiBeatsReadConfig (FLEXIO_MCULCD_Type * *base*)

At the begining or multiple beats read operation, the FLEXIO MCULCD is configured to multiple beats read mode using this function. After read operation, the configuration is cleared by FLEXIO_MCULCD_ClearMultBeatsReadConfig.

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type .
-------------	---

Note

This is an internal used function, upper layer should not use.

22.6.7.20 void FLEXIO_MCULCD_ClearMultiBeatsReadConfig (FLEXIO_MCULCD_Type * *base*)

Clear the read configuration set by FLEXIO_MCULCD_SetMultBeatsReadConfig.

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type .
-------------	---

Note

This is an internal used function, upper layer should not use.

22.6.7.21 static void FLEXIO_MCULCD_Enable (FLEXIO_MCULCD_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type .
<i>enable</i>	True to enable, false does not have any effect.

22.6.7.22 uint32_t FLEXIO_MCULCD_ReadData (FLEXIO_MCULCD_Type * base)

Read data from the RX shift buffer directly, it does no check whether the buffer is empty or not.

If the data bus width is 8-bit:

```
* uint8_t value;
* value = (uint8_t)FLEXIO_MCULCD_ReadData(base);
*
```

If the data bus width is 16-bit:

```
* uint16_t value;
* value = (uint16_t)FLEXIO_MCULCD_ReadData(base);
*
```

Note

This function returns the RX shifter buffer value (32-bit) directly. The return value should be converted according to data bus width.

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
-------------	--

Returns

The data read out.

Note

Don't use this function with DMA APIs.

22.6.7.23 static void FLEXIO_MCULCD_WriteData (FLEXIO_MCULCD_Type * base, uint32_t data) [inline], [static]

Write data into the TX shift buffer directly, it does no check whether the buffer is full or not.

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>data</i>	The data to write.

Note

Don't use this function with DMA APIs.

22.6.7.24 `static void FLEXIO_MCULCD_StartTransfer (FLEXIO_MCULCD_Type * base) [inline], [static]`

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
-------------	--

22.6.7.25 `static void FLEXIO_MCULCD_StopTransfer (FLEXIO_MCULCD_Type * base) [inline], [static]`

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
-------------	--

22.6.7.26 `void FLEXIO_MCULCD_WaitTransmitComplete (void)`

Currently there is no effective method to wait for the data send out from the shiter, so here use a while loop to wait.

Note

This is an internal used function.

22.6.7.27 `void FLEXIO_MCULCD_WriteCommandBlocking (FLEXIO_MCULCD_Type * base, uint32_t command)`

This function sends the command and returns when the command has been sent out.

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>command</i>	The command to send.

22.6.7.28 void FLEXIO_MCULCD_WriteDataArrayBlocking (FLEXIO_MCULCD_Type * *base*, const void * *data*, size_t *size*)

This function sends the data array and returns when the data sent out.

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>data</i>	The data array to send.
<i>size</i>	How many bytes to write.

22.6.7.29 void FLEXIO_MCULCD_ReadDataArrayBlocking (FLEXIO_MCULCD_Type * *base*, void * *data*, size_t *size*)

This function reads the data into array and returns when the data read finished.

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>data</i>	The array to save the data.
<i>size</i>	How many bytes to read.

22.6.7.30 void FLEXIO_MCULCD_WriteSameValueBlocking (FLEXIO_MCULCD_Type * *base*, uint32_t *sameValue*, size_t *size*)

This function sends the same value many times. It could be used to clear the LCD screen. If the data bus width is 8, this function will send LSB 8 bits of *sameValue* for *size* times. If the data bus is 16, this function will send LSB 16 bits of *sameValue* for *size* / 2 times.

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>sameValue</i>	The same value to send.
<i>size</i>	How many bytes to send.

22.6.7.31 void FLEXIO_MCULCD_TransferBlocking (FLEXIO_MCULCD_Type * *base*, flexio_mculcd_transfer_t * *xfer*)

Note

The API does not return until the transfer finished.

Parameters

<i>base</i>	pointer to FLEXIO_MCULCD_Type structure.
<i>xfer</i>	pointer to flexio_mculcd_transfer_t structure.

22.6.7.32 status_t FLEXIO_MCULCD_TransferCreateHandle (FLEXIO_MCULCD_Type * *base*, flexio_mculcd_handle_t * *handle*, flexio_mculcd_transfer_callback_t *callback*, void * *userData*)

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>handle</i>	Pointer to the flexio_mculcd_handle_t structure to store the transfer state.
<i>callback</i>	The callback function.
<i>userData</i>	The parameter of the callback function.

Return values

<i>kStatus_Success</i>	Successfully create the handle.
<i>kStatus_OutOfRange</i>	The FlexIO type/handle/ISR table out of range.

22.6.7.33 status_t FLEXIO_MCULCD_TransferNonBlocking (FLEXIO_MCULCD_Type * *base*, flexio_mculcd_handle_t * *handle*, flexio_mculcd_transfer_t * *xfer*)

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

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>handle</i>	Pointer to the <code>flexio_mculcd_handle_t</code> structure to store the transfer state.
<i>xfer</i>	FlexIO MCULCD transfer structure. See flexio_mculcd_transfer_t .

Return values

<i>kStatus_Success</i>	Successfully start a transfer.
<i>kStatus_InvalidArgument</i>	Input argument is invalid.
<i>kStatus_FLEXIO_MCULCD_Busy</i>	MCULCD is busy with another transfer.

22.6.7.34 `void FLEXIO_MCULCD_TransferAbort (FLEXIO_MCULCD_Type * base, flexio_mculcd_handle_t * handle)`

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>handle</i>	Pointer to the <code>flexio_mculcd_handle_t</code> structure to store the transfer state.

22.6.7.35 `status_t FLEXIO_MCULCD_TransferGetCount (FLEXIO_MCULCD_Type * base, flexio_mculcd_handle_t * handle, size_t * count)`

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>handle</i>	Pointer to the <code>flexio_mculcd_handle_t</code> structure to store the transfer state.
<i>count</i>	How many bytes transferred so far by the non-blocking transaction.

Return values

<i>kStatus_Success</i>	Get the transferred count Successfully.
<i>kStatus_NoTransferInProgress</i>	No transfer in process.

22.6.7.36 `void FLEXIO_MCULCD_TransferHandleIRQ (void * base, void * handle)`

Parameters

<i>base</i>	Pointer to the FLEXIO_MCULCD_Type structure.
<i>handle</i>	Pointer to the flexio_mculcd_handle_t structure to store the transfer state.

22.6.8 FlexIO eDMA MCU Interface LCD Driver

SDK provide eDMA transactional APIs to transfer data using eDMA, the eDMA method is similar with interrupt transactional method.

22.6.8.1 Overview

Note

eDMA transactional functions use multiple beats method for better performance, in contrast, the blocking functions and interrupt functions use single beat method. The function `FLEXIO_MCULCD_ReadData`, `FLEXIO_MCULCD_WriteData`, `FLEXIO_MCULCD_GetStatusFlags`, and `FLEXIO_MCULCD_ClearStatusFlags` are only used for single beat case, so don't use these functions to work together with eDMA functions.

FlexIO eDMA MCU Interface LCD Driver

FLEXIO LCD send/receive using a DMA method

```
flexio_MCULCD_edma_handle_t handle;
volatile bool completeFlag = false;
edma_handle_t rxEdmaHandle;
edma_handle_t txEdmaHandle;

void flexioLcdCallback(FLEXIO_MCULCD_Type *base, flexio_MCULCD_edma_handle_t *handle,
    status_t status, void *userData)
{
    if (kStatus_FLEXIO_MCULCD_Idle == status)
    {
        completeFlag = true;
    }
}

void main(void)
{
    // Create the edma Handle.
    EDMA_CreateHandle(&rxEdmaHandle, DMA0, channel);
    EDMA_CreateHandle(&txEdmaHandle, DMA0, channel);

    // Configure the DMAMUX.
    // ...
    // rxEdmaHandle should use the last FlexIO RX shifters as DMA request source.
    // txEdmaHandle should use the first FlexIO TX shifters as DMA request source.

    // Init the FlexIO LCD driver.
    FLEXIO_MCULCD_Init(...);

    // Create the transactional handle.
    FLEXIO_MCULCD_TransferCreateHandleEDMA(&flexioLcdDev, &handle,
        flexioLcdCallback, NULL, &txEdmaHandle, &rxEdmaHandle);

    xfer.command = command2;
    xfer.mode = kFLEXIO_MCULCD_WriteArray;
    xfer.dataAddrOrSameValue = (uint32_t)dataToSend;
    xfer.dataCount = sizeof(dataToSend);
    completeFlag = false;
    FLEXIO_MCULCD_TransferEDMA(&flexioLcdDev, &handle, &xfer);
}
```

```

while (!completeFlag)
{
}

xfer.command = command2;
xfer.mode = kFLEXIO_MCULCD_WriteSameValue;
xfer.dataAddrOrSameValue = value;
xfer.dataCount = 1000;
completeFlag = false;
FLEXIO_MCULCD_TransferEDMA(&flexioLcdDev, &handle, &xfer);

while (!completeFlag)
{
}

xfer.command = command3;
xfer.mode = kFLEXIO_MCULCD_ReadArray;
xfer.dataAddrOrSameValue = (uint32_t)dataToReceive;
xfer.dataCount = sizeof(dataToReceive);
completeFlag = false;
FLEXIO_MCULCD_TransferEDMA(&flexioLcdDev, &handle, &xfer);

while (!completeFlag)
{
}
}

```

Data Structures

- struct [flexio_mculcd_edma_handle_t](#)
FlexIO MCULCD eDMA transfer handle, users should not touch the content of the handle. [More...](#)

Macros

- #define [FSL_FLEXIO_MCULCD_EDMA_DRIVER_VERSION](#) (MAKE_VERSION(2, 0, 4))
FlexIO MCULCD EDMA driver version.

Typedefs

- typedef void(* [flexio_mculcd_edma_transfer_callback_t](#))(FLEXIO_MCULCD_Type *base, flexio_mculcd_edma_handle_t *handle, [status_t](#) status, void *userData)
FlexIO MCULCD master callback for transfer complete.

eDMA Transactional

- [status_t FLEXIO_MCULCD_TransferCreateHandleEDMA](#) (FLEXIO_MCULCD_Type *base, flexio_mculcd_edma_handle_t *handle, [flexio_mculcd_edma_transfer_callback_t](#) callback, void *userData, [edma_handle_t](#) *txDmaHandle, [edma_handle_t](#) *rxDmaHandle)
Initializes the FLEXIO MCULCD master eDMA handle.
- [status_t FLEXIO_MCULCD_TransferEDMA](#) (FLEXIO_MCULCD_Type *base, flexio_mculcd_edma_handle_t *handle, [flexio_mculcd_transfer_t](#) *xfer)
Performs a non-blocking FlexIO MCULCD transfer using eDMA.

- void `FLEXIO_MCULCD_TransferAbortEDMA` (`FLEXIO_MCULCD_Type *base`, `flexio_mculcd_edma_handle_t *handle`)
Aborts a FlexIO MCULCD transfer using eDMA.
- `status_t FLEXIO_MCULCD_TransferGetCountEDMA` (`FLEXIO_MCULCD_Type *base`, `flexio_mculcd_edma_handle_t *handle`, `size_t *count`)
Gets the remaining bytes for FlexIO MCULCD eDMA transfer.

22.6.8.2 Data Structure Documentation

22.6.8.2.1 struct flexio_mculcd_edma_handle

typedef for `flexio_mculcd_edma_handle_t` in advance.

Data Fields

- `FLEXIO_MCULCD_Type * base`
Pointer to the `FLEXIO_MCULCD_Type`.
- `uint8_t txShifterNum`
Number of shifters used for TX.
- `uint8_t rxShifterNum`
Number of shifters used for RX.
- `uint32_t minorLoopBytes`
eDMA transfer minor loop bytes.
- `edma_modulo_t txEdmaModulo`
Modulo value for the FlexIO shifter buffer access.
- `edma_modulo_t rxEdmaModulo`
Modulo value for the FlexIO shifter buffer access.
- `uint32_t dataAddrOrSameValue`
When sending the same value for many times, this is the value to send.
- `size_t dataCount`
Total count to be transferred.
- `volatile size_t remainingCount`
Remaining count still not transferred.
- `volatile uint32_t state`
FlexIO MCULCD driver internal state.
- `edma_handle_t * txDmaHandle`
DMA handle for MCULCD TX.
- `edma_handle_t * rxDmaHandle`
DMA handle for MCULCD RX.
- `flexio_mculcd_edma_transfer_callback_t completionCallback`
Callback for MCULCD DMA transfer.
- `void * userData`
User Data for MCULCD DMA callback.

Field Documentation

(1) `FLEXIO_MCULCD_Type* flexio_mculcd_edma_handle_t::base`

- (2) `uint8_t flexio_mculcd_edma_handle_t::txShifterNum`
- (3) `uint8_t flexio_mculcd_edma_handle_t::rxShifterNum`
- (4) `uint32_t flexio_mculcd_edma_handle_t::minorLoopBytes`
- (5) `edma_modulo_t flexio_mculcd_edma_handle_t::txEdmaModulo`
- (6) `edma_modulo_t flexio_mculcd_edma_handle_t::rxEdmaModulo`
- (7) `uint32_t flexio_mculcd_edma_handle_t::dataAddrOrSameValue`

When writing or reading array, this is the address of the data array.

- (8) `size_t flexio_mculcd_edma_handle_t::dataCount`
- (9) `volatile size_t flexio_mculcd_edma_handle_t::remainingCount`
- (10) `volatile uint32_t flexio_mculcd_edma_handle_t::state`

22.6.8.3 Macro Definition Documentation

22.6.8.3.1 `#define FSL_FLEXIO_MCULCD_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 0, 4))`

22.6.8.4 Typedef Documentation

22.6.8.4.1 `typedef void(* flexio_mculcd_edma_transfer_callback_t)(FLEXIO_MCULCD_Type *base, flexio_mculcd_edma_handle_t *handle, status_t status, void *userData)`

When transfer finished, the callback function is called and returns the `status` as `kStatus_FLEXIO_MCULCD_Idle`.

22.6.8.5 Function Documentation

22.6.8.5.1 `status_t FLEXIO_MCULCD_TransferCreateHandleEDMA (FLEXIO_MCULCD_Type * base, flexio_mculcd_edma_handle_t * handle, flexio_mculcd_edma_transfer_callback_t callback, void * userData, edma_handle_t * txDmaHandle, edma_handle_t * rxDmaHandle)`

This function initializes the FLEXIO MCULCD master eDMA handle which can be used for other FLEXIO MCULCD transactional APIs. For a specified FLEXIO MCULCD instance, call this API once to get the initialized handle.

Parameters

<i>base</i>	Pointer to FLEXIO_MCULCD_Type structure.
<i>handle</i>	Pointer to flexio_mculcd_edma_handle_t structure to store the transfer state.
<i>callback</i>	MCULCD transfer complete callback, NULL means no callback.
<i>userData</i>	callback function parameter.
<i>txDmaHandle</i>	User requested eDMA handle for FlexIO MCULCD eDMA TX, the DMA request source of this handle should be the first of TX shifters.
<i>rxDmaHandle</i>	User requested eDMA handle for FlexIO MCULCD eDMA RX, the DMA request source of this handle should be the last of RX shifters.

Return values

<i>kStatus_Success</i>	Successfully create the handle.
------------------------	---------------------------------

22.6.8.5.2 status_t FLEXIO_MCULCD_TransferEDMA (FLEXIO_MCULCD_Type * base, flexio_mculcd_edma_handle_t * handle, flexio_mculcd_transfer_t * xfer)

This function returns immediately after transfer initiates. To check whether the transfer is completed, user could:

1. Use the transfer completed callback;
2. Polling function FLEXIO_MCULCD_GetTransferCountEDMA

Parameters

<i>base</i>	pointer to FLEXIO_MCULCD_Type structure.
<i>handle</i>	pointer to flexio_mculcd_edma_handle_t structure to store the transfer state.
<i>xfer</i>	Pointer to FlexIO MCULCD transfer structure.

Return values

<i>kStatus_Success</i>	Successfully start a transfer.
<i>kStatus_InvalidArgument</i>	Input argument is invalid.
<i>kStatus_FLEXIO_MCULCD_Busy</i>	FlexIO MCULCD is not idle, it is running another transfer.

22.6.8.5.3 void FLEXIO_MCULCD_TransferAbortEDMA (FLEXIO_MCULCD_Type * base, flexio_mculcd_edma_handle_t * handle)

Parameters

<i>base</i>	pointer to FLEXIO_MCULCD_Type structure.
<i>handle</i>	FlexIO MCULCD eDMA handle pointer.

22.6.8.5.4 `status_t FLEXIO_MCULCD_TransferGetCountEDMA (FLEXIO_MCULCD_Type * base, flexio_mculcd_edma_handle_t * handle, size_t * count)`

Parameters

<i>base</i>	pointer to FLEXIO_MCULCD_Type structure.
<i>handle</i>	FlexIO MCULCD eDMA handle pointer.
<i>count</i>	Number of count transferred so far by the eDMA transaction.

Return values

<i>kStatus_Success</i>	Get the transferred count Successfully.
<i>kStatus_NoTransferInProgress</i>	No transfer in process.

22.7 FlexIO SPI Driver

22.7.1 Overview

The MCUXpresso SDK provides a peripheral driver for an SPI function using the Flexible I/O module of MCUXpresso SDK devices.

FlexIO SPI driver includes functional APIs and transactional APIs.

Functional APIs target low-level APIs. Functional APIs can be used for FlexIO SPI initialization/configuration/operation for optimization/customization purpose. Using the functional API requires the knowledge of the FlexIO SPI peripheral and how to organize functional APIs to meet the application requirements. All functional API use the `FLEXIO_SPI_Type` *base as the first parameter. FlexIO SPI functional operation groups provide the functional API set.

Transactional APIs target high-level APIs. Transactional APIs can be used to enable the peripheral and also in the application if the code size and performance of transactional APIs can satisfy requirements. If the code size and performance are critical requirements, see the transactional API implementation and write custom code. All transactional APIs use the `flexio_spi_master_handle_t`/`flexio_spi_slave_handle_t` as the second parameter. Initialize the handle by calling the `FLEXIO_SPI_MasterTransferCreateHandle()` or `FLEXIO_SPI_SlaveTransferCreateHandle()` API.

Transactional APIs support asynchronous transfer. This means that the functions `FLEXIO_SPI_MasterTransferNonBlocking()`/`FLEXIO_SPI_SlaveTransferNonBlocking()` set up an interrupt for data transfer. When the transfer is complete, the upper layer is notified through a callback function with the `kStatus_FLEXIO_SPI_Idle` status.

Note that the FlexIO SPI slave driver only supports discontinuous PCS access, which is a limitation. The FlexIO SPI slave driver can support continuous PCS, but the slave cannot adapt discontinuous and continuous PCS automatically. Users can change the timer disable mode in `FLEXIO_SPI_SlaveInit` manually, from `kFLEXIO_TimerDisableOnTimerCompare` to `kFLEXIO_TimerDisableNever` to enable a discontinuous PCS access. Only `CPHA = 0` is supported.

22.7.2 Typical use case

22.7.2.1 FlexIO SPI send/receive using an interrupt method

```
flexio_spi_master_handle_t g_spiHandle;
FLEXIO_SPI_Type spiDev;
volatile bool txFinished;
static uint8_t srcBuff[BUFFER_SIZE];
static uint8_t destBuff[BUFFER_SIZE];

void FLEXIO_SPI_MasterUserCallback(FLEXIO_SPI_Type *base, flexio_spi_master_handle_t *handle
    , status_t status, void *userData)
{
    userData = userData;

    if (kStatus_FLEXIO_SPI_Idle == status)
    {
        txFinished = true;
    }
}
```

```

}

void main(void)
{
    //...
    flexio_spi_transfer_t xfer = {0};
    flexio_spi_master_config_t userConfig;

    FLEXIO_SPI_MasterGetDefaultConfig(&userConfig);
    userConfig.baudRate_Bps = 500000U;

    spiDev.flexioBase = BOARD_FLEXIO_BASE;
    spiDev.SDOPinIndex = FLEXIO_SPI_MOSI_PIN;
    spiDev.SDIPinIndex = FLEXIO_SPI_MISO_PIN;
    spiDev.SCKPinIndex = FLEXIO_SPI_SCK_PIN;
    spiDev.CSnPinIndex = FLEXIO_SPI_CSn_PIN;
    spiDev.shifterIndex[0] = 0U;
    spiDev.shifterIndex[1] = 1U;
    spiDev.timerIndex[0] = 0U;
    spiDev.timerIndex[1] = 1U;

    FLEXIO_SPI_MasterInit(&spiDev, &userConfig, FLEXIO_CLOCK_FREQUENCY);

    xfer.txData = srcBuff;
    xfer.rxData = destBuff;
    xfer.dataSize = BUFFER_SIZE;
    xfer.flags = kFLEXIO_SPI_8bitMsb;
    FLEXIO_SPI_MasterTransferCreateHandle(&spiDev, &g_spiHandle,
        FLEXIO_SPI_MasterUserCallback, NULL);
    FLEXIO_SPI_MasterTransferNonBlocking(&spiDev, &g_spiHandle, &xfer);

    // Send finished.
    while (!txFinished)
    {
        // ...
    }
}

```

22.7.2.2 FlexIO_SPI Send/Receive in DMA way

```

dma_handle_t g_spiTxDmaHandle;
dma_handle_t g_spiRxDmaHandle;
flexio_spi_master_handle_t g_spiHandle;
FLEXIO_SPI_Type spiDev;
volatile bool txFinished;
static uint8_t srcBuff[BUFFER_SIZE];
static uint8_t destBuff[BUFFER_SIZE];
void FLEXIO_SPI_MasterUserCallback(FLEXIO_SPI_Type *base, flexio_spi_master_dma_handle_t
    *handle, status_t status, void *userData)
{
    userData = userData;

    if (kStatus_FLEXIO_SPI_Idle == status)
    {
        txFinished = true;
    }
}

void main(void)
{
    flexio_spi_transfer_t xfer = {0};
    flexio_spi_master_config_t userConfig;

    FLEXIO_SPI_MasterGetDefaultConfig(&userConfig);

```

```

userConfig.baudRate_Bps = 500000U;

spiDev.flexioBase = BOARD_FLEXIO_BASE;
spiDev.SDOPinIndex = FLEXIO_SPI_MOSI_PIN;
spiDev.SDIPinIndex = FLEXIO_SPI_MISO_PIN;
spiDev.SCKPinIndex = FLEXIO_SPI_SCK_PIN;
spiDev.CSnPinIndex = FLEXIO_SPI_CSn_PIN;
spiDev.shifterIndex[0] = 0U;
spiDev.shifterIndex[1] = 1U;
spiDev.timerIndex[0] = 0U;
spiDev.timerIndex[1] = 1U;

/* Init DMAMUX. */
DMAMUX_Init(EXAMPLE_FLEXIO_SPI_DMAMUX_BASEADDR)

/* Init the DMA/EDMA module */
#if defined(FSL_FEATURE_SOC_DMA_COUNT) && FSL_FEATURE_SOC_DMA_COUNT > 0U
DMA_Init(EXAMPLE_FLEXIO_SPI_DMA_BASEADDR);
DMA_CreateHandle(&txHandle, EXAMPLE_FLEXIO_SPI_DMA_BASEADDR, FLEXIO_SPI_TX_DMA_CHANNEL);
DMA_CreateHandle(&rxHandle, EXAMPLE_FLEXIO_SPI_DMA_BASEADDR, FLEXIO_SPI_RX_DMA_CHANNEL);
#endif /* FSL_FEATURE_SOC_DMA_COUNT */

#if defined(FSL_FEATURE_SOC_EDMA_COUNT) && FSL_FEATURE_SOC_EDMA_COUNT > 0U
edma_config_t edmaConfig;

EDMA_GetDefaultConfig(&edmaConfig);
EDMA_Init(EXAMPLE_FLEXIO_SPI_DMA_BASEADDR, &edmaConfig);
EDMA_CreateHandle(&txHandle, EXAMPLE_FLEXIO_SPI_DMA_BASEADDR,
FLEXIO_SPI_TX_DMA_CHANNEL);
EDMA_CreateHandle(&rxHandle, EXAMPLE_FLEXIO_SPI_DMA_BASEADDR,
FLEXIO_SPI_RX_DMA_CHANNEL);
#endif /* FSL_FEATURE_SOC_EDMA_COUNT */

dma_request_source_tx = (dma_request_source_t)(FLEXIO_DMA_REQUEST_BASE + spiDev.
shifterIndex[0]);
dma_request_source_rx = (dma_request_source_t)(FLEXIO_DMA_REQUEST_BASE + spiDev.
shifterIndex[1]);

/* Requests DMA channels for transmit and receive. */
DMAMUX_SetSource(EXAMPLE_FLEXIO_SPI_DMAMUX_BASEADDR, FLEXIO_SPI_TX_DMA_CHANNEL, (
dma_request_source_t)dma_request_source_tx);
DMAMUX_SetSource(EXAMPLE_FLEXIO_SPI_DMAMUX_BASEADDR, FLEXIO_SPI_RX_DMA_CHANNEL, (
dma_request_source_t)dma_request_source_rx);
DMAMUX_EnableChannel(EXAMPLE_FLEXIO_SPI_DMAMUX_BASEADDR,
FLEXIO_SPI_TX_DMA_CHANNEL);
DMAMUX_EnableChannel(EXAMPLE_FLEXIO_SPI_DMAMUX_BASEADDR,
FLEXIO_SPI_RX_DMA_CHANNEL);

FLEXIO_SPI_MasterInit(&spiDev, &userConfig, FLEXIO_CLOCK_FREQUENCY);

/* Initializes the buffer. */
for (i = 0; i < BUFFER_SIZE; i++)
{
    srcBuff[i] = i;
}

/* Sends to the slave. */
xfer.txData = srcBuff;
xfer.rxData = destBuff;
xfer.dataSize = BUFFER_SIZE;
xfer.flags = kFLEXIO_SPI_8bitMsb;
FLEXIO_SPI_MasterTransferCreateHandleDMA(&spiDev, &g_spiHandle, FLEXIO_SPI_MasterUserCallback, NULL
, &g_spiTxDmaHandle, &g_spiRxDmaHandle);
FLEXIO_SPI_MasterTransferDMA(&spiDev, &g_spiHandle, &xfer);

// Send finished.
while (!txFinished)
{

```

```

    }
    // ...
}

```

Modules

- [FlexIO eDMA SPI Driver](#)

Data Structures

- struct [FLEXIO_SPI_Type](#)
Define FlexIO SPI access structure typedef. [More...](#)
- struct [flexio_spi_master_config_t](#)
Define FlexIO SPI master configuration structure. [More...](#)
- struct [flexio_spi_slave_config_t](#)
Define FlexIO SPI slave configuration structure. [More...](#)
- struct [flexio_spi_transfer_t](#)
Define FlexIO SPI transfer structure. [More...](#)
- struct [flexio_spi_master_handle_t](#)
Define FlexIO SPI handle structure. [More...](#)

Macros

- #define [FLEXIO_SPI_DUMMYDATA](#) (0xFFFFFFFFFU)
FlexIO SPI dummy transfer data, the data is sent while txData is NULL.
- #define [SPI_RETRY_TIMES](#) 0U /* Define to zero means keep waiting until the flag is assert/deassert. */
Retry times for waiting flag.
- #define [FLEXIO_SPI_XFER_DATA_FORMAT](#)(flag) ((flag) & (0x7U))
Get the transfer data format of width and bit order.

Typedefs

- 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.

Enumerations

- enum {
 - kStatus_FLEXIO_SPI_Busy = MAKE_STATUS(kStatusGroup_FLEXIO_SPI, 1),
 - kStatus_FLEXIO_SPI_Idle = MAKE_STATUS(kStatusGroup_FLEXIO_SPI, 2),
 - kStatus_FLEXIO_SPI_Error = MAKE_STATUS(kStatusGroup_FLEXIO_SPI, 3),
 - kStatus_FLEXIO_SPI_Timeout }

Error codes for the FlexIO SPI driver.
- enum flexio_spi_clock_phase_t {
 - kFLEXIO_SPI_ClockPhaseFirstEdge = 0x0U,
 - kFLEXIO_SPI_ClockPhaseSecondEdge = 0x1U }

FlexIO SPI clock phase configuration.
- enum flexio_spi_shift_direction_t {
 - kFLEXIO_SPI_MsbFirst = 0,
 - kFLEXIO_SPI_LsbFirst = 1 }

FlexIO SPI data shifter direction options.
- enum flexio_spi_data_bitcount_mode_t {
 - kFLEXIO_SPI_8BitMode = 0x08U,
 - kFLEXIO_SPI_16BitMode = 0x10U,
 - kFLEXIO_SPI_32BitMode = 0x20U }

FlexIO SPI data length mode options.
- enum _flexio_spi_interrupt_enable {
 - kFLEXIO_SPI_TxEmptyInterruptEnable = 0x1U,
 - kFLEXIO_SPI_RxFullInterruptEnable = 0x2U }

Define FlexIO SPI interrupt mask.
- enum _flexio_spi_status_flags {
 - kFLEXIO_SPI_TxBufferEmptyFlag = 0x1U,
 - kFLEXIO_SPI_RxBufferFullFlag = 0x2U }

Define FlexIO SPI status mask.
- enum _flexio_spi_dma_enable {
 - kFLEXIO_SPI_TxDmaEnable = 0x1U,
 - kFLEXIO_SPI_RxDmaEnable = 0x2U,
 - kFLEXIO_SPI_DmaAllEnable = 0x3U }

Define FlexIO SPI DMA mask.
- enum _flexio_spi_transfer_flags {
 - kFLEXIO_SPI_8bitMsb = 0x0U,
 - kFLEXIO_SPI_8bitLsb = 0x1U,
 - kFLEXIO_SPI_16bitMsb = 0x2U,
 - kFLEXIO_SPI_16bitLsb = 0x3U,
 - kFLEXIO_SPI_32bitMsb = 0x4U,
 - kFLEXIO_SPI_32bitLsb = 0x5U,
 - kFLEXIO_SPI_csContinuous = 0x8U }

Define FlexIO SPI transfer flags.

Driver version

- #define `FSL_FLEXIO_SPI_DRIVER_VERSION` (`MAKE_VERSION(2, 3, 0)`)
FlexIO SPI driver version.

FlexIO SPI Configuration

- 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.
- void `FLEXIO_SPI_MasterDeinit` (`FLEXIO_SPI_Type *base`)
Resets the FlexIO SPI timer and shifter config.
- void `FLEXIO_SPI_MasterGetDefaultConfig` (`flexio_spi_master_config_t *masterConfig`)
Gets the default configuration to configure the FlexIO SPI master.
- 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.
- void `FLEXIO_SPI_SlaveDeinit` (`FLEXIO_SPI_Type *base`)
Gates the FlexIO clock.
- void `FLEXIO_SPI_SlaveGetDefaultConfig` (`flexio_spi_slave_config_t *slaveConfig`)
Gets the default configuration to configure the FlexIO SPI slave.

Status

- `uint32_t FLEXIO_SPI_GetStatusFlags` (`FLEXIO_SPI_Type *base`)
Gets FlexIO SPI status flags.
- void `FLEXIO_SPI_ClearStatusFlags` (`FLEXIO_SPI_Type *base`, `uint32_t mask`)
Clears FlexIO SPI status flags.

Interrupts

- void `FLEXIO_SPI_EnableInterrupts` (`FLEXIO_SPI_Type *base`, `uint32_t mask`)
Enables the FlexIO SPI interrupt.
- void `FLEXIO_SPI_DisableInterrupts` (`FLEXIO_SPI_Type *base`, `uint32_t mask`)
Disables the FlexIO SPI interrupt.

DMA Control

- void `FLEXIO_SPI_EnableDMA` (`FLEXIO_SPI_Type *base`, `uint32_t mask`, `bool enable`)
Enables/disables the FlexIO SPI transmit DMA.
- static `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.

- static 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.

Bus Operations

- static void `FLEXIO_SPI_Enable` (`FLEXIO_SPI_Type *base`, bool enable)
Enables/disables the FlexIO SPI module operation.
- 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.
- static 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.
- static uint32_t `FLEXIO_SPI_ReadData` (`FLEXIO_SPI_Type *base`, `flexio_spi_shift_direction_t direction`)
Reads 8 bit/16 bit data.
- `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.
- `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.
- `status_t FLEXIO_SPI_MasterTransferBlocking` (`FLEXIO_SPI_Type *base`, `flexio_spi_transfer_t *xfer`)
Receives a buffer of bytes.
- void `FLEXIO_SPI_FlushShifters` (`FLEXIO_SPI_Type *base`)
Flush tx/rx shifters.

Transactional

- `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.
- `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.
- void `FLEXIO_SPI_MasterTransferAbort` (`FLEXIO_SPI_Type *base`, `flexio_spi_master_handle_t *handle`)
Aborts the master data transfer, which used IRQ.
- `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.
- void `FLEXIO_SPI_MasterTransferHandleIRQ` (void *spiType, void *spiHandle)
FlexIO SPI master IRQ handler function.
- `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.*

 - `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.*
 - `static 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.*
 - `static 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.*
 - `void FLEXIO_SPI_SlaveTransferHandleIRQ` (`void *spiType`, `void *spiHandle`)
 - FlexIO SPI slave IRQ handler function.*

22.7.3 Data Structure Documentation

22.7.3.1 struct FLEXIO_SPI_Type

Data Fields

- `FLEXIO_Type * flexioBase`
 - FlexIO base pointer.*
- `uint8_t SDOPinIndex`
 - Pin select for data output.*
- `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.*

Field Documentation

(1) `FLEXIO_Type* FLEXIO_SPI_Type::flexioBase`

(2) `uint8_t FLEXIO_SPI_Type::SDOPinIndex`

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.

(3) `uint8_t FLEXIO_SPI_Type::SDIPinIndex`

(4) `uint8_t FLEXIO_SPI_Type::SCKPinIndex`

(5) `uint8_t FLEXIO_SPI_Type::CSnPinIndex`

(6) `uint8_t FLEXIO_SPI_Type::shifterIndex[2]`

(7) `uint8_t FLEXIO_SPI_Type::timerIndex[2]`

22.7.3.2 struct flexio_spi_master_config_t

Data Fields

- `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.

Field Documentation

(1) `bool flexio_spi_master_config_t::enableMaster`

(2) `bool flexio_spi_master_config_t::enableInDoze`

(3) `bool flexio_spi_master_config_t::enableInDebug`

(4) `bool flexio_spi_master_config_t::enableFastAccess`

(5) `uint32_t flexio_spi_master_config_t::baudRate_Bps`

(6) `flexio_spi_clock_phase_t flexio_spi_master_config_t::phase`

(7) `flexio_spi_data_bitcount_mode_t flexio_spi_master_config_t::dataMode`

22.7.3.3 struct flexio_spi_slave_config_t

Data Fields

- `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.

Field Documentation

- (1) **bool flexio_spi_slave_config_t::enableSlave**
- (2) **bool flexio_spi_slave_config_t::enableInDoze**
- (3) **bool flexio_spi_slave_config_t::enableInDebug**
- (4) **bool flexio_spi_slave_config_t::enableFastAccess**
- (5) **flexio_spi_clock_phase_t flexio_spi_slave_config_t::phase**
- (6) **flexio_spi_data_bitcount_mode_t flexio_spi_slave_config_t::dataMode**

22.7.3.4 struct flexio_spi_transfer_t

Data Fields

- `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.

Field Documentation

- (1) **uint8_t* flexio_spi_transfer_t::txData**
- (2) **uint8_t* flexio_spi_transfer_t::rxData**
- (3) **size_t flexio_spi_transfer_t::dataSize**
- (4) **uint8_t flexio_spi_transfer_t::flags**

22.7.3.5 struct flexio_spi_master_handle

typedef for `flexio_spi_master_handle_t` in advance.

Data Fields

- `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.

Field Documentation

- (1) `uint8_t* flexio_spi_master_handle_t::txData`
- (2) `uint8_t* flexio_spi_master_handle_t::rxData`
- (3) `size_t flexio_spi_master_handle_t::transferSize`
- (4) `volatile size_t flexio_spi_master_handle_t::txRemainingBytes`
- (5) `volatile size_t flexio_spi_master_handle_t::rxRemainingBytes`
- (6) `volatile uint32_t flexio_spi_master_handle_t::state`
- (7) `flexio_spi_shift_direction_t flexio_spi_master_handle_t::direction`
- (8) `flexio_spi_master_transfer_callback_t flexio_spi_master_handle_t::callback`
- (9) `void* flexio_spi_master_handle_t::userData`

22.7.4 Macro Definition Documentation

22.7.4.1 `#define FSL_FLEXIO_SPI_DRIVER_VERSION (MAKE_VERSION(2, 3, 0))`

22.7.4.2 `#define FLEXIO_SPI_DUMMYDATA (0xFFFFFFFFU)`

22.7.4.3 `#define SPI_RETRY_TIMES 0U` /* Define to zero means keep waiting until the flag is assert/deassert. */

22.7.4.4 `#define FLEXIO_SPI_XFER_DATA_FORMAT(flag) ((flag) & (0x7U))`

22.7.5 Typedef Documentation

22.7.5.1 `typedef flexio_spi_master_handle_t flexio_spi_slave_handle_t`

22.7.6 Enumeration Type Documentation

22.7.6.1 anonymous enum

Enumerator

kStatus_FLEXIO_SPI_Busy FlexIO SPI is busy.

kStatus_FLEXIO_SPI_Idle SPI is idle.

kStatus_FLEXIO_SPI_Error FlexIO SPI error.

kStatus_FLEXIO_SPI_Timeout FlexIO SPI timeout polling status flags.

22.7.6.2 enum flexio_spi_clock_phase_t

Enumerator

kFLEXIO_SPI_ClockPhaseFirstEdge First edge on SPSCCK occurs at the middle of the first cycle of a data transfer.

kFLEXIO_SPI_ClockPhaseSecondEdge First edge on SPSCCK occurs at the start of the first cycle of a data transfer.

22.7.6.3 enum flexio_spi_shift_direction_t

Enumerator

kFLEXIO_SPI_MsbFirst Data transfers start with most significant bit.

kFLEXIO_SPI_LsbFirst Data transfers start with least significant bit.

22.7.6.4 enum flexio_spi_data_bitcount_mode_t

Enumerator

kFLEXIO_SPI_8BitMode 8-bit data transmission mode.

kFLEXIO_SPI_16BitMode 16-bit data transmission mode.

kFLEXIO_SPI_32BitMode 32-bit data transmission mode.

22.7.6.5 enum `_flexio_spi_interrupt_enable`

Enumerator

kFLEXIO_SPI_TxEmptyInterruptEnable Transmit buffer empty interrupt enable.
kFLEXIO_SPI_RxFullInterruptEnable Receive buffer full interrupt enable.

22.7.6.6 enum `_flexio_spi_status_flags`

Enumerator

kFLEXIO_SPI_TxBufferEmptyFlag Transmit buffer empty flag.
kFLEXIO_SPI_RxBufferFullFlag Receive buffer full flag.

22.7.6.7 enum `_flexio_spi_dma_enable`

Enumerator

kFLEXIO_SPI_TxDmaEnable Tx DMA request source.
kFLEXIO_SPI_RxDmaEnable Rx DMA request source.
kFLEXIO_SPI_DmaAllEnable All DMA request source.

22.7.6.8 enum `_flexio_spi_transfer_flags`

Note

Use `kFLEXIO_SPI_csContinuous` and one of the other flags to OR together to form the transfer flag.

Enumerator

kFLEXIO_SPI_8bitMsb FlexIO SPI 8-bit MSB first.
kFLEXIO_SPI_8bitLsb FlexIO SPI 8-bit LSB first.
kFLEXIO_SPI_16bitMsb FlexIO SPI 16-bit MSB first.
kFLEXIO_SPI_16bitLsb FlexIO SPI 16-bit LSB first.
kFLEXIO_SPI_32bitMsb FlexIO SPI 32-bit MSB first.
kFLEXIO_SPI_32bitLsb FlexIO SPI 32-bit LSB first.
kFLEXIO_SPI_csContinuous Enable the CS signal continuous mode.

22.7.7 Function Documentation

22.7.7.1 void `FLEXIO_SPI_MasterInit (FLEXIO_SPI_Type * base, flexio_spi_master_config_t * masterConfig, uint32_t srcClock_Hz)`

The configuration structure can be filled by the user, or be set with default values by the [FLEXIO_SPI_MasterGetDefaultConfig\(\)](#).

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 $(1.5+2.5)*2=8$.

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);
```

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>masterConfig</i>	Pointer to the flexio_spi_master_config_t structure.
<i>srcClock_Hz</i>	FlexIO source clock in Hz.

22.7.7.2 void FLEXIO_SPI_MasterDeinit (FLEXIO_SPI_Type * *base*)

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type .
-------------	--

22.7.7.3 void FLEXIO_SPI_MasterGetDefaultConfig (flexio_spi_master_config_t * *masterConfig*)

The configuration can be used directly by calling the `FLEXIO_SPI_MasterConfigure()`. Example:

```
flexio_spi_master_config_t masterConfig;
FLEXIO_SPI_MasterGetDefaultConfig(&masterConfig);
```

Parameters

<i>masterConfig</i>	Pointer to the flexio_spi_master_config_t structure.
---------------------	--

22.7.7.4 void FLEXIO_SPI_SlaveInit (FLEXIO_SPI_Type * *base*, flexio_spi_slave_config_t * *slaveConfig*)

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

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>slaveConfig</i>	Pointer to the flexio_spi_slave_config_t structure.

22.7.7.5 void FLEXIO_SPI_SlaveDeinit (FLEXIO_SPI_Type * *base*)

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type .
-------------	--

22.7.7.6 void FLEXIO_SPI_SlaveGetDefaultConfig (flexio_spi_slave_config_t * slaveConfig)

The configuration can be used directly for calling the FLEXIO_SPI_SlaveConfigure(). Example:

```
flexio_spi_slave_config_t slaveConfig;
FLEXIO_SPI_SlaveGetDefaultConfig(&slaveConfig);
```

Parameters

<i>slaveConfig</i>	Pointer to the flexio_spi_slave_config_t structure.
--------------------	---

22.7.7.7 uint32_t FLEXIO_SPI_GetStatusFlags (FLEXIO_SPI_Type * base)

Parameters

<i>base</i>	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

22.7.7.8 void FLEXIO_SPI_ClearStatusFlags (FLEXIO_SPI_Type * base, uint32_t mask)

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>mask</i>	status flag The parameter can be any combination of the following values: <ul style="list-style-type: none"> • kFLEXIO_SPI_TxEmptyFlag • kFLEXIO_SPI_RxEmptyFlag

```
22.7.7.9 void FLEXIO_SPI_EnableInterrupts ( FLEXIO_SPI_Type * base, uint32_t mask
      )
```

This function enables the FlexIO SPI interrupt.

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>mask</i>	interrupt source. The parameter can be any combination of the following values: <ul style="list-style-type: none"> • kFLEXIO_SPI_RxFullInterruptEnable • kFLEXIO_SPI_TxEmptyInterruptEnable

22.7.7.10 void FLEXIO_SPI_DisableInterrupts (FLEXIO_SPI_Type * *base*, uint32_t *mask*)

This function disables the FlexIO SPI interrupt.

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>mask</i>	interrupt source The parameter can be any combination of the following values: <ul style="list-style-type: none"> • kFLEXIO_SPI_RxFullInterruptEnable • kFLEXIO_SPI_TxEmptyInterruptEnable

22.7.7.11 void FLEXIO_SPI_EnableDMA (FLEXIO_SPI_Type * *base*, uint32_t *mask*, bool *enable*)

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

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>mask</i>	SPI DMA source.
<i>enable</i>	True means enable DMA, false means disable DMA.

22.7.7.12 static uint32_t FLEXIO_SPI_GetTxDataRegisterAddress (FLEXIO_SPI_Type * *base*, flexio_spi_shift_direction_t *direction*) [inline], [static]

This function returns the SPI data register address, which is mainly used by DMA/eDMA.

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>direction</i>	Shift direction of MSB first or LSB first.

Returns

FlexIO SPI transmit data register address.

22.7.7.13 `static uint32_t FLEXIO_SPI_GetRxDataRegisterAddress (FLEXIO_SPI_Type * base, flexio_spi_shift_direction_t direction) [inline], [static]`

This function returns the SPI data register address, which is mainly used by DMA/eDMA.

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>direction</i>	Shift direction of MSB first or LSB first.

Returns

FlexIO SPI receive data register address.

22.7.7.14 `static void FLEXIO_SPI_Enable (FLEXIO_SPI_Type * base, bool enable) [inline], [static]`

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type .
<i>enable</i>	True to enable, false does not have any effect.

22.7.7.15 `void FLEXIO_SPI_MasterSetBaudRate (FLEXIO_SPI_Type * base, uint32_t baudRate_Bps, uint32_t srcClockHz)`

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>baudRate_Bps</i>	Baud Rate needed in Hz.
<i>srcClockHz</i>	SPI source clock frequency in Hz.

22.7.7.16 `static void FLEXIO_SPI_WriteData (FLEXIO_SPI_Type * base,
flexio_spi_shift_direction_t direction, uint32_t data) [inline], [static]`

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

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>direction</i>	Shift direction of MSB first or LSB first.
<i>data</i>	8/16/32 bit data.

22.7.7.17 `static uint32_t FLEXIO_SPI_ReadData (FLEXIO_SPI_Type * base,
flexio_spi_shift_direction_t direction) [inline], [static]`

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

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>direction</i>	Shift direction of MSB first or LSB first.

Returns

8 bit/16 bit data received.

22.7.7.18 `status_t FLEXIO_SPI_WriteBlocking (FLEXIO_SPI_Type * base,
flexio_spi_shift_direction_t direction, const uint8_t * buffer, size_t size)`

Note

This function blocks using the polling method until all bytes have been sent.

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>direction</i>	Shift direction of MSB first or LSB first.
<i>buffer</i>	The data bytes to send.
<i>size</i>	The number of data bytes to send.

Return values

<i>kStatus_Success</i>	Successfully create the handle.
<i>kStatus_FLEXIO_SPI_ - Timeout</i>	The transfer timed out and was aborted.

22.7.7.19 `status_t FLEXIO_SPI_ReadBlocking (FLEXIO_SPI_Type * base, flexio_spi_shift_direction_t direction, uint8_t * buffer, size_t size)`

Note

This function blocks using the polling method until all bytes have been received.

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>direction</i>	Shift direction of MSB first or LSB first.
<i>buffer</i>	The buffer to store the received bytes.
<i>size</i>	The number of data bytes to be received.
<i>direction</i>	Shift direction of MSB first or LSB first.

Return values

<i>kStatus_Success</i>	Successfully create the handle.
<i>kStatus_FLEXIO_SPI_ - Timeout</i>	The transfer timed out and was aborted.

22.7.7.20 `status_t FLEXIO_SPI_MasterTransferBlocking (FLEXIO_SPI_Type * base, flexio_spi_transfer_t * xfer)`

Note

This function blocks via polling until all bytes have been received.

Parameters

<i>base</i>	pointer to FLEXIO_SPI_Type structure
<i>xfer</i>	FlexIO SPI transfer structure, see flexio_spi_transfer_t .

Return values

<i>kStatus_Success</i>	Successfully create the handle.
<i>kStatus_FLEXIO_SPI_Timeout</i>	The transfer timed out and was aborted.

22.7.7.21 void FLEXIO_SPI_FlushShifters (FLEXIO_SPI_Type * *base*)

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
-------------	---

22.7.7.22 status_t FLEXIO_SPI_MasterTransferCreateHandle (FLEXIO_SPI_Type * *base*, flexio_spi_master_handle_t * *handle*, flexio_spi_master_transfer_callback_t *callback*, void * *userData*)

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>handle</i>	Pointer to the flexio_spi_master_handle_t structure to store the transfer state.
<i>callback</i>	The callback function.
<i>userData</i>	The parameter of the callback function.

Return values

<i>kStatus_Success</i>	Successfully create the handle.
------------------------	---------------------------------

<i>kStatus_OutOfRange</i>	The FlexIO type/handle/ISR table out of range.
---------------------------	--

22.7.7.23 `status_t FLEXIO_SPI_MasterTransferNonBlocking (FLEXIO_SPI_Type * base, flexio_spi_master_handle_t * handle, flexio_spi_transfer_t * xfer)`

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

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>handle</i>	Pointer to the <code>flexio_spi_master_handle_t</code> structure to store the transfer state.
<i>xfer</i>	FlexIO SPI transfer structure. See flexio_spi_transfer_t .

Return values

<i>kStatus_Success</i>	Successfully start a transfer.
<i>kStatus_InvalidArgument</i>	Input argument is invalid.
<i>kStatus_FLEXIO_SPI_Busy</i>	SPI is not idle, is running another transfer.

22.7.7.24 `void FLEXIO_SPI_MasterTransferAbort (FLEXIO_SPI_Type * base, flexio_spi_master_handle_t * handle)`

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>handle</i>	Pointer to the <code>flexio_spi_master_handle_t</code> structure to store the transfer state.

22.7.7.25 `status_t FLEXIO_SPI_MasterTransferGetCount (FLEXIO_SPI_Type * base, flexio_spi_master_handle_t * handle, size_t * count)`

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>handle</i>	Pointer to the <code>flexio_spi_master_handle_t</code> structure to store the transfer state.
<i>count</i>	Number of bytes transferred so far by the non-blocking transaction.

Return values

<i>kStatus_InvalidArgument</i>	count is Invalid.
<i>kStatus_Success</i>	Successfully return the count.

22.7.7.26 void FLEXIO_SPI_MasterTransferHandleIRQ (void * *spiType*, void * *spiHandle*)

Parameters

<i>spiType</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>spiHandle</i>	Pointer to the <code>flexio_spi_master_handle_t</code> structure to store the transfer state.

22.7.7.27 status_t FLEXIO_SPI_SlaveTransferCreateHandle (FLEXIO_SPI_Type * *base*, flexio_spi_slave_handle_t * *handle*, flexio_spi_slave_transfer_callback_t *callback*, void * *userData*)

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>handle</i>	Pointer to the <code>flexio_spi_slave_handle_t</code> structure to store the transfer state.
<i>callback</i>	The callback function.
<i>userData</i>	The parameter of the callback function.

Return values

<i>kStatus_Success</i>	Successfully create the handle.
<i>kStatus_OutOfRange</i>	The FlexIO type/handle/ISR table out of range.

22.7.7.28 status_t FLEXIO_SPI_SlaveTransferNonBlocking (FLEXIO_SPI_Type * *base*, flexio_spi_slave_handle_t * *handle*, flexio_spi_transfer_t * *xfer*)

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

<i>handle</i>	Pointer to the <code>flexio_spi_slave_handle_t</code> structure to store the transfer state.
<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>xfer</i>	FlexIO SPI transfer structure. See flexio_spi_transfer_t .

Return values

<i>kStatus_Success</i>	Successfully start a transfer.
<i>kStatus_InvalidArgument</i>	Input argument is invalid.
<i>kStatus_FLEXIO_SPI_Busy</i>	SPI is not idle; it is running another transfer.

22.7.7.29 `static void FLEXIO_SPI_SlaveTransferAbort (FLEXIO_SPI_Type * base, flexio_spi_slave_handle_t * handle) [inline], [static]`

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>handle</i>	Pointer to the <code>flexio_spi_slave_handle_t</code> structure to store the transfer state.

22.7.7.30 `static status_t FLEXIO_SPI_SlaveTransferGetCount (FLEXIO_SPI_Type * base, flexio_spi_slave_handle_t * handle, size_t * count) [inline], [static]`

Parameters

<i>base</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>handle</i>	Pointer to the <code>flexio_spi_slave_handle_t</code> structure to store the transfer state.
<i>count</i>	Number of bytes transferred so far by the non-blocking transaction.

Return values

<i>kStatus_InvalidArgument</i>	<code>count</code> is Invalid.
<i>kStatus_Success</i>	Successfully return the count.

22.7.7.31 `void FLEXIO_SPI_SlaveTransferHandleIRQ (void * spiType, void * spiHandle)`

Parameters

<i>spiType</i>	Pointer to the FLEXIO_SPI_Type structure.
<i>spiHandle</i>	Pointer to the <code>flexio_spi_slave_handle_t</code> structure to store the transfer state.

22.7.8 FlexIO eDMA SPI Driver

22.7.8.1 Overview

Data Structures

- struct `flexio_spi_master_edma_handle_t`
FlexIO SPI eDMA transfer handle, users should not touch the content of the handle. [More...](#)

Typedefs

- typedef
`flexio_spi_master_edma_handle_t flexio_spi_slave_edma_handle_t`
Slave handle is the same with master handle.
- typedef void(* `flexio_spi_master_edma_transfer_callback_t`)(`FLEXIO_SPI_Type *base`, `flexio_spi_master_edma_handle_t *handle`, `status_t status`, void *userData)
FlexIO SPI master callback for finished transmit.
- typedef void(* `flexio_spi_slave_edma_transfer_callback_t`)(`FLEXIO_SPI_Type *base`, `flexio_spi_slave_edma_handle_t *handle`, `status_t status`, void *userData)
FlexIO SPI slave callback for finished transmit.

Driver version

- #define `FSL_FLEXIO_SPI_EDMA_DRIVER_VERSION` (`MAKE_VERSION(2, 3, 0)`)
FlexIO SPI EDMA driver version.

eDMA Transactional

- `status_t FLEXIO_SPI_MasterTransferCreateHandleEDMA` (`FLEXIO_SPI_Type *base`, `flexio_spi_master_edma_handle_t *handle`, `flexio_spi_master_edma_transfer_callback_t callback`, void *userData, `edma_handle_t *txHandle`, `edma_handle_t *rxHandle`)
Initializes the FlexIO SPI master eDMA handle.
- `status_t FLEXIO_SPI_MasterTransferEDMA` (`FLEXIO_SPI_Type *base`, `flexio_spi_master_edma_handle_t *handle`, `flexio_spi_transfer_t *xfer`)
Performs a non-blocking FlexIO SPI transfer using eDMA.
- void `FLEXIO_SPI_MasterTransferAbortEDMA` (`FLEXIO_SPI_Type *base`, `flexio_spi_master_edma_handle_t *handle`)
Aborts a FlexIO SPI transfer using eDMA.
- `status_t FLEXIO_SPI_MasterTransferGetCountEDMA` (`FLEXIO_SPI_Type *base`, `flexio_spi_master_edma_handle_t *handle`, `size_t *count`)
Gets the number of bytes transferred so far using FlexIO SPI master eDMA.
- static void `FLEXIO_SPI_SlaveTransferCreateHandleEDMA` (`FLEXIO_SPI_Type *base`, `flexio_spi_slave_edma_handle_t *handle`, `flexio_spi_slave_edma_transfer_callback_t callback`, void *userData, `edma_handle_t *txHandle`, `edma_handle_t *rxHandle`)
Initializes the FlexIO SPI slave eDMA handle.

- `status_t FLEXIO_SPI_SlaveTransferEDMA` (`FLEXIO_SPI_Type *base`, `flexio_spi_slave_edma_handle_t *handle`, `flexio_spi_transfer_t *xfer`)
Performs a non-blocking FlexIO SPI transfer using eDMA.
- `static void FLEXIO_SPI_SlaveTransferAbortEDMA` (`FLEXIO_SPI_Type *base`, `flexio_spi_slave_edma_handle_t *handle`)
Aborts a FlexIO SPI transfer using eDMA.
- `static status_t FLEXIO_SPI_SlaveTransferGetCountEDMA` (`FLEXIO_SPI_Type *base`, `flexio_spi_slave_edma_handle_t *handle`, `size_t *count`)
Gets the number of bytes transferred so far using FlexIO SPI slave eDMA.

22.7.8.2 Data Structure Documentation

22.7.8.2.1 struct flexio_spi_master_edma_handle

typedef for `flexio_spi_master_edma_handle_t` in advance.

Data Fields

- `size_t transferSize`
Total bytes to be transferred.
- `uint8_t nbytes`
eDMA minor byte transfer count initially configured.
- `bool txInProgress`
Send transfer in progress.
- `bool rxInProgress`
Receive transfer in progress.
- `edma_handle_t * txHandle`
DMA handler for SPI send.
- `edma_handle_t * rxHandle`
DMA handler for SPI receive.
- `flexio_spi_master_edma_transfer_callback_t callback`
Callback for SPI DMA transfer.
- `void * userData`
User Data for SPI DMA callback.

Field Documentation

(1) `size_t flexio_spi_master_edma_handle_t::transferSize`

(2) `uint8_t flexio_spi_master_edma_handle_t::nbytes`

22.7.8.3 Macro Definition Documentation

22.7.8.3.1 `#define FSL_FLEXIO_SPI_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 3, 0))`

22.7.8.4 Typedef Documentation

22.7.8.4.1 typedef flexio_spi_master_edma_handle_t flexio_spi_slave_edma_handle_t

22.7.8.5 Function Documentation

22.7.8.5.1 status_t FLEXIO_SPI_MasterTransferCreateHandleEDMA (FLEXIO_SPI_Type * *base*, flexio_spi_master_edma_handle_t * *handle*, flexio_spi_master_edma_transfer_callback_t *callback*, void * *userData*, edma_handle_t * *txHandle*, edma_handle_t * *rxHandle*)

This function initializes the FlexIO SPI master eDMA handle which can be used for other FlexIO SPI master transactional APIs. For a specified FlexIO SPI instance, call this API once to get the initialized handle.

Parameters

<i>base</i>	Pointer to FLEXIO_SPI_Type structure.
<i>handle</i>	Pointer to flexio_spi_master_edma_handle_t structure to store the transfer state.
<i>callback</i>	SPI callback, NULL means no callback.
<i>userData</i>	callback function parameter.
<i>txHandle</i>	User requested eDMA handle for FlexIO SPI RX eDMA transfer.
<i>rxHandle</i>	User requested eDMA handle for FlexIO SPI TX eDMA transfer.

Return values

<i>kStatus_Success</i>	Successfully create the handle.
<i>kStatus_OutOfRange</i>	The FlexIO SPI eDMA type/handle table out of range.

22.7.8.5.2 status_t FLEXIO_SPI_MasterTransferEDMA (FLEXIO_SPI_Type * *base*, flexio_spi_master_edma_handle_t * *handle*, flexio_spi_transfer_t * *xfer*)

Note

This interface returns immediately after transfer initiates. Call FLEXIO_SPI_MasterGetTransferCountEDMA to poll the transfer status and check whether the FlexIO SPI transfer is finished.

Parameters

<i>base</i>	Pointer to FLEXIO_SPI_Type structure.
-------------	---

<i>handle</i>	Pointer to flexio_spi_master_edma_handle_t structure to store the transfer state.
<i>xfer</i>	Pointer to FlexIO SPI transfer structure.

Return values

<i>kStatus_Success</i>	Successfully start a transfer.
<i>kStatus_InvalidArgument</i>	Input argument is invalid.
<i>kStatus_FLEXIO_SPI_Busy</i>	FlexIO SPI is not idle, is running another transfer.

22.7.8.5.3 void FLEXIO_SPI_MasterTransferAbortEDMA (FLEXIO_SPI_Type * *base*, flexio_spi_master_edma_handle_t * *handle*)

Parameters

<i>base</i>	Pointer to FLEXIO_SPI_Type structure.
<i>handle</i>	FlexIO SPI eDMA handle pointer.

22.7.8.5.4 status_t FLEXIO_SPI_MasterTransferGetCountEDMA (FLEXIO_SPI_Type * *base*, flexio_spi_master_edma_handle_t * *handle*, size_t * *count*)

Parameters

<i>base</i>	Pointer to FLEXIO_SPI_Type structure.
<i>handle</i>	FlexIO SPI eDMA handle pointer.
<i>count</i>	Number of bytes transferred so far by the non-blocking transaction.

22.7.8.5.5 static void FLEXIO_SPI_SlaveTransferCreateHandleEDMA (FLEXIO_SPI_Type * *base*, flexio_spi_slave_edma_handle_t * *handle*, flexio_spi_slave_edma_transfer_callback_t *callback*, void * *userData*, edma_handle_t * *txHandle*, edma_handle_t * *rxHandle*) [inline], [static]

This function initializes the FlexIO SPI slave eDMA handle.

Parameters

<i>base</i>	Pointer to FLEXIO_SPI_Type structure.
<i>handle</i>	Pointer to <code>flexio_spi_slave_edma_handle_t</code> structure to store the transfer state.
<i>callback</i>	SPI callback, NULL means no callback.
<i>userData</i>	callback function parameter.
<i>txHandle</i>	User requested eDMA handle for FlexIO SPI TX eDMA transfer.
<i>rxHandle</i>	User requested eDMA handle for FlexIO SPI RX eDMA transfer.

22.7.8.5.6 `status_t FLEXIO_SPI_SlaveTransferEDMA (FLEXIO_SPI_Type * base, flexio_spi_slave_edma_handle_t * handle, flexio_spi_transfer_t * xfer)`

Note

This interface returns immediately after transfer initiates. Call `FLEXIO_SPI_SlaveGetTransferCountEDMA` to poll the transfer status and check whether the FlexIO SPI transfer is finished.

Parameters

<i>base</i>	Pointer to FLEXIO_SPI_Type structure.
<i>handle</i>	Pointer to <code>flexio_spi_slave_edma_handle_t</code> structure to store the transfer state.
<i>xfer</i>	Pointer to FlexIO SPI transfer structure.

Return values

<i>kStatus_Success</i>	Successfully start a transfer.
<i>kStatus_InvalidArgument</i>	Input argument is invalid.
<i>kStatus_FLEXIO_SPI_Busy</i>	FlexIO SPI is not idle, is running another transfer.

22.7.8.5.7 `static void FLEXIO_SPI_SlaveTransferAbortEDMA (FLEXIO_SPI_Type * base, flexio_spi_slave_edma_handle_t * handle) [inline], [static]`

Parameters

<i>base</i>	Pointer to FLEXIO_SPI_Type structure.
<i>handle</i>	Pointer to flexio_spi_slave_edma_handle_t structure to store the transfer state.

22.7.8.5.8 static status_t FLEXIO_SPI_SlaveTransferGetCountEDMA (FLEXIO_SPI_Type * *base*, flexio_spi_slave_edma_handle_t * *handle*, size_t * *count*) [inline], [static]

Parameters

<i>base</i>	Pointer to FLEXIO_SPI_Type structure.
<i>handle</i>	FlexIO SPI eDMA handle pointer.
<i>count</i>	Number of bytes transferred so far by the non-blocking transaction.

22.8 FlexIO UART Driver

22.8.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Universal Asynchronous Receiver/Transmitter (UART) function using the Flexible I/O.

FlexIO UART driver includes functional APIs and transactional APIs. Functional APIs target low-level APIs. Functional APIs can be used for the FlexIO UART initialization/configuration/operation for optimization/customization purpose. Using the functional APIs requires the knowledge of the FlexIO UART peripheral and how to organize functional APIs to meet the application requirements. All functional API use the `FLEXIO_UART_Type *` as the first parameter. FlexIO UART functional operation groups provide the functional APIs set.

Transactional APIs target high-level APIs. Transactional APIs can be used to enable the peripheral and also in the application if the code size and performance of transactional APIs satisfy requirements. If the code size and performance are critical requirements, see the transactional API implementation and write custom code. All transactional APIs use the `flexio_uart_handle_t` as the second parameter. Initialize the handle by calling the `FLEXIO_UART_TransferCreateHandle()` API.

Transactional APIs support asynchronous transfer. This means that the functions `FLEXIO_UART_SendNonBlocking()` and `FLEXIO_UART_ReceiveNonBlocking()` set up an interrupt for data transfer. When the transfer is complete, the upper layer is notified through a callback function with the `kStatus_FLEXIO_UART_TxIdle` and `kStatus_FLEXIO_UART_RxIdle` status.

Transactional receive APIs support the ring buffer. Prepare the memory for the ring buffer and pass in the start address and size through calling the `FLEXIO_UART_InstallRingBuffer()`. When the ring buffer is enabled, the received data is saved to the ring buffer in the background. The function `FLEXIO_UART_ReceiveNonBlocking()` first gets data from the ring buffer. If ring buffer does not have enough data, the function returns the data to the ring buffer and saves the received data to user memory. When all data is received, the upper layer is informed through a callback with the `statuskStatus_FLEXIO_UART_RxIdle` status.

If the receive ring buffer is full, the upper layer is informed through a callback with status `kStatus_FLEXIO_UART_RxRingBufferOverrun`. In the callback function, the upper layer reads data from the ring buffer. If not, the oldest data is overwritten by the new data.

The ring buffer size is specified when calling the `FLEXIO_UART_InstallRingBuffer`. Note that one byte is reserved for the ring buffer maintenance. Create a handle as follows.

```
FLEXIO_UART_InstallRingBuffer(&uartDev, &handle, &ringBuffer, 32);
```

In this example, the buffer size is 32. However, only 31 bytes are used for saving data.

22.8.2 Typical use case

22.8.2.1 FlexIO UART send/receive using a polling method

```
uint8_t ch;
```

```

FLEXIO_UART_Type uartDev;
status_t result = kStatus_Success;
flexio_uart_user_config user_config;
FLEXIO_UART_GetDefaultConfig(&user_config);
user_config.baudRate_Bps = 115200U;
user_config.enableUart = true;

uartDev.flexioBase = BOARD_FLEXIO_BASE;
uartDev.TxPinIndex = FLEXIO_UART_TX_PIN;
uartDev.RxPinIndex = FLEXIO_UART_RX_PIN;
uartDev.shifterIndex[0] = 0U;
uartDev.shifterIndex[1] = 1U;
uartDev.timerIndex[0] = 0U;
uartDev.timerIndex[1] = 1U;

result = FLEXIO_UART_Init(&uartDev, &user_config, 48000000U);
//Check if configuration is correct.
if(result != kStatus_Success)
{
    return;
}
FLEXIO_UART_WriteBlocking(&uartDev, txbuff, sizeof(txbuff));

while(1)
{
    FLEXIO_UART_ReadBlocking(&uartDev, &ch, 1);
    FLEXIO_UART_WriteBlocking(&uartDev, &ch, 1);
}

```

22.8.2.2 FlexIO UART send/receive using an interrupt method

```

FLEXIO_UART_Type uartDev;
flexio_uart_handle_t g_uartHandle;
flexio_uart_config_t user_config;
flexio_uart_transfer_t sendXfer;
flexio_uart_transfer_t receiveXfer;
volatile bool txFinished;
volatile bool rxFinished;
uint8_t sendData[] = {'H', 'e', 'l', 'l', 'o'};
uint8_t receiveData[32];

void FLEXIO_UART_UserCallback(FLEXIO_UART_Type *base, flexio_uart_handle_t *handle,
    status_t status, void *userData)
{
    userData = userData;

    if (kStatus_FLEXIO_UART_TxIdle == status)
    {
        txFinished = true;
    }

    if (kStatus_FLEXIO_UART_RxIdle == status)
    {
        rxFinished = true;
    }
}

void main(void)
{
    //...

    FLEXIO_UART_GetDefaultConfig(&user_config);
    user_config.baudRate_Bps = 115200U;
    user_config.enableUart = true;

```

```

uartDev.flexioBase = BOARD_FLEXIO_BASE;
uartDev.TxPinIndex = FLEXIO_UART_TX_PIN;
uartDev.RxPinIndex = FLEXIO_UART_RX_PIN;
uartDev.shifterIndex[0] = 0U;
uartDev.shifterIndex[1] = 1U;
uartDev.timerIndex[0] = 0U;
uartDev.timerIndex[1] = 1U;

result = FLEXIO_UART_Init(&uartDev, &user_config, 120000000U);
//Check if configuration is correct.
if(result != kStatus_Success)
{
    return;
}

FLEXIO_UART_TransferCreateHandle(&uartDev, &g_uartHandle,
    FLEXIO_UART_UserCallback, NULL);

// Prepares to send.
sendXfer.data = sendData;
sendXfer.dataSize = sizeof(sendData)/sizeof(sendData[0]);
txFinished = false;

// Sends out.
FLEXIO_UART_SendNonBlocking(&uartDev, &g_uartHandle, &sendXfer);

// Send finished.
while (!txFinished)
{
}

// Prepares to receive.
receiveXfer.data = receiveData;
receiveXfer.dataSize = sizeof(receiveData)/sizeof(receiveData[0]);
rxFinished = false;

// Receives.
FLEXIO_UART_ReceiveNonBlocking(&uartDev, &g_uartHandle, &receiveXfer, NULL);

// Receive finished.
while (!rxFinished)
{
}

// ...
}

```

22.8.2.3 FlexIO UART receive using the ringbuffer feature

```

#define RING_BUFFER_SIZE 64
#define RX_DATA_SIZE 32

FLEXIO_UART_Type uartDev;
flexio_uart_handle_t g_uartHandle;
flexio_uart_config_t user_config;
flexio_uart_transfer_t sendXfer;
flexio_uart_transfer_t receiveXfer;
volatile bool txFinished;
volatile bool rxFinished;
uint8_t receiveData[RX_DATA_SIZE];
uint8_t ringBuffer[RING_BUFFER_SIZE];

void FLEXIO_UART_UserCallback(FLEXIO_UART_Type *base, flexio_uart_handle_t *handle,
    status_t status, void *userData)
{

```

```

    userData = userData;

    if (kStatus_FLEXIO_UART_RxIdle == status)
    {
        rxFinished = true;
    }
}

void main(void)
{
    size_t bytesRead;
    //...

    FLEXIO_UART_GetDefaultConfig(&user_config);
    user_config.baudRate_Bps = 115200U;
    user_config.enableUart = true;

    uartDev.flexioBase = BOARD_FLEXIO_BASE;
    uartDev.TxPinIndex = FLEXIO_UART_TX_PIN;
    uartDev.RxPinIndex = FLEXIO_UART_RX_PIN;
    uartDev.shifterIndex[0] = 0U;
    uartDev.shifterIndex[1] = 1U;
    uartDev.timerIndex[0] = 0U;
    uartDev.timerIndex[1] = 1U;

    result = FLEXIO_UART_Init(&uartDev, &user_config, 48000000U);
    //Check if configuration is correct.
    if(result != kStatus_Success)
    {
        return;
    }

    FLEXIO_UART_TransferCreateHandle(&uartDev, &g_uartHandle,
        FLEXIO_UART_UserCallback, NULL);
    FLEXIO_UART_InstallRingBuffer(&uartDev, &g_uartHandle, ringBuffer, RING_BUFFER_SIZE);

    // Receive is working in the background to the ring buffer.

    // Prepares to receive.
    receiveXfer.data = receiveData;
    receiveXfer.dataSize = RX_DATA_SIZE;
    rxFinished = false;

    // Receives.
    FLEXIO_UART_ReceiveNonBlocking(&uartDev, &g_uartHandle, &receiveXfer, &bytesRead);

    if (bytesRead == RX_DATA_SIZE) /* Have read enough data. */
    {
        ;
    }
    else
    {
        if (bytesRead) /* Received some data, process first. */
        {
            ;
        }

        // Receive finished.
        while (!rxFinished)
        {
        }
    }

    // ...
}

```


22.8.2.4 FlexIO UART send/receive using a DMA method

```

FLEXIO_UART_Type uartDev;
flexio_uart_handle_t g_uartHandle;
dma_handle_t g_uartTxDmaHandle;
dma_handle_t g_uartRxDmaHandle;
flexio_uart_config_t user_config;
flexio_uart_transfer_t sendXfer;
flexio_uart_transfer_t receiveXfer;
volatile bool txFinished;
volatile bool rxFinished;
uint8_t sendData[] = {'H', 'e', 'l', 'l', 'o'};
uint8_t receiveData[32];

void FLEXIO_UART_UserCallback(FLEXIO_UART_Type *base, flexio_uart_handle_t *handle,
    status_t status, void *userData)
{
    userData = userData;

    if (kStatus_FLEXIO_UART_TxIdle == status)
    {
        txFinished = true;
    }

    if (kStatus_FLEXIO_UART_RxIdle == status)
    {
        rxFinished = true;
    }
}

void main(void)
{
    //...

    FLEXIO_UART_GetDefaultConfig(&user_config);
    user_config.baudRate_Bps = 115200U;
    user_config.enableUart = true;

    uartDev.flexioBase = BOARD_FLEXIO_BASE;
    uartDev.TxPinIndex = FLEXIO_UART_TX_PIN;
    uartDev.RxPinIndex = FLEXIO_UART_RX_PIN;
    uartDev.shifterIndex[0] = 0U;
    uartDev.shifterIndex[1] = 1U;
    uartDev.timerIndex[0] = 0U;
    uartDev.timerIndex[1] = 1U;
    result = FLEXIO_UART_Init(&uartDev, &user_config, 48000000U);
    //Check if configuration is correct.
    if(result != kStatus_Success)
    {
        return;
    }

    /* Init DMAMUX. */
    DMAMUX_Init(EXAMPLE_FLEXIO_UART_DMAMUX_BASEADDR)

    /* Init the DMA/EDMA module */
#ifdef FSL_FEATURE_SOC_DMA_COUNT && FSL_FEATURE_SOC_DMA_COUNT > 0U
    DMA_Init(EXAMPLE_FLEXIO_UART_DMA_BASEADDR);
    DMA_CreateHandle(&g_uartTxDmaHandle, EXAMPLE_FLEXIO_UART_DMA_BASEADDR, FLEXIO_UART_TX_DMA_CHANNEL);
    DMA_CreateHandle(&g_uartRxDmaHandle, EXAMPLE_FLEXIO_UART_DMA_BASEADDR, FLEXIO_UART_RX_DMA_CHANNEL);
#endif /* FSL_FEATURE_SOC_DMA_COUNT */

#ifdef FSL_FEATURE_SOC_EDMA_COUNT && FSL_FEATURE_SOC_EDMA_COUNT > 0U
    edma_config_t edmaConfig;

    EDMA_GetDefaultConfig(&edmaConfig);
    EDMA_Init(EXAMPLE_FLEXIO_UART_DMA_BASEADDR, &edmaConfig);
#endif
}

```

```

    EDMA_CreateHandle(&g_uartTxDmaHandle, EXAMPLE_FLEXIO_UART_DMA_BASEADDR,
FLEXIO_UART_TX_DMA_CHANNEL);
    EDMA_CreateHandle(&g_uartRxDmaHandle, EXAMPLE_FLEXIO_UART_DMA_BASEADDR,
FLEXIO_UART_RX_DMA_CHANNEL);
#endif /* FSL_FEATURE_SOC_EDMA_COUNT */

    dma_request_source_tx = (dma_request_source_t)(FLEXIO_DMA_REQUEST_BASE + uartDev.
shifterIndex[0]);
    dma_request_source_rx = (dma_request_source_t)(FLEXIO_DMA_REQUEST_BASE + uartDev.
shifterIndex[1]);

    /* Requests DMA channels for transmit and receive. */
    DMAMUX_SetSource(EXAMPLE_FLEXIO_UART_DMAMUX_BASEADDR, FLEXIO_UART_TX_DMA_CHANNEL, (
dma_request_source_t)dma_request_source_tx);
    DMAMUX_SetSource(EXAMPLE_FLEXIO_UART_DMAMUX_BASEADDR, FLEXIO_UART_RX_DMA_CHANNEL, (
dma_request_source_t)dma_request_source_rx);
    DMAMUX_EnableChannel(EXAMPLE_FLEXIO_UART_DMAMUX_BASEADDR,
FLEXIO_UART_TX_DMA_CHANNEL);
    DMAMUX_EnableChannel(EXAMPLE_FLEXIO_UART_DMAMUX_BASEADDR,
FLEXIO_UART_RX_DMA_CHANNEL);

    FLEXIO_UART_TransferCreateHandleDMA(&uartDev, &g_uartHandle, FLEXIO_UART_UserCallback, NULL, &
g_uartTxDmaHandle, &g_uartRxDmaHandle);

    // Prepares to send.
    sendXfer.data = sendData
    sendXfer.dataSize = sizeof(sendData)/sizeof(sendData[0]);
    txFinished = false;

    // Sends out.
    FLEXIO_UART_SendDMA(&uartDev, &g_uartHandle, &sendXfer);

    // Send finished.
    while (!txFinished)
    {
    }

    // Prepares to receive.
    receiveXfer.data = receiveData;
    receiveXfer.dataSize = sizeof(receiveData)/sizeof(receiveData[0]);
    rxFinished = false;

    // Receives.
    FLEXIO_UART_ReceiveDMA(&uartDev, &g_uartHandle, &receiveXfer, NULL);

    // Receive finished.
    while (!rxFinished)
    {
    }

    // ...
}

```

Modules

- [FlexIO eDMA UART Driver](#)

Data Structures

- struct [FLEXIO_UART_Type](#)
Define FlexIO UART access structure typedef. [More...](#)

- struct `flexio_uart_config_t`
Define FlexIO UART user configuration structure. [More...](#)
- struct `flexio_uart_transfer_t`
Define FlexIO UART transfer structure. [More...](#)
- struct `flexio_uart_handle_t`
Define FLEXIO UART handle structure. [More...](#)

Macros

- #define `UART_RETRY_TIMES` 0U /* Defining to zero means to keep waiting for the flag until it is assert/deassert. */
Retry times for waiting flag.

Typedefs

- 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.

Enumerations

- enum {
`kStatus_FLEXIO_UART_TxBusy` = MAKE_STATUS(kStatusGroup_FLEXIO_UART, 0),
`kStatus_FLEXIO_UART_RxBusy` = MAKE_STATUS(kStatusGroup_FLEXIO_UART, 1),
`kStatus_FLEXIO_UART_TxIdle` = MAKE_STATUS(kStatusGroup_FLEXIO_UART, 2),
`kStatus_FLEXIO_UART_RxIdle` = MAKE_STATUS(kStatusGroup_FLEXIO_UART, 3),
`kStatus_FLEXIO_UART_ERROR` = MAKE_STATUS(kStatusGroup_FLEXIO_UART, 4),
`kStatus_FLEXIO_UART_RxRingBufferOverrun`,
`kStatus_FLEXIO_UART_RxHardwareOverrun` = MAKE_STATUS(kStatusGroup_FLEXIO_UART, 6),
`kStatus_FLEXIO_UART_Timeout` = MAKE_STATUS(kStatusGroup_FLEXIO_UART, 7),
`kStatus_FLEXIO_UART_BaudrateNotSupport` }
Error codes for the UART driver.
- enum `flexio_uart_bit_count_per_char_t` {
`kFLEXIO_UART_7BitsPerChar` = 7U,
`kFLEXIO_UART_8BitsPerChar` = 8U,
`kFLEXIO_UART_9BitsPerChar` = 9U }
FlexIO UART bit count per char.
- enum `_flexio_uart_interrupt_enable` {
`kFLEXIO_UART_TxDataRegEmptyInterruptEnable` = 0x1U,
`kFLEXIO_UART_RxDataRegFullInterruptEnable` = 0x2U }
Define FlexIO UART interrupt mask.
- enum `_flexio_uart_status_flags` {

```
kFLEXIO_UART_TxDataRegEmptyFlag = 0x1U,
kFLEXIO_UART_RxDataRegFullFlag = 0x2U,
kFLEXIO_UART_RxOverRunFlag = 0x4U }
```

Define FlexIO UART status mask.

Driver version

- #define `FSL_FLEXIO_UART_DRIVER_VERSION` (`MAKE_VERSION(2, 4, 0)`)
FlexIO UART driver version.

Initialization and deinitialization

- `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.
- `void FLEXIO_UART_Deinit` (`FLEXIO_UART_Type *base`)
Resets the FlexIO UART shifter and timer config.
- `void FLEXIO_UART_GetDefaultConfig` (`flexio_uart_config_t *userConfig`)
Gets the default configuration to configure the FlexIO UART.

Status

- `uint32_t FLEXIO_UART_GetStatusFlags` (`FLEXIO_UART_Type *base`)
Gets the FlexIO UART status flags.
- `void FLEXIO_UART_ClearStatusFlags` (`FLEXIO_UART_Type *base`, `uint32_t mask`)
Gets the FlexIO UART status flags.

Interrupts

- `void FLEXIO_UART_EnableInterrupts` (`FLEXIO_UART_Type *base`, `uint32_t mask`)
Enables the FlexIO UART interrupt.
- `void FLEXIO_UART_DisableInterrupts` (`FLEXIO_UART_Type *base`, `uint32_t mask`)
Disables the FlexIO UART interrupt.

DMA Control

- `static uint32_t FLEXIO_UART_GetTxDataRegisterAddress` (`FLEXIO_UART_Type *base`)
Gets the FlexIO UART transmit data register address.
- `static uint32_t FLEXIO_UART_GetRxDataRegisterAddress` (`FLEXIO_UART_Type *base`)
Gets the FlexIO UART receive data register address.
- `static void FLEXIO_UART_EnableTxDMA` (`FLEXIO_UART_Type *base`, `bool enable`)
Enables/disables the FlexIO UART transmit DMA.
- `static void FLEXIO_UART_EnableRxDMA` (`FLEXIO_UART_Type *base`, `bool enable`)

Enables/disables the FlexIO UART receive DMA.

Bus Operations

- static void `FLEXIO_UART_Enable` (`FLEXIO_UART_Type *base`, bool enable)
Enables/disables the FlexIO UART module operation.
- static void `FLEXIO_UART_WriteByte` (`FLEXIO_UART_Type *base`, const uint8_t *buffer)
Writes one byte of data.
- static void `FLEXIO_UART_ReadByte` (`FLEXIO_UART_Type *base`, uint8_t *buffer)
Reads one byte of data.
- `status_t FLEXIO_UART_WriteBlocking` (`FLEXIO_UART_Type *base`, const uint8_t *txData, size_t txSize)
Sends a buffer of data bytes.
- `status_t FLEXIO_UART_ReadBlocking` (`FLEXIO_UART_Type *base`, uint8_t *rxData, size_t rxSize)
Receives a buffer of bytes.

Transactional

- `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.
- 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.
- void `FLEXIO_UART_TransferStopRingBuffer` (`FLEXIO_UART_Type *base`, flexio_uart_handle_t *handle)
Aborts the background transfer and uninstalls the ring buffer.
- `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.
- void `FLEXIO_UART_TransferAbortSend` (`FLEXIO_UART_Type *base`, flexio_uart_handle_t *handle)
Aborts the interrupt-driven data transmit.
- `status_t FLEXIO_UART_TransferGetSendCount` (`FLEXIO_UART_Type *base`, flexio_uart_handle_t *handle, size_t *count)
Gets the number of bytes sent.
- `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.
- void `FLEXIO_UART_TransferAbortReceive` (`FLEXIO_UART_Type *base`, flexio_uart_handle_t *handle)
Aborts the receive data which was using IRQ.
- `status_t FLEXIO_UART_TransferGetReceiveCount` (`FLEXIO_UART_Type *base`, flexio_uart_handle_t *handle, size_t *count)
Gets the number of bytes received.
- void `FLEXIO_UART_TransferHandleIRQ` (void *uartType, void *uartHandle)

FlexIO UART IRQ handler function.

22.8.3 Data Structure Documentation

22.8.3.1 struct FLEXIO_UART_Type

Data Fields

- 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.

Field Documentation

- (1) FLEXIO_Type* FLEXIO_UART_Type::flexioBase
- (2) uint8_t FLEXIO_UART_Type::TxPinIndex
- (3) uint8_t FLEXIO_UART_Type::RxPinIndex
- (4) uint8_t FLEXIO_UART_Type::shifterIndex[2]
- (5) uint8_t FLEXIO_UART_Type::timerIndex[2]

22.8.3.2 struct flexio_uart_config_t

Data Fields

- 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

Field Documentation

- (1) `bool flexio_uart_config_t::enableUart`
- (2) `bool flexio_uart_config_t::enableFastAccess`
- (3) `uint32_t flexio_uart_config_t::baudRate_Bps`

22.8.3.3 struct flexio_uart_transfer_t**Data Fields**

- `size_t dataSize`
Transfer size.
- `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.

Field Documentation

- (1) `uint8_t* flexio_uart_transfer_t::data`
- (2) `uint8_t* flexio_uart_transfer_t::rxData`
- (3) `const uint8_t* flexio_uart_transfer_t::txData`

22.8.3.4 struct _flexio_uart_handle**Data Fields**

- `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.

Field Documentation

- (1) `const uint8_t* volatile flexio_uart_handle_t::txData`
- (2) `volatile size_t flexio_uart_handle_t::txDataSize`
- (3) `uint8_t* volatile flexio_uart_handle_t::rxData`
- (4) `volatile size_t flexio_uart_handle_t::rxDataSize`
- (5) `size_t flexio_uart_handle_t::txDataSizeAll`
- (6) `size_t flexio_uart_handle_t::rxDataSizeAll`
- (7) `uint8_t* flexio_uart_handle_t::rxRingBuffer`
- (8) `size_t flexio_uart_handle_t::rxRingBufferSize`
- (9) `volatile uint16_t flexio_uart_handle_t::rxRingBufferHead`
- (10) `volatile uint16_t flexio_uart_handle_t::rxRingBufferTail`
- (11) `flexio_uart_transfer_callback_t flexio_uart_handle_t::callback`
- (12) `void* flexio_uart_handle_t::userData`
- (13) `volatile uint8_t flexio_uart_handle_t::txState`

22.8.4 Macro Definition Documentation

22.8.4.1 `#define FSL_FLEXIO_UART_DRIVER_VERSION (MAKE_VERSION(2, 4, 0))`

22.8.4.2 `#define UART_RETRY_TIMES 0U /* Defining to zero means to keep waiting for the flag until it is assert/deassert. */`

22.8.5 Typedef Documentation

22.8.5.1 `typedef void(* flexio_uart_transfer_callback_t)(FLEXIO_UART_Type *base, flexio_uart_handle_t *handle, status_t status, void *userData)`

22.8.6 Enumeration Type Documentation

22.8.6.1 anonymous enum

Enumerator

kStatus_FLEXIO_UART_TxBusy Transmitter is busy.
kStatus_FLEXIO_UART_RxBusy Receiver is busy.
kStatus_FLEXIO_UART_TxIdle UART transmitter is idle.
kStatus_FLEXIO_UART_RxIdle UART receiver is idle.
kStatus_FLEXIO_UART_ERROR ERROR happens on UART.
kStatus_FLEXIO_UART_RxRingBufferOverrun UART RX software ring buffer overrun.
kStatus_FLEXIO_UART_RxHardwareOverrun UART RX receiver overrun.
kStatus_FLEXIO_UART_Timeout UART times out.
kStatus_FLEXIO_UART_BaudrateNotSupport Baudrate is not supported in current clock source.

22.8.6.2 enum flexio_uart_bit_count_per_char_t

Enumerator

kFLEXIO_UART_7BitsPerChar 7-bit data characters
kFLEXIO_UART_8BitsPerChar 8-bit data characters
kFLEXIO_UART_9BitsPerChar 9-bit data characters

22.8.6.3 enum flexio_uart_interrupt_enable

Enumerator

kFLEXIO_UART_TxDataRegEmptyInterruptEnable Transmit buffer empty interrupt enable.
kFLEXIO_UART_RxDataRegFullInterruptEnable Receive buffer full interrupt enable.

22.8.6.4 enum flexio_uart_status_flags

Enumerator

kFLEXIO_UART_TxDataRegEmptyFlag Transmit buffer empty flag.
kFLEXIO_UART_RxDataRegFullFlag Receive buffer full flag.
kFLEXIO_UART_RxOverRunFlag Receive buffer over run flag.

22.8.7 Function Documentation

22.8.7.1 `status_t FLEXIO_UART_Init (FLEXIO_UART_Type * base, const flexio_uart_config_t * userConfig, uint32_t srcClock_Hz)`

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

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>userConfig</i>	Pointer to the flexio_uart_config_t structure.
<i>srcClock_Hz</i>	FlexIO source clock in Hz.

Return values

<i>kStatus_Success</i>	Configuration success.
<i>kStatus_FLEXIO_UART-_BaudrateNotSupport</i>	Baudrate is not supported for current clock source frequency.

22.8.7.2 `void FLEXIO_UART_Deinit (FLEXIO_UART_Type * base)`

Note

After calling this API, call the [FLEXIO_UART_Init](#) to use the FlexIO UART module.

Parameters

<i>base</i>	Pointer to FLEXIO_UART_Type structure
-------------	---

22.8.7.3 void FLEXIO_UART_GetDefaultConfig (flexio_uart_config_t * userConfig)

The configuration can be used directly for calling the [FLEXIO_UART_Init\(\)](#). Example:

```
flexio_uart_config_t config;
FLEXIO_UART_GetDefaultConfig(&userConfig);
```

Parameters

<i>userConfig</i>	Pointer to the flexio_uart_config_t structure.
-------------------	--

22.8.7.4 uint32_t FLEXIO_UART_GetStatusFlags (FLEXIO_UART_Type * base)

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
-------------	--

Returns

FlexIO UART status flags.

22.8.7.5 void FLEXIO_UART_ClearStatusFlags (FLEXIO_UART_Type * base, uint32_t mask)

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>mask</i>	Status flag. The parameter can be any combination of the following values: <ul style="list-style-type: none"> • kFLEXIO_UART_TxDataRegEmptyFlag • kFLEXIO_UART_RxEmptyFlag • kFLEXIO_UART_RxOverRunFlag

22.8.7.6 void FLEXIO_UART_EnableInterrupts (FLEXIO_UART_Type * base, uint32_t mask)

This function enables the FlexIO UART interrupt.

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>mask</i>	Interrupt source.

22.8.7.7 void FLEXIO_UART_DisableInterrupts (FLEXIO_UART_Type * *base*, uint32_t *mask*)

This function disables the FlexIO UART interrupt.

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>mask</i>	Interrupt source.

22.8.7.8 static uint32_t FLEXIO_UART_GetTxDataRegisterAddress (FLEXIO_UART_Type * *base*) [inline], [static]

This function returns the UART data register address, which is mainly used by DMA/eDMA.

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
-------------	--

Returns

FlexIO UART transmit data register address.

22.8.7.9 static uint32_t FLEXIO_UART_GetRxDataRegisterAddress (FLEXIO_UART_Type * *base*) [inline], [static]

This function returns the UART data register address, which is mainly used by DMA/eDMA.

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
-------------	--

Returns

FlexIO UART receive data register address.

22.8.7.10 `static void FLEXIO_UART_EnableTxDMA (FLEXIO_UART_Type * base, bool enable) [inline], [static]`

This function enables/disables the FlexIO UART Tx DMA, which means asserting the kFLEXIO_UART_TxDataRegEmptyFlag does/doesn't trigger the DMA request.

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>enable</i>	True to enable, false to disable.

22.8.7.11 static void FLEXIO_UART_EnableRxDMA (FLEXIO_UART_Type * *base*, bool *enable*) [inline], [static]

This function enables/disables the FlexIO UART Rx DMA, which means asserting kFLEXIO_UART_RxDataRegFullFlag does/doesn't trigger the DMA request.

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>enable</i>	True to enable, false to disable.

22.8.7.12 static void FLEXIO_UART_Enable (FLEXIO_UART_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type .
<i>enable</i>	True to enable, false does not have any effect.

22.8.7.13 static void FLEXIO_UART_WriteByte (FLEXIO_UART_Type * *base*, const uint8_t * *buffer*) [inline], [static]

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

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
-------------	--

<i>buffer</i>	The data bytes to send.
---------------	-------------------------

22.8.7.14 `static void FLEXIO_UART_ReadByte (FLEXIO_UART_Type * base, uint8_t * buffer) [inline], [static]`

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

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>buffer</i>	The buffer to store the received bytes.

22.8.7.15 `status_t FLEXIO_UART_WriteBlocking (FLEXIO_UART_Type * base, const uint8_t * txData, size_t txSize)`

Note

This function blocks using the polling method until all bytes have been sent.

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>txData</i>	The data bytes to send.
<i>txSize</i>	The number of data bytes to send.

Return values

<i>kStatus_FLEXIO_UART- _Timeout</i>	Transmission timed out and was aborted.
<i>kStatus_Success</i>	Successfully wrote all data.

22.8.7.16 `status_t FLEXIO_UART_ReadBlocking (FLEXIO_UART_Type * base, uint8_t * rxData, size_t rxSize)`

Note

This function blocks using the polling method until all bytes have been received.

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>rxData</i>	The buffer to store the received bytes.
<i>rxSize</i>	The number of data bytes to be received.

Return values

<i>kStatus_FLEXIO_UART- _Timeout</i>	Transmission timed out and was aborted.
<i>kStatus_Success</i>	Successfully received all data.

22.8.7.17 `status_t FLEXIO_UART_TransferCreateHandle (FLEXIO_UART_Type * base, flexio_uart_handle_t * handle, flexio_uart_transfer_callback_t callback, void * userData)`

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

<i>base</i>	to FLEXIO_UART_Type structure.
<i>handle</i>	Pointer to the <code>flexio_uart_handle_t</code> structure to store the transfer state.
<i>callback</i>	The callback function.
<i>userData</i>	The parameter of the callback function.

Return values

<i>kStatus_Success</i>	Successfully create the handle.
<i>kStatus_OutOfRange</i>	The FlexIO type/handle/ISR table out of range.

22.8.7.18 `void FLEXIO_UART_TransferStartRingBuffer (FLEXIO_UART_Type * base, flexio_uart_handle_t * handle, uint8_t * ringBuffer, size_t ringBufferSize)`

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

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>handle</i>	Pointer to the <code>flexio_uart_handle_t</code> structure to store the transfer state.
<i>ringBuffer</i>	Start address of ring buffer for background receiving. Pass NULL to disable the ring buffer.
<i>ringBufferSize</i>	Size of the ring buffer.

22.8.7.19 void FLEXIO_UART_TransferStopRingBuffer (FLEXIO_UART_Type * *base*, flexio_uart_handle_t * *handle*)

This function aborts the background transfer and uninstalls the ring buffer.

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>handle</i>	Pointer to the <code>flexio_uart_handle_t</code> structure to store the transfer state.

22.8.7.20 status_t FLEXIO_UART_TransferSendNonBlocking (FLEXIO_UART_Type * *base*, flexio_uart_handle_t * *handle*, flexio_uart_transfer_t * *xfer*)

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

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>handle</i>	Pointer to the <code>flexio_uart_handle_t</code> structure to store the transfer state.
<i>xfer</i>	FlexIO UART transfer structure. See flexio_uart_transfer_t .

Return values

<i>kStatus_Success</i>	Successfully starts the data transmission.
<i>kStatus_UART_TxBusy</i>	Previous transmission still not finished, data not written to the TX register.

22.8.7.21 void FLEXIO_UART_TransferAbortSend (FLEXIO_UART_Type * *base*, flexio_uart_handle_t * *handle*)

This function aborts the interrupt-driven data sending. Get the `remainBytes` to find out how many bytes are still not sent out.

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>handle</i>	Pointer to the <code>flexio_uart_handle_t</code> structure to store the transfer state.

22.8.7.22 status_t FLEXIO_UART_TransferGetSendCount (FLEXIO_UART_Type * *base*, flexio_uart_handle_t * *handle*, size_t * *count*)

This function gets the number of bytes sent driven by interrupt.

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>handle</i>	Pointer to the <code>flexio_uart_handle_t</code> structure to store the transfer state.
<i>count</i>	Number of bytes sent so far by the non-blocking transaction.

Return values

<i>kStatus_NoTransferInProgress</i>	transfer has finished or no transfer in progress.
<i>kStatus_Success</i>	Successfully return the count.

22.8.7.23 `status_t FLEXIO_UART_TransferReceiveNonBlocking (FLEXIO_UART_Type * base, flexio_uart_handle_t * handle, flexio_uart_transfer_t * xfer, size_t * receivedBytes)`

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_FLEXIO_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

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>handle</i>	Pointer to the <code>flexio_uart_handle_t</code> structure to store the transfer state.
<i>xfer</i>	UART transfer structure. See flexio_uart_transfer_t .
<i>receivedBytes</i>	Bytes received from the ring buffer directly.

Return values

<i>kStatus_Success</i>	Successfully queue the transfer into the transmit queue.
<i>kStatus_FLEXIO_UART-RxBusy</i>	Previous receive request is not finished.

22.8.7.24 `void FLEXIO_UART_TransferAbortReceive (FLEXIO_UART_Type * base, flexio_uart_handle_t * handle)`

This function aborts the receive data which was using IRQ.

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>handle</i>	Pointer to the <code>flexio_uart_handle_t</code> structure to store the transfer state.

22.8.7.25 `status_t FLEXIO_UART_TransferGetReceiveCount (FLEXIO_UART_Type *
base, flexio_uart_handle_t * handle, size_t * count)`

This function gets the number of bytes received driven by interrupt.

Parameters

<i>base</i>	Pointer to the FLEXIO_UART_Type structure.
<i>handle</i>	Pointer to the flexio_uart_handle_t structure to store the transfer state.
<i>count</i>	Number of bytes received so far by the non-blocking transaction.

Return values

<i>kStatus_NoTransferInProgress</i>	transfer has finished or no transfer in progress.
<i>kStatus_Success</i>	Successfully return the count.

22.8.7.26 void FLEXIO_UART_TransferHandleIRQ (void * *uartType*, void * *uartHandle*)

This function processes the FlexIO UART transmit and receives the IRQ request.

Parameters

<i>uartType</i>	Pointer to the FLEXIO_UART_Type structure.
<i>uartHandle</i>	Pointer to the flexio_uart_handle_t structure to store the transfer state.

22.8.8 FlexIO eDMA UART Driver

22.8.8.1 Overview

Data Structures

- struct `flexio_uart_edma_handle_t`
UART eDMA handle. [More...](#)

Typedefs

- typedef void(* `flexio_uart_edma_transfer_callback_t`)(`FLEXIO_UART_Type` *base, `flexio_uart_edma_handle_t` *handle, `status_t` status, void *userData)
UART transfer callback function.

Driver version

- #define `FSL_FLEXIO_UART_EDMA_DRIVER_VERSION` (`MAKE_VERSION(2, 4, 1)`)
FlexIO UART EDMA driver version.

eDMA transactional

- `status_t FLEXIO_UART_TransferCreateHandleEDMA` (`FLEXIO_UART_Type` *base, `flexio_uart_edma_handle_t` *handle, `flexio_uart_edma_transfer_callback_t` callback, void *userData, `edma_handle_t` *txEdmaHandle, `edma_handle_t` *rxEdmaHandle)
Initializes the UART handle which is used in transactional functions.
- `status_t FLEXIO_UART_TransferSendEDMA` (`FLEXIO_UART_Type` *base, `flexio_uart_edma_handle_t` *handle, `flexio_uart_transfer_t` *xfer)
Sends data using eDMA.
- `status_t FLEXIO_UART_TransferReceiveEDMA` (`FLEXIO_UART_Type` *base, `flexio_uart_edma_handle_t` *handle, `flexio_uart_transfer_t` *xfer)
Receives data using eDMA.
- void `FLEXIO_UART_TransferAbortSendEDMA` (`FLEXIO_UART_Type` *base, `flexio_uart_edma_handle_t` *handle)
Aborts the sent data which using eDMA.
- void `FLEXIO_UART_TransferAbortReceiveEDMA` (`FLEXIO_UART_Type` *base, `flexio_uart_edma_handle_t` *handle)
Aborts the receive data which using eDMA.
- `status_t FLEXIO_UART_TransferGetSendCountEDMA` (`FLEXIO_UART_Type` *base, `flexio_uart_edma_handle_t` *handle, `size_t` *count)
Gets the number of bytes sent out.
- `status_t FLEXIO_UART_TransferGetReceiveCountEDMA` (`FLEXIO_UART_Type` *base, `flexio_uart_edma_handle_t` *handle, `size_t` *count)
Gets the number of bytes received.

22.8.8.2 Data Structure Documentation

22.8.8.2.1 struct flexio_uart_edma_handle

Data Fields

- [flexio_uart_edma_transfer_callback_t](#) `callback`
Callback function.
- `void * userData`
UART callback function parameter.
- `size_t txDataSizeAll`
Total bytes to be sent.
- `size_t rxDataSizeAll`
Total bytes to be received.
- `edma_handle_t * txEdmaHandle`
The eDMA TX channel used.
- `edma_handle_t * rxEdmaHandle`
The eDMA RX channel used.
- `uint8_t nbytes`
eDMA minor byte transfer count initially configured.
- `volatile uint8_t txState`
TX transfer state.
- `volatile uint8_t rxState`
RX transfer state.

Field Documentation

- (1) `flexio_uart_edma_transfer_callback_t flexio_uart_edma_handle_t::callback`
- (2) `void* flexio_uart_edma_handle_t::userData`
- (3) `size_t flexio_uart_edma_handle_t::txDataSizeAll`
- (4) `size_t flexio_uart_edma_handle_t::rxDataSizeAll`
- (5) `edma_handle_t* flexio_uart_edma_handle_t::txEdmaHandle`
- (6) `edma_handle_t* flexio_uart_edma_handle_t::rxEdmaHandle`
- (7) `uint8_t flexio_uart_edma_handle_t::nbytes`
- (8) `volatile uint8_t flexio_uart_edma_handle_t::txState`

22.8.8.3 Macro Definition Documentation

22.8.8.3.1 #define FSL_FLEXIO_UART_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 4, 1))

22.8.8.4 Typedef Documentation

22.8.8.4.1 typedef void(* flexio_uart_edma_transfer_callback_t)(FLEXIO_UART_Type *base, flexio_uart_edma_handle_t *handle, status_t status, void *userData)

22.8.8.5 Function Documentation

22.8.8.5.1 status_t FLEXIO_UART_TransferCreateHandleEDMA (FLEXIO_UART_Type * base, flexio_uart_edma_handle_t * handle, flexio_uart_edma_transfer_callback_t callback, void * userData, edma_handle_t * txEdmaHandle, edma_handle_t * rxEdmaHandle)

Parameters

<i>base</i>	Pointer to FLEXIO_UART_Type .
<i>handle</i>	Pointer to flexio_uart_edma_handle_t structure.
<i>callback</i>	The callback function.
<i>userData</i>	The parameter of the callback function.
<i>rxEdmaHandle</i>	User requested DMA handle for RX DMA transfer.
<i>txEdmaHandle</i>	User requested DMA handle for TX DMA transfer.

Return values

<i>kStatus_Success</i>	Successfully create the handle.
<i>kStatus_OutOfRange</i>	The FlexIO SPI eDMA type/handle table out of range.

22.8.8.5.2 status_t FLEXIO_UART_TransferSendEDMA (FLEXIO_UART_Type * base, flexio_uart_edma_handle_t * handle, flexio_uart_transfer_t * xfer)

This function sends data using eDMA. This is a non-blocking function, which returns right away. When all data is sent out, the send callback function is called.

Parameters

<i>base</i>	Pointer to FLEXIO_UART_Type
<i>handle</i>	UART handle pointer.
<i>xfer</i>	UART eDMA transfer structure, see flexio_uart_transfer_t .

Return values

<i>kStatus_Success</i>	if succeed, others failed.
<i>kStatus_FLEXIO_UART-TxBusy</i>	Previous transfer on going.

22.8.8.5.3 **status_t FLEXIO_UART_TransferReceiveEDMA (FLEXIO_UART_Type * *base*, flexio_uart_edma_handle_t * *handle*, flexio_uart_transfer_t * *xfer*)**

This function receives data using eDMA. This is a non-blocking function, which returns right away. When all data is received, the receive callback function is called.

Parameters

<i>base</i>	Pointer to FLEXIO_UART_Type
<i>handle</i>	Pointer to flexio_uart_edma_handle_t structure
<i>xfer</i>	UART eDMA transfer structure, see flexio_uart_transfer_t .

Return values

<i>kStatus_Success</i>	if succeed, others failed.
<i>kStatus_UART_RxBusy</i>	Previous transfer on going.

22.8.8.5.4 **void FLEXIO_UART_TransferAbortSendEDMA (FLEXIO_UART_Type * *base*, flexio_uart_edma_handle_t * *handle*)**

This function aborts sent data which using eDMA.

Parameters

<i>base</i>	Pointer to FLEXIO_UART_Type
<i>handle</i>	Pointer to flexio_uart_edma_handle_t structure

22.8.8.5.5 **void FLEXIO_UART_TransferAbortReceiveEDMA (FLEXIO_UART_Type * *base*, flexio_uart_edma_handle_t * *handle*)**

This function aborts the receive data which using eDMA.

Parameters

<i>base</i>	Pointer to FLEXIO_UART_Type
<i>handle</i>	Pointer to flexio_uart_edma_handle_t structure

22.8.8.5.6 `status_t FLEXIO_UART_TransferGetSendCountEDMA (FLEXIO_UART_Type * base, flexio_uart_edma_handle_t * handle, size_t * count)`

This function gets the number of bytes sent out.

Parameters

<i>base</i>	Pointer to FLEXIO_UART_Type
<i>handle</i>	Pointer to flexio_uart_edma_handle_t structure
<i>count</i>	Number of bytes sent so far by the non-blocking transaction.

Return values

<i>kStatus_NoTransferInProgress</i>	transfer has finished or no transfer in progress.
<i>kStatus_Success</i>	Successfully return the count.

22.8.8.5.7 `status_t FLEXIO_UART_TransferGetReceiveCountEDMA (FLEXIO_UART_Type * base, flexio_uart_edma_handle_t * handle, size_t * count)`

This function gets the number of bytes received.

Parameters

<i>base</i>	Pointer to FLEXIO_UART_Type
<i>handle</i>	Pointer to flexio_uart_edma_handle_t structure
<i>count</i>	Number of bytes received so far by the non-blocking transaction.

Return values

<i>kStatus_NoTransferInProgress</i>	transfer has finished or no transfer in progress.
-------------------------------------	---

<i>kStatus_Success</i>	Successfully return the count.
------------------------	--------------------------------

Chapter 23

FLEXRAM: on-chip RAM manager

23.1 Overview

The MCUXpresso SDK provides a driver for the FLEXRAM module of MCUXpresso SDK devices.

The FLEXRAM module integrates the ITCM, DTCM, and OCRAM controllers, and supports parameterized RAM array and RAM array portioning.

This example code shows how to allocate RAM using the FLEXRAM driver.

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/flexram`.

Macros

- #define `FLEXRAM_ECC_ERROR_DETAILED_INFO` 0U /* Define to zero means get raw ECC error information, which needs parse it by user. */
Get ECC error detailed information.

Enumerations

- enum {
 `kFLEXRAM_Read` = 0U,
 `kFLEXRAM_Write` = 1U }
Flexram write/read selection.
- enum {
 `kFLEXRAM_OCRAccessError` = FLEXRAM_INT_STATUS_OCRAM_ERR_STATUS_MASK,
 `kFLEXRAM_DTCMAccessError` = FLEXRAM_INT_STATUS_DTCM_ERR_STATUS_MASK,
 `kFLEXRAM_ITCMAccessError` = FLEXRAM_INT_STATUS_ITCM_ERR_STATUS_MASK,
 `kFLEXRAM_InterruptStatusAll` }
Interrupt status flag mask.
- enum `flexram_tcm_access_mode_t` {
 `kFLEXRAM_TCMAccessFastMode` = 0U,
 `kFLEXRAM_TCMAccessWaitMode` = 1U }
FLEXRAM TCM access mode.
- enum {
 `kFLEXRAM_TCMSize32KB` = 32 * 1024U,
 `kFLEXRAM_TCMSize64KB` = 64 * 1024U,
 `kFLEXRAM_TCMSize128KB` = 128 * 1024U,
 `kFLEXRAM_TCMSize256KB` = 256 * 1024U,
 `kFLEXRAM_TCMSize512KB` = 512 * 1024U }
FLEXRAM TCM support size.

Functions

- static void `FLEXRAM_SetTCMReadAccessMode` (FLEXRAM_Type *base, `flexram_tcm_access_mode_t` mode)
FLEXRAM module sets TCM read access mode.
- static void `FLEXRAM_SetTCMWriteAccessMode` (FLEXRAM_Type *base, `flexram_tcm_access_mode_t` mode)
FLEXRAM module set TCM write access mode.
- static void `FLEXRAM_EnableForceRamClockOn` (FLEXRAM_Type *base, bool enable)
FLEXRAM module force ram clock on.

Driver version

- `#define FSL_FLEXRAM_DRIVER_VERSION (MAKE_VERSION(2U, 2U, 0U))`
Driver version.

Initialization and de-initialization

- void `FLEXRAM_Init` (FLEXRAM_Type *base)
FLEXRAM module initialization function.
- void `FLEXRAM_Deinit` (FLEXRAM_Type *base)
De-initializes the FLEXRAM.

Status

- static `uint32_t` `FLEXRAM_GetInterruptStatus` (FLEXRAM_Type *base)
FLEXRAM module gets interrupt status.
- static void `FLEXRAM_ClearInterruptStatus` (FLEXRAM_Type *base, `uint32_t` status)
FLEXRAM module clears interrupt status.
- static void `FLEXRAM_EnableInterruptStatus` (FLEXRAM_Type *base, `uint32_t` status)
FLEXRAM module enables interrupt status.
- static void `FLEXRAM_DisableInterruptStatus` (FLEXRAM_Type *base, `uint32_t` status)
FLEXRAM module disable interrupt status.

Interrupts

- static void `FLEXRAM_EnableInterruptSignal` (FLEXRAM_Type *base, `uint32_t` status)
FLEXRAM module enables interrupt.
- static void `FLEXRAM_DisableInterruptSignal` (FLEXRAM_Type *base, `uint32_t` status)
FLEXRAM module disables interrupt.

23.2 Macro Definition Documentation

23.2.1 `#define FSL_FLEXRAM_DRIVER_VERSION (MAKE_VERSION(2U, 2U, 0U))`

23.2.2 `#define FLEXRAM_ECC_ERROR_DETAILED_INFO 0U /* Define to zero means get raw ECC error information, which needs parse it by user. */`

23.3 Enumeration Type Documentation

23.3.1 anonymous enum

Enumerator

kFLEXRAM_Read read
kFLEXRAM_Write write

23.3.2 anonymous enum

Enumerator

kFLEXRAM_OCRAccessError OCRAM accesses unallocated address.
kFLEXRAM_DTCMAccessError DTCM accesses unallocated address.
kFLEXRAM_ITCMAccessError ITCM accesses unallocated address.
kFLEXRAM_InterruptStatusAll all the interrupt status mask

23.3.3 enum flexram_tcm_access_mode_t

Fast access mode expected to be finished in 1-cycle; Wait access mode expected to be finished in 2-cycle. Wait access mode is a feature of the flexram and it should be used when the CPU clock is too fast to finish TCM access in 1-cycle. Normally, fast mode is the default mode, the efficiency of the TCM access will be better.

Enumerator

kFLEXRAM_TCMAccessFastMode fast access mode
kFLEXRAM_TCMAccessWaitMode wait access mode

23.3.4 anonymous enum

Enumerator

kFLEXRAM_TCMSize32KB TCM total size be 32KB.
kFLEXRAM_TCMSize64KB TCM total size be 64KB.
kFLEXRAM_TCMSize128KB TCM total size be 128KB.
kFLEXRAM_TCMSize256KB TCM total size be 256KB.
kFLEXRAM_TCMSize512KB TCM total size be 512KB.

23.4 Function Documentation

23.4.1 void FLEXRAM_Init (FLEXRAM_Type * base)

Parameters

<i>base</i>	FLEXRAM base address.
-------------	-----------------------

**23.4.2 static uint32_t FLEXRAM_GetInterruptStatus (FLEXRAM_Type * *base*)
[inline], [static]**

Parameters

<i>base</i>	FLEXRAM base address.
-------------	-----------------------

**23.4.3 static void FLEXRAM_ClearInterruptStatus (FLEXRAM_Type * *base*,
uint32_t *status*) [inline], [static]**

Parameters

<i>base</i>	FLEXRAM base address.
<i>status</i>	Status to be cleared.

**23.4.4 static void FLEXRAM_EnableInterruptStatus (FLEXRAM_Type * *base*,
uint32_t *status*) [inline], [static]**

Parameters

<i>base</i>	FLEXRAM base address.
<i>status</i>	Status to be enabled.

**23.4.5 static void FLEXRAM_DisableInterruptStatus (FLEXRAM_Type * *base*,
uint32_t *status*) [inline], [static]**

Parameters

<i>base</i>	FLEXRAM base address.
<i>status</i>	Status to be disabled.

23.4.6 static void FLEXRAM_EnableInterruptSignal (FLEXRAM_Type * *base*, uint32_t *status*) [inline], [static]

Parameters

<i>base</i>	FLEXRAM base address.
<i>status</i>	Status interrupt to be enabled.

23.4.7 static void FLEXRAM_DisableInterruptSignal (FLEXRAM_Type * *base*, uint32_t *status*) [inline], [static]

Parameters

<i>base</i>	FLEXRAM base address.
<i>status</i>	Status interrupt to be disabled.

23.4.8 static void FLEXRAM_SetTCMReadAccessMode (FLEXRAM_Type * *base*, flexram_tcm_access_mode_t *mode*) [inline], [static]

Parameters

<i>base</i>	FLEXRAM base address.
<i>mode</i>	Access mode.

23.4.9 static void FLEXRAM_SetTCMWriteAccessMode (FLEXRAM_Type * *base*, flexram_tcm_access_mode_t *mode*) [inline], [static]

Parameters

<i>base</i>	FLEXRAM base address.
<i>mode</i>	Access mode.

23.4.10 `static void FLEXRAM_EnableForceRamClockOn (FLEXRAM_Type * base,
bool enable) [inline], [static]`

Parameters

<i>base</i>	FLEXRAM base address.
<i>enable</i>	Enable or disable clock force on.

Chapter 24

FLEXSPI: Flexible Serial Peripheral Interface Driver

24.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Flexible Serial Peripheral Interface (FLEXSPI) module of MCUXpresso SDK/i.MX devices.

FLEXSPI driver includes functional APIs and interrupt/EDMA non-blocking transactional APIs.

Functional APIs are feature/property target low level APIs. Functional APIs can be used for FLEXSPI initialization/configuration/operation for optimization/customization purpose. Using the functional API requires the knowledge of the FLEXSPI peripheral and how to organize functional APIs to meet the application requirements. All functional API use the peripheral base address as the first parameter. FLEXSPI functional operation groups provide the functional API set.

Transactional APIs are transaction target high level APIs. Transactional APIs can be used to enable the peripheral and in the application if the code size and performance of transactional APIs satisfy the requirements. If the code size and performance are a critical requirement, see the transactional API implementation and write a custom code. All transactional APIs use the `flexspi_handle_t`/`flexspi_edma_handle_t` as the second parameter. Initialize the handle for interrupt non-blocking transfer by calling the `FLEXSPI_TransferCreateHandle` API. Initialize the handle for interrupt non-blocking transfer by calling the `FLEXSPI_TransferCreateHandleEDMA` API.

Transactional APIs support asynchronous transfer. This means that the functions `FLEXSPI_TransferNonBlocking()` and `FLEXSPI_TransferEDMA()` set up data transfer. When the transfer completes, the upper layer is notified through a callback function with the `kStatus_FLEXSPI_Idle` status.

Data Structures

- struct `flexspi_config_t`
FLEXSPI configuration structure. [More...](#)
- struct `flexspi_device_config_t`
External device configuration items. [More...](#)
- struct `flexspi_transfer_t`
Transfer structure for FLEXSPI. [More...](#)
- struct `flexspi_handle_t`
Transfer handle structure for FLEXSPI. [More...](#)

Macros

- #define `FLEXSPI_LUT_SEQ(cmd0, pad0, op0, cmd1, pad1, op1)`
Formula to form FLEXSPI instructions in LUT table.

Typedefs

- typedef void(* flexspi_transfer_callback_t)(FLEXSPI_Type *base, flexspi_handle_t *handle, status_t status, void *userData)
FLEXSPI transfer callback function.

Enumerations

- enum {
kStatus_FLEXSPI_Busy = MAKE_STATUS(kStatusGroup_FLEXSPI, 0),
kStatus_FLEXSPI_SequenceExecutionTimeout = MAKE_STATUS(kStatusGroup_FLEXSPI, 1),
kStatus_FLEXSPI_IpCommandSequenceError = MAKE_STATUS(kStatusGroup_FLEXSPI, 2),
kStatus_FLEXSPI_IpCommandGrantTimeout = MAKE_STATUS(kStatusGroup_FLEXSPI, 3) }
Status structure of FLEXSPI.

- enum {
kFLEXSPI_Command_STOP = 0x00U,
kFLEXSPI_Command_SDR = 0x01U,
kFLEXSPI_Command_RADDR_SDR = 0x02U,
kFLEXSPI_Command_CADDR_SDR = 0x03U,
kFLEXSPI_Command_MODE1_SDR = 0x04U,
kFLEXSPI_Command_MODE2_SDR = 0x05U,
kFLEXSPI_Command_MODE4_SDR = 0x06U,
kFLEXSPI_Command_MODE8_SDR = 0x07U,
kFLEXSPI_Command_WRITE_SDR = 0x08U,
kFLEXSPI_Command_READ_SDR = 0x09U,
kFLEXSPI_Command_LEARN_SDR = 0x0AU,
kFLEXSPI_Command_DATSZ_SDR = 0x0BU,
kFLEXSPI_Command_DUMMY_SDR = 0x0CU,
kFLEXSPI_Command_DUMMY_RWDS_SDR = 0x0DU,
kFLEXSPI_Command_DDR = 0x21U,
kFLEXSPI_Command_RADDR_DDR = 0x22U,
kFLEXSPI_Command_CADDR_DDR = 0x23U,
kFLEXSPI_Command_MODE1_DDR = 0x24U,
kFLEXSPI_Command_MODE2_DDR = 0x25U,
kFLEXSPI_Command_MODE4_DDR = 0x26U,
kFLEXSPI_Command_MODE8_DDR = 0x27U,
kFLEXSPI_Command_WRITE_DDR = 0x28U,
kFLEXSPI_Command_READ_DDR = 0x29U,
kFLEXSPI_Command_LEARN_DDR = 0x2AU,
kFLEXSPI_Command_DATSZ_DDR = 0x2BU,
kFLEXSPI_Command_DUMMY_DDR = 0x2CU,
kFLEXSPI_Command_DUMMY_RWDS_DDR = 0x2DU,
kFLEXSPI_Command_JUMP_ON_CS = 0x1FU }
CMD definition of FLEXSPI, use to form LUT instruction, _flexspi_command.
- enum flexspi_pad_t {

```

kFLEXSPI_1PAD = 0x00U,
kFLEXSPI_2PAD = 0x01U,
kFLEXSPI_4PAD = 0x02U,
kFLEXSPI_8PAD = 0x03U }

```

pad definition of FLEXSPI, use to form LUT instruction.

- enum flexspi_flags_t {

```

kFLEXSPI_SequenceExecutionTimeoutFlag = FLEXSPI_INTEN_SEQTIMEOUTEN_MASK,
kFLEXSPI_AhbBusTimeoutFlag = FLEXSPI_INTEN_AHBBUSTIMEOUTEN_MASK,
kFLEXSPI_SckStoppedBecauseTxEmptyFlag,
kFLEXSPI_SckStoppedBecauseRxFullFlag,
kFLEXSPI_IpTxFifoWatermarkEmptyFlag = FLEXSPI_INTEN_IPTXWEEN_MASK,
kFLEXSPI_IpRxFifoWatermarkAvailableFlag = FLEXSPI_INTEN_IPRXWAEN_MASK,
kFLEXSPI_AhbCommandSequenceErrorFlag,
kFLEXSPI_IpCommandSequenceErrorFlag = FLEXSPI_INTEN_IPCMDERREN_MASK,
kFLEXSPI_AhbCommandGrantTimeoutFlag,
kFLEXSPI_IpCommandGrantTimeoutFlag,
kFLEXSPI_IpCommandExecutionDoneFlag,
kFLEXSPI_AllInterruptFlags = 0xFFFU }

```

FLEXSPI interrupt status flags.

- enum flexspi_read_sample_clock_t {

```

kFLEXSPI_ReadSampleClkLoopbackInternally = 0x0U,
kFLEXSPI_ReadSampleClkLoopbackFromDqsPad = 0x1U,
kFLEXSPI_ReadSampleClkLoopbackFromSckPad = 0x2U,
kFLEXSPI_ReadSampleClkExternalInputFromDqsPad = 0x3U }

```

FLEXSPI sample clock source selection for Flash Reading.

- enum flexspi_cs_interval_cycle_unit_t {

```

kFLEXSPI_CsIntervalUnit1SckCycle = 0x0U,
kFLEXSPI_CsIntervalUnit256SckCycle = 0x1U }

```

FLEXSPI interval unit for flash device select.

- enum flexspi_ahb_write_wait_unit_t {

```

kFLEXSPI_AhbWriteWaitUnit2AhbCycle = 0x0U,
kFLEXSPI_AhbWriteWaitUnit8AhbCycle = 0x1U,
kFLEXSPI_AhbWriteWaitUnit32AhbCycle = 0x2U,
kFLEXSPI_AhbWriteWaitUnit128AhbCycle = 0x3U,
kFLEXSPI_AhbWriteWaitUnit512AhbCycle = 0x4U,
kFLEXSPI_AhbWriteWaitUnit2048AhbCycle = 0x5U,
kFLEXSPI_AhbWriteWaitUnit8192AhbCycle = 0x6U,
kFLEXSPI_AhbWriteWaitUnit32768AhbCycle = 0x7U }

```

FLEXSPI AHB wait interval unit for writing.

- enum flexspi_ip_error_code_t {

```

kFLEXSPI_IpCmdErrorNoError = 0x0U,
kFLEXSPI_IpCmdErrorJumpOnCsInIpCmd = 0x2U,
kFLEXSPI_IpCmdErrorUnknownOpCode = 0x3U,
kFLEXSPI_IpCmdErrorSdrDummyInDdrSequence = 0x4U,
kFLEXSPI_IpCmdErrorDdrDummyInSdrSequence = 0x5U,
kFLEXSPI_IpCmdErrorInvalidAddress = 0x6U,
kFLEXSPI_IpCmdErrorSequenceExecutionTimeout = 0xEU,
kFLEXSPI_IpCmdErrorFlashBoundaryAcrosss = 0xFU }

```

Error Code when IP command Error detected.

- enum flexspi_ahb_error_code_t {

```

kFLEXSPI_AhbCmdErrorNoError = 0x0U,
kFLEXSPI_AhbCmdErrorJumpOnCsInWriteCmd = 0x2U,
kFLEXSPI_AhbCmdErrorUnknownOpCode = 0x3U,
kFLEXSPI_AhbCmdErrorSdrDummyInDdrSequence = 0x4U,
kFLEXSPI_AhbCmdErrorDdrDummyInSdrSequence = 0x5U,
kFLEXSPI_AhbCmdSequenceExecutionTimeout = 0x6U }

```

Error Code when AHB command Error detected.

- enum flexspi_port_t {

```

kFLEXSPI_PortA1 = 0x0U,
kFLEXSPI_PortA2,
kFLEXSPI_PortB1,
kFLEXSPI_PortB2 }

```

FLEXSPI operation port select.

- enum flexspi_arb_command_source_t

Trigger source of current command sequence granted by arbitrator.
- enum flexspi_command_type_t {

```

kFLEXSPI_Command,
kFLEXSPI_Config }

```

Command type.

Driver version

- #define FSL_FLEXSPI_DRIVER_VERSION (MAKE_VERSION(2, 3, 6))

FLEXSPI driver version 2.3.5.

Initialization and deinitialization

- uint32_t FLEXSPI_GetInstance (FLEXSPI_Type *base)

Get the instance number for FLEXSPI.
- status_t FLEXSPI_CheckAndClearError (FLEXSPI_Type *base, uint32_t status)

Check and clear IP command execution errors.
- void FLEXSPI_Init (FLEXSPI_Type *base, const flexspi_config_t *config)

Initializes the FLEXSPI module and internal state.
- void FLEXSPI_GetDefaultConfig (flexspi_config_t *config)

Gets default settings for FLEXSPI.
- void FLEXSPI_Deinit (FLEXSPI_Type *base)

Deinitializes the FLEXSPI module.

- void [FLEXSPI_UpdateDllValue](#) (FLEXSPI_Type *base, flexspi_device_config_t *config, flexspi_port_t port)
Update FLEXSPI DLL value depending on currently flexspi root clock.
- void [FLEXSPI_SetFlashConfig](#) (FLEXSPI_Type *base, flexspi_device_config_t *config, flexspi_port_t port)
Configures the connected device parameter.
- static void [FLEXSPI_SoftwareReset](#) (FLEXSPI_Type *base)
Software reset for the FLEXSPI logic.
- static void [FLEXSPI_Enable](#) (FLEXSPI_Type *base, bool enable)
Enables or disables the FLEXSPI module.

Interrupts

- static void [FLEXSPI_EnableInterrupts](#) (FLEXSPI_Type *base, uint32_t mask)
Enables the FLEXSPI interrupts.
- static void [FLEXSPI_DisableInterrupts](#) (FLEXSPI_Type *base, uint32_t mask)
Disable the FLEXSPI interrupts.

DMA control

- static void [FLEXSPI_EnableTxDMA](#) (FLEXSPI_Type *base, bool enable)
Enables or disables FLEXSPI IP Tx FIFO DMA requests.
- static void [FLEXSPI_EnableRxDMA](#) (FLEXSPI_Type *base, bool enable)
Enables or disables FLEXSPI IP Rx FIFO DMA requests.
- static uint32_t [FLEXSPI_GetTxFifoAddress](#) (FLEXSPI_Type *base)
Gets FLEXSPI IP tx fifo address for DMA transfer.
- static uint32_t [FLEXSPI_GetRxFifoAddress](#) (FLEXSPI_Type *base)
Gets FLEXSPI IP rx fifo address for DMA transfer.

FIFO control

- static void [FLEXSPI_ResetFifos](#) (FLEXSPI_Type *base, bool txFifo, bool rxFifo)
Clears the FLEXSPI IP FIFO logic.
- static void [FLEXSPI_GetFifoCounts](#) (FLEXSPI_Type *base, size_t *txCount, size_t *rxCount)
Gets the valid data entries in the FLEXSPI FIFOs.

Status

- static uint32_t [FLEXSPI_GetInterruptStatusFlags](#) (FLEXSPI_Type *base)
Get the FLEXSPI interrupt status flags.
- static void [FLEXSPI_ClearInterruptStatusFlags](#) (FLEXSPI_Type *base, uint32_t mask)
Get the FLEXSPI interrupt status flags.
- static flexspi_arb_command_source_t [FLEXSPI_GetArbitratorCommandSource](#) (FLEXSPI_Type *base)
Gets the trigger source of current command sequence granted by arbitrator.
- static flexspi_ip_error_code_t [FLEXSPI_GetIPCommandErrorCode](#) (FLEXSPI_Type *base, uint8_t *index)
Gets the error code when IP command error detected.
- static flexspi_ahb_error_code_t [FLEXSPI_GetAHBCommandErrorCode](#) (FLEXSPI_Type *base, uint8_t *index)

Gets the error code when AHB command error detected.

- static bool [FLEXSPI_GetBusIdleStatus](#) (FLEXSPI_Type *base)
Returns whether the bus is idle.

Bus Operations

- void [FLEXSPI_UpdateRxSampleClock](#) (FLEXSPI_Type *base, [flexspi_read_sample_clock_t](#) clockSource)
Update read sample clock source.
- static void [FLEXSPI_EnableIPParallelMode](#) (FLEXSPI_Type *base, bool enable)
Enables/disables the FLEXSPI IP command parallel mode.
- static void [FLEXSPI_EnableAHBParallelMode](#) (FLEXSPI_Type *base, bool enable)
Enables/disables the FLEXSPI AHB command parallel mode.
- void [FLEXSPI_UpdateLUT](#) (FLEXSPI_Type *base, uint32_t index, const uint32_t *cmd, uint32_t count)
Updates the LUT table.
- static void [FLEXSPI_WriteData](#) (FLEXSPI_Type *base, uint32_t data, uint8_t fifoIndex)
Writes data into FIFO.
- static uint32_t [FLEXSPI_ReadData](#) (FLEXSPI_Type *base, uint8_t fifoIndex)
Receives data from data FIFO.
- [status_t FLEXSPI_WriteBlocking](#) (FLEXSPI_Type *base, uint32_t *buffer, size_t size)
Sends a buffer of data bytes using blocking method.
- [status_t FLEXSPI_ReadBlocking](#) (FLEXSPI_Type *base, uint32_t *buffer, size_t size)
Receives a buffer of data bytes using a blocking method.
- [status_t FLEXSPI_TransferBlocking](#) (FLEXSPI_Type *base, [flexspi_transfer_t](#) *xfer)
Execute command to transfer a buffer data bytes using a blocking method.

Transactional

- void [FLEXSPI_TransferCreateHandle](#) (FLEXSPI_Type *base, [flexspi_handle_t](#) *handle, [flexspi_transfer_callback_t](#) callback, void *userData)
Initializes the FLEXSPI handle which is used in transactional functions.
- [status_t FLEXSPI_TransferNonBlocking](#) (FLEXSPI_Type *base, [flexspi_handle_t](#) *handle, [flexspi_transfer_t](#) *xfer)
Performs a interrupt non-blocking transfer on the FLEXSPI bus.
- [status_t FLEXSPI_TransferGetCount](#) (FLEXSPI_Type *base, [flexspi_handle_t](#) *handle, size_t *count)
Gets the master transfer status during a interrupt non-blocking transfer.
- void [FLEXSPI_TransferAbort](#) (FLEXSPI_Type *base, [flexspi_handle_t](#) *handle)
Aborts an interrupt non-blocking transfer early.
- void [FLEXSPI_TransferHandleIRQ](#) (FLEXSPI_Type *base, [flexspi_handle_t](#) *handle)
Master interrupt handler.

24.2 Data Structure Documentation

24.2.1 struct flexspi_config_t

Data Fields

- [flexspi_read_sample_clock_t rxSampleClock](#)

- Sample Clock source selection for Flash Reading.*
- bool `enableSckFreeRunning`
Enable/disable SCK output free-running.
- bool `enableCombination`
Enable/disable combining PORT A and B Data Pins (SIOA[3:0] and SIOB[3:0]) to support Flash Octal mode.
- bool `enableDoze`
Enable/disable doze mode support.
- bool `enableHalfSpeedAccess`
Enable/disable divide by 2 of the clock for half speed commands.
- bool `enableSckBDiffOpt`
Enable/disable SCKB pad use as SCKA differential clock output, when enable, Port B flash access is not available.
- bool `enableSameConfigForAll`
Enable/disable same configuration for all connected devices when enabled, same configuration in FLASHA1CRx is applied to all.
- uint16_t `seqTimeoutCycle`
*Timeout wait cycle for command sequence execution, timeout after $ahbGrantTimeoutCyle*1024$ serial root clock cycles.*
- uint8_t `ipGrantTimeoutCycle`
*Timeout wait cycle for IP command grant, timeout after $ipGrantTimeoutCycle*1024$ AHB clock cycles.*
- uint8_t `txWatermark`
FLEXSPI IP transmit watermark value.
- uint8_t `rxWatermark`
FLEXSPI receive watermark value.
- bool `enableAHBWriteIpTxFifo`
Enable AHB bus write access to IP TX FIFO.
- bool `enableAHBWriteIpRxFifo`
Enable AHB bus write access to IP RX FIFO.
- uint8_t `ahbGrantTimeoutCycle`
*Timeout wait cycle for AHB command grant, timeout after $ahbGrantTimeoutCyle*1024$ AHB clock cycles.*
- uint16_t `ahbBusTimeoutCycle`
*Timeout wait cycle for AHB read/write access, timeout after $ahbBusTimeoutCycle*1024$ AHB clock cycles.*
- uint8_t `resumeWaitCycle`
Wait cycle for idle state before suspended command sequence resume, timeout after $ahbBusTimeoutCycle$ AHB clock cycles.
- flexspi_ahbBuffer_config_t `buffer` [FSL_FEATURE_FLEXSPI_AHB_BUFFER_COUNT]
AHB buffer size.
- bool `enableClearAHBBufferOpt`
Enable/disable automatically clean AHB RX Buffer and TX Buffer when FLEXSPI returns STOP mode ACK.
- bool `enableReadAddressOpt`
Enable/disable remove AHB read burst start address alignment limitation.
- bool `enableAHBPrefetch`
Enable/disable AHB read prefetch feature, when enabled, FLEXSPI will fetch more data than current AHB burst.
- bool `enableAHBBufferable`
Enable/disable AHB bufferable write access support, when enabled,

- *FLEXSPI return before waiting for command execution finished.*
 • bool `enableAHBCachable`
Enable AHB bus cachable read access support.

Field Documentation

- (1) `flexspi_read_sample_clock_t flexspi_config_t::rxSampleClock`
- (2) `bool flexspi_config_t::enableSckFreeRunning`
- (3) `bool flexspi_config_t::enableCombination`
- (4) `bool flexspi_config_t::enableDoze`
- (5) `bool flexspi_config_t::enableHalfSpeedAccess`
- (6) `bool flexspi_config_t::enableSckBDiffOpt`
- (7) `bool flexspi_config_t::enableSameConfigForAll`
- (8) `uint16_t flexspi_config_t::seqTimeoutCycle`
- (9) `uint8_t flexspi_config_t::ipGrantTimeoutCycle`
- (10) `uint8_t flexspi_config_t::txWatermark`
- (11) `uint8_t flexspi_config_t::rxWatermark`
- (12) `bool flexspi_config_t::enableAHBWriteIpTxFifo`
- (13) `bool flexspi_config_t::enableAHBWriteIpRxFifo`
- (14) `uint8_t flexspi_config_t::ahbGrantTimeoutCycle`
- (15) `uint16_t flexspi_config_t::ahbBusTimeoutCycle`
- (16) `uint8_t flexspi_config_t::resumeWaitCycle`
- (17) `flexspi_ahbBuffer_config_t flexspi_config_t::buffer[FSL_FEATURE_FLEXSPI_AHB_BUFFER_COUNT]`
- (18) `bool flexspi_config_t::enableClearAHBBufferOpt`
- (19) `bool flexspi_config_t::enableReadAddressOpt`
 when enable, there is no AHB read burst start address alignment limitation.
- (20) `bool flexspi_config_t::enableAHBPrefetch`
- (21) `bool flexspi_config_t::enableAHBBufferable`

(22) `bool flexspi_config_t::enableAHBCachable`

24.2.2 struct flexspi_device_config_t

Data Fields

- `uint32_t flexspiRootClk`
FLEXSPI serial root clock.
- `bool isSck2Enabled`
FLEXSPI use SCK2.
- `uint32_t flashSize`
Flash size in KByte.
- `flexspi_cs_interval_cycle_unit_t CSIntervalUnit`
CS interval unit, 1 or 256 cycle.
- `uint16_t CSInterval`
CS line assert interval, multiply CS interval unit to get the CS line assert interval cycles.
- `uint8_t CSHoldTime`
CS line hold time.
- `uint8_t CSSetupTime`
CS line setup time.
- `uint8_t dataValidTime`
Data valid time for external device.
- `uint8_t columnSpace`
Column space size.
- `bool enableWordAddress`
If enable word address.
- `uint8_t AWRSeqIndex`
Sequence ID for AHB write command.
- `uint8_t AWRSeqNumber`
Sequence number for AHB write command.
- `uint8_t ARDSeqIndex`
Sequence ID for AHB read command.
- `uint8_t ARDSeqNumber`
Sequence number for AHB read command.
- `flexspi_ahb_write_wait_unit_t AHBWriteWaitUnit`
AHB write wait unit.
- `uint16_t AHBWriteWaitInterval`
AHB write wait interval, multiply AHB write interval unit to get the AHB write wait cycles.
- `bool enableWriteMask`
Enable/Disable FLEXSPI drive DQS pin as write mask when writing to external device.

Field Documentation

(1) `uint32_t flexspi_device_config_t::flexspiRootClk`

(2) `bool flexspi_device_config_t::isSck2Enabled`

- (3) `uint32_t flexspi_device_config_t::flashSize`
- (4) `flexspi_cs_interval_cycle_unit_t flexspi_device_config_t::CSIntervalUnit`
- (5) `uint16_t flexspi_device_config_t::CSInterval`
- (6) `uint8_t flexspi_device_config_t::CSHoldTime`
- (7) `uint8_t flexspi_device_config_t::CSSetupTime`
- (8) `uint8_t flexspi_device_config_t::dataValidTime`
- (9) `uint8_t flexspi_device_config_t::columnspace`
- (10) `bool flexspi_device_config_t::enableWordAddress`
- (11) `uint8_t flexspi_device_config_t::AWRSeqIndex`
- (12) `uint8_t flexspi_device_config_t::AWRSeqNumber`
- (13) `uint8_t flexspi_device_config_t::ARDSeqIndex`
- (14) `uint8_t flexspi_device_config_t::ARDSeqNumber`
- (15) `flexspi_ahb_write_wait_unit_t flexspi_device_config_t::AHBWriteWaitUnit`
- (16) `uint16_t flexspi_device_config_t::AHBWriteWaitInterval`
- (17) `bool flexspi_device_config_t::enableWriteMask`

24.2.3 struct flexspi_transfer_t

Data Fields

- `uint32_t deviceAddress`
Operation device address.
- `flexspi_port_t port`
Operation port.
- `flexspi_command_type_t cmdType`
Execution command type.
- `uint8_t seqIndex`
Sequence ID for command.
- `uint8_t SeqNumber`
Sequence number for command.
- `uint32_t * data`
Data buffer.
- `size_t dataSize`
Data size in bytes.

Field Documentation

- (1) `uint32_t flexspi_transfer_t::deviceAddress`
- (2) `flexspi_port_t flexspi_transfer_t::port`
- (3) `flexspi_command_type_t flexspi_transfer_t::cmdType`
- (4) `uint8_t flexspi_transfer_t::seqIndex`
- (5) `uint8_t flexspi_transfer_t::SeqNumber`
- (6) `uint32_t* flexspi_transfer_t::data`
- (7) `size_t flexspi_transfer_t::dataSize`

24.2.4 struct `flexspi_handle`

Data Fields

- `uint32_t state`
Internal state for FLEXSPI transfer.
- `uint32_t * data`
Data buffer.
- `size_t dataSize`
Remaining Data size in bytes.
- `size_t transferTotalSize`
Total Data size in bytes.
- `flexspi_transfer_callback_t completionCallback`
Callback for users while transfer finish or error occurred.
- `void * userData`
FLEXSPI callback function parameter.

Field Documentation

- (1) `uint32_t* flexspi_handle_t::data`
- (2) `size_t flexspi_handle_t::dataSize`
- (3) `size_t flexspi_handle_t::transferTotalSize`
- (4) `void* flexspi_handle_t::userData`

24.3 Macro Definition Documentation

24.3.1 #define FSL_FLEXSPI_DRIVER_VERSION (MAKE_VERSION(2, 3, 6))

24.3.2 #define FLEXSPI_LUT_SEQ(cmd0, pad0, op0, cmd1, pad1, op1)

Value:

(FLEXSPI_LUT_OPERAND0 (op0) | FLEXSPI_LUT_NUM_PADS0 (pad0) | FLEXSPI_LUT_OPCODE0 (cmd0) | FLEXSPI_LUT_OPERAND1

```
(op1) | \
FLEXSPI_LUT_NUM_PADS1 (pad1) | FLEXSPI_LUT_OPCODE1 (cmd1)
```

24.4 Typedef Documentation

24.4.1 `typedef void(* flexspi_transfer_callback_t)(FLEXSPI_Type *base, flexspi_handle_t *handle, status_t status, void *userData)`

24.5 Enumeration Type Documentation

24.5.1 anonymous enum

Enumerator

- kStatus_FLEXSPI_Busy* FLEXSPI is busy.
- kStatus_FLEXSPI_SequenceExecutionTimeout* Sequence execution timeout error occurred during FLEXSPI transfer.
- kStatus_FLEXSPI_IpCommandSequenceError* IP command Sequence execution timeout error occurred during FLEXSPI transfer.
- kStatus_FLEXSPI_IpCommandGrantTimeout* IP command grant timeout error occurred during FLEXSPI transfer.

24.5.2 anonymous enum

Enumerator

- kFLEXSPI_Command_STOP* Stop execution, deassert CS.
- kFLEXSPI_Command_SDR* Transmit Command code to Flash, using SDR mode.
- kFLEXSPI_Command_RADDR_SDR* Transmit Row Address to Flash, using SDR mode.
- kFLEXSPI_Command_CADDR_SDR* Transmit Column Address to Flash, using SDR mode.
- kFLEXSPI_Command_MODE1_SDR* Transmit 1-bit Mode bits to Flash, using SDR mode.
- kFLEXSPI_Command_MODE2_SDR* Transmit 2-bit Mode bits to Flash, using SDR mode.
- kFLEXSPI_Command_MODE4_SDR* Transmit 4-bit Mode bits to Flash, using SDR mode.
- kFLEXSPI_Command_MODE8_SDR* Transmit 8-bit Mode bits to Flash, using SDR mode.
- kFLEXSPI_Command_WRITE_SDR* Transmit Programming Data to Flash, using SDR mode.
- kFLEXSPI_Command_READ_SDR* Receive Read Data from Flash, using SDR mode.
- kFLEXSPI_Command_LEARN_SDR* Receive Read Data or Preamble bit from Flash, SDR mode.
- kFLEXSPI_Command_DATSZ_SDR* Transmit Read/Program Data size (byte) to Flash, SDR mode.
- kFLEXSPI_Command_DUMMY_SDR* Leave data lines undriven by FlexSPI controller.
- kFLEXSPI_Command_DUMMY_RWDS_SDR* Leave data lines undriven by FlexSPI controller, dummy cycles decided by RWDS.
- kFLEXSPI_Command_DDR* Transmit Command code to Flash, using DDR mode.
- kFLEXSPI_Command_RADDR_DDR* Transmit Row Address to Flash, using DDR mode.
- kFLEXSPI_Command_CADDR_DDR* Transmit Column Address to Flash, using DDR mode.

- kFLEXSPI_Command_MODE1_DDR*** Transmit 1-bit Mode bits to Flash, using DDR mode.
- kFLEXSPI_Command_MODE2_DDR*** Transmit 2-bit Mode bits to Flash, using DDR mode.
- kFLEXSPI_Command_MODE4_DDR*** Transmit 4-bit Mode bits to Flash, using DDR mode.
- kFLEXSPI_Command_MODE8_DDR*** Transmit 8-bit Mode bits to Flash, using DDR mode.
- kFLEXSPI_Command_WRITE_DDR*** Transmit Programming Data to Flash, using DDR mode.
- kFLEXSPI_Command_READ_DDR*** Receive Read Data from Flash, using DDR mode.
- kFLEXSPI_Command_LEARN_DDR*** Receive Read Data or Preamble bit from Flash, DDR mode.
- kFLEXSPI_Command_DATSZ_DDR*** Transmit Read/Program Data size (byte) to Flash, DDR mode.
- kFLEXSPI_Command_DUMMY_DDR*** Leave data lines undriven by FlexSPI controller.
- kFLEXSPI_Command_DUMMY_RWDS_DDR*** Leave data lines undriven by FlexSPI controller, dummy cycles decided by RWDS.
- kFLEXSPI_Command_JUMP_ON_CS*** Stop execution, deassert CS and save operand[7:0] as the instruction start pointer for next sequence.

24.5.3 enum flexspi_pad_t

Enumerator

- kFLEXSPI_1PAD*** Transmit command/address and transmit/receive data only through DATA0/DATA1.
- kFLEXSPI_2PAD*** Transmit command/address and transmit/receive data only through DATA[1:0].
- kFLEXSPI_4PAD*** Transmit command/address and transmit/receive data only through DATA[3:0].
- kFLEXSPI_8PAD*** Transmit command/address and transmit/receive data only through DATA[7:0].

24.5.4 enum flexspi_flags_t

Enumerator

- kFLEXSPI_SequenceExecutionTimeoutFlag*** Sequence execution timeout.
- kFLEXSPI_AhbBusTimeoutFlag*** AHB Bus timeout.
- kFLEXSPI_SckStoppedBecauseTxEmptyFlag*** SCK is stopped during command sequence because Async TX FIFO empty.
- kFLEXSPI_SckStoppedBecauseRxFullFlag*** SCK is stopped during command sequence because Async RX FIFO full.
- kFLEXSPI_IpTxFifoWatermarkEmptyFlag*** IP TX FIFO WaterMark empty.
- kFLEXSPI_IpRxFifoWatermarkAvailableFlag*** IP RX FIFO WaterMark available.
- kFLEXSPI_AhbCommandSequenceErrorFlag*** AHB triggered Command Sequences Error.
- kFLEXSPI_IpCommandSequenceErrorFlag*** IP triggered Command Sequences Error.

kFLEXSPI_AhbCommandGrantTimeoutFlag AHB triggered Command Sequences Grant Timeout.

kFLEXSPI_IpCommandGrantTimeoutFlag IP triggered Command Sequences Grant Timeout.

kFLEXSPI_IpCommandExecutionDoneFlag IP triggered Command Sequences Execution finished.

kFLEXSPI_AllInterruptFlags All flags.

24.5.5 enum flexspi_read_sample_clock_t

Enumerator

kFLEXSPI_ReadSampleClkLoopbackInternally Dummy Read strobe generated by FlexSPI Controller and loopback internally.

kFLEXSPI_ReadSampleClkLoopbackFromDqsPad Dummy Read strobe generated by FlexSPI Controller and loopback from DQS pad.

kFLEXSPI_ReadSampleClkLoopbackFromSckPad SCK output clock and loopback from SCK pad.

kFLEXSPI_ReadSampleClkExternalInputFromDqsPad Flash provided Read strobe and input from DQS pad.

24.5.6 enum flexspi_cs_interval_cycle_unit_t

Enumerator

kFLEXSPI_CsIntervalUnit1SckCycle Chip selection interval: CSINTERVAL * 1 serial clock cycle.

kFLEXSPI_CsIntervalUnit256SckCycle Chip selection interval: CSINTERVAL * 256 serial clock cycle.

24.5.7 enum flexspi_ahb_write_wait_unit_t

Enumerator

kFLEXSPI_AhbWriteWaitUnit2AhbCycle AWRWAIT unit is 2 ahb clock cycle.

kFLEXSPI_AhbWriteWaitUnit8AhbCycle AWRWAIT unit is 8 ahb clock cycle.

kFLEXSPI_AhbWriteWaitUnit32AhbCycle AWRWAIT unit is 32 ahb clock cycle.

kFLEXSPI_AhbWriteWaitUnit128AhbCycle AWRWAIT unit is 128 ahb clock cycle.

kFLEXSPI_AhbWriteWaitUnit512AhbCycle AWRWAIT unit is 512 ahb clock cycle.

kFLEXSPI_AhbWriteWaitUnit2048AhbCycle AWRWAIT unit is 2048 ahb clock cycle.

kFLEXSPI_AhbWriteWaitUnit8192AhbCycle AWRWAIT unit is 8192 ahb clock cycle.

kFLEXSPI_AhbWriteWaitUnit32768AhbCycle AWRWAIT unit is 32768 ahb clock cycle.

24.5.8 enum flexspi_ip_error_code_t

Enumerator

- kFLEXSPI_IpCmdErrorNoError* No error.
- kFLEXSPI_IpCmdErrorJumpOnCsInIpCmd* IP command with JMP_ON_CS instruction used.
- kFLEXSPI_IpCmdErrorUnknownOpCode* Unknown instruction opcode in the sequence.
- kFLEXSPI_IpCmdErrorSdrDummyInDdrSequence* Instruction DUMMY_SDR/DUMMY_RW-DS_SDR used in DDR sequence.
- kFLEXSPI_IpCmdErrorDdrDummyInSdrSequence* Instruction DUMMY_DDR/DUMMY_RW-DS_DDR used in SDR sequence.
- kFLEXSPI_IpCmdErrorInvalidAddress* Flash access start address exceed the whole flash address range (A1/A2/B1/B2).
- kFLEXSPI_IpCmdErrorSequenceExecutionTimeout* Sequence execution timeout.
- kFLEXSPI_IpCmdErrorFlashBoundaryAcrosss* Flash boundary crossed.

24.5.9 enum flexspi_ahb_error_code_t

Enumerator

- kFLEXSPI_AhbCmdErrorNoError* No error.
- kFLEXSPI_AhbCmdErrorJumpOnCsInWriteCmd* AHB Write command with JMP_ON_CS instruction used in the sequence.
- kFLEXSPI_AhbCmdErrorUnknownOpCode* Unknown instruction opcode in the sequence.
- kFLEXSPI_AhbCmdErrorSdrDummyInDdrSequence* Instruction DUMMY_SDR/DUMMY_R-WDS_SDR used in DDR sequence.
- kFLEXSPI_AhbCmdErrorDdrDummyInSdrSequence* Instruction DUMMY_DDR/DUMMY_R-WDS_DDR used in SDR sequence.
- kFLEXSPI_AhbCmdSequenceExecutionTimeout* Sequence execution timeout.

24.5.10 enum flexspi_port_t

Enumerator

- kFLEXSPI_PortA1* Access flash on A1 port.
- kFLEXSPI_PortA2* Access flash on A2 port.
- kFLEXSPI_PortB1* Access flash on B1 port.
- kFLEXSPI_PortB2* Access flash on B2 port.

24.5.11 enum flexspi_arb_command_source_t

24.5.12 enum flexspi_command_type_t

Enumerator

kFLEXSPI_Command FlexSPI operation: Only command, both TX and Rx buffer are ignored.

kFLEXSPI_Config FlexSPI operation: Configure device mode, the TX fifo size is fixed in LUT.

24.6 Function Documentation

24.6.1 uint32_t FLEXSPI_GetInstance (FLEXSPI_Type * *base*)

Parameters

<i>base</i>	FLEXSPI base pointer.
-------------	-----------------------

24.6.2 status_t FLEXSPI_CheckAndClearError (FLEXSPI_Type * *base*, uint32_t *status*)

Parameters

<i>base</i>	FLEXSPI base pointer.
<i>status</i>	interrupt status.

24.6.3 void FLEXSPI_Init (FLEXSPI_Type * *base*, const flexspi_config_t * *config*)

This function enables the clock for FLEXSPI and also configures the FLEXSPI with the input configure parameters. Users should call this function before any FLEXSPI operations.

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>config</i>	FLEXSPI configure structure.

24.6.4 void FLEXSPI_GetDefaultConfig (flexspi_config_t * *config*)

Parameters

<i>config</i>	FLEXSPI configuration structure.
---------------	----------------------------------

24.6.5 void FLEXSPI_Deinit (FLEXSPI_Type * *base*)

Clears the FLEXSPI state and FLEXSPI module registers.

Parameters

<i>base</i>	FLEXSPI peripheral base address.
-------------	----------------------------------

24.6.6 void FLEXSPI_UpdateDIIValue (FLEXSPI_Type * *base*, flexspi_device_config_t * *config*, flexspi_port_t *port*)

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>config</i>	Flash configuration parameters.
<i>port</i>	FLEXSPI Operation port.

24.6.7 void FLEXSPI_SetFlashConfig (FLEXSPI_Type * *base*, flexspi_device_config_t * *config*, flexspi_port_t *port*)

This function configures the connected device relevant parameters, such as the size, command, and so on. The flash configuration value cannot have a default value. The user needs to configure it according to the connected device.

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>config</i>	Flash configuration parameters.
<i>port</i>	FLEXSPI Operation port.

**24.6.8 static void FLEXSPI_SoftwareReset (FLEXSPI_Type * *base*) [inline],
[static]**

This function sets the software reset flags for both AHB and buffer domain and resets both AHB buffer and also IP FIFOs.

Parameters

<i>base</i>	FLEXSPI peripheral base address.
-------------	----------------------------------

**24.6.9 static void FLEXSPI_Enable (FLEXSPI_Type * *base*, bool *enable*)
[inline], [static]**

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>enable</i>	True means enable FLEXSPI, false means disable.

**24.6.10 static void FLEXSPI_EnableInterrupts (FLEXSPI_Type * *base*, uint32_t
mask) [inline], [static]**

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>mask</i>	FLEXSPI interrupt source.

**24.6.11 static void FLEXSPI_DisableInterrupts (FLEXSPI_Type * *base*, uint32_t
mask) [inline], [static]**

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>mask</i>	FLEXSPI interrupt source.

**24.6.12 static void FLEXSPI_EnableTxDMA (FLEXSPI_Type * *base*, bool *enable*)
[inline], [static]**

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>enable</i>	Enable flag for transmit DMA request. Pass true for enable, false for disable.

24.6.13 `static void FLEXSPI_EnableRxDMA (FLEXSPI_Type * base, bool enable)`
`[inline], [static]`

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>enable</i>	Enable flag for receive DMA request. Pass true for enable, false for disable.

24.6.14 `static uint32_t FLEXSPI_GetTxFifoAddress (FLEXSPI_Type * base)`
`[inline], [static]`

Parameters

<i>base</i>	FLEXSPI peripheral base address.
-------------	----------------------------------

Return values

<i>The</i>	tx fifo address.
------------	------------------

24.6.15 `static uint32_t FLEXSPI_GetRxFifoAddress (FLEXSPI_Type * base)`
`[inline], [static]`

Parameters

<i>base</i>	FLEXSPI peripheral base address.
-------------	----------------------------------

Return values

<i>The</i>	rx fifo address.
------------	------------------

24.6.16 static void FLEXSPI_ResetFifos (FLEXSPI_Type * *base*, bool *txFifo*, bool *rxFifo*) [inline], [static]

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>txFifo</i>	Pass true to reset TX FIFO.
<i>rxFifo</i>	Pass true to reset RX FIFO.

24.6.17 static void FLEXSPI_GetFifoCounts (FLEXSPI_Type * *base*, size_t * *txCount*, size_t * *rxCount*) [inline], [static]

Parameters

	<i>base</i>	FLEXSPI peripheral base address.
out	<i>txCount</i>	Pointer through which the current number of bytes in the transmit FIFO is returned. Pass NULL if this value is not required.
out	<i>rxCount</i>	Pointer through which the current number of bytes in the receive FIFO is returned. Pass NULL if this value is not required.

24.6.18 static uint32_t FLEXSPI_GetInterruptStatusFlags (FLEXSPI_Type * *base*) [inline], [static]

Parameters

<i>base</i>	FLEXSPI peripheral base address.
-------------	----------------------------------

Return values

<i>interrupt</i>	status flag, use status flag to AND flexspi_flags_t could get the related status.
------------------	---

24.6.19 `static void FLEXSPI_ClearInterruptStatusFlags (FLEXSPI_Type * base,
uint32_t mask) [inline], [static]`

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>mask</i>	FLEXSPI interrupt source.

24.6.20 `static flexspi_arb_command_source_t FLEXSPI_GetArbitrator-CommandSource (FLEXSPI_Type * base) [inline], [static]`

Parameters

<i>base</i>	FLEXSPI peripheral base address.
-------------	----------------------------------

Return values

<i>trigger</i>	source of current command sequence.
----------------	-------------------------------------

24.6.21 `static flexspi_ip_error_code_t FLEXSPI_GetIPCommandErrorCode (FLEXSPI_Type * base, uint8_t * index) [inline], [static]`

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>index</i>	Pointer to a uint8_t type variable to receive the sequence index when error detected.

Return values

<i>error</i>	code when IP command error detected.
--------------	--------------------------------------

24.6.22 `static flexspi_ahb_error_code_t FLEXSPI_GetAHBCommandErrorCode (FLEXSPI_Type * base, uint8_t * index) [inline], [static]`

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>index</i>	Pointer to a uint8_t type variable to receive the sequence index when error detected.

Return values

<i>error</i>	code when AHB command error detected.
--------------	---------------------------------------

24.6.23 `static bool FLEXSPI_GetBusIdleStatus (FLEXSPI_Type * base)
[inline], [static]`

Parameters

<i>base</i>	FLEXSPI peripheral base address.
-------------	----------------------------------

Return values

<i>true</i>	Bus is idle.
<i>false</i>	Bus is busy.

24.6.24 `void FLEXSPI_UpdateRxSampleClock (FLEXSPI_Type * base,
flexspi_read_sample_clock_t clockSource)`

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>clockSource</i>	clockSource of type flexspi_read_sample_clock_t

24.6.25 `static void FLEXSPI_EnableIPParallelMode (FLEXSPI_Type * base, bool
enable) [inline], [static]`

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>enable</i>	True means enable parallel mode, false means disable parallel mode.

24.6.26 `static void FLEXSPI_EnableAHBParallelMode (FLEXSPI_Type * base,
bool enable) [inline], [static]`

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>enable</i>	True means enable parallel mode, false means disable parallel mode.

24.6.27 void FLEXSPI_UpdateLUT (FLEXSPI_Type * *base*, uint32_t *index*, const uint32_t * *cmd*, uint32_t *count*)

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>index</i>	From which index start to update. It could be any index of the LUT table, which also allows user to update command content inside a command. Each command consists of up to 8 instructions and occupy 4*32-bit memory.
<i>cmd</i>	Command sequence array.
<i>count</i>	Number of sequences.

24.6.28 static void FLEXSPI_WriteData (FLEXSPI_Type * *base*, uint32_t *data*, uint8_t *fifoIndex*) [inline], [static]

Parameters

<i>base</i>	FLEXSPI peripheral base address
<i>data</i>	The data bytes to send
<i>fifoIndex</i>	Destination fifo index.

24.6.29 static uint32_t FLEXSPI_ReadData (FLEXSPI_Type * *base*, uint8_t *fifoIndex*) [inline], [static]

Parameters

<i>base</i>	FLEXSPI peripheral base address
<i>fifoIndex</i>	Source fifo index.

Returns

The data in the FIFO.

24.6.30 `status_t FLEXSPI_WriteBlocking (FLEXSPI_Type * base, uint32_t * buffer, size_t size)`

Note

This function blocks via polling until all bytes have been sent.

Parameters

<i>base</i>	FLEXSPI peripheral base address
<i>buffer</i>	The data bytes to send
<i>size</i>	The number of data bytes to send

Return values

<i>kStatus_Success</i>	write success without error
<i>kStatus_FLEXSPI_SequenceExecutionTimeout</i>	sequence execution timeout
<i>kStatus_FLEXSPI_IpCommandSequenceError</i>	IP command sequence error detected
<i>kStatus_FLEXSPI_IpCommandGrantTimeout</i>	IP command grant timeout detected

24.6.31 `status_t FLEXSPI_ReadBlocking (FLEXSPI_Type * base, uint32_t * buffer, size_t size)`

Note

This function blocks via polling until all bytes have been sent.

Parameters

<i>base</i>	FLEXSPI peripheral base address
<i>buffer</i>	The data bytes to send
<i>size</i>	The number of data bytes to receive

Return values

<i>kStatus_Success</i>	read success without error
<i>kStatus_FLEXSPI_SequenceExecutionTimeout</i>	sequence execution timeout
<i>kStatus_FLEXSPI_IpCommandSequenceError</i>	IP command sequencen error detected
<i>kStatus_FLEXSPI_IpCommandGrantTimeout</i>	IP command grant timeout detected

24.6.32 status_t FLEXSPI_TransferBlocking (FLEXSPI_Type * *base*, flexspi_transfer_t * *xfer*)

Parameters

<i>base</i>	FLEXSPI peripheral base address
<i>xfer</i>	pointer to the transfer structure.

Return values

<i>kStatus_Success</i>	command transfer success without error
<i>kStatus_FLEXSPI_SequenceExecutionTimeout</i>	sequence execution timeout
<i>kStatus_FLEXSPI_IpCommandSequenceError</i>	IP command sequence error detected
<i>kStatus_FLEXSPI_IpCommandGrantTimeout</i>	IP command grant timeout detected

24.6.33 void FLEXSPI_TransferCreateHandle (FLEXSPI_Type * *base*, flexspi_handle_t * *handle*, flexspi_transfer_callback_t *callback*, void * *userData*)

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>handle</i>	pointer to flexspi_handle_t structure to store the transfer state.
<i>callback</i>	pointer to user callback function.
<i>userData</i>	user parameter passed to the callback function.

24.6.34 status_t FLEXSPI_TransferNonBlocking (FLEXSPI_Type * *base*, flexspi_handle_t * *handle*, flexspi_transfer_t * *xfer*)

Note

Calling the API returns immediately after transfer initiates. The user needs to call FLEXSPI_GetTransferCount to poll the transfer status to check whether the transfer is finished. If the return status is not kStatus_FLEXSPI_Busy, the transfer is finished. For FLEXSPI_Read, the dataSize should be multiple of rx watermark level, or FLEXSPI could not read data properly.

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>handle</i>	pointer to flexspi_handle_t structure which stores the transfer state.
<i>xfer</i>	pointer to flexspi_transfer_t structure.

Return values

<i>kStatus_Success</i>	Successfully start the data transmission.
<i>kStatus_FLEXSPI_Busy</i>	Previous transmission still not finished.

24.6.35 status_t FLEXSPI_TransferGetCount (FLEXSPI_Type * *base*, flexspi_handle_t * *handle*, size_t * *count*)

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>handle</i>	pointer to flexspi_handle_t structure which stores the transfer state.
<i>count</i>	Number of bytes transferred so far by the non-blocking transaction.

Return values

<i>kStatus_InvalidArgument</i>	count is Invalid.
<i>kStatus_Success</i>	Successfully return the count.

24.6.36 void FLEXSPI_TransferAbort (FLEXSPI_Type * *base*, flexspi_handle_t * *handle*)

Note

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

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>handle</i>	pointer to flexspi_handle_t structure which stores the transfer state

24.6.37 void FLEXSPI_TransferHandleIRQ (FLEXSPI_Type * *base*, flexspi_handle_t * *handle*)

Parameters

<i>base</i>	FLEXSPI peripheral base address.
<i>handle</i>	pointer to flexspi_handle_t structure.

Chapter 25

GPC: General Power Controller Driver

25.1 Overview

The MCUXpresso SDK provides a peripheral driver for the General Power Controller (GPC) module of MCUXpresso SDK devices.

API functions are provided to configure the system about working in dedicated power mode. There are mainly about enabling the power for memory, enabling the wakeup sources for STOP modes, and power up/down operations for various peripherals.

Functions

- void [GPC_EnableIRQ](#) (GPC_Type *base, uint32_t irqId)
Enable the IRQ.
- void [GPC_DisableIRQ](#) (GPC_Type *base, uint32_t irqId)
Disable the IRQ.
- bool [GPC_GetIRQStatusFlag](#) (GPC_Type *base, uint32_t irqId)
Get the IRQ/Event flag.
- static void [GPC_RequestPDRAM0PowerDown](#) (GPC_Type *base, bool enable)
FLEXRAM PDRAM0 Power Gate Enable.
- static void [GPC_RequestMEGAPowerOn](#) (GPC_Type *base, bool enable)
Requests the MEGA power switch sequence.

Driver version

- #define [FSL_GPC_DRIVER_VERSION](#) ([MAKE_VERSION](#)(2, 1, 1))
GPC driver version 2.1.1.

25.2 Macro Definition Documentation

25.2.1 #define [FSL_GPC_DRIVER_VERSION](#) ([MAKE_VERSION](#)(2, 1, 1))

25.3 Function Documentation

25.3.1 void [GPC_EnableIRQ](#) (GPC_Type * *base*, uint32_t *irqId*)

Parameters

<i>base</i>	GPC peripheral base address.
<i>irqId</i>	ID number of IRQ to be enabled, available range is 32-159. 0-31 is available in some platforms.

25.3.2 void GPC_DisableIRQ (GPC_Type * *base*, uint32_t *irqId*)

Parameters

<i>base</i>	GPC peripheral base address.
<i>irqId</i>	ID number of IRQ to be disabled, available range is 32-159. 0-31 is available in some platforms.

25.3.3 bool GPC_GetIRQStatusFlag (GPC_Type * *base*, uint32_t *irqId*)

Parameters

<i>base</i>	GPC peripheral base address.
<i>irqId</i>	ID number of IRQ to be enabled, available range is 32-159. 0-31 is available in some platforms.

Returns

Indicated IRQ/Event is asserted or not.

25.3.4 static void GPC_RequestPdram0PowerDown (GPC_Type * *base*, bool *enable*) [inline], [static]

This function configures the FLEXRAM PDRAM0 if it will keep power when cpu core is power down. When the PDRAM0 Power is 1, PDRAM0 will be power down once when CPU core is power down. When the PDRAM0 Power is 0, PDRAM0 will keep power on even if CPU core is power down. When CPU core is re-power up, the default setting is 1.

Parameters

<i>base</i>	GPC peripheral base address.
<i>enable</i>	Enable the request or not.

25.3.5 static void GPC_RequestMEGAPowerOn (GPC_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	GPC peripheral base address.
<i>enable</i>	Enable the power on sequence, or the power down sequence.

Chapter 26

GPT: General Purpose Timer

26.1 Overview

The MCUXpresso SDK provides a driver for the General Purpose Timer (GPT) of MCUXpresso SDK devices.

26.2 Function groups

The gpt driver supports the generation of PWM signals, input capture, and setting up the timer match conditions.

26.2.1 Initialization and deinitialization

The function `GPT_Init()` initializes the gpt with specified configurations. The function `GPT_GetDefaultConfig()` gets the default configurations. The initialization function configures the restart/free-run mode and input selection when running.

The function `GPT_Deinit()` stops the timer and turns off the module clock.

26.3 Typical use case

26.3.1 GPT interrupt example

Set up a channel to trigger a periodic interrupt after every 1 second. Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/gpt`

Data Structures

- struct `gpt_config_t`
Structure to configure the running mode. [More...](#)

Enumerations

- enum `gpt_clock_source_t` {
 `kGPT_ClockSource_Off` = 0U,
 `kGPT_ClockSource_Periph` = 1U,
 `kGPT_ClockSource_HighFreq` = 2U,
 `kGPT_ClockSource_Ext` = 3U,
 `kGPT_ClockSource_LowFreq` = 4U,
 `kGPT_ClockSource_Osc` = 5U }
List of clock sources.

- enum `gpt_input_capture_channel_t` {
`kGPT_InputCapture_Channel1` = 0U,
`kGPT_InputCapture_Channel2` = 1U }
List of input capture channel number.
- enum `gpt_input_operation_mode_t` {
`kGPT_InputOperation_Disabled` = 0U,
`kGPT_InputOperation_RiseEdge` = 1U,
`kGPT_InputOperation_FallEdge` = 2U,
`kGPT_InputOperation_BothEdge` = 3U }
List of input capture operation mode.
- enum `gpt_output_compare_channel_t` {
`kGPT_OutputCompare_Channel1` = 0U,
`kGPT_OutputCompare_Channel2` = 1U,
`kGPT_OutputCompare_Channel3` = 2U }
List of output compare channel number.
- enum `gpt_output_operation_mode_t` {
`kGPT_OutputOperation_Disconnected` = 0U,
`kGPT_OutputOperation_Toggle` = 1U,
`kGPT_OutputOperation_Clear` = 2U,
`kGPT_OutputOperation_Set` = 3U,
`kGPT_OutputOperation_Activelow` = 4U }
List of output compare operation mode.
- enum `gpt_interrupt_enable_t` {
`kGPT_OutputCompare1InterruptEnable` = GPT_IR_OF1IE_MASK,
`kGPT_OutputCompare2InterruptEnable` = GPT_IR_OF2IE_MASK,
`kGPT_OutputCompare3InterruptEnable` = GPT_IR_OF3IE_MASK,
`kGPT_InputCapture1InterruptEnable` = GPT_IR_IF1IE_MASK,
`kGPT_InputCapture2InterruptEnable` = GPT_IR_IF2IE_MASK,
`kGPT_RollOverFlagInterruptEnable` = GPT_IR_ROVIE_MASK }
List of GPT interrupts.
- enum `gpt_status_flag_t` {
`kGPT_OutputCompare1Flag` = GPT_SR_OF1_MASK,
`kGPT_OutputCompare2Flag` = GPT_SR_OF2_MASK,
`kGPT_OutputCompare3Flag` = GPT_SR_OF3_MASK,
`kGPT_InputCapture1Flag` = GPT_SR_IF1_MASK,
`kGPT_InputCapture2Flag` = GPT_SR_IF2_MASK,
`kGPT_RollOverFlag` = GPT_SR_ROV_MASK }
Status flag.

Driver version

- #define `FSL_GPT_DRIVER_VERSION` (`MAKE_VERSION(2, 0, 4)`)

Initialization and deinitialization

- void `GPT_Init` (`GPT_Type *base`, const `gpt_config_t *initConfig`)
Initialize GPT to reset state and initialize running mode.

- void [GPT_Deinit](#) (GPT_Type *base)
Disables the module and gates the GPT clock.
- void [GPT_GetDefaultConfig](#) (gpt_config_t *config)
Fills in the GPT configuration structure with default settings.

Software Reset

- static void [GPT_SoftwareReset](#) (GPT_Type *base)
Software reset of GPT module.

Clock source and frequency control

- static void [GPT_SetClockSource](#) (GPT_Type *base, gpt_clock_source_t gptClkSource)
Set clock source of GPT.
- static [gpt_clock_source_t](#) [GPT_GetClockSource](#) (GPT_Type *base)
Get clock source of GPT.
- static void [GPT_SetClockDivider](#) (GPT_Type *base, uint32_t divider)
Set pre scaler of GPT.
- static uint32_t [GPT_GetClockDivider](#) (GPT_Type *base)
Get clock divider in GPT module.
- static void [GPT_SetOscClockDivider](#) (GPT_Type *base, uint32_t divider)
OSC 24M pre-scaler before selected by clock source.
- static uint32_t [GPT_GetOscClockDivider](#) (GPT_Type *base)
Get OSC 24M clock divider in GPT module.

Timer Start and Stop

- static void [GPT_StartTimer](#) (GPT_Type *base)
Start GPT timer.
- static void [GPT_StopTimer](#) (GPT_Type *base)
Stop GPT timer.

Read the timer period

- static uint32_t [GPT_GetCurrentTimerCount](#) (GPT_Type *base)
Reads the current GPT counting value.

GPT Input/Output Signal Control

- static void [GPT_SetInputOperationMode](#) (GPT_Type *base, gpt_input_capture_channel_t channel, gpt_input_operation_mode_t mode)
Set GPT operation mode of input capture channel.
- static [gpt_input_operation_mode_t](#) [GPT_GetInputOperationMode](#) (GPT_Type *base, gpt_input_capture_channel_t channel)
Get GPT operation mode of input capture channel.
- static uint32_t [GPT_GetInputCaptureValue](#) (GPT_Type *base, gpt_input_capture_channel_t channel)
Get GPT input capture value of certain channel.
- static void [GPT_SetOutputOperationMode](#) (GPT_Type *base, gpt_output_compare_channel_t channel, gpt_output_operation_mode_t mode)

- *Set GPT operation mode of output compare channel.*
static [gpt_output_operation_mode_t](#) [GPT_GetOutputOperationMode](#) (GPT_Type *base, [gpt_output_compare_channel_t](#) channel)
- *Get GPT operation mode of output compare channel.*
static void [GPT_SetOutputCompareValue](#) (GPT_Type *base, [gpt_output_compare_channel_t](#) channel, uint32_t value)
- *Set GPT output compare value of output compare channel.*
static uint32_t [GPT_GetOutputCompareValue](#) (GPT_Type *base, [gpt_output_compare_channel_t](#) channel)
- *Get GPT output compare value of output compare channel.*
static void [GPT_ForceOutput](#) (GPT_Type *base, [gpt_output_compare_channel_t](#) channel)
Force GPT output action on output compare channel, ignoring comparator.

GPT Interrupt and Status Interface

- static void [GPT_EnableInterrupts](#) (GPT_Type *base, uint32_t mask)
Enables the selected GPT interrupts.
- static void [GPT_DisableInterrupts](#) (GPT_Type *base, uint32_t mask)
Disables the selected GPT interrupts.
- static uint32_t [GPT_GetEnabledInterrupts](#) (GPT_Type *base)
Gets the enabled GPT interrupts.

Status Interface

- static uint32_t [GPT_GetStatusFlags](#) (GPT_Type *base, [gpt_status_flag_t](#) flags)
Get GPT status flags.
- static void [GPT_ClearStatusFlags](#) (GPT_Type *base, [gpt_status_flag_t](#) flags)
Clears the GPT status flags.

26.4 Data Structure Documentation

26.4.1 struct gpt_config_t

Data Fields

- [gpt_clock_source_t](#) clockSource
clock source for GPT module.
- uint32_t divider
clock divider (prescaler+1) from clock source to counter.
- bool [enableFreeRun](#)
true: FreeRun mode, false: Restart mode.
- bool [enableRunInWait](#)
GPT enabled in wait mode.
- bool [enableRunInStop](#)
GPT enabled in stop mode.
- bool [enableRunInDoze](#)
GPT enabled in doze mode.
- bool [enableRunInDbg](#)
GPT enabled in debug mode.

- bool `enableMode`
true: counter reset to 0 when enabled;
false: counter retain its value when enabled.

Field Documentation

- (1) `gpt_clock_source_t gpt_config_t::clockSource`
- (2) `uint32_t gpt_config_t::divider`
- (3) `bool gpt_config_t::enableFreeRun`
- (4) `bool gpt_config_t::enableRunInWait`
- (5) `bool gpt_config_t::enableRunInStop`
- (6) `bool gpt_config_t::enableRunInDoze`
- (7) `bool gpt_config_t::enableRunInDbg`
- (8) `bool gpt_config_t::enableMode`

26.5 Enumeration Type Documentation

26.5.1 enum `gpt_clock_source_t`

Note

Actual number of clock sources is SoC dependent

Enumerator

kGPT_ClockSource_Off GPT Clock Source Off.
kGPT_ClockSource_Periph GPT Clock Source from Peripheral Clock.
kGPT_ClockSource_HighFreq GPT Clock Source from High Frequency Reference Clock.
kGPT_ClockSource_Ext GPT Clock Source from external pin.
kGPT_ClockSource_LowFreq GPT Clock Source from Low Frequency Reference Clock.
kGPT_ClockSource_Osc GPT Clock Source from Crystal oscillator.

26.5.2 enum `gpt_input_capture_channel_t`

Enumerator

kGPT_InputCapture_Channel1 GPT Input Capture Channel1.
kGPT_InputCapture_Channel2 GPT Input Capture Channel2.

26.5.3 enum gpt_input_operation_mode_t

Enumerator

kGPT_InputOperation_Disabled Don't capture.
kGPT_InputOperation_RiseEdge Capture on rising edge of input pin.
kGPT_InputOperation_FallEdge Capture on falling edge of input pin.
kGPT_InputOperation_BothEdge Capture on both edges of input pin.

26.5.4 enum gpt_output_compare_channel_t

Enumerator

kGPT_OutputCompare_Channel1 Output Compare Channel1.
kGPT_OutputCompare_Channel2 Output Compare Channel2.
kGPT_OutputCompare_Channel3 Output Compare Channel3.

26.5.5 enum gpt_output_operation_mode_t

Enumerator

kGPT_OutputOperation_Disconnected Don't change output pin.
kGPT_OutputOperation_Toggle Toggle output pin.
kGPT_OutputOperation_Clear Set output pin low.
kGPT_OutputOperation_Set Set output pin high.
kGPT_OutputOperation_Activelow Generate a active low pulse on output pin.

26.5.6 enum gpt_interrupt_enable_t

Enumerator

kGPT_OutputCompare1InterruptEnable Output Compare Channel1 interrupt enable.
kGPT_OutputCompare2InterruptEnable Output Compare Channel2 interrupt enable.
kGPT_OutputCompare3InterruptEnable Output Compare Channel3 interrupt enable.
kGPT_InputCapture1InterruptEnable Input Capture Channel1 interrupt enable.
kGPT_InputCapture2InterruptEnable Input Capture Channel1 interrupt enable.
kGPT_RollOverFlagInterruptEnable Counter rolled over interrupt enable.

26.5.7 enum gpt_status_flag_t

Enumerator

kGPT_OutputCompare1Flag Output compare channel 1 event.
kGPT_OutputCompare2Flag Output compare channel 2 event.
kGPT_OutputCompare3Flag Output compare channel 3 event.
kGPT_InputCapture1Flag Input Capture channel 1 event.
kGPT_InputCapture2Flag Input Capture channel 2 event.
kGPT_RollOverFlag Counter reaches maximum value and rolled over to 0 event.

26.6 Function Documentation

26.6.1 void GPT_Init (GPT_Type * *base*, const gpt_config_t * *initConfig*)

Parameters

<i>base</i>	GPT peripheral base address.
<i>initConfig</i>	GPT mode setting configuration.

26.6.2 void GPT_Deinit (GPT_Type * *base*)

Parameters

<i>base</i>	GPT peripheral base address.
-------------	------------------------------

26.6.3 void GPT_GetDefaultConfig (gpt_config_t * *config*)

The default values are:

```
* config->clockSource = kGPT_ClockSource_Periph;
* config->divider = 1U;
* config->enableRunInStop = true;
* config->enableRunInWait = true;
* config->enableRunInDoze = false;
* config->enableRunInDbg = false;
* config->enableFreeRun = false;
* config->enableMode = true;
*
```


Parameters

<i>config</i>	Pointer to the user configuration structure.
---------------	--

26.6.4 static void GPT_SoftwareReset (GPT_Type * *base*) [inline], [static]

Parameters

<i>base</i>	GPT peripheral base address.
-------------	------------------------------

26.6.5 static void GPT_SetClockSource (GPT_Type * *base*, gpt_clock_source_t *gptClkSource*) [inline], [static]

Parameters

<i>base</i>	GPT peripheral base address.
<i>gptClkSource</i>	Clock source (see gpt_clock_source_t typedef enumeration).

26.6.6 static gpt_clock_source_t GPT_GetClockSource (GPT_Type * *base*) [inline], [static]

Parameters

<i>base</i>	GPT peripheral base address.
-------------	------------------------------

Returns

clock source (see [gpt_clock_source_t](#) typedef enumeration).

26.6.7 static void GPT_SetClockDivider (GPT_Type * *base*, uint32_t *divider*) [inline], [static]

Parameters

<i>base</i>	GPT peripheral base address.
<i>divider</i>	Divider of GPT (1-4096).

26.6.8 `static uint32_t GPT_GetClockDivider (GPT_Type * base) [inline], [static]`

Parameters

<i>base</i>	GPT peripheral base address.
-------------	------------------------------

Returns

clock divider in GPT module (1-4096).

26.6.9 `static void GPT_SetOscClockDivider (GPT_Type * base, uint32_t divider) [inline], [static]`

Parameters

<i>base</i>	GPT peripheral base address.
<i>divider</i>	OSC Divider(1-16).

26.6.10 `static uint32_t GPT_GetOscClockDivider (GPT_Type * base) [inline], [static]`

Parameters

<i>base</i>	GPT peripheral base address.
-------------	------------------------------

Returns

OSC clock divider in GPT module (1-16).

26.6.11 `static void GPT_StartTimer (GPT_Type * base) [inline], [static]`

Parameters

<i>base</i>	GPT peripheral base address.
-------------	------------------------------

26.6.12 `static void GPT_StopTimer (GPT_Type * base) [inline], [static]`

Parameters

<i>base</i>	GPT peripheral base address.
-------------	------------------------------

26.6.13 `static uint32_t GPT_GetCurrentTimerCount (GPT_Type * base) [inline], [static]`

Parameters

<i>base</i>	GPT peripheral base address.
-------------	------------------------------

Returns

Current GPT counter value.

26.6.14 `static void GPT_SetInputOperationMode (GPT_Type * base,
gpt_input_capture_channel_t channel, gpt_input_operation_mode_t mode
) [inline], [static]`

Parameters

<i>base</i>	GPT peripheral base address.
<i>channel</i>	GPT capture channel (see gpt_input_capture_channel_t typedef enumeration).
<i>mode</i>	GPT input capture operation mode (see gpt_input_operation_mode_t typedef enumeration).

26.6.15 `static gpt_input_operation_mode_t GPT_GetInputOperationMode (GPT_Type * base, gpt_input_capture_channel_t channel) [inline], [static]`

Parameters

<i>base</i>	GPT peripheral base address.
<i>channel</i>	GPT capture channel (see gpt_input_capture_channel_t typedef enumeration).

Returns

GPT input capture operation mode (see [gpt_input_operation_mode_t](#) typedef enumeration).

26.6.16 `static uint32_t GPT_GetInputCaptureValue (GPT_Type * base,
gpt_input_capture_channel_t channel) [inline], [static]`

Parameters

<i>base</i>	GPT peripheral base address.
<i>channel</i>	GPT capture channel (see gpt_input_capture_channel_t typedef enumeration).

Returns

GPT input capture value.

26.6.17 `static void GPT_SetOutputOperationMode (GPT_Type * base,
gpt_output_compare_channel_t channel, gpt_output_operation_mode_t
mode) [inline], [static]`

Parameters

<i>base</i>	GPT peripheral base address.
<i>channel</i>	GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).
<i>mode</i>	GPT output operation mode (see gpt_output_operation_mode_t typedef enumeration).

26.6.18 `static gpt_output_operation_mode_t GPT_GetOutputOperationMode (
GPT_Type * base, gpt_output_compare_channel_t channel) [inline],
[static]`

Parameters

<i>base</i>	GPT peripheral base address.
<i>channel</i>	GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).

Returns

GPT output operation mode (see [gpt_output_operation_mode_t](#) typedef enumeration).

26.6.19 `static void GPT_SetOutputCompareValue (GPT_Type * base,
gpt_output_compare_channel_t channel, uint32_t value) [inline],
[static]`

Parameters

<i>base</i>	GPT peripheral base address.
<i>channel</i>	GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).
<i>value</i>	GPT output compare value.

26.6.20 `static uint32_t GPT_GetOutputCompareValue (GPT_Type * base,
gpt_output_compare_channel_t channel) [inline], [static]`

Parameters

<i>base</i>	GPT peripheral base address.
<i>channel</i>	GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).

Returns

GPT output compare value.

26.6.21 `static void GPT_ForceOutput (GPT_Type * base, gpt_output_compare_
channel_t channel) [inline], [static]`

Parameters

<i>base</i>	GPT peripheral base address.
<i>channel</i>	GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).

26.6.22 static void GPT_EnableInterrupts (GPT_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

<i>base</i>	GPT peripheral base address.
<i>mask</i>	The interrupts to enable. This is a logical OR of members of the enumeration gpt_interrupt_enable_t

26.6.23 static void GPT_DisableInterrupts (GPT_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

<i>base</i>	GPT peripheral base address
<i>mask</i>	The interrupts to disable. This is a logical OR of members of the enumeration gpt_interrupt_enable_t

26.6.24 static uint32_t GPT_GetEnabledInterrupts (GPT_Type * *base*) [inline], [static]

Parameters

<i>base</i>	GPT peripheral base address
-------------	-----------------------------

Returns

The enabled interrupts. This is the logical OR of members of the enumeration [gpt_interrupt_enable_t](#)

26.6.25 static uint32_t GPT_GetStatusFlags (GPT_Type * *base*, gpt_status_flag_t *flags*) [inline], [static]

Parameters

<i>base</i>	GPT peripheral base address.
<i>flags</i>	GPT status flag mask (see gpt_status_flag_t for bit definition).

Returns

GPT status, each bit represents one status flag.

26.6.26 `static void GPT_ClearStatusFlags (GPT_Type * base, gpt_status_flag_t flags) [inline], [static]`

Parameters

<i>base</i>	GPT peripheral base address.
<i>flags</i>	GPT status flag mask (see gpt_status_flag_t for bit definition).

Chapter 27

GPIO: General-Purpose Input/Output Driver

27.1 Overview

The MCUXpresso SDK provides a peripheral driver for the General-Purpose Input/Output (GPIO) module of MCUXpresso SDK devices.

27.2 Typical use case

27.2.1 Input Operation

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/gpio`

Data Structures

- struct `gpio_pin_config_t`
GPIO Init structure definition. [More...](#)

Enumerations

- enum `gpio_pin_direction_t` {
 `kGPIO_DigitalInput` = 0U,
 `kGPIO_DigitalOutput` = 1U }
GPIO direction definition.
- enum `gpio_interrupt_mode_t` {
 `kGPIO_NoIntmode` = 0U,
 `kGPIO_IntLowLevel` = 1U,
 `kGPIO_IntHighLevel` = 2U,
 `kGPIO_IntRisingEdge` = 3U,
 `kGPIO_IntFallingEdge` = 4U,
 `kGPIO_IntRisingOrFallingEdge` = 5U }
GPIO interrupt mode definition.

Driver version

- #define `FSL_GPIO_DRIVER_VERSION` (`MAKE_VERSION(2, 0, 6)`)
GPIO driver version.

GPIO Initialization and Configuration functions

- void `GPIO_PinInit` (`GPIO_Type *base`, `uint32_t pin`, const `gpio_pin_config_t *Config`)
Initializes the GPIO peripheral according to the specified parameters in the `initConfig`.

GPIO Reads and Write Functions

- void [GPIO_PinWrite](#) (GPIO_Type *base, uint32_t pin, uint8_t output)
Sets the output level of the individual GPIO pin to logic 1 or 0.
- static void [GPIO_WritePinOutput](#) (GPIO_Type *base, uint32_t pin, uint8_t output)
Sets the output level of the individual GPIO pin to logic 1 or 0.
- static void [GPIO_PortSet](#) (GPIO_Type *base, uint32_t mask)
Sets the output level of the multiple GPIO pins to the logic 1.
- static void [GPIO_SetPinsOutput](#) (GPIO_Type *base, uint32_t mask)
Sets the output level of the multiple GPIO pins to the logic 1.
- static void [GPIO_PortClear](#) (GPIO_Type *base, uint32_t mask)
Sets the output level of the multiple GPIO pins to the logic 0.
- static void [GPIO_ClearPinsOutput](#) (GPIO_Type *base, uint32_t mask)
Sets the output level of the multiple GPIO pins to the logic 0.
- static void [GPIO_PortToggle](#) (GPIO_Type *base, uint32_t mask)
Reverses the current output logic of the multiple GPIO pins.
- static uint32_t [GPIO_PinRead](#) (GPIO_Type *base, uint32_t pin)
Reads the current input value of the GPIO port.
- static uint32_t [GPIO_ReadPinInput](#) (GPIO_Type *base, uint32_t pin)
Reads the current input value of the GPIO port.

GPIO Reads Pad Status Functions

- static uint8_t [GPIO_PinReadPadStatus](#) (GPIO_Type *base, uint32_t pin)
Reads the current GPIO pin pad status.
- static uint8_t [GPIO_ReadPadStatus](#) (GPIO_Type *base, uint32_t pin)
Reads the current GPIO pin pad status.

Interrupts and flags management functions

- void [GPIO_PinSetInterruptConfig](#) (GPIO_Type *base, uint32_t pin, [gpio_interrupt_mode_t](#) pinInterruptMode)
Sets the current pin interrupt mode.
- static void [GPIO_SetPinInterruptConfig](#) (GPIO_Type *base, uint32_t pin, [gpio_interrupt_mode_t](#) pinInterruptMode)
Sets the current pin interrupt mode.
- static void [GPIO_PortEnableInterrupts](#) (GPIO_Type *base, uint32_t mask)
Enables the specific pin interrupt.
- static void [GPIO_EnableInterrupts](#) (GPIO_Type *base, uint32_t mask)
Enables the specific pin interrupt.
- static void [GPIO_PortDisableInterrupts](#) (GPIO_Type *base, uint32_t mask)
Disables the specific pin interrupt.
- static void [GPIO_DisableInterrupts](#) (GPIO_Type *base, uint32_t mask)
Disables the specific pin interrupt.
- static uint32_t [GPIO_PortGetInterruptFlags](#) (GPIO_Type *base)
Reads individual pin interrupt status.
- static uint32_t [GPIO_GetPinsInterruptFlags](#) (GPIO_Type *base)
Reads individual pin interrupt status.
- static void [GPIO_PortClearInterruptFlags](#) (GPIO_Type *base, uint32_t mask)
Clears pin interrupt flag.
- static void [GPIO_ClearPinsInterruptFlags](#) (GPIO_Type *base, uint32_t mask)

Clears pin interrupt flag.

27.3 Data Structure Documentation

27.3.1 struct gpio_pin_config_t

Data Fields

- [gpio_pin_direction_t direction](#)
Specifies the pin direction.
- uint8_t [outputLogic](#)
Set a default output logic, which has no use in input.
- [gpio_interrupt_mode_t interruptMode](#)
Specifies the pin interrupt mode, a value of [gpio_interrupt_mode_t](#).

Field Documentation

(1) `gpio_pin_direction_t gpio_pin_config_t::direction`

(2) `gpio_interrupt_mode_t gpio_pin_config_t::interruptMode`

27.4 Macro Definition Documentation

27.4.1 `#define FSL_GPIO_DRIVER_VERSION (MAKE_VERSION(2, 0, 6))`

27.5 Enumeration Type Documentation

27.5.1 enum gpio_pin_direction_t

Enumerator

kGPIO_DigitalInput Set current pin as digital input.
kGPIO_DigitalOutput Set current pin as digital output.

27.5.2 enum gpio_interrupt_mode_t

Enumerator

kGPIO_NoIntmode Set current pin general IO functionality.
kGPIO_IntLowLevel Set current pin interrupt is low-level sensitive.
kGPIO_IntHighLevel Set current pin interrupt is high-level sensitive.
kGPIO_IntRisingEdge Set current pin interrupt is rising-edge sensitive.
kGPIO_IntFallingEdge Set current pin interrupt is falling-edge sensitive.
kGPIO_IntRisingOrFallingEdge Enable the edge select bit to override the ICR register's configuration.

27.6 Function Documentation

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

Parameters

<i>base</i>	GPIO base pointer.
<i>pin</i>	Specifies the pin number
<i>Config</i>	pointer to a gpio_pin_config_t structure that contains the configuration information.

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

Parameters

<i>base</i>	GPIO base pointer.
<i>pin</i>	GPIO port pin number.
<i>output</i>	GPIO pin output logic level. <ul style="list-style-type: none"> • 0: corresponding pin output low-logic level. • 1: corresponding pin output high-logic level.

27.6.3 static void GPIO_WritePinOutput (GPIO_Type * *base*, uint32_t *pin*, uint8_t *output*) [inline], [static]

Deprecated Do not use this function. It has been superseded by [GPIO_PinWrite](#).

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

Parameters

<i>base</i>	GPIO peripheral base pointer (GPIO1, GPIO2, GPIO3, and so on.)
<i>mask</i>	GPIO pin number macro

27.6.5 static void GPIO_SetPinsOutput (GPIO_Type * *base*, uint32_t *mask*) [inline], [static]

Deprecated Do not use this function. It has been superseded by [GPIO_PortSet](#).

27.6.6 `static void GPIO_PortClear (GPIO_Type * base, uint32_t mask)`
`[inline], [static]`

Parameters

<i>base</i>	GPIO peripheral base pointer (GPIO1, GPIO2, GPIO3, and so on.)
<i>mask</i>	GPIO pin number macro

27.6.7 static void GPIO_ClearPinsOutput (GPIO_Type * *base*, uint32_t *mask*)
[inline], [static]

Deprecated Do not use this function. It has been superseded by [GPIO_PortClear](#).

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

Parameters

<i>base</i>	GPIO peripheral base pointer (GPIO1, GPIO2, GPIO3, and so on.)
<i>mask</i>	GPIO pin number macro

27.6.9 static uint32_t GPIO_PinRead (GPIO_Type * *base*, uint32_t *pin*)
[inline], [static]

Parameters

<i>base</i>	GPIO base pointer.
<i>pin</i>	GPIO port pin number.

Return values

<i>GPIO</i>	port input value.
-------------	-------------------

27.6.10 static uint32_t GPIO_ReadPinInput (GPIO_Type * *base*, uint32_t *pin*)
[inline], [static]

Deprecated Do not use this function. It has been superseded by [GPIO_PinRead](#).

27.6.11 `static uint8_t GPIO_PinReadPadStatus (GPIO_Type * base, uint32_t pin)`
`[inline], [static]`

Parameters

<i>base</i>	GPIO base pointer.
<i>pin</i>	GPIO port pin number.

Return values

<i>GPIO</i>	pin pad status value.
-------------	-----------------------

27.6.12 `static uint8_t GPIO_ReadPadStatus (GPIO_Type * base, uint32_t pin)
[inline], [static]`

Deprecated Do not use this function. It has been superseded by [GPIO_PinReadPadStatus](#).

27.6.13 `void GPIO_PinSetInterruptConfig (GPIO_Type * base, uint32_t pin,
gpio_interrupt_mode_t pinInterruptMode)`

Parameters

<i>base</i>	GPIO base pointer.
<i>pin</i>	GPIO port pin number.
<i>pinInterrupt- Mode</i>	pointer to a gpio_interrupt_mode_t structure that contains the interrupt mode information.

27.6.14 `static void GPIO_SetPinInterruptConfig (GPIO_Type * base, uint32_t pin,
gpio_interrupt_mode_t pinInterruptMode) [inline], [static]`

Deprecated Do not use this function. It has been superseded by [GPIO_PinSetInterruptConfig](#).

27.6.15 `static void GPIO_PortEnableInterrupts (GPIO_Type * base, uint32_t mask
) [inline], [static]`

Parameters

<i>base</i>	GPIO base pointer.
<i>mask</i>	GPIO pin number macro.

27.6.16 static void GPIO_EnableInterrupts (GPIO_Type * *base*, uint32_t *mask*)
[inline], [static]

Parameters

<i>base</i>	GPIO base pointer.
<i>mask</i>	GPIO pin number macro.

27.6.17 static void GPIO_PortDisableInterrupts (GPIO_Type * *base*, uint32_t *mask*)
[inline], [static]

Parameters

<i>base</i>	GPIO base pointer.
<i>mask</i>	GPIO pin number macro.

27.6.18 static void GPIO_DisableInterrupts (GPIO_Type * *base*, uint32_t *mask*)
[inline], [static]

Deprecated Do not use this function. It has been superseded by [GPIO_PortDisableInterrupts](#).

27.6.19 static uint32_t GPIO_PortGetInterruptFlags (GPIO_Type * *base*)
[inline], [static]

Parameters

<i>base</i>	GPIO base pointer.
-------------	--------------------

Return values

<i>current</i>	pin interrupt status flag.
----------------	----------------------------

27.6.20 `static uint32_t GPIO_GetPinsInterruptFlags (GPIO_Type * base) [inline], [static]`

Parameters

<i>base</i>	GPIO base pointer.
-------------	--------------------

Return values

<i>current</i>	pin interrupt status flag.
----------------	----------------------------

27.6.21 `static void GPIO_PortClearInterruptFlags (GPIO_Type * base, uint32_t mask) [inline], [static]`

Status flags are cleared by writing a 1 to the corresponding bit position.

Parameters

<i>base</i>	GPIO base pointer.
<i>mask</i>	GPIO pin number macro.

27.6.22 `static void GPIO_ClearPinsInterruptFlags (GPIO_Type * base, uint32_t mask) [inline], [static]`

Status flags are cleared by writing a 1 to the corresponding bit position.

Parameters

<i>base</i>	GPIO base pointer.
<i>mask</i>	GPIO pin number macro.

Chapter 28

KPP: KeyPad Port Driver

28.1 Overview

The MCUXpresso SDK provides a peripheral driver for the KeyPad Port block of MCUXpresso SDK devices.

KPP: KeyPad Port Driver

KPP Initialization Operation

The KPP Initialize is to initialize for common configure: gate the KPP clock, configure columns, and rows features. The KPP Deinitialize is to ungate the clock.

KPP Basic Operation

The KPP provide the function to enable/disable interrupts. The KPP provide key press scanning function `KPP_keyPressScanning`. This API should be called by the Interrupt handler in application. KPP still provides functions to get and clear status flags.

28.2 Typical use case

Data Structures

- struct `kpp_config_t`
Lists of KPP status. [More...](#)

Enumerations

- enum `kpp_interrupt_enable_t` {
`kKPP_keyDepressInterrupt` = `KPP_KPSR_KDIE_MASK`,
`kKPP_keyReleaseInterrupt` = `KPP_KPSR_KRIE_MASK` }
List of interrupts supported by the peripheral.
- enum `kpp_sync_operation_t` {
`kKPP_ClearKeyDepressSyncChain` = `KPP_KPSR_KDSC_MASK`,
`kKPP_SetKeyReleasesSyncChain` = `KPP_KPSR_KRSS_MASK` }
Lists of KPP synchronize chain operation.

Driver version

- #define `FSL_KPP_DRIVER_VERSION` (`MAKE_VERSION(2, 0, 0)`)
KPP driver version 2.0.0.

Initialization and De-initialization

- void `KPP_Init` (KPP_Type *base, `kpp_config_t` *configure)
KPP initialize.
- void `KPP_Deinit` (KPP_Type *base)
Deinitializes the KPP module and gates the clock.

KPP Basic Operation

- static void `KPP_EnableInterrupts` (KPP_Type *base, uint16_t mask)
Enable the interrupt.
- static void `KPP_DisableInterrupts` (KPP_Type *base, uint16_t mask)
Disable the interrupt.
- static uint16_t `KPP_GetStatusFlag` (KPP_Type *base)
Gets the KPP interrupt event status.
- static void `KPP_ClearStatusFlag` (KPP_Type *base, uint16_t mask)
Clears KPP status flag.
- static void `KPP_SetSynchronizeChain` (KPP_Type *base, uint16_t mask)
Set KPP synchronization chain.
- void `KPP_keyPressScanning` (KPP_Type *base, uint8_t *data, uint32_t clockSrc_Hz)
Keypad press scanning.

28.3 Data Structure Documentation

28.3.1 struct `kpp_config_t`

Data Fields

- uint8_t `activeRow`
The row number: bit 7 ~ 0 represents the row 7 ~ 0.
- uint8_t `activeColumn`
The column number: bit 7 ~ 0 represents the column 7 ~ 0.
- uint16_t `interrupt`
KPP interrupt source.

Field Documentation

- (1) `uint8_t kpp_config_t::activeRow`
- (2) `uint8_t kpp_config_t::activeColumn`
- (3) `uint16_t kpp_config_t::interrupt`

A logical OR of "kpp_interrupt_enable_t".

28.4 Macro Definition Documentation

28.4.1 `#define FSL_KPP_DRIVER_VERSION (MAKE_VERSION(2, 0, 0))`

28.5 Enumeration Type Documentation

28.5.1 enum kpp_interrupt_enable_t

This enumeration uses one-bit encoding to allow a logical OR of multiple members. Members usually map to interrupt enable bits in one or more peripheral registers.

Enumerator

kKPP_keyDepressInterrupt Keypad depress interrupt source.
kKPP_keyReleaseInterrupt Keypad release interrupt source.

28.5.2 enum kpp_sync_operation_t

Enumerator

kKPP_ClearKeyDepressSyncChain Keypad depress interrupt status.
kKPP_SetKeyReleasesSyncChain Keypad release interrupt status.

28.6 Function Documentation

28.6.1 void KPP_Init (KPP_Type * *base*, kpp_config_t * *configure*)

This function ungates the KPP clock and initializes KPP. This function must be called before calling any other KPP driver functions.

Parameters

<i>base</i>	KPP peripheral base address.
<i>configure</i>	The KPP configuration structure pointer.

28.6.2 void KPP_Deinit (KPP_Type * *base*)

This function gates the KPP clock. As a result, the KPP module doesn't work after calling this function.

Parameters

<i>base</i>	KPP peripheral base address.
-------------	------------------------------

28.6.3 static void KPP_EnableInterrupts (KPP_Type * *base*, uint16_t *mask*) [inline], [static]

Parameters

<i>base</i>	KPP peripheral base address.
<i>mask</i>	KPP interrupts to enable. This is a logical OR of the enumeration :: kpp_interrupt_enable_t.

28.6.4 static void KPP_DisableInterrupts (KPP_Type * *base*, uint16_t *mask*) [inline], [static]

Parameters

<i>base</i>	KPP peripheral base address.
<i>mask</i>	KPP interrupts to disable. This is a logical OR of the enumeration :: kpp_interrupt_enable_t.

28.6.5 static uint16_t KPP_GetStatusFlag (KPP_Type * *base*) [inline], [static]

Parameters

<i>base</i>	KPP peripheral base address.
-------------	------------------------------

Returns

The status of the KPP. Application can use the enum type in the "kpp_interrupt_enable_t" to get the right status of the related event.

28.6.6 static void KPP_ClearStatusFlag (KPP_Type * *base*, uint16_t *mask*) [inline], [static]

Parameters

<i>base</i>	KPP peripheral base address.
-------------	------------------------------

<i>mask</i>	KPP mask to be cleared. This is a logical OR of the enumeration :: <code>kpp_interrupt_enable_t</code> .
-------------	--

**28.6.7 static void KPP_SetSynchronizeChain (KPP_Type * *base*, uint16_t *mask*)
[inline], [static]**

Parameters

<i>base</i>	KPP peripheral base address.
<i>mask</i>	KPP mask to be cleared. This is a logical OR of the enumeration :: <code>kpp_sync_operation_t</code> .

28.6.8 void KPP_keyPressScanning (KPP_Type * *base*, uint8_t * *data*, uint32_t *clockSrc_Hz*)

This function will scanning all columns and rows. so all scanning data will be stored in the data pointer.

Parameters

<i>base</i>	KPP peripheral base address.
<i>data</i>	KPP key press scanning data. The data buffer should be prepared with length at least equal to <code>KPP_KEYPAD_COLUMNNUM_MAX * KPP_KEYPAD_ROWNUM_MAX</code> . the data pointer is recommended to be a array like <code>uint8_t data[KPP_KEYPAD_COLUMNNUM_MAX]</code> . for example the <code>data[2] = 4</code> , that means in column 1 row 2 has a key press event.
<i>clockSrc_Hz</i>	Source clock.

Chapter 29

LPI2C: Low Power Inter-Integrated Circuit Driver

29.1 Overview

Modules

- [LPI2C CMSIS Driver](#)
- [LPI2C FreeRTOS Driver](#)
- [LPI2C Master DMA Driver](#)
- [LPI2C Master Driver](#)
- [LPI2C Slave Driver](#)

Macros

- `#define I2C_RETRY_TIMES 0U /* Define to zero means keep waiting until the flag is assert/deassert. */`
Retry times for waiting flag.

Enumerations

- `enum {`
`kStatus_LPI2C_Busy = MAKE_STATUS(kStatusGroup_LPI2C, 0),`
`kStatus_LPI2C_Idle = MAKE_STATUS(kStatusGroup_LPI2C, 1),`
`kStatus_LPI2C_Nak = MAKE_STATUS(kStatusGroup_LPI2C, 2),`
`kStatus_LPI2C_FifoError = MAKE_STATUS(kStatusGroup_LPI2C, 3),`
`kStatus_LPI2C_BitError = MAKE_STATUS(kStatusGroup_LPI2C, 4),`
`kStatus_LPI2C_ArbitrationLost = MAKE_STATUS(kStatusGroup_LPI2C, 5),`
`kStatus_LPI2C_PinLowTimeout,`
`kStatus_LPI2C_NoTransferInProgress,`
`kStatus_LPI2C_DmaRequestFail = MAKE_STATUS(kStatusGroup_LPI2C, 8),`
`kStatus_LPI2C_Timeout = MAKE_STATUS(kStatusGroup_LPI2C, 9) }`
LPI2C status return codes.

Driver version

- `#define FSL_LPI2C_DRIVER_VERSION (MAKE_VERSION(2, 3, 1))`
LPI2C driver version.

29.2 Macro Definition Documentation

29.2.1 `#define FSL_LPI2C_DRIVER_VERSION (MAKE_VERSION(2, 3, 1))`

29.2.2 #define I2C_RETRY_TIMES 0U /* Define to zero means keep waiting until the flag is assert/deassert. */

29.3 Enumeration Type Documentation

29.3.1 anonymous enum

Enumerator

kStatus_LPI2C_Busy The master is already performing a transfer.

kStatus_LPI2C_Idle The slave driver is idle.

kStatus_LPI2C_Nak The slave device sent a NAK in response to a byte.

kStatus_LPI2C_FifoError FIFO under run or overrun.

kStatus_LPI2C_BitError Transferred bit was not seen on the bus.

kStatus_LPI2C_ArbitrationLost Arbitration lost error.

kStatus_LPI2C_PinLowTimeout SCL or SDA were held low longer than the timeout.

kStatus_LPI2C_NoTransferInProgress Attempt to abort a transfer when one is not in progress.

kStatus_LPI2C_DmaRequestFail DMA request failed.

kStatus_LPI2C_Timeout Timeout polling status flags.

29.4 LPI2C Master Driver

29.4.1 Overview

Data Structures

- struct `lpi2c_master_config_t`
Structure with settings to initialize the LPI2C master module. [More...](#)
- struct `lpi2c_data_match_config_t`
LPI2C master data match configuration structure. [More...](#)
- struct `lpi2c_master_transfer_t`
Non-blocking transfer descriptor structure. [More...](#)
- struct `lpi2c_master_handle_t`
Driver handle for master non-blocking APIs. [More...](#)

Typedefs

- typedef `void(* lpi2c_master_transfer_callback_t)(LPI2C_Type *base, lpi2c_master_handle_t *handle, status_t completionStatus, void *userData)`
Master completion callback function pointer type.
- typedef `void(* lpi2c_master_isr_t)(LPI2C_Type *base, void *handle)`
Typedef for master interrupt handler, used internally for LPI2C master interrupt and EDMA transactional APIs.

Enumerations

- enum `_lpi2c_master_flags` {
`kLPI2C_MasterTxReadyFlag = LPI2C_MSR_TDF_MASK,`
`kLPI2C_MasterRxReadyFlag = LPI2C_MSR_RDF_MASK,`
`kLPI2C_MasterEndOfPacketFlag = LPI2C_MSR_EPF_MASK,`
`kLPI2C_MasterStopDetectFlag = LPI2C_MSR_SDF_MASK,`
`kLPI2C_MasterNackDetectFlag = LPI2C_MSR_NDF_MASK,`
`kLPI2C_MasterArbitrationLostFlag = LPI2C_MSR_ALF_MASK,`
`kLPI2C_MasterFifoErrFlag = LPI2C_MSR_FEF_MASK,`
`kLPI2C_MasterPinLowTimeoutFlag = LPI2C_MSR_PLTF_MASK,`
`kLPI2C_MasterDataMatchFlag = LPI2C_MSR_DMF_MASK,`
`kLPI2C_MasterBusyFlag = LPI2C_MSR_MBF_MASK,`
`kLPI2C_MasterBusBusyFlag = LPI2C_MSR_BBF_MASK,`
`kLPI2C_MasterClearFlags,`
`kLPI2C_MasterIrqFlags,`
`kLPI2C_MasterErrorFlags }`
LPI2C master peripheral flags.
- enum `lpi2c_direction_t` {
`kLPI2C_Write = 0U,`
`kLPI2C_Read = 1U }`

- Direction of master and slave transfers.*

 - enum `lpi2c_master_pin_config_t` {
`kLPI2C_2PinOpenDrain = 0x0U`,
`kLPI2C_2PinOutputOnly = 0x1U`,
`kLPI2C_2PinPushPull = 0x2U`,
`kLPI2C_4PinPushPull = 0x3U`,
`kLPI2C_2PinOpenDrainWithSeparateSlave`,
`kLPI2C_2PinOutputOnlyWithSeparateSlave`,
`kLPI2C_2PinPushPullWithSeparateSlave`,
`kLPI2C_4PinPushPullWithInvertedOutput = 0x7U` }

LPI2C pin configuration.

 - enum `lpi2c_host_request_source_t` {
`kLPI2C_HostRequestExternalPin = 0x0U`,
`kLPI2C_HostRequestInputTrigger = 0x1U` }

LPI2C master host request selection.

 - enum `lpi2c_host_request_polarity_t` {
`kLPI2C_HostRequestPinActiveLow = 0x0U`,
`kLPI2C_HostRequestPinActiveHigh = 0x1U` }

LPI2C master host request pin polarity configuration.

 - enum `lpi2c_data_match_config_mode_t` {
`kLPI2C_MatchDisabled = 0x0U`,
`kLPI2C_1stWordEqualsM0OrM1 = 0x2U`,
`kLPI2C_AnyWordEqualsM0OrM1 = 0x3U`,
`kLPI2C_1stWordEqualsM0And2ndWordEqualsM1`,
`kLPI2C_AnyWordEqualsM0AndNextWordEqualsM1`,
`kLPI2C_1stWordAndM1EqualsM0AndM1`,
`kLPI2C_AnyWordAndM1EqualsM0AndM1` }

LPI2C master data match configuration modes.

 - enum `_lpi2c_master_transfer_flags` {
`kLPI2C_TransferDefaultFlag = 0x00U`,
`kLPI2C_TransferNoStartFlag = 0x01U`,
`kLPI2C_TransferRepeatedStartFlag = 0x02U`,
`kLPI2C_TransferNoStopFlag = 0x04U` }

Transfer option flags.

Initialization and deinitialization

- void `LPI2C_MasterGetDefaultConfig` (`lpi2c_master_config_t *masterConfig`)
Provides a default configuration for the LPI2C master peripheral.
- void `LPI2C_MasterInit` (`LPI2C_Type *base`, `const lpi2c_master_config_t *masterConfig`, `uint32_t sourceClock_Hz`)
Initializes the LPI2C master peripheral.
- void `LPI2C_MasterDeinit` (`LPI2C_Type *base`)
Deinitializes the LPI2C master peripheral.
- void `LPI2C_MasterConfigureDataMatch` (`LPI2C_Type *base`, `const lpi2c_data_match_config_t *matchConfig`)

Configures LPI2C master data match feature.

- `status_t LPI2C_MasterCheckAndClearError` (LPI2C_Type *base, uint32_t status)
- `status_t LPI2C_CheckForBusyBus` (LPI2C_Type *base)
- `static void LPI2C_MasterReset` (LPI2C_Type *base)

Performs a software reset.

- `static void LPI2C_MasterEnable` (LPI2C_Type *base, bool enable)
Enables or disables the LPI2C module as master.

Status

- `static uint32_t LPI2C_MasterGetStatusFlags` (LPI2C_Type *base)
Gets the LPI2C master status flags.
- `static void LPI2C_MasterClearStatusFlags` (LPI2C_Type *base, uint32_t statusMask)
Clears the LPI2C master status flag state.

Interrupts

- `static void LPI2C_MasterEnableInterrupts` (LPI2C_Type *base, uint32_t interruptMask)
Enables the LPI2C master interrupt requests.
- `static void LPI2C_MasterDisableInterrupts` (LPI2C_Type *base, uint32_t interruptMask)
Disables the LPI2C master interrupt requests.
- `static uint32_t LPI2C_MasterGetEnabledInterrupts` (LPI2C_Type *base)
Returns the set of currently enabled LPI2C master interrupt requests.

DMA control

- `static void LPI2C_MasterEnableDMA` (LPI2C_Type *base, bool enableTx, bool enableRx)
Enables or disables LPI2C master DMA requests.
- `static uint32_t LPI2C_MasterGetTxFifoAddress` (LPI2C_Type *base)
Gets LPI2C master transmit data register address for DMA transfer.
- `static uint32_t LPI2C_MasterGetRxFifoAddress` (LPI2C_Type *base)
Gets LPI2C master receive data register address for DMA transfer.

FIFO control

- `static void LPI2C_MasterSetWatermarks` (LPI2C_Type *base, size_t txWords, size_t rxWords)
Sets the watermarks for LPI2C master FIFOs.
- `static void LPI2C_MasterGetFifoCounts` (LPI2C_Type *base, size_t *rxCount, size_t *txCount)
Gets the current number of words in the LPI2C master FIFOs.

Bus operations

- `void LPI2C_MasterSetBaudRate` (LPI2C_Type *base, uint32_t sourceClock_Hz, uint32_t baudRate_Hz)

- *Sets the I2C bus frequency for master transactions.*
- static bool [LPI2C_MasterGetBusIdleState](#) (LPI2C_Type *base)
Returns whether the bus is idle.
- [status_t LPI2C_MasterStart](#) (LPI2C_Type *base, uint8_t address, [lpi2c_direction_t](#) dir)
Sends a START signal and slave address on the I2C bus.
- static [status_t LPI2C_MasterRepeatedStart](#) (LPI2C_Type *base, uint8_t address, [lpi2c_direction_t](#) dir)
Sends a repeated START signal and slave address on the I2C bus.
- [status_t LPI2C_MasterSend](#) (LPI2C_Type *base, void *txBuff, size_t txSize)
Performs a polling send transfer on the I2C bus.
- [status_t LPI2C_MasterReceive](#) (LPI2C_Type *base, void *rxBuff, size_t rxSize)
Performs a polling receive transfer on the I2C bus.
- [status_t LPI2C_MasterStop](#) (LPI2C_Type *base)
Sends a STOP signal on the I2C bus.
- [status_t LPI2C_MasterTransferBlocking](#) (LPI2C_Type *base, [lpi2c_master_transfer_t](#) *transfer)
Performs a master polling transfer on the I2C bus.

Non-blocking

- void [LPI2C_MasterTransferCreateHandle](#) (LPI2C_Type *base, [lpi2c_master_handle_t](#) *handle, [lpi2c_master_transfer_callback_t](#) callback, void *userData)
Creates a new handle for the LPI2C master non-blocking APIs.
- [status_t LPI2C_MasterTransferNonBlocking](#) (LPI2C_Type *base, [lpi2c_master_handle_t](#) *handle, [lpi2c_master_transfer_t](#) *transfer)
Performs a non-blocking transaction on the I2C bus.
- [status_t LPI2C_MasterTransferGetCount](#) (LPI2C_Type *base, [lpi2c_master_handle_t](#) *handle, size_t *count)
Returns number of bytes transferred so far.
- void [LPI2C_MasterTransferAbort](#) (LPI2C_Type *base, [lpi2c_master_handle_t](#) *handle)
Terminates a non-blocking LPI2C master transmission early.

IRQ handler

- void [LPI2C_MasterTransferHandleIRQ](#) (LPI2C_Type *base, void *lpi2cMasterHandle)
Reusable routine to handle master interrupts.

29.4.2 Data Structure Documentation

29.4.2.1 struct [lpi2c_master_config_t](#)

This structure holds configuration settings for the LPI2C peripheral. To initialize this structure to reasonable defaults, call the [LPI2C_MasterGetDefaultConfig\(\)](#) function and pass a pointer to your configuration structure instance.

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

Data Fields

- bool `enableMaster`
Whether to enable master mode.
- bool `enableDoze`
Whether master is enabled in doze mode.
- bool `debugEnable`
Enable transfers to continue when halted in debug mode.
- bool `ignoreAck`
Whether to ignore ACK/NACK.
- `lpi2c_master_pin_config_t` `pinConfig`
The pin configuration option.
- `uint32_t` `baudRate_Hz`
Desired baud rate in Hertz.
- `uint32_t` `busIdleTimeout_ns`
Bus idle timeout in nanoseconds.
- `uint32_t` `pinLowTimeout_ns`
Pin low timeout in nanoseconds.
- `uint8_t` `sdaGlitchFilterWidth_ns`
Width in nanoseconds of glitch filter on SDA pin.
- `uint8_t` `sclGlitchFilterWidth_ns`
Width in nanoseconds of glitch filter on SCL pin.
- struct {
 - bool `enable`
Enable host request.
 - `lpi2c_host_request_source_t` `source`
Host request source.
 - `lpi2c_host_request_polarity_t` `polarity`
Host request pin polarity.
- } `hostRequest`

Host request options.

Field Documentation

- (1) `bool lpi2c_master_config_t::enableMaster`
- (2) `bool lpi2c_master_config_t::enableDoze`
- (3) `bool lpi2c_master_config_t::debugEnable`
- (4) `bool lpi2c_master_config_t::ignoreAck`
- (5) `lpi2c_master_pin_config_t lpi2c_master_config_t::pinConfig`
- (6) `uint32_t lpi2c_master_config_t::baudRate_Hz`
- (7) `uint32_t lpi2c_master_config_t::busIdleTimeout_ns`

Set to 0 to disable.

(8) uint32_t lpi2c_master_config_t::pinLowTimeout_ns

Set to 0 to disable.

(9) uint8_t lpi2c_master_config_t::sdaGlitchFilterWidth_ns

Set to 0 to disable.

(10) uint8_t lpi2c_master_config_t::sclGlitchFilterWidth_ns

Set to 0 to disable.

(11) bool lpi2c_master_config_t::enable**(12) lpi2c_host_request_source_t lpi2c_master_config_t::source****(13) lpi2c_host_request_polarity_t lpi2c_master_config_t::polarity****(14) struct { ... } lpi2c_master_config_t::hostRequest****29.4.2.2 struct lpi2c_data_match_config_t****Data Fields**

- [lpi2c_data_match_config_mode_t matchMode](#)
Data match configuration setting.
- [bool rxDataMatchOnly](#)
When set to true, received data is ignored until a successful match.
- [uint32_t match0](#)
Match value 0.
- [uint32_t match1](#)
Match value 1.

Field Documentation**(1) lpi2c_data_match_config_mode_t lpi2c_data_match_config_t::matchMode****(2) bool lpi2c_data_match_config_t::rxDataMatchOnly****(3) uint32_t lpi2c_data_match_config_t::match0****(4) uint32_t lpi2c_data_match_config_t::match1****29.4.2.3 struct lpi2c_master_transfer**

This structure is used to pass transaction parameters to the [LPI2C_MasterTransferNonBlocking\(\)](#) API.

Data Fields

- [uint32_t flags](#)

- *Bit mask of options for the transfer.*
- `uint16_t slaveAddress`
The 7-bit slave address.
- `lpi2c_direction_t direction`
Either `kLPI2C_Read` or `kLPI2C_Write`.
- `uint32_t subaddress`
Sub address.
- `size_t subaddressSize`
Length of sub address to send in bytes.
- `void * data`
Pointer to data to transfer.
- `size_t dataSize`
Number of bytes to transfer.

Field Documentation

(1) `uint32_t lpi2c_master_transfer_t::flags`

See enumeration `_lpi2c_master_transfer_flags` for available options. Set to 0 or `kLPI2C_TransferDefaultFlag` for normal transfers.

(2) `uint16_t lpi2c_master_transfer_t::slaveAddress`

(3) `lpi2c_direction_t lpi2c_master_transfer_t::direction`

(4) `uint32_t lpi2c_master_transfer_t::subaddress`

Transferred MSB first.

(5) `size_t lpi2c_master_transfer_t::subaddressSize`

Maximum size is 4 bytes.

(6) `void* lpi2c_master_transfer_t::data`

(7) `size_t lpi2c_master_transfer_t::dataSize`

29.4.2.4 `struct _lpi2c_master_handle`

Note

The contents of this structure are private and subject to change.

Data Fields

- `uint8_t state`
Transfer state machine current state.
- `uint16_t remainingBytes`
Remaining byte count in current state.
- `uint8_t * buf`

- *Buffer pointer for current state.*
uint16_t `commandBuffer` [6]
LPI2C command sequence.
- `lpi2c_master_transfer_t` `transfer`
Copy of the current transfer info.
- `lpi2c_master_transfer_callback_t` `completionCallback`
Callback function pointer.
- void * `userData`
Application data passed to callback.

Field Documentation

- (1) `uint8_t lpi2c_master_handle_t::state`
- (2) `uint16_t lpi2c_master_handle_t::remainingBytes`
- (3) `uint8_t* lpi2c_master_handle_t::buf`
- (4) `uint16_t lpi2c_master_handle_t::commandBuffer[6]`

When all 6 command words are used: Start&addr&write[1 word] + subaddr[4 words] + restart&addr&read[1 word]

- (5) `lpi2c_master_transfer_t lpi2c_master_handle_t::transfer`
- (6) `lpi2c_master_transfer_callback_t lpi2c_master_handle_t::completionCallback`
- (7) `void* lpi2c_master_handle_t::userData`

29.4.3 Typedef Documentation

29.4.3.1 `typedef void(* lpi2c_master_transfer_callback_t)(LPI2C_Type *base, lpi2c_master_handle_t *handle, status_t completionStatus, void *userData)`

This callback is used only for the non-blocking master transfer API. Specify the callback you wish to use in the call to `LPI2C_MasterTransferCreateHandle()`.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>completion-Status</i>	Either <code>kStatus_Success</code> or an error code describing how the transfer completed.

<i>userData</i>	Arbitrary pointer-sized value passed from the application.
-----------------	--

29.4.4 Enumeration Type Documentation

29.4.4.1 enum `_lpi2c_master_flags`

The following status register flags can be cleared:

- `kLPI2C_MasterEndOfPacketFlag`
- `kLPI2C_MasterStopDetectFlag`
- `kLPI2C_MasterNackDetectFlag`
- `kLPI2C_MasterArbitrationLostFlag`
- `kLPI2C_MasterFifoErrFlag`
- `kLPI2C_MasterPinLowTimeoutFlag`
- `kLPI2C_MasterDataMatchFlag`

All flags except `kLPI2C_MasterBusyFlag` and `kLPI2C_MasterBusBusyFlag` can be enabled as interrupts.

Note

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

Enumerator

- `kLPI2C_MasterTxReadyFlag`*** Transmit data flag.
- `kLPI2C_MasterRxReadyFlag`*** Receive data flag.
- `kLPI2C_MasterEndOfPacketFlag`*** End Packet flag.
- `kLPI2C_MasterStopDetectFlag`*** Stop detect flag.
- `kLPI2C_MasterNackDetectFlag`*** NACK detect flag.
- `kLPI2C_MasterArbitrationLostFlag`*** Arbitration lost flag.
- `kLPI2C_MasterFifoErrFlag`*** FIFO error flag.
- `kLPI2C_MasterPinLowTimeoutFlag`*** Pin low timeout flag.
- `kLPI2C_MasterDataMatchFlag`*** Data match flag.
- `kLPI2C_MasterBusyFlag`*** Master busy flag.
- `kLPI2C_MasterBusBusyFlag`*** Bus busy flag.
- `kLPI2C_MasterClearFlags`*** All flags which are cleared by the driver upon starting a transfer.
- `kLPI2C_MasterIrqFlags`*** IRQ sources enabled by the non-blocking transactional API.
- `kLPI2C_MasterErrorFlags`*** Errors to check for.

29.4.4.2 enum `lpi2c_direction_t`

Enumerator

- `kLPI2C_Write`*** Master transmit.
- `kLPI2C_Read`*** Master receive.

29.4.4.3 enum lpi2c_master_pin_config_t

Enumerator

- kLPI2C_2PinOpenDrain* LPI2C Configured for 2-pin open drain mode.
- kLPI2C_2PinOutputOnly* LPI2C Configured for 2-pin output only mode (ultra-fast mode)
- kLPI2C_2PinPushPull* LPI2C Configured for 2-pin push-pull mode.
- kLPI2C_4PinPushPull* LPI2C Configured for 4-pin push-pull mode.
- kLPI2C_2PinOpenDrainWithSeparateSlave* LPI2C Configured for 2-pin open drain mode with separate LPI2C slave.
- kLPI2C_2PinOutputOnlyWithSeparateSlave* LPI2C Configured for 2-pin output only mode(ultra-fast mode) with separate LPI2C slave.
- kLPI2C_2PinPushPullWithSeparateSlave* LPI2C Configured for 2-pin push-pull mode with separate LPI2C slave.
- kLPI2C_4PinPushPullWithInvertedOutput* LPI2C Configured for 4-pin push-pull mode(inverted outputs)

29.4.4.4 enum lpi2c_host_request_source_t

Enumerator

- kLPI2C_HostRequestExternalPin* Select the LPI2C_HREQ pin as the host request input.
- kLPI2C_HostRequestInputTrigger* Select the input trigger as the host request input.

29.4.4.5 enum lpi2c_host_request_polarity_t

Enumerator

- kLPI2C_HostRequestPinActiveLow* Configure the LPI2C_HREQ pin active low.
- kLPI2C_HostRequestPinActiveHigh* Configure the LPI2C_HREQ pin active high.

29.4.4.6 enum lpi2c_data_match_config_mode_t

Enumerator

- kLPI2C_MatchDisabled* LPI2C Match Disabled.
- kLPI2C_1stWordEqualsM0OrM1* LPI2C Match Enabled and 1st data word equals MATCH0 OR MATCH1.
- kLPI2C_AnyWordEqualsM0OrM1* LPI2C Match Enabled and any data word equals MATCH0 OR MATCH1.
- kLPI2C_1stWordEqualsM0And2ndWordEqualsM1* LPI2C Match Enabled and 1st data word equals MATCH0, 2nd data equals MATCH1.
- kLPI2C_AnyWordEqualsM0AndNextWordEqualsM1* LPI2C Match Enabled and any data word equals MATCH0, next data equals MATCH1.

kLPI2C_1stWordAndM1EqualsM0AndM1 LPI2C Match Enabled and 1st data word and MATCH0 equals MATCH0 and MATCH1.

kLPI2C_AnyWordAndM1EqualsM0AndM1 LPI2C Match Enabled and any data word and MATCH0 equals MATCH0 and MATCH1.

29.4.4.7 enum _lpi2c_master_transfer_flags

Note

These enumerations are intended to be OR'd together to form a bit mask of options for the `_lpi2c_master_transfer::flags` field.

Enumerator

kLPI2C_TransferDefaultFlag Transfer starts with a start signal, stops with a stop signal.

kLPI2C_TransferNoStartFlag Don't send a start condition, address, and sub address.

kLPI2C_TransferRepeatedStartFlag Send a repeated start condition.

kLPI2C_TransferNoStopFlag Don't send a stop condition.

29.4.5 Function Documentation

29.4.5.1 void LPI2C_MasterGetDefaultConfig (lpi2c_master_config_t * masterConfig)

This function provides the following default configuration for the LPI2C master peripheral:

```
* masterConfig->enableMaster           = true;
* masterConfig->debugEnable             = false;
* masterConfig->ignoreAck               = false;
* masterConfig->pinConfig                = kLPI2C_2PinOpenDrain;
* masterConfig->baudRate_Hz             = 100000U;
* masterConfig->busIdleTimeout_ns       = 0;
* masterConfig->pinLowTimeout_ns        = 0;
* masterConfig->sdaGlitchFilterWidth_ns  = 0;
* masterConfig->sclGlitchFilterWidth_ns  = 0;
* masterConfig->hostRequest.enable      = false;
* masterConfig->hostRequest.source      = kLPI2C_HostRequestExternalPin;
* masterConfig->hostRequest.polarity    = kLPI2C_HostRequestPinActiveHigh;
*
```

After calling this function, you can override any settings in order to customize the configuration, prior to initializing the master driver with `LPI2C_MasterInit()`.

Parameters

out	<i>masterConfig</i>	User provided configuration structure for default values. Refer to lpi2c_master_config_t .
-----	---------------------	--

29.4.5.2 void LPI2C_MasterInit (LPI2C_Type * *base*, const lpi2c_master_config_t * *masterConfig*, uint32_t *sourceClock_Hz*)

This function enables the peripheral clock and initializes the LPI2C master peripheral as described by the user provided configuration. A software reset is performed prior to configuration.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>masterConfig</i>	User provided peripheral configuration. Use LPI2C_MasterGetDefaultConfig() to get a set of defaults that you can override.
<i>sourceClock_Hz</i>	Frequency in Hertz of the LPI2C functional clock. Used to calculate the baud rate divisors, filter widths, and timeout periods.

29.4.5.3 void LPI2C_MasterDeinit (LPI2C_Type * *base*)

This function disables the LPI2C master peripheral and gates the clock. It also performs a software reset to restore the peripheral to reset conditions.

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

29.4.5.4 void LPI2C_MasterConfigureDataMatch (LPI2C_Type * *base*, const lpi2c_data_match_config_t * *matchConfig*)

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>matchConfig</i>	Settings for the data match feature.

29.4.5.5 static void LPI2C_MasterReset (LPI2C_Type * *base*) [inline], [static]

Restores the LPI2C master peripheral to reset conditions.

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

29.4.5.6 `static void LPI2C_MasterEnable (LPI2C_Type * base, bool enable) [inline], [static]`

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>enable</i>	Pass true to enable or false to disable the specified LPI2C as master.

29.4.5.7 `static uint32_t LPI2C_MasterGetStatusFlags (LPI2C_Type * base) [inline], [static]`

A bit mask with the state of all LPI2C master status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

Returns

State of the status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

See Also

[_lpi2c_master_flags](#)

29.4.5.8 `static void LPI2C_MasterClearStatusFlags (LPI2C_Type * base, uint32_t statusMask) [inline], [static]`

The following status register flags can be cleared:

- [kLPI2C_MasterEndOfPacketFlag](#)
- [kLPI2C_MasterStopDetectFlag](#)
- [kLPI2C_MasterNackDetectFlag](#)
- [kLPI2C_MasterArbitrationLostFlag](#)

- [kLPI2C_MasterFifoErrFlag](#)
- [kLPI2C_MasterPinLowTimeoutFlag](#)
- [kLPI2C_MasterDataMatchFlag](#)

Attempts to clear other flags has no effect.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>statusMask</i>	A bitmask of status flags that are to be cleared. The mask is composed of <code>_lpi2c_master_flags</code> enumerators OR'd together. You may pass the result of a previous call to LPI2C_MasterGetStatusFlags() .

See Also

[_lpi2c_master_flags](#).

29.4.5.9 `static void LPI2C_MasterEnableInterrupts (LPI2C_Type * base, uint32_t interruptMask) [inline], [static]`

All flags except [kLPI2C_MasterBusyFlag](#) and [kLPI2C_MasterBusBusyFlag](#) can be enabled as interrupts.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>interruptMask</i>	Bit mask of interrupts to enable. See _lpi2c_master_flags for the set of constants that should be OR'd together to form the bit mask.

29.4.5.10 `static void LPI2C_MasterDisableInterrupts (LPI2C_Type * base, uint32_t interruptMask) [inline], [static]`

All flags except [kLPI2C_MasterBusyFlag](#) and [kLPI2C_MasterBusBusyFlag](#) can be enabled as interrupts.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>interruptMask</i>	Bit mask of interrupts to disable. See _lpi2c_master_flags for the set of constants that should be OR'd together to form the bit mask.

29.4.5.11 `static uint32_t LPI2C_MasterGetEnabledInterrupts (LPI2C_Type * base) [inline], [static]`

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

Returns

A bitmask composed of `_lpi2c_master_flags` enumerators OR'd together to indicate the set of enabled interrupts.

29.4.5.12 `static void LPI2C_MasterEnableDMA (LPI2C_Type * base, bool enableTx, bool enableRx) [inline], [static]`

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>enableTx</i>	Enable flag for transmit DMA request. Pass true for enable, false for disable.
<i>enableRx</i>	Enable flag for receive DMA request. Pass true for enable, false for disable.

29.4.5.13 `static uint32_t LPI2C_MasterGetTxFifoAddress (LPI2C_Type * base) [inline], [static]`

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

Returns

The LPI2C Master Transmit Data Register address.

29.4.5.14 `static uint32_t LPI2C_MasterGetRxFifoAddress (LPI2C_Type * base) [inline], [static]`

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

Returns

The LPI2C Master Receive Data Register address.

29.4.5.15 `static void LPI2C_MasterSetWatermarks (LPI2C_Type * base, size_t txWords, size_t rxWords) [inline], [static]`

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>txWords</i>	Transmit FIFO watermark value in words. The <code>kLPI2C_MasterTxReadyFlag</code> flag is set whenever the number of words in the transmit FIFO is equal or less than <i>txWords</i> . Writing a value equal or greater than the FIFO size is truncated.
<i>rxWords</i>	Receive FIFO watermark value in words. The <code>kLPI2C_MasterRxReadyFlag</code> flag is set whenever the number of words in the receive FIFO is greater than <i>rxWords</i> . Writing a value equal or greater than the FIFO size is truncated.

29.4.5.16 `static void LPI2C_MasterGetFifoCounts (LPI2C_Type * base, size_t * rxCount, size_t * txCount) [inline], [static]`

Parameters

	<i>base</i>	The LPI2C peripheral base address.
out	<i>txCount</i>	Pointer through which the current number of words in the transmit FIFO is returned. Pass NULL if this value is not required.
out	<i>rxCount</i>	Pointer through which the current number of words in the receive FIFO is returned. Pass NULL if this value is not required.

29.4.5.17 `void LPI2C_MasterSetBaudRate (LPI2C_Type * base, uint32_t sourceClock_Hz, uint32_t baudRate_Hz)`

The LPI2C master is automatically disabled and re-enabled as necessary to configure the baud rate. Do not call this function during a transfer, or the transfer is aborted.

Note

Please note that the second parameter is the clock frequency of LPI2C module, the third parameter means user configured bus baudrate, this implementation is different from other I2C drivers which use baudrate configuration as second parameter and source clock frequency as third parameter.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>sourceClock_Hz</i>	LPI2C functional clock frequency in Hertz.
<i>baudRate_Hz</i>	Requested bus frequency in Hertz.

29.4.5.18 static bool LPI2C_MasterGetBusIdleState (LPI2C_Type * *base*) [inline], [static]

Requires the master mode to be enabled.

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

Return values

<i>true</i>	Bus is busy.
<i>false</i>	Bus is idle.

29.4.5.19 status_t LPI2C_MasterStart (LPI2C_Type * *base*, uint8_t *address*, lpi2c_direction_t *dir*)

This function is used to initiate a new master mode transfer. First, the bus state is checked to ensure that another master is not occupying the bus. Then a START signal is transmitted, followed by the 7-bit address specified in the *address* parameter. Note that this function does not actually wait until the START and address are successfully sent on the bus before returning.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>address</i>	7-bit slave device address, in bits [6:0].
<i>dir</i>	Master transfer direction, either kLPI2C_Read or kLPI2C_Write . This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.

Return values

<i>kStatus_Success</i>	START signal and address were successfully enqueued in the transmit FIFO.
<i>kStatus_LPI2C_Busy</i>	Another master is currently utilizing the bus.

29.4.5.20 static status_t LPI2C_MasterRepeatedStart (LPI2C_Type * base, uint8_t address, lpi2c_direction_t dir) [inline], [static]

This function is used to send a Repeated START signal when a transfer is already in progress. Like [LPI2C_MasterStart\(\)](#), it also sends the specified 7-bit address.

Note

This function exists primarily to maintain compatible APIs between LPI2C and I2C drivers, as well as to better document the intent of code that uses these APIs.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>address</i>	7-bit slave device address, in bits [6:0].
<i>dir</i>	Master transfer direction, either kLPI2C_Read or kLPI2C_Write . This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.

Return values

<i>kStatus_Success</i>	Repeated START signal and address were successfully enqueued in the transmit FIFO.
<i>kStatus_LPI2C_Busy</i>	Another master is currently utilizing the bus.

29.4.5.21 status_t LPI2C_MasterSend (LPI2C_Type * base, void * txBuff, size_t txSize)

Sends up to *txSize* number of bytes to the previously addressed slave device. The slave may reply with a NAK to any byte in order to terminate the transfer early. If this happens, this function returns [kStatus_LPI2C_Nak](#).

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>txBuff</i>	The pointer to the data to be transferred.
<i>txSize</i>	The length in bytes of the data to be transferred.

Return values

<i>kStatus_Success</i>	Data was sent successfully.
<i>kStatus_LPI2C_Busy</i>	Another master is currently utilizing the bus.
<i>kStatus_LPI2C_Nak</i>	The slave device sent a NAK in response to a byte.
<i>kStatus_LPI2C_FifoError</i>	FIFO under run or over run.
<i>kStatus_LPI2C_ArbitrationLost</i>	Arbitration lost error.
<i>kStatus_LPI2C_PinLowTimeout</i>	SCL or SDA were held low longer than the timeout.

29.4.5.22 `status_t LPI2C_MasterReceive (LPI2C_Type * base, void * rxBuff, size_t rxSize)`

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>rxBuff</i>	The pointer to the data to be transferred.
<i>rxSize</i>	The length in bytes of the data to be transferred.

Return values

<i>kStatus_Success</i>	Data was received successfully.
<i>kStatus_LPI2C_Busy</i>	Another master is currently utilizing the bus.
<i>kStatus_LPI2C_Nak</i>	The slave device sent a NAK in response to a byte.
<i>kStatus_LPI2C_FifoError</i>	FIFO under run or overrun.
<i>kStatus_LPI2C_ArbitrationLost</i>	Arbitration lost error.
<i>kStatus_LPI2C_PinLowTimeout</i>	SCL or SDA were held low longer than the timeout.

29.4.5.23 `status_t LPI2C_MasterStop (LPI2C_Type * base)`

This function does not return until the STOP signal is seen on the bus, or an error occurs.

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

Return values

<i>kStatus_Success</i>	The STOP signal was successfully sent on the bus and the transaction terminated.
<i>kStatus_LPI2C_Busy</i>	Another master is currently utilizing the bus.
<i>kStatus_LPI2C_Nak</i>	The slave device sent a NAK in response to a byte.
<i>kStatus_LPI2C_FifoError</i>	FIFO under run or overrun.
<i>kStatus_LPI2C_ArbitrationLost</i>	Arbitration lost error.
<i>kStatus_LPI2C_PinLowTimeout</i>	SCL or SDA were held low longer than the timeout.

29.4.5.24 `status_t LPI2C_MasterTransferBlocking (LPI2C_Type * base, lpi2c_master_transfer_t * transfer)`

Note

The API does not return until the transfer succeeds or fails due to error happens during transfer.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>transfer</i>	Pointer to the transfer structure.

Return values

<i>kStatus_Success</i>	Data was received successfully.
<i>kStatus_LPI2C_Busy</i>	Another master is currently utilizing the bus.
<i>kStatus_LPI2C_Nak</i>	The slave device sent a NAK in response to a byte.
<i>kStatus_LPI2C_FifoError</i>	FIFO under run or overrun.
<i>kStatus_LPI2C_ArbitrationLost</i>	Arbitration lost error.
<i>kStatus_LPI2C_PinLowTimeout</i>	SCL or SDA were held low longer than the timeout.

29.4.5.25 void LPI2C_MasterTransferCreateHandle (LPI2C_Type * *base*,
lpi2c_master_handle_t * *handle*, lpi2c_master_transfer_callback_t *callback*,
void * *userData*)

The creation of a handle is for use with the non-blocking APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the [LPI2C_MasterTransferAbort\(\)](#) API shall be called.

Note

The function also enables the NVIC IRQ for the input LPI2C. Need to notice that on some SoCs the LPI2C IRQ is connected to INTMUX, in this case user needs to enable the associated INTMUX IRQ in application.

Parameters

	<i>base</i>	The LPI2C peripheral base address.
out	<i>handle</i>	Pointer to the LPI2C master driver handle.
	<i>callback</i>	User provided pointer to the asynchronous callback function.
	<i>userData</i>	User provided pointer to the application callback data.

29.4.5.26 status_t LPI2C_MasterTransferNonBlocking (LPI2C_Type * *base*,
lpi2c_master_handle_t * *handle*, lpi2c_master_transfer_t * *transfer*)

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>handle</i>	Pointer to the LPI2C master driver handle.
<i>transfer</i>	The pointer to the transfer descriptor.

Return values

<i>kStatus_Success</i>	The transaction was started successfully.
<i>kStatus_LPI2C_Busy</i>	Either another master is currently utilizing the bus, or a non-blocking transaction is already in progress.

29.4.5.27 status_t LPI2C_MasterTransferGetCount (LPI2C_Type * *base*,
lpi2c_master_handle_t * *handle*, size_t * *count*)

Parameters

	<i>base</i>	The LPI2C peripheral base address.
	<i>handle</i>	Pointer to the LPI2C master driver handle.
out	<i>count</i>	Number of bytes transferred so far by the non-blocking transaction.

Return values

<i>kStatus_Success</i>	
<i>kStatus_NoTransferInProgress</i>	There is not a non-blocking transaction currently in progress.

29.4.5.28 void LPI2C_MasterTransferAbort (LPI2C_Type * *base*, lpi2c_master_handle_t * *handle*)

Note

It is not safe to call this function from an IRQ handler that has a higher priority than the LPI2C peripheral's IRQ priority.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>handle</i>	Pointer to the LPI2C master driver handle.

Return values

<i>kStatus_Success</i>	A transaction was successfully aborted.
<i>kStatus_LPI2C_Idle</i>	There is not a non-blocking transaction currently in progress.

29.4.5.29 void LPI2C_MasterTransferHandleIRQ (LPI2C_Type * *base*, void * *lpi2cMasterHandle*)

Note

This function does not need to be called unless you are reimplementing the nonblocking API's interrupt handler routines to add special functionality.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>lpi2cMaster-Handle</i>	Pointer to the LPI2C master driver handle.

29.5 LPI2C Slave Driver

29.5.1 Overview

Data Structures

- struct `lpi2c_slave_config_t`
Structure with settings to initialize the LPI2C slave module. [More...](#)
- struct `lpi2c_slave_transfer_t`
LPI2C slave transfer structure. [More...](#)
- struct `lpi2c_slave_handle_t`
LPI2C slave handle structure. [More...](#)

Typedefs

- typedef `void(* lpi2c_slave_transfer_callback_t)(LPI2C_Type *base, lpi2c_slave_transfer_t *transfer, void *userData)`
Slave event callback function pointer type.

Enumerations

- enum `_lpi2c_slave_flags` {
`kLPI2C_SlaveTxReadyFlag = LPI2C_SSR_TDF_MASK,`
`kLPI2C_SlaveRxReadyFlag = LPI2C_SSR_RDF_MASK,`
`kLPI2C_SlaveAddressValidFlag = LPI2C_SSR_AVF_MASK,`
`kLPI2C_SlaveTransmitAckFlag = LPI2C_SSR_TAF_MASK,`
`kLPI2C_SlaveRepeatedStartDetectFlag = LPI2C_SSR_RSF_MASK,`
`kLPI2C_SlaveStopDetectFlag = LPI2C_SSR_SDF_MASK,`
`kLPI2C_SlaveBitErrFlag = LPI2C_SSR_BEF_MASK,`
`kLPI2C_SlaveFifoErrFlag = LPI2C_SSR_FEF_MASK,`
`kLPI2C_SlaveAddressMatch0Flag = LPI2C_SSR_AM0F_MASK,`
`kLPI2C_SlaveAddressMatch1Flag = LPI2C_SSR_AM1F_MASK,`
`kLPI2C_SlaveGeneralCallFlag = LPI2C_SSR_GCF_MASK,`
`kLPI2C_SlaveBusyFlag = LPI2C_SSR_SBF_MASK,`
`kLPI2C_SlaveBusBusyFlag = LPI2C_SSR_BBF_MASK,`
`kLPI2C_SlaveClearFlags,`
`kLPI2C_SlaveIrqFlags,`
`kLPI2C_SlaveErrorFlags = kLPI2C_SlaveFifoErrFlag | kLPI2C_SlaveBitErrFlag }`
LPI2C slave peripheral flags.
- enum `lpi2c_slave_address_match_t` {
`kLPI2C_MatchAddress0 = 0U,`
`kLPI2C_MatchAddress0OrAddress1 = 2U,`
`kLPI2C_MatchAddress0ThroughAddress1 = 6U }`
LPI2C slave address match options.

- enum `lpi2c_slave_transfer_event_t` {
`kLPI2C_SlaveAddressMatchEvent` = 0x01U,
`kLPI2C_SlaveTransmitEvent` = 0x02U,
`kLPI2C_SlaveReceiveEvent` = 0x04U,
`kLPI2C_SlaveTransmitAckEvent` = 0x08U,
`kLPI2C_SlaveRepeatedStartEvent` = 0x10U,
`kLPI2C_SlaveCompletionEvent` = 0x20U,
`kLPI2C_SlaveAllEvents` }
- Set of events sent to the callback for non blocking slave transfers.*

Slave initialization and deinitialization

- void `LPI2C_SlaveGetDefaultConfig` (`lpi2c_slave_config_t` *slaveConfig)
Provides a default configuration for the LPI2C slave peripheral.
- void `LPI2C_SlaveInit` (`LPI2C_Type` *base, const `lpi2c_slave_config_t` *slaveConfig, `uint32_t` sourceClock_Hz)
Initializes the LPI2C slave peripheral.
- void `LPI2C_SlaveDeinit` (`LPI2C_Type` *base)
Deinitializes the LPI2C slave peripheral.
- static void `LPI2C_SlaveReset` (`LPI2C_Type` *base)
Performs a software reset of the LPI2C slave peripheral.
- static void `LPI2C_SlaveEnable` (`LPI2C_Type` *base, bool enable)
Enables or disables the LPI2C module as slave.

Slave status

- static `uint32_t` `LPI2C_SlaveGetStatusFlags` (`LPI2C_Type` *base)
Gets the LPI2C slave status flags.
- static void `LPI2C_SlaveClearStatusFlags` (`LPI2C_Type` *base, `uint32_t` statusMask)
Clears the LPI2C status flag state.

Slave interrupts

- static void `LPI2C_SlaveEnableInterrupts` (`LPI2C_Type` *base, `uint32_t` interruptMask)
Enables the LPI2C slave interrupt requests.
- static void `LPI2C_SlaveDisableInterrupts` (`LPI2C_Type` *base, `uint32_t` interruptMask)
Disables the LPI2C slave interrupt requests.
- static `uint32_t` `LPI2C_SlaveGetEnabledInterrupts` (`LPI2C_Type` *base)
Returns the set of currently enabled LPI2C slave interrupt requests.

Slave DMA control

- static void `LPI2C_SlaveEnableDMA` (`LPI2C_Type` *base, bool enableAddressValid, bool enableRx, bool enableTx)

Enables or disables the LPI2C slave peripheral DMA requests.

Slave bus operations

- static bool [LPI2C_SlaveGetBusIdleState](#) (LPI2C_Type *base)
Returns whether the bus is idle.
- static void [LPI2C_SlaveTransmitAck](#) (LPI2C_Type *base, bool ackOrNack)
Transmits either an ACK or NAK on the I2C bus in response to a byte from the master.
- static uint32_t [LPI2C_SlaveGetReceivedAddress](#) (LPI2C_Type *base)
Returns the slave address sent by the I2C master.
- [status_t LPI2C_SlaveSend](#) (LPI2C_Type *base, void *txBuff, size_t txSize, size_t *actualTxSize)
Performs a polling send transfer on the I2C bus.
- [status_t LPI2C_SlaveReceive](#) (LPI2C_Type *base, void *rxBuff, size_t rxSize, size_t *actualRxSize)
Performs a polling receive transfer on the I2C bus.

Slave non-blocking

- void [LPI2C_SlaveTransferCreateHandle](#) (LPI2C_Type *base, lpi2c_slave_handle_t *handle, [lpi2c_slave_transfer_callback_t](#) callback, void *userData)
Creates a new handle for the LPI2C slave non-blocking APIs.
- [status_t LPI2C_SlaveTransferNonBlocking](#) (LPI2C_Type *base, lpi2c_slave_handle_t *handle, uint32_t eventMask)
Starts accepting slave transfers.
- [status_t LPI2C_SlaveTransferGetCount](#) (LPI2C_Type *base, lpi2c_slave_handle_t *handle, size_t *count)
Gets the slave transfer status during a non-blocking transfer.
- void [LPI2C_SlaveTransferAbort](#) (LPI2C_Type *base, lpi2c_slave_handle_t *handle)
Aborts the slave non-blocking transfers.

Slave IRQ handler

- void [LPI2C_SlaveTransferHandleIRQ](#) (LPI2C_Type *base, lpi2c_slave_handle_t *handle)
Reusable routine to handle slave interrupts.

29.5.2 Data Structure Documentation

29.5.2.1 struct lpi2c_slave_config_t

This structure holds configuration settings for the LPI2C slave peripheral. To initialize this structure to reasonable defaults, call the [LPI2C_SlaveGetDefaultConfig\(\)](#) function and pass a pointer to your configuration structure instance.

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

Data Fields

- bool `enableSlave`
Enable slave mode.
- uint8_t `address0`
Slave's 7-bit address.
- uint8_t `address1`
Alternate slave 7-bit address.
- `lpi2c_slave_address_match_t` `addressMatchMode`
Address matching options.
- bool `filterDozeEnable`
Enable digital glitch filter in doze mode.
- bool `filterEnable`
Enable digital glitch filter.
- bool `enableGeneralCall`
Enable general call address matching.
- bool `ignoreAck`
Continue transfers after a NACK is detected.
- bool `enableReceivedAddressRead`
Enable reading the address received address as the first byte of data.
- uint32_t `sdaGlitchFilterWidth_ns`
Width in nanoseconds of the digital filter on the SDA signal.
- uint32_t `sclGlitchFilterWidth_ns`
Width in nanoseconds of the digital filter on the SCL signal.
- uint32_t `dataValidDelay_ns`
Width in nanoseconds of the data valid delay.
- uint32_t `clockHoldTime_ns`
Width in nanoseconds of the clock hold time.
- bool `enableAck`
Enables SCL clock stretching during slave-transmit address byte(s) and slave-receiver address and data byte(s) to allow software to write the Transmit ACK Register before the ACK or NACK is transmitted.
- bool `enableTx`
Enables SCL clock stretching when the transmit data flag is set during a slave-transmit transfer.
- bool `enableRx`
Enables SCL clock stretching when receive data flag is set during a slave-receive transfer.
- bool `enableAddress`
Enables SCL clock stretching when the address valid flag is asserted.

Field Documentation

- (1) `bool lpi2c_slave_config_t::enableSlave`
- (2) `uint8_t lpi2c_slave_config_t::address0`
- (3) `uint8_t lpi2c_slave_config_t::address1`
- (4) `lpi2c_slave_address_match_t lpi2c_slave_config_t::addressMatchMode`
- (5) `bool lpi2c_slave_config_t::filterDozeEnable`
- (6) `bool lpi2c_slave_config_t::filterEnable`

(7) `bool lpi2c_slave_config_t::enableGeneralCall`

(8) `bool lpi2c_slave_config_t::enableAck`

Clock stretching occurs when transmitting the 9th bit. When `enableAckSCLStall` is enabled, there is no need to set either `enableRxDataSCLStall` or `enableAddressSCLStall`.

(9) `bool lpi2c_slave_config_t::enableTx`

(10) `bool lpi2c_slave_config_t::enableRx`

(11) `bool lpi2c_slave_config_t::enableAddress`

(12) `bool lpi2c_slave_config_t::ignoreAck`

(13) `bool lpi2c_slave_config_t::enableReceivedAddressRead`

(14) `uint32_t lpi2c_slave_config_t::sdaGlitchFilterWidth_ns`

Set to 0 to disable.

(15) `uint32_t lpi2c_slave_config_t::sclGlitchFilterWidth_ns`

Set to 0 to disable.

(16) `uint32_t lpi2c_slave_config_t::dataValidDelay_ns`

(17) `uint32_t lpi2c_slave_config_t::clockHoldTime_ns`

29.5.2.2 struct `lpi2c_slave_transfer_t`

Data Fields

- `lpi2c_slave_transfer_event_t event`
Reason the callback is being invoked.
- `uint8_t receivedAddress`
Matching address send by master.
- `uint8_t * data`
Transfer buffer.
- `size_t dataSize`
Transfer size.
- `status_t completionStatus`
Success or error code describing how the transfer completed.
- `size_t transferredCount`
Number of bytes actually transferred since start or last repeated start.

Field Documentation

(1) `lpi2c_slave_transfer_event_t lpi2c_slave_transfer_t::event`

- (2) `uint8_t lpi2c_slave_transfer_t::receivedAddress`
- (3) `status_t lpi2c_slave_transfer_t::completionStatus`

Only applies for `kLPI2C_SlaveCompletionEvent`.

- (4) `size_t lpi2c_slave_transfer_t::transferredCount`

29.5.2.3 struct `_lpi2c_slave_handle`

Note

The contents of this structure are private and subject to change.

Data Fields

- `lpi2c_slave_transfer_t transfer`
LPI2C slave transfer copy.
- `bool isBusy`
Whether transfer is busy.
- `bool wasTransmit`
Whether the last transfer was a transmit.
- `uint32_t eventMask`
Mask of enabled events.
- `uint32_t transferredCount`
Count of bytes transferred.
- `lpi2c_slave_transfer_callback_t callback`
Callback function called at transfer event.
- `void * userData`
Callback parameter passed to callback.

Field Documentation

- (1) `lpi2c_slave_transfer_t lpi2c_slave_handle_t::transfer`
- (2) `bool lpi2c_slave_handle_t::isBusy`
- (3) `bool lpi2c_slave_handle_t::wasTransmit`
- (4) `uint32_t lpi2c_slave_handle_t::eventMask`
- (5) `uint32_t lpi2c_slave_handle_t::transferredCount`
- (6) `lpi2c_slave_transfer_callback_t lpi2c_slave_handle_t::callback`
- (7) `void* lpi2c_slave_handle_t::userData`

29.5.3 Typedef Documentation

29.5.3.1 `typedef void(* lpi2c_slave_transfer_callback_t)(LPI2C_Type *base,
lpi2c_slave_transfer_t *transfer, void *userData)`

This callback is used only for the slave non-blocking transfer API. To install a callback, use the LPI2C_SlaveSetCallback() function after you have created a handle.

Parameters

<i>base</i>	Base address for the LPI2C instance on which the event occurred.
<i>transfer</i>	Pointer to transfer descriptor containing values passed to and/or from the callback.
<i>userData</i>	Arbitrary pointer-sized value passed from the application.

29.5.4 Enumeration Type Documentation

29.5.4.1 enum _lpi2c_slave_flags

The following status register flags can be cleared:

- [kLPI2C_SlaveRepeatedStartDetectFlag](#)
- [kLPI2C_SlaveStopDetectFlag](#)
- [kLPI2C_SlaveBitErrFlag](#)
- [kLPI2C_SlaveFifoErrFlag](#)

All flags except [kLPI2C_SlaveBusyFlag](#) and [kLPI2C_SlaveBusBusyFlag](#) can be enabled as interrupts.

Note

These enumerations are meant to be OR'd together to form a bit mask.

Enumerator

- kLPI2C_SlaveTxReadyFlag* Transmit data flag.
- kLPI2C_SlaveRxReadyFlag* Receive data flag.
- kLPI2C_SlaveAddressValidFlag* Address valid flag.
- kLPI2C_SlaveTransmitAckFlag* Transmit ACK flag.
- kLPI2C_SlaveRepeatedStartDetectFlag* Repeated start detect flag.
- kLPI2C_SlaveStopDetectFlag* Stop detect flag.
- kLPI2C_SlaveBitErrFlag* Bit error flag.
- kLPI2C_SlaveFifoErrFlag* FIFO error flag.
- kLPI2C_SlaveAddressMatch0Flag* Address match 0 flag.
- kLPI2C_SlaveAddressMatch1Flag* Address match 1 flag.
- kLPI2C_SlaveGeneralCallFlag* General call flag.
- kLPI2C_SlaveBusyFlag* Master busy flag.
- kLPI2C_SlaveBusBusyFlag* Bus busy flag.
- kLPI2C_SlaveClearFlags* All flags which are cleared by the driver upon starting a transfer.
- kLPI2C_SlaveIrqFlags* IRQ sources enabled by the non-blocking transactional API.
- kLPI2C_SlaveErrorFlags* Errors to check for.

29.5.4.2 enum lpi2c_slave_address_match_t

Enumerator

kLPI2C_MatchAddress0 Match only address 0.

kLPI2C_MatchAddress0OrAddress1 Match either address 0 or address 1.

kLPI2C_MatchAddress0ThroughAddress1 Match a range of slave addresses from address 0 through address 1.

29.5.4.3 enum lpi2c_slave_transfer_event_t

These event enumerations are used for two related purposes. First, a bit mask created by OR'ing together events is passed to [LPI2C_SlaveTransferNonBlocking\(\)](#) in order to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

Note

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

Enumerator

kLPI2C_SlaveAddressMatchEvent Received the slave address after a start or repeated start.

kLPI2C_SlaveTransmitEvent Callback is requested to provide data to transmit (slave-transmitter role).

kLPI2C_SlaveReceiveEvent Callback is requested to provide a buffer in which to place received data (slave-receiver role).

kLPI2C_SlaveTransmitAckEvent Callback needs to either transmit an ACK or NACK.

kLPI2C_SlaveRepeatedStartEvent A repeated start was detected.

kLPI2C_SlaveCompletionEvent A stop was detected, completing the transfer.

kLPI2C_SlaveAllEvents Bit mask of all available events.

29.5.5 Function Documentation

29.5.5.1 void LPI2C_SlaveGetDefaultConfig (lpi2c_slave_config_t * slaveConfig)

This function provides the following default configuration for the LPI2C slave peripheral:

```
* slaveConfig->enableSlave           = true;
* slaveConfig->address0              = 0U;
* slaveConfig->address1              = 0U;
* slaveConfig->addressMatchMode      = kLPI2C_MatchAddress0;
* slaveConfig->filterDozeEnable      = true;
* slaveConfig->filterEnable          = true;
* slaveConfig->enableGeneralCall     = false;
* slaveConfig->sclStall.enableAck    = false;
* slaveConfig->sclStall.enableTx     = true;
* slaveConfig->sclStall.enableRx     = true;
* slaveConfig->sclStall.enableAddress = true;
```

```

* slaveConfig->ignoreAck           = false;
* slaveConfig->enableReceivedAddressRead = false;
* slaveConfig->sdaGlitchFilterWidth_ns = 0;
* slaveConfig->sclGlitchFilterWidth_ns = 0;
* slaveConfig->dataValidDelay_ns    = 0;
* slaveConfig->clockHoldTime_ns     = 0;
*

```

After calling this function, override any settings to customize the configuration, prior to initializing the master driver with [LPI2C_SlaveInit\(\)](#). Be sure to override at least the *address0* member of the configuration structure with the desired slave address.

Parameters

out	<i>slaveConfig</i>	User provided configuration structure that is set to default values. Refer to lpi2c_slave_config_t .
-----	--------------------	--

29.5.5.2 void LPI2C_SlaveInit (LPI2C_Type * *base*, const lpi2c_slave_config_t * *slaveConfig*, uint32_t *sourceClock_Hz*)

This function enables the peripheral clock and initializes the LPI2C slave peripheral as described by the user provided configuration.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>slaveConfig</i>	User provided peripheral configuration. Use LPI2C_SlaveGetDefaultConfig() to get a set of defaults that you can override.
<i>sourceClock_ - Hz</i>	Frequency in Hertz of the LPI2C functional clock. Used to calculate the filter widths, data valid delay, and clock hold time.

29.5.5.3 void LPI2C_SlaveDeinit (LPI2C_Type * *base*)

This function disables the LPI2C slave peripheral and gates the clock. It also performs a software reset to restore the peripheral to reset conditions.

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

29.5.5.4 static void LPI2C_SlaveReset (LPI2C_Type * *base*) [inline], [static]

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

29.5.5.5 static void LPI2C_SlaveEnable (LPI2C_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>enable</i>	Pass true to enable or false to disable the specified LPI2C as slave.

29.5.5.6 static uint32_t LPI2C_SlaveGetStatusFlags (LPI2C_Type * *base*) [inline], [static]

A bit mask with the state of all LPI2C slave status flags is returned. For each flag, the corresponding bit in the return value is set if the flag is asserted.

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

Returns

State of the status flags:

- 1: related status flag is set.
- 0: related status flag is not set.

See Also

[_lpi2c_slave_flags](#)

29.5.5.7 static void LPI2C_SlaveClearStatusFlags (LPI2C_Type * *base*, uint32_t *statusMask*) [inline], [static]

The following status register flags can be cleared:

- [kLPI2C_SlaveRepeatedStartDetectFlag](#)
- [kLPI2C_SlaveStopDetectFlag](#)
- [kLPI2C_SlaveBitErrFlag](#)
- [kLPI2C_SlaveFifoErrFlag](#)

Attempts to clear other flags has no effect.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>statusMask</i>	A bitmask of status flags that are to be cleared. The mask is composed of _lpi2c_slave_flags enumerators OR'd together. You may pass the result of a previous call to LPI2C_SlaveGetStatusFlags() .

See Also

[_lpi2c_slave_flags](#).

29.5.5.8 static void LPI2C_SlaveEnableInterrupts (LPI2C_Type * *base*, uint32_t *interruptMask*) [inline], [static]

All flags except [kLPI2C_SlaveBusyFlag](#) and [kLPI2C_SlaveBusBusyFlag](#) can be enabled as interrupts.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>interruptMask</i>	Bit mask of interrupts to enable. See _lpi2c_slave_flags for the set of constants that should be OR'd together to form the bit mask.

29.5.5.9 static void LPI2C_SlaveDisableInterrupts (LPI2C_Type * *base*, uint32_t *interruptMask*) [inline], [static]

All flags except [kLPI2C_SlaveBusyFlag](#) and [kLPI2C_SlaveBusBusyFlag](#) can be enabled as interrupts.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>interruptMask</i>	Bit mask of interrupts to disable. See _lpi2c_slave_flags for the set of constants that should be OR'd together to form the bit mask.

29.5.5.10 static uint32_t LPI2C_SlaveGetEnabledInterrupts (LPI2C_Type * *base*) [inline], [static]

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

Returns

A bitmask composed of `_lpi2c_slave_flags` enumerators OR'd together to indicate the set of enabled interrupts.

29.5.5.11 `static void LPI2C_SlaveEnableDMA (LPI2C_Type * base, bool enableAddressValid, bool enableRx, bool enableTx) [inline], [static]`

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>enableAddressValid</i>	Enable flag for the address valid DMA request. Pass true for enable, false for disable. The address valid DMA request is shared with the receive data DMA request.
<i>enableRx</i>	Enable flag for the receive data DMA request. Pass true for enable, false for disable.
<i>enableTx</i>	Enable flag for the transmit data DMA request. Pass true for enable, false for disable.

29.5.5.12 `static bool LPI2C_SlaveGetBusIdleState (LPI2C_Type * base) [inline], [static]`

Requires the slave mode to be enabled.

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

Return values

<i>true</i>	Bus is busy.
<i>false</i>	Bus is idle.

29.5.5.13 `static void LPI2C_SlaveTransmitAck (LPI2C_Type * base, bool ackOrNack) [inline], [static]`

Use this function to send an ACK or NAK when the `kLPI2C_SlaveTransmitAckFlag` is asserted. This only happens if you enable the `sclStall.enableAck` field of the `lpi2c_slave_config_t` configuration structure used to initialize the slave peripheral.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>ackOrNack</i>	Pass true for an ACK or false for a NAK.

29.5.5.14 `static uint32_t LPI2C_SlaveGetReceivedAddress (LPI2C_Type * base) [inline], [static]`

This function should only be called if the [kLPI2C_SlaveAddressValidFlag](#) is asserted.

Parameters

<i>base</i>	The LPI2C peripheral base address.
-------------	------------------------------------

Returns

The 8-bit address matched by the LPI2C slave. Bit 0 contains the R/w direction bit, and the 7-bit slave address is in the upper 7 bits.

29.5.5.15 `status_t LPI2C_SlaveSend (LPI2C_Type * base, void * txBuff, size_t txSize, size_t * actualTxSize)`

Parameters

	<i>base</i>	The LPI2C peripheral base address.
	<i>txBuff</i>	The pointer to the data to be transferred.
	<i>txSize</i>	The length in bytes of the data to be transferred.
out	<i>actualTxSize</i>	

Returns

Error or success status returned by API.

29.5.5.16 `status_t LPI2C_SlaveReceive (LPI2C_Type * base, void * rxBuff, size_t rxSize, size_t * actualRxSize)`

Parameters

	<i>base</i>	The LPI2C peripheral base address.
	<i>rxBuff</i>	The pointer to the data to be transferred.
	<i>rxSize</i>	The length in bytes of the data to be transferred.
out	<i>actualRxSize</i>	

Returns

Error or success status returned by API.

**29.5.5.17 void LPI2C_SlaveTransferCreateHandle (LPI2C_Type * *base*,
lpi2c_slave_handle_t * *handle*, lpi2c_slave_transfer_callback_t *callback*, void *
userData)**

The creation of a handle is for use with the non-blocking APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the [LPI2C_SlaveTransferAbort\(\)](#) API shall be called.

Note

The function also enables the NVIC IRQ for the input LPI2C. Need to notice that on some SoCs the LPI2C IRQ is connected to INTMUX, in this case user needs to enable the associated INTMUX IRQ in application.

Parameters

	<i>base</i>	The LPI2C peripheral base address.
out	<i>handle</i>	Pointer to the LPI2C slave driver handle.
	<i>callback</i>	User provided pointer to the asynchronous callback function.
	<i>userData</i>	User provided pointer to the application callback data.

**29.5.5.18 status_t LPI2C_SlaveTransferNonBlocking (LPI2C_Type * *base*,
lpi2c_slave_handle_t * *handle*, uint32_t *eventMask*)**

Call this API after calling [I2C_SlaveInit\(\)](#) and [LPI2C_SlaveTransferCreateHandle\(\)](#) to start processing transactions driven by an I2C master. The slave monitors the I2C bus and pass events to the callback that was passed into the call to [LPI2C_SlaveTransferCreateHandle\(\)](#). The callback is always invoked from the interrupt context.

The set of events received by the callback is customizable. To do so, set the *eventMask* parameter to the OR'd combination of [lpi2c_slave_transfer_event_t](#) enumerators for the events you wish to receive. The

[kLPI2C_SlaveTransmitEvent](#) and [kLPI2C_SlaveReceiveEvent](#) events are always enabled and do not need to be included in the mask. Alternatively, you can pass 0 to get a default set of only the transmit and receive events that are always enabled. In addition, the [kLPI2C_SlaveAllEvents](#) constant is provided as a convenient way to enable all events.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>handle</i>	Pointer to <code>lpi2c_slave_handle_t</code> structure which stores the transfer state.
<i>eventMask</i>	Bit mask formed by OR'ing together <code>lpi2c_slave_transfer_event_t</code> enumerators to specify which events to send to the callback. Other accepted values are 0 to get a default set of only the transmit and receive events, and kLPI2C_SlaveAllEvents to enable all events.

Return values

<i>kStatus_Success</i>	Slave transfers were successfully started.
<i>kStatus_LPI2C_Busy</i>	Slave transfers have already been started on this handle.

29.5.5.19 `status_t LPI2C_SlaveTransferGetCount (LPI2C_Type * base, lpi2c_slave_handle_t * handle, size_t * count)`

Parameters

	<i>base</i>	The LPI2C peripheral base address.
	<i>handle</i>	Pointer to <code>i2c_slave_handle_t</code> structure.
out	<i>count</i>	Pointer to a value to hold the number of bytes transferred. May be NULL if the count is not required.

Return values

<i>kStatus_Success</i>	
<i>kStatus_NoTransferInProgress</i>	

29.5.5.20 `void LPI2C_SlaveTransferAbort (LPI2C_Type * base, lpi2c_slave_handle_t * handle)`

Note

This API could be called at any time to stop slave for handling the bus events.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>handle</i>	Pointer to <code>lpi2c_slave_handle_t</code> structure which stores the transfer state.

Return values

<i>kStatus_Success</i>	
<i>kStatus_LPI2C_Idle</i>	

29.5.5.21 void LPI2C_SlaveTransferHandleIRQ (LPI2C_Type * *base*, lpi2c_slave_handle_t * *handle*)

Note

This function does not need to be called unless you are reimplementing the non blocking API's interrupt handler routines to add special functionality.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>handle</i>	Pointer to <code>lpi2c_slave_handle_t</code> structure which stores the transfer state.

29.6 LPI2C Master DMA Driver

29.6.1 Overview

Data Structures

- struct `lpi2c_master_edma_handle_t`
Driver handle for master DMA APIs. [More...](#)

Typedefs

- typedef void(* `lpi2c_master_edma_transfer_callback_t`)(LPI2C_Type *base, lpi2c_master_edma_handle_t *handle, `status_t` completionStatus, void *userData)
Master DMA completion callback function pointer type.

Master DMA

- void `LPI2C_MasterCreateEDMAHandle` (LPI2C_Type *base, lpi2c_master_edma_handle_t *handle, `edma_handle_t` *rxDmaHandle, `edma_handle_t` *txDmaHandle, `lpi2c_master_edma_transfer_callback_t` callback, void *userData)
Create a new handle for the LPI2C master DMA APIs.
- `status_t` `LPI2C_MasterTransferEDMA` (LPI2C_Type *base, lpi2c_master_edma_handle_t *handle, lpi2c_master_transfer_t *transfer)
Performs a non-blocking DMA-based transaction on the I2C bus.
- `status_t` `LPI2C_MasterTransferGetCountEDMA` (LPI2C_Type *base, lpi2c_master_edma_handle_t *handle, `size_t` *count)
Returns number of bytes transferred so far.
- `status_t` `LPI2C_MasterTransferAbortEDMA` (LPI2C_Type *base, lpi2c_master_edma_handle_t *handle)
Terminates a non-blocking LPI2C master transmission early.

29.6.2 Data Structure Documentation

29.6.2.1 struct `_lpi2c_master_edma_handle`

Note

The contents of this structure are private and subject to change.

Data Fields

- LPI2C_Type * `base`
LPI2C base pointer.
- bool `isBusy`

- *Transfer state machine current state.*
- `uint8_t nbytes`
eDMA minor byte transfer count initially configured.
- `uint16_t commandBuffer [10]`
LPI2C command sequence.
- `lpi2c_master_transfer_t transfer`
Copy of the current transfer info.
- `lpi2c_master_edma_transfer_callback_t completionCallback`
Callback function pointer.
- `void * userData`
Application data passed to callback.
- `edma_handle_t * rx`
Handle for receive DMA channel.
- `edma_handle_t * tx`
Handle for transmit DMA channel.
- `edma_tcd_t tcds [3]`
Software TCD.

Field Documentation

- (1) `LPI2C_Type* lpi2c_master_edma_handle_t::base`
- (2) `bool lpi2c_master_edma_handle_t::isBusy`
- (3) `uint8_t lpi2c_master_edma_handle_t::nbytes`
- (4) `uint16_t lpi2c_master_edma_handle_t::commandBuffer[10]`

When all 10 command words are used: Start&addr&write[1 word] + subaddr[4 words] + restart&addr&read[1 word] + receive&Size[4 words]

- (5) `lpi2c_master_transfer_t lpi2c_master_edma_handle_t::transfer`
- (6) `lpi2c_master_edma_transfer_callback_t lpi2c_master_edma_handle_t::completionCallback`
- (7) `void* lpi2c_master_edma_handle_t::userData`
- (8) `edma_handle_t* lpi2c_master_edma_handle_t::rx`
- (9) `edma_handle_t* lpi2c_master_edma_handle_t::tx`
- (10) `edma_tcd_t lpi2c_master_edma_handle_t::tcds[3]`

Three are allocated to provide enough room to align to 32-bytes.

29.6.3 Typedef Documentation

29.6.3.1 `typedef void(* lpi2c_master_edma_transfer_callback_t)(LPI2C_Type *base,
lpi2c_master_edma_handle_t *handle, status_t completionStatus, void
*userData)`

This callback is used only for the non-blocking master transfer API. Specify the callback you wish to use in the call to [LPI2C_MasterCreateEDMAHandle\(\)](#).

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>handle</i>	Handle associated with the completed transfer.
<i>completion-Status</i>	Either kStatus_Success or an error code describing how the transfer completed.
<i>userData</i>	Arbitrary pointer-sized value passed from the application.

29.6.4 Function Documentation

29.6.4.1 void LPI2C_MasterCreateEDMAHandle (LPI2C_Type * *base*, lpi2c_master_edma_handle_t * *handle*, edma_handle_t * *rxDmaHandle*, edma_handle_t * *txDmaHandle*, lpi2c_master_edma_transfer_callback_t *callback*, void * *userData*)

The creation of a handle is for use with the DMA APIs. Once a handle is created, there is not a corresponding destroy handle. If the user wants to terminate a transfer, the [LPI2C_MasterTransferAbortEDMA\(\)](#) API shall be called.

For devices where the LPI2C send and receive DMA requests are OR'd together, the *txDmaHandle* parameter is ignored and may be set to NULL.

Parameters

	<i>base</i>	The LPI2C peripheral base address.
out	<i>handle</i>	Pointer to the LPI2C master driver handle.
	<i>rxDmaHandle</i>	Handle for the eDMA receive channel. Created by the user prior to calling this function.
	<i>txDmaHandle</i>	Handle for the eDMA transmit channel. Created by the user prior to calling this function.
	<i>callback</i>	User provided pointer to the asynchronous callback function.
	<i>userData</i>	User provided pointer to the application callback data.

29.6.4.2 status_t LPI2C_MasterTransferEDMA (LPI2C_Type * *base*, lpi2c_master_edma_handle_t * *handle*, lpi2c_master_transfer_t * *transfer*)

The callback specified when the *handle* was created is invoked when the transaction has completed.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>handle</i>	Pointer to the LPI2C master driver handle.
<i>transfer</i>	The pointer to the transfer descriptor.

Return values

<i>kStatus_Success</i>	The transaction was started successfully.
<i>kStatus_LPI2C_Busy</i>	Either another master is currently utilizing the bus, or another DMA transaction is already in progress.

29.6.4.3 `status_t LPI2C_MasterTransferGetCountEDMA (LPI2C_Type * base, lpi2c_master_edma_handle_t * handle, size_t * count)`

Parameters

	<i>base</i>	The LPI2C peripheral base address.
	<i>handle</i>	Pointer to the LPI2C master driver handle.
out	<i>count</i>	Number of bytes transferred so far by the non-blocking transaction.

Return values

<i>kStatus_Success</i>	
<i>kStatus_NoTransferInProgress</i>	There is not a DMA transaction currently in progress.

29.6.4.4 `status_t LPI2C_MasterTransferAbortEDMA (LPI2C_Type * base, lpi2c_master_edma_handle_t * handle)`

Note

It is not safe to call this function from an IRQ handler that has a higher priority than the eDMA peripheral's IRQ priority.

Parameters

<i>base</i>	The LPI2C peripheral base address.
<i>handle</i>	Pointer to the LPI2C master driver handle.

Return values

<i>kStatus_Success</i>	A transaction was successfully aborted.
<i>kStatus_LPI2C_Idle</i>	There is not a DMA transaction currently in progress.

29.7 LPI2C FreeRTOS Driver

29.7.1 Overview

Driver version

- #define `FSL_LPI2C_FREERTOS_DRIVER_VERSION` (`MAKE_VERSION(2, 3, 0)`)
LPI2C FreeRTOS driver version.

LPI2C RTOS Operation

- `status_t LPI2C_RTOS_Init` (`lpi2c_rtos_handle_t *handle`, `LPI2C_Type *base`, `const lpi2c_master_config_t *masterConfig`, `uint32_t srcClock_Hz`)
Initializes LPI2C.
- `status_t LPI2C_RTOS_Deinit` (`lpi2c_rtos_handle_t *handle`)
Deinitializes the LPI2C.
- `status_t LPI2C_RTOS_Transfer` (`lpi2c_rtos_handle_t *handle`, `lpi2c_master_transfer_t *transfer`)
Performs I2C transfer.

29.7.2 Macro Definition Documentation

29.7.2.1 #define FSL_LPI2C_FREERTOS_DRIVER_VERSION (MAKE_VERSION(2, 3, 0))

29.7.3 Function Documentation

29.7.3.1 `status_t LPI2C_RTOS_Init (lpi2c_rtos_handle_t * handle, LPI2C_Type * base, const lpi2c_master_config_t * masterConfig, uint32_t srcClock_Hz)`

This function initializes the LPI2C module and related RTOS context.

Parameters

<i>handle</i>	The RTOS LPI2C handle, the pointer to an allocated space for RTOS context.
<i>base</i>	The pointer base address of the LPI2C instance to initialize.
<i>masterConfig</i>	Configuration structure to set-up LPI2C in master mode.
<i>srcClock_Hz</i>	Frequency of input clock of the LPI2C module.

Returns

status of the operation.

29.7.3.2 status_t LPI2C_RTOS_Deinit (lpi2c_rtos_handle_t * *handle*)

This function deinitializes the LPI2C module and related RTOS context.

Parameters

<i>handle</i>	The RTOS LPI2C handle.
---------------	------------------------

29.7.3.3 `status_t LPI2C_RTOS_Transfer (lpi2c_rtos_handle_t * handle, lpi2c_master_transfer_t * transfer)`

This function performs an I2C transfer using LPI2C module according to data given in the transfer structure.

Parameters

<i>handle</i>	The RTOS LPI2C handle.
<i>transfer</i>	Structure specifying the transfer parameters.

Returns

status of the operation.

29.8 LPI2C CMSIS Driver

This section describes the programming interface of the LPI2C Cortex Microcontroller Software Interface Standard (CMSIS) driver. And this driver defines generic peripheral driver interfaces for middleware making it reusable across a wide range of supported microcontroller devices. The API connects microcontroller peripherals with middleware that implements for example communication stacks, file systems, or graphic user interfaces. More information and usage method see <http://www.keil.com/pack/doc/cmsis/Driver/html/index.html>.

The LPI2C CMSIS driver includes transactional APIs.

Transactional APIs are transaction target high-level APIs. The transactional APIs can be used to enable the peripheral quickly and also in the application if the code size and performance of transactional APIs satisfy the requirements. If the code size and performance are critical requirements, see the transactional API implementation and write custom code accessing the hardware registers.

29.8.1 LPI2C CMSIS Driver

29.8.1.1 Master Operation in interrupt transactional method

```
void I2C_MasterSignalEvent_t(uint32_t event)
{
    if (event == ARM_I2C_EVENT_TRANSFER_DONE)
    {
        g_MasterCompletionFlag = true;
    }
}
/*Init I2C0*/
Driver_I2C0.Initialize(I2C_MasterSignalEvent_t);

Driver_I2C0.PowerControl(ARM_POWER_FULL);

/*config transmit speed*/
Driver_I2C0.Control(ARM_I2C_BUS_SPEED, ARM_I2C_BUS_SPEED_STANDARD);

/*start transmit*/
Driver_I2C0.MasterTransmit(I2C_MASTER_SLAVE_ADDR, g_master_buff, I2C_DATA_LENGTH, false);

/* Wait for transfer completed. */
while (!g_MasterCompletionFlag)
{
}
g_MasterCompletionFlag = false;
```

29.8.1.2 Master Operation in DMA transactional method

```
void I2C_MasterSignalEvent_t(uint32_t event)
{
    /* Transfer done */
    if (event == ARM_I2C_EVENT_TRANSFER_DONE)
    {
        g_MasterCompletionFlag = true;
    }
}

/* DMAMux init and EDMA init. */
DMAMUX_Init(EXAMPLE_LPI2C_DMAMUX_BASEADDR);
```

```

edma_config_t edmaConfig;
EDMA_GetDefaultConfig(&edmaConfig);
EDMA_Init(EXAMPLE_LPI2C_DMA_BASEADDR, &edmaConfig);

/*Init I2C0*/
Driver_I2C0.Initialize(I2C_MasterSignalEvent_t);

Driver_I2C0.PowerControl(ARM_POWER_FULL);

/*config transmit speed*/
Driver_I2C0.Control(ARM_I2C_BUS_SPEED, ARM_I2C_BUS_SPEED_STANDARD);

/*start transfer*/
Driver_I2C0.MasterReceive(I2C_MASTER_SLAVE_ADDR, g_master_buff, I2C_DATA_LENGTH, false);

/* Wait for transfer completed. */
while (!g_MasterCompletionFlag)
{
}
g_MasterCompletionFlag = false;

```

29.8.1.3 Slave Operation in interrupt transactional method

```

void I2C_SlaveSignalEvent_t(uint32_t event)
{
    /* Transfer done */
    if (event == ARM_I2C_EVENT_TRANSFER_DONE)
    {
        g_SlaveCompletionFlag = true;
    }
}

/*Init I2C1*/
Driver_I2C1.Initialize(I2C_SlaveSignalEvent_t);

Driver_I2C1.PowerControl(ARM_POWER_FULL);

/*config slave addr*/
Driver_I2C1.Control(ARM_I2C_OWN_ADDRESS, I2C_MASTER_SLAVE_ADDR);

/*start transfer*/
Driver_I2C1.SlaveReceive(g_slave_buff, I2C_DATA_LENGTH);

/* Wait for transfer completed. */
while (!g_SlaveCompletionFlag)
{
}
g_SlaveCompletionFlag = false;

```

Chapter 30

LPSPI: Low Power Serial Peripheral Interface

30.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Low Power Serial Peripheral Interface (LPSPI) module of MCUXpresso SDK devices.

Modules

- [LPSPI CMSIS Driver](#)
- [LPSPI FreeRTOS Driver](#)
- [LPSPI Peripheral driver](#)
- [LPSPI eDMA Driver](#)

30.2 LPSPI Peripheral driver

30.2.1 Overview

This section describes the programming interface of the LPSPI Peripheral driver. The LPSPI driver configures LPSPI module, provides the functional and transactional interfaces to build the LPSPI application.

30.2.2 Function groups

30.2.2.1 LPSPI Initialization and De-initialization

This function group initializes the default configuration structure for master and slave, initializes the LPSPI master with a master configuration, initializes the LPSPI slave with a slave configuration, and de-initializes the LPSPI module.

30.2.2.2 LPSPI Basic Operation

This function group enables/disables the LPSPI module both interrupt and DMA, gets the data register address for the DMA transfer, sets master and slave, starts and stops the transfer, and so on.

30.2.2.3 LPSPI Transfer Operation

This function group controls the transfer, master send/receive data, and slave send/receive data.

30.2.2.4 LPSPI Status Operation

This function group gets/clears the LPSPI status.

30.2.2.5 LPSPI Block Transfer Operation

This function group transfers a block of data, gets the transfer status, and aborts the transfer.

30.2.3 Typical use case

30.2.3.1 Master Operation

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/lpspi`

30.2.3.2 Slave Operation

Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOARD>/driver_examples/lpspi

Data Structures

- struct `lpspi_master_config_t`
LPSPI master configuration structure. [More...](#)
- struct `lpspi_slave_config_t`
LPSPI slave configuration structure. [More...](#)
- struct `lpspi_transfer_t`
LPSPI master/slave transfer structure. [More...](#)
- struct `lpspi_master_handle_t`
LPSPI master transfer handle structure used for transactional API. [More...](#)
- struct `lpspi_slave_handle_t`
LPSPI slave transfer handle structure used for transactional API. [More...](#)

Macros

- #define `LPSPI_DUMMY_DATA` (0x00U)
LPSPI dummy data if no Tx data.
- #define `SPI_RETRY_TIMES` 0U /* Define to zero means keep waiting until the flag is assert/deassert. */
Retry times for waiting flag.
- #define `LPSPI_MASTER_PCS_SHIFT` (4U)
LPSPI master PCS shift macro , internal used.
- #define `LPSPI_MASTER_PCS_MASK` (0xF0U)
LPSPI master PCS shift macro , internal used.
- #define `LPSPI_SLAVE_PCS_SHIFT` (4U)
LPSPI slave PCS shift macro , internal used.
- #define `LPSPI_SLAVE_PCS_MASK` (0xF0U)
LPSPI slave PCS shift macro , internal used.

Typedefs

- typedef void(* `lpspi_master_transfer_callback_t`)(LPSPI_Type *base, lpspi_master_handle_t *handle, `status_t` status, void *userData)
Master completion callback function pointer type.
- typedef void(* `lpspi_slave_transfer_callback_t`)(LPSPI_Type *base, lpspi_slave_handle_t *handle, `status_t` status, void *userData)
Slave completion callback function pointer type.

Enumerations

- enum {
 - kStatus_LPSPi_Busy = MAKE_STATUS(kStatusGroup_LPSPi, 0),
 - kStatus_LPSPi_Error = MAKE_STATUS(kStatusGroup_LPSPi, 1),
 - kStatus_LPSPi_Idle = MAKE_STATUS(kStatusGroup_LPSPi, 2),
 - kStatus_LPSPi_OutOfRange = MAKE_STATUS(kStatusGroup_LPSPi, 3),
 - kStatus_LPSPi_Timeout = MAKE_STATUS(kStatusGroup_LPSPi, 4) }

Status for the LPSPi driver.
- enum _lpspi_flags {
 - kLPSPi_TxDataRequestFlag = LPSPi_SR_TDF_MASK,
 - kLPSPi_RxDataReadyFlag = LPSPi_SR_RDF_MASK,
 - kLPSPi_WordCompleteFlag = LPSPi_SR_WCF_MASK,
 - kLPSPi_FrameCompleteFlag = LPSPi_SR_FCF_MASK,
 - kLPSPi_TransferCompleteFlag = LPSPi_SR_TCF_MASK,
 - kLPSPi_TransmitErrorFlag = LPSPi_SR_TEF_MASK,
 - kLPSPi_ReceiveErrorFlag = LPSPi_SR_REF_MASK,
 - kLPSPi_DataMatchFlag = LPSPi_SR_DMF_MASK,
 - kLPSPi_ModuleBusyFlag = LPSPi_SR_MBF_MASK,
 - kLPSPi_AllStatusFlag }

LPSPi status flags in SPIx_SR register.
- enum _lpspi_interrupt_enable {
 - kLPSPi_TxInterruptEnable = LPSPi_IER_TDIE_MASK,
 - kLPSPi_RxInterruptEnable = LPSPi_IER_RDIE_MASK,
 - kLPSPi_WordCompleteInterruptEnable = LPSPi_IER_WCIE_MASK,
 - kLPSPi_FrameCompleteInterruptEnable = LPSPi_IER_FCIE_MASK,
 - kLPSPi_TransferCompleteInterruptEnable = LPSPi_IER_TCIE_MASK,
 - kLPSPi_TransmitErrorInterruptEnable = LPSPi_IER_TEIE_MASK,
 - kLPSPi_ReceiveErrorInterruptEnable = LPSPi_IER_REIE_MASK,
 - kLPSPi_DataMatchInterruptEnable = LPSPi_IER_DMIE_MASK,
 - kLPSPi_AllInterruptEnable }

LPSPi interrupt source.
- enum _lpspi_dma_enable {
 - kLPSPi_TxDmaEnable = LPSPi_DER_TDDE_MASK,
 - kLPSPi_RxDmaEnable = LPSPi_DER_RDDE_MASK }

LPSPi DMA source.
- enum lpspi_master_slave_mode_t {
 - kLPSPi_Master = 1U,
 - kLPSPi_Slave = 0U }

LPSPi master or slave mode configuration.
- enum lpspi_which_pcs_t {
 - kLPSPi_Pcs0 = 0U,
 - kLPSPi_Pcs1 = 1U,
 - kLPSPi_Pcs2 = 2U,
 - kLPSPi_Pcs3 = 3U }

LPSPi Peripheral Chip Select (PCS) configuration (which PCS to configure).

- enum `lpspi_pcs_polarity_config_t` {
`kLPSPI_PcsActiveHigh = 1U`,
`kLPSPI_PcsActiveLow = 0U` }
LPSPI Peripheral Chip Select (PCS) Polarity configuration.
- enum `_lpspi_pcs_polarity` {
`kLPSPI_Pcs0ActiveLow = 1U << 0`,
`kLPSPI_Pcs1ActiveLow = 1U << 1`,
`kLPSPI_Pcs2ActiveLow = 1U << 2`,
`kLPSPI_Pcs3ActiveLow = 1U << 3`,
`kLPSPI_PcsAllActiveLow = 0xFU` }
LPSPI Peripheral Chip Select (PCS) Polarity.
- enum `lpspi_clock_polarity_t` {
`kLPSPI_ClockPolarityActiveHigh = 0U`,
`kLPSPI_ClockPolarityActiveLow = 1U` }
LPSPI clock polarity configuration.
- enum `lpspi_clock_phase_t` {
`kLPSPI_ClockPhaseFirstEdge = 0U`,
`kLPSPI_ClockPhaseSecondEdge = 1U` }
LPSPI clock phase configuration.
- enum `lpspi_shift_direction_t` {
`kLPSPI_MsbFirst = 0U`,
`kLPSPI_LsbFirst = 1U` }
LPSPI data shifter direction options.
- enum `lpspi_host_request_select_t` {
`kLPSPI_HostReqExtPin = 0U`,
`kLPSPI_HostReqInternalTrigger = 1U` }
LPSPI Host Request select configuration.
- enum `lpspi_match_config_t` {
`kLPSI_MatchDisabled = 0x0U`,
`kLPSI_1stWordEqualsM0orM1 = 0x2U`,
`kLPSI_AnyWordEqualsM0orM1 = 0x3U`,
`kLPSI_1stWordEqualsM0and2ndWordEqualsM1 = 0x4U`,
`kLPSI_AnyWordEqualsM0andNxtWordEqualsM1 = 0x5U`,
`kLPSI_1stWordAndM1EqualsM0andM1 = 0x6U`,
`kLPSI_AnyWordAndM1EqualsM0andM1 = 0x7U` }
LPSPI Match configuration options.
- enum `lpspi_pin_config_t` {
`kLPSPI_SdiInSdoOut = 0U`,
`kLPSPI_SdiInSdiOut = 1U`,
`kLPSPI_SdoInSdoOut = 2U`,
`kLPSPI_SdoInSdiOut = 3U` }
LPSPI pin (SDO and SDI) configuration.
- enum `lpspi_data_out_config_t` {
`kLpspiDataOutRetained = 0U`,
`kLpspiDataOutTristate = 1U` }
LPSPI data output configuration.
- enum `lpspi_transfer_width_t` {

```
kLPSPI_SingleBitXfer = 0U,
kLPSPI_TwoBitXfer = 1U,
kLPSPI_FourBitXfer = 2U }
```

LPSPI transfer width configuration.

- enum `lpspi_delay_type_t` {


```
kLPSPI_PcsToSck = 1U,
kLPSPI_LastSckToPcs,
kLPSPI_BetweenTransfer }
```

LPSPI delay type selection.

- enum `_lpspi_transfer_config_flag_for_master` {


```
kLPSPI_MasterPcs0 = 0U << LPSPI_MASTER_PCS_SHIFT,
kLPSPI_MasterPcs1 = 1U << LPSPI_MASTER_PCS_SHIFT,
kLPSPI_MasterPcs2 = 2U << LPSPI_MASTER_PCS_SHIFT,
kLPSPI_MasterPcs3 = 3U << LPSPI_MASTER_PCS_SHIFT,
kLPSPI_MasterPcsContinuous = 1U << 20,
kLPSPI_MasterByteSwap }
```

Use this enumeration for LPSPI master transfer configFlags.

- enum `_lpspi_transfer_config_flag_for_slave` {


```
kLPSPI_SlavePcs0 = 0U << LPSPI_SLAVE_PCS_SHIFT,
kLPSPI_SlavePcs1 = 1U << LPSPI_SLAVE_PCS_SHIFT,
kLPSPI_SlavePcs2 = 2U << LPSPI_SLAVE_PCS_SHIFT,
kLPSPI_SlavePcs3 = 3U << LPSPI_SLAVE_PCS_SHIFT,
kLPSPI_SlaveByteSwap }
```

Use this enumeration for LPSPI slave transfer configFlags.

- enum `_lpspi_transfer_state` {


```
kLPSPI_Idle = 0x0U,
kLPSPI_Busy,
kLPSPI_Error }
```

LPSPI transfer state, which is used for LPSPI transactional API state machine.

Variables

- volatile `uint8_t g_lpspiDummyData []`
Global variable for dummy data value setting.

Driver version

- #define `FSL_LPSPI_DRIVER_VERSION` (`MAKE_VERSION(2, 2, 1)`)
LPSPI driver version.

Initialization and deinitialization

- void `LPSPI_MasterInit` (`LPSPI_Type *base`, const `lpspi_master_config_t *masterConfig`, `uint32_t srcClock_Hz`)

- *Initializes the LPSPI master.*
- void **LPSPI_MasterGetDefaultConfig** (lpspi_master_config_t *masterConfig)
Sets the lpspi_master_config_t structure to default values.
- void **LPSPI_SlaveInit** (LPSPI_Type *base, const lpspi_slave_config_t *slaveConfig)
LPSPI slave configuration.
- void **LPSPI_SlaveGetDefaultConfig** (lpspi_slave_config_t *slaveConfig)
Sets the lpspi_slave_config_t structure to default values.
- void **LPSPI_Deinit** (LPSPI_Type *base)
De-initializes the LPSPI peripheral.
- void **LPSPI_Reset** (LPSPI_Type *base)
Restores the LPSPI peripheral to reset state.
- uint32_t **LPSPI_GetInstance** (LPSPI_Type *base)
Get the LPSPI instance from peripheral base address.
- static void **LPSPI_Enable** (LPSPI_Type *base, bool enable)
Enables the LPSPI peripheral and sets the MCR MDIS to 0.

Status

- static uint32_t **LPSPI_GetStatusFlags** (LPSPI_Type *base)
Gets the LPSPI status flag state.
- static uint8_t **LPSPI_GetTxFifoSize** (LPSPI_Type *base)
Gets the LPSPI Tx FIFO size.
- static uint8_t **LPSPI_GetRxFifoSize** (LPSPI_Type *base)
Gets the LPSPI Rx FIFO size.
- static uint32_t **LPSPI_GetTxFifoCount** (LPSPI_Type *base)
Gets the LPSPI Tx FIFO count.
- static uint32_t **LPSPI_GetRxFifoCount** (LPSPI_Type *base)
Gets the LPSPI Rx FIFO count.
- static void **LPSPI_ClearStatusFlags** (LPSPI_Type *base, uint32_t statusFlags)
Clears the LPSPI status flag.

Interrupts

- static void **LPSPI_EnableInterrupts** (LPSPI_Type *base, uint32_t mask)
Enables the LPSPI interrupts.
- static void **LPSPI_DisableInterrupts** (LPSPI_Type *base, uint32_t mask)
Disables the LPSPI interrupts.

DMA Control

- static void **LPSPI_EnableDMA** (LPSPI_Type *base, uint32_t mask)
Enables the LPSPI DMA request.
- static void **LPSPI_DisableDMA** (LPSPI_Type *base, uint32_t mask)
Disables the LPSPI DMA request.
- static uint32_t **LPSPI_GetTxRegisterAddress** (LPSPI_Type *base)
Gets the LPSPI Transmit Data Register address for a DMA operation.
- static uint32_t **LPSPI_GetRxRegisterAddress** (LPSPI_Type *base)

Gets the LPSPI Receive Data Register address for a DMA operation.

Bus Operations

- bool [LPSPI_CheckTransferArgument](#) (LPSPI_Type *base, [lpspi_transfer_t](#) *transfer, bool isEdma)
Check the argument for transfer .
- static void [LPSPI_SetMasterSlaveMode](#) (LPSPI_Type *base, [lpspi_master_slave_mode_t](#) mode)
Configures the LPSPI for either master or slave.
- static void [LPSPI_SelectTransferPCS](#) (LPSPI_Type *base, [lpspi_which_pcs_t](#) select)
Configures the peripheral chip select used for the transfer.
- static void [LPSPI_SetPCSContinuous](#) (LPSPI_Type *base, bool IsContinuous)
Set the PCS signal to continuous or uncontinuous mode.
- static bool [LPSPI_IsMaster](#) (LPSPI_Type *base)
Returns whether the LPSPI module is in master mode.
- static void [LPSPI_FlushFifo](#) (LPSPI_Type *base, bool flushTxFifo, bool flushRxFifo)
Flushes the LPSPI FIFOs.
- static void [LPSPI_SetFifoWatermarks](#) (LPSPI_Type *base, uint32_t txWater, uint32_t rxWater)
Sets the transmit and receive FIFO watermark values.
- static void [LPSPI_SetAllPcsPolarity](#) (LPSPI_Type *base, uint32_t mask)
Configures all LPSPI peripheral chip select polarities simultaneously.
- static void [LPSPI_SetFrameSize](#) (LPSPI_Type *base, uint32_t frameSize)
Configures the frame size.
- uint32_t [LPSPI_MasterSetBaudRate](#) (LPSPI_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz, uint32_t *tcrPrescaleValue)
Sets the LPSPI baud rate in bits per second.
- void [LPSPI_MasterSetDelayScaler](#) (LPSPI_Type *base, uint32_t scaler, [lpspi_delay_type_t](#) whichDelay)
Manually configures a specific LPSPI delay parameter (module must be disabled to change the delay values).
- uint32_t [LPSPI_MasterSetDelayTimes](#) (LPSPI_Type *base, uint32_t delayTimeInNanoSec, [lpspi_delay_type_t](#) whichDelay, uint32_t srcClock_Hz)
Calculates the delay based on the desired delay input in nanoseconds (module must be disabled to change the delay values).
- static void [LPSPI_WriteData](#) (LPSPI_Type *base, uint32_t data)
Writes data into the transmit data buffer.
- static uint32_t [LPSPI_ReadData](#) (LPSPI_Type *base)
Reads data from the data buffer.
- void [LPSPI_SetDummyData](#) (LPSPI_Type *base, uint8_t dummyData)
Set up the dummy data.

Transactional

- void [LPSPI_MasterTransferCreateHandle](#) (LPSPI_Type *base, [lpspi_master_handle_t](#) *handle, [lpspi_master_transfer_callback_t](#) callback, void *userData)
Initializes the LPSPI master handle.
- [status_t](#) [LPSPI_MasterTransferBlocking](#) (LPSPI_Type *base, [lpspi_transfer_t](#) *transfer)
LPSPI master transfer data using a polling method.

- [status_t LPSPI_MasterTransferNonBlocking](#) (LPSPI_Type *base, lpspi_master_handle_t *handle, lpspi_transfer_t *transfer)
LPSPI master transfer data using an interrupt method.
- [status_t LPSPI_MasterTransferGetCount](#) (LPSPI_Type *base, lpspi_master_handle_t *handle, size_t *count)
Gets the master transfer remaining bytes.
- void [LPSPI_MasterTransferAbort](#) (LPSPI_Type *base, lpspi_master_handle_t *handle)
LPSPI master abort transfer which uses an interrupt method.
- void [LPSPI_MasterTransferHandleIRQ](#) (LPSPI_Type *base, lpspi_master_handle_t *handle)
LPSPI Master IRQ handler function.
- void [LPSPI_SlaveTransferCreateHandle](#) (LPSPI_Type *base, lpspi_slave_handle_t *handle, lpspi_slave_transfer_callback_t callback, void *userData)
Initializes the LPSPI slave handle.
- [status_t LPSPI_SlaveTransferNonBlocking](#) (LPSPI_Type *base, lpspi_slave_handle_t *handle, lpspi_transfer_t *transfer)
LPSPI slave transfer data using an interrupt method.
- [status_t LPSPI_SlaveTransferGetCount](#) (LPSPI_Type *base, lpspi_slave_handle_t *handle, size_t *count)
Gets the slave transfer remaining bytes.
- void [LPSPI_SlaveTransferAbort](#) (LPSPI_Type *base, lpspi_slave_handle_t *handle)
LPSPI slave aborts a transfer which uses an interrupt method.
- void [LPSPI_SlaveTransferHandleIRQ](#) (LPSPI_Type *base, lpspi_slave_handle_t *handle)
LPSPI Slave IRQ handler function.

30.2.4 Data Structure Documentation

30.2.4.1 struct lpspi_master_config_t

Data Fields

- uint32_t [baudRate](#)
Baud Rate for LPSPI.
- uint32_t [bitsPerFrame](#)
Bits per frame, minimum 8, maximum 4096.
- [lpspi_clock_polarity_t](#) [cpol](#)
Clock polarity.
- [lpspi_clock_phase_t](#) [cpha](#)
Clock phase.
- [lpspi_shift_direction_t](#) [direction](#)
MSB or LSB data shift direction.
- uint32_t [pcsToSckDelayInNanoSec](#)
PCS to SCK delay time in nanoseconds, setting to 0 sets the minimum delay.
- uint32_t [lastSckToPcsDelayInNanoSec](#)
Last SCK to PCS delay time in nanoseconds, setting to 0 sets the minimum delay.
- uint32_t [betweenTransferDelayInNanoSec](#)
After the SCK delay time with nanoseconds, setting to 0 sets the minimum delay.
- [lpspi_which_pcs_t](#) [whichPcs](#)
Desired Peripheral Chip Select (PCS).

- [lpspi_pcs_polarity_config_t pcsActiveHighOrLow](#)
Desired PCS active high or low.
- [lpspi_pin_config_t pinCfg](#)
Configures which pins are used for input and output data during single bit transfers.
- [lpspi_data_out_config_t dataOutConfig](#)
Configures if the output data is tristated between accesses (LPSPI_PCS is negated).

Field Documentation

- (1) **uint32_t lpspi_master_config_t::baudRate**
- (2) **uint32_t lpspi_master_config_t::bitsPerFrame**
- (3) **lpspi_clock_polarity_t lpspi_master_config_t::cpol**
- (4) **lpspi_clock_phase_t lpspi_master_config_t::cpha**
- (5) **lpspi_shift_direction_t lpspi_master_config_t::direction**
- (6) **uint32_t lpspi_master_config_t::pcsToSckDelayInNanoSec**

It sets the boundary value if out of range.

- (7) **uint32_t lpspi_master_config_t::lastSckToPcsDelayInNanoSec**

It sets the boundary value if out of range.

- (8) **uint32_t lpspi_master_config_t::betweenTransferDelayInNanoSec**

It sets the boundary value if out of range.

- (9) **lpspi_which_pcs_t lpspi_master_config_t::whichPcs**
- (10) **lpspi_pin_config_t lpspi_master_config_t::pinCfg**
- (11) **lpspi_data_out_config_t lpspi_master_config_t::dataOutConfig**

30.2.4.2 struct lpspi_slave_config_t

Data Fields

- **uint32_t bitsPerFrame**
Bits per frame, minimum 8, maximum 4096.
- [lpspi_clock_polarity_t cpol](#)
Clock polarity.
- [lpspi_clock_phase_t cpha](#)
Clock phase.
- [lpspi_shift_direction_t direction](#)
MSB or LSB data shift direction.
- [lpspi_which_pcs_t whichPcs](#)
Desired Peripheral Chip Select (pcs)

- [lpspi_pcs_polarity_config_t pcsActiveHighOrLow](#)
Desired PCS active high or low.
- [lpspi_pin_config_t pinCfg](#)
Configures which pins are used for input and output data during single bit transfers.
- [lpspi_data_out_config_t dataOutConfig](#)
Configures if the output data is tristated between accesses (LPSPI_PCS is negated).

Field Documentation

- (1) `uint32_t lpspi_slave_config_t::bitsPerFrame`
- (2) `lpspi_clock_polarity_t lpspi_slave_config_t::cpol`
- (3) `lpspi_clock_phase_t lpspi_slave_config_t::cpha`
- (4) `lpspi_shift_direction_t lpspi_slave_config_t::direction`
- (5) `lpspi_pin_config_t lpspi_slave_config_t::pinCfg`
- (6) `lpspi_data_out_config_t lpspi_slave_config_t::dataOutConfig`

30.2.4.3 struct `lpspi_transfer_t`

Data Fields

- `uint8_t * txData`
Send buffer.
- `uint8_t * rxData`
Receive buffer.
- `volatile size_t dataSize`
Transfer bytes.
- `uint32_t configFlags`
Transfer transfer configuration flags.

Field Documentation

- (1) `uint8_t* lpspi_transfer_t::txData`
- (2) `uint8_t* lpspi_transfer_t::rxData`
- (3) `volatile size_t lpspi_transfer_t::dataSize`
- (4) `uint32_t lpspi_transfer_t::configFlags`

Set from `_lpspi_transfer_config_flag_for_master` if the transfer is used for master or `_lpspi_transfer_config_flag_for_slave` enumeration if the transfer is used for slave.

30.2.4.4 struct `_lpspi_master_handle`

Forward declaration of the `_lpspi_master_handle` typedefs.

Data Fields

- volatile bool `isPcsContinuous`
Is PCS continuous in transfer.
- volatile bool `writeTcrInIsr`
A flag that whether should write TCR in ISR.
- volatile bool `isByteSwap`
A flag that whether should byte swap.
- volatile bool `isTxMask`
A flag that whether TCR[TXMSK] is set.
- volatile uint16_t `bytesPerFrame`
Number of bytes in each frame.
- volatile uint8_t `fifoSize`
FIFO dataSize.
- volatile uint8_t `rxWatermark`
Rx watermark.
- volatile uint8_t `bytesEachWrite`
Bytes for each write TDR.
- volatile uint8_t `bytesEachRead`
Bytes for each read RDR.
- uint8_t *volatile `txData`
Send buffer.
- uint8_t *volatile `rxData`
Receive buffer.
- volatile size_t `txRemainingByteCount`
Number of bytes remaining to send.
- volatile size_t `rxRemainingByteCount`
Number of bytes remaining to receive.
- volatile uint32_t `writeRegRemainingTimes`
Write TDR register remaining times.
- volatile uint32_t `readRegRemainingTimes`
Read RDR register remaining times.
- uint32_t `totalByteCount`
Number of transfer bytes.
- uint32_t `txBuffIfNull`
Used if the txData is NULL.
- volatile uint8_t `state`
LPSPI transfer state , `_lpspi_transfer_state`.
- `lpspi_master_transfer_callback_t` `callback`
Completion callback.
- void * `userData`
Callback user data.

Field Documentation

- (1) volatile bool `lpspi_master_handle_t::isPcsContinuous`
- (2) volatile bool `lpspi_master_handle_t::writeTcrInIsr`
- (3) volatile bool `lpspi_master_handle_t::isByteSwap`

- (4) `volatile bool lpspi_master_handle_t::isTxMask`
- (5) `volatile uint8_t lpspi_master_handle_t::fifoSize`
- (6) `volatile uint8_t lpspi_master_handle_t::rxWatermark`
- (7) `volatile uint8_t lpspi_master_handle_t::bytesEachWrite`
- (8) `volatile uint8_t lpspi_master_handle_t::bytesEachRead`
- (9) `uint8_t* volatile lpspi_master_handle_t::txData`
- (10) `uint8_t* volatile lpspi_master_handle_t::rxData`
- (11) `volatile size_t lpspi_master_handle_t::txRemainingByteCount`
- (12) `volatile size_t lpspi_master_handle_t::rxRemainingByteCount`
- (13) `volatile uint32_t lpspi_master_handle_t::writeRegRemainingTimes`
- (14) `volatile uint32_t lpspi_master_handle_t::readRegRemainingTimes`
- (15) `uint32_t lpspi_master_handle_t::txBuffflfNull`
- (16) `volatile uint8_t lpspi_master_handle_t::state`
- (17) `lpspi_master_transfer_callback_t lpspi_master_handle_t::callback`
- (18) `void* lpspi_master_handle_t::userData`

30.2.4.5 struct `_lpspi_slave_handle`

Forward declaration of the `_lpspi_slave_handle` typedefs.

Data Fields

- `volatile bool isByteSwap`
A flag that whether should byte swap.
- `volatile uint8_t fifoSize`
FIFO dataSize.
- `volatile uint8_t rxWatermark`
Rx watermark.
- `volatile uint8_t bytesEachWrite`
Bytes for each write TDR.
- `volatile uint8_t bytesEachRead`
Bytes for each read RDR.
- `uint8_t *volatile txData`
Send buffer.
- `uint8_t *volatile rxData`
Receive buffer.

- volatile size_t `txRemainingByteCount`
Number of bytes remaining to send.
- volatile size_t `rxRemainingByteCount`
Number of bytes remaining to receive.
- volatile uint32_t `writeRegRemainingTimes`
Write TDR register remaining times.
- volatile uint32_t `readRegRemainingTimes`
Read RDR register remaining times.
- uint32_t `totalByteCount`
Number of transfer bytes.
- volatile uint8_t `state`
LPSPI transfer state , `_lpspi_transfer_state`.
- volatile uint32_t `errorCount`
Error count for slave transfer.
- `lpspi_slave_transfer_callback_t` `callback`
Completion callback.
- void * `userData`
Callback user data.

Field Documentation

- (1) volatile bool `lpspi_slave_handle_t::isByteSwap`
- (2) volatile uint8_t `lpspi_slave_handle_t::fifoSize`
- (3) volatile uint8_t `lpspi_slave_handle_t::rxWatermark`
- (4) volatile uint8_t `lpspi_slave_handle_t::bytesEachWrite`
- (5) volatile uint8_t `lpspi_slave_handle_t::bytesEachRead`
- (6) uint8_t* volatile `lpspi_slave_handle_t::txData`
- (7) uint8_t* volatile `lpspi_slave_handle_t::rxData`
- (8) volatile size_t `lpspi_slave_handle_t::txRemainingByteCount`
- (9) volatile size_t `lpspi_slave_handle_t::rxRemainingByteCount`
- (10) volatile uint32_t `lpspi_slave_handle_t::writeRegRemainingTimes`
- (11) volatile uint32_t `lpspi_slave_handle_t::readRegRemainingTimes`
- (12) volatile uint8_t `lpspi_slave_handle_t::state`
- (13) volatile uint32_t `lpspi_slave_handle_t::errorCount`
- (14) `lpspi_slave_transfer_callback_t` `lpspi_slave_handle_t::callback`
- (15) void* `lpspi_slave_handle_t::userData`

30.2.5 Macro Definition Documentation

30.2.5.1 #define FSL_LPSPI_DRIVER_VERSION (MAKE_VERSION(2, 2, 1))

30.2.5.2 #define LPSPI_DUMMY_DATA (0x00U)

Dummy data used for tx if there is not txData.

30.2.5.3 #define SPI_RETRY_TIMES 0U /* Define to zero means keep waiting until the flag is assert/deassert. */

30.2.5.4 #define LPSPI_MASTER_PCS_SHIFT (4U)

30.2.5.5 #define LPSPI_MASTER_PCS_MASK (0xF0U)

30.2.5.6 #define LPSPI_SLAVE_PCS_SHIFT (4U)

30.2.5.7 #define LPSPI_SLAVE_PCS_MASK (0xF0U)

30.2.6 Typedef Documentation

30.2.6.1 typedef void(* lpspi_master_transfer_callback_t)(LPSPI_Type *base, lpspi_master_handle_t *handle, status_t status, void *userData)

Parameters

<i>base</i>	LPSPI peripheral address.
<i>handle</i>	Pointer to the handle for the LPSPI master.
<i>status</i>	Success or error code describing whether the transfer is completed.
<i>userData</i>	Arbitrary pointer-dataSized value passed from the application.

30.2.6.2 typedef void(* lpspi_slave_transfer_callback_t)(LPSPI_Type *base, lpspi_slave_handle_t *handle, status_t status, void *userData)

Parameters

<i>base</i>	LPSPI peripheral address.
<i>handle</i>	Pointer to the handle for the LPSPI slave.
<i>status</i>	Success or error code describing whether the transfer is completed.
<i>userData</i>	Arbitrary pointer-dataSized value passed from the application.

30.2.7 Enumeration Type Documentation

30.2.7.1 anonymous enum

Enumerator

kStatus_LPSPI_Busy LPSPI transfer is busy.
kStatus_LPSPI_Error LPSPI driver error.
kStatus_LPSPI_Idle LPSPI is idle.
kStatus_LPSPI_OutOfRange LPSPI transfer out Of range.
kStatus_LPSPI_Timeout LPSPI timeout polling status flags.

30.2.7.2 enum _lpspi_flags

Enumerator

kLPSPI_TxDataRequestFlag Transmit data flag.
kLPSPI_RxDataReadyFlag Receive data flag.
kLPSPI_WordCompleteFlag Word Complete flag.
kLPSPI_FrameCompleteFlag Frame Complete flag.
kLPSPI_TransferCompleteFlag Transfer Complete flag.
kLPSPI_TransmitErrorFlag Transmit Error flag (FIFO underrun)
kLPSPI_ReceiveErrorFlag Receive Error flag (FIFO overrun)
kLPSPI_DataMatchFlag Data Match flag.
kLPSPI_ModuleBusyFlag Module Busy flag.
kLPSPI_AllStatusFlag Used for clearing all wlc status flags.

30.2.7.3 enum _lpspi_interrupt_enable

Enumerator

kLPSPI_TxInterruptEnable Transmit data interrupt enable.
kLPSPI_RxInterruptEnable Receive data interrupt enable.
kLPSPI_WordCompleteInterruptEnable Word complete interrupt enable.
kLPSPI_FrameCompleteInterruptEnable Frame complete interrupt enable.
kLPSPI_TransferCompleteInterruptEnable Transfer complete interrupt enable.

kLPSPI_TransmitErrorInterruptEnable Transmit error interrupt enable(FIFO underrun)

kLPSPI_ReceiveErrorInterruptEnable Receive Error interrupt enable (FIFO overrun)

kLPSPI_DataMatchInterruptEnable Data Match interrupt enable.

kLPSPI_AllInterruptEnable All above interrupts enable.

30.2.7.4 enum _lpspi_dma_enable

Enumerator

kLPSPI_TxDmaEnable Transmit data DMA enable.

kLPSPI_RxDmaEnable Receive data DMA enable.

30.2.7.5 enum lpspi_master_slave_mode_t

Enumerator

kLPSPI_Master LPSPI peripheral operates in master mode.

kLPSPI_Slave LPSPI peripheral operates in slave mode.

30.2.7.6 enum lpspi_which_pcs_t

Enumerator

kLPSPI_Pcs0 PCS[0].

kLPSPI_Pcs1 PCS[1].

kLPSPI_Pcs2 PCS[2].

kLPSPI_Pcs3 PCS[3].

30.2.7.7 enum lpspi_pcs_polarity_config_t

Enumerator

kLPSPI_PcsActiveHigh PCS Active High (idles low)

kLPSPI_PcsActiveLow PCS Active Low (idles high)

30.2.7.8 enum _lpspi_pcs_polarity

Enumerator

kLPSPI_Pcs0ActiveLow Pcs0 Active Low (idles high).

kLPSPI_Pcs1ActiveLow Pcs1 Active Low (idles high).

kLPSPi_Pcs2ActiveLow Pcs2 Active Low (idles high).
kLPSPi_Pcs3ActiveLow Pcs3 Active Low (idles high).
kLPSPi_PcsAllActiveLow Pcs0 to Pcs5 Active Low (idles high).

30.2.7.9 enum lpspi_clock_polarity_t

Enumerator

kLPSPi_ClockPolarityActiveHigh CPOL=0. Active-high LPSPi clock (idles low)
kLPSPi_ClockPolarityActiveLow CPOL=1. Active-low LPSPi clock (idles high)

30.2.7.10 enum lpspi_clock_phase_t

Enumerator

kLPSPi_ClockPhaseFirstEdge CPHA=0. Data is captured on the leading edge of the SCK and changed on the following edge.
kLPSPi_ClockPhaseSecondEdge CPHA=1. Data is changed on the leading edge of the SCK and captured on the following edge.

30.2.7.11 enum lpspi_shift_direction_t

Enumerator

kLPSPi_MsbFirst Data transfers start with most significant bit.
kLPSPi_LsbFirst Data transfers start with least significant bit.

30.2.7.12 enum lpspi_host_request_select_t

Enumerator

kLPSPi_HostReqExtPin Host Request is an ext pin.
kLPSPi_HostReqInternalTrigger Host Request is an internal trigger.

30.2.7.13 enum lpspi_match_config_t

Enumerator

kLPSPi_MatchDisabled LPSPi Match Disabled.
kLPSPi_1stWordEqualsM0orM1 LPSPi Match Enabled.
kLPSPi_AnyWordEqualsM0orM1 LPSPi Match Enabled.

kLPSPI_1stWordEqualsM0and2ndWordEqualsM1 LPSPI Match Enabled.
kLPSPI_AnyWordEqualsM0andNxtWordEqualsM1 LPSPI Match Enabled.
kLPSPI_1stWordAndM1EqualsM0andM1 LPSPI Match Enabled.
kLPSPI_AnyWordAndM1EqualsM0andM1 LPSPI Match Enabled.

30.2.7.14 enum lpspi_pin_config_t

Enumerator

kLPSPI_SdiInSdoOut LPSPI SDI input, SDO output.
kLPSPI_SdiInSdiOut LPSPI SDI input, SDI output.
kLPSPI_SdoInSdoOut LPSPI SDO input, SDO output.
kLPSPI_SdoInSdiOut LPSPI SDO input, SDI output.

30.2.7.15 enum lpspi_data_out_config_t

Enumerator

kLpspiDataOutRetained Data out retains last value when chip select is de-asserted.
kLpspiDataOutTristate Data out is tristated when chip select is de-asserted.

30.2.7.16 enum lpspi_transfer_width_t

Enumerator

kLPSPI_SingleBitXfer 1-bit shift at a time, data out on SDO, in on SDI (normal mode)
kLPSPI_TwoBitXfer 2-bits shift out on SDO/SDI and in on SDO/SDI
kLPSPI_FourBitXfer 4-bits shift out on SDO/SDI/PCS[3:2] and in on SDO/SDI/PCS[3:2]

30.2.7.17 enum lpspi_delay_type_t

Enumerator

kLPSPI_PcsToSck PCS-to-SCK delay.
kLPSPI_LastSckToPcs Last SCK edge to PCS delay.
kLPSPI_BetweenTransfer Delay between transfers.

30.2.7.18 enum _lpspi_transfer_config_flag_for_master

Enumerator

kLPSPi_MasterPcs0 LPSPi master transfer use PCS0 signal.

kLPSPi_MasterPcs1 LPSPi master transfer use PCS1 signal.

kLPSPi_MasterPcs2 LPSPi master transfer use PCS2 signal.

kLPSPi_MasterPcs3 LPSPi master transfer use PCS3 signal.

kLPSPi_MasterPcsContinuous Is PCS signal continuous.

kLPSPi_MasterByteSwap Is master swap the byte. For example, when want to send data 1 2 3 4 5 6 7 8 (suppose you set `lpspi_shift_direction_t` to MSB).

1. If you set `bitPerFrame = 8`, no matter the `kLPSPi_MasterByteSwap` flag is used or not, the waveform is 1 2 3 4 5 6 7 8.
2. If you set `bitPerFrame = 16`: (1) the waveform is 2 1 4 3 6 5 8 7 if you do not use the `kLPSPi_MasterByteSwap` flag. (2) the waveform is 1 2 3 4 5 6 7 8 if you use the `kLPSPi_MasterByteSwap` flag.
3. If you set `bitPerFrame = 32`: (1) the waveform is 4 3 2 1 8 7 6 5 if you do not use the `kLPSPi_MasterByteSwap` flag. (2) the waveform is 1 2 3 4 5 6 7 8 if you use the `kLPSPi_MasterByteSwap` flag.

30.2.7.19 enum _lpspi_transfer_config_flag_for_slave

Enumerator

kLPSPi_SlavePcs0 LPSPi slave transfer use PCS0 signal.

kLPSPi_SlavePcs1 LPSPi slave transfer use PCS1 signal.

kLPSPi_SlavePcs2 LPSPi slave transfer use PCS2 signal.

kLPSPi_SlavePcs3 LPSPi slave transfer use PCS3 signal.

kLPSPi_SlaveByteSwap Is slave swap the byte. For example, when want to send data 1 2 3 4 5 6 7 8 (suppose you set `lpspi_shift_direction_t` to MSB).

1. If you set `bitPerFrame = 8`, no matter the `kLPSPi_SlaveByteSwap` flag is used or not, the waveform is 1 2 3 4 5 6 7 8.
2. If you set `bitPerFrame = 16`: (1) the waveform is 2 1 4 3 6 5 8 7 if you do not use the `kLPSPi_SlaveByteSwap` flag. (2) the waveform is 1 2 3 4 5 6 7 8 if you use the `kLPSPi_SlaveByteSwap` flag.
3. If you set `bitPerFrame = 32`: (1) the waveform is 4 3 2 1 8 7 6 5 if you do not use the `kLPSPi_SlaveByteSwap` flag. (2) the waveform is 1 2 3 4 5 6 7 8 if you use the `kLPSPi_SlaveByteSwap` flag.

30.2.7.20 enum _lpspi_transfer_state

Enumerator

kLPSPi_Idle Nothing in the transmitter/receiver.

kLPSPI_Busy Transfer queue is not finished.
kLPSPI_Error Transfer error.

30.2.8 Function Documentation

30.2.8.1 void LPSPI_MasterInit (LPSPI_Type * *base*, const lpspi_master_config_t * *masterConfig*, uint32_t *srcClock_Hz*)

Parameters

<i>base</i>	LPSPI peripheral address.
<i>masterConfig</i>	Pointer to structure lpspi_master_config_t .
<i>srcClock_Hz</i>	Module source input clock in Hertz

30.2.8.2 void LPSPI_MasterGetDefaultConfig (lpspi_master_config_t * *masterConfig*)

This API initializes the configuration structure for [LPSPI_MasterInit\(\)](#). The initialized structure can remain unchanged in [LPSPI_MasterInit\(\)](#), or can be modified before calling the [LPSPI_MasterInit\(\)](#). Example:

```
* lpspi_master_config_t masterConfig;
* LPSPI_MasterGetDefaultConfig(&masterConfig);
*
```

Parameters

<i>masterConfig</i>	pointer to lpspi_master_config_t structure
---------------------	--

30.2.8.3 void LPSPI_SlaveInit (LPSPI_Type * *base*, const lpspi_slave_config_t * *slaveConfig*)

Parameters

<i>base</i>	LPSPI peripheral address.
<i>slaveConfig</i>	Pointer to a structure lpspi_slave_config_t .

30.2.8.4 void LPSPI_SlaveGetDefaultConfig (lpspi_slave_config_t * *slaveConfig*)

This API initializes the configuration structure for [LPSPI_SlaveInit\(\)](#). The initialized structure can remain unchanged in [LPSPI_SlaveInit\(\)](#) or can be modified before calling the [LPSPI_SlaveInit\(\)](#). Example:

```
* lpspi_slave_config_t slaveConfig;
* LPSPI_SlaveGetDefaultConfig(&slaveConfig);
*
```

Parameters

<i>slaveConfig</i>	pointer to <code>lpspi_slave_config_t</code> structure.
--------------------	---

30.2.8.5 void LPSPI_Deinit (LPSPI_Type * *base*)

Call this API to disable the LPSPI clock.

Parameters

<i>base</i>	LPSPI peripheral address.
-------------	---------------------------

30.2.8.6 void LPSPI_Reset (LPSPI_Type * *base*)

Note that this function sets all registers to reset state. As a result, the LPSPI module can't work after calling this API.

Parameters

<i>base</i>	LPSPI peripheral address.
-------------	---------------------------

30.2.8.7 uint32_t LPSPI_GetInstance (LPSPI_Type * *base*)

Parameters

<i>base</i>	LPSPI peripheral base address.
-------------	--------------------------------

Returns

LPSPI instance.

30.2.8.8 static void LPSPI_Enable (LPSPI_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	LPSPI peripheral address.
<i>enable</i>	Pass true to enable module, false to disable module.

30.2.8.9 `static uint32_t LPSPI_GetStatusFlags (LPSPI_Type * base) [inline], [static]`

Parameters

<i>base</i>	LPSPI peripheral address.
-------------	---------------------------

Returns

The LPSPI status(in SR register).

30.2.8.10 `static uint8_t LPSPI_GetTxFifoSize (LPSPI_Type * base) [inline], [static]`

Parameters

<i>base</i>	LPSPI peripheral address.
-------------	---------------------------

Returns

The LPSPI Tx FIFO size.

30.2.8.11 `static uint8_t LPSPI_GetRxFifoSize (LPSPI_Type * base) [inline], [static]`

Parameters

<i>base</i>	LPSPI peripheral address.
-------------	---------------------------

Returns

The LPSPI Rx FIFO size.

30.2.8.12 `static uint32_t LPSPI_GetTxFifoCount (LPSPI_Type * base) [inline], [static]`

Parameters

<i>base</i>	LPSPI peripheral address.
-------------	---------------------------

Returns

The number of words in the transmit FIFO.

30.2.8.13 static uint32_t LPSPI_GetRxFifoCount (LPSPI_Type * *base*) [inline], [static]

Parameters

<i>base</i>	LPSPI peripheral address.
-------------	---------------------------

Returns

The number of words in the receive FIFO.

30.2.8.14 static void LPSPI_ClearStatusFlags (LPSPI_Type * *base*, uint32_t *statusFlags*) [inline], [static]

This function clears the desired status bit by using a write-1-to-clear. The user passes in the base and the desired status flag bit to clear. The list of status flags is defined in the `_lpspi_flags`. Example usage:

```
* LPSPI_ClearStatusFlags(base, kLPSPI_TxDataRequestFlag |
    kLPSPI_RxDataReadyFlag);
*
```

Parameters

<i>base</i>	LPSPI peripheral address.
<i>statusFlags</i>	The status flag used from type <code>_lpspi_flags</code> .

< The status flags are cleared by writing 1 (w1c).

30.2.8.15 static void LPSPI_EnableInterrupts (LPSPI_Type * *base*, uint32_t *mask*) [inline], [static]

This function configures the various interrupt masks of the LPSPI. The parameters are base and an interrupt mask. Note that, for Tx fill and Rx FIFO drain requests, enabling the interrupt request disables the DMA request.

```
* LPSPI_EnableInterrupts(base, kLPSPI_TxInterruptEnable |
    kLPSPI_RxInterruptEnable );
*
```

Parameters

<i>base</i>	LPSPi peripheral address.
<i>mask</i>	The interrupt mask; Use the enum <code>_lpspi_interrupt_enable</code> .

**30.2.8.16 static void LPSPi_DisableInterrupts (LPSPi_Type * *base*, uint32_t *mask*)
[inline], [static]**

```
* LPSPi_DisableInterrupts(base, kLPSPi_TxInterruptEnable |
    kLPSPi_RxInterruptEnable );
*
```

Parameters

<i>base</i>	LPSPi peripheral address.
<i>mask</i>	The interrupt mask; Use the enum <code>_lpspi_interrupt_enable</code> .

**30.2.8.17 static void LPSPi_EnableDMA (LPSPi_Type * *base*, uint32_t *mask*)
[inline], [static]**

This function configures the Rx and Tx DMA mask of the LPSPi. The parameters are base and a DMA mask.

```
* LPSPi_EnableDMA(base, kLPSPi_TxDmaEnable |
    kLPSPi_RxDmaEnable);
*
```

Parameters

<i>base</i>	LPSPi peripheral address.
<i>mask</i>	The interrupt mask; Use the enum <code>_lpspi_dma_enable</code> .

**30.2.8.18 static void LPSPi_DisableDMA (LPSPi_Type * *base*, uint32_t *mask*)
[inline], [static]**

This function configures the Rx and Tx DMA mask of the LPSPi. The parameters are base and a DMA mask.

```
* LPSPi_DisableDMA(base, kLPSPi_TxDmaEnable |
    kLPSPi_RxDmaEnable);
*
```

Parameters

<i>base</i>	LPSPI peripheral address.
<i>mask</i>	The interrupt mask; Use the enum <code>_lpspi_dma_enable</code> .

30.2.8.19 `static uint32_t LPSPI_GetTxRegisterAddress (LPSPI_Type * base)` `[inline], [static]`

This function gets the LPSPI Transmit Data Register address because this value is needed for the DMA operation. This function can be used for either master or slave mode.

Parameters

<i>base</i>	LPSPI peripheral address.
-------------	---------------------------

Returns

The LPSPI Transmit Data Register address.

30.2.8.20 `static uint32_t LPSPI_GetRxRegisterAddress (LPSPI_Type * base)` `[inline], [static]`

This function gets the LPSPI Receive Data Register address because this value is needed for the DMA operation. This function can be used for either master or slave mode.

Parameters

<i>base</i>	LPSPI peripheral address.
-------------	---------------------------

Returns

The LPSPI Receive Data Register address.

30.2.8.21 `bool LPSPI_CheckTransferArgument (LPSPI_Type * base, lpspi_transfer_t * transfer, bool isEdma)`

Parameters

<i>base</i>	LPSPi peripheral address.
<i>transfer</i>	the transfer struct to be used.
<i>isEdma</i>	True to check for EDMA transfer, false to check interrupt non-blocking transfer

Returns

Return true for right and false for wrong.

30.2.8.22 static void LPSPi_SetMasterSlaveMode (LPSPi_Type * *base*, lpspi_master_slave_mode_t *mode*) [inline], [static]

Note that the CFGR1 should only be written when the LPSPi is disabled (LPSPi_x_CR_MEN = 0).

Parameters

<i>base</i>	LPSPi peripheral address.
<i>mode</i>	Mode setting (master or slave) of type lpspi_master_slave_mode_t.

30.2.8.23 static void LPSPi_SelectTransferPCS (LPSPi_Type * *base*, lpspi_which_pcs_t *select*) [inline], [static]

Parameters

<i>base</i>	LPSPi peripheral address.
<i>select</i>	LPSPi Peripheral Chip Select (PCS) configuration.

30.2.8.24 static void LPSPi_SetPCSContinuous (LPSPi_Type * *base*, bool *IsContinuous*) [inline], [static]

Note

In master mode, continuous transfer will keep the PCS asserted at the end of the frame size, until a command word is received that starts a new frame. So PCS must be set back to uncontinuous when transfer finishes. In slave mode, when continuous transfer is enabled, the LPSPi will only transmit the first frame size bits, after that the LPSPi will transmit received data back (assuming a 32-bit shift register).

Parameters

<i>base</i>	LPSPI peripheral address.
<i>IsContinous</i>	True to set the transfer PCS to continuous mode, false to set to uncontinuous mode.

30.2.8.25 static bool LPSPI_IsMaster (LPSPI_Type * *base*) [inline], [static]

Parameters

<i>base</i>	LPSPI peripheral address.
-------------	---------------------------

Returns

Returns true if the module is in master mode or false if the module is in slave mode.

30.2.8.26 static void LPSPI_FlushFifo (LPSPI_Type * *base*, bool *flushTxFifo*, bool *flushRxFifo*) [inline], [static]

Parameters

<i>base</i>	LPSPI peripheral address.
<i>flushTxFifo</i>	Flushes (true) the Tx FIFO, else do not flush (false) the Tx FIFO.
<i>flushRxFifo</i>	Flushes (true) the Rx FIFO, else do not flush (false) the Rx FIFO.

30.2.8.27 static void LPSPI_SetFifoWatermarks (LPSPI_Type * *base*, uint32_t *txWater*, uint32_t *rxWater*) [inline], [static]

This function allows the user to set the receive and transmit FIFO watermarks. The function does not compare the watermark settings to the FIFO size. The FIFO watermark should not be equal to or greater than the FIFO size. It is up to the higher level driver to make this check.

Parameters

<i>base</i>	LPSPI peripheral address.
-------------	---------------------------

<i>txWater</i>	The TX FIFO watermark value. Writing a value equal or greater than the FIFO size is truncated.
<i>rxWater</i>	The RX FIFO watermark value. Writing a value equal or greater than the FIFO size is truncated.

**30.2.8.28 static void LPSPI_SetAllPcsPolarity (LPSPI_Type * *base*, uint32_t *mask*)
[inline], [static]**

Note that the CFGR1 should only be written when the LPSPI is disabled (LPSPIx_CR_MEN = 0).

This is an example: PCS0 and PCS1 set to active low and other PCSs set to active high. Note that the number of PCS is device-specific.

```
* LPSPI_SetAllPcsPolarity(base, kLPSPI_Pcs0ActiveLow |
    kLPSPI_Pcs1ActiveLow);
*
```

Parameters

<i>base</i>	LPSPI peripheral address.
<i>mask</i>	The PCS polarity mask; Use the enum <code>_lpspi_pcs_polarity</code> .

**30.2.8.29 static void LPSPI_SetFrameSize (LPSPI_Type * *base*, uint32_t *frameSize*)
[inline], [static]**

The minimum frame size is 8-bits and the maximum frame size is 4096-bits. If the frame size is less than or equal to 32-bits, the word size and frame size are identical. If the frame size is greater than 32-bits, the word size is 32-bits for each word except the last (the last word contains the remainder bits if the frame size is not divisible by 32). The minimum word size is 2-bits. A frame size of 33-bits (or similar) is not supported.

Note 1: The transmit command register should be initialized before enabling the LPSPI in slave mode, although the command register does not update until after the LPSPI is enabled. After it is enabled, the transmit command register should only be changed if the LPSPI is idle.

Note 2: The transmit and command FIFO is a combined FIFO that includes both transmit data and command words. That means the TCR register should be written to when the Tx FIFO is not full.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>frameSize</i>	The frame size in number of bits.

30.2.8.30 uint32_t LPSPI_MasterSetBaudRate (LPSPI_Type * *base*, uint32_t *baudRate_Bps*, uint32_t *srcClock_Hz*, uint32_t * *tcrPrescaleValue*)

This function takes in the desired bitsPerSec (baud rate) and calculates the nearest possible baud rate without exceeding the desired baud rate and returns the calculated baud rate in bits-per-second. It requires the caller to provide the frequency of the module source clock (in Hertz). Note that the baud rate does not go into effect until the Transmit Control Register (TCR) is programmed with the prescale value. Hence, this function returns the prescale *tcrPrescaleValue* parameter for later programming in the TCR. The higher level peripheral driver should alert the user of an out of range baud rate input.

Note that the LPSPI module must first be disabled before configuring this. Note that the LPSPI module must be configured for master mode before configuring this.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>baudRate_Bps</i>	The desired baud rate in bits per second.
<i>srcClock_Hz</i>	Module source input clock in Hertz.
<i>tcrPrescale-Value</i>	The TCR prescale value needed to program the TCR.

Returns

The actual calculated baud rate. This function may also return a "0" if the LPSPI is not configured for master mode or if the LPSPI module is not disabled.

30.2.8.31 void LPSPI_MasterSetDelayScaler (LPSPI_Type * *base*, uint32_t *scaler*, lpspi_delay_type_t *whichDelay*)

This function configures the following: SCK to PCS delay, or PCS to SCK delay, or The configurations must occur between the transfer delay.

The delay names are available in type *lpspi_delay_type_t*.

The user passes the desired delay along with the delay value. This allows the user to directly set the delay values if they have pre-calculated them or if they simply wish to manually increment the value.

Note that the LPSPI module must first be disabled before configuring this. Note that the LPSPI module must be configured for master mode before configuring this.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>scaler</i>	The 8-bit delay value 0x00 to 0xFF (255).
<i>whichDelay</i>	The desired delay to configure, must be of type <i>lpspi_delay_type_t</i> .

30.2.8.32 `uint32_t LPSPI_MasterSetDelayTimes (LPSPI_Type * base, uint32_t delayTimeInNanoSec, lpspi_delay_type_t whichDelay, uint32_t srcClock_Hz)`

This function calculates the values for the following: SCK to PCS delay, or PCS to SCK delay, or The configurations must occur between the transfer delay.

The delay names are available in type `lpspi_delay_type_t`.

The user passes the desired delay and the desired delay value in nano-seconds. The function calculates the value needed for the desired delay parameter and returns the actual calculated delay because an exact delay match may not be possible. In this case, the closest match is calculated without going below the desired delay value input. It is possible to input a very large delay value that exceeds the capability of the part, in which case the maximum supported delay is returned. It is up to the higher level peripheral driver to alert the user of an out of range delay input.

Note that the LPSPI module must be configured for master mode before configuring this. And note that the `delayTime = LPSPI_clockSource / (PRESCALE * Delay_scaler)`.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>delayTimeInNanoSec</i>	The desired delay value in nano-seconds.
<i>whichDelay</i>	The desired delay to configuration, which must be of type <code>lpspi_delay_type_t</code> .
<i>srcClock_Hz</i>	Module source input clock in Hertz.

Returns

actual Calculated delay value in nano-seconds.

30.2.8.33 `static void LPSPI_WriteData (LPSPI_Type * base, uint32_t data) [inline], [static]`

This function writes data passed in by the user to the Transmit Data Register (TDR). The user can pass up to 32-bits of data to load into the TDR. If the frame size exceeds 32-bits, the user has to manage sending the data one 32-bit word at a time. Any writes to the TDR result in an immediate push to the transmit FIFO. This function can be used for either master or slave modes.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>data</i>	The data word to be sent.

30.2.8.34 `static uint32_t LPSPI_ReadData (LPSPI_Type * base) [inline], [static]`

This function reads the data from the Receive Data Register (RDR). This function can be used for either master or slave mode.

Parameters

<i>base</i>	LPSPi peripheral address.
-------------	---------------------------

Returns

The data read from the data buffer.

30.2.8.35 void LPSPi_SetDummyData (LPSPi_Type * *base*, uint8_t *dummyData*)

Parameters

<i>base</i>	LPSPi peripheral address.
<i>dummyData</i>	Data to be transferred when tx buffer is NULL. Note: This API has no effect when LPSPi in slave interrupt mode, because driver will set the TXMSK bit to 1 if txData is NULL, no data is loaded from transmit FIFO and output pin is tristated.

**30.2.8.36 void LPSPi_MasterTransferCreateHandle (LPSPi_Type * *base*,
lpspi_master_handle_t * *handle*, lpspi_master_transfer_callback_t *callback*,
void * *userData*)**

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

Parameters

<i>base</i>	LPSPi peripheral address.
<i>handle</i>	LPSPi handle pointer to lpspi_master_handle_t.
<i>callback</i>	DSPI callback.
<i>userData</i>	callback function parameter.

30.2.8.37 status_t LPSPi_MasterTransferBlocking (LPSPi_Type * *base*, lpspi_transfer_t * *transfer*)

This function transfers data using a polling method. This is a blocking function, which does not return until all transfers have been completed.

Note: The transfer data size should be integer multiples of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size should be equal to bytesPerFrame if the bytesPerFrame is not integer multiples of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>transfer</i>	pointer to lpspi_transfer_t structure.

Returns

status of `status_t`.

30.2.8.38 `status_t LPSPI_MasterTransferNonBlocking (LPSPI_Type * base, lpspi_master_handle_t * handle, lpspi_transfer_t * transfer)`

This function transfers data using an interrupt method. This is a non-blocking function, which returns right away. When all data is transferred, the callback function is called.

Note: The transfer data size should be integer multiples of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size should be equal to bytesPerFrame if the bytesPerFrame is not integer multiples of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>handle</i>	pointer to <code>lpspi_master_handle_t</code> structure which stores the transfer state.
<i>transfer</i>	pointer to lpspi_transfer_t structure.

Returns

status of `status_t`.

30.2.8.39 `status_t LPSPI_MasterTransferGetCount (LPSPI_Type * base, lpspi_master_handle_t * handle, size_t * count)`

This function gets the master transfer remaining bytes.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>handle</i>	pointer to <code>lpspi_master_handle_t</code> structure which stores the transfer state.
<i>count</i>	Number of bytes transferred so far by the non-blocking transaction.

Returns

status of `status_t`.

30.2.8.40 void LPSPI_MasterTransferAbort (LPSPI_Type * *base*, lpspi_master_handle_t * *handle*)

This function aborts a transfer which uses an interrupt method.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>handle</i>	pointer to <code>lpspi_master_handle_t</code> structure which stores the transfer state.

30.2.8.41 void LPSPI_MasterTransferHandleIRQ (LPSPI_Type * *base*, lpspi_master_handle_t * *handle*)

This function processes the LPSPI transmit and receive IRQ.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>handle</i>	pointer to <code>lpspi_master_handle_t</code> structure which stores the transfer state.

30.2.8.42 void LPSPI_SlaveTransferCreateHandle (LPSPI_Type * *base*, lpspi_slave_handle_t * *handle*, lpspi_slave_transfer_callback_t *callback*, void * *userData*)

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

Parameters

<i>base</i>	LPSPI peripheral address.
<i>handle</i>	LPSPI handle pointer to <code>lpspi_slave_handle_t</code> .
<i>callback</i>	DSPI callback.
<i>userData</i>	callback function parameter.

30.2.8.43 `status_t LPSPI_SlaveTransferNonBlocking (LPSPI_Type * base,
lpspi_slave_handle_t * handle, lpspi_transfer_t * transfer)`

This function transfer data using an interrupt method. This is a non-blocking function, which returns right away. When all data is transferred, the callback function is called.

Note: The transfer data size should be integer multiples of bytesPerFrame if bytesPerFrame is less than or equal to 4. For bytesPerFrame greater than 4: The transfer data size should be equal to bytesPerFrame if the bytesPerFrame is not an integer multiple of 4. Otherwise, the transfer data size can be an integer multiple of bytesPerFrame.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>handle</i>	pointer to <code>lpspi_slave_handle_t</code> structure which stores the transfer state.
<i>transfer</i>	pointer to <code>lpspi_transfer_t</code> structure.

Returns

status of `status_t`.

30.2.8.44 `status_t LPSPI_SlaveTransferGetCount (LPSPI_Type * base,
lpspi_slave_handle_t * handle, size_t * count)`

This function gets the slave transfer remaining bytes.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>handle</i>	pointer to <code>lpspi_slave_handle_t</code> structure which stores the transfer state.
<i>count</i>	Number of bytes transferred so far by the non-blocking transaction.

Returns

status of `status_t`.

30.2.8.45 void LPSPI_SlaveTransferAbort (LPSPI_Type * *base*, lpspi_slave_handle_t * *handle*)

This function aborts a transfer which uses an interrupt method.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>handle</i>	pointer to <code>lpspi_slave_handle_t</code> structure which stores the transfer state.

30.2.8.46 `void LPSPI_SlaveTransferHandleIRQ (LPSPI_Type * base,
lpspi_slave_handle_t * handle)`

This function processes the LPSPI transmit and receives an IRQ.

Parameters

<i>base</i>	LPSPI peripheral address.
<i>handle</i>	pointer to <code>lpspi_slave_handle_t</code> structure which stores the transfer state.

30.2.9 Variable Documentation

30.2.9.1 `volatile uint8_t g_lpspiDummyData[]`

30.3 LPSPI eDMA Driver

30.3.1 Overview

Data Structures

- struct `lpspi_master_edma_handle_t`
LPSPI master eDMA transfer handle structure used for transactional API. [More...](#)
- struct `lpspi_slave_edma_handle_t`
LPSPI slave eDMA transfer handle structure used for transactional API. [More...](#)

Typedefs

- typedef void(* `lpspi_master_edma_transfer_callback_t`)(LPSPI_Type *base, lpspi_master_edma_handle_t *handle, `status_t` status, void *userData)
Completion callback function pointer type.
- typedef void(* `lpspi_slave_edma_transfer_callback_t`)(LPSPI_Type *base, lpspi_slave_edma_handle_t *handle, `status_t` status, void *userData)
Completion callback function pointer type.

Functions

- void `LPSPI_MasterTransferCreateHandleEDMA` (LPSPI_Type *base, lpspi_master_edma_handle_t *handle, `lpspi_master_edma_transfer_callback_t` callback, void *userData, `edma_handle_t` *edmaRxRegToRxDataHandle, `edma_handle_t` *edmaTxDataToTxRegHandle)
Initializes the LPSPI master eDMA handle.
- `status_t` `LPSPI_MasterTransferEDMA` (LPSPI_Type *base, lpspi_master_edma_handle_t *handle, `lpspi_transfer_t` *transfer)
LPSPI master transfer data using eDMA.
- void `LPSPI_MasterTransferAbortEDMA` (LPSPI_Type *base, lpspi_master_edma_handle_t *handle)
LPSPI master aborts a transfer which is using eDMA.
- `status_t` `LPSPI_MasterTransferGetCountEDMA` (LPSPI_Type *base, lpspi_master_edma_handle_t *handle, `size_t` *count)
Gets the master eDMA transfer remaining bytes.
- void `LPSPI_SlaveTransferCreateHandleEDMA` (LPSPI_Type *base, lpspi_slave_edma_handle_t *handle, `lpspi_slave_edma_transfer_callback_t` callback, void *userData, `edma_handle_t` *edmaRxRegToRxDataHandle, `edma_handle_t` *edmaTxDataToTxRegHandle)
Initializes the LPSPI slave eDMA handle.
- `status_t` `LPSPI_SlaveTransferEDMA` (LPSPI_Type *base, lpspi_slave_edma_handle_t *handle, `lpspi_transfer_t` *transfer)
LPSPI slave transfers data using eDMA.
- void `LPSPI_SlaveTransferAbortEDMA` (LPSPI_Type *base, lpspi_slave_edma_handle_t *handle)
LPSPI slave aborts a transfer which is using eDMA.
- `status_t` `LPSPI_SlaveTransferGetCountEDMA` (LPSPI_Type *base, lpspi_slave_edma_handle_t *handle, `size_t` *count)

Gets the slave eDMA transfer remaining bytes.

Driver version

- #define `FSL_LPSPI_EDMA_DRIVER_VERSION` (`MAKE_VERSION(2, 1, 0)`)
LPSPI EDMA driver version.

30.3.2 Data Structure Documentation

30.3.2.1 struct `_lpspi_master_edma_handle`

Forward declaration of the `_lpspi_master_edma_handle` typedefs.

Data Fields

- volatile bool `isPcsContinuous`
Is PCS continuous in transfer.
- volatile bool `isByteSwap`
A flag that whether should byte swap.
- volatile uint8_t `fifoSize`
FIFO dataSize.
- volatile uint8_t `rxWatermark`
Rx watermark.
- volatile uint8_t `bytesEachWrite`
Bytes for each write TDR.
- volatile uint8_t `bytesEachRead`
Bytes for each read RDR.
- volatile uint8_t `bytesLastRead`
Bytes for last read RDR.
- volatile bool `isThereExtraRxBytes`
Is there extra RX byte.
- uint8_t *volatile `txData`
Send buffer.
- uint8_t *volatile `rxData`
Receive buffer.
- volatile size_t `txRemainingByteCount`
Number of bytes remaining to send.
- volatile size_t `rxRemainingByteCount`
Number of bytes remaining to receive.
- volatile uint32_t `writeRegRemainingTimes`
Write TDR register remaining times.
- volatile uint32_t `readRegRemainingTimes`
Read RDR register remaining times.
- uint32_t `totalByteCount`
Number of transfer bytes.
- uint32_t `txBuffIfNull`
Used if there is not txData for DMA purpose.

- `uint32_t rxBuffIfNull`
Used if there is not rxData for DMA purpose.
- `uint32_t transmitCommand`
Used to write TCR for DMA purpose.
- `volatile uint8_t state`
LPSPI transfer state , `_lpspi_transfer_state`.
- `uint8_t nbytes`
eDMA minor byte transfer count initially configured.
- `lpspi_master_edma_transfer_callback_t callback`
Completion callback.
- `void * userData`
Callback user data.
- `edma_handle_t * edmaRxRegToRxDataHandle`
`edma_handle_t` handle point used for RxReg to RxData buff
- `edma_handle_t * edmaTxDataToTxRegHandle`
`edma_handle_t` handle point used for TxData to TxReg buff
- `edma_tcd_t lpspiSoftwareTCD [3]`
SoftwareTCD, internal used.

Field Documentation

- (1) `volatile bool lpspi_master_edma_handle_t::isPcsContinuous`
- (2) `volatile bool lpspi_master_edma_handle_t::isByteSwap`
- (3) `volatile uint8_t lpspi_master_edma_handle_t::fifoSize`
- (4) `volatile uint8_t lpspi_master_edma_handle_t::rxWatermark`
- (5) `volatile uint8_t lpspi_master_edma_handle_t::bytesEachWrite`
- (6) `volatile uint8_t lpspi_master_edma_handle_t::bytesEachRead`
- (7) `volatile uint8_t lpspi_master_edma_handle_t::bytesLastRead`
- (8) `volatile bool lpspi_master_edma_handle_t::isThereExtraRxBytes`
- (9) `uint8_t* volatile lpspi_master_edma_handle_t::txData`
- (10) `uint8_t* volatile lpspi_master_edma_handle_t::rxData`
- (11) `volatile size_t lpspi_master_edma_handle_t::txRemainingByteCount`
- (12) `volatile size_t lpspi_master_edma_handle_t::rxRemainingByteCount`
- (13) `volatile uint32_t lpspi_master_edma_handle_t::writeRegRemainingTimes`
- (14) `volatile uint32_t lpspi_master_edma_handle_t::readRegRemainingTimes`
- (15) `uint32_t lpspi_master_edma_handle_t::txBuffIfNull`

- (16) `uint32_t lpspi_master_edma_handle_t::rxBuffIfNull`
- (17) `uint32_t lpspi_master_edma_handle_t::transmitCommand`
- (18) `volatile uint8_t lpspi_master_edma_handle_t::state`
- (19) `uint8_t lpspi_master_edma_handle_t::nbytes`
- (20) `lpspi_master_edma_transfer_callback_t lpspi_master_edma_handle_t::callback`
- (21) `void* lpspi_master_edma_handle_t::userData`

30.3.2.2 struct `_lpspi_slave_edma_handle`

Forward declaration of the `_lpspi_slave_edma_handle` typedefs.

Data Fields

- volatile bool `isByteSwap`
A flag that whether should byte swap.
- volatile `uint8_t fifoSize`
FIFO dataSize.
- volatile `uint8_t rxWatermark`
Rx watermark.
- volatile `uint8_t bytesEachWrite`
Bytes for each write TDR.
- volatile `uint8_t bytesEachRead`
Bytes for each read RDR.
- volatile `uint8_t bytesLastRead`
Bytes for last read RDR.
- volatile bool `isThereExtraRxBytes`
Is there extra RX byte.
- `uint8_t nbytes`
eDMA minor byte transfer count initially configured.
- `uint8_t *volatile txData`
Send buffer.
- `uint8_t *volatile rxData`
Receive buffer.
- volatile `size_t txRemainingByteCount`
Number of bytes remaining to send.
- volatile `size_t rxRemainingByteCount`
Number of bytes remaining to receive.
- volatile `uint32_t writeRegRemainingTimes`
Write TDR register remaining times.
- volatile `uint32_t readRegRemainingTimes`
Read RDR register remaining times.
- `uint32_t totalByteCount`
Number of transfer bytes.
- `uint32_t txBuffIfNull`
Used if there is not txData for DMA purpose.

- `uint32_t rxBuffIfNull`
Used if there is not rxData for DMA purpose.
- `volatile uint8_t state`
LPSPI transfer state.
- `uint32_t errorCount`
Error count for slave transfer.
- `lpspi_slave_edma_transfer_callback_t callback`
Completion callback.
- `void * userData`
Callback user data.
- `edma_handle_t * edmaRxRegToRxDataHandle`
edma_handle_t handle point used for RxReg to RxData buff
- `edma_handle_t * edmaTxDataToTxRegHandle`
edma_handle_t handle point used for TxData to TxReg
- `edma_tcd_t lpspiSoftwareTCD [2]`
SoftwareTCD, internal used.

Field Documentation

- (1) `volatile bool lpspi_slave_edma_handle_t::isByteSwap`
- (2) `volatile uint8_t lpspi_slave_edma_handle_t::fifoSize`
- (3) `volatile uint8_t lpspi_slave_edma_handle_t::rxWatermark`
- (4) `volatile uint8_t lpspi_slave_edma_handle_t::bytesEachWrite`
- (5) `volatile uint8_t lpspi_slave_edma_handle_t::bytesEachRead`
- (6) `volatile uint8_t lpspi_slave_edma_handle_t::bytesLastRead`
- (7) `volatile bool lpspi_slave_edma_handle_t::isThereExtraRxBytes`
- (8) `uint8_t lpspi_slave_edma_handle_t::nbytes`
- (9) `uint8_t* volatile lpspi_slave_edma_handle_t::txData`
- (10) `uint8_t* volatile lpspi_slave_edma_handle_t::rxData`
- (11) `volatile size_t lpspi_slave_edma_handle_t::txRemainingByteCount`
- (12) `volatile size_t lpspi_slave_edma_handle_t::rxRemainingByteCount`
- (13) `volatile uint32_t lpspi_slave_edma_handle_t::writeRegRemainingTimes`
- (14) `volatile uint32_t lpspi_slave_edma_handle_t::readRegRemainingTimes`
- (15) `uint32_t lpspi_slave_edma_handle_t::txBuffIfNull`
- (16) `uint32_t lpspi_slave_edma_handle_t::rxBuffIfNull`

- (17) `volatile uint8_t lpspi_slave_edma_handle_t::state`
- (18) `uint32_t lpspi_slave_edma_handle_t::errorCount`
- (19) `lpspi_slave_edma_transfer_callback_t lpspi_slave_edma_handle_t::callback`
- (20) `void* lpspi_slave_edma_handle_t::userData`

30.3.3 Macro Definition Documentation

30.3.3.1 `#define FSL_LPSPI_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 1, 0))`

30.3.4 Typedef Documentation

30.3.4.1 `typedef void(* lpspi_master_edma_transfer_callback_t)(LPSPI_Type *base, lpspi_master_edma_handle_t *handle, status_t status, void *userData)`

Parameters

<i>base</i>	LPSPI peripheral base address.
<i>handle</i>	Pointer to the handle for the LPSPI master.
<i>status</i>	Success or error code describing whether the transfer completed.
<i>userData</i>	Arbitrary pointer-dataSized value passed from the application.

30.3.4.2 `typedef void(* lpspi_slave_edma_transfer_callback_t)(LPSPI_Type *base, lpspi_slave_edma_handle_t *handle, status_t status, void *userData)`

Parameters

<i>base</i>	LPSPI peripheral base address.
<i>handle</i>	Pointer to the handle for the LPSPI slave.
<i>status</i>	Success or error code describing whether the transfer completed.
<i>userData</i>	Arbitrary pointer-dataSized value passed from the application.

30.3.5 Function Documentation

**30.3.5.1 void LPSPI_MasterTransferCreateHandleEDMA (LPSPI_Type * *base*,
 lpspi_master_edma_handle_t * *handle*, lpspi_master_edma_transfer_callback_t
callback, void * *userData*, edma_handle_t * *edmaRxRegToRxDataHandle*,
 edma_handle_t * *edmaTxDataToTxRegHandle*)**

This function initializes the LPSPI eDMA handle which can be used for other LPSPI transactional APIs. Usually, for a specified LPSPI instance, call this API once to get the initialized handle.

Note that the LPSPI eDMA has a separated (Rx and Tx as two sources) or shared (Rx and Tx are the same source) DMA request source. (1) For a separated DMA request source, enable and set the Rx DMAMUX source for *edmaRxRegToRxDataHandle* and Tx DMAMUX source for *edmaTxDataToTxRegHandle*. (2) For a shared DMA request source, enable and set the Rx/Tx DMAMUX source for *edmaRxRegToRxDataHandle*.

Parameters

<i>base</i>	LPSPI peripheral base address.
<i>handle</i>	LPSPI handle pointer to <i>lpspi_master_edma_handle_t</i> .
<i>callback</i>	LPSPI callback.
<i>userData</i>	callback function parameter.
<i>edmaRxRegTo-RxDataHandle</i>	<i>edmaRxRegToRxDataHandle</i> pointer to edma_handle_t .
<i>edmaTxData-ToTxReg-Handle</i>	<i>edmaTxDataToTxRegHandle</i> pointer to edma_handle_t .

**30.3.5.2 status_t LPSPI_MasterTransferEDMA (LPSPI_Type * *base*,
 lpspi_master_edma_handle_t * *handle*, lpspi_transfer_t * *transfer*)**

This function transfers data using eDMA. This is a non-blocking function, which returns right away. When all data is transferred, the callback function is called.

Note: The transfer data size should be an integer multiple of *bytesPerFrame* if *bytesPerFrame* is less than or equal to 4. For *bytesPerFrame* greater than 4: The transfer data size should be equal to *bytesPerFrame* if the *bytesPerFrame* is not an integer multiple of 4. Otherwise, the transfer data size can be an integer multiple of *bytesPerFrame*.

Parameters

<i>base</i>	LPSPI peripheral base address.
<i>handle</i>	pointer to <code>lpspi_master_edma_handle_t</code> structure which stores the transfer state.
<i>transfer</i>	pointer to <code>lpspi_transfer_t</code> structure.

Returns

status of `status_t`.

30.3.5.3 void LPSPI_MasterTransferAbortEDMA (LPSPI_Type * *base*, lpspi_master_edma_handle_t * *handle*)

This function aborts a transfer which is using eDMA.

Parameters

<i>base</i>	LPSPI peripheral base address.
<i>handle</i>	pointer to <code>lpspi_master_edma_handle_t</code> structure which stores the transfer state.

30.3.5.4 status_t LPSPI_MasterTransferGetCountEDMA (LPSPI_Type * *base*, lpspi_master_edma_handle_t * *handle*, size_t * *count*)

This function gets the master eDMA transfer remaining bytes.

Parameters

<i>base</i>	LPSPI peripheral base address.
<i>handle</i>	pointer to <code>lpspi_master_edma_handle_t</code> structure which stores the transfer state.
<i>count</i>	Number of bytes transferred so far by the EDMA transaction.

Returns

status of `status_t`.

30.3.5.5 void LPSPI_SlaveTransferCreateHandleEDMA (LPSPI_Type * *base*, lpspi_slave_edma_handle_t * *handle*, lpspi_slave_edma_transfer_callback_t *callback*, void * *userData*, edma_handle_t * *edmaRxRegToRxDataHandle*, edma_handle_t * *edmaTxDataToTxRegHandle*)

This function initializes the LPSPI eDMA handle which can be used for other LPSPI transactional APIs. Usually, for a specified LPSPI instance, call this API once to get the initialized handle.

Note that LPSPI eDMA has a separated (Rx and Tx as two sources) or shared (Rx and Tx as the same source) DMA request source.

(1) For a separated DMA request source, enable and set the Rx DMAMUX source for `edmaRxRegToRxDataHandle` and Tx DMAMUX source for `edmaTxDataToTxRegHandle`. (2) For a shared DMA request source, enable and set the Rx/Rx DMAMUX source for `edmaRxRegToRxDataHandle` .

Parameters

<i>base</i>	LPSPI peripheral base address.
<i>handle</i>	LPSPI handle pointer to <code>lpspi_slave_edma_handle_t</code> .
<i>callback</i>	LPSPI callback.
<i>userData</i>	callback function parameter.
<i>edmaRxRegToRxDataHandle</i>	<code>edmaRxRegToRxDataHandle</code> pointer to edma_handle_t .
<i>edmaTxDataToTxRegHandle</i>	<code>edmaTxDataToTxRegHandle</code> pointer to edma_handle_t .

30.3.5.6 `status_t LPSPI_SlaveTransferEDMA (LPSPI_Type * base, lpspi_slave_edma_handle_t * handle, lpspi_transfer_t * transfer)`

This function transfers data using eDMA. This is a non-blocking function, which return right away. When all data is transferred, the callback function is called.

Note: The transfer data size should be an integer multiple of `bytesPerFrame` if `bytesPerFrame` is less than or equal to 4. For `bytesPerFrame` greater than 4: The transfer data size should be equal to `bytesPerFrame` if the `bytesPerFrame` is not an integer multiple of 4. Otherwise, the transfer data size can be an integer multiple of `bytesPerFrame`.

Parameters

<i>base</i>	LPSPI peripheral base address.
<i>handle</i>	pointer to <code>lpspi_slave_edma_handle_t</code> structure which stores the transfer state.
<i>transfer</i>	pointer to lpspi_transfer_t structure.

Returns

status of status_t.

**30.3.5.7 void LPSPI_SlaveTransferAbortEDMA (LPSPI_Type * *base*,
lpspi_slave_edma_handle_t * *handle*)**

This function aborts a transfer which is using eDMA.

Parameters

<i>base</i>	LPSPI peripheral base address.
<i>handle</i>	pointer to <code>lpspi_slave_edma_handle_t</code> structure which stores the transfer state.

30.3.5.8 `status_t LPSPI_SlaveTransferGetCountEDMA (LPSPI_Type * base, lpspi_slave_edma_handle_t * handle, size_t * count)`

This function gets the slave eDMA transfer remaining bytes.

Parameters

<i>base</i>	LPSPI peripheral base address.
<i>handle</i>	pointer to <code>lpspi_slave_edma_handle_t</code> structure which stores the transfer state.
<i>count</i>	Number of bytes transferred so far by the eDMA transaction.

Returns

status of `status_t`.

30.4 LPSPI FreeRTOS Driver

30.4.1 Overview

Driver version

- #define `FSL_LPSPI_FREERTOS_DRIVER_VERSION` (`MAKE_VERSION(2, 0, 5)`)
LPSPI FreeRTOS driver version 2.0.5.

LPSPI RTOS Operation

- `status_t LPSPI_RTOS_Init` (`lpspi_rtos_handle_t *handle`, `LPSPI_Type *base`, `const lpspi_master_config_t *masterConfig`, `uint32_t srcClock_Hz`)
Initializes LPSPI.
- `status_t LPSPI_RTOS_Deinit` (`lpspi_rtos_handle_t *handle`)
Deinitializes the LPSPI.
- `status_t LPSPI_RTOS_Transfer` (`lpspi_rtos_handle_t *handle`, `lpspi_transfer_t *transfer`)
Performs SPI transfer.

30.4.2 Macro Definition Documentation

30.4.2.1 #define FSL_LPSPI_FREERTOS_DRIVER_VERSION (MAKE_VERSION(2, 0, 5))

30.4.3 Function Documentation

30.4.3.1 `status_t LPSPI_RTOS_Init (lpspi_rtos_handle_t * handle, LPSPI_Type * base, const lpspi_master_config_t * masterConfig, uint32_t srcClock_Hz)`

This function initializes the LPSPI module and related RTOS context.

Parameters

<i>handle</i>	The RTOS LPSPI handle, the pointer to an allocated space for RTOS context.
<i>base</i>	The pointer base address of the LPSPI instance to initialize.
<i>masterConfig</i>	Configuration structure to set-up LPSPI in master mode.
<i>srcClock_Hz</i>	Frequency of input clock of the LPSPI module.

Returns

status of the operation.

30.4.3.2 status_t LPSPI_RTOS_Deinit (lpspi_rtos_handle_t * *handle*)

This function deinitializes the LPSPI module and related RTOS context.

Parameters

<i>handle</i>	The RTOS LPSPI handle.
---------------	------------------------

30.4.3.3 `status_t LPSPI_RTOS_Transfer (lpspi_rtos_handle_t * handle, lpspi_transfer_t * transfer)`

This function performs an SPI transfer according to data given in the transfer structure.

Parameters

<i>handle</i>	The RTOS LPSPI handle.
<i>transfer</i>	Structure specifying the transfer parameters.

Returns

status of the operation.

30.5 LPSPI CMSIS Driver

This section describes the programming interface of the LPSPI Cortex Microcontroller Software Interface Standard (CMSIS) driver. And this driver defines generic peripheral driver interfaces for middleware making it reusable across a wide range of supported microcontroller devices. The API connects microcontroller peripherals with middleware that implements for example communication stacks, file systems, or graphic user interfaces. More information and usage method please refer to <http://www.keil.com/pack/doc/cmsis/Driver/html/index.html>.

30.5.1 Function groups

30.5.1.1 LPSPI CMSIS GetVersion Operation

This function group will return the DSPICMSIS Driver version to user.

30.5.1.2 LPSPI CMSIS GetCapabilities Operation

This function group will return the capabilities of this driver.

30.5.1.3 LPSPI CMSIS Initialize and Uninitialize Operation

This function will initialize and uninitialize the instance in master mode or slave mode. And this API must be called before you configure an instance or after you Deinit an instance. The right steps to start an instance is that you must initialize the instance which been selected firstly, then you can power on the instance. After these all have been done, you can configure the instance by using control operation. If you want to Uninitialize the instance, you must power off the instance first.

30.5.1.4 LPSPI Transfer Operation

This function group controls the transfer, master send/receive data, and slave send/receive data.

30.5.1.5 LPSPI Status Operation

This function group gets the LPSPI transfer status.

30.5.1.6 LPSPI CMSIS Control Operation

This function can select instance as master mode or slave mode, set baudrate for master mode transfer, get current baudrate of master mode transfer, set transfer data bits and set other control command.

30.5.2 Typical use case

30.5.2.1 Master Operation

```
/* Variables */
uint8_t masterRxData[TRANSFER_SIZE] = {0U};
uint8_t masterTxData[TRANSFER_SIZE] = {0U};

/*DSPI master init*/
Driver_SPI0.Initialize(DSPI_MasterSignalEvent_t);
Driver_SPI0.PowerControl(ARM_POWER_FULL);
Driver_SPI0.Control(ARM_SPI_MODE_MASTER, TRANSFER_BAUDRATE);

/* Start master transfer */
Driver_SPI0.Transfer(masterTxData, masterRxData, TRANSFER_SIZE);

/* Master power off */
Driver_SPI0.PowerControl(ARM_POWER_OFF);

/* Master uninitialized */
Driver_SPI0.Uninitialize();
```

30.5.2.2 Slave Operation

```
/* Variables */
uint8_t slaveRxData[TRANSFER_SIZE] = {0U};
uint8_t slaveTxData[TRANSFER_SIZE] = {0U};

/*DSPI slave init*/
Driver_SPI2.Initialize(DSPI_SlaveSignalEvent_t);
Driver_SPI2.PowerControl(ARM_POWER_FULL);
Driver_SPI2.Control(ARM_SPI_MODE_SLAVE, false);

/* Start slave transfer */
Driver_SPI2.Transfer(slaveTxData, slaveRxData, TRANSFER_SIZE);

/* slave power off */
Driver_SPI2.PowerControl(ARM_POWER_OFF);

/* slave uninitialized */
Driver_SPI2.Uninitialize();
```

Chapter 31

LPUART: Low Power Universal Asynchronous Receiver/- Transmitter Driver

31.1 Overview

Modules

- [LPUART CMSIS Driver](#)
- [LPUART Driver](#)
- [LPUART FreeRTOS Driver](#)
- [LPUART eDMA Driver](#)

31.2 LPUART Driver

31.2.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Low Power UART (LPUART) module of MCUXpresso SDK devices.

31.2.2 Typical use case

31.2.2.1 LPUART Operation

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/lpuart`

Data Structures

- struct `lpuart_config_t`
LPUART configuration structure. [More...](#)
- struct `lpuart_transfer_t`
LPUART transfer structure. [More...](#)
- struct `lpuart_handle_t`
LPUART handle structure. [More...](#)

Macros

- `#define UART_RETRY_TIMES 0U` /* Defining to zero means to keep waiting for the flag until it is assert/deassert. */
Retry times for waiting flag.

Typedefs

- typedef void(* `lpuart_transfer_callback_t`)(LPUART_Type *base, lpuart_handle_t *handle, `status_t` status, void *userData)
LPUART transfer callback function.

Enumerations

- enum {
 - kStatus_LPUART_TxBusy = MAKE_STATUS(kStatusGroup_LPUART, 0),
 - kStatus_LPUART_RxBusy = MAKE_STATUS(kStatusGroup_LPUART, 1),
 - kStatus_LPUART_TxIdle = MAKE_STATUS(kStatusGroup_LPUART, 2),
 - kStatus_LPUART_RxIdle = MAKE_STATUS(kStatusGroup_LPUART, 3),
 - kStatus_LPUART_TxWatermarkTooLarge = MAKE_STATUS(kStatusGroup_LPUART, 4),
 - kStatus_LPUART_RxWatermarkTooLarge = MAKE_STATUS(kStatusGroup_LPUART, 5),
 - kStatus_LPUART_FlagCannotClearManually = MAKE_STATUS(kStatusGroup_LPUART, 6),
 - kStatus_LPUART_Error = MAKE_STATUS(kStatusGroup_LPUART, 7),
 - kStatus_LPUART_RxRingBufferOverrun,
 - kStatus_LPUART_RxHardwareOverrun = MAKE_STATUS(kStatusGroup_LPUART, 9),
 - kStatus_LPUART_NoiseError = MAKE_STATUS(kStatusGroup_LPUART, 10),
 - kStatus_LPUART_FramingError = MAKE_STATUS(kStatusGroup_LPUART, 11),
 - kStatus_LPUART_ParityError = MAKE_STATUS(kStatusGroup_LPUART, 12),
 - kStatus_LPUART_BaudrateNotSupport,
 - kStatus_LPUART_IdleLineDetected = MAKE_STATUS(kStatusGroup_LPUART, 14),
 - kStatus_LPUART_Timeout = MAKE_STATUS(kStatusGroup_LPUART, 15) }

Error codes for the LPUART driver.
- enum lpuart_parity_mode_t {
 - kLPUART_ParityDisabled = 0x0U,
 - kLPUART_ParityEven = 0x2U,
 - kLPUART_ParityOdd = 0x3U }

LPUART parity mode.
- enum lpuart_data_bits_t {
 - kLPUART_EightDataBits = 0x0U,
 - kLPUART_SevenDataBits = 0x1U }

LPUART data bits count.
- enum lpuart_stop_bit_count_t {
 - kLPUART_OneStopBit = 0U,
 - kLPUART_TwoStopBit = 1U }

LPUART stop bit count.
- enum lpuart_transmit_cts_source_t {
 - kLPUART_CtsSourcePin = 0U,
 - kLPUART_CtsSourceMatchResult = 1U }

LPUART transmit CTS source.
- enum lpuart_transmit_cts_config_t {
 - kLPUART_CtsSampleAtStart = 0U,
 - kLPUART_CtsSampleAtIdle = 1U }

LPUART transmit CTS configure.
- enum lpuart_idle_type_select_t {
 - kLPUART_IdleTypeStartBit = 0U,
 - kLPUART_IdleTypeStopBit = 1U }

LPUART idle flag type defines when the receiver starts counting.
- enum lpuart_idle_config_t {

```

kLPUART_IdleCharacter1 = 0U,
kLPUART_IdleCharacter2 = 1U,
kLPUART_IdleCharacter4 = 2U,
kLPUART_IdleCharacter8 = 3U,
kLPUART_IdleCharacter16 = 4U,
kLPUART_IdleCharacter32 = 5U,
kLPUART_IdleCharacter64 = 6U,
kLPUART_IdleCharacter128 = 7U }

```

LPUART idle detected configuration.

- enum `_lpuart_interrupt_enable` {


```

kLPUART_LinBreakInterruptEnable = (LPUART_BAUD_LBKDIE_MASK >> 8U),
kLPUART_RxActiveEdgeInterruptEnable = (LPUART_BAUD_RXEDGIE_MASK >> 8U),
kLPUART_TxDataRegEmptyInterruptEnable = (LPUART_CTRL_TIE_MASK),
kLPUART_TransmissionCompleteInterruptEnable = (LPUART_CTRL_TCIE_MASK),
kLPUART_RxDataRegFullInterruptEnable = (LPUART_CTRL_RIE_MASK),
kLPUART_IdleLineInterruptEnable = (LPUART_CTRL_ILIE_MASK),
kLPUART_RxOverrunInterruptEnable = (LPUART_CTRL_ORIE_MASK),
kLPUART_NoiseErrorInterruptEnable = (LPUART_CTRL_NEIE_MASK),
kLPUART_FramingErrorInterruptEnable = (LPUART_CTRL_FEIE_MASK),
kLPUART_ParityErrorInterruptEnable = (LPUART_CTRL_PEIE_MASK),
kLPUART_Match1InterruptEnable = (LPUART_CTRL_MA1IE_MASK),
kLPUART_Match2InterruptEnable = (LPUART_CTRL_MA2IE_MASK),
kLPUART_TxFifoOverflowInterruptEnable = (LPUART_FIFO_TXOFE_MASK),
kLPUART_RxFifoUnderflowInterruptEnable = (LPUART_FIFO_RXUFE_MASK) }

```

LPUART interrupt configuration structure, default settings all disabled.

- enum `_lpuart_flags` {


```

kLPUART_TxDataRegEmptyFlag,
kLPUART_TransmissionCompleteFlag,
kLPUART_RxDataRegFullFlag = (LPUART_STAT_RDRF_MASK),
kLPUART_IdleLineFlag = (LPUART_STAT_IDLE_MASK),
kLPUART_RxOverrunFlag = (LPUART_STAT_OR_MASK),
kLPUART_NoiseErrorFlag = (LPUART_STAT_NF_MASK),
kLPUART_FramingErrorFlag,
kLPUART_ParityErrorFlag = (LPUART_STAT_PF_MASK),
kLPUART_LinBreakFlag = (LPUART_STAT_LBKDIF_MASK),
kLPUART_RxActiveEdgeFlag = (LPUART_STAT_RXEDGIF_MASK),
kLPUART_RxActiveFlag,
kLPUART_DataMatch1Flag,
kLPUART_DataMatch2Flag,
kLPUART_TxFifoEmptyFlag,
kLPUART_RxFifoEmptyFlag,
kLPUART_TxFifoOverflowFlag,
kLPUART_RxFifoUnderflowFlag }

```

LPUART status flags.

Driver version

- #define `FSL_LPUART_DRIVER_VERSION` (`MAKE_VERSION(2, 5, 3)`)
LPUART driver version.

Software Reset

- static void `LPUART_SoftwareReset` (`LPUART_Type *base`)
Resets the LPUART using software.

Initialization and deinitialization

- `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.
- void `LPUART_Deinit` (`LPUART_Type *base`)
Deinitializes a LPUART instance.
- void `LPUART_GetDefaultConfig` (`lpuart_config_t *config`)
Gets the default configuration structure.

Module configuration

- `status_t LPUART_SetBaudRate` (`LPUART_Type *base`, `uint32_t baudRate_Bps`, `uint32_t srcClock_Hz`)
Sets the LPUART instance baudrate.
- void `LPUART_Enable9bitMode` (`LPUART_Type *base`, `bool enable`)
Enable 9-bit data mode for LPUART.
- static void `LPUART_SetMatchAddress` (`LPUART_Type *base`, `uint16_t address1`, `uint16_t address2`)
Set the LPUART address.
- static void `LPUART_EnableMatchAddress` (`LPUART_Type *base`, `bool match1`, `bool match2`)
Enable the LPUART match address feature.
- static void `LPUART_SetRxFifoWatermark` (`LPUART_Type *base`, `uint8_t water`)
Sets the rx FIFO watermark.
- static void `LPUART_SetTxFifoWatermark` (`LPUART_Type *base`, `uint8_t water`)
Sets the tx FIFO watermark.

Status

- `uint32_t LPUART_GetStatusFlags` (`LPUART_Type *base`)
Gets LPUART status flags.
- `status_t LPUART_ClearStatusFlags` (`LPUART_Type *base`, `uint32_t mask`)
Clears status flags with a provided mask.

Interrupts

- void [LPUART_EnableInterrupts](#) (LPUART_Type *base, uint32_t mask)
Enables LPUART interrupts according to a provided mask.
- void [LPUART_DisableInterrupts](#) (LPUART_Type *base, uint32_t mask)
Disables LPUART interrupts according to a provided mask.
- uint32_t [LPUART_GetEnabledInterrupts](#) (LPUART_Type *base)
Gets enabled LPUART interrupts.

DMA Configuration

- static uint32_t [LPUART_GetDataRegisterAddress](#) (LPUART_Type *base)
Gets the LPUART data register address.
- static void [LPUART_EnableTxDMA](#) (LPUART_Type *base, bool enable)
Enables or disables the LPUART transmitter DMA request.
- static void [LPUART_EnableRxDMA](#) (LPUART_Type *base, bool enable)
Enables or disables the LPUART receiver DMA.

Bus Operations

- uint32_t [LPUART_GetInstance](#) (LPUART_Type *base)
Get the LPUART instance from peripheral base address.
- static void [LPUART_EnableTx](#) (LPUART_Type *base, bool enable)
Enables or disables the LPUART transmitter.
- static void [LPUART_EnableRx](#) (LPUART_Type *base, bool enable)
Enables or disables the LPUART receiver.
- static void [LPUART_WriteByte](#) (LPUART_Type *base, uint8_t data)
Writes to the transmitter register.
- static uint8_t [LPUART_ReadByte](#) (LPUART_Type *base)
Reads the receiver register.
- static uint8_t [LPUART_GetRxFifoCount](#) (LPUART_Type *base)
Gets the rx FIFO data count.
- static uint8_t [LPUART_GetTxFifoCount](#) (LPUART_Type *base)
Gets the tx FIFO data count.
- void [LPUART_SendAddress](#) (LPUART_Type *base, uint8_t address)
Transmit an address frame in 9-bit data mode.
- [status_t](#) [LPUART_WriteBlocking](#) (LPUART_Type *base, const uint8_t *data, size_t length)
Writes to the transmitter register using a blocking method.
- [status_t](#) [LPUART_ReadBlocking](#) (LPUART_Type *base, uint8_t *data, size_t length)
Reads the receiver data register using a blocking method.

Transactional

- void [LPUART_TransferCreateHandle](#) (LPUART_Type *base, lpuart_handle_t *handle, [lpuart_transfer_callback_t](#) callback, void *userData)
Initializes the LPUART handle.

- `status_t LPUART_TransferSendNonBlocking` (LPUART_Type *base, lpuart_handle_t *handle, lpuart_transfer_t *xfer)
Transmits a buffer of data using the interrupt method.
- void `LPUART_TransferStartRingBuffer` (LPUART_Type *base, lpuart_handle_t *handle, uint8_t *ringBuffer, size_t ringBufferSize)
Sets up the RX ring buffer.
- void `LPUART_TransferStopRingBuffer` (LPUART_Type *base, lpuart_handle_t *handle)
Aborts the background transfer and uninstalls the ring buffer.
- size_t `LPUART_TransferGetRxRingBufferLength` (LPUART_Type *base, lpuart_handle_t *handle)
Get the length of received data in RX ring buffer.
- void `LPUART_TransferAbortSend` (LPUART_Type *base, lpuart_handle_t *handle)
Aborts the interrupt-driven data transmit.
- `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.
- `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.
- void `LPUART_TransferAbortReceive` (LPUART_Type *base, lpuart_handle_t *handle)
Aborts the interrupt-driven data receiving.
- `status_t LPUART_TransferGetReceiveCount` (LPUART_Type *base, lpuart_handle_t *handle, uint32_t *count)
Gets the number of bytes that have been received.
- void `LPUART_TransferHandleIRQ` (LPUART_Type *base, void *irqHandle)
LPUART IRQ handle function.
- void `LPUART_TransferHandleErrorIRQ` (LPUART_Type *base, void *irqHandle)
LPUART Error IRQ handle function.

31.2.3 Data Structure Documentation

31.2.3.1 struct lpuart_config_t

Data Fields

- 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.

Field Documentation

(1) `lpuart_idle_type_select_t lpuart_config_t::rxIdleType`

(2) `lpuart_idle_config_t lpuart_config_t::rxIdleConfig`

31.2.3.2 struct `lpuart_transfer_t`

Data Fields

- `size_t dataSize`
The byte count to be transfer.
- `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.

Field Documentation

(1) `uint8_t* lpuart_transfer_t::data`

(2) `uint8_t* lpuart_transfer_t::rxData`

(3) `const uint8_t* lpuart_transfer_t::txData`

(4) `size_t lpuart_transfer_t::dataSize`

31.2.3.3 struct `_lpuart_handle`

Data Fields

- `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.
- `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.

Field Documentation

- (1) `const uint8_t* volatile lpuart_handle_t::txData`
- (2) `volatile size_t lpuart_handle_t::txDataSize`
- (3) `size_t lpuart_handle_t::txDataSizeAll`
- (4) `uint8_t* volatile lpuart_handle_t::rxData`
- (5) `volatile size_t lpuart_handle_t::rxDataSize`
- (6) `size_t lpuart_handle_t::rxDataSizeAll`
- (7) `uint8_t* lpuart_handle_t::rxRingBuffer`

- (8) `size_t lpuart_handle_t::rxRingBufferSize`
- (9) `volatile uint16_t lpuart_handle_t::rxRingBufferHead`
- (10) `volatile uint16_t lpuart_handle_t::rxRingBufferTail`
- (11) `lpuart_transfer_callback_t lpuart_handle_t::callback`
- (12) `void* lpuart_handle_t::userData`
- (13) `volatile uint8_t lpuart_handle_t::txState`
- (14) `volatile uint8_t lpuart_handle_t::rxState`
- (15) `bool lpuart_handle_t::isSevenDataBits`

31.2.4 Macro Definition Documentation

31.2.4.1 `#define FSL_LPUART_DRIVER_VERSION (MAKE_VERSION(2, 5, 3))`

31.2.4.2 `#define UART_RETRY_TIMES 0U /* Defining to zero means to keep waiting for the flag until it is assert/deassert. */`

31.2.5 Typedef Documentation

31.2.5.1 `typedef void(* lpuart_transfer_callback_t)(LPUART_Type *base, lpuart_handle_t *handle, status_t status, void *userData)`

31.2.6 Enumeration Type Documentation

31.2.6.1 anonymous enum

Enumerator

- kStatus_LPUART_TxBusy* TX busy.
- kStatus_LPUART_RxBusy* RX busy.
- kStatus_LPUART_TxIdle* LPUART transmitter is idle.
- kStatus_LPUART_RxIdle* LPUART receiver is idle.
- kStatus_LPUART_TxWatermarkTooLarge* TX FIFO watermark too large.
- kStatus_LPUART_RxWatermarkTooLarge* RX FIFO watermark too large.
- kStatus_LPUART_FlagCannotClearManually* Some flag can't manually clear.
- kStatus_LPUART_Error* Error happens on LPUART.
- kStatus_LPUART_RxRingBufferOverrun* LPUART RX software ring buffer overrun.
- kStatus_LPUART_RxHardwareOverrun* LPUART RX receiver overrun.
- kStatus_LPUART_NoiseError* LPUART noise error.
- kStatus_LPUART_FramingError* LPUART framing error.

kStatus_LPUART_ParityError LPUART parity error.

kStatus_LPUART_BaudrateNotSupport Baudrate is not support in current clock source.

kStatus_LPUART_IdleLineDetected IDLE flag.

kStatus_LPUART_Timeout LPUART times out.

31.2.6.2 enum lpuart_parity_mode_t

Enumerator

kLPUART_ParityDisabled Parity disabled.

kLPUART_ParityEven Parity enabled, type even, bit setting: PE|PT = 10.

kLPUART_ParityOdd Parity enabled, type odd, bit setting: PE|PT = 11.

31.2.6.3 enum lpuart_data_bits_t

Enumerator

kLPUART_EightDataBits Eight data bit.

kLPUART_SevenDataBits Seven data bit.

31.2.6.4 enum lpuart_stop_bit_count_t

Enumerator

kLPUART_OneStopBit One stop bit.

kLPUART_TwoStopBit Two stop bits.

31.2.6.5 enum lpuart_transmit_cts_source_t

Enumerator

kLPUART_CtsSourcePin CTS resource is the LPUART_CTS pin.

kLPUART_CtsSourceMatchResult CTS resource is the match result.

31.2.6.6 enum lpuart_transmit_cts_config_t

Enumerator

kLPUART_CtsSampleAtStart CTS input is sampled at the start of each character.

kLPUART_CtsSampleAtIdle CTS input is sampled when the transmitter is idle.

31.2.6.7 enum lpuart_idle_type_select_t

Enumerator

kLPUART_IdleTypeStartBit Start counting after a valid start bit.

kLPUART_IdleTypeStopBit Start counting after a stop bit.

31.2.6.8 enum lpuart_idle_config_t

This structure defines the number of idle characters that must be received before the IDLE flag is set.

Enumerator

kLPUART_IdleCharacter1 the number of idle characters.

kLPUART_IdleCharacter2 the number of idle characters.

kLPUART_IdleCharacter4 the number of idle characters.

kLPUART_IdleCharacter8 the number of idle characters.

kLPUART_IdleCharacter16 the number of idle characters.

kLPUART_IdleCharacter32 the number of idle characters.

kLPUART_IdleCharacter64 the number of idle characters.

kLPUART_IdleCharacter128 the number of idle characters.

31.2.6.9 enum _lpuart_interrupt_enable

This structure contains the settings for all LPUART interrupt configurations.

Enumerator

kLPUART_LinBreakInterruptEnable LIN break detect. bit 7

kLPUART_RxActiveEdgeInterruptEnable Receive Active Edge. bit 6

kLPUART_TxDataRegEmptyInterruptEnable Transmit data register empty. bit 23

kLPUART_TransmissionCompleteInterruptEnable Transmission complete. bit 22

kLPUART_RxDataRegFullInterruptEnable Receiver data register full. bit 21

kLPUART_IdleLineInterruptEnable Idle line. bit 20

kLPUART_RxOverrunInterruptEnable Receiver Overrun. bit 27

kLPUART_NoiseErrorInterruptEnable Noise error flag. bit 26

kLPUART_FramingErrorInterruptEnable Framing error flag. bit 25

kLPUART_ParityErrorInterruptEnable Parity error flag. bit 24

kLPUART_Match1InterruptEnable Parity error flag. bit 15

kLPUART_Match2InterruptEnable Parity error flag. bit 14

kLPUART_TxFifoOverflowInterruptEnable Transmit FIFO Overflow. bit 9

kLPUART_RxFifoUnderflowInterruptEnable Receive FIFO Underflow. bit 8

31.2.6.10 enum _lpuart_flags

This provides constants for the LPUART status flags for use in the LPUART functions.

Enumerator

- kLPUART_TxDataRegEmptyFlag* Transmit data register empty flag, sets when transmit buffer is empty. bit 23
- kLPUART_TransmissionCompleteFlag* Transmission complete flag, sets when transmission activity complete. bit 22
- kLPUART_RxDataRegFullFlag* Receive data register full flag, sets when the receive data buffer is full. bit 21
- kLPUART_IdleLineFlag* Idle line detect flag, sets when idle line detected. bit 20
- kLPUART_RxOverrunFlag* Receive Overrun, sets when new data is received before data is read from receive register. bit 19
- kLPUART_NoiseErrorFlag* Receive takes 3 samples of each received bit. If any of these samples differ, noise flag sets. bit 18
- kLPUART_FramingErrorFlag* Frame error flag, sets if logic 0 was detected where stop bit expected. bit 17
- kLPUART_ParityErrorFlag* If parity enabled, sets upon parity error detection. bit 16
- kLPUART_LinBreakFlag* LIN break detect interrupt flag, sets when LIN break char detected and LIN circuit enabled. bit 31
- kLPUART_RxActiveEdgeFlag* Receive pin active edge interrupt flag, sets when active edge detected. bit 30
- kLPUART_RxActiveFlag* Receiver Active Flag (RAF), sets at beginning of valid start. bit 24
- kLPUART_DataMatch1Flag* The next character to be read from LPUART_DATA matches MA1. bit 15
- kLPUART_DataMatch2Flag* The next character to be read from LPUART_DATA matches MA2. bit 14
- kLPUART_TxFifoEmptyFlag* TXEMPT bit, sets if transmit buffer is empty. bit 7
- kLPUART_RxFifoEmptyFlag* RXEMPT bit, sets if receive buffer is empty. bit 6
- kLPUART_TxFifoOverflowFlag* TXOF bit, sets if transmit buffer overflow occurred. bit 1
- kLPUART_RxFifoUnderflowFlag* RXUF bit, sets if receive buffer underflow occurred. bit 0

31.2.7 Function Documentation

31.2.7.1 static void LPUART_SoftwareReset (LPUART_Type * base) [inline], [static]

This function resets all internal logic and registers except the Global Register. Remains set until cleared by software.

Parameters

<i>base</i>	LPUART peripheral base address.
-------------	---------------------------------

31.2.7.2 `status_t LPUART_Init (LPUART_Type * base, const lpuart_config_t * config, uint32_t srcClock_Hz)`

This function configures the LPUART module with user-defined settings. Call the [LPUART_GetDefault-Config\(\)](#) 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

<i>base</i>	LPUART peripheral base address.
<i>config</i>	Pointer to a user-defined configuration structure.
<i>srcClock_Hz</i>	LPUART clock source frequency in HZ.

Return values

<i>kStatus_LPUART_-BaudrateNotSupport</i>	Baudrate is not support in current clock source.
<i>kStatus_Success</i>	LPUART initialize succeed

31.2.7.3 `void LPUART_Deinit (LPUART_Type * base)`

This function waits for transmit to complete, disables TX and RX, and disables the LPUART clock.

Parameters

<i>base</i>	LPUART peripheral base address.
-------------	---------------------------------

31.2.7.4 void LPUART_GetDefaultConfig (lpuart_config_t * config)

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

<i>config</i>	Pointer to a configuration structure.
---------------	---------------------------------------

31.2.7.5 status_t LPUART_SetBaudRate (LPUART_Type * base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)

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, 200000000U);
*
```

Parameters

<i>base</i>	LPUART peripheral base address.
<i>baudRate_Bps</i>	LPUART baudrate to be set.
<i>srcClock_Hz</i>	LPUART clock source frequency in HZ.

Return values

<i>kStatus_LPUART_-BaudrateNotSupport</i>	Baudrate is not supported in the current clock source.
<i>kStatus_Success</i>	Set baudrate succeeded.

31.2.7.6 void LPUART_Enable9bitMode (LPUART_Type * base, bool enable)

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

<i>base</i>	LPUART peripheral base address.
<i>enable</i>	true to enable, false to disable.

31.2.7.7 static void LPUART_SetMatchAddress (LPUART_Type * *base*, uint16_t *address1*, uint16_t *address2*) [inline], [static]

This function configures the address for LPUART module that works as slave in 9-bit data mode. One or two address fields can be configured. When the address field's match enable bit is set, the frame it receives with MSB being 1 is considered as an address frame, otherwise it is considered as data frame. Once the address frame matches one of slave's own addresses, this slave is addressed. This address frame and its following data frames are stored in the receive buffer, otherwise the frames will be discarded. To un-address a slave, just send an address frame with unmatched address.

Note

Any LPUART instance joined in the multi-slave system can work as slave. The position of the address mark is the same as the parity bit when parity is enabled for 8 bit and 9 bit data formats.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>address1</i>	LPUART slave address1.
<i>address2</i>	LPUART slave address2.

31.2.7.8 static void LPUART_EnableMatchAddress (LPUART_Type * *base*, bool *match1*, bool *match2*) [inline], [static]

Parameters

<i>base</i>	LPUART peripheral base address.
<i>match1</i>	true to enable match address1, false to disable.
<i>match2</i>	true to enable match address2, false to disable.

31.2.7.9 static void LPUART_SetRxFifoWatermark (LPUART_Type * *base*, uint8_t *water*) [inline], [static]

Parameters

<i>base</i>	LPUART peripheral base address.
<i>water</i>	Rx FIFO watermark.

31.2.7.10 static void LPUART_SetTxFifoWatermark (LPUART_Type * *base*, uint8_t *water*) [inline], [static]

Parameters

<i>base</i>	LPUART peripheral base address.
<i>water</i>	Tx FIFO watermark.

31.2.7.11 uint32_t LPUART_GetStatusFlags (LPUART_Type * *base*)

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

<i>base</i>	LPUART peripheral base address.
-------------	---------------------------------

Returns

LPUART status flags which are ORed by the enumerators in the `_lpuart_flags`.

31.2.7.12 status_t LPUART_ClearStatusFlags (LPUART_Type * *base*, uint32_t *mask*)

This function clears LPUART status flags with a provided mask. Automatically cleared flags can't be cleared by this function. Flags that can only be cleared or set by hardware are: `kLPUART_TxDataRegEmptyFlag`, `kLPUART_TransmissionCompleteFlag`, `kLPUART_RxDataRegFullFlag`, `kLPUART_RxActiveFlag`, `kLPUART_NoiseErrorFlag`, `kLPUART_ParityErrorFlag`, `kLPUART_TxFifoEmptyFlag`, `kLPUART_RxFifoEmptyFlag`. Note: This API should be called when the Tx/Rx is idle, otherwise it takes no effects.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>mask</i>	the status flags to be cleared. The user can use the enumerators in the <code>_lpuart_status_flag_t</code> to do the OR operation and get the mask.

Returns

0 succeed, others failed.

Return values

<i>kStatus_LPUART_Flag- CannotClearManually</i>	The flag can't be cleared by this function but it is cleared automatically by hardware.
<i>kStatus_Success</i>	Status in the mask are cleared.

31.2.7.13 void LPUART_EnableInterrupts (LPUART_Type * *base*, uint32_t *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

<i>base</i>	LPUART peripheral base address.
<i>mask</i>	The interrupts to enable. Logical OR of _lpuart_interrupt_enable .

31.2.7.14 void LPUART_DisableInterrupts (LPUART_Type * *base*, uint32_t *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

<i>base</i>	LPUART peripheral base address.
<i>mask</i>	The interrupts to disable. Logical OR of _lpuart_interrupt_enable .

31.2.7.15 uint32_t LPUART_GetEnabledInterrupts (LPUART_Type * *base*)

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

<i>base</i>	LPUART peripheral base address.
-------------	---------------------------------

Returns

LPUART interrupt flags which are logical OR of the enumerators in [_lpuart_interrupt_enable](#).

**31.2.7.16 static uint32_t LPUART_GetDataRegisterAddress (LPUART_Type * *base*)
[inline], [static]**

This function returns the LPUART data register address, which is mainly used by the DMA/eDMA.

Parameters

<i>base</i>	LPUART peripheral base address.
-------------	---------------------------------

Returns

LPUART data register addresses which are used both by the transmitter and receiver.

**31.2.7.17 static void LPUART_EnableTxDMA (LPUART_Type * *base*, bool *enable*)
[inline], [static]**

This function enables or disables the transmit data register empty flag, STAT[TDRE], to generate DMA requests.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>enable</i>	True to enable, false to disable.

**31.2.7.18 static void LPUART_EnableRxDMA (LPUART_Type * *base*, bool *enable*)
[inline], [static]**

This function enables or disables the receiver data register full flag, STAT[RDRF], to generate DMA requests.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>enable</i>	True to enable, false to disable.

31.2.7.19 uint32_t LPUART_GetInstance (LPUART_Type * *base*)

Parameters

<i>base</i>	LPUART peripheral base address.
-------------	---------------------------------

Returns

LPUART instance.

**31.2.7.20 static void LPUART_EnableTx (LPUART_Type * *base*, bool *enable*)
[inline], [static]**

This function enables or disables the LPUART transmitter.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>enable</i>	True to enable, false to disable.

**31.2.7.21 static void LPUART_EnableRx (LPUART_Type * *base*, bool *enable*)
[inline], [static]**

This function enables or disables the LPUART receiver.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>enable</i>	True to enable, false to disable.

**31.2.7.22 static void LPUART_WriteByte (LPUART_Type * *base*, uint8_t *data*)
[inline], [static]**

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

<i>base</i>	LPUART peripheral base address.
<i>data</i>	Data write to the TX register.

**31.2.7.23 static uint8_t LPUART_ReadByte (LPUART_Type * *base*) [inline],
[static]**

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

<i>base</i>	LPUART peripheral base address.
-------------	---------------------------------

Returns

Data read from data register.

**31.2.7.24 static uint8_t LPUART_GetRxFifoCount (LPUART_Type * *base*) [inline],
[static]**

Parameters

<i>base</i>	LPUART peripheral base address.
-------------	---------------------------------

Returns

rx FIFO data count.

31.2.7.25 static uint8_t LPUART_GetTxFifoCount (LPUART_Type * *base*) [inline], [static]

Parameters

<i>base</i>	LPUART peripheral base address.
-------------	---------------------------------

Returns

tx FIFO data count.

31.2.7.26 void LPUART_SendAddress (LPUART_Type * *base*, uint8_t *address*)

Parameters

<i>base</i>	LPUART peripheral base address.
<i>address</i>	LPUART slave address.

31.2.7.27 status_t LPUART_WriteBlocking (LPUART_Type * *base*, const uint8_t * *data*, size_t *length*)

This function polls the transmitter register, first waits for the register to be empty or TX FIFO to have room, and writes data to the transmitter buffer, then waits for the data to be sent out to the bus.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>data</i>	Start address of the data to write.
<i>length</i>	Size of the data to write.

Return values

<i>kStatus_LPUART_-Timeout</i>	Transmission timed out and was aborted.
<i>kStatus_Success</i>	Successfully wrote all data.

31.2.7.28 **status_t LPUART_ReadBlocking (LPUART_Type * *base*, uint8_t * *data*, size_t *length*)**

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

<i>base</i>	LPUART peripheral base address.
<i>data</i>	Start address of the buffer to store the received data.
<i>length</i>	Size of the buffer.

Return values

<i>kStatus_LPUART_Rx-HardwareOverrun</i>	Receiver overrun happened while receiving data.
<i>kStatus_LPUART_Noise-Error</i>	Noise error happened while receiving data.
<i>kStatus_LPUART_-FramingError</i>	Framing error happened while receiving data.
<i>kStatus_LPUART_Parity-Error</i>	Parity error happened while receiving data.
<i>kStatus_LPUART_-Timeout</i>	Transmission timed out and was aborted.
<i>kStatus_Success</i>	Successfully received all data.

31.2.7.29 **void LPUART_TransferCreateHandle (LPUART_Type * *base*, lpuart_handle_t * *handle*, lpuart_transfer_callback_t *callback*, void * *userData*)**

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

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	LPUART handle pointer.
<i>callback</i>	Callback function.
<i>userData</i>	User data.

31.2.7.30 `status_t LPUART_TransferSendNonBlocking (LPUART_Type * base, lpuart_handle_t * handle, lpuart_transfer_t * xfer)`

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 T-X, check the `kLPUART_TransmissionCompleteFlag` to ensure that the transmit is finished.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	LPUART handle pointer.
<i>xfer</i>	LPUART transfer structure, see lpuart_transfer_t .

Return values

<i>kStatus_Success</i>	Successfully start the data transmission.
<i>kStatus_LPUART_TxBusy</i>	Previous transmission still not finished, data not all written to the TX register.
<i>kStatus_InvalidArgument</i>	Invalid argument.

31.2.7.31 `void LPUART_TransferStartRingBuffer (LPUART_Type * base, lpuart_handle_t * handle, uint8_t * ringBuffer, size_t ringBufferSize)`

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

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	LPUART handle pointer.
<i>ringBuffer</i>	Start address of ring buffer for background receiving. Pass NULL to disable the ring buffer.
<i>ringBufferSize</i>	size of the ring buffer.

31.2.7.32 void LPUART_TransferStopRingBuffer (LPUART_Type * *base*, lpuart_handle_t * *handle*)

This function aborts the background transfer and uninstalls the ring buffer.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	LPUART handle pointer.

31.2.7.33 size_t LPUART_TransferGetRxRingBufferLength (LPUART_Type * *base*, lpuart_handle_t * *handle*)

Parameters

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	LPUART handle pointer.

Returns

Length of received data in RX ring buffer.

31.2.7.34 void LPUART_TransferAbortSend (LPUART_Type * *base*, lpuart_handle_t * *handle*)

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

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	LPUART handle pointer.

31.2.7.35 `status_t LPUART_TransferGetSendCount (LPUART_Type * base, lpuart_handle_t * handle, uint32_t * count)`

This function gets the number of bytes that have been sent out to bus by an interrupt method.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	LPUART handle pointer.
<i>count</i>	Send bytes count.

Return values

<i>kStatus_NoTransferInProgress</i>	No send in progress.
<i>kStatus_InvalidArgument</i>	Parameter is invalid.
<i>kStatus_Success</i>	Get successfully through the parameter <code>count</code> ;

31.2.7.36 `status_t LPUART_TransferReceiveNonBlocking (LPUART_Type * base, lpuart_handle_t * handle, lpuart_transfer_t * xfer, size_t * receivedBytes)`

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

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	LPUART handle pointer.
<i>xfer</i>	LPUART transfer structure, see <code>uart_transfer_t</code> .
<i>receivedBytes</i>	Bytes received from the ring buffer directly.

Return values

<i>kStatus_Success</i>	Successfully queue the transfer into the transmit queue.
<i>kStatus_LPUART_Rx-Busy</i>	Previous receive request is not finished.
<i>kStatus_InvalidArgument</i>	Invalid argument.

31.2.7.37 void LPUART_TransferAbortReceive (LPUART_Type * *base*, lpuart_handle_t * *handle*)

This function aborts the interrupt-driven data receiving. The user can get the `remainBytes` to find out how many bytes not received yet.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	LPUART handle pointer.

31.2.7.38 status_t LPUART_TransferGetReceiveCount (LPUART_Type * *base*, lpuart_handle_t * *handle*, uint32_t * *count*)

This function gets the number of bytes that have been received.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	LPUART handle pointer.
<i>count</i>	Receive bytes count.

Return values

<i>kStatus_NoTransferInProgress</i>	No receive in progress.
<i>kStatus_InvalidArgument</i>	Parameter is invalid.
<i>kStatus_Success</i>	Get successfully through the parameter count;

31.2.7.39 void LPUART_TransferHandleIRQ (LPUART_Type * *base*, void * *irqHandle*)

This function handles the LPUART transmit and receive IRQ request.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>irqHandle</i>	LPUART handle pointer.

31.2.7.40 void LPUART_TransferHandleErrorIRQ (LPUART_Type * *base*, void * *irqHandle*)

This function handles the LPUART error IRQ request.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>irqHandle</i>	LPUART handle pointer.

31.3 LPUART eDMA Driver

31.3.1 Overview

Data Structures

- struct `lpuart_edma_handle_t`
LPUART eDMA handle. [More...](#)

Typedefs

- typedef void(* `lpuart_edma_transfer_callback_t`)(LPUART_Type *base, lpuart_edma_handle_t *handle, `status_t` status, void *userData)
LPUART transfer callback function.

Driver version

- #define `FSL_LPUART_EDMA_DRIVER_VERSION` (`MAKE_VERSION(2, 5, 2)`)
LPUART EDMA driver version.

eDMA transactional

- void `LPUART_TransferCreateHandleEDMA` (LPUART_Type *base, lpuart_edma_handle_t *handle, `lpuart_edma_transfer_callback_t` callback, void *userData, `edma_handle_t` *txEdmaHandle, `edma_handle_t` *rxEdmaHandle)
Initializes the LPUART handle which is used in transactional functions.
- `status_t` `LPUART_SendEDMA` (LPUART_Type *base, lpuart_edma_handle_t *handle, `lpuart_transfer_t` *xfer)
Sends data using eDMA.
- `status_t` `LPUART_ReceiveEDMA` (LPUART_Type *base, lpuart_edma_handle_t *handle, `lpuart_transfer_t` *xfer)
Receives data using eDMA.
- void `LPUART_TransferAbortSendEDMA` (LPUART_Type *base, lpuart_edma_handle_t *handle)
Aborts the sent data using eDMA.
- void `LPUART_TransferAbortReceiveEDMA` (LPUART_Type *base, lpuart_edma_handle_t *handle)
Aborts the received data using eDMA.
- `status_t` `LPUART_TransferGetSendCountEDMA` (LPUART_Type *base, lpuart_edma_handle_t *handle, `uint32_t` *count)
Gets the number of bytes written to the LPUART TX register.
- `status_t` `LPUART_TransferGetReceiveCountEDMA` (LPUART_Type *base, lpuart_edma_handle_t *handle, `uint32_t` *count)
Gets the number of received bytes.
- void `LPUART_TransferEdmaHandleIRQ` (LPUART_Type *base, void *lpuartEdmaHandle)
LPUART eDMA IRQ handle function.

31.3.2 Data Structure Documentation

31.3.2.1 struct `_lpuart_edma_handle`

Data Fields

- `lpuart_edma_transfer_callback_t` `callback`
Callback function.
- `void *` `userData`
LPUART callback function parameter.
- `size_t` `rxDataSizeAll`
Size of the data to receive.
- `size_t` `txDataSizeAll`
Size of the data to send out.
- `edma_handle_t *` `txEdmaHandle`
The eDMA TX channel used.
- `edma_handle_t *` `rxEdmaHandle`
The eDMA RX channel used.
- `uint8_t` `nbytes`
eDMA minor byte transfer count initially configured.
- `volatile uint8_t` `txState`
TX transfer state.
- `volatile uint8_t` `rxState`
RX transfer state.

Field Documentation

- (1) `lpuart_edma_transfer_callback_t` `lpuart_edma_handle_t::callback`
- (2) `void*` `lpuart_edma_handle_t::userData`
- (3) `size_t` `lpuart_edma_handle_t::rxDataSizeAll`
- (4) `size_t` `lpuart_edma_handle_t::txDataSizeAll`
- (5) `edma_handle_t*` `lpuart_edma_handle_t::txEdmaHandle`
- (6) `edma_handle_t*` `lpuart_edma_handle_t::rxEdmaHandle`
- (7) `uint8_t` `lpuart_edma_handle_t::nbytes`
- (8) `volatile uint8_t` `lpuart_edma_handle_t::txState`

31.3.3 Macro Definition Documentation

31.3.3.1 `#define FSL_LPUART_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 5, 2))`

31.3.4 Typedef Documentation

31.3.4.1 `typedef void(* lpuart_edma_transfer_callback_t)(LPUART_Type *base, lpuart_edma_handle_t *handle, status_t status, void *userData)`

31.3.5 Function Documentation

31.3.5.1 `void LPUART_TransferCreateHandleEDMA (LPUART_Type * base, lpuart_edma_handle_t * handle, lpuart_edma_transfer_callback_t callback, void * userData, edma_handle_t * txEdmaHandle, edma_handle_t * rxEdmaHandle)`

Note

This function disables all LPUART interrupts.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	Pointer to <code>lpuart_edma_handle_t</code> structure.
<i>callback</i>	Callback function.
<i>userData</i>	User data.
<i>txEdmaHandle</i>	User requested DMA handle for TX DMA transfer.
<i>rxEdmaHandle</i>	User requested DMA handle for RX DMA transfer.

31.3.5.2 `status_t LPUART_SendEDMA (LPUART_Type * base, lpuart_edma_handle_t * handle, lpuart_transfer_t * xfer)`

This function sends data using eDMA. This is a non-blocking function, which returns right away. When all data is sent, the send callback function is called.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	LPUART handle pointer.
<i>xfer</i>	LPUART eDMA transfer structure. See lpuart_transfer_t .

Return values

<i>kStatus_Success</i>	if succeed, others failed.
<i>kStatus_LPUART_TxBusy</i>	Previous transfer on going.
<i>kStatus_InvalidArgument</i>	Invalid argument.

31.3.5.3 **status_t LPUART_ReceiveEDMA (LPUART_Type * *base*, lpuart_edma_handle_t * *handle*, lpuart_transfer_t * *xfer*)**

This function receives data using eDMA. This is non-blocking function, which returns right away. When all data is received, the receive callback function is called.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	Pointer to lpuart_edma_handle_t structure.
<i>xfer</i>	LPUART eDMA transfer structure, see lpuart_transfer_t .

Return values

<i>kStatus_Success</i>	if succeed, others fail.
<i>kStatus_LPUART_RxBusy</i>	Previous transfer ongoing.
<i>kStatus_InvalidArgument</i>	Invalid argument.

31.3.5.4 **void LPUART_TransferAbortSendEDMA (LPUART_Type * *base*, lpuart_edma_handle_t * *handle*)**

This function aborts the sent data using eDMA.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	Pointer to lpuart_edma_handle_t structure.

31.3.5.5 **void LPUART_TransferAbortReceiveEDMA (LPUART_Type * *base*, lpuart_edma_handle_t * *handle*)**

This function aborts the received data using eDMA.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	Pointer to <code>lpuart_edma_handle_t</code> structure.

31.3.5.6 `status_t LPUART_TransferGetSendCountEDMA (LPUART_Type * base, lpuart_edma_handle_t * handle, uint32_t * count)`

This function gets the number of bytes written to the LPUART TX register by DMA.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	LPUART handle pointer.
<i>count</i>	Send bytes count.

Return values

<i>kStatus_NoTransferInProgress</i>	No send in progress.
<i>kStatus_InvalidArgument</i>	Parameter is invalid.
<i>kStatus_Success</i>	Get successfully through the parameter <code>count</code> ;

31.3.5.7 `status_t LPUART_TransferGetReceiveCountEDMA (LPUART_Type * base, lpuart_edma_handle_t * handle, uint32_t * count)`

This function gets the number of received bytes.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>handle</i>	LPUART handle pointer.
<i>count</i>	Receive bytes count.

Return values

<i>kStatus_NoTransferInProgress</i>	No receive in progress.
<i>kStatus_InvalidArgument</i>	Parameter is invalid.
<i>kStatus_Success</i>	Get successfully through the parameter count;

31.3.5.8 void LPUART_TransferEdmaHandleIRQ (LPUART_Type * *base*, void * *lpuartEdmaHandle*)

This function handles the LPUART tx complete IRQ request and invoke user callback. It is not set to static so that it can be used in user application.

Note

This function is used as default IRQ handler by double weak mechanism. If user's specific IRQ handler is implemented, make sure this function is invoked in the handler.

Parameters

<i>base</i>	LPUART peripheral base address.
<i>lpuartEdmaHandle</i>	LPUART handle pointer.

31.4 LPUART FreeRTOS Driver

31.4.1 Overview

Data Structures

- struct [lpuart_rtos_config_t](#)
LPUART RTOS configuration structure. [More...](#)

Driver version

- #define [FSL_LPUART_FREERTOS_DRIVER_VERSION](#) (MAKE_VERSION(2, 6, 0))
LPUART FreeRTOS driver version.

LPUART RTOS Operation

- int [LPUART_RTOS_Init](#) (lpuart_rtos_handle_t *handle, lpuart_handle_t *t_handle, const [lpuart_rtos_config_t](#) *cfg)
Initializes an LPUART instance for operation in RTOS.
- int [LPUART_RTOS_Deinit](#) (lpuart_rtos_handle_t *handle)
Deinitializes an LPUART instance for operation.

LPUART transactional Operation

- int [LPUART_RTOS_Send](#) (lpuart_rtos_handle_t *handle, uint8_t *buffer, uint32_t length)
Sends data in the background.
- int [LPUART_RTOS_Receive](#) (lpuart_rtos_handle_t *handle, uint8_t *buffer, uint32_t length, size_t *received)
Receives data.
- int [LPUART_RTOS_SetRxTimeout](#) (lpuart_rtos_handle_t *handle, uint32_t rx_timeout_constant_ms, uint32_t rx_timeout_multiplier_ms)
Set RX timeout in runtime.
- int [LPUART_RTOS_SetTxTimeout](#) (lpuart_rtos_handle_t *handle, uint32_t tx_timeout_constant_ms, uint32_t tx_timeout_multiplier_ms)
Set TX timeout in runtime.

31.4.2 Data Structure Documentation

31.4.2.1 struct lpuart_rtos_config_t

Data Fields

- LPUART_Type * [base](#)
UART base address.

- uint32_t `srcclk`
UART source clock in Hz.
- uint32_t `baudrate`
Desired communication speed.
- lpuart_parity_mode_t `parity`
Parity setting.
- lpuart_stop_bit_count_t `stopbits`
Number of stop bits to use.
- uint8_t * `buffer`
Buffer for background reception.
- uint32_t `buffer_size`
Size of buffer for background reception.
- uint32_t `rx_timeout_constant_ms`
RX timeout applied per receive.
- uint32_t `rx_timeout_multiplier_ms`
RX timeout added for each byte of the receive.
- uint32_t `tx_timeout_constant_ms`
TX timeout applied per transmission.
- uint32_t `tx_timeout_multiplier_ms`
TX timeout added for each byte of the transmission.
- 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.

Field Documentation

- (1) uint32_t `lpuart_rtos_config_t::rx_timeout_multiplier_ms`
- (2) uint32_t `lpuart_rtos_config_t::tx_timeout_multiplier_ms`

31.4.3 Macro Definition Documentation

- 31.4.3.1 #define `FSL_LPUART_FREERTOS_DRIVER_VERSION (MAKE_VERSION(2, 6, 0))`

31.4.4 Function Documentation

- 31.4.4.1 int `LPUART_RTOS_Init (lpuart_rtos_handle_t * handle, lpuart_handle_t * t_handle, const lpuart_rtos_config_t * cfg)`

Parameters

<i>handle</i>	The RTOS LPUART handle, the pointer to an allocated space for RTOS context.
<i>t_handle</i>	The pointer to an allocated space to store the transactional layer internal state.
<i>cfg</i>	The pointer to the parameters required to configure the LPUART after initialization.

Returns

0 succeed, others failed

31.4.4.2 int LPUART_RTOS_Deinit (lpuart_rtos_handle_t * *handle*)

This function deinitializes the LPUART module, sets all register value to the reset value, and releases the resources.

Parameters

<i>handle</i>	The RTOS LPUART handle.
---------------	-------------------------

31.4.4.3 int LPUART_RTOS_Send (lpuart_rtos_handle_t * *handle*, uint8_t * *buffer*, uint32_t *length*)

This function sends data. It is an synchronous API. If the hardware buffer is full, the task is in the blocked state.

Parameters

<i>handle</i>	The RTOS LPUART handle.
<i>buffer</i>	The pointer to buffer to send.
<i>length</i>	The number of bytes to send.

31.4.4.4 int LPUART_RTOS_Receive (lpuart_rtos_handle_t * *handle*, uint8_t * *buffer*, uint32_t *length*, size_t * *received*)

This function receives data from LPUART. It is an synchronous API. If any data is immediately available it is returned immediately and the number of bytes received.

Parameters

<i>handle</i>	The RTOS LPUART handle.
<i>buffer</i>	The pointer to buffer where to write received data.
<i>length</i>	The number of bytes to receive.
<i>received</i>	The pointer to a variable of size_t where the number of received data is filled.

31.4.4.5 int LPUART_RTOS_SetRxTimeout (lpuart_rtos_handle_t * *handle*, uint32_t *rx_timeout_constant_ms*, uint32_t *rx_timeout_multiplier_ms*)

This function can modify RX timeout between initialization and receive.

param *handle* The RTOS LPUART handle. param *rx_timeout_constant_ms* RX timeout applied per receive. param *rx_timeout_multiplier_ms* RX timeout added for each byte of the receive.

31.4.4.6 int LPUART_RTOS_SetTxTimeout (lpuart_rtos_handle_t * *handle*, uint32_t *tx_timeout_constant_ms*, uint32_t *tx_timeout_multiplier_ms*)

This function can modify TX timeout between initialization and send.

param *handle* The RTOS LPUART handle. param *tx_timeout_constant_ms* TX timeout applied per transmission. param *tx_timeout_multiplier_ms* TX timeout added for each byte of the transmission.

31.5 LPUART CMSIS Driver

This section describes the programming interface of the LPUART Cortex Microcontroller Software Interface Standard (CMSIS) driver. And this driver defines generic peripheral driver interfaces for middleware making it reusable across a wide range of supported microcontroller devices. The API connects microcontroller peripherals with middleware that implements for example communication stacks, file systems, or graphic user interfaces. More information and usage method please refer to <http://www.keil.com/pack/doc/cmsis/Driver/html/index.html>.

The LPUART driver includes transactional APIs.

Transactional APIs can be used to enable the peripheral quickly and in the application if the code size and performance of transactional APIs can satisfy the requirements. If the code size and performance are critical requirements please write custom code.

31.5.1 Function groups

31.5.1.1 LPUART CMSIS GetVersion Operation

This function group will return the LPUART CMSIS Driver version to user.

31.5.1.2 LPUART CMSIS GetCapabilities Operation

This function group will return the capabilities of this driver.

31.5.1.3 LPUART CMSIS Initialize and Uninitialize Operation

This function will initialize and uninitialize the lpuart instance . And this API must be called before you configure a lpuart instance or after you Deinit a lpuart instance.The right steps to start an instance is that you must initialize the instance which been slected firstly,then you can power on the instance.After these all have been done,you can configure the instance by using control operation.If you want to Uninitialize the instance, you must power off the instance first.

31.5.1.4 LPUART CMSIS Transfer Operation

This function group controls the transfer, send/receive data.

31.5.1.5 LPUART CMSIS Status Operation

This function group gets the LPUART transfer status.

31.5.1.6 LPUART CMSIS Control Operation

This function can configure an instance ,set baudrate for lpuart, get current baudrate ,set transfer data bits and other control command.

Chapter 32

OCOTP: On Chip One-Time Programmable controller.

32.1 Overview

The MCUXpresso SDK provides a peripheral driver for the OCOTP module of MCUXpresso SDK devices.

This section contains information describing the requirements for the on-chip eFuse OTP controller along with details about the block functionality and implementation.

32.2 OCOTP function group

The OCOTP driver support operating API to allow read and write the fuse map.

32.2.1 Initialization and de-initialization

The function [OCOTP_Init\(\)](#) is to initialize the OCOTP with peripheral base address and source clock frequency.

The function [OCOTP_Deinit\(\)](#) is to de-initialize the OCOTP controller with peripheral base address.

32.2.2 Read and Write operation

The function [OCOTP_ReloadShadowRegister\(\)](#) is to reload the value from the fuse map. this API should be called firstly before reading the register.

The [OCOTP_ReadFuseShadowRegister\(\)](#) is to read the value from a given address, if operation is success, a known value will be return, othwise, a value of 0xBADABADA will be returned.

The function [OCOTP_WriteFuseShadowRegister\(\)](#) will write a specific value to a known address. please check the return status o make sure whether the access to register is success.

32.3 OCOTP example

This example shows how to get the controller version using API. Due to the eFuse is One-Time programmable, example will only print the information of OCOTP controller version. If more operations are needed, please using the API to implement the write and read operation.

Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOARD>/driver_examples/ocotp

Data Structures

- struct [ocotp_timing_t](#)
OCOTP timing structure. [More...](#)

Enumerations

- enum {
 - `kStatus_OCOTP_AccessError` = MAKE_STATUS(kStatusGroup_SDK_OCOTP, 0),
 - `kStatus_OCOTP_CrcFail` = MAKE_STATUS(kStatusGroup_SDK_OCOTP, 1),
 - `kStatus_OCOTP_ReloadError`,
 - `kStatus_OCOTP_ProgramFail` = MAKE_STATUS(kStatusGroup_SDK_OCOTP, 3),
 - `kStatus_OCOTP_Locked` = MAKE_STATUS(kStatusGroup_SDK_OCOTP, 4) }*_ocotp_status Error codes for the OCOTP driver.*

Functions

- void `OCOTP_Init` (OCOTP_Type *base, uint32_t srcClock_Hz)
 - Initializes OCOTP controller.*
- void `OCOTP_Deinit` (OCOTP_Type *base)
 - De-initializes OCOTP controller.*
- static bool `OCOTP_CheckBusyStatus` (OCOTP_Type *base)
 - Checking the BUSY bit in CTRL register.*
- static bool `OCOTP_CheckErrorStatus` (OCOTP_Type *base)
 - Checking the ERROR bit in CTRL register.*
- static void `OCOTP_ClearErrorStatus` (OCOTP_Type *base)
 - Clear the error bit if this bit is set.*
- status_t `OCOTP_ReloadShadowRegister` (OCOTP_Type *base)
 - Reload the shadow register.*
- uint32_t `OCOTP_ReadFuseShadowRegister` (OCOTP_Type *base, uint32_t address)
 - Read the fuse shadow register with the fuse address.*
- status_t `OCOTP_ReadFuseShadowRegisterExt` (OCOTP_Type *base, uint32_t address, uint32_t *data, uint8_t fuseWords)
 - Read the fuse shadow register from the fuse address.*
- status_t `OCOTP_WriteFuseShadowRegister` (OCOTP_Type *base, uint32_t address, uint32_t data)
 - Write the fuse shadow register with the fuse address and data.*
- status_t `OCOTP_WriteFuseShadowRegisterWithLock` (OCOTP_Type *base, uint32_t address, uint32_t data, bool lock)
 - Write the fuse shadow register and lock it.*
- static uint32_t `OCOTP_GetVersion` (OCOTP_Type *base)
 - Get the OCOTP controller version from the register.*

Driver version

- #define `FSL_OCOTP_DRIVER_VERSION` (MAKE_VERSION(2, 1, 3))
 - OCOTP driver version.*

32.4 Data Structure Documentation

32.4.1 struct ocotp_timing_t

Note that, these value are used for calcalating the read/write timings. And the values should satisfy below rules:

$Tsp_rd = (WAIT+1)/ipg_clk_freq$ should be ≥ 150 ns; $Tsp_pgm = (RELAX+1)/ipg_clk_freq$ should be ≥ 100 ns; $Trd = ((STROBE_READ+1) - 2*(RELAX_READ+1)) / ipg_clk_freq$, The Trd is required to be larger than 40 ns. $Tpgm = ((STROBE_PROG+1) - 2*(RELAX_PROG+1)) / ipg_clk_freq$; The $Tpgm$ should be configured within the range of $9000\text{ ns} < Tpgm < 11000\text{ ns}$;

Data Fields

- `uint32_t wait`
Wait time value to fill in the TIMING register.
- `uint32_t relax`
Relax time value to fill in the TIMING register.
- `uint32_t strobe_prog`
Strobe program time value to fill in the TIMING register.
- `uint32_t strobe_read`
Strobe read time value to fill in the TIMING register.

Field Documentation

- (1) `uint32_t ocotp_timing_t::wait`
- (2) `uint32_t ocotp_timing_t::relax`
- (3) `uint32_t ocotp_timing_t::strobe_prog`
- (4) `uint32_t ocotp_timing_t::strobe_read`

32.5 Macro Definition Documentation

32.5.1 `#define FSL_OCOTP_DRIVER_VERSION (MAKE_VERSION(2, 1, 3))`

32.6 Enumeration Type Documentation

32.6.1 anonymous enum

Enumerator

- kStatus_OCOTP_AccessError*** eFuse and shadow register access error.
- kStatus_OCOTP_CrcFail*** CRC check failed.
- kStatus_OCOTP_ReloadError*** Error happens during reload shadow register.
- kStatus_OCOTP_ProgramFail*** Fuse programming failed.
- kStatus_OCOTP_Locked*** Fuse is locked and cannot be programmed.

32.7 Function Documentation

32.7.1 `void OCOTP_Init (OCOTP_Type * base, uint32_t srcClock_Hz)`

Parameters

<i>base</i>	OCOTP peripheral base address.
<i>srcClock_Hz</i>	source clock frequency in unit of Hz. When the macro FSL_FEATURE_OCOTP_HAS_TIMING_CTRL is defined as 0, this parameter is not used, application could pass in 0 in this case.

32.7.2 void OCOTP_Deinit (OCOTP_Type * *base*)

Return values

<i>kStatus_Success</i>	upon successful execution, error status otherwise.
------------------------	--

32.7.3 static bool OCOTP_CheckBusyStatus (OCOTP_Type * *base*) [inline], [static]

Checking this BUSY bit will help confirm if the OCOTP controller is ready for access.

Parameters

<i>base</i>	OCOTP peripheral base address.
-------------	--------------------------------

Return values

<i>true</i>	for bit set and false for cleared.
-------------	------------------------------------

32.7.4 static bool OCOTP_CheckErrorStatus (OCOTP_Type * *base*) [inline], [static]

Parameters

<i>base</i>	OCOTP peripheral base address.
-------------	--------------------------------

Return values

<i>true</i>	for bit set and false for cleared.
-------------	------------------------------------

32.7.5 static void OCOTP_ClearErrorStatus (OCOTP_Type * *base*) [inline], [static]

Parameters

<i>base</i>	OCOTP peripheral base address.
-------------	--------------------------------

32.7.6 status_t OCOTP_ReloadShadowRegister (OCOTP_Type * *base*)

This function will help reload the shadow register without resetting the OCOTP module. Please make sure the OCOTP has been initialized before calling this API.

Parameters

<i>base</i>	OCOTP peripheral base address.
-------------	--------------------------------

Return values

<i>kStatus_Success</i>	Reload success.
<i>kStatus_OCOTP_Reload-Error</i>	Reload failed.

32.7.7 uint32_t OCOTP_ReadFuseShadowRegister (OCOTP_Type * *base*, uint32_t *address*)

Deprecated Use [OCOTP_ReadFuseShadowRegisterExt](#) instead of this function.

Parameters

<i>base</i>	OCOTP peripheral base address.
-------------	--------------------------------

<i>address</i>	the fuse address to be read from.
----------------	-----------------------------------

Returns

The read out data.

32.7.8 **status_t OCOTP_ReadFuseShadowRegisterExt (OCOTP_Type * *base*, uint32_t *address*, uint32_t * *data*, uint8_t *fuseWords*)**

This function reads fuse from *address*, how many words to read is specified by the parameter *fuseWords*. This function could read at most OCOTP_READ_FUSE_DATA_COUNT fuse word one time.

Parameters

<i>base</i>	OCOTP peripheral base address.
<i>address</i>	the fuse address to be read from.
<i>data</i>	Data array to save the readout fuse value.
<i>fuseWords</i>	How many words to read.

Return values

<i>kStatus_Success</i>	Read success.
<i>kStatus_Fail</i>	Error occurs during read.

32.7.9 **status_t OCOTP_WriteFuseShadowRegister (OCOTP_Type * *base*, uint32_t *address*, uint32_t *data*)**

Please make sure the write address is not locked while calling this API.

Parameters

<i>base</i>	OCOTP peripheral base address.
<i>address</i>	the fuse address to be written.
<i>data</i>	the value will be written to fuse address.

Return values

<i>write</i>	status, kStatus_Success for success and kStatus_Fail for failed.
--------------	--

32.7.10 `status_t OCOTP_WriteFuseShadowRegisterWithLock (OCOTP_Type * base, uint32_t address, uint32_t data, bool lock)`

Please make sure the write address is not locked while calling this API.

Some OCOTP controller supports ECC mode and redundancy mode (see reference manual for more details). OCOTP controller will auto select ECC or redundancy mode to program the fuse word according to fuse map definition. In ECC mode, the 32 fuse bits in one word can only be written once. In redundancy mode, the word can be written more than once as long as they are different fuse bits. Set parameter `lock` as true to force use ECC mode.

Parameters

<i>base</i>	OCOTP peripheral base address.
<i>address</i>	The fuse address to be written.
<i>data</i>	The value will be written to fuse address.
<i>lock</i>	Lock or unlock write fuse shadow register operation.

Return values

<i>kStatus_Success</i>	Program and reload success.
<i>kStatus_OCOTP_Locked</i>	The eFuse word is locked and cannot be programmed.
<i>kStatus_OCOTP_ProgramFail</i>	eFuse word programming failed.
<i>kStatus_OCOTP_Reload-Error</i>	eFuse word programming success, but error happens during reload the values.
<i>kStatus_OCOTP_Access-Error</i>	Cannot access eFuse word.

32.7.11 `static uint32_t OCOTP_GetVersion (OCOTP_Type * base) [inline], [static]`

Parameters

<i>base</i>	OCOTP peripheral base address.
-------------	--------------------------------

Return values

<i>return</i>	the version value.
---------------	--------------------

Chapter 33

PIT: Periodic Interrupt Timer

33.1 Overview

The MCUXpresso SDK provides a driver for the Periodic Interrupt Timer (PIT) of MCUXpresso SDK devices.

33.2 Function groups

The PIT driver supports operating the module as a time counter.

33.2.1 Initialization and deinitialization

The function `PIT_Init()` initializes the PIT with specified configurations. The function `PIT_GetDefaultConfig()` gets the default configurations. The initialization function configures the PIT operation in debug mode.

The function `PIT_SetTimerChainMode()` configures the chain mode operation of each PIT channel.

The function `PIT_Deinit()` disables the PIT timers and disables the module clock.

33.2.2 Timer period Operations

The function `PITR_SetTimerPeriod()` sets the timer period in units of count. Timers begin counting down from the value set by this function until it reaches 0.

The function `PIT_GetCurrentTimerCount()` reads the current timer counting value. This function returns the real-time timer counting value, in a range from 0 to a timer period.

The timer period operation functions takes the count value in ticks. Users can call the utility macros provided in `fsl_common.h` to convert to microseconds or milliseconds.

33.2.3 Start and Stop timer operations

The function `PIT_StartTimer()` starts the timer counting. After calling this function, the timer loads the period value set earlier via the `PIT_SetPeriod()` function and starts counting down to 0. When the timer reaches 0, it generates a trigger pulse and sets the timeout interrupt flag.

The function `PIT_StopTimer()` stops the timer counting.

33.2.4 Status

Provides functions to get and clear the PIT status.

33.2.5 Interrupt

Provides functions to enable/disable PIT interrupts and get current enabled interrupts.

33.3 Typical use case

33.3.1 PIT tick example

Updates the PIT period and toggles an LED periodically. Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/pit`

Data Structures

- struct `pit_config_t`
PIT configuration structure. [More...](#)

Enumerations

- enum `pit_chnl_t` {
 `kPIT_Chnl_0` = 0U,
 `kPIT_Chnl_1`,
 `kPIT_Chnl_2`,
 `kPIT_Chnl_3` }
List of PIT channels.
- enum `pit_interrupt_enable_t` { `kPIT_TimerInterruptEnable` = `PIT_TCTRL_TIE_MASK` }
List of PIT interrupts.
- enum `pit_status_flags_t` { `kPIT_TimerFlag` = `PIT_TFLG_TIF_MASK` }
List of PIT status flags.

Functions

- `uint64_t PIT_GetLifetimeTimerCount` (`PIT_Type *base`)
Reads the current lifetime counter value.

Driver version

- `#define FSL_PIT_DRIVER_VERSION` (`MAKE_VERSION(2, 0, 4)`)
PIT Driver Version 2.0.4.

Initialization and deinitialization

- `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.*
- void `PIT_Deinit` (PIT_Type *base)
- *Gates the PIT clock and disables the PIT module.*
- static void `PIT_GetDefaultConfig` (pit_config_t *config)
- *Fills in the PIT configuration structure with the default settings.*
- static void `PIT_SetTimerChainMode` (PIT_Type *base, pit_chnl_t channel, bool enable)
- *Enables or disables chaining a timer with the previous timer.*

Interrupt Interface

- static void `PIT_EnableInterrupts` (PIT_Type *base, pit_chnl_t channel, uint32_t mask)
- *Enables the selected PIT interrupts.*
- static void `PIT_DisableInterrupts` (PIT_Type *base, pit_chnl_t channel, uint32_t mask)
- *Disables the selected PIT interrupts.*
- static uint32_t `PIT_GetEnabledInterrupts` (PIT_Type *base, pit_chnl_t channel)
- *Gets the enabled PIT interrupts.*

Status Interface

- static uint32_t `PIT_GetStatusFlags` (PIT_Type *base, pit_chnl_t channel)
- *Gets the PIT status flags.*
- static void `PIT_ClearStatusFlags` (PIT_Type *base, pit_chnl_t channel, uint32_t mask)
- *Clears the PIT status flags.*

Read and Write the timer period

- static void `PIT_SetTimerPeriod` (PIT_Type *base, pit_chnl_t channel, uint32_t count)
- *Sets the timer period in units of count.*
- static uint32_t `PIT_GetCurrentTimerCount` (PIT_Type *base, pit_chnl_t channel)
- *Reads the current timer counting value.*

Timer Start and Stop

- static void `PIT_StartTimer` (PIT_Type *base, pit_chnl_t channel)
- *Starts the timer counting.*
- static void `PIT_StopTimer` (PIT_Type *base, pit_chnl_t channel)
- *Stops the timer counting.*

33.4 Data Structure Documentation

33.4.1 struct pit_config_t

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.

Data Fields

- bool `enableRunInDebug`
true: Timers run in debug mode; false: Timers stop in debug mode

33.5 Enumeration Type Documentation

33.5.1 enum `pit_chnl_t`

Note

Actual number of available channels is SoC dependent

Enumerator

kPIT_Chnl_0 PIT channel number 0.
kPIT_Chnl_1 PIT channel number 1.
kPIT_Chnl_2 PIT channel number 2.
kPIT_Chnl_3 PIT channel number 3.

33.5.2 enum `pit_interrupt_enable_t`

Enumerator

kPIT_TimerInterruptEnable Timer interrupt enable.

33.5.3 enum `pit_status_flags_t`

Enumerator

kPIT_TimerFlag Timer flag.

33.6 Function Documentation

33.6.1 void `PIT_Init (PIT_Type * base, const pit_config_t * config)`

Note

This API should be called at the beginning of the application using the PIT driver.

Parameters

<i>base</i>	PIT peripheral base address
<i>config</i>	Pointer to the user's PIT config structure

33.6.2 void PIT_Deinit (PIT_Type * *base*)

Parameters

<i>base</i>	PIT peripheral base address
-------------	-----------------------------

33.6.3 static void PIT_GetDefaultConfig (pit_config_t * *config*) [inline], [static]

The default values are as follows.

```
* config->enableRunInDebug = false;
*
```

Parameters

<i>config</i>	Pointer to the configuration structure.
---------------	---

33.6.4 static void PIT_SetTimerChainMode (PIT_Type * *base*, pit_chnl_t *channel*, bool *enable*) [inline], [static]

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

<i>base</i>	PIT peripheral base address
-------------	-----------------------------

<i>channel</i>	Timer channel number which is chained with the previous timer
<i>enable</i>	Enable or disable chain. true: Current timer is chained with the previous timer. false: Timer doesn't chain with other timers.

33.6.5 static void PIT_EnableInterrupts (PIT_Type * *base*, pit_chnl_t *channel*, uint32_t *mask*) [inline], [static]

Parameters

<i>base</i>	PIT peripheral base address
<i>channel</i>	Timer channel number
<i>mask</i>	The interrupts to enable. This is a logical OR of members of the enumeration pit_interrupt_enable_t

33.6.6 static void PIT_DisableInterrupts (PIT_Type * *base*, pit_chnl_t *channel*, uint32_t *mask*) [inline], [static]

Parameters

<i>base</i>	PIT peripheral base address
<i>channel</i>	Timer channel number
<i>mask</i>	The interrupts to disable. This is a logical OR of members of the enumeration pit_interrupt_enable_t

33.6.7 static uint32_t PIT_GetEnabledInterrupts (PIT_Type * *base*, pit_chnl_t *channel*) [inline], [static]

Parameters

<i>base</i>	PIT peripheral base address
<i>channel</i>	Timer channel number

Returns

The enabled interrupts. This is the logical OR of members of the enumeration [pit_interrupt_enable_t](#)

33.6.8 `static uint32_t PIT_GetStatusFlags (PIT_Type * base, pit_chnl_t channel)`
`[inline], [static]`

Parameters

<i>base</i>	PIT peripheral base address
<i>channel</i>	Timer channel number

Returns

The status flags. This is the logical OR of members of the enumeration [pit_status_flags_t](#)

33.6.9 static void PIT_ClearStatusFlags (PIT_Type * *base*, pit_chnl_t *channel*, uint32_t *mask*) [inline], [static]

Parameters

<i>base</i>	PIT peripheral base address
<i>channel</i>	Timer channel number
<i>mask</i>	The status flags to clear. This is a logical OR of members of the enumeration pit_status_flags_t

33.6.10 static void PIT_SetTimerPeriod (PIT_Type * *base*, pit_chnl_t *channel*, uint32_t *count*) [inline], [static]

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

<i>base</i>	PIT peripheral base address
<i>channel</i>	Timer channel number

<i>count</i>	Timer period in units of ticks
--------------	--------------------------------

33.6.11 `static uint32_t PIT_GetCurrentTimerCount (PIT_Type * base, pit_chnl_t channel) [inline], [static]`

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

<i>base</i>	PIT peripheral base address
<i>channel</i>	Timer channel number

Returns

Current timer counting value in ticks

33.6.12 `static void PIT_StartTimer (PIT_Type * base, pit_chnl_t channel) [inline], [static]`

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

<i>base</i>	PIT peripheral base address
<i>channel</i>	Timer channel number.

33.6.13 `static void PIT_StopTimer (PIT_Type * base, pit_chnl_t channel) [inline], [static]`

This function stops every timer counting. Timers reload their periods respectively after the next time they call the `PIT_DRV_StartTimer`.

Parameters

<i>base</i>	PIT peripheral base address
<i>channel</i>	Timer channel number.

33.6.14 uint64_t PIT_GetLifetimeTimerCount (PIT_Type * *base*)

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

<i>base</i>	PIT peripheral base address
-------------	-----------------------------

Returns

Current lifetime timer value

Chapter 34

PMU: Power Management Unit

34.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Power Management Unit (PMU) module of MCUXpresso SDK devices. The power management unit (PMU) is designed to simplify the external power interface. The power system can be split into the input power sources and their characteristics, the integrated power transforming and controlling elements, and the final load interconnection and requirements. By using the internal LDO regulators, the number of external supplies is greatly reduced.

The PMU driver provides the APIs to adjust the work condition of each regulator, and can gate the power of some modules.

Enumerations

- enum {
 kPMU_1P1RegulatorOutputOK = (1U << 0U),
 kPMU_1P1BrownoutOnOutput = (1U << 1U),
 kPMU_3P0RegulatorOutputOK = (1U << 2U),
 kPMU_3P0BrownoutOnOutput = (1U << 3U),
 kPMU_2P5RegulatorOutputOK = (1U << 4U),
 kPMU_2P5BrownoutOnOutput = (1U << 5U) }
 PMU Status flags.
- enum pmu_1p1_weak_reference_source_t {
 kPMU_1P1WeakReferenceSourceAlt0 = 0U,
 kPMU_1P1WeakReferenceSourceAlt1 = 1U }
 The source for the reference voltage of the weak 1P1 regulator.
- enum pmu_3p0_vbus_voltage_source_t {
 kPMU_3P0VBusVoltageSourceAlt0 = 0U,
 kPMU_3P0VBusVoltageSourceAlt1 = 1U }
 Input voltage source for LDO_3P0 from USB VBus.
- enum pmu_core_reg_voltage_ramp_rate_t {
 kPMU_CoreRegVoltageRampRateFast = 0U,
 kPMU_CoreRegVoltageRampRateMediumFast = 1U,
 kPMU_CoreRegVoltageRampRateMediumSlow = 2U,
 kPMU_CoreRegVoltageRampRateSlow = 0U }
 Regulator voltage ramp rate.
- enum pmu_power_bandgap_t {
 kPMU_NormalPowerBandgap = 0U,
 kPMU_LowPowerBandgap = 1U }
 Bandgap select.

Driver version

- #define `FSL_PMU_DRIVER_VERSION` (`MAKE_VERSION(2, 1, 1)`)
PMU driver version.

Status.

- `uint32_t PMU_GetStatusFlags` (`PMU_Type *base`)
Get PMU status flags.

1P1 Regular

- static void `PMU_1P1SetWeakReferenceSource` (`PMU_Type *base`, `pmu_1p1_weak_reference_source_t` option)
Selects the source for the reference voltage of the weak 1P1 regulator.
- static void `PMU_1P1EnableWeakRegulator` (`PMU_Type *base`, `bool enable`)
Enables the weak 1P1 regulator.
- static void `PMU_1P1SetRegulatorOutputVoltage` (`PMU_Type *base`, `uint32_t value`)
Adjust the 1P1 regulator output voltage.
- static void `PMU_1P1SetBrownoutOffsetVoltage` (`PMU_Type *base`, `uint32_t value`)
Adjust the 1P1 regulator brownout offset voltage.
- static void `PMU_1P1EnablePullDown` (`PMU_Type *base`, `bool enable`)
Enable the pull-down circuitry in the regulator.
- static void `PMU_1P1EnableCurrentLimit` (`PMU_Type *base`, `bool enable`)
Enable the current-limit circuitry in the regulator.
- static void `PMU_1P1EnableBrownout` (`PMU_Type *base`, `bool enable`)
Enable the brownout circuitry in the regulator.
- static void `PMU_1P1EnableOutput` (`PMU_Type *base`, `bool enable`)
Enable the regulator output.

3P0 Regular

- static void `PMU_3P0SetRegulatorOutputVoltage` (`PMU_Type *base`, `uint32_t value`)
Adjust the 3P0 regulator output voltage.
- static void `PMU_3P0SetVBusVoltageSource` (`PMU_Type *base`, `pmu_3p0_vbus_voltage_source_t` option)
Select input voltage source for LDO_3P0.
- static void `PMU_3P0SetBrownoutOffsetVoltage` (`PMU_Type *base`, `uint32_t value`)
Adjust the 3P0 regulator brownout offset voltage.
- static void `PMU_3P0EnableCurrentLimit` (`PMU_Type *base`, `bool enable`)
Enable the current-limit circuitry in the 3P0 regulator.
- static void `PMU_3P0EnableBrownout` (`PMU_Type *base`, `bool enable`)
Enable the brownout circuitry in the 3P0 regulator.
- static void `PMU_3P0EnableOutput` (`PMU_Type *base`, `bool enable`)
Enable the 3P0 regulator output.

2P5 Regulator

- static void `PMU_2P5EnableWeakRegulator` (`PMU_Type *base`, `bool enable`)
Enables the weak 2P5 regulator.
- static void `PMU_2P5SetRegulatorOutputVoltage` (`PMU_Type *base`, `uint32_t value`)

- *Adjust the 1P1 regulator output voltage.*
static void [PMU_2P5SetBrownoutOffsetVoltage](#) (PMU_Type *base, uint32_t value)
- *Adjust the 2P5 regulator brownout offset voltage.*
static void [PMU_2P5EnablePullDown](#) (PMU_Type *base, bool enable)
- *Enable the pull-down circuitry in the 2P5 regulator.*
static void [PMU_2P1EnablePullDown](#) (PMU_Type *base, bool enable)
- *Enable the pull-down circuitry in the 2P5 regulator.*
static void [PMU_2P5EnableCurrentLimit](#) (PMU_Type *base, bool enable)
- *Enable the current-limit circuitry in the 2P5 regulator.*
static void [PMU_2P5enableBrownout](#) (PMU_Type *base, bool enable)
- *Enable the brownout circuitry in the 2P5 regulator.*
static void [PMU_2P5EnableOutput](#) (PMU_Type *base, bool enable)
- *Enable the 2P5 regulator output.*

Core Regulator

- static void [PMU_CoreEnableIncreaseGateDrive](#) (PMU_Type *base, bool enable)
Increase the gate drive on power gating FETs.
- static void [PMU_CoreSetRegulatorVoltageRampRate](#) (PMU_Type *base, [pmu_core_reg_voltage_ramp_rate_t](#) option)
Set the CORE regulator voltage ramp rate.
- static void [PMU_CoreSetSOCDomainVoltage](#) (PMU_Type *base, uint32_t value)
Define the target voltage for the SOC power domain.
- static void [PMU_CoreSetARMCoreDomainVoltage](#) (PMU_Type *base, uint32_t value)
Define the target voltage for the ARM Core power domain.

34.2 Macro Definition Documentation

34.2.1 #define FSL_PMU_DRIVER_VERSION (MAKE_VERSION(2, 1, 1))

Version 2.1.1.

34.3 Enumeration Type Documentation

34.3.1 anonymous enum

Enumerator

- ***kPMU_1P1RegulatorOutputOK*** Status bit that signals when the 1p1 regulator output is ok. 1 = regulator output > brownout target.
- ***kPMU_1P1BrownoutOnOutput*** Status bit that signals when a 1p1 brownout is detected on the regulator output.
- ***kPMU_3P0RegulatorOutputOK*** Status bit that signals when the 3p0 regulator output is ok. 1 = regulator output > brownout target.
- ***kPMU_3P0BrownoutOnOutput*** Status bit that signals when a 3p0 brownout is detected on the regulator output.
- ***kPMU_2P5RegulatorOutputOK*** Status bit that signals when the 2p5 regulator output is ok. 1 = regulator output > brownout target.

kPMU_2P5BrownoutOnOutput Status bit that signals when a 2p5 brownout is detected on the regulator output.

34.3.2 enum pmu_1p1_weak_reference_source_t

Enumerator

kPMU_1P1WeakReferenceSourceAlt0 Weak-linreg output tracks low-power-bandgap voltage.

kPMU_1P1WeakReferenceSourceAlt1 Weak-linreg output tracks VDD_SOC_CAP voltage.

34.3.3 enum pmu_3p0_vbus_voltage_source_t

Enumerator

kPMU_3P0VBusVoltageSourceAlt0 USB_OTG1_VBUS - Utilize VBUS OTG1 for power.

kPMU_3P0VBusVoltageSourceAlt1 USB_OTG2_VBUS - Utilize VBUS OTG2 for power.

34.3.4 enum pmu_core_reg_voltage_ramp_rate_t

Enumerator

kPMU_CoreRegVoltageRampRateFast Fast.

kPMU_CoreRegVoltageRampRateMediumFast Medium Fast.

kPMU_CoreRegVoltageRampRateMediumSlow Medium Slow.

kPMU_CoreRegVoltageRampRateSlow Slow.

34.3.5 enum pmu_power_bandgap_t

Enumerator

kPMU_NormalPowerBandgap Normal power bandgap.

kPMU_LowPowerBandgap Low power bandgap.

34.4 Function Documentation

34.4.1 uint32_t PMU_GetStatusFlags (PMU_Type * base)

Parameters

<i>base</i>	PMU peripheral base address.
-------------	------------------------------

Returns

PMU status flags. It indicates if regulator output of 1P1, 3P0 and 2P5 is ok and brownout output of 1P1, 3P0 and 2P5 is detected.

34.4.2 `static void PMU_1P1SetWeakReferenceSource (PMU_Type * base, pmu_1p1_weak_reference_source_t option) [inline], [static]`

Parameters

<i>base</i>	PMU peripheral base address.
<i>option</i>	The option for reference voltage source, see to pmu_1p1_weak_reference_source_t .

34.4.3 `static void PMU_1P1EnableWeakRegulator (PMU_Type * base, bool enable) [inline], [static]`

This regulator can be used when the main 1P1 regulator is disabled, under low-power conditions.

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.4 `static void PMU_1P1SetRegulatorOutputVoltage (PMU_Type * base, uint32_t value) [inline], [static]`

Each LSB is worth 25mV. Programming examples are detailed below. Other output target voltages may be interpolated from these examples. Choices must be in this range:

- 0x1b(1.375V) >= output_trg >= 0x04(0.8V)
- 0x04 : 0.8V
- 0x10 : 1.1V (typical)
- 0x1b : 1.375V NOTE: There may be reduced chip functionality or reliability at the extremes of the programming range.

Parameters

<i>base</i>	PMU peripheral base address.
<i>value</i>	Setting value for the output.

34.4.5 static void PMU_1P1SetBrownoutOffsetVoltage (PMU_Type * *base*, uint32_t *value*) [inline], [static]

Control bits to adjust the regulator brownout offset voltage in 25mV steps. The reset brown-offset is 175mV below the programmed target code. Brownout target = OUTPUT_TRG - BO_OFFSET. Some steps may be irrelevant because of input supply limitations or load operation.

Parameters

<i>base</i>	PMU peripheral base address.
<i>value</i>	Setting value for the brownout offset. The available range is in 3-bit.

34.4.6 static void PMU_1P1EnablePullDown (PMU_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.7 static void PMU_1P1EnableCurrentLimit (PMU_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.8 static void PMU_1P1EnableBrownout (PMU_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.9 static void PMU_1P1EnableOutput (PMU_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.10 static void PMU_3P0SetRegulatorOutputVoltage (PMU_Type * *base*, uint32_t *value*) [inline], [static]

Each LSB is worth 25mV. Programming examples are detailed below. Other output target voltages may be interpolated from these examples. Choices must be in this range:

- 0x00(2.625V) >= output_trg >= 0x1f(3.4V)
- 0x00 : 2.625V
- 0x0f : 3.0V (typical)
- 0x1f : 3.4V

Parameters

<i>base</i>	PMU peripheral base address.
<i>value</i>	Setting value for the output.

34.4.11 static void PMU_3P0SetVBusVoltageSource (PMU_Type * *base*, pmu_3p0_vbus_voltage_source_t *option*) [inline], [static]

Select input voltage source for LDO_3P0 from either USB_OTG1_VBUS or USB_OTG2_VBUS. If only one of the two VBUS voltages is present, it is automatically selected.

Parameters

<i>base</i>	PMU peripheral base address.
<i>option</i>	User-defined input voltage source for LDO_3P0.

34.4.12 **static void PMU_3P0SetBrownoutOffsetVoltage (PMU_Type * *base*, uint32_t *value*) [inline], [static]**

Control bits to adjust the 3P0 regulator brownout offset voltage in 25mV steps. The reset brown-offset is 175mV below the programmed target code. Brownout target = OUTPUT_TRG - BO_OFFSET. Some steps may be irrelevant because of input supply limitations or load operation.

Parameters

<i>base</i>	PMU peripheral base address.
<i>value</i>	Setting value for the brownout offset. The available range is in 3-bit.

34.4.13 **static void PMU_3P0EnableCurrentLimit (PMU_Type * *base*, bool *enable*) [inline], [static]**

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.14 **static void PMU_3P0EnableBrownout (PMU_Type * *base*, bool *enable*) [inline], [static]**

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.15 **static void PMU_3P0EnableOutput (PMU_Type * *base*, bool *enable*) [inline], [static]**

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.16 `static void PMU_2P5EnableWeakRegulator (PMU_Type * base, bool enable) [inline], [static]`

This low power regulator is used when the main 2P5 regulator is disabled to keep the 2.5V output roughly at 2.5V. Scales directly with the value of VDDHIGH_IN.

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.17 `static void PMU_2P5SetRegulatorOutputVoltage (PMU_Type * base, uint32_t value) [inline], [static]`

Each LSB is worth 25mV. Programming examples are detailed below. Other output target voltages may be interpolated from these examples. Choices must be in this range:

- 0x00(2.1V) >= output_trg >= 0x1f(2.875V)
- 0x00 : 2.1V
- 0x10 : 2.5V (typical)
- 0x1f : 2.875V NOTE: There may be reduced chip functionality or reliability at the extremes of the programming range.

Parameters

<i>base</i>	PMU peripheral base address.
<i>value</i>	Setting value for the output.

34.4.18 `static void PMU_2P5SetBrownoutOffsetVoltage (PMU_Type * base, uint32_t value) [inline], [static]`

Adjust the regulator brownout offset voltage in 25mV steps. The reset brown-offset is 175mV below the programmed target code. Brownout target = OUTPUT_TRG - BO_OFFSET. Some steps may be irrelevant because of input supply limitations or load operation.

Parameters

<i>base</i>	PMU peripheral base address.
<i>value</i>	Setting value for the brownout offset. The available range is in 3-bit.

34.4.19 `static void PMU_2P5EnablePullDown (PMU_Type * base, bool enable)`
`[inline], [static]`

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.20 `static void PMU_2P1EnablePullDown (PMU_Type * base, bool enable)`
`[inline], [static]`

Deprecated Do not use this function. It has been superseded by [PMU_2P5EnablePullDown](#).

34.4.21 `static void PMU_2P5EnableCurrentLimit (PMU_Type * base, bool enable)`
`[inline], [static]`

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.22 `static void PMU_2P5nableBrownout (PMU_Type * base, bool enable)`
`[inline], [static]`

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.23 `static void PMU_2P5EnableOutput (PMU_Type * base, bool enable)`
`[inline], [static]`

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.24 `static void PMU_CoreEnableIncreaseGateDrive (PMU_Type * base, bool enable)`
`[inline], [static]`

If set, increases the gate drive on power gating FETs to reduce leakage in the off state. Care must be taken to apply this bit only when the input supply voltage to the power FET is less than 1.1V. NOTE: This bit should only be used in low-power modes where the external input supply voltage is nominally 0.9V.

Parameters

<i>base</i>	PMU peripheral base address.
<i>enable</i>	Enable the feature or not.

34.4.25 `static void PMU_CoreSetRegulatorVoltageRampRate (PMU_Type * base,`
`pmu_core_reg_voltage_ramp_rate_t option)` `[inline], [static]`

Parameters

<i>base</i>	PMU peripheral base address.
<i>option</i>	User-defined option for voltage ramp rate, see to pmu_core_reg_voltage_ramp_rate_t .

34.4.26 `static void PMU_CoreSetSOCDomainVoltage (PMU_Type * base, uint32_t value) [inline], [static]`

Define the target voltage for the SOC power domain. Single-bit increments reflect 25mV core voltage steps. Some steps may not be relevant because of input supply limitations or load operation.

- 0x00 : Power gated off.
- 0x01 : Target core voltage = 0.725V
- 0x02 : Target core voltage = 0.750V
- ...
- 0x10 : Target core voltage = 1.100V
- ...
- 0x1e : Target core voltage = 1.450V
- 0x1F : Power FET switched full on. No regulation. NOTE: This register is capable of programming an over-voltage condition on the device. Consult the datasheet Operating Ranges table for the allowed voltages.

Parameters

<i>base</i>	PMU peripheral base address.
<i>value</i>	Setting value for target voltage. 5-bit available

34.4.27 `static void PMU_CoreSetARMCoreDomainVoltage (PMU_Type * base, uint32_t value) [inline], [static]`

Define the target voltage for the ARM Core power domain. Single-bit increments reflect 25mV core voltage steps. Some steps may not be relevant because of input supply limitations or load operation.

- 0x00 : Power gated off.
- 0x01 : Target core voltage = 0.725V
- 0x02 : Target core voltage = 0.750V
- ...
- 0x10 : Target core voltage = 1.100V
- ...
- 0x1e : Target core voltage = 1.450V
- 0x1F : Power FET switched full on. No regulation. NOTE: This register is capable of programming an over-voltage condition on the device. Consult the datasheet Operating Ranges table for the allowed voltages.

Parameters

<i>base</i>	PMU peripheral base address.
<i>value</i>	Setting value for target voltage. 5-bit available

Chapter 35

PWM: Pulse Width Modulator

35.1 Overview

The MCUXpresso SDK provides a driver for the Pulse Width Modulator (PWM) of MCUXpresso SDK devices.

35.2 PWM: Pulse Width Modulator

35.2.1 Initialization and deinitialization

The function [PWM_Init\(\)](#) initializes the PWM sub module with specified configurations, the function [PWM_GetDefaultConfig\(\)](#) could help to get the default configurations. The initialization function configures the sub module for the requested register update mode for registers with buffers. It also sets up the sub module operation in debug and wait modes.

35.2.2 PWM Operations

The function [PWM_SetupPwm\(\)](#) sets up PWM channels for PWM output, the function can set up PWM signal properties for multiple channels. The PWM has 2 channels: A and B. Each channel has its own duty cycle and level-mode specified, however the same PWM period and PWM mode is applied to all channels requesting PWM output. The signal duty cycle is provided as a percentage of the PWM period, its value should be between 0 and 100; 0=inactive signal(0% duty cycle) and 100=always active signal (100% duty cycle). The function also sets up the channel dead time value which is used when the user selects complementary mode of operation.

The function [PWM_UpdatePwmDutycycle\(\)](#) updates the PWM signal duty cycle of a particular PWM channel.

35.2.3 Input capture operations

The function [PWM_SetupInputCapture\(\)](#) sets up a PWM channel for input capture. The user can specify the capture edge and the mode; one-shot capture or free-running capture.

35.2.4 Fault operation

The function [PWM_SetupFault\(\)](#) sets up the properties for each fault.

35.2.5 PWM Start and Stop operations

The function [PWM_StartTimer\(\)](#) can be used to start one or multiple sub modules. The function [PWM_StopTimer\(\)](#) can be used to stop one or multiple sub modules.

35.2.6 Status

Provide functions to get and clear the PWM status.

35.2.7 Interrupt

Provide functions to enable/disable PWM interrupts and get current enabled interrupts.

35.3 Register Update

Some of the PWM registers have buffers, the driver support various methods to update these registers with the content of the register buffer. The update mechanism for register with buffers can be specified through the following fields available in the configuration structure. Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/pwm` The user can select one of the reload options provided in enumeration [pwm_register_reload_t](#). When using immediate reload, the `reloadFrequency` field is not used.

The driver initialization function sets up the appropriate bits in the PWM module based on the register update options selected.

The below function should be used to initiate a register reload. The example shows register reload initiated on PWM sub modules 0, 1, and 2. Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/pwm`

35.4 Typical use case

35.4.1 PWM output

Output PWM signal on 3 PWM sub module with different dutycycles. Periodically update the PWM signal duty cycle. Each sub module runs in Complementary output mode with PWM A used to generate the complementary PWM pair. Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/pwm`

Data Structures

- struct [pwm_signal_param_t](#)
Structure for the user to define the PWM signal characteristics. [More...](#)
- struct [pwm_config_t](#)
PWM config structure. [More...](#)
- struct [pwm_fault_input_filter_param_t](#)

- Structure for the user to configure the fault input filter. [More...](#)
- struct `pwm_fault_param_t`
Structure is used to hold the parameters to configure a PWM fault. [More...](#)
- struct `pwm_input_capture_param_t`
Structure is used to hold parameters to configure the capture capability of a signal pin. [More...](#)

Macros

- #define `PWM_SUBMODULE_SWCONTROL_WIDTH` 2
Number of bits per submodule for software output control.

Enumerations

- enum `pwm_submodule_t` {
 `kPWM_Module_0` = 0U,
 `kPWM_Module_1`,
 `kPWM_Module_2`,
 `kPWM_Module_3` }
 List of PWM submodules.
- enum `pwm_channels_t`
 List of PWM channels in each module.
- enum `pwm_value_register_t` {
 `kPWM_ValueRegister_0` = 0U,
 `kPWM_ValueRegister_1`,
 `kPWM_ValueRegister_2`,
 `kPWM_ValueRegister_3`,
 `kPWM_ValueRegister_4`,
 `kPWM_ValueRegister_5` }
 List of PWM value registers.
- enum `_pwm_value_register_mask` {
 `kPWM_ValueRegisterMask_0` = (1U << 0),
 `kPWM_ValueRegisterMask_1` = (1U << 1),
 `kPWM_ValueRegisterMask_2` = (1U << 2),
 `kPWM_ValueRegisterMask_3` = (1U << 3),
 `kPWM_ValueRegisterMask_4` = (1U << 4),
 `kPWM_ValueRegisterMask_5` = (1U << 5) }
 List of PWM value registers mask.
- enum `pwm_clock_source_t` {
 `kPWM_BusClock` = 0U,
 `kPWM_ExternalClock`,
 `kPWM_Submodule0Clock` }
 PWM clock source selection.
- enum `pwm_clock_prescale_t` {

```
kPWM_Prescale_Divide_1 = 0U,  
kPWM_Prescale_Divide_2,  
kPWM_Prescale_Divide_4,  
kPWM_Prescale_Divide_8,  
kPWM_Prescale_Divide_16,  
kPWM_Prescale_Divide_32,  
kPWM_Prescale_Divide_64,  
kPWM_Prescale_Divide_128 }
```

PWM prescaler factor selection for clock source.

- enum `pwm_force_output_trigger_t` {
kPWM_Force_Local = 0U,
kPWM_Force_Master,
kPWM_Force_LocalReload,
kPWM_Force_MasterReload,
kPWM_Force_LocalSync,
kPWM_Force_MasterSync,
kPWM_Force_External,
kPWM_Force_ExternalSync }

Options that can trigger a PWM FORCE_OUT.

- enum `pwm_init_source_t` {
kPWM_Initialize_LocalSync = 0U,
kPWM_Initialize_MasterReload,
kPWM_Initialize_MasterSync,
kPWM_Initialize_ExtSync }

PWM counter initialization options.

- enum `pwm_load_frequency_t` {
kPWM_LoadEveryOportunity = 0U,
kPWM_LoadEvery2Oportunity,
kPWM_LoadEvery3Oportunity,
kPWM_LoadEvery4Oportunity,
kPWM_LoadEvery5Oportunity,
kPWM_LoadEvery6Oportunity,
kPWM_LoadEvery7Oportunity,
kPWM_LoadEvery8Oportunity,
kPWM_LoadEvery9Oportunity,
kPWM_LoadEvery10Oportunity,
kPWM_LoadEvery11Oportunity,
kPWM_LoadEvery12Oportunity,
kPWM_LoadEvery13Oportunity,
kPWM_LoadEvery14Oportunity,
kPWM_LoadEvery15Oportunity,
kPWM_LoadEvery16Oportunity }

PWM load frequency selection.

- enum `pwm_fault_input_t` {


```
kPWM_Fault_0 = 0U,
kPWM_Fault_1,
kPWM_Fault_2,
kPWM_Fault_3 }
```

List of PWM fault selections.

- enum `pwm_fault_disable_t` {


```
kPWM_FaultDisable_0 = (1U << 0),
kPWM_FaultDisable_1 = (1U << 1),
kPWM_FaultDisable_2 = (1U << 2),
kPWM_FaultDisable_3 = (1U << 3) }
```

List of PWM fault disable mapping selections.

- enum `pwm_fault_channels_t`

List of PWM fault channels.

- enum `pwm_input_capture_edge_t` {


```
kPWM_Disable = 0U,
kPWM_FallingEdge,
kPWM_RisingEdge,
kPWM_RiseAndFallEdge }
```

PWM capture edge select.

- enum `pwm_force_signal_t` {


```
kPWM_UsePwm = 0U,
kPWM_InvertedPwm,
kPWM_SoftwareControl,
kPWM_UseExternal }
```

PWM output options when a FORCE_OUT signal is asserted.

- enum `pwm_chnl_pair_operation_t` {


```
kPWM_Independent = 0U,
kPWM_ComplementaryPwmA,
kPWM_ComplementaryPwmB }
```

Options available for the PWM A & B pair operation.

- enum `pwm_register_reload_t` {


```
kPWM_ReloadImmediate = 0U,
kPWM_ReloadPwmHalfCycle,
kPWM_ReloadPwmFullCycle,
kPWM_ReloadPwmHalfAndFullCycle }
```

Options available on how to load the buffered-registers with new values.

- enum `pwm_fault_recovery_mode_t` {


```
kPWM_NoRecovery = 0U,
kPWM_RecoverHalfCycle,
kPWM_RecoverFullCycle,
kPWM_RecoverHalfAndFullCycle }
```

Options available on how to re-enable the PWM output when recovering from a fault.

- enum `pwm_interrupt_enable_t` {

```

kPWM_CompareVal0InterruptEnable = (1U << 0),
kPWM_CompareVal1InterruptEnable = (1U << 1),
kPWM_CompareVal2InterruptEnable = (1U << 2),
kPWM_CompareVal3InterruptEnable = (1U << 3),
kPWM_CompareVal4InterruptEnable = (1U << 4),
kPWM_CompareVal5InterruptEnable = (1U << 5),
kPWM_CaptureX0InterruptEnable = (1U << 6),
kPWM_CaptureX1InterruptEnable = (1U << 7),
kPWM_CaptureB0InterruptEnable = (1U << 8),
kPWM_CaptureB1InterruptEnable = (1U << 9),
kPWM_CaptureA0InterruptEnable = (1U << 10),
kPWM_CaptureA1InterruptEnable = (1U << 11),
kPWM_ReloadInterruptEnable = (1U << 12),
kPWM_ReloadErrorInterruptEnable = (1U << 13),
kPWM_Fault0InterruptEnable = (1U << 16),
kPWM_Fault1InterruptEnable = (1U << 17),
kPWM_Fault2InterruptEnable = (1U << 18),
kPWM_Fault3InterruptEnable = (1U << 19) }

```

List of PWM interrupt options.

- enum `pwm_status_flags_t` {

```

kPWM_CompareVal0Flag = (1U << 0),
kPWM_CompareVal1Flag = (1U << 1),
kPWM_CompareVal2Flag = (1U << 2),
kPWM_CompareVal3Flag = (1U << 3),
kPWM_CompareVal4Flag = (1U << 4),
kPWM_CompareVal5Flag = (1U << 5),
kPWM_CaptureX0Flag = (1U << 6),
kPWM_CaptureX1Flag = (1U << 7),
kPWM_CaptureB0Flag = (1U << 8),
kPWM_CaptureB1Flag = (1U << 9),
kPWM_CaptureA0Flag = (1U << 10),
kPWM_CaptureA1Flag = (1U << 11),
kPWM_ReloadFlag = (1U << 12),
kPWM_ReloadErrorFlag = (1U << 13),
kPWM_RegUpdatedFlag = (1U << 14),
kPWM_Fault0Flag = (1U << 16),
kPWM_Fault1Flag = (1U << 17),
kPWM_Fault2Flag = (1U << 18),
kPWM_Fault3Flag = (1U << 19) }

```

List of PWM status flags.

- enum `pwm_dma_enable_t` {

```

kPWM_CaptureX0DMAEnable = (1U << 0),
kPWM_CaptureX1DMAEnable = (1U << 1),
kPWM_CaptureB0DMAEnable = (1U << 2),
kPWM_CaptureB1DMAEnable = (1U << 3),
kPWM_CaptureA0DMAEnable = (1U << 4),
kPWM_CaptureA1DMAEnable = (1U << 5) }

```

List of PWM DMA options.

- enum `pwm_dma_source_select_t` {
`kPWM_DMARequestDisable` = 0U,
`kPWM_DMAWatermarksEnable`,
`kPWM_DMALocalSync`,
`kPWM_DMALocalReload` }

List of PWM capture DMA enable source select.

- enum `pwm_watermark_control_t` {
`kPWM_FIFOWatermarksOR` = 0U,
`kPWM_FIFOWatermarksAND` }

PWM FIFO Watermark AND Control.

- enum `pwm_mode_t` {
`kPWM_SignedCenterAligned` = 0U,
`kPWM_CenterAligned`,
`kPWM_SignedEdgeAligned`,
`kPWM_EdgeAligned` }

PWM operation mode.

- enum `pwm_level_select_t` {
`kPWM_HighTrue` = 0U,
`kPWM_LowTrue` }

PWM output pulse mode, high-true or low-true.

- enum `pwm_fault_state_t` {
`kPWM_PwmFaultState0`,
`kPWM_PwmFaultState1`,
`kPWM_PwmFaultState2`,
`kPWM_PwmFaultState3` }

PWM output fault status.

- enum `pwm_reload_source_select_t` {
`kPWM_LocalReload` = 0U,
`kPWM_MasterReload` }

PWM reload source select.

- enum `pwm_fault_clear_t` {
`kPWM_Automatic` = 0U,
`kPWM_ManualNormal`,
`kPWM_ManualSafety` }

PWM fault clearing options.

- enum `pwm_module_control_t` {
`kPWM_Control_Module_0` = (1U << 0),
`kPWM_Control_Module_1` = (1U << 1),
`kPWM_Control_Module_2` = (1U << 2),
`kPWM_Control_Module_3` = (1U << 3) }

Options for submodule master control operation.

Functions

- void `PWM_SetupInputCapture` (`PWM_Type *base`, `pwm_submodule_t subModule`, `pwm_channels_t pwmChannel`, `const pwm_input_capture_param_t *inputCaptureParams`)
Sets up the PWM input capture.
- void `PWM_SetupFaultInputFilter` (`PWM_Type *base`, `const pwm_fault_input_filter_param_t *faultInputFilterParams`)
Sets up the PWM fault input filter.
- void `PWM_SetupFaults` (`PWM_Type *base`, `pwm_fault_input_t faultNum`, `const pwm_fault_param_t *faultParams`)
Sets up the PWM fault protection.
- void `PWM_FaultDefaultConfig` (`pwm_fault_param_t *config`)
Fill in the PWM fault config struct with the default settings.
- void `PWM_SetupForceSignal` (`PWM_Type *base`, `pwm_submodule_t subModule`, `pwm_channels_t pwmChannel`, `pwm_force_signal_t mode`)
Selects the signal to output on a PWM pin when a FORCE_OUT signal is asserted.
- static void `PWM_OutputTriggerEnable` (`PWM_Type *base`, `pwm_submodule_t subModule`, `pwm_value_register_t valueRegister`, `bool activate`)
Enables or disables the PWM output trigger.
- static void `PWM_ActivateOutputTrigger` (`PWM_Type *base`, `pwm_submodule_t subModule`, `uint16_t valueRegisterMask`)
Enables the PWM output trigger.
- static void `PWM_DeactivateOutputTrigger` (`PWM_Type *base`, `pwm_submodule_t subModule`, `uint16_t valueRegisterMask`)
Disables the PWM output trigger.
- static void `PWM_SetupSwCtrlOut` (`PWM_Type *base`, `pwm_submodule_t subModule`, `pwm_channels_t pwmChannel`, `bool value`)
Sets the software control output for a pin to high or low.
- static void `PWM_SetPwmLdok` (`PWM_Type *base`, `uint8_t subModulesToUpdate`, `bool value`)
Sets or clears the PWM LDOK bit on a single or multiple submodules.
- static void `PWM_SetPwmFaultState` (`PWM_Type *base`, `pwm_submodule_t subModule`, `pwm_channels_t pwmChannel`, `pwm_fault_state_t faultState`)
Set PWM output fault status.
- static void `PWM_SetupFaultDisableMap` (`PWM_Type *base`, `pwm_submodule_t subModule`, `pwm_channels_t pwmChannel`, `pwm_fault_channels_t pwm_fault_channels`, `uint16_t value`)
Set PWM fault disable mapping.

Driver version

- #define `FSL_PWM_DRIVER_VERSION` (`MAKE_VERSION(2, 2, 1)`)
Version 2.2.1.

Initialization and deinitialization

- `status_t PWM_Init` (`PWM_Type *base`, `pwm_submodule_t subModule`, `const pwm_config_t *config`)
Un-gates the PWM submodule clock and configures the peripheral for basic operation.

- void `PWM_Deinit` (`PWM_Type *base`, `pwm_submodule_t subModule`)
Gate the PWM submodule clock.
- void `PWM_GetDefaultConfig` (`pwm_config_t *config`)
Fill in the PWM config struct with the default settings.

Module PWM output

- `status_t PWM_SetupPwm` (`PWM_Type *base`, `pwm_submodule_t subModule`, const `pwm_signal_param_t *chnlParams`, `uint8_t numOfChnls`, `pwm_mode_t mode`, `uint32_t pwmFreq_Hz`, `uint32_t srcClock_Hz`)
Sets up the PWM signals for a PWM submodule.
- void `PWM_UpdatePwmDutycycle` (`PWM_Type *base`, `pwm_submodule_t subModule`, `pwm_channels_t pwmSignal`, `pwm_mode_t currPwmMode`, `uint8_t dutyCyclePercent`)
Updates the PWM signal's dutycycle.
- void `PWM_UpdatePwmDutycycleHighAccuracy` (`PWM_Type *base`, `pwm_submodule_t subModule`, `pwm_channels_t pwmSignal`, `pwm_mode_t currPwmMode`, `uint16_t dutyCycle`)
Updates the PWM signal's dutycycle with 16-bit accuracy.

Interrupts Interface

- void `PWM_EnableInterrupts` (`PWM_Type *base`, `pwm_submodule_t subModule`, `uint32_t mask`)
Enables the selected PWM interrupts.
- void `PWM_DisableInterrupts` (`PWM_Type *base`, `pwm_submodule_t subModule`, `uint32_t mask`)
Disables the selected PWM interrupts.
- `uint32_t PWM_GetEnabledInterrupts` (`PWM_Type *base`, `pwm_submodule_t subModule`)
Gets the enabled PWM interrupts.

DMA Interface

- static void `PWM_DMAFIFOWatermarkControl` (`PWM_Type *base`, `pwm_submodule_t subModule`, `pwm_watermark_control_t pwm_watermark_control`)
Capture DMA Enable Source Select.
- static void `PWM_DMACaptureSourceSelect` (`PWM_Type *base`, `pwm_submodule_t subModule`, `pwm_dma_source_select_t pwm_dma_source_select`)
Capture DMA Enable Source Select.
- static void `PWM_EnableDMACapture` (`PWM_Type *base`, `pwm_submodule_t subModule`, `uint16_t mask`, `bool activate`)
Enables or disables the selected PWM DMA Capture read request.
- static void `PWM_EnableDMAWrite` (`PWM_Type *base`, `pwm_submodule_t subModule`, `bool activate`)
Enables or disables the PWM DMA write request.

Status Interface

- `uint32_t PWM_GetStatusFlags` (`PWM_Type *base`, `pwm_submodule_t subModule`)
Gets the PWM status flags.
- void `PWM_ClearStatusFlags` (`PWM_Type *base`, `pwm_submodule_t subModule`, `uint32_t mask`)
Clears the PWM status flags.

Timer Start and Stop

- static void [PWM_StartTimer](#) (PWM_Type *base, uint8_t subModulesToStart)
Starts the PWM counter for a single or multiple submodules.
- static void [PWM_StopTimer](#) (PWM_Type *base, uint8_t subModulesToStop)
Stops the PWM counter for a single or multiple submodules.

35.5 Data Structure Documentation

35.5.1 struct pwm_signal_param_t

Data Fields

- [pwm_channels_t pwmChannel](#)
PWM channel being configured; PWM A or PWM B.
- uint8_t [dutyCyclePercent](#)
PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)...
- [pwm_level_select_t level](#)
PWM output active level select.
- uint16_t [deadtimeValue](#)
The deadtime value; only used if channel pair is operating in complementary mode.
- [pwm_fault_state_t faultState](#)
PWM output fault status.

Field Documentation

(1) uint8_t pwm_signal_param_t::dutyCyclePercent

100=always active signal (100% duty cycle)

35.5.2 struct pwm_config_t

This structure holds the configuration settings for the PWM peripheral. To initialize this structure to reasonable defaults, call the [PWM_GetDefaultConfig\(\)](#) function and pass a pointer to your config structure instance.

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

Data Fields

- bool [enableDebugMode](#)
true: PWM continues to run in debug mode; false: PWM is paused in debug mode
- bool [enableWait](#)
true: PWM continues to run in WAIT mode; false: PWM is paused in WAIT mode
- [pwm_init_source_t initializationControl](#)
Option to initialize the counter.
- [pwm_clock_source_t clockSource](#)

- *Clock source for the counter.*
[pwm_clock_prescale_t prescale](#)
- *Pre-scaler to divide down the clock.*
[pwm_chnl_pair_operation_t pairOperation](#)
- *Channel pair in independent or complementary mode.*
[pwm_register_reload_t reloadLogic](#)
- *PWM Reload logic setup.*
[pwm_reload_source_select_t reloadSelect](#)
- *Reload source select.*
[pwm_load_frequency_t reloadFrequency](#)
- *Specifies when to reload, used when user's choice is not immediate reload.*
[pwm_force_output_trigger_t forceTrigger](#)
- *Specify which signal will trigger a FORCE_OUT.*

35.5.3 struct pwm_fault_input_filter_param_t

Data Fields

- [uint8_t faultFilterCount](#)
Fault filter count.
- [uint8_t faultFilterPeriod](#)
Fault filter period; value of 0 will bypass the filter.
- [bool faultGlitchStretch](#)
Fault Glitch Stretch Enable: A logic 1 means that input fault signals will be stretched to at least 2 IPBus clock cycles.

35.5.4 struct pwm_fault_param_t

Data Fields

- [pwm_fault_clear_t faultClearingMode](#)
Fault clearing mode to use.
- [bool faultLevel](#)
true: Logic 1 indicates fault; false: Logic 0 indicates fault
- [bool enableCombinationalPath](#)
true: Combinational Path from fault input is enabled; false: No combination path is available
- [pwm_fault_recovery_mode_t recoverMode](#)
Specify when to re-enable the PWM output.

35.5.5 struct pwm_input_capture_param_t

Data Fields

- [bool captureInputSel](#)
true: Use the edge counter signal as source false: Use the raw input signal from the pin as source

- `uint8_t edgeCompareValue`
Compare value, used only if edge counter is used as source.
- `pwm_input_capture_edge_t edge0`
Specify which edge causes a capture for input circuitry 0.
- `pwm_input_capture_edge_t edge1`
Specify which edge causes a capture for input circuitry 1.
- `bool enableOneShotCapture`
true: Use one-shot capture mode; false: Use free-running capture mode
- `uint8_t fifoWatermark`
Watermark level for capture FIFO.

Field Documentation

(1) `uint8_t pwm_input_capture_param_t::fifoWatermark`

The capture flags in the status register will set if the word count in the FIFO is greater than this watermark level

35.6 Enumeration Type Documentation

35.6.1 `enum pwm_submodule_t`

Enumerator

- `kPWM_Module_0` Submodule 0.
- `kPWM_Module_1` Submodule 1.
- `kPWM_Module_2` Submodule 2.
- `kPWM_Module_3` Submodule 3.

35.6.2 `enum pwm_value_register_t`

Enumerator

- `kPWM_ValueRegister_0` PWM Value0 register.
- `kPWM_ValueRegister_1` PWM Value1 register.
- `kPWM_ValueRegister_2` PWM Value2 register.
- `kPWM_ValueRegister_3` PWM Value3 register.
- `kPWM_ValueRegister_4` PWM Value4 register.
- `kPWM_ValueRegister_5` PWM Value5 register.

35.6.3 `enum _pwm_value_register_mask`

Enumerator

- `kPWM_ValueRegisterMask_0` PWM Value0 register mask.

kPWM_ValueRegisterMask_1 PWM Value1 register mask.
kPWM_ValueRegisterMask_2 PWM Value2 register mask.
kPWM_ValueRegisterMask_3 PWM Value3 register mask.
kPWM_ValueRegisterMask_4 PWM Value4 register mask.
kPWM_ValueRegisterMask_5 PWM Value5 register mask.

35.6.4 enum pwm_clock_source_t

Enumerator

kPWM_BusClock The IPBus clock is used as the clock.
kPWM_ExternalClock EXT_CLK is used as the clock.
kPWM_Submodule0Clock Clock of the submodule 0 (AUX_CLK) is used as the source clock.

35.6.5 enum pwm_clock_prescale_t

Enumerator

kPWM_Prescale_Divide_1 PWM clock frequency = fclk/1.
kPWM_Prescale_Divide_2 PWM clock frequency = fclk/2.
kPWM_Prescale_Divide_4 PWM clock frequency = fclk/4.
kPWM_Prescale_Divide_8 PWM clock frequency = fclk/8.
kPWM_Prescale_Divide_16 PWM clock frequency = fclk/16.
kPWM_Prescale_Divide_32 PWM clock frequency = fclk/32.
kPWM_Prescale_Divide_64 PWM clock frequency = fclk/64.
kPWM_Prescale_Divide_128 PWM clock frequency = fclk/128.

35.6.6 enum pwm_force_output_trigger_t

Enumerator

kPWM_Force_Local The local force signal, CTRL2[FORCE], from the submodule is used to force updates.
kPWM_Force_Master The master force signal from submodule 0 is used to force updates.
kPWM_Force_LocalReload The local reload signal from this submodule is used to force updates without regard to the state of LDOK.
kPWM_Force_MasterReload The master reload signal from submodule 0 is used to force updates if LDOK is set.
kPWM_Force_LocalSync The local sync signal from this submodule is used to force updates.
kPWM_Force_MasterSync The master sync signal from submodule0 is used to force updates.
kPWM_Force_External The external force signal, EXT_FORCE, from outside the PWM module causes updates.

kPWM_Force_ExternalSync The external sync signal, EXT_SYNC, from outside the PWM module causes updates.

35.6.7 enum pwm_init_source_t

Enumerator

kPWM_Initialize_LocalSync Local sync causes initialization.
kPWM_Initialize_MasterReload Master reload from submodule 0 causes initialization.
kPWM_Initialize_MasterSync Master sync from submodule 0 causes initialization.
kPWM_Initialize_ExtSync EXT_SYNC causes initialization.

35.6.8 enum pwm_load_frequency_t

Enumerator

kPWM_LoadEvery0portunity Every PWM opportunity.
kPWM_LoadEvery2Oportunity Every 2 PWM opportunities.
kPWM_LoadEvery3Oportunity Every 3 PWM opportunities.
kPWM_LoadEvery4Oportunity Every 4 PWM opportunities.
kPWM_LoadEvery5Oportunity Every 5 PWM opportunities.
kPWM_LoadEvery6Oportunity Every 6 PWM opportunities.
kPWM_LoadEvery7Oportunity Every 7 PWM opportunities.
kPWM_LoadEvery8Oportunity Every 8 PWM opportunities.
kPWM_LoadEvery9Oportunity Every 9 PWM opportunities.
kPWM_LoadEvery10Oportunity Every 10 PWM opportunities.
kPWM_LoadEvery11Oportunity Every 11 PWM opportunities.
kPWM_LoadEvery12Oportunity Every 12 PWM opportunities.
kPWM_LoadEvery13Oportunity Every 13 PWM opportunities.
kPWM_LoadEvery14Oportunity Every 14 PWM opportunities.
kPWM_LoadEvery15Oportunity Every 15 PWM opportunities.
kPWM_LoadEvery16Oportunity Every 16 PWM opportunities.

35.6.9 enum pwm_fault_input_t

Enumerator

kPWM_Fault_0 Fault 0 input pin.
kPWM_Fault_1 Fault 1 input pin.
kPWM_Fault_2 Fault 2 input pin.
kPWM_Fault_3 Fault 3 input pin.

35.6.10 enum pwm_fault_disable_t

Enumerator

- kPWM_FaultDisable_0* Fault 0 disable mapping.
- kPWM_FaultDisable_1* Fault 1 disable mapping.
- kPWM_FaultDisable_2* Fault 2 disable mapping.
- kPWM_FaultDisable_3* Fault 3 disable mapping.

35.6.11 enum pwm_input_capture_edge_t

Enumerator

- kPWM_Disable* Disabled.
- kPWM_FallingEdge* Capture on falling edge only.
- kPWM_RisingEdge* Capture on rising edge only.
- kPWM_RiseAndFallEdge* Capture on rising or falling edge.

35.6.12 enum pwm_force_signal_t

Enumerator

- kPWM_UsePwm* Generated PWM signal is used by the deadtime logic.
- kPWM_InvertedPwm* Inverted PWM signal is used by the deadtime logic.
- kPWM_SoftwareControl* Software controlled value is used by the deadtime logic.
- kPWM_UseExternal* PWM_EXT_A signal is used by the deadtime logic.

35.6.13 enum pwm_chnl_pair_operation_t

Enumerator

- kPWM_Independent* PWM A & PWM B operate as 2 independent channels.
- kPWM_ComplementaryPwmA* PWM A & PWM B are complementary channels, PWM A generates the signal.
- kPWM_ComplementaryPwmB* PWM A & PWM B are complementary channels, PWM B generates the signal.

35.6.14 enum pwm_register_reload_t

Enumerator

kPWM_ReloadImmediate Buffered-registers get loaded with new values as soon as LDOK bit is set.

kPWM_ReloadPwmHalfCycle Registers loaded on a PWM half cycle.

kPWM_ReloadPwmFullCycle Registers loaded on a PWM full cycle.

kPWM_ReloadPwmHalfAndFullCycle Registers loaded on a PWM half & full cycle.

35.6.15 enum pwm_fault_recovery_mode_t

Enumerator

kPWM_NoRecovery PWM output will stay inactive.

kPWM_RecoverHalfCycle PWM output re-enabled at the first half cycle.

kPWM_RecoverFullCycle PWM output re-enabled at the first full cycle.

kPWM_RecoverHalfAndFullCycle PWM output re-enabled at the first half or full cycle.

35.6.16 enum pwm_interrupt_enable_t

Enumerator

kPWM_CompareVal0InterruptEnable PWM VAL0 compare interrupt.

kPWM_CompareVal1InterruptEnable PWM VAL1 compare interrupt.

kPWM_CompareVal2InterruptEnable PWM VAL2 compare interrupt.

kPWM_CompareVal3InterruptEnable PWM VAL3 compare interrupt.

kPWM_CompareVal4InterruptEnable PWM VAL4 compare interrupt.

kPWM_CompareVal5InterruptEnable PWM VAL5 compare interrupt.

kPWM_CaptureX0InterruptEnable PWM capture X0 interrupt.

kPWM_CaptureX1InterruptEnable PWM capture X1 interrupt.

kPWM_CaptureB0InterruptEnable PWM capture B0 interrupt.

kPWM_CaptureB1InterruptEnable PWM capture B1 interrupt.

kPWM_CaptureA0InterruptEnable PWM capture A0 interrupt.

kPWM_CaptureA1InterruptEnable PWM capture A1 interrupt.

kPWM_ReloadInterruptEnable PWM reload interrupt.

kPWM_ReloadErrorInterruptEnable PWM reload error interrupt.

kPWM_Fault0InterruptEnable PWM fault 0 interrupt.

kPWM_Fault1InterruptEnable PWM fault 1 interrupt.

kPWM_Fault2InterruptEnable PWM fault 2 interrupt.

kPWM_Fault3InterruptEnable PWM fault 3 interrupt.

35.6.17 enum pwm_status_flags_t

Enumerator

kPWM_CompareVal0Flag PWM VAL0 compare flag.
kPWM_CompareVal1Flag PWM VAL1 compare flag.
kPWM_CompareVal2Flag PWM VAL2 compare flag.
kPWM_CompareVal3Flag PWM VAL3 compare flag.
kPWM_CompareVal4Flag PWM VAL4 compare flag.
kPWM_CompareVal5Flag PWM VAL5 compare flag.
kPWM_CaptureX0Flag PWM capture X0 flag.
kPWM_CaptureX1Flag PWM capture X1 flag.
kPWM_CaptureB0Flag PWM capture B0 flag.
kPWM_CaptureB1Flag PWM capture B1 flag.
kPWM_CaptureA0Flag PWM capture A0 flag.
kPWM_CaptureA1Flag PWM capture A1 flag.
kPWM_ReloadFlag PWM reload flag.
kPWM_ReloadErrorFlag PWM reload error flag.
kPWM_RegUpdatedFlag PWM registers updated flag.
kPWM_Fault0Flag PWM fault 0 flag.
kPWM_Fault1Flag PWM fault 1 flag.
kPWM_Fault2Flag PWM fault 2 flag.
kPWM_Fault3Flag PWM fault 3 flag.

35.6.18 enum pwm_dma_enable_t

Enumerator

kPWM_CaptureX0DMAEnable PWM capture X0 DMA.
kPWM_CaptureX1DMAEnable PWM capture X1 DMA.
kPWM_CaptureB0DMAEnable PWM capture B0 DMA.
kPWM_CaptureB1DMAEnable PWM capture B1 DMA.
kPWM_CaptureA0DMAEnable PWM capture A0 DMA.
kPWM_CaptureA1DMAEnable PWM capture A1 DMA.

35.6.19 enum pwm_dma_source_select_t

Enumerator

kPWM_DMAResourceDisable Read DMA requests disabled.
kPWM_DMAResourceWatermarksEnable Exceeding a FIFO watermark sets the DMA read request.
kPWM_DMAResourceLocalSync A local sync (VAL1 matches counter) sets the read DMA request.
kPWM_DMAResourceLocalReload A local reload (STS[RF] being set) sets the read DMA request.

35.6.20 enum pwm_watermark_control_t

Enumerator

- kPWM_FIFOWatermarksOR* Selected FIFO watermarks are OR'ed together.
- kPWM_FIFOWatermarksAND* Selected FIFO watermarks are AND'ed together.

35.6.21 enum pwm_mode_t

Enumerator

- kPWM_SignedCenterAligned* Signed center-aligned.
- kPWM_CenterAligned* Unsigned center-aligned.
- kPWM_SignedEdgeAligned* Signed edge-aligned.
- kPWM_EdgeAligned* Unsigned edge-aligned.

35.6.22 enum pwm_level_select_t

Enumerator

- kPWM_HighTrue* High level represents "on" or "active" state.
- kPWM_LowTrue* Low level represents "on" or "active" state.

35.6.23 enum pwm_fault_state_t

Enumerator

- kPWM_PwmFaultState0* Output is forced to logic 0 state prior to consideration of output polarity control.
- kPWM_PwmFaultState1* Output is forced to logic 1 state prior to consideration of output polarity control.
- kPWM_PwmFaultState2* Output is tristated.
- kPWM_PwmFaultState3* Output is tristated.

35.6.24 enum pwm_reload_source_select_t

Enumerator

- kPWM_LocalReload* The local reload signal is used to reload registers.
- kPWM_MasterReload* The master reload signal (from submodule 0) is used to reload.

35.6.25 enum pwm_fault_clear_t

Enumerator

kPWM_Automatic Automatic fault clearing.

kPWM_ManualNormal Manual fault clearing with no fault safety mode.

kPWM_ManualSafety Manual fault clearing with fault safety mode.

35.6.26 enum pwm_module_control_t

Enumerator

kPWM_Control_Module_0 Control submodule 0's start/stop,buffer reload operation.

kPWM_Control_Module_1 Control submodule 1's start/stop,buffer reload operation.

kPWM_Control_Module_2 Control submodule 2's start/stop,buffer reload operation.

kPWM_Control_Module_3 Control submodule 3's start/stop,buffer reload operation.

35.7 Function Documentation

35.7.1 status_t PWM_Init (PWM_Type * *base*, pwm_submodule_t *subModule*, const pwm_config_t * *config*)

Note

This API should be called at the beginning of the application using the PWM driver.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>config</i>	Pointer to user's PWM config structure.

Returns

kStatus_Success means success; else failed.

35.7.2 void PWM_Deinit (PWM_Type * *base*, pwm_submodule_t *subModule*)

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to deinitialize

35.7.3 void PWM_GetDefaultConfig (pwm_config_t * config)

The default values are:

```
* config->enableDebugMode = false;
* config->enableWait = false;
* config->reloadSelect = kPWM_LocalReload;
* config->clockSource = kPWM_BusClock;
* config->prescale = kPWM_Prescale_Divide_1;
* config->initializationControl = kPWM_Initialize_LocalSync;
* config->forceTrigger = kPWM_Force_Local;
* config->reloadFrequency = kPWM_LoadEveryOpportunity;
* config->reloadLogic = kPWM_ReloadImmediate;
* config->pairOperation = kPWM_Independent;
*
```

Parameters

<i>config</i>	Pointer to user's PWM config structure.
---------------	---

35.7.4 status_t PWM_SetupPwm (PWM_Type * base, pwm_submodule_t subModule, const pwm_signal_param_t * chnlParams, uint8_t numOfChnls, pwm_mode_t mode, uint32_t pwmFreq_Hz, uint32_t srcClock_Hz)

The function initializes the submodule according to the parameters passed in by the user. The function also sets up the value compare registers to match the PWM signal requirements. If the dead time insertion logic is enabled, the pulse period is reduced by the dead time period specified by the user.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure

<i>chnlParams</i>	Array of PWM channel parameters to configure the channel(s)
<i>numOfChnls</i>	Number of channels to configure, this should be the size of the array passed in. Array size should not be more than 2 as each submodule has 2 pins to output PWM
<i>mode</i>	PWM operation mode, options available in enumeration pwm_mode_t
<i>pwmFreq_Hz</i>	PWM signal frequency in Hz
<i>srcClock_Hz</i>	PWM main counter clock in Hz.

Returns

Returns `kStatusFail` if there was error setting up the signal; `kStatusSuccess` otherwise

35.7.5 void PWM_UpdatePwmDutycycle (PWM_Type * *base*, pwm_submodule_t *subModule*, pwm_channels_t *pwmSignal*, pwm_mode_t *currPwmMode*, uint8_t *dutyCyclePercent*)

The function updates the PWM dutycycle to the new value that is passed in. If the dead time insertion logic is enabled then the pulse period is reduced by the dead time period specified by the user.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>pwmSignal</i>	Signal (PWM A or PWM B) to update
<i>currPwmMode</i>	The current PWM mode set during PWM setup
<i>dutyCycle-Percent</i>	New PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)... 100=active signal (100% duty cycle)

35.7.6 void PWM_UpdatePwmDutycycleHighAccuracy (PWM_Type * *base*, pwm_submodule_t *subModule*, pwm_channels_t *pwmSignal*, pwm_mode_t *currPwmMode*, uint16_t *dutyCycle*)

The function updates the PWM dutycycle to the new value that is passed in. If the dead time insertion logic is enabled then the pulse period is reduced by the dead time period specified by the user.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>pwmSignal</i>	Signal (PWM A or PWM B) to update
<i>currPwmMode</i>	The current PWM mode set during PWM setup
<i>dutyCycle</i>	New PWM pulse width, value should be between 0 to 65535 0=inactive signal(0% duty cycle)... 65535=active signal (100% duty cycle)

35.7.7 void PWM_SetupInputCapture (PWM_Type * *base*, pwm_- submodule_t *subModule*, pwm_channels_t *pwmChannel*, const pwm_input_capture_param_t * *inputCaptureParams*)

Each PWM submodule has 3 pins that can be configured for use as input capture pins. This function sets up the capture parameters for each pin and enables the pin for input capture operation.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>pwmChannel</i>	Channel in the submodule to setup
<i>inputCapture-Params</i>	Parameters passed in to set up the input pin

35.7.8 void PWM_SetupFaultInputFilter (PWM_Type * *base*, const pwm_fault_input_filter_param_t * *faultInputFilterParams*)

Parameters

<i>base</i>	PWM peripheral base address
<i>faultInput-FilterParams</i>	Parameters passed in to set up the fault input filter.

35.7.9 void PWM_SetupFaults (PWM_Type * *base*, pwm_fault_input_t *faultNum*, const pwm_fault_param_t * *faultParams*)

PWM has 4 fault inputs.

Parameters

<i>base</i>	PWM peripheral base address
<i>faultNum</i>	PWM fault to configure.
<i>faultParams</i>	Pointer to the PWM fault config structure

35.7.10 void PWM_FaultDefaultConfig (pwm_fault_param_t * config)

The default values are:

```
* config->faultClearingMode = kPWM_Automatic;
* config->faultLevel = false;
* config->enableCombinationalPath = true;
* config->recoverMode = kPWM_NoRecovery;
*
```

Parameters

<i>config</i>	Pointer to user's PWM fault config structure.
---------------	---

35.7.11 void PWM_SetupForceSignal (PWM_Type * base, pwm_submodule_t subModule, pwm_channels_t pwmChannel, pwm_force_signal_t mode)

The user specifies which channel to configure by supplying the submodule number and whether to modify PWM A or PWM B within that submodule.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>pwmChannel</i>	Channel to configure
<i>mode</i>	Signal to output when a FORCE_OUT is triggered

35.7.12 void PWM_EnableInterrupts (PWM_Type * base, pwm_submodule_t subModule, uint32_t mask)

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>mask</i>	The interrupts to enable. This is a logical OR of members of the enumeration pwm_interrupt_enable_t

35.7.13 void PWM_DisableInterrupts (PWM_Type * *base*, pwm_submodule_t *subModule*, uint32_t *mask*)

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>mask</i>	The interrupts to enable. This is a logical OR of members of the enumeration pwm_interrupt_enable_t

35.7.14 uint32_t PWM_GetEnabledInterrupts (PWM_Type * *base*, pwm_submodule_t *subModule*)

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure

Returns

The enabled interrupts. This is the logical OR of members of the enumeration [pwm_interrupt_enable_t](#)

35.7.15 static void PWM_DMAFIFOWatermarkControl (PWM_Type * *base*, pwm_submodule_t *subModule*, pwm_watermark_control_t *pwm_watermark_control*) [inline], [static]

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>pwm_- watermark_- control</i>	PWM FIFO watermark and control

35.7.16 `static void PWM_DMACaptureSourceSelect (PWM_Type * base, pwm_submodule_t subModule, pwm_dma_source_select_t pwm_dma_source_select) [inline], [static]`

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>pwm_dma_- source_select</i>	PWM capture DMA enable source select

35.7.17 `static void PWM_EnableDMACapture (PWM_Type * base, pwm_submodule_t subModule, uint16_t mask, bool activate) [inline], [static]`

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>mask</i>	The DMA to enable or disable. This is a logical OR of members of the enumeration pwm_dma_enable_t
<i>activate</i>	true: Enable DMA read request; false: Disable DMA read request

35.7.18 `static void PWM_EnableDMAWrite (PWM_Type * base, pwm_submodule_t subModule, bool activate) [inline], [static]`

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>activate</i>	true: Enable DMA write request; false: Disable DMA write request

35.7.19 `uint32_t PWM_GetStatusFlags (PWM_Type * base, pwm_submodule_t subModule)`

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure

Returns

The status flags. This is the logical OR of members of the enumeration [pwm_status_flags_t](#)

35.7.20 `void PWM_ClearStatusFlags (PWM_Type * base, pwm_submodule_t subModule, uint32_t mask)`

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>mask</i>	The status flags to clear. This is a logical OR of members of the enumeration pwm_status_flags_t

35.7.21 `static void PWM_StartTimer (PWM_Type * base, uint8_t subModulesToStart) [inline], [static]`

Sets the Run bit which enables the clocks to the PWM submodule. This function can start multiple submodules at the same time.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModulesTo-Start</i>	PWM submodules to start. This is a logical OR of members of the enumeration pwm-_module_control_t

35.7.22 **static void PWM_StopTimer (PWM_Type * *base*, uint8_t *subModulesToStop*) [inline], [static]**

Clears the Run bit which resets the submodule's counter. This function can stop multiple submodules at the same time.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModulesTo-Stop</i>	PWM submodules to stop. This is a logical OR of members of the enumeration pwm-_module_control_t

35.7.23 **static void PWM_OutputTriggerEnable (PWM_Type * *base*, pwm_submodule_t *subModule*, pwm_value_register_t *valueRegister*, bool *activate*) [inline], [static]**

This function allows the user to enable or disable the PWM trigger. The PWM has 2 triggers. Trigger 0 is activated when the counter matches VAL 0, VAL 2, or VAL 4 register. Trigger 1 is activated when the counter matches VAL 1, VAL 3, or VAL 5 register.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>valueRegister</i>	Value register that will activate the trigger
<i>activate</i>	true: Enable the trigger; false: Disable the trigger

35.7.24 **static void PWM_ActivateOutputTrigger (PWM_Type * *base*, pwm_submodule_t *subModule*, uint16_t *valueRegisterMask*) [inline], [static]**

This function allows the user to enable one or more (VAL0-5) PWM trigger.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>valueRegisterMask</i>	Value register mask that will activate one or more (VAL0-5) trigger enumeration _pwm_value_register_mask

35.7.25 static void PWM_DeactivateOutputTrigger (PWM_Type * *base*, pwm_submodule_t *subModule*, uint16_t *valueRegisterMask*) [inline], [static]

This function allows the user to disables one or more (VAL0-5) PWM trigger.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>valueRegisterMask</i>	Value register mask that will Deactivate one or more (VAL0-5) trigger enumeration _pwm_value_register_mask

35.7.26 static void PWM_SetupSwCtrlOut (PWM_Type * *base*, pwm_submodule_t *subModule*, pwm_channels_t *pwmChannel*, bool *value*) [inline], [static]

The user specifies which channel to modify by supplying the submodule number and whether to modify PWM A or PWM B within that submodule.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>pwmChannel</i>	Channel to configure
<i>value</i>	true: Supply a logic 1, false: Supply a logic 0.

35.7.27 **static void PWM_SetPwmLdok (PWM_Type * *base*, uint8_t *subModulesToUpdate*, bool *value*) [inline], [static]**

Set LDOK bit to load buffered values into CTRL[PRSC] and the INIT, FRACVAL and VAL registers. The values are loaded immediately if kPWM_ReloadImmediate option was chosen during config. Else the values are loaded at the next PWM reload point. This function can issue the load command to multiple submodules at the same time.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModulesToUpdate</i>	PWM submodules to update with buffered values. This is a logical OR of members of the enumeration pwm_module_control_t
<i>value</i>	true: Set LDOK bit for the submodule list; false: Clear LDOK bit

35.7.28 **static void PWM_SetPwmFaultState (PWM_Type * *base*, pwm_submodule_t *subModule*, pwm_channels_t *pwmChannel*, pwm_fault_state_t *faultState*) [inline], [static]**

These bits determine the fault state for the PWM_A output in fault conditions and STOP mode. It may also define the output state in WAIT and DEBUG modes depending on the settings of CTRL2[WAITEN] and CTRL2[DBGEN]. This function can update PWM output fault status.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>pwmChannel</i>	Channel to configure
<i>faultState</i>	PWM output fault status

35.7.29 **static void PWM_SetupFaultDisableMap (PWM_Type * *base*, pwm_submodule_t *subModule*, pwm_channels_t *pwmChannel*, pwm_fault_channels_t *pwm_fault_channels*, uint16_t *value*) [inline], [static]**

Each of the four bits of this read/write field is one-to-one associated with the four FAULTx inputs of fault channel 0/1. The PWM output will be turned off if there is a logic 1 on an FAULTx input and a 1 in the corresponding bit of this field. A reset sets all bits in this field.

Parameters

<i>base</i>	PWM peripheral base address
<i>subModule</i>	PWM submodule to configure
<i>pwmChannel</i>	PWM channel to configure
<i>pwm_fault_channels</i>	PWM fault channel to configure
<i>value</i>	Fault disable mapping mask value enumeration pwm_fault_disable_t

Chapter 36

QTMR: Quad Timer Driver

36.1 Overview

The MCUXpresso SDK provides a driver for the QTMR module of MCUXpresso SDK devices.

Data Structures

- struct `qtmr_config_t`
Quad Timer config structure. [More...](#)

Enumerations

- enum `qtmr_primary_count_source_t` {
 `kQTMR_ClockCounter0InputPin` = 0,
 `kQTMR_ClockCounter1InputPin`,
 `kQTMR_ClockCounter2InputPin`,
 `kQTMR_ClockCounter3InputPin`,
 `kQTMR_ClockCounter0Output`,
 `kQTMR_ClockCounter1Output`,
 `kQTMR_ClockCounter2Output`,
 `kQTMR_ClockCounter3Output`,
 `kQTMR_ClockDivide_1`,
 `kQTMR_ClockDivide_2`,
 `kQTMR_ClockDivide_4`,
 `kQTMR_ClockDivide_8`,
 `kQTMR_ClockDivide_16`,
 `kQTMR_ClockDivide_32`,
 `kQTMR_ClockDivide_64`,
 `kQTMR_ClockDivide_128` }
Quad Timer primary clock source selection.
- enum `qtmr_input_source_t` {
 `kQTMR_Counter0InputPin` = 0,
 `kQTMR_Counter1InputPin`,
 `kQTMR_Counter2InputPin`,
 `kQTMR_Counter3InputPin` }
Quad Timer input sources selection.
- enum `qtmr_counting_mode_t` {

- ```

kQTMR_NoOperation = 0,
kQTMR_PriSrcRiseEdge,
kQTMR_PriSrcRiseAndFallEdge,
kQTMR_PriSrcRiseEdgeSecInpHigh,
kQTMR_QuadCountMode,
kQTMR_PriSrcRiseEdgeSecDir,
kQTMR_SecSrcTrigPriCnt,
kQTMR_CascadeCount }

```
- *Quad Timer counting mode selection.*

```

enum qtmr_output_mode_t {
kQTMR_AssertWhenCountActive = 0,
kQTMR_ClearOnCompare,
kQTMR_SetOnCompare,
kQTMR_ToggleOnCompare,
kQTMR_ToggleOnAltCompareReg,
kQTMR_SetOnCompareClearOnSecSrcInp,
kQTMR_SetOnCompareClearOnCountRoll,
kQTMR_EnableGateClock }

```
  - *Quad Timer output mode selection.*

```

enum qtmr_input_capture_edge_t {
kQTMR_NoCapture = 0,
kQTMR_RisingEdge,
kQTMR_FallingEdge,
kQTMR_RisingAndFallingEdge }

```
  - *Quad Timer input capture edge mode, rising edge, or falling edge.*

```

enum qtmr_preload_control_t {
kQTMR_NoPreload = 0,
kQTMR_LoadOnComp1,
kQTMR_LoadOnComp2 }

```
  - *Quad Timer input capture edge mode, rising edge, or falling edge.*

```

enum qtmr_debug_action_t {
kQTMR_RunNormalInDebug = 0U,
kQTMR_HaltCounter,
kQTMR_ForceOutToZero,
kQTMR_HaltCountForceOutZero }

```
  - *List of Quad Timer run options when in Debug mode.*

```

enum qtmr_interrupt_enable_t {
kQTMR_CompareInterruptEnable = (1U << 0),
kQTMR_Compare1InterruptEnable = (1U << 1),
kQTMR_Compare2InterruptEnable = (1U << 2),
kQTMR_OverflowInterruptEnable = (1U << 3),
kQTMR_EdgeInterruptEnable = (1U << 4) }

```
  - *List of Quad Timer interrupts.*

```

enum qtmr_status_flags_t {

```

```

kQTMR_CompareFlag = (1U << 0),
kQTMR_Compare1Flag = (1U << 1),
kQTMR_Compare2Flag = (1U << 2),
kQTMR_OverflowFlag = (1U << 3),
kQTMR_EdgeFlag = (1U << 4) }

```

*List of Quad Timer flags.*

- enum `qtmr_channel_selection_t` {  
`kQTMR_Channel_0` = 0U,  
`kQTMR_Channel_1`,  
`kQTMR_Channel_2`,  
`kQTMR_Channel_3` }

*List of channel selection.*

- enum `qtmr_dma_enable_t` {  
`kQTMR_InputEdgeFlagDmaEnable` = (1U << 0),  
`kQTMR_ComparatorPreload1DmaEnable` = (1U << 1),  
`kQTMR_ComparatorPreload2DmaEnable` = (1U << 2) }

*List of Quad Timer DMA enable.*

## Functions

- `status_t QTMR_SetupPwm` (TMR\_Type \*base, `qtmr_channel_selection_t` channel, uint32\_t pwmFreqHz, uint8\_t dutyCyclePercent, bool outputPolarity, uint32\_t srcClock\_Hz)  
*Sets up Quad timer module for PWM signal output.*
- `void QTMR_SetupInputCapture` (TMR\_Type \*base, `qtmr_channel_selection_t` channel, `qtmr_input_source_t` capturePin, bool inputPolarity, bool reloadOnCapture, `qtmr_input_capture_edge_t` captureMode)  
*Allows the user to count the source clock cycles until a capture event arrives.*

## Driver version

- #define `FSL_QTMR_DRIVER_VERSION` (MAKE\_VERSION(2, 1, 0))  
*Version.*

## Initialization and deinitialization

- `void QTMR_Init` (TMR\_Type \*base, `qtmr_channel_selection_t` channel, const `qtmr_config_t` \*config)  
*Ungates the Quad Timer clock and configures the peripheral for basic operation.*
- `void QTMR_Deinit` (TMR\_Type \*base, `qtmr_channel_selection_t` channel)  
*Stops the counter and gates the Quad Timer clock.*
- `void QTMR_GetDefaultConfig` (`qtmr_config_t` \*config)  
*Fill in the Quad Timer config struct with the default settings.*

## Interrupt Interface

- `void QTMR_EnableInterrupts` (TMR\_Type \*base, `qtmr_channel_selection_t` channel, uint32\_t mask)  
*Enables the selected Quad Timer interrupts.*

- void [QTMR\\_DisableInterrupts](#) (TMR\_Type \*base, [qtmr\\_channel\\_selection\\_t](#) channel, uint32\_t mask)  
*Disables the selected Quad Timer interrupts.*
- uint32\_t [QTMR\\_GetEnabledInterrupts](#) (TMR\_Type \*base, [qtmr\\_channel\\_selection\\_t](#) channel)  
*Gets the enabled Quad Timer interrupts.*

## Status Interface

- uint32\_t [QTMR\\_GetStatus](#) (TMR\_Type \*base, [qtmr\\_channel\\_selection\\_t](#) channel)  
*Gets the Quad Timer status flags.*
- void [QTMR\\_ClearStatusFlags](#) (TMR\_Type \*base, [qtmr\\_channel\\_selection\\_t](#) channel, uint32\_t mask)  
*Clears the Quad Timer status flags.*

## Read and Write the timer period

- void [QTMR\\_SetTimerPeriod](#) (TMR\_Type \*base, [qtmr\\_channel\\_selection\\_t](#) channel, uint16\_t ticks)  
*Sets the timer period in ticks.*
- void [QTMR\\_SetCompareValue](#) (TMR\_Type \*base, [qtmr\\_channel\\_selection\\_t](#) channel, uint16\_t ticks)  
*Set compare value.*
- static void [QTMR\\_SetLoadValue](#) (TMR\_Type \*base, [qtmr\\_channel\\_selection\\_t](#) channel, uint16\_t value)  
*Set load value.*
- static uint16\_t [QTMR\\_GetCurrentTimerCount](#) (TMR\_Type \*base, [qtmr\\_channel\\_selection\\_t](#) channel)  
*Reads the current timer counting value.*

## Timer Start and Stop

- static void [QTMR\\_StartTimer](#) (TMR\_Type \*base, [qtmr\\_channel\\_selection\\_t](#) channel, [qtmr\\_counting\\_mode\\_t](#) clockSource)  
*Starts the Quad Timer counter.*
- static void [QTMR\\_StopTimer](#) (TMR\_Type \*base, [qtmr\\_channel\\_selection\\_t](#) channel)  
*Stops the Quad Timer counter.*

## Enable and Disable the Quad Timer DMA

- void [QTMR\\_EnableDma](#) (TMR\_Type \*base, [qtmr\\_channel\\_selection\\_t](#) channel, uint32\_t mask)  
*Enable the Quad Timer DMA.*
- void [QTMR\\_DisableDma](#) (TMR\_Type \*base, [qtmr\\_channel\\_selection\\_t](#) channel, uint32\_t mask)  
*Disable the Quad Timer DMA.*

## 36.2 Data Structure Documentation

### 36.2.1 struct [qtmr\\_config\\_t](#)

This structure holds the configuration settings for the Quad Timer peripheral. To initialize this structure to reasonable defaults, call the [QTMR\\_GetDefaultConfig\(\)](#) function and pass a pointer to your config structure instance.

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

## Data Fields

- [qtmr\\_primary\\_count\\_source\\_t primarySource](#)  
*Specify the primary count source.*
- [qtmr\\_input\\_source\\_t secondarySource](#)  
*Specify the secondary count source.*
- bool [enableMasterMode](#)  
*true: Broadcast compare function output to other counters; false no broadcast*
- bool [enableExternalForce](#)  
*true: Compare from another counter force state of OFLAG signal false: OFLAG controlled by local counter*
- uint8\_t [faultFilterCount](#)  
*Fault filter count.*
- uint8\_t [faultFilterPeriod](#)  
*Fault filter period; value of 0 will bypass the filter.*
- [qtmr\\_debug\\_action\\_t debugMode](#)  
*Operation in Debug mode.*

## 36.3 Enumeration Type Documentation

### 36.3.1 enum qtmr\_primary\_count\_source\_t

Enumerator

- kQTMR\_ClockCounter0InputPin*** Use counter 0 input pin.
- kQTMR\_ClockCounter1InputPin*** Use counter 1 input pin.
- kQTMR\_ClockCounter2InputPin*** Use counter 2 input pin.
- kQTMR\_ClockCounter3InputPin*** Use counter 3 input pin.
- kQTMR\_ClockCounter0Output*** Use counter 0 output.
- kQTMR\_ClockCounter1Output*** Use counter 1 output.
- kQTMR\_ClockCounter2Output*** Use counter 2 output.
- kQTMR\_ClockCounter3Output*** Use counter 3 output.
- kQTMR\_ClockDivide\_1*** IP bus clock divide by 1 prescaler.
- kQTMR\_ClockDivide\_2*** IP bus clock divide by 2 prescaler.
- kQTMR\_ClockDivide\_4*** IP bus clock divide by 4 prescaler.
- kQTMR\_ClockDivide\_8*** IP bus clock divide by 8 prescaler.
- kQTMR\_ClockDivide\_16*** IP bus clock divide by 16 prescaler.
- kQTMR\_ClockDivide\_32*** IP bus clock divide by 32 prescaler.
- kQTMR\_ClockDivide\_64*** IP bus clock divide by 64 prescaler.
- kQTMR\_ClockDivide\_128*** IP bus clock divide by 128 prescaler.

### 36.3.2 enum qtmr\_input\_source\_t

Enumerator

*kQTMR\_Counter0InputPin* Use counter 0 input pin.  
*kQTMR\_Counter1InputPin* Use counter 1 input pin.  
*kQTMR\_Counter2InputPin* Use counter 2 input pin.  
*kQTMR\_Counter3InputPin* Use counter 3 input pin.

### 36.3.3 enum qtmr\_counting\_mode\_t

Enumerator

*kQTMR\_NoOperation* No operation.  
*kQTMR\_PriSrcRiseEdge* Count rising edges of primary source.  
*kQTMR\_PriSrcRiseAndFallEdge* Count rising and falling edges of primary source.  
*kQTMR\_PriSrcRiseEdgeSecInpHigh* Count rise edges of pri SRC while sec inp high active.  
*kQTMR\_QuadCountMode* Quadrature count mode, uses pri and sec sources.  
*kQTMR\_PriSrcRiseEdgeSecDir* Count rising edges of pri SRC; sec SRC specifies dir.  
*kQTMR\_SecSrcTrigPriCnt* Edge of sec SRC trigger primary count until compare.  
*kQTMR\_CascadeCount* Cascaded count mode (up/down)

### 36.3.4 enum qtmr\_output\_mode\_t

Enumerator

*kQTMR\_AssertWhenCountActive* Assert OFLAG while counter is active.  
*kQTMR\_ClearOnCompare* Clear OFLAG on successful compare.  
*kQTMR\_SetOnCompare* Set OFLAG on successful compare.  
*kQTMR\_ToggleOnCompare* Toggle OFLAG on successful compare.  
*kQTMR\_ToggleOnAltCompareReg* Toggle OFLAG using alternating compare registers.  
*kQTMR\_SetOnCompareClearOnSecSrcInp* Set OFLAG on compare, clear on sec SRC input edge.  
  
*kQTMR\_SetOnCompareClearOnCountRoll* Set OFLAG on compare, clear on counter rollover.  
*kQTMR\_EnableGateClock* Enable gated clock output while count is active.

### 36.3.5 enum qtmr\_input\_capture\_edge\_t

Enumerator

*kQTMR\_NoCapture* Capture is disabled.  
*kQTMR\_RisingEdge* Capture on rising edge (IPS=0) or falling edge (IPS=1)



*kQTMR\_FallingEdge* Capture on falling edge (IPS=0) or rising edge (IPS=1)

*kQTMR\_RisingAndFallingEdge* Capture on both edges.

### 36.3.6 enum qtmr\_preload\_control\_t

Enumerator

*kQTMR\_NoPreload* Never preload.

*kQTMR\_LoadOnComp1* Load upon successful compare with value in COMP1.

*kQTMR\_LoadOnComp2* Load upon successful compare with value in COMP2.

### 36.3.7 enum qtmr\_debug\_action\_t

Enumerator

*kQTMR\_RunNormalInDebug* Continue with normal operation.

*kQTMR\_HaltCounter* Halt counter.

*kQTMR\_ForceOutToZero* Force output to logic 0.

*kQTMR\_HaltCountForceOutZero* Halt counter and force output to logic 0.

### 36.3.8 enum qtmr\_interrupt\_enable\_t

Enumerator

*kQTMR\_CompareInterruptEnable* Compare interrupt.

*kQTMR\_Compare1InterruptEnable* Compare 1 interrupt.

*kQTMR\_Compare2InterruptEnable* Compare 2 interrupt.

*kQTMR\_OverflowInterruptEnable* Timer overflow interrupt.

*kQTMR\_EdgeInterruptEnable* Input edge interrupt.

### 36.3.9 enum qtmr\_status\_flags\_t

Enumerator

*kQTMR\_CompareFlag* Compare flag.

*kQTMR\_Compare1Flag* Compare 1 flag.

*kQTMR\_Compare2Flag* Compare 2 flag.

*kQTMR\_OverflowFlag* Timer overflow flag.

*kQTMR\_EdgeFlag* Input edge flag.

### 36.3.10 enum qtmr\_channel\_selection\_t

Enumerator

*kQTMR\_Channel\_0* TMR Channel 0.  
*kQTMR\_Channel\_1* TMR Channel 1.  
*kQTMR\_Channel\_2* TMR Channel 2.  
*kQTMR\_Channel\_3* TMR Channel 3.

### 36.3.11 enum qtmr\_dma\_enable\_t

Enumerator

*kQTMR\_InputEdgeFlagDmaEnable* Input Edge Flag DMA Enable.  
*kQTMR\_ComparatorPreload1DmaEnable* Comparator Preload Register 1 DMA Enable.  
*kQTMR\_ComparatorPreload2DmaEnable* Comparator Preload Register 2 DMA Enable.

## 36.4 Function Documentation

### 36.4.1 void QTMR\_Init ( TMR\_Type \* *base*, qtmr\_channel\_selection\_t *channel*, const qtmr\_config\_t \* *config* )

Note

This API should be called at the beginning of the application using the Quad Timer driver.

Parameters

|                |                                               |
|----------------|-----------------------------------------------|
| <i>base</i>    | Quad Timer peripheral base address            |
| <i>channel</i> | Quad Timer channel number                     |
| <i>config</i>  | Pointer to user's Quad Timer config structure |

### 36.4.2 void QTMR\_Deinit ( TMR\_Type \* *base*, qtmr\_channel\_selection\_t *channel* )

Parameters

|                |                                    |
|----------------|------------------------------------|
| <i>base</i>    | Quad Timer peripheral base address |
| <i>channel</i> | Quad Timer channel number          |

### 36.4.3 void QTMR\_GetDefaultConfig ( qtmr\_config\_t \* config )

The default values are:

```
* config->debugMode = kQTMR_RunNormalInDebug;
* config->enableExternalForce = false;
* config->enableMasterMode = false;
* config->faultFilterCount = 0;
* config->faultFilterPeriod = 0;
* config->primarySource = kQTMR_ClockDivide_2;
* config->secondarySource = kQTMR_Counter0InputPin;
*
```

Parameters

|               |                                                |
|---------------|------------------------------------------------|
| <i>config</i> | Pointer to user's Quad Timer config structure. |
|---------------|------------------------------------------------|

### 36.4.4 status\_t QTMR\_SetupPwm ( TMR\_Type \* base, qtmr\_channel\_selection\_t channel, uint32\_t pwmFreqHz, uint8\_t dutyCyclePercent, bool outputPolarity, uint32\_t srcClock\_Hz )

The function initializes the timer module according to the parameters passed in by the user. The function also sets up the value compare registers to match the PWM signal requirements.

Parameters

|                          |                                                                                                                           |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>              | Quad Timer peripheral base address                                                                                        |
| <i>channel</i>           | Quad Timer channel number                                                                                                 |
| <i>pwmFreqHz</i>         | PWM signal frequency in Hz                                                                                                |
| <i>dutyCycle-Percent</i> | PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)... 100=active signal (100% duty cycle) |
| <i>outputPolarity</i>    | true: invert polarity of the output signal, false: no inversion                                                           |

|                    |                           |
|--------------------|---------------------------|
| <i>srcClock_Hz</i> | Main counter clock in Hz. |
|--------------------|---------------------------|

Returns

Returns an error if there was error setting up the signal.

**36.4.5 void QTMR\_SetupInputCapture ( TMR\_Type \* *base*, qtmr\_channel\_selection\_t *channel*, qtmr\_input\_source\_t *capturePin*, bool *inputPolarity*, bool *reloadOnCapture*, qtmr\_input\_capture\_edge\_t *captureMode* )**

The count is stored in the capture register.

Parameters

|                         |                                                                         |
|-------------------------|-------------------------------------------------------------------------|
| <i>base</i>             | Quad Timer peripheral base address                                      |
| <i>channel</i>          | Quad Timer channel number                                               |
| <i>capturePin</i>       | Pin through which we receive the input signal to trigger the capture    |
| <i>inputPolarity</i>    | true: invert polarity of the input signal, false: no inversion          |
| <i>reloadOn-Capture</i> | true: reload the counter when an input capture occurs, false: no reload |
| <i>captureMode</i>      | Specifies which edge of the input signal triggers a capture             |

**36.4.6 void QTMR\_EnableInterrupts ( TMR\_Type \* *base*, qtmr\_channel\_selection\_t *channel*, uint32\_t *mask* )**

Parameters

|                |                                                                                                                      |
|----------------|----------------------------------------------------------------------------------------------------------------------|
| <i>base</i>    | Quad Timer peripheral base address                                                                                   |
| <i>channel</i> | Quad Timer channel number                                                                                            |
| <i>mask</i>    | The interrupts to enable. This is a logical OR of members of the enumeration <a href="#">qtmr_interrupt_enable_t</a> |

**36.4.7 void QTMR\_DisableInterrupts ( TMR\_Type \* *base*, qtmr\_channel\_selection\_t *channel*, uint32\_t *mask* )**

## Parameters

|                |                                                                                                                      |
|----------------|----------------------------------------------------------------------------------------------------------------------|
| <i>base</i>    | Quad Timer peripheral base address                                                                                   |
| <i>channel</i> | Quad Timer channel number                                                                                            |
| <i>mask</i>    | The interrupts to enable. This is a logical OR of members of the enumeration <a href="#">qtmr_interrupt_enable_t</a> |

### 36.4.8 uint32\_t QTMR\_GetEnabledInterrupts ( TMR\_Type \* *base*, qtmr\_channel\_selection\_t *channel* )

## Parameters

|                |                                    |
|----------------|------------------------------------|
| <i>base</i>    | Quad Timer peripheral base address |
| <i>channel</i> | Quad Timer channel number          |

## Returns

The enabled interrupts. This is the logical OR of members of the enumeration [qtmr\\_interrupt\\_enable\\_t](#)

### 36.4.9 uint32\_t QTMR\_GetStatus ( TMR\_Type \* *base*, qtmr\_channel\_selection\_t *channel* )

## Parameters

|                |                                    |
|----------------|------------------------------------|
| <i>base</i>    | Quad Timer peripheral base address |
| <i>channel</i> | Quad Timer channel number          |

## Returns

The status flags. This is the logical OR of members of the enumeration [qtmr\\_status\\_flags\\_t](#)

### 36.4.10 void QTMR\_ClearStatusFlags ( TMR\_Type \* *base*, qtmr\_channel\_selection\_t *channel*, uint32\_t *mask* )

## Parameters

|                |                                                                                                                   |
|----------------|-------------------------------------------------------------------------------------------------------------------|
| <i>base</i>    | Quad Timer peripheral base address                                                                                |
| <i>channel</i> | Quad Timer channel number                                                                                         |
| <i>mask</i>    | The status flags to clear. This is a logical OR of members of the enumeration <a href="#">qtmr_status_flags_t</a> |

### 36.4.11 void QTMR\_SetTimerPeriod ( TMR\_Type \* *base*, qtmr\_channel\_selection\_t *channel*, uint16\_t *ticks* )

Timers counts from initial value till it equals the count value set here. The counter will then reinitialize to the value specified in the Load register.

## Note

1. This function will write the time period in ticks to COMP1 or COMP2 register depending on the count direction
2. User can call the utility macros provided in `fsl_common.h` to convert to ticks
3. This function supports cases, providing only primary source clock without secondary source clock.

## Parameters

|                |                                    |
|----------------|------------------------------------|
| <i>base</i>    | Quad Timer peripheral base address |
| <i>channel</i> | Quad Timer channel number          |
| <i>ticks</i>   | Timer period in units of ticks     |

### 36.4.12 void QTMR\_SetCompareValue ( TMR\_Type \* *base*, qtmr\_channel\_selection\_t *channel*, uint16\_t *ticks* )

This function sets the value used for comparison with the counter value.

## Parameters

|             |                                    |
|-------------|------------------------------------|
| <i>base</i> | Quad Timer peripheral base address |
|-------------|------------------------------------|

|                |                                 |
|----------------|---------------------------------|
| <i>channel</i> | Quad Timer channel number       |
| <i>ticks</i>   | Timer period in units of ticks. |

**36.4.13** `static void QTMR_SetLoadValue ( TMR_Type * base, qtmr_channel_selection_t channel, uint16_t value ) [inline], [static]`

This function sets the value used to initialize the counter after a counter comparison.

Parameters

|                |                                     |
|----------------|-------------------------------------|
| <i>base</i>    | Quad Timer peripheral base address  |
| <i>channel</i> | Quad Timer channel number           |
| <i>value</i>   | Load register initialization value. |

**36.4.14** `static uint16_t QTMR_GetCurrentTimerCount ( TMR_Type * base, qtmr_channel_selection_t channel ) [inline], [static]`

This function returns the real-time timer counting value, in a range from 0 to a timer period.

Note

User can call the utility macros provided in `fsl_common.h` to convert ticks to usec or msec

Parameters

|                |                                    |
|----------------|------------------------------------|
| <i>base</i>    | Quad Timer peripheral base address |
| <i>channel</i> | Quad Timer channel number          |

Returns

Current counter value in ticks

**36.4.15** `static void QTMR_StartTimer ( TMR_Type * base, qtmr_channel_selection_t channel, qtmr_counting_mode_t clockSource ) [inline], [static]`

Parameters

|                    |                                    |
|--------------------|------------------------------------|
| <i>base</i>        | Quad Timer peripheral base address |
| <i>channel</i>     | Quad Timer channel number          |
| <i>clockSource</i> | Quad Timer clock source            |

**36.4.16** `static void QTMR_StopTimer ( TMR_Type * base, qtmr_channel_selection_t channel ) [inline], [static]`

Parameters

|                |                                    |
|----------------|------------------------------------|
| <i>base</i>    | Quad Timer peripheral base address |
| <i>channel</i> | Quad Timer channel number          |

**36.4.17** `void QTMR_EnableDma ( TMR_Type * base, qtmr_channel_selection_t channel, uint32_t mask )`

Parameters

|                |                                                                                                         |
|----------------|---------------------------------------------------------------------------------------------------------|
| <i>base</i>    | Quad Timer peripheral base address                                                                      |
| <i>channel</i> | Quad Timer channel number                                                                               |
| <i>mask</i>    | The DMA to enable. This is a logical OR of members of the enumeration <a href="#">qtmr_dma_enable_t</a> |

**36.4.18** `void QTMR_DisableDma ( TMR_Type * base, qtmr_channel_selection_t channel, uint32_t mask )`

Parameters

|                |                                                                                                         |
|----------------|---------------------------------------------------------------------------------------------------------|
| <i>base</i>    | Quad Timer peripheral base address                                                                      |
| <i>channel</i> | Quad Timer channel number                                                                               |
| <i>mask</i>    | The DMA to enable. This is a logical OR of members of the enumeration <a href="#">qtmr_dma_enable_t</a> |



## Chapter 37

# RTWDOG: 32-bit Watchdog Timer

### 37.1 Overview

The MCUXpresso SDK provides a peripheral driver for the RTWDOG module of MCUXpresso SDK devices.

### 37.2 Typical use case

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/rtwdog`

### Data Structures

- struct `rtwdog_work_mode_t`  
*Defines RTWDOG work mode. [More...](#)*
- struct `rtwdog_config_t`  
*Describes RTWDOG configuration structure. [More...](#)*

### Enumerations

- enum `rtwdog_clock_source_t` {  
    `kRTWDOG_ClockSource0` = 0U,  
    `kRTWDOG_ClockSource1` = 1U,  
    `kRTWDOG_ClockSource2` = 2U,  
    `kRTWDOG_ClockSource3` = 3U }  
*Describes RTWDOG clock source.*
- enum `rtwdog_clock_prescaler_t` {  
    `kRTWDOG_ClockPrescalerDivide1` = 0x0U,  
    `kRTWDOG_ClockPrescalerDivide256` = 0x1U }  
*Describes the selection of the clock prescaler.*
- enum `rtwdog_test_mode_t` {  
    `kRTWDOG_TestModeDisabled` = 0U,  
    `kRTWDOG_UserModeEnabled` = 1U,  
    `kRTWDOG_LowByteTest` = 2U,  
    `kRTWDOG_HighByteTest` = 3U }  
*Describes RTWDOG test mode.*
- enum `_rtwdog_interrupt_enable_t` { `kRTWDOG_InterruptEnable` = RTWDOG\_CS\_INT\_MASK }  
*RTWDOG interrupt configuration structure.*
- enum `_rtwdog_status_flags_t` {  
    `kRTWDOG_RunningFlag` = RTWDOG\_CS\_EN\_MASK,  
    `kRTWDOG_InterruptFlag` = RTWDOG\_CS\_FLG\_MASK }  
*RTWDOG status flags.*

## Unlock sequence

- #define `WDOG_FIRST_WORD_OF_UNLOCK` (RTWDOG\_UPDATE\_KEY & 0xFFFFU)  
*First word of unlock sequence.*
- #define `WDOG_SECOND_WORD_OF_UNLOCK` ((RTWDOG\_UPDATE\_KEY >> 16U) & 0xFFFFU)  
*Second word of unlock sequence.*

## Refresh sequence

- #define `WDOG_FIRST_WORD_OF_REFRESH` (RTWDOG\_REFRESH\_KEY & 0xFFFFU)  
*First word of refresh sequence.*
- #define `WDOG_SECOND_WORD_OF_REFRESH` ((RTWDOG\_REFRESH\_KEY >> 16U) & 0xFFFFU)  
*Second word of refresh sequence.*

## Driver version

- #define `FSL_RTWDOG_DRIVER_VERSION` (MAKE\_VERSION(2, 1, 2))  
*RTWDOG driver version 2.1.2.*

## RTWDOG Initialization and De-initialization

- void `RTWDOG_GetDefaultConfig` (rtwdog\_config\_t \*config)  
*Initializes the RTWDOG configuration structure.*
- void `RTWDOG_Init` (RTWDOG\_Type \*base, const rtwdog\_config\_t \*config)  
*Initializes the RTWDOG module.*
- void `RTWDOG_Deinit` (RTWDOG\_Type \*base)  
*De-initializes the RTWDOG module.*

## RTWDOG functional Operation

- static void `RTWDOG_Enable` (RTWDOG\_Type \*base)  
*Enables the RTWDOG module.*
- static void `RTWDOG_Disable` (RTWDOG\_Type \*base)  
*Disables the RTWDOG module.*
- static void `RTWDOG_EnableInterrupts` (RTWDOG\_Type \*base, uint32\_t mask)  
*Enables the RTWDOG interrupt.*
- static void `RTWDOG_DisableInterrupts` (RTWDOG\_Type \*base, uint32\_t mask)  
*Disables the RTWDOG interrupt.*
- static uint32\_t `RTWDOG_GetStatusFlags` (RTWDOG\_Type \*base)  
*Gets the RTWDOG all status flags.*
- static void `RTWDOG_EnableWindowMode` (RTWDOG\_Type \*base, bool enable)  
*Enables/disables the window mode.*
- static uint32\_t `RTWDOG_CountToMesec` (RTWDOG\_Type \*base, uint32\_t count, uint32\_t clock-FreqInHz)  
*Converts raw count value to millisecond.*
- void `RTWDOG_ClearStatusFlags` (RTWDOG\_Type \*base, uint32\_t mask)  
*Clears the RTWDOG flag.*
- static void `RTWDOG_SetTimeoutValue` (RTWDOG\_Type \*base, uint16\_t timeoutCount)

- *Sets the RTWDOG timeout value.*  
static void [RTWDOG\\_SetWindowValue](#) (RTWDOG\_Type \*base, uint16\_t windowValue)
- *Sets the RTWDOG window value.*  
\_\_STATIC\_FORCEINLINE void [RTWDOG\\_Unlock](#) (RTWDOG\_Type \*base)
- *Unlocks the RTWDOG register written.*  
static void [RTWDOG\\_Refresh](#) (RTWDOG\_Type \*base)
- *Refreshes the RTWDOG timer.*  
static uint16\_t [RTWDOG\\_GetCounterValue](#) (RTWDOG\_Type \*base)
- *Gets the RTWDOG counter value.*

## 37.3 Data Structure Documentation

### 37.3.1 struct rtwdog\_work\_mode\_t

#### Data Fields

- bool [enableWait](#)  
*Enables or disables RTWDOG in wait mode.*
- bool [enableStop](#)  
*Enables or disables RTWDOG in stop mode.*
- bool [enableDebug](#)  
*Enables or disables RTWDOG in debug mode.*

### 37.3.2 struct rtwdog\_config\_t

#### Data Fields

- bool [enableRtwdog](#)  
*Enables or disables RTWDOG.*
- [rtwdog\\_clock\\_source\\_t](#) clockSource  
*Clock source select.*
- [rtwdog\\_clock\\_prescaler\\_t](#) prescaler  
*Clock prescaler value.*
- [rtwdog\\_work\\_mode\\_t](#) workMode  
*Configures RTWDOG work mode in debug stop and wait mode.*
- [rtwdog\\_test\\_mode\\_t](#) testMode  
*Configures RTWDOG test mode.*
- bool [enableUpdate](#)  
*Update write-once register enable.*
- bool [enableInterrupt](#)  
*Enables or disables RTWDOG interrupt.*
- bool [enableWindowMode](#)  
*Enables or disables RTWDOG window mode.*
- uint16\_t [windowValue](#)  
*Window value.*
- uint16\_t [timeoutValue](#)  
*Timeout value.*

## 37.4 Macro Definition Documentation

### 37.4.1 #define FSL\_RTWD0G\_DRIVER\_VERSION (MAKE\_VERSION(2, 1, 2))

## 37.5 Enumeration Type Documentation

### 37.5.1 enum rtwdog\_clock\_source\_t

Enumerator

*kRTWD0G\_ClockSource0* Clock source 0.  
*kRTWD0G\_ClockSource1* Clock source 1.  
*kRTWD0G\_ClockSource2* Clock source 2.  
*kRTWD0G\_ClockSource3* Clock source 3.

### 37.5.2 enum rtwdog\_clock\_prescaler\_t

Enumerator

*kRTWD0G\_ClockPrescalerDivide1* Divided by 1.  
*kRTWD0G\_ClockPrescalerDivide256* Divided by 256.

### 37.5.3 enum rtwdog\_test\_mode\_t

Enumerator

*kRTWD0G\_TestModeDisabled* Test Mode disabled.  
*kRTWD0G\_UserModeEnabled* User Mode enabled.  
*kRTWD0G\_LowByteTest* Test Mode enabled, only low byte is used.  
*kRTWD0G\_HighByteTest* Test Mode enabled, only high byte is used.

### 37.5.4 enum \_rtwdog\_interrupt\_enable\_t

This structure contains the settings for all of the RTWD0G interrupt configurations.

Enumerator

*kRTWD0G\_InterruptEnable* Interrupt is generated before forcing a reset.

### 37.5.5 enum \_rtwdog\_status\_flags\_t

This structure contains the RTWDOG status flags for use in the RTWDOG functions.

Enumerator

- kRTWDOG\_RunningFlag* Running flag, set when RTWDOG is enabled.
- kRTWDOG\_InterruptFlag* Interrupt flag, set when interrupt occurs.

## 37.6 Function Documentation

### 37.6.1 void RTWDOG\_GetDefaultConfig ( rtwdog\_config\_t \* config )

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

```
* rtwdogConfig->enableRtdog = true;
* rtwdogConfig->clockSource = kRTWDOG_ClockSource1;
* rtwdogConfig->prescaler = kRTWDOG_ClockPrescalerDivide1;
* rtwdogConfig->workMode.enableWait = true;
* rtwdogConfig->workMode.enableStop = false;
* rtwdogConfig->workMode.enableDebug = false;
* rtwdogConfig->testMode = kRTWDOG_TestModeDisabled;
* rtwdogConfig->enableUpdate = true;
* rtwdogConfig->enableInterrupt = false;
* rtwdogConfig->enableWindowMode = false;
* rtwdogConfig->windowValue = 0U;
* rtwdogConfig->timeoutValue = 0xFFFFU;
*
```

Parameters

|               |                                                |
|---------------|------------------------------------------------|
| <i>config</i> | Pointer to the RTWDOG configuration structure. |
|---------------|------------------------------------------------|

See Also

[rtwdog\\_config\\_t](#)

### 37.6.2 void RTWDOG\_Init ( RTWDOG\_Type \* base, const rtwdog\_config\_t \* config )

This function initializes the RTWDOG. To reconfigure the RTWDOG without forcing a reset first, enableUpdate must be set to true in the configuration.

Example:

```
* rtwdog_config_t config;
* RTWDOG_GetDefaultConfig(&config);
* config.timeoutValue = 0x7ffU;
* config.enableUpdate = true;
* RTWDOG_Init(wdog_base, &config);
*
```

Parameters

|               |                                  |
|---------------|----------------------------------|
| <i>base</i>   | RTWDOG peripheral base address.  |
| <i>config</i> | The configuration of the RTWDOG. |

### 37.6.3 void RTWDOG\_Deinit ( RTWDOG\_Type \* *base* )

This function shuts down the RTWDOG. Ensure that the WDOG\_CS.UPDATE is 1, which means that the register update is enabled.

Parameters

|             |                                 |
|-------------|---------------------------------|
| <i>base</i> | RTWDOG peripheral base address. |
|-------------|---------------------------------|

### 37.6.4 static void RTWDOG\_Enable ( RTWDOG\_Type \* *base* ) [inline], [static]

This function writes a value into the WDOG\_CS register to enable the RTWDOG. The WDOG\_CS register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

|             |                                 |
|-------------|---------------------------------|
| <i>base</i> | RTWDOG peripheral base address. |
|-------------|---------------------------------|

### 37.6.5 static void RTWDOG\_Disable ( RTWDOG\_Type \* *base* ) [inline], [static]

This function writes a value into the WDOG\_CS register to disable the RTWDOG. The WDOG\_CS register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | RTWDOG peripheral base address |
|-------------|--------------------------------|

### 37.6.6 static void RTWDOG\_EnableInterrupts ( RTWDOG\_Type \* *base*, uint32\_t *mask* ) [inline], [static]

This function writes a value into the WDOG\_CS register to enable the RTWDOG interrupt. The WDOG\_CS register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

|             |                                                                                                                                                                              |
|-------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i> | RTWDOG peripheral base address.                                                                                                                                              |
| <i>mask</i> | The interrupts to enable. The parameter can be a combination of the following source if defined: <ul style="list-style-type: none"> <li>• kRTWDOG_InterruptEnable</li> </ul> |

### 37.6.7 static void RTWDOG\_DisableInterrupts ( RTWDOG\_Type \* *base*, uint32\_t *mask* ) [inline], [static]

This function writes a value into the WDOG\_CS register to disable the RTWDOG interrupt. The WDOG\_CS register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

Parameters

|             |                                                                                                                                                                                |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i> | RTWDOG peripheral base address.                                                                                                                                                |
| <i>mask</i> | The interrupts to disabled. The parameter can be a combination of the following source if defined: <ul style="list-style-type: none"> <li>• kRTWDOG_InterruptEnable</li> </ul> |

### 37.6.8 static uint32\_t RTWDOG\_GetStatusFlags ( RTWDOG\_Type \* *base* ) [inline], [static]

This function gets all status flags.

Example to get the running flag:

```
* uint32_t status;
* status = RTWDOG_GetStatusFlags(wdog_base) &
* kRTWDOG_RunningFlag;
*
```

## Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | RTWDOG peripheral base address |
|-------------|--------------------------------|

## Returns

State of the status flag: asserted (true) or not-asserted (false).

## See Also

[\\_rtwdog\\_status\\_flags\\_t](#)

- true: related status flag has been set.
- false: related status flag is not set.

### 37.6.9 static void RTWDOG\_EnableWindowMode ( RTWDOG\_Type \* *base*, bool *enable* ) [inline], [static]

## Parameters

|               |                                               |
|---------------|-----------------------------------------------|
| <i>base</i>   | RTWDOG peripheral base address.               |
| <i>enable</i> | Enables(true) or disables(false) the feature. |

### 37.6.10 static uint32\_t RTWDOG\_CountToMesec ( RTWDOG\_Type \* *base*, uint32\_t *count*, uint32\_t *clockFreqInHz* ) [inline], [static]

Note that if the clock frequency is too high the timeout period can be less than 1 ms. In this case this api will return 0 value.

## Parameters

|                      |                                                |
|----------------------|------------------------------------------------|
| <i>base</i>          | RTWDOG peripheral base address.                |
| <i>count</i>         | Raw count value.                               |
| <i>clockFreqInHz</i> | The frequency of the clock source RTWDOG uses. |

### 37.6.11 void RTWDOG\_ClearStatusFlags ( RTWDOG\_Type \* *base*, uint32\_t *mask* )

This function clears the RTWDOG status flag.

Example to clear an interrupt flag:



```
* RTWDOG_ClearStatusFlags (wdog_base,
* kRTWDOG_InterruptFlag);
*
```

## Parameters

|             |                                                                                                                                                                    |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i> | RTWDOG peripheral base address.                                                                                                                                    |
| <i>mask</i> | The status flags to clear. The parameter can be any combination of the following values: <ul style="list-style-type: none"> <li>• kRTWDOG_InterruptFlag</li> </ul> |

### 37.6.12 static void RTWDOG\_SetTimeoutValue ( RTWDOG\_Type \* *base*, uint16\_t *timeoutCount* ) [inline], [static]

This function writes a timeout value into the WDOG\_TOVAL register. The WDOG\_TOVAL register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

## Parameters

|                     |                                                    |
|---------------------|----------------------------------------------------|
| <i>base</i>         | RTWDOG peripheral base address                     |
| <i>timeoutCount</i> | RTWDOG timeout value, count of RTWDOG clock ticks. |

### 37.6.13 static void RTWDOG\_SetWindowValue ( RTWDOG\_Type \* *base*, uint16\_t *windowValue* ) [inline], [static]

This function writes a window value into the WDOG\_WIN register. The WDOG\_WIN register is a write-once register. Ensure that the WCT window is still open and this register has not been written in this WCT while the function is called.

## Parameters

|                    |                                 |
|--------------------|---------------------------------|
| <i>base</i>        | RTWDOG peripheral base address. |
| <i>windowValue</i> | RTWDOG window value.            |

### 37.6.14 \_\_STATIC\_FORCEINLINE void RTWDOG\_Unlock ( RTWDOG\_Type \* *base* )

This function unlocks the RTWDOG register written.

Before starting the unlock sequence and following the configuration, disable the global interrupts. Otherwise, an interrupt could effectively invalidate the unlock sequence and the WCT may expire. After the configuration finishes, re-enable the global interrupts.

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | RTWDOG peripheral base address |
|-------------|--------------------------------|

**37.6.15 static void RTWDOG\_Refresh ( RTWDOG\_Type \* *base* ) [inline], [static]**

This function feeds the RTWDOG. This function should be called before the Watchdog timer is in timeout. Otherwise, a reset is asserted.

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | RTWDOG peripheral base address |
|-------------|--------------------------------|

**37.6.16 static uint16\_t RTWDOG\_GetCounterValue ( RTWDOG\_Type \* *base* ) [inline], [static]**

This function gets the RTWDOG counter value.

Parameters

|             |                                 |
|-------------|---------------------------------|
| <i>base</i> | RTWDOG peripheral base address. |
|-------------|---------------------------------|

Returns

Current RTWDOG counter value.

# Chapter 38

## SAI: Serial Audio Interface

### 38.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Serial Audio Interface (SAI) module of MCUXpresso SDK devices.

SAI driver includes functional APIs and transactional APIs.

Functional APIs target low-level APIs. Functional APIs can be used for SAI initialization, configuration and operation, and for optimization and customization purposes. Using the functional API requires the knowledge of the SAI peripheral and how to organize functional APIs to meet the application requirements. All functional API use the peripheral base address as the first parameter. SAI functional operation groups provide the functional API set.

Transactional APIs target high-level APIs. Transactional APIs can be used to enable the peripheral and in the application if the code size and performance of transactional APIs satisfy the requirements. If the code size and performance are a critical requirement, see the transactional API implementation and write a custom code. All transactional APIs use the `sai_handle_t` as the first parameter. Initialize the handle by calling the [SAI\\_TransferTxCreateHandle\(\)](#) or [SAI\\_TransferRxCreateHandle\(\)](#) API.

Transactional APIs support asynchronous transfer. This means that the functions [SAI\\_TransferSendNonBlocking\(\)](#) and [SAI\\_TransferReceiveNonBlocking\(\)](#) set up the interrupt for data transfer. When the transfer completes, the upper layer is notified through a callback function with the `kStatus_SAI_TxIdle` and `kStatus_SAI_RxIdle` status.

### 38.2 Typical configurations

#### Bit width configuration

SAI driver support 8/16/24/32bits stereo/mono raw audio data transfer. SAI EDMA driver support 8/16/32bits stereo/mono raw audio data transfer, since the EDMA doesn't support 24bit data width, so application should pre-convert the 24bit data to 32bit. SAI DMA driver support 8/16/32bits stereo/mono raw audio data transfer, since the EDMA doesn't support 24bit data width, so application should pre-convert the 24bit data to 32bit. SAI SDMA driver support 8/16/24/32bits stereo/mono raw audio data transfer.

#### Frame configuration

SAI driver support I2S, DSP, Left justified, Right justified, TDM mode. Application can call the api directly: `SAI_GetClassicI2SConfig` `SAI_GetLeftJustifiedConfig` `SAI_GetRightJustifiedConfig` `SAI_GetTDMConfig` `SAI_GetDSPConfig`

## 38.3 Typical use case

### 38.3.1 SAI Send/receive using an interrupt method

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/sai`

### 38.3.2 SAI Send/receive using a DMA method

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/sai`

## Modules

- [SAI Driver](#)
- [SAI EDMA Driver](#)

## 38.4 SAI Driver

### 38.4.1 Overview

#### Data Structures

- struct [sai\\_config\\_t](#)  
*SAI user configuration structure. [More...](#)*
- struct [sai\\_transfer\\_format\\_t](#)  
*sai transfer format [More...](#)*
- struct [sai\\_fifo\\_t](#)  
*sai fifo configurations [More...](#)*
- struct [sai\\_bit\\_clock\\_t](#)  
*sai bit clock configurations [More...](#)*
- struct [sai\\_frame\\_sync\\_t](#)  
*sai frame sync configurations [More...](#)*
- struct [sai\\_serial\\_data\\_t](#)  
*sai serial data configurations [More...](#)*
- struct [sai\\_transceiver\\_t](#)  
*sai transceiver configurations [More...](#)*
- struct [sai\\_transfer\\_t](#)  
*SAI transfer structure. [More...](#)*
- struct [sai\\_handle\\_t](#)  
*SAI handle structure. [More...](#)*

#### Macros

- #define [SAI\\_XFER\\_QUEUE\\_SIZE](#) (4U)  
*SAI transfer queue size, user can refine it according to use case.*
- #define [FSL\\_SAI\\_HAS\\_FIFO\\_EXTEND\\_FEATURE](#) 1  
*sai fifo feature*

#### Typedefs

- typedef void(\* [sai\\_transfer\\_callback\\_t](#))(I2S\_Type \*base, sai\_handle\_t \*handle, [status\\_t](#) status, void \*userData)  
*SAI transfer callback prototype.*

## Enumerations

- enum {
  - kStatus\_SAI\_TxBusy = MAKE\_STATUS(kStatusGroup\_SAI, 0),
  - kStatus\_SAI\_RxBusy = MAKE\_STATUS(kStatusGroup\_SAI, 1),
  - kStatus\_SAI\_TxError = MAKE\_STATUS(kStatusGroup\_SAI, 2),
  - kStatus\_SAI\_RxError = MAKE\_STATUS(kStatusGroup\_SAI, 3),
  - kStatus\_SAI\_QueueFull = MAKE\_STATUS(kStatusGroup\_SAI, 4),
  - kStatus\_SAI\_TxIdle = MAKE\_STATUS(kStatusGroup\_SAI, 5),
  - kStatus\_SAI\_RxIdle = MAKE\_STATUS(kStatusGroup\_SAI, 6) }

*\_sai\_status\_t, SAI return status.*
- enum {
  - kSAI\_Channel0Mask = 1 << 0U,
  - kSAI\_Channel1Mask = 1 << 1U,
  - kSAI\_Channel2Mask = 1 << 2U,
  - kSAI\_Channel3Mask = 1 << 3U,
  - kSAI\_Channel4Mask = 1 << 4U,
  - kSAI\_Channel5Mask = 1 << 5U,
  - kSAI\_Channel6Mask = 1 << 6U,
  - kSAI\_Channel7Mask = 1 << 7U }

*\_sai\_channel\_mask, sai channel mask value, actual channel numbers is depend soc specific*
- enum sai\_protocol\_t {
  - kSAI\_BusLeftJustified = 0x0U,
  - kSAI\_BusRightJustified,
  - kSAI\_BusI2S,
  - kSAI\_BusPCMA,
  - kSAI\_BusPCMB }

*Define the SAI bus type.*
- enum sai\_master\_slave\_t {
  - kSAI\_Master = 0x0U,
  - kSAI\_Slave = 0x1U,
  - kSAI\_Bclk\_Master\_FrameSync\_Slave = 0x2U,
  - kSAI\_Bclk\_Slave\_FrameSync\_Master = 0x3U }

*Master or slave mode.*
- enum sai\_mono\_stereo\_t {
  - kSAI\_Stereo = 0x0U,
  - kSAI\_MonoRight,
  - kSAI\_MonoLeft }

*Mono or stereo audio format.*
- enum sai\_data\_order\_t {
  - kSAI\_DataLSB = 0x0U,
  - kSAI\_DataMSB }

*SAI data order, MSB or LSB.*
- enum sai\_clock\_polarity\_t {

- ```

kSAI_PolarityActiveHigh = 0x0U,
kSAI_PolarityActiveLow = 0x1U,
kSAI_SampleOnFallingEdge = 0x0U,
kSAI_SampleOnRisingEdge = 0x1U }
    SAI clock polarity, active high or low.
• enum sai_sync_mode_t {
    kSAI_ModeAsync = 0x0U,
    kSAI_ModeSync }
    Synchronous or asynchronous mode.
• enum sai_bclk_source_t {
    kSAI_BclkSourceBusclk = 0x0U,
    kSAI_BclkSourceMclkOption1 = 0x1U,
    kSAI_BclkSourceMclkOption2 = 0x2U,
    kSAI_BclkSourceMclkOption3 = 0x3U,
    kSAI_BclkSourceMclkDiv = 0x1U,
    kSAI_BclkSourceOtherSai0 = 0x2U,
    kSAI_BclkSourceOtherSai1 = 0x3U }
    Bit clock source.
• enum {
    kSAI_WordStartInterruptEnable,
    kSAI_SyncErrorInterruptEnable = I2S_TCSR_SEIE_MASK,
    kSAI_FIFOWarningInterruptEnable = I2S_TCSR_FWIE_MASK,
    kSAI_FIFOErrorInterruptEnable = I2S_TCSR_FEIE_MASK,
    kSAI_FIFORequestInterruptEnable = I2S_TCSR_FRIE_MASK }
    _sai_interrupt_enable_t, The SAI interrupt enable flag
• enum {
    kSAI_FIFOWarningDMAEnable = I2S_TCSR_FWDE_MASK,
    kSAI_FIFORequestDMAEnable = I2S_TCSR_FRDE_MASK }
    _sai_dma_enable_t, The DMA request sources
• enum {
    kSAI_WordStartFlag = I2S_TCSR_WSF_MASK,
    kSAI_SyncErrorFlag = I2S_TCSR_SEF_MASK,
    kSAI_FIFOErrorFlag = I2S_TCSR_FEF_MASK,
    kSAI_FIFORequestFlag = I2S_TCSR_FRF_MASK,
    kSAI_FIFOWarningFlag = I2S_TCSR_FWF_MASK }
    _sai_flags, The SAI status flag
• enum sai_reset_type_t {
    kSAI_ResetTypeSoftware = I2S_TCSR_SR_MASK,
    kSAI_ResetTypeFIFO = I2S_TCSR_FR_MASK,
    kSAI_ResetAll = I2S_TCSR_SR_MASK | I2S_TCSR_FR_MASK }
    The reset type.
• enum sai_fifo_packing_t {
    kSAI_FifoPackingDisabled = 0x0U,
    kSAI_FifoPacking8bit = 0x2U,
    kSAI_FifoPacking16bit = 0x3U }
    The SAI packing mode The mode includes 8 bit and 16 bit packing.
• enum sai_sample_rate_t {

```

```

kSAI_SampleRate8KHz = 8000U,
kSAI_SampleRate11025Hz = 11025U,
kSAI_SampleRate12KHz = 12000U,
kSAI_SampleRate16KHz = 16000U,
kSAI_SampleRate22050Hz = 22050U,
kSAI_SampleRate24KHz = 24000U,
kSAI_SampleRate32KHz = 32000U,
kSAI_SampleRate44100Hz = 44100U,
kSAI_SampleRate48KHz = 48000U,
kSAI_SampleRate96KHz = 96000U,
kSAI_SampleRate192KHz = 192000U,
kSAI_SampleRate384KHz = 384000U }

```

Audio sample rate.

- enum `sai_word_width_t` {


```

kSAI_WordWidth8bits = 8U,
kSAI_WordWidth16bits = 16U,
kSAI_WordWidth24bits = 24U,
kSAI_WordWidth32bits = 32U }

```

Audio word width.
- enum `sai_data_pin_state_t` {


```

kSAI_DataPinStateTriState,
kSAI_DataPinStateOutputZero = 1U }

```

sai data pin state definition
- enum `sai_fifo_combine_t` {


```

kSAI_FifoCombineDisabled = 0U,
kSAI_FifoCombineModeEnabledOnRead,
kSAI_FifoCombineModeEnabledOnWrite,
kSAI_FifoCombineModeEnabledOnReadWrite }

```

sai fifo combine mode definition
- enum `sai_transceiver_type_t` {


```

kSAI_Transmitter = 0U,
kSAI_Receiver = 1U }

```

sai transceiver type
- enum `sai_frame_sync_len_t` {


```

kSAI_FrameSyncLenOneBitClk = 0U,
kSAI_FrameSyncLenPerWordWidth = 1U }

```

sai frame sync len

Driver version

- #define `FSL_SAI_DRIVER_VERSION` (`MAKE_VERSION(2, 3, 6)`)
Version 2.3.6.

Initialization and deinitialization

- void [SAI_TxInit](#) (I2S_Type *base, const [sai_config_t](#) *config)
Initializes the SAI Tx peripheral.
- void [SAI_RxInit](#) (I2S_Type *base, const [sai_config_t](#) *config)
Initializes the SAI Rx peripheral.
- void [SAI_TxGetDefaultConfig](#) ([sai_config_t](#) *config)
Sets the SAI Tx configuration structure to default values.
- void [SAI_RxGetDefaultConfig](#) ([sai_config_t](#) *config)
Sets the SAI Rx configuration structure to default values.
- void [SAI_Init](#) (I2S_Type *base)
Initializes the SAI peripheral.
- void [SAI_Deinit](#) (I2S_Type *base)
De-initializes the SAI peripheral.
- void [SAI_TxReset](#) (I2S_Type *base)
Resets the SAI Tx.
- void [SAI_RxReset](#) (I2S_Type *base)
Resets the SAI Rx.
- void [SAI_TxEnable](#) (I2S_Type *base, bool enable)
Enables/disables the SAI Tx.
- void [SAI_RxEnable](#) (I2S_Type *base, bool enable)
Enables/disables the SAI Rx.
- static void [SAI_TxSetBitClockDirection](#) (I2S_Type *base, [sai_master_slave_t](#) masterSlave)
Set Tx bit clock direction.
- static void [SAI_RxSetBitClockDirection](#) (I2S_Type *base, [sai_master_slave_t](#) masterSlave)
Set Rx bit clock direction.
- static void [SAI_RxSetFrameSyncDirection](#) (I2S_Type *base, [sai_master_slave_t](#) masterSlave)
Set Rx frame sync direction.
- static void [SAI_TxSetFrameSyncDirection](#) (I2S_Type *base, [sai_master_slave_t](#) masterSlave)
Set Tx frame sync direction.
- void [SAI_TxSetBitClockRate](#) (I2S_Type *base, uint32_t sourceClockHz, uint32_t sampleRate, uint32_t bitWidth, uint32_t channelNumbers)
Transmitter bit clock rate configurations.
- void [SAI_RxSetBitClockRate](#) (I2S_Type *base, uint32_t sourceClockHz, uint32_t sampleRate, uint32_t bitWidth, uint32_t channelNumbers)
Receiver bit clock rate configurations.
- void [SAI_TxSetBitclockConfig](#) (I2S_Type *base, [sai_master_slave_t](#) masterSlave, [sai_bit_clock_t](#) *config)
Transmitter Bit clock configurations.
- void [SAI_RxSetBitclockConfig](#) (I2S_Type *base, [sai_master_slave_t](#) masterSlave, [sai_bit_clock_t](#) *config)
Receiver Bit clock configurations.
- void [SAI_TxSetFifoConfig](#) (I2S_Type *base, [sai_fifo_t](#) *config)
SAI transmitter fifo configurations.
- void [SAI_RxSetFifoConfig](#) (I2S_Type *base, [sai_fifo_t](#) *config)
SAI receiver fifo configurations.
- void [SAI_TxSetFrameSyncConfig](#) (I2S_Type *base, [sai_master_slave_t](#) masterSlave, [sai_frame_sync_t](#) *config)
SAI transmitter Frame sync configurations.
- void [SAI_RxSetFrameSyncConfig](#) (I2S_Type *base, [sai_master_slave_t](#) masterSlave, [sai_frame_sync_t](#) *config)
SAI receiver Frame sync configurations.

`sync_t *config`)

SAI receiver Frame sync configurations.

- void `SAI_TxSetSerialDataConfig` (`I2S_Type *base`, `sai_serial_data_t *config`)
SAI transmitter Serial data configurations.
- void `SAI_RxSetSerialDataConfig` (`I2S_Type *base`, `sai_serial_data_t *config`)
SAI receiver Serial data configurations.
- void `SAI_TxSetConfig` (`I2S_Type *base`, `sai_transceiver_t *config`)
SAI transmitter configurations.
- void `SAI_RxSetConfig` (`I2S_Type *base`, `sai_transceiver_t *config`)
SAI receiver configurations.
- void `SAI_GetClassicI2SConfig` (`sai_transceiver_t *config`, `sai_word_width_t bitWidth`, `sai_mono_stereo_t mode`, `uint32_t saiChannelMask`)
Get classic I2S mode configurations.
- void `SAI_GetLeftJustifiedConfig` (`sai_transceiver_t *config`, `sai_word_width_t bitWidth`, `sai_mono_stereo_t mode`, `uint32_t saiChannelMask`)
Get left justified mode configurations.
- void `SAI_GetRightJustifiedConfig` (`sai_transceiver_t *config`, `sai_word_width_t bitWidth`, `sai_mono_stereo_t mode`, `uint32_t saiChannelMask`)
Get right justified mode configurations.
- void `SAI_GetTDMConfig` (`sai_transceiver_t *config`, `sai_frame_sync_len_t frameSyncWidth`, `sai_word_width_t bitWidth`, `uint32_t dataWordNum`, `uint32_t saiChannelMask`)
Get TDM mode configurations.
- void `SAI_GetDSPConfig` (`sai_transceiver_t *config`, `sai_frame_sync_len_t frameSyncWidth`, `sai_word_width_t bitWidth`, `sai_mono_stereo_t mode`, `uint32_t saiChannelMask`)
Get DSP mode configurations.

Status

- static `uint32_t SAI_TxGetStatusFlag` (`I2S_Type *base`)
Gets the SAI Tx status flag state.
- static void `SAI_TxClearStatusFlags` (`I2S_Type *base`, `uint32_t mask`)
Clears the SAI Tx status flag state.
- static `uint32_t SAI_RxGetStatusFlag` (`I2S_Type *base`)
Gets the SAI Rx status flag state.
- static void `SAI_RxClearStatusFlags` (`I2S_Type *base`, `uint32_t mask`)
Clears the SAI Rx status flag state.
- void `SAI_TxSoftwareReset` (`I2S_Type *base`, `sai_reset_type_t resetType`)
Do software reset or FIFO reset.
- void `SAI_RxSoftwareReset` (`I2S_Type *base`, `sai_reset_type_t resetType`)
Do software reset or FIFO reset.
- void `SAI_TxSetChannelFIFOMask` (`I2S_Type *base`, `uint8_t mask`)
Set the Tx channel FIFO enable mask.
- void `SAI_RxSetChannelFIFOMask` (`I2S_Type *base`, `uint8_t mask`)
Set the Rx channel FIFO enable mask.
- void `SAI_TxSetDataOrder` (`I2S_Type *base`, `sai_data_order_t order`)
Set the Tx data order.
- void `SAI_RxSetDataOrder` (`I2S_Type *base`, `sai_data_order_t order`)
Set the Rx data order.
- void `SAI_TxSetBitClockPolarity` (`I2S_Type *base`, `sai_clock_polarity_t polarity`)

- *Set the Tx data order.*
- void [SAI_RxSetBitClockPolarity](#) (I2S_Type *base, [sai_clock_polarity_t](#) polarity)
- *Set the Rx data order.*
- void [SAI_TxSetFrameSyncPolarity](#) (I2S_Type *base, [sai_clock_polarity_t](#) polarity)
- *Set the Tx data order.*
- void [SAI_RxSetFrameSyncPolarity](#) (I2S_Type *base, [sai_clock_polarity_t](#) polarity)
- *Set the Rx data order.*
- void [SAI_TxSetFIFOPacking](#) (I2S_Type *base, [sai_fifo_packing_t](#) pack)
- *Set Tx FIFO packing feature.*
- void [SAI_RxSetFIFOPacking](#) (I2S_Type *base, [sai_fifo_packing_t](#) pack)
- *Set Rx FIFO packing feature.*
- static void [SAI_TxSetFIFOErrorContinue](#) (I2S_Type *base, bool isEnabled)
- *Set Tx FIFO error continue.*
- static void [SAI_RxSetFIFOErrorContinue](#) (I2S_Type *base, bool isEnabled)
- *Set Rx FIFO error continue.*

Interrupts

- static void [SAI_TxEnableInterrupts](#) (I2S_Type *base, uint32_t mask)
- *Enables the SAI Tx interrupt requests.*
- static void [SAI_RxEnableInterrupts](#) (I2S_Type *base, uint32_t mask)
- *Enables the SAI Rx interrupt requests.*
- static void [SAI_TxDisableInterrupts](#) (I2S_Type *base, uint32_t mask)
- *Disables the SAI Tx interrupt requests.*
- static void [SAI_RxDisableInterrupts](#) (I2S_Type *base, uint32_t mask)
- *Disables the SAI Rx interrupt requests.*

DMA Control

- static void [SAI_TxEnableDMA](#) (I2S_Type *base, uint32_t mask, bool enable)
- *Enables/disables the SAI Tx DMA requests.*
- static void [SAI_RxEnableDMA](#) (I2S_Type *base, uint32_t mask, bool enable)
- *Enables/disables the SAI Rx DMA requests.*
- static uintptr_t [SAI_TxGetDataRegisterAddress](#) (I2S_Type *base, uint32_t channel)
- *Gets the SAI Tx data register address.*
- static uintptr_t [SAI_RxGetDataRegisterAddress](#) (I2S_Type *base, uint32_t channel)
- *Gets the SAI Rx data register address.*

Bus Operations

- void [SAI_TxSetFormat](#) (I2S_Type *base, [sai_transfer_format_t](#) *format, uint32_t mclkSourceClockHz, uint32_t bclkSourceClockHz)
- *Configures the SAI Tx audio format.*
- void [SAI_RxSetFormat](#) (I2S_Type *base, [sai_transfer_format_t](#) *format, uint32_t mclkSourceClockHz, uint32_t bclkSourceClockHz)
- *Configures the SAI Rx audio format.*

- void [SAI_WriteBlocking](#) (I2S_Type *base, uint32_t channel, uint32_t bitWidth, uint8_t *buffer, uint32_t size)
Sends data using a blocking method.
- void [SAI_WriteMultiChannelBlocking](#) (I2S_Type *base, uint32_t channel, uint32_t channelMask, uint32_t bitWidth, uint8_t *buffer, uint32_t size)
Sends data to multi channel using a blocking method.
- static void [SAI_WriteData](#) (I2S_Type *base, uint32_t channel, uint32_t data)
Writes data into SAI FIFO.
- void [SAI_ReadBlocking](#) (I2S_Type *base, uint32_t channel, uint32_t bitWidth, uint8_t *buffer, uint32_t size)
Receives data using a blocking method.
- void [SAI_ReadMultiChannelBlocking](#) (I2S_Type *base, uint32_t channel, uint32_t channelMask, uint32_t bitWidth, uint8_t *buffer, uint32_t size)
Receives multi channel data using a blocking method.
- static uint32_t [SAI_ReadData](#) (I2S_Type *base, uint32_t channel)
Reads data from the SAI FIFO.

Transactional

- void [SAI_TransferTxCreateHandle](#) (I2S_Type *base, sai_handle_t *handle, sai_transfer_callback_t callback, void *userData)
Initializes the SAI Tx handle.
- void [SAI_TransferRxCreateHandle](#) (I2S_Type *base, sai_handle_t *handle, sai_transfer_callback_t callback, void *userData)
Initializes the SAI Rx handle.
- void [SAI_TransferTxSetConfig](#) (I2S_Type *base, sai_handle_t *handle, sai_transceiver_t *config)
SAI transmitter transfer configurations.
- void [SAI_TransferRxSetConfig](#) (I2S_Type *base, sai_handle_t *handle, sai_transceiver_t *config)
SAI receiver transfer configurations.
- [status_t SAI_TransferTxSetFormat](#) (I2S_Type *base, sai_handle_t *handle, sai_transfer_format_t *format, uint32_t mclkSourceClockHz, uint32_t bclkSourceClockHz)
Configures the SAI Tx audio format.
- [status_t SAI_TransferRxSetFormat](#) (I2S_Type *base, sai_handle_t *handle, sai_transfer_format_t *format, uint32_t mclkSourceClockHz, uint32_t bclkSourceClockHz)
Configures the SAI Rx audio format.
- [status_t SAI_TransferSendNonBlocking](#) (I2S_Type *base, sai_handle_t *handle, sai_transfer_t *xfer)
Performs an interrupt non-blocking send transfer on SAI.
- [status_t SAI_TransferReceiveNonBlocking](#) (I2S_Type *base, sai_handle_t *handle, sai_transfer_t *xfer)
Performs an interrupt non-blocking receive transfer on SAI.
- [status_t SAI_TransferGetSendCount](#) (I2S_Type *base, sai_handle_t *handle, size_t *count)
Gets a set byte count.
- [status_t SAI_TransferGetReceiveCount](#) (I2S_Type *base, sai_handle_t *handle, size_t *count)
Gets a received byte count.
- void [SAI_TransferAbortSend](#) (I2S_Type *base, sai_handle_t *handle)
Aborts the current send.
- void [SAI_TransferAbortReceive](#) (I2S_Type *base, sai_handle_t *handle)

- *Aborts the current IRQ receive.*
- void [SAI_TransferTerminateSend](#) (I2S_Type *base, sai_handle_t *handle)
Terminate all SAI send.
- void [SAI_TransferTerminateReceive](#) (I2S_Type *base, sai_handle_t *handle)
Terminate all SAI receive.
- void [SAI_TransferTxHandleIRQ](#) (I2S_Type *base, sai_handle_t *handle)
Tx interrupt handler.
- void [SAI_TransferRxHandleIRQ](#) (I2S_Type *base, sai_handle_t *handle)
Tx interrupt handler.

38.4.2 Data Structure Documentation

38.4.2.1 struct sai_config_t

Data Fields

- [sai_protocol_t protocol](#)
Audio bus protocol in SAI.
- [sai_sync_mode_t syncMode](#)
SAI sync mode, control Tx/Rx clock sync.
- [sai_bclk_source_t bclkSource](#)
Bit Clock source.
- [sai_master_slave_t masterSlave](#)
Master or slave.

38.4.2.2 struct sai_transfer_format_t

Data Fields

- uint32_t [sampleRate_Hz](#)
Sample rate of audio data.
- uint32_t [bitWidth](#)
Data length of audio data, usually 8/16/24/32 bits.
- [sai_mono_stereo_t stereo](#)
Mono or stereo.
- uint8_t [watermark](#)
Watermark value.
- uint8_t [channel](#)
Transfer start channel.
- uint8_t [channelMask](#)
enabled channel mask value, reference `_sai_channel_mask`
- uint8_t [endChannel](#)
end channel number
- uint8_t [channelNums](#)
Total enabled channel numbers.
- [sai_protocol_t protocol](#)
Which audio protocol used.
- bool [isFrameSyncCompact](#)

True means Frame sync length is configurable according to bitWidth, false means frame sync length is 64 times of bit clock.

Field Documentation

(1) `bool sai_transfer_format_t::isFrameSyncCompact`

38.4.2.3 struct sai_fifo_t

Data Fields

- `bool fifoContinueOnError`
fifo continues when error occur
- `sai_fifo_combine_t fifoCombine`
fifo combine mode
- `sai_fifo_packing_t fifoPacking`
fifo packing mode
- `uint8_t fifoWatermark`
fifo watermark

38.4.2.4 struct sai_bit_clock_t

Data Fields

- `bool bclkSrcSwap`
bit clock source swap
- `bool bclkInputDelay`
bit clock actually used by the transmitter is delayed by the pad output delay, this has effect of decreasing the data input setup time, but increasing the data output valid time .
- `sai_clock_polarity_t bclkPolarity`
bit clock polarity
- `sai_bclk_source_t bclkSource`
bit Clock source

Field Documentation

(1) `bool sai_bit_clock_t::bclkInputDelay`

38.4.2.5 struct sai_frame_sync_t

Data Fields

- `uint8_t frameSyncWidth`
frame sync width in number of bit clocks
- `bool frameSyncEarly`
TRUE is frame sync assert one bit before the first bit of frame FALSE is frame sync assert with the first bit of the frame.
- `bool frameSyncGenerateOnDemand`
internal frame sync is generated when FIFO warning flag is clear
- `sai_clock_polarity_t frameSyncPolarity`

frame sync polarity

38.4.2.6 struct sai_serial_data_t

Data Fields

- [sai_data_pin_state_t dataMode](#)
sai data pin state when slots masked or channel disabled
- [sai_data_order_t dataOrder](#)
configure whether the LSB or MSB is transmitted first
- [uint8_t dataWord0Length](#)
configure the number of bits in the first word in each frame
- [uint8_t dataWordNLength](#)
configure the number of bits in the each word in each frame, except the first word
- [uint8_t dataWordLength](#)
used to record the data length for dma transfer
- [uint8_t dataFirstBitShifted](#)
Configure the bit index for the first bit transmitted for each word in the frame.
- [uint8_t dataWordNum](#)
configure the number of words in each frame
- [uint32_t dataMaskedWord](#)
configure whether the transmit word is masked

38.4.2.7 struct sai_transceiver_t

Data Fields

- [sai_serial_data_t serialData](#)
serial data configurations
- [sai_frame_sync_t frameSync](#)
ws configurations
- [sai_bit_clock_t bitClock](#)
bit clock configurations
- [sai_fifo_t fifo](#)
fifo configurations
- [sai_master_slave_t masterSlave](#)
transceiver is master or slave
- [sai_sync_mode_t syncMode](#)
transceiver sync mode
- [uint8_t startChannel](#)
Transfer start channel.
- [uint8_t channelMask](#)
enabled channel mask value, reference `_sai_channel_mask`
- [uint8_t endChannel](#)
end channel number
- [uint8_t channelNums](#)
Total enabled channel numbers.

38.4.2.8 struct sai_transfer_t

Data Fields

- uint8_t * [data](#)
Data start address to transfer.
- size_t [dataSize](#)
Transfer size.

Field Documentation

(1) `uint8_t* sai_transfer_t::data`

(2) `size_t sai_transfer_t::dataSize`

38.4.2.9 struct _sai_handle

Data Fields

- I2S_Type * [base](#)
base address
- uint32_t [state](#)
Transfer status.
- [sai_transfer_callback_t](#) [callback](#)
Callback function called at transfer event.
- void * [userData](#)
Callback parameter passed to callback function.
- uint8_t [bitWidth](#)
Bit width for transfer, 8/16/24/32 bits.
- uint8_t [channel](#)
Transfer start channel.
- uint8_t [channelMask](#)
enabled channel mask value, refernece `_sai_channel_mask`
- uint8_t [endChannel](#)
end channel number
- uint8_t [channelNums](#)
Total enabled channel numbers.
- [sai_transfer_t](#) [saiQueue](#) [`SAI_XFER_QUEUE_SIZE`]
Transfer queue storing queued transfer.
- size_t [transferSize](#) [`SAI_XFER_QUEUE_SIZE`]
Data bytes need to transfer.
- volatile uint8_t [queueUser](#)
Index for user to queue transfer.
- volatile uint8_t [queueDriver](#)
Index for driver to get the transfer data and size.
- uint8_t [watermark](#)
Watermark value.

38.4.3 Macro Definition Documentation

38.4.3.1 #define SAI_XFER_QUEUE_SIZE (4U)

38.4.4 Enumeration Type Documentation

38.4.4.1 anonymous enum

Enumerator

kStatus_SAI_TxBusy SAI Tx is busy.
kStatus_SAI_RxBusy SAI Rx is busy.
kStatus_SAI_TxError SAI Tx FIFO error.
kStatus_SAI_RxError SAI Rx FIFO error.
kStatus_SAI_QueueFull SAI transfer queue is full.
kStatus_SAI_TxIdle SAI Tx is idle.
kStatus_SAI_RxIdle SAI Rx is idle.

38.4.4.2 anonymous enum

Enumerator

kSAI_Channel0Mask channel 0 mask value
kSAI_Channel1Mask channel 1 mask value
kSAI_Channel2Mask channel 2 mask value
kSAI_Channel3Mask channel 3 mask value
kSAI_Channel4Mask channel 4 mask value
kSAI_Channel5Mask channel 5 mask value
kSAI_Channel6Mask channel 6 mask value
kSAI_Channel7Mask channel 7 mask value

38.4.4.3 enum sai_protocol_t

Enumerator

kSAI_BusLeftJustified Uses left justified format.
kSAI_BusRightJustified Uses right justified format.
kSAI_BusI2S Uses I2S format.
kSAI_BusPCMA Uses I2S PCM A format.
kSAI_BusPCMB Uses I2S PCM B format.

38.4.4.4 enum sai_master_slave_t

Enumerator

kSAI_Master Master mode include bclk and frame sync.

kSAI_Slave Slave mode include bclk and frame sync.

kSAI_Bclk_Master_FrameSync_Slave bclk in master mode, frame sync in slave mode

kSAI_Bclk_Slave_FrameSync_Master bclk in slave mode, frame sync in master mode

38.4.4.5 enum sai_mono_stereo_t

Enumerator

kSAI_Stereo Stereo sound.

kSAI_MonoRight Only Right channel have sound.

kSAI_MonoLeft Only left channel have sound.

38.4.4.6 enum sai_data_order_t

Enumerator

kSAI_DataLSB LSB bit transferred first.

kSAI_DataMSB MSB bit transferred first.

38.4.4.7 enum sai_clock_polarity_t

Enumerator

kSAI_PolarityActiveHigh Drive outputs on rising edge.

kSAI_PolarityActiveLow Drive outputs on falling edge.

kSAI_SampleOnFallingEdge Sample inputs on falling edge.

kSAI_SampleOnRisingEdge Sample inputs on rising edge.

38.4.4.8 enum sai_sync_mode_t

Enumerator

kSAI_ModeAsync Asynchronous mode.

kSAI_ModeSync Synchronous mode (with receiver or transmit)

38.4.4.9 enum sai_bclk_source_t

Enumerator

kSAI_BclkSourceBusclk Bit clock using bus clock.

kSAI_BclkSourceMclkOption1 Bit clock MCLK option 1.

kSAI_BclkSourceMclkOption2 Bit clock MCLK option2.
kSAI_BclkSourceMclkOption3 Bit clock MCLK option3.
kSAI_BclkSourceMclkDiv Bit clock using master clock divider.
kSAI_BclkSourceOtherSai0 Bit clock from other SAI device.
kSAI_BclkSourceOtherSai1 Bit clock from other SAI device.

38.4.4.10 anonymous enum

Enumerator

kSAI_WordStartInterruptEnable Word start flag, means the first word in a frame detected.
kSAI_SyncErrorInterruptEnable Sync error flag, means the sync error is detected.
kSAI_FIFOWarningInterruptEnable FIFO warning flag, means the FIFO is empty.
kSAI_FIFOErrorInterruptEnable FIFO error flag.
kSAI_FIFORequestInterruptEnable FIFO request, means reached watermark.

38.4.4.11 anonymous enum

Enumerator

kSAI_FIFOWarningDMAEnable FIFO warning caused by the DMA request.
kSAI_FIFORequestDMAEnable FIFO request caused by the DMA request.

38.4.4.12 anonymous enum

Enumerator

kSAI_WordStartFlag Word start flag, means the first word in a frame detected.
kSAI_SyncErrorFlag Sync error flag, means the sync error is detected.
kSAI_FIFOErrorFlag FIFO error flag.
kSAI_FIFORequestFlag FIFO request flag.
kSAI_FIFOWarningFlag FIFO warning flag.

38.4.4.13 enum sai_reset_type_t

Enumerator

kSAI_ResetTypeSoftware Software reset, reset the logic state.
kSAI_ResetTypeFIFO FIFO reset, reset the FIFO read and write pointer.
kSAI_ResetAll All reset.

38.4.4.14 enum sai_fifo_packing_t

Enumerator

kSAI_FifoPackingDisabled Packing disabled.
kSAI_FifoPacking8bit 8 bit packing enabled
kSAI_FifoPacking16bit 16bit packing enabled

38.4.4.15 enum sai_sample_rate_t

Enumerator

kSAI_SampleRate8KHz Sample rate 8000 Hz.
kSAI_SampleRate11025Hz Sample rate 11025 Hz.
kSAI_SampleRate12KHz Sample rate 12000 Hz.
kSAI_SampleRate16KHz Sample rate 16000 Hz.
kSAI_SampleRate22050Hz Sample rate 22050 Hz.
kSAI_SampleRate24KHz Sample rate 24000 Hz.
kSAI_SampleRate32KHz Sample rate 32000 Hz.
kSAI_SampleRate44100Hz Sample rate 44100 Hz.
kSAI_SampleRate48KHz Sample rate 48000 Hz.
kSAI_SampleRate96KHz Sample rate 96000 Hz.
kSAI_SampleRate192KHz Sample rate 192000 Hz.
kSAI_SampleRate384KHz Sample rate 384000 Hz.

38.4.4.16 enum sai_word_width_t

Enumerator

kSAI_WordWidth8bits Audio data width 8 bits.
kSAI_WordWidth16bits Audio data width 16 bits.
kSAI_WordWidth24bits Audio data width 24 bits.
kSAI_WordWidth32bits Audio data width 32 bits.

38.4.4.17 enum sai_data_pin_state_t

Enumerator

kSAI_DataPinStateTriState transmit data pins are tri-stated when slots are masked or channels are disabled
kSAI_DataPinStateOutputZero transmit data pins are never tri-stated and will output zero when slots are masked or channel disabled

38.4.4.18 enum sai_fifo_combine_t

Enumerator

kSAI_FifoCombineDisabled sai fifo combine mode disabled
kSAI_FifoCombineModeEnabledOnRead sai fifo combine mode enabled on FIFO reads
kSAI_FifoCombineModeEnabledOnWrite sai fifo combine mode enabled on FIFO write
kSAI_FifoCombineModeEnabledOnReadWrite sai fifo combined mode enabled on FIFO read/writes

38.4.4.19 enum sai_transceiver_type_t

Enumerator

kSAI_Transmitter sai transmitter
kSAI_Receiver sai receiver

38.4.4.20 enum sai_frame_sync_len_t

Enumerator

kSAI_FrameSyncLenOneBitClk 1 bit clock frame sync len for DSP mode
kSAI_FrameSyncLenPerWordWidth Frame sync length decided by word width.

38.4.5 Function Documentation**38.4.5.1 void SAI_TxInit (I2S_Type * base, const sai_config_t * config)**

Deprecated Do not use this function. It has been superseded by [SAI_Init](#)

Ungates the SAI clock, resets the module, and configures SAI Tx with a configuration structure. The configuration structure can be custom filled or set with default values by [SAI_TxGetDefaultConfig\(\)](#).

Note

This API should be called at the beginning of the application to use the SAI driver. Otherwise, accessing the SAIM module can cause a hard fault because the clock is not enabled.

Parameters

<i>base</i>	SAI base pointer
<i>config</i>	SAI configuration structure.

38.4.5.2 void SAI_RxInit (I2S_Type * *base*, const sai_config_t * *config*)

Deprecated Do not use this function. It has been superseded by [SAI_Init](#)

Ungates the SAI clock, resets the module, and configures the SAI Rx with a configuration structure. The configuration structure can be custom filled or set with default values by [SAI_RxGetDefaultConfig\(\)](#).

Note

This API should be called at the beginning of the application to use the SAI driver. Otherwise, accessing the SAI module can cause a hard fault because the clock is not enabled.

Parameters

<i>base</i>	SAI base pointer
<i>config</i>	SAI configuration structure.

38.4.5.3 void SAI_TxGetDefaultConfig (sai_config_t * *config*)

Deprecated Do not use this function. It has been superseded by [SAI_GetClassicI2SConfig](#), [SAI_GetLeftJustifiedConfig](#), [SAI_GetRightJustifiedConfig](#), [SAI_GetDSPConfig](#), [SAI_GetTDMConfig](#)

This API initializes the configuration structure for use in [SAI_TxConfig\(\)](#). The initialized structure can remain unchanged in [SAI_TxConfig\(\)](#), or it can be modified before calling [SAI_TxConfig\(\)](#). This is an example.

```
sai_config_t config;
SAI_TxGetDefaultConfig(&config);
```

Parameters

<i>config</i>	pointer to master configuration structure
---------------	---

38.4.5.4 void SAI_RxGetDefaultConfig (sai_config_t * config)

Deprecated Do not use this function. It has been superseded by [SAI_GetClassicI2SConfig](#), [SAI_GetLeft-JustifiedConfig](#), [SAI_GetRightJustifiedConfig](#), [SAI_GetDSPConfig](#), [SAI_GetTDMConfig](#)

This API initializes the configuration structure for use in SAI_RxConfig(). The initialized structure can remain unchanged in SAI_RxConfig() or it can be modified before calling SAI_RxConfig(). This is an example.

```
sai_config_t config;
SAI_RxGetDefaultConfig(&config);
```

Parameters

<i>config</i>	pointer to master configuration structure
---------------	---

38.4.5.5 void SAI_Init (I2S_Type * base)

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

Parameters

<i>base</i>	SAI base pointer.
-------------	-------------------

38.4.5.6 void SAI_Deinit (I2S_Type * base)

This API gates the SAI clock. The SAI module can't operate unless SAI_TxInit or SAI_RxInit is called to enable the clock.

Parameters

<i>base</i>	SAI base pointer.
-------------	-------------------

38.4.5.7 void SAI_TxReset (I2S_Type * base)

This function enables the software reset and FIFO reset of SAI Tx. After reset, clear the reset bit.

Parameters

<i>base</i>	SAI base pointer
-------------	------------------

38.4.5.8 void SAI_RxReset (I2S_Type * *base*)

This function enables the software reset and FIFO reset of SAI Rx. After reset, clear the reset bit.

Parameters

<i>base</i>	SAI base pointer
-------------	------------------

38.4.5.9 void SAI_TxEnable (I2S_Type * *base*, bool *enable*)

Parameters

<i>base</i>	SAI base pointer.
<i>enable</i>	True means enable SAI Tx, false means disable.

38.4.5.10 void SAI_RxEnable (I2S_Type * *base*, bool *enable*)

Parameters

<i>base</i>	SAI base pointer.
<i>enable</i>	True means enable SAI Rx, false means disable.

38.4.5.11 static void SAI_TxSetBitClockDirection (I2S_Type * *base*, sai_master_slave_t *masterSlave*) [inline], [static]

Select bit clock direction, master or slave.

Parameters

<i>base</i>	SAI base pointer.
-------------	-------------------

<i>masterSlave</i>	reference sai_master_slave_t.
--------------------	-------------------------------

38.4.5.12 static void SAI_RxSetBitClockDirection (I2S_Type * *base*, sai_master_slave_t *masterSlave*) [inline], [static]

Select bit clock direction, master or slave.

Parameters

<i>base</i>	SAI base pointer.
<i>masterSlave</i>	reference sai_master_slave_t.

38.4.5.13 static void SAI_RxSetFrameSyncDirection (I2S_Type * *base*, sai_master_slave_t *masterSlave*) [inline], [static]

Select frame sync direction, master or slave.

Parameters

<i>base</i>	SAI base pointer.
<i>masterSlave</i>	reference sai_master_slave_t.

38.4.5.14 static void SAI_TxSetFrameSyncDirection (I2S_Type * *base*, sai_master_slave_t *masterSlave*) [inline], [static]

Select frame sync direction, master or slave.

Parameters

<i>base</i>	SAI base pointer.
<i>masterSlave</i>	reference sai_master_slave_t.

38.4.5.15 void SAI_TxSetBitClockRate (I2S_Type * *base*, uint32_t *sourceClockHz*, uint32_t *sampleRate*, uint32_t *bitWidth*, uint32_t *channelNumbers*)

Parameters

<i>base</i>	SAI base pointer.
<i>sourceClockHz</i>	Bit clock source frequency.
<i>sampleRate</i>	Audio data sample rate.
<i>bitWidth</i>	Audio data bitWidth.
<i>channel-Numbers</i>	Audio channel numbers.

38.4.5.16 void SAI_RxSetBitClockRate (I2S_Type * *base*, uint32_t *sourceClockHz*, uint32_t *sampleRate*, uint32_t *bitWidth*, uint32_t *channelNumbers*)

Parameters

<i>base</i>	SAI base pointer.
<i>sourceClockHz</i>	Bit clock source frequency.
<i>sampleRate</i>	Audio data sample rate.
<i>bitWidth</i>	Audio data bitWidth.
<i>channel-Numbers</i>	Audio channel numbers.

38.4.5.17 void SAI_TxSetBitclockConfig (I2S_Type * *base*, sai_master_slave_t *masterSlave*, sai_bit_clock_t * *config*)

Parameters

<i>base</i>	SAI base pointer.
<i>masterSlave</i>	master or slave.
<i>config</i>	bit clock other configurations, can be NULL in slave mode.

38.4.5.18 void SAI_RxSetBitclockConfig (I2S_Type * *base*, sai_master_slave_t *masterSlave*, sai_bit_clock_t * *config*)

Parameters

<i>base</i>	SAI base pointer.
<i>masterSlave</i>	master or slave.
<i>config</i>	bit clock other configurations, can be NULL in slave mode.

38.4.5.19 void SAI_TxSetFifoConfig (I2S_Type * *base*, sai_fifo_t * *config*)

Parameters

<i>base</i>	SAI base pointer.
<i>config</i>	fifo configurations.

38.4.5.20 void SAI_RxSetFifoConfig (I2S_Type * *base*, sai_fifo_t * *config*)

Parameters

<i>base</i>	SAI base pointer.
<i>config</i>	fifo configurations.

38.4.5.21 void SAI_TxSetFrameSyncConfig (I2S_Type * *base*, sai_master_slave_t *masterSlave*, sai_frame_sync_t * *config*)

Parameters

<i>base</i>	SAI base pointer.
<i>masterSlave</i>	master or slave.
<i>config</i>	frame sync configurations, can be NULL in slave mode.

38.4.5.22 void SAI_RxSetFrameSyncConfig (I2S_Type * *base*, sai_master_slave_t *masterSlave*, sai_frame_sync_t * *config*)

Parameters

<i>base</i>	SAI base pointer.
<i>masterSlave</i>	master or slave.
<i>config</i>	frame sync configurations, can be NULL in slave mode.

38.4.5.23 void SAI_TxSetSerialDataConfig (I2S_Type * *base*, sai_serial_data_t * *config*)

Parameters

<i>base</i>	SAI base pointer.
<i>config</i>	serial data configurations.

38.4.5.24 void SAI_RxSetSerialDataConfig (I2S_Type * *base*, sai_serial_data_t * *config*)

Parameters

<i>base</i>	SAI base pointer.
<i>config</i>	serial data configurations.

38.4.5.25 void SAI_TxSetConfig (I2S_Type * *base*, sai_transceiver_t * *config*)

Parameters

<i>base</i>	SAI base pointer.
<i>config</i>	transmitter configurations.

38.4.5.26 void SAI_RxSetConfig (I2S_Type * *base*, sai_transceiver_t * *config*)

Parameters

<i>base</i>	SAI base pointer.
-------------	-------------------

<i>config</i>	receiver configurations.
---------------	--------------------------

38.4.5.27 void SAI_GetClassicI2SConfig (sai_transceiver_t * config, sai_word_width_t bitWidth, sai_mono_stereo_t mode, uint32_t saiChannelMask)

Parameters

<i>config</i>	transceiver configurations.
<i>bitWidth</i>	audio data bitWidth.
<i>mode</i>	audio data channel.
<i>saiChannel-Mask</i>	mask value of the channel to be enable.

38.4.5.28 void SAI_GetLeftJustifiedConfig (sai_transceiver_t * config, sai_word_width_t bitWidth, sai_mono_stereo_t mode, uint32_t saiChannelMask)

Parameters

<i>config</i>	transceiver configurations.
<i>bitWidth</i>	audio data bitWidth.
<i>mode</i>	audio data channel.
<i>saiChannel-Mask</i>	mask value of the channel to be enable.

38.4.5.29 void SAI_GetRightJustifiedConfig (sai_transceiver_t * config, sai_word_width_t bitWidth, sai_mono_stereo_t mode, uint32_t saiChannelMask)

Parameters

<i>config</i>	transceiver configurations.
<i>bitWidth</i>	audio data bitWidth.

<i>mode</i>	audio data channel.
<i>saiChannelMask</i>	mask value of the channel to be enable.

38.4.5.30 void SAI_GetTDMConfig (sai_transceiver_t * *config*, sai_frame_sync_len_t *frameSyncWidth*, sai_word_width_t *bitWidth*, uint32_t *dataWordNum*, uint32_t *saiChannelMask*)

Parameters

<i>config</i>	transceiver configurations.
<i>frameSyncWidth</i>	length of frame sync.
<i>bitWidth</i>	audio data word width.
<i>dataWordNum</i>	word number in one frame.
<i>saiChannelMask</i>	mask value of the channel to be enable.

38.4.5.31 void SAI_GetDSPConfig (sai_transceiver_t * *config*, sai_frame_sync_len_t *frameSyncWidth*, sai_word_width_t *bitWidth*, sai_mono_stereo_t *mode*, uint32_t *saiChannelMask*)

Note

DSP mode is also called PCM mode which support MODE A and MODE B, DSP/PCM MODE A configuration flow. RX is similiar but uses SAI_RxSetConfig instead of SAI_TxSetConfig:

```
* SAI_GetDSPConfig(config, kSAI_FrameSyncLenOneBitClk, bitWidth,
    kSAI_Stereo, channelMask)
* config->frameSync.frameSyncEarly = true;
* SAI_TxSetConfig(base, config)
*
```

DSP/PCM MODE B configuration flow for TX. RX is similiar but uses SAI_RxSetConfig instead of SAI_TxSetConfig:

```
* SAI_GetDSPConfig(config, kSAI_FrameSyncLenOneBitClk, bitWidth,
    kSAI_Stereo, channelMask)
* SAI_TxSetConfig(base, config)
*
```

Parameters

<i>config</i>	transceiver configurations.
<i>frameSync-Width</i>	length of frame sync.
<i>bitWidth</i>	audio data bitWidth.
<i>mode</i>	audio data channel.
<i>saiChannel-Mask</i>	mask value of the channel to enable.

38.4.5.32 `static uint32_t SAI_TxGetStatusFlag (I2S_Type * base) [inline], [static]`

Parameters

<i>base</i>	SAI base pointer
-------------	------------------

Returns

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

38.4.5.33 `static void SAI_TxClearStatusFlags (I2S_Type * base, uint32_t mask) [inline], [static]`

Parameters

<i>base</i>	SAI base pointer
<i>mask</i>	State mask. It can be a combination of the following source if defined: <ul style="list-style-type: none"> • kSAI_WordStartFlag • kSAI_SyncErrorFlag • kSAI_FIFOErrorFlag

38.4.5.34 `static uint32_t SAI_RxGetStatusFlag (I2S_Type * base) [inline], [static]`

Parameters

<i>base</i>	SAI base pointer
-------------	------------------

Returns

SAI Rx status flag value. Use the Status Mask to get the status value needed.

38.4.5.35 static void SAI_RxClearStatusFlags (I2S_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

<i>base</i>	SAI base pointer
<i>mask</i>	State mask. It can be a combination of the following sources if defined. <ul style="list-style-type: none"> • kSAI_WordStartFlag • kSAI_SyncErrorFlag • kSAI_FIFOErrorFlag

38.4.5.36 void SAI_TxSoftwareReset (I2S_Type * *base*, sai_reset_type_t *resetType*)

FIFO reset means clear all the data in the FIFO, and make the FIFO pointer both to 0. Software reset means clear the Tx internal logic, including the bit clock, frame count etc. But software reset will not clear any configuration registers like TCR1~TCR5. This function will also clear all the error flags such as FIFO error, sync error etc.

Parameters

<i>base</i>	SAI base pointer
<i>resetType</i>	Reset type, FIFO reset or software reset

38.4.5.37 void SAI_RxSoftwareReset (I2S_Type * *base*, sai_reset_type_t *resetType*)

FIFO reset means clear all the data in the FIFO, and make the FIFO pointer both to 0. Software reset means clear the Rx internal logic, including the bit clock, frame count etc. But software reset will not clear any configuration registers like RCR1~RCR5. This function will also clear all the error flags such as FIFO error, sync error etc.

Parameters

<i>base</i>	SAI base pointer
<i>resetType</i>	Reset type, FIFO reset or software reset

38.4.5.38 void SAI_TxSetChannelFIFOMask (I2S_Type * *base*, uint8_t *mask*)

Parameters

<i>base</i>	SAI base pointer
<i>mask</i>	Channel enable mask, 0 means all channel FIFO disabled, 1 means channel 0 enabled, 3 means both channel 0 and channel 1 enabled.

38.4.5.39 void SAI_RxSetChannelFIFOMask (I2S_Type * *base*, uint8_t *mask*)

Parameters

<i>base</i>	SAI base pointer
<i>mask</i>	Channel enable mask, 0 means all channel FIFO disabled, 1 means channel 0 enabled, 3 means both channel 0 and channel 1 enabled.

38.4.5.40 void SAI_TxSetDataOrder (I2S_Type * *base*, sai_data_order_t *order*)

Parameters

<i>base</i>	SAI base pointer
<i>order</i>	Data order MSB or LSB

38.4.5.41 void SAI_RxSetDataOrder (I2S_Type * *base*, sai_data_order_t *order*)

Parameters

<i>base</i>	SAI base pointer
-------------	------------------

<i>order</i>	Data order MSB or LSB
--------------	-----------------------

38.4.5.42 void SAI_TxSetBitClockPolarity (I2S_Type * *base*, sai_clock_polarity_t *polarity*)

Parameters

<i>base</i>	SAI base pointer
<i>polarity</i>	

38.4.5.43 void SAI_RxSetBitClockPolarity (I2S_Type * *base*, sai_clock_polarity_t *polarity*)

Parameters

<i>base</i>	SAI base pointer
<i>polarity</i>	

38.4.5.44 void SAI_TxSetFrameSyncPolarity (I2S_Type * *base*, sai_clock_polarity_t *polarity*)

Parameters

<i>base</i>	SAI base pointer
<i>polarity</i>	

38.4.5.45 void SAI_RxSetFrameSyncPolarity (I2S_Type * *base*, sai_clock_polarity_t *polarity*)

Parameters

<i>base</i>	SAI base pointer
<i>polarity</i>	

38.4.5.46 void SAI_TxSetFIFOPacking (I2S_Type * *base*, sai_fifo_packing_t *pack*)

Parameters

<i>base</i>	SAI base pointer.
<i>pack</i>	FIFO pack type. It is element of <code>sai_fifo_packing_t</code> .

38.4.5.47 `void SAI_RxSetFIFOPacking (I2S_Type * base, sai_fifo_packing_t pack)`

Parameters

<i>base</i>	SAI base pointer.
<i>pack</i>	FIFO pack type. It is element of <code>sai_fifo_packing_t</code> .

38.4.5.48 `static void SAI_TxSetFIFOErrorContinue (I2S_Type * base, bool isEnabled)`
[inline], [static]

FIFO error continue mode means SAI will keep running while FIFO error occurred. If this feature not enabled, SAI will hang and users need to clear FEF flag in TCSR register.

Parameters

<i>base</i>	SAI base pointer.
<i>isEnabled</i>	Is FIFO error continue enabled, true means enable, false means disable.

38.4.5.49 `static void SAI_RxSetFIFOErrorContinue (I2S_Type * base, bool isEnabled)`
[inline], [static]

FIFO error continue mode means SAI will keep running while FIFO error occurred. If this feature not enabled, SAI will hang and users need to clear FEF flag in RCSR register.

Parameters

<i>base</i>	SAI base pointer.
<i>isEnabled</i>	Is FIFO error continue enabled, true means enable, false means disable.

38.4.5.50 `static void SAI_TxEnableInterrupts (I2S_Type * base, uint32_t mask)`
[inline], [static]

Parameters

<i>base</i>	SAI base pointer
<i>mask</i>	interrupt source The parameter can be a combination of the following sources if defined. <ul style="list-style-type: none"> • kSAI_WordStartInterruptEnable • kSAI_SyncErrorInterruptEnable • kSAI_FIFOWarningInterruptEnable • kSAI_FIFORequestInterruptEnable • kSAI_FIFOErrorInterruptEnable

38.4.5.51 static void SAI_RxEnableInterrupts (I2S_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

<i>base</i>	SAI base pointer
<i>mask</i>	interrupt source The parameter can be a combination of the following sources if defined. <ul style="list-style-type: none"> • kSAI_WordStartInterruptEnable • kSAI_SyncErrorInterruptEnable • kSAI_FIFOWarningInterruptEnable • kSAI_FIFORequestInterruptEnable • kSAI_FIFOErrorInterruptEnable

38.4.5.52 static void SAI_TxDisableInterrupts (I2S_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

<i>base</i>	SAI base pointer
<i>mask</i>	interrupt source The parameter can be a combination of the following sources if defined. <ul style="list-style-type: none"> • kSAI_WordStartInterruptEnable • kSAI_SyncErrorInterruptEnable • kSAI_FIFOWarningInterruptEnable • kSAI_FIFORequestInterruptEnable • kSAI_FIFOErrorInterruptEnable

38.4.5.53 static void SAI_RxDisableInterrupts (I2S_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

<i>base</i>	SAI base pointer
<i>mask</i>	interrupt source The parameter can be a combination of the following sources if defined. <ul style="list-style-type: none"> • kSAI_WordStartInterruptEnable • kSAI_SyncErrorInterruptEnable • kSAI_FIFOWarningInterruptEnable • kSAI_FIFORequestInterruptEnable • kSAI_FIFOErrorInterruptEnable

38.4.5.54 static void SAI_TxEnableDMA (I2S_Type * *base*, uint32_t *mask*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	SAI base pointer
<i>mask</i>	DMA source The parameter can be combination of the following sources if defined. <ul style="list-style-type: none"> • kSAI_FIFOWarningDMAEnable • kSAI_FIFORequestDMAEnable
<i>enable</i>	True means enable DMA, false means disable DMA.

38.4.5.55 static void SAI_RxEnableDMA (I2S_Type * *base*, uint32_t *mask*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	SAI base pointer
-------------	------------------

<i>mask</i>	DMA source The parameter can be a combination of the following sources if defined. <ul style="list-style-type: none"> • kSAI_FIFOWarningDMAEnable • kSAI_FIFORequestDMAEnable
<i>enable</i>	True means enable DMA, false means disable DMA.

38.4.5.56 `static uintptr_t SAI_TxGetDataRegisterAddress (I2S_Type * base, uint32_t channel) [inline], [static]`

This API is used to provide a transfer address for the SAI DMA transfer configuration.

Parameters

<i>base</i>	SAI base pointer.
<i>channel</i>	Which data channel used.

Returns

data register address.

38.4.5.57 `static uintptr_t SAI_RxGetDataRegisterAddress (I2S_Type * base, uint32_t channel) [inline], [static]`

This API is used to provide a transfer address for the SAI DMA transfer configuration.

Parameters

<i>base</i>	SAI base pointer.
<i>channel</i>	Which data channel used.

Returns

data register address.

38.4.5.58 `void SAI_TxSetFormat (I2S_Type * base, sai_transfer_format_t * format, uint32_t mclkSourceClockHz, uint32_t bclkSourceClockHz)`

Deprecated Do not use this function. It has been superseded by [SAI_TxSetConfig](#)

The audio format can be changed at run-time. This function configures the sample rate and audio data format to be transferred.

Parameters

<i>base</i>	SAI base pointer.
<i>format</i>	Pointer to the SAI audio data format structure.
<i>mclkSource-ClockHz</i>	SAI master clock source frequency in Hz.
<i>bclkSource-ClockHz</i>	SAI bit clock source frequency in Hz. If the bit clock source is a master clock, this value should equal the masterClockHz.

38.4.5.59 void SAI_RxSetFormat (I2S_Type * *base*, sai_transfer_format_t * *format*, uint32_t *mclkSourceClockHz*, uint32_t *bclkSourceClockHz*)

Deprecated Do not use this function. It has been superseded by [SAI_RxSetConfig](#)

The audio format can be changed at run-time. This function configures the sample rate and audio data format to be transferred.

Parameters

<i>base</i>	SAI base pointer.
<i>format</i>	Pointer to the SAI audio data format structure.
<i>mclkSource-ClockHz</i>	SAI master clock source frequency in Hz.
<i>bclkSource-ClockHz</i>	SAI bit clock source frequency in Hz. If the bit clock source is a master clock, this value should equal the masterClockHz.

38.4.5.60 void SAI_WriteBlocking (I2S_Type * *base*, uint32_t *channel*, uint32_t *bitWidth*, uint8_t * *buffer*, uint32_t *size*)

Note

This function blocks by polling until data is ready to be sent.

Parameters

<i>base</i>	SAI base pointer.
<i>channel</i>	Data channel used.
<i>bitWidth</i>	How many bits in an audio word; usually 8/16/24/32 bits.
<i>buffer</i>	Pointer to the data to be written.
<i>size</i>	Bytes to be written.

38.4.5.61 void SAI_WriteMultiChannelBlocking (I2S_Type * *base*, uint32_t *channel*, uint32_t *channelMask*, uint32_t *bitWidth*, uint8_t * *buffer*, uint32_t *size*)

Note

This function blocks by polling until data is ready to be sent.

Parameters

<i>base</i>	SAI base pointer.
<i>channel</i>	Data channel used.
<i>channelMask</i>	channel mask.
<i>bitWidth</i>	How many bits in an audio word; usually 8/16/24/32 bits.
<i>buffer</i>	Pointer to the data to be written.
<i>size</i>	Bytes to be written.

**38.4.5.62 static void SAI_WriteData (I2S_Type * *base*, uint32_t *channel*, uint32_t *data*)
[inline], [static]**

Parameters

<i>base</i>	SAI base pointer.
<i>channel</i>	Data channel used.
<i>data</i>	Data needs to be written.

38.4.5.63 void SAI_ReadBlocking (I2S_Type * *base*, uint32_t *channel*, uint32_t *bitWidth*, uint8_t * *buffer*, uint32_t *size*)

Note

This function blocks by polling until data is ready to be sent.

Parameters

<i>base</i>	SAI base pointer.
<i>channel</i>	Data channel used.
<i>bitWidth</i>	How many bits in an audio word; usually 8/16/24/32 bits.
<i>buffer</i>	Pointer to the data to be read.
<i>size</i>	Bytes to be read.

38.4.5.64 `void SAI_ReadMultiChannelBlocking (I2S_Type * base, uint32_t channel, uint32_t channelMask, uint32_t bitWidth, uint8_t * buffer, uint32_t size)`

Note

This function blocks by polling until data is ready to be sent.

Parameters

<i>base</i>	SAI base pointer.
<i>channel</i>	Data channel used.
<i>channelMask</i>	channel mask.
<i>bitWidth</i>	How many bits in an audio word; usually 8/16/24/32 bits.
<i>buffer</i>	Pointer to the data to be read.
<i>size</i>	Bytes to be read.

38.4.5.65 `static uint32_t SAI_ReadData (I2S_Type * base, uint32_t channel)`
`[inline], [static]`

Parameters

<i>base</i>	SAI base pointer.
<i>channel</i>	Data channel used.

Returns

Data in SAI FIFO.

**38.4.5.66 void SAI_TransferTxCreateHandle (I2S_Type * *base*, sai_handle_t * *handle*,
sai_transfer_callback_t *callback*, void * *userData*)**

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

Parameters

<i>base</i>	SAI base pointer
<i>handle</i>	SAI handle pointer.
<i>callback</i>	Pointer to the user callback function.
<i>userData</i>	User parameter passed to the callback function

38.4.5.67 void SAI_TransferRxCreateHandle (I2S_Type * *base*, sai_handle_t * *handle*, sai_transfer_callback_t *callback*, void * *userData*)

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

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI handle pointer.
<i>callback</i>	Pointer to the user callback function.
<i>userData</i>	User parameter passed to the callback function.

38.4.5.68 void SAI_TransferTxSetConfig (I2S_Type * *base*, sai_handle_t * *handle*, sai_transceiver_t * *config*)

This function initializes the Tx, include bit clock, frame sync, master clock, serial data and fifo configurations.

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI handle pointer.
<i>config</i>	transmitter configurations.

38.4.5.69 void SAI_TransferRxSetConfig (I2S_Type * *base*, sai_handle_t * *handle*, sai_transceiver_t * *config*)

This function initializes the Rx, include bit clock, frame sync, master clock, serial data and fifo configurations.

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI handle pointer.
<i>config</i>	receiver configurations.

38.4.5.70 `status_t SAI_TransferTxSetFormat (I2S_Type * base, sai_handle_t * handle, sai_transfer_format_t * format, uint32_t mclkSourceClockHz, uint32_t bclkSourceClockHz)`

Deprecated Do not use this function. It has been superseded by [SAI_TransferTxSetConfig](#)

The audio format can be changed at run-time. This function configures the sample rate and audio data format to be transferred.

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI handle pointer.
<i>format</i>	Pointer to the SAI audio data format structure.
<i>mclkSource-ClockHz</i>	SAI master clock source frequency in Hz.
<i>bclkSource-ClockHz</i>	SAI bit clock source frequency in Hz. If a bit clock source is a master clock, this value should equal the masterClockHz in format.

Returns

Status of this function. Return value is the `status_t`.

38.4.5.71 `status_t SAI_TransferRxSetFormat (I2S_Type * base, sai_handle_t * handle, sai_transfer_format_t * format, uint32_t mclkSourceClockHz, uint32_t bclkSourceClockHz)`

Deprecated Do not use this function. It has been superseded by [SAI_TransferRxSetConfig](#)

The audio format can be changed at run-time. This function configures the sample rate and audio data format to be transferred.

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI handle pointer.
<i>format</i>	Pointer to the SAI audio data format structure.
<i>mclkSource-ClockHz</i>	SAI master clock source frequency in Hz.
<i>bclkSource-ClockHz</i>	SAI bit clock source frequency in Hz. If a bit clock source is a master clock, this value should equal the masterClockHz in format.

Returns

Status of this function. Return value is one of `status_t`.

38.4.5.72 `status_t SAI_TransferSendNonBlocking (I2S_Type * base, sai_handle_t * handle, sai_transfer_t * xfer)`

Note

This API returns immediately after the transfer initiates. Call the `SAI_TxGetTransferStatusIRQ` to poll the transfer status and check whether the transfer is finished. If the return status is not `kStatus_SAI_Busy`, the transfer is finished.

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	Pointer to the <code>sai_handle_t</code> structure which stores the transfer state.
<i>xfer</i>	Pointer to the <code>sai_transfer_t</code> structure.

Return values

<i>kStatus_Success</i>	Successfully started the data receive.
<i>kStatus_SAI_TxBusy</i>	Previous receive still not finished.
<i>kStatus_InvalidArgument</i>	The input parameter is invalid.

38.4.5.73 `status_t SAI_TransferReceiveNonBlocking (I2S_Type * base, sai_handle_t * handle, sai_transfer_t * xfer)`

Note

This API returns immediately after the transfer initiates. Call the SAI_RxGetTransferStatusIRQ to poll the transfer status and check whether the transfer is finished. If the return status is not kStatus_SAI_Busy, the transfer is finished.

Parameters

<i>base</i>	SAI base pointer
<i>handle</i>	Pointer to the sai_handle_t structure which stores the transfer state.
<i>xfer</i>	Pointer to the sai_transfer_t structure.

Return values

<i>kStatus_Success</i>	Successfully started the data receive.
<i>kStatus_SAI_RxBusy</i>	Previous receive still not finished.
<i>kStatus_InvalidArgument</i>	The input parameter is invalid.

38.4.5.74 status_t SAI_TransferGetSendCount (I2S_Type * *base*, sai_handle_t * *handle*, size_t * *count*)

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	Pointer to the sai_handle_t structure which stores the transfer state.
<i>count</i>	Bytes count sent.

Return values

<i>kStatus_Success</i>	Succeed get the transfer count.
<i>kStatus_NoTransferInProgress</i>	There is not a non-blocking transaction currently in progress.

38.4.5.75 status_t SAI_TransferGetReceiveCount (I2S_Type * *base*, sai_handle_t * *handle*, size_t * *count*)

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	Pointer to the sai_handle_t structure which stores the transfer state.
<i>count</i>	Bytes count received.

Return values

<i>kStatus_Success</i>	Succeed get the transfer count.
<i>kStatus_NoTransferInProgress</i>	There is not a non-blocking transaction currently in progress.

38.4.5.76 void SAI_TransferAbortSend (I2S_Type * *base*, sai_handle_t * *handle*)

Note

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

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	Pointer to the sai_handle_t structure which stores the transfer state.

38.4.5.77 void SAI_TransferAbortReceive (I2S_Type * *base*, sai_handle_t * *handle*)

Note

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

Parameters

<i>base</i>	SAI base pointer
<i>handle</i>	Pointer to the sai_handle_t structure which stores the transfer state.

38.4.5.78 void SAI_TransferTerminateSend (I2S_Type * *base*, sai_handle_t * *handle*)

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

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.

38.4.5.79 void SAI_TransferTerminateReceive (I2S_Type * *base*, sai_handle_t * *handle*)

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

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.

38.4.5.80 void SAI_TransferTxHandleIRQ (I2S_Type * *base*, sai_handle_t * *handle*)

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	Pointer to the sai_handle_t structure.

38.4.5.81 void SAI_TransferRxHandleIRQ (I2S_Type * *base*, sai_handle_t * *handle*)

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	Pointer to the sai_handle_t structure.

38.5 SAI EDMA Driver

38.5.1 Overview

Data Structures

- struct [sai_edma_handle_t](#)
SAI DMA transfer handle, users should not touch the content of the handle. [More...](#)

Typedefs

- typedef void(* [sai_edma_callback_t](#))(I2S_Type *base, sai_edma_handle_t *handle, [status_t](#) status, void *userData)
SAI eDMA transfer callback function for finish and error.

Driver version

- #define [FSL_SAI_EDMA_DRIVER_VERSION](#) ([MAKE_VERSION](#)(2, 5, 0))
Version 2.5.0.

eDMA Transactional

- void [SAI_TransferTxCreateHandleEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle, [sai_edma_callback_t](#) callback, void *userData, [edma_handle_t](#) *txDmaHandle)
Initializes the SAI eDMA handle.
- void [SAI_TransferRxCreateHandleEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle, [sai_edma_callback_t](#) callback, void *userData, [edma_handle_t](#) *rxDmaHandle)
Initializes the SAI Rx eDMA handle.
- void [SAI_TransferTxSetFormatEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle, [sai_transfer_format_t](#) *format, uint32_t mclkSourceClockHz, uint32_t bclkSourceClockHz)
Configures the SAI Tx audio format.
- void [SAI_TransferRxSetFormatEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle, [sai_transfer_format_t](#) *format, uint32_t mclkSourceClockHz, uint32_t bclkSourceClockHz)
Configures the SAI Rx audio format.
- void [SAI_TransferTxSetConfigEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle, [sai_transceiver_t](#) *saiConfig)
Configures the SAI Tx.
- void [SAI_TransferRxSetConfigEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle, [sai_transceiver_t](#) *saiConfig)
Configures the SAI Rx.
- [status_t](#) [SAI_TransferSendEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle, [sai_transfer_t](#) *xfer)
Performs a non-blocking SAI transfer using DMA.
- [status_t](#) [SAI_TransferReceiveEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle, [sai_transfer_t](#) *xfer)

- Performs a non-blocking SAI receive using eDMA.*

 - [status_t SAI_TransferSendLoopEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle, [sai_transfer_t](#) *xfer, uint32_t loopTransferCount)
- Performs a non-blocking SAI loop transfer using eDMA.*

 - [status_t SAI_TransferReceiveLoopEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle, [sai_transfer_t](#) *xfer, uint32_t loopTransferCount)
- Performs a non-blocking SAI loop transfer using eDMA.*

 - void [SAI_TransferTerminateSendEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle)
- Terminate all SAI send.*

 - void [SAI_TransferTerminateReceiveEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle)
- Terminate all SAI receive.*

 - void [SAI_TransferAbortSendEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle)
- Aborts a SAI transfer using eDMA.*

 - void [SAI_TransferAbortReceiveEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle)
- Aborts a SAI receive using eDMA.*

 - [status_t SAI_TransferGetSendCountEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle, size_t *count)
- Gets byte count sent by SAI.*

 - [status_t SAI_TransferGetReceiveCountEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle, size_t *count)
- Gets byte count received by SAI.*

 - uint32_t [SAI_TransferGetValidTransferSlotsEDMA](#) (I2S_Type *base, sai_edma_handle_t *handle)
- Gets valid transfer slot.*

38.5.2 Data Structure Documentation

38.5.2.1 struct sai_edma_handle

Data Fields

- [edma_handle_t](#) * [dmaHandle](#)
DMA handler for SAI send.
- uint8_t [nbytes](#)
eDMA minor byte transfer count initially configured.
- uint8_t [bytesPerFrame](#)
Bytes in a frame.
- uint8_t [channelMask](#)
Enabled channel mask value, reference [_sai_channel_mask](#).
- uint8_t [channelNums](#)
total enabled channel nums
- uint8_t [channel](#)
Which data channel.
- uint8_t [count](#)
The transfer data count in a DMA request.
- uint32_t [state](#)
Internal state for SAI eDMA transfer.
- [sai_edma_callback_t](#) [callback](#)
Callback for users while transfer finish or error occurs.
- void * [userData](#)

- *User callback parameter.*
uint8_t `tcd` [(SAI_XFER_QUEUE_SIZE+1U)*sizeof(edma_tcd_t)]
TCD pool for eDMA transfer.
- sai_transfer_t `saiQueue` [SAI_XFER_QUEUE_SIZE]
Transfer queue storing queued transfer.
- size_t `transferSize` [SAI_XFER_QUEUE_SIZE]
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.

Field Documentation

- (1) uint8_t `sai_edma_handle_t::nbytes`
- (2) uint8_t `sai_edma_handle_t::tcd`[(SAI_XFER_QUEUE_SIZE+1U)*sizeof(edma_tcd_t)]
- (3) sai_transfer_t `sai_edma_handle_t::saiQueue`[SAI_XFER_QUEUE_SIZE]
- (4) volatile uint8_t `sai_edma_handle_t::queueUser`

38.5.3 Function Documentation

38.5.3.1 void SAI_TransferTxCreateHandleEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*, sai_edma_callback_t *callback*, void * *userData*, edma_handle_t * *txDmaHandle*)

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

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.
<i>base</i>	SAI peripheral base address.
<i>callback</i>	Pointer to user callback function.
<i>userData</i>	User parameter passed to the callback function.
<i>txDmaHandle</i>	eDMA handle pointer, this handle shall be static allocated by users.

38.5.3.2 void SAI_TransferRxCreateHandleEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*, sai_edma_callback_t *callback*, void * *userData*, edma_handle_t * *rxDmaHandle*)

This function initializes the SAI slave DMA handle, which can be used for other SAI master transactional APIs. Usually, for a specified SAI instance, call this API once to get the initialized handle.

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.
<i>base</i>	SAI peripheral base address.
<i>callback</i>	Pointer to user callback function.
<i>userData</i>	User parameter passed to the callback function.
<i>rxDmaHandle</i>	eDMA handle pointer, this handle shall be static allocated by users.

38.5.3.3 void SAI_TransferTxSetFormatEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*, sai_transfer_format_t * *format*, uint32_t *mclkSourceClockHz*, uint32_t *bclkSourceClockHz*)

Deprecated Do not use this function. It has been superseded by [SAI_TransferTxSetConfigEDMA](#)

The audio format can be changed at run-time. This function configures the sample rate and audio data format to be transferred. This function also sets the eDMA parameter according to formatting requirements.

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.
<i>format</i>	Pointer to SAI audio data format structure.
<i>mclkSource-ClockHz</i>	SAI master clock source frequency in Hz.
<i>bclkSource-ClockHz</i>	SAI bit clock source frequency in Hz. If bit clock source is master clock, this value should equals to masterClockHz in format.

Return values

<i>kStatus_Success</i>	Audio format set successfully.
<i>kStatus_InvalidArgument</i>	The input argument is invalid.

38.5.3.4 void SAI_TransferRxSetFormatEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*, sai_transfer_format_t * *format*, uint32_t *mclkSourceClockHz*, uint32_t *bclkSourceClockHz*)

Deprecated Do not use this function. It has been superseded by [SAI_TransferRxSetConfigEDMA](#)

The audio format can be changed at run-time. This function configures the sample rate and audio data format to be transferred. This function also sets the eDMA parameter according to formatting requirements.

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.
<i>format</i>	Pointer to SAI audio data format structure.
<i>mclkSource-ClockHz</i>	SAI master clock source frequency in Hz.
<i>bclkSource-ClockHz</i>	SAI bit clock source frequency in Hz. If a bit clock source is the master clock, this value should equal to masterClockHz in format.

Return values

<i>kStatus_Success</i>	Audio format set successfully.
<i>kStatus_InvalidArgument</i>	The input argument is invalid.

38.5.3.5 void SAI_TransferTxSetConfigEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*, sai_transceiver_t * *saiConfig*)

Note

SAI eDMA supports data transfer in a multiple SAI channels if the FIFO Combine feature is supported. To activate the multi-channel transfer enable SAI channels by filling the channelMask of [sai_transceiver_t](#) with the corresponding values of `_sai_channel_mask` enum, enable the FIFO Combine mode by assigning `kSAI_FifoCombineModeEnabledOnWrite` to the `fifoCombine` member of `sai_fifo_combine_t` which is a member of [sai_transceiver_t](#). This is an example of multi-channel data transfer configuration step.

```
* sai_transceiver_t config;
* SAI_GetClassicI2SConfig(&config, kSAI_WordWidth16bits,
*   kSAI_Stereo, kSAI_Channel0Mask|kSAI_Channel1Mask);
* config.fifo.fifoCombine = kSAI_FifoCombineModeEnabledOnWrite
*   ;
* SAI_TransferTxSetConfigEDMA(I2S0, &edmaHandle, &config);
*
```

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.
<i>saiConfig</i>	sai configurations.

38.5.3.6 void SAI_TransferRxSetConfigEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*, sai_transceiver_t * *saiConfig*)

Note

SAI eDMA supports data transfer in a multiple SAI channels if the FIFO Combine feature is supported. To activate the multi-channel transfer enable SAI channels by filling the channelMask of *sai_transceiver_t* with the corresponding values of *_sai_channel_mask* enum, enable the FIFO Combine mode by assigning *kSAI_FifoCombineModeEnabledOnRead* to the *fifoCombine* member of *sai_fifo_combine_t* which is a member of *sai_transceiver_t*. This is an example of multi-channel data transfer configuration step.

```
* sai_transceiver_t config;
* SAI_GetClassicI2SConfig(&config, kSAI_WordWidth16bits,
*   kSAI_Stereo, kSAI_Channel0Mask|kSAI_Channel1Mask);
* config.fifo.fifoCombine = kSAI_FifoCombineModeEnabledOnRead
*   ;
* SAI_TransferRxSetConfigEDMA(I2S0, &edmaHandle, &config);
*
```

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.
<i>saiConfig</i>	sai configurations.

38.5.3.7 status_t SAI_TransferSendEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*, sai_transfer_t * *xfer*)

Note

This interface returns immediately after the transfer initiates. Call *SAI_GetTransferStatus* to poll the transfer status and check whether the SAI transfer is finished.

This function support multi channel transfer,

1. for the sai IP support fifo combine mode, application should enable the fifo combine mode, no limitation on channel numbers
2. for the sai IP not support fifo combine mode, sai edma provide another solution which using EDMA modulo feature, but support 2 or 4 channels only.

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.
<i>xfer</i>	Pointer to the DMA transfer structure.

Return values

<i>kStatus_Success</i>	Start a SAI eDMA send successfully.
<i>kStatus_InvalidArgument</i>	The input argument is invalid.
<i>kStatus_TxBusy</i>	SAI is busy sending data.

38.5.3.8 status_t SAI_TransferReceiveEDMA (I2S_Type * base, sai_edma_handle_t * handle, sai_transfer_t * xfer)

Note

This interface returns immediately after the transfer initiates. Call the SAI_GetReceiveRemainingBytes to poll the transfer status and check whether the SAI transfer is finished.

This function support multi channel transfer,

1. for the sai IP support fifo combine mode, application should enable the fifo combine mode, no limitation on channel numbers
2. for the sai IP not support fifo combine mode, sai edma provide another solution which using EDMA modulo feature, but support 2 or 4 channels only.

Parameters

<i>base</i>	SAI base pointer
<i>handle</i>	SAI eDMA handle pointer.
<i>xfer</i>	Pointer to DMA transfer structure.

Return values

<i>kStatus_Success</i>	Start a SAI eDMA receive successfully.
<i>kStatus_InvalidArgument</i>	The input argument is invalid.

<i>kStatus_RxBusy</i>	SAI is busy receiving data.
-----------------------	-----------------------------

38.5.3.9 **status_t SAI_TransferSendLoopEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*, sai_transfer_t * *xfer*, uint32_t *loopTransferCount*)**

Note

This function support loop transfer only,such as A->B->...->A, application must be aware of that the more counts of the loop transfer, then more tcd memory required, as the function use the tcd pool in sai_edma_handle_t, so application could redefine the SAI_XFER_QUEUE_SIZE to determine the proper TCD pool size.

Once the loop transfer start, application can use function SAI_TransferAbortSendEDMA to stop the loop transfer.

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.
<i>xfer</i>	Pointer to the DMA transfer structure, should be a array with elements counts ≥ 1 (loopTransferCount).
<i>loopTransfer-Count</i>	the counts of xfer array.

Return values

<i>kStatus_Success</i>	Start a SAI eDMA send successfully.
<i>kStatus_InvalidArgument</i>	The input argument is invalid.

38.5.3.10 **status_t SAI_TransferReceiveLoopEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*, sai_transfer_t * *xfer*, uint32_t *loopTransferCount*)**

Note

This function support loop transfer only,such as A->B->...->A, application must be aware of that the more counts of the loop transfer, then more tcd memory required, as the function use the tcd pool in sai_edma_handle_t, so application could redefine the SAI_XFER_QUEUE_SIZE to determine the proper TCD pool size.

Once the loop transfer start, application can use function SAI_TransferAbortReceiveEDMA to stop the loop transfer.

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.
<i>xfer</i>	Pointer to the DMA transfer structure, should be a array with elements counts ≥ 1 (loopTransferCount).
<i>loopTransfer-Count</i>	the counts of xfer array.

Return values

<i>kStatus_Success</i>	Start a SAI eDMA receive successfully.
<i>kStatus_InvalidArgument</i>	The input argument is invalid.

38.5.3.11 void SAI_TransferTerminateSendEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*)

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

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.

38.5.3.12 void SAI_TransferTerminateReceiveEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*)

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

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.

38.5.3.13 void SAI_TransferAbortSendEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*)

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

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.

38.5.3.14 void SAI_TransferAbortReceiveEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*)

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

Parameters

<i>base</i>	SAI base pointer
<i>handle</i>	SAI eDMA handle pointer.

38.5.3.15 status_t SAI_TransferGetSendCountEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*, size_t * *count*)

Parameters

<i>base</i>	SAI base pointer.
<i>handle</i>	SAI eDMA handle pointer.
<i>count</i>	Bytes count sent by SAI.

Return values

<i>kStatus_Success</i>	Succeed get the transfer count.
<i>kStatus_NoTransferInProgress</i>	There is no non-blocking transaction in progress.

38.5.3.16 status_t SAI_TransferGetReceiveCountEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*, size_t * *count*)

Parameters

<i>base</i>	SAI base pointer
<i>handle</i>	SAI eDMA handle pointer.
<i>count</i>	Bytes count received by SAI.

Return values

<i>kStatus_Success</i>	Succeed get the transfer count.
<i>kStatus_NoTransferInProgress</i>	There is no non-blocking transaction in progress.

38.5.3.17 `uint32_t SAI_TransferGetValidTransferSlotsEDMA (I2S_Type * base, sai_edma_handle_t * handle)`

This function can be used to query the valid transfer request slot that the application can submit. It should be called in the critical section, that means the application could call it in the corresponding callback function or disable IRQ before calling it in the application, otherwise, the returned value may not correct.

Parameters

<i>base</i>	SAI base pointer
<i>handle</i>	SAI eDMA handle pointer.

Return values

<i>valid</i>	slot count that application submit.
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Chapter 39

SEMC: Smart External DRAM Controller Driver

39.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Smart External DRAM Controller block of MCUXpresso SDK devices.

39.2 SEMC: Smart External DRAM Controller Driver

39.2.1 SEMC Initialization Operation

The SEMC Initialize is to initialize for common configure: gate the SEMC clock, configure IOMUX, and queue weight setting. The SEMC Deinitialize is to ungate the clock and disable SEMC module.

39.2.2 SEMC Interrupt Operation

The interrupt and disable operation for SEMC.

39.2.3 SEMC Memory access Operation

This group is mainly provide NAND/NOR memory access API which is through IP bus/ IP command access. Since the AXI access is directly read/write is so easy, so the AXI read/write part is not provided in SEMC.

39.3 Typical use case

Data Structures

- struct [semc_sdram_config_t](#)
SEMC SDRAM configuration structure. [More...](#)
- struct [semc_nand_timing_config_t](#)
SEMC NAND device timing configuration structure. [More...](#)
- struct [semc_nand_config_t](#)
SEMC NAND configuration structure. [More...](#)
- struct [semc_nor_config_t](#)
SEMC NOR configuration structure. [More...](#)
- struct [semc_sram_config_t](#)
SEMC SRAM configuration structure. [More...](#)
- struct [semc_dbi_config_t](#)
SEMC DBI configuration structure. [More...](#)
- struct [semc_queuea_weight_struct_t](#)

- *SEMC AXI queue a weight setting structure. [More...](#)*
- union `semc_queuea_weight_t`
SEMC AXI queue a weight setting union. [More...](#)
- struct `semc_queueb_weight_struct_t`
SEMC AXI queue b weight setting structure. [More...](#)
- union `semc_queueb_weight_t`
SEMC AXI queue b weight setting union. [More...](#)
- struct `semc_axi_queueweight_t`
SEMC AXI queue weight setting. [More...](#)
- struct `semc_config_t`
SEMC configuration structure. [More...](#)

Enumerations

- enum {
`kStatus_SEMC_InvalidDeviceType = MAKE_STATUS(kStatusGroup_SEMC, 0),`
`kStatus_SEMC_IpCommandExecutionError = MAKE_STATUS(kStatusGroup_SEMC, 1),`
`kStatus_SEMC_AxiCommandExecutionError = MAKE_STATUS(kStatusGroup_SEMC, 2),`
`kStatus_SEMC_InvalidMemorySize = MAKE_STATUS(kStatusGroup_SEMC, 3),`
`kStatus_SEMC_InvalidIpcmdDataSize = MAKE_STATUS(kStatusGroup_SEMC, 4),`
`kStatus_SEMC_InvalidAddressPortWidth = MAKE_STATUS(kStatusGroup_SEMC, 5),`
`kStatus_SEMC_InvalidDataPortWidth = MAKE_STATUS(kStatusGroup_SEMC, 6),`
`kStatus_SEMC_InvalidSwPinmuxSelection = MAKE_STATUS(kStatusGroup_SEMC, 7),`
`kStatus_SEMC_InvalidBurstLength = MAKE_STATUS(kStatusGroup_SEMC, 8),`
`kStatus_SEMC_InvalidColumnAddressBitWidth = MAKE_STATUS(kStatusGroup_SEMC, 9),`
`kStatus_SEMC_InvalidBaseAddress = MAKE_STATUS(kStatusGroup_SEMC, 10),`
`kStatus_SEMC_InvalidTimerSetting = MAKE_STATUS(kStatusGroup_SEMC, 11) }`
SEMC status, `_semc_status`.
- enum `semc_mem_type_t` {
`kSEMC_MemType_SDRAM = 0,`
`kSEMC_MemType_SRAM,`
`kSEMC_MemType_NOR,`
`kSEMC_MemType_NAND,`
`kSEMC_MemType_8080 }`
SEMC memory device type.
- enum `semc_waitready_polarity_t` {
`kSEMC_LowActive = 0,`
`kSEMC_HighActive }`
SEMC WAIT/RDY polarity.
- enum `semc_sdram_cs_t` {
`kSEMC_SDRAM_CS0 = 0,`
`kSEMC_SDRAM_CS1,`
`kSEMC_SDRAM_CS2,`
`kSEMC_SDRAM_CS3 }`
SEMC SDRAM Chip selection .
- enum `semc_sram_cs_t` { `kSEMC_SRAM_CS0 = 0 }`
SEMC SRAM Chip selection .
- enum `semc_nand_access_type_t` {

```
kSEMC_NAND_ACCESS_BY_AXI = 0,
kSEMC_NAND_ACCESS_BY_IPCMD }
```

SEMC NAND device type.

- enum `semc_interrupt_enable_t` {


```
kSEMC_IPCmdDoneInterrupt = SEMC_INTEN_IPCMDDONEEN_MASK,
kSEMC_IPCmdErrInterrupt = SEMC_INTEN_IPCMDERREN_MASK,
kSEMC_AXICmdErrInterrupt = SEMC_INTEN_AXICMDERREN_MASK,
kSEMC_AXIBusErrInterrupt = SEMC_INTEN_AXIBUSERREN_MASK }
```

SEMC interrupts .

- enum `semc_ipcmd_datasize_t` {


```
kSEMC_IPcmdDataSize_1bytes = 1,
kSEMC_IPcmdDataSize_2bytes,
kSEMC_IPcmdDataSize_3bytes,
kSEMC_IPcmdDataSize_4bytes }
```

SEMC IP command data size in bytes.

- enum `semc_refresh_time_t` {


```
kSEMC_RefreshThreeClocks = 0x0U,
kSEMC_RefreshSixClocks,
kSEMC_RefreshNineClocks }
```

SEMC auto-refresh timing.

- enum `semc_caslatency_t` {


```
kSEMC_LatencyOne = 1,
kSEMC_LatencyTwo,
kSEMC_LatencyThree }
```

CAS latency.

- enum `semc_sdram_column_bit_num_t` {


```
kSEMC_SdramColumn_12bit = 0x0U,
kSEMC_SdramColumn_11bit,
kSEMC_SdramColumn_10bit,
kSEMC_SdramColumn_9bit }
```

SEMC sdram column address bit number.

- enum `sem_sdram_burst_len_t` { `kSEMC_Sdram_BurstLen1 = 0` }

SEMC sdram burst length.

- enum `semc_nand_column_bit_num_t` {


```
kSEMC_NandColumn_16bit = 0x0U,
kSEMC_NandColumn_15bit,
kSEMC_NandColumn_14bit,
kSEMC_NandColumn_13bit,
kSEMC_NandColumn_12bit,
kSEMC_NandColumn_11bit,
kSEMC_NandColumn_10bit,
kSEMC_NandColumn_9bit }
```

SEMC nand column address bit number.

- enum `sem_nand_burst_len_t` {


```
kSEMC_Nand_BurstLen1 = 0,
kSEMC_Nand_BurstLen2,
kSEMC_Nand_BurstLen4,
kSEMC_Nand_BurstLen8,
kSEMC_Nand_BurstLen16,
kSEMC_Nand_BurstLen32,
kSEMC_Nand_BurstLen64 }
```

SEMC nand burst length.

- enum `semc_norsram_column_bit_num_t` {


```
kSEMC_NorColumn_12bit = 0x0U,
kSEMC_NorColumn_11bit,
kSEMC_NorColumn_10bit,
kSEMC_NorColumn_9bit,
kSEMC_NorColumn_8bit,
kSEMC_NorColumn_7bit,
kSEMC_NorColumn_6bit,
kSEMC_NorColumn_5bit,
kSEMC_NorColumn_4bit,
kSEMC_NorColumn_3bit,
kSEMC_NorColumn_2bit }
```

SEMC nor/sram column address bit number.

- enum `sem_norsram_burst_len_t` {


```
kSEMC_Nor_BurstLen1 = 0,
kSEMC_Nor_BurstLen2,
kSEMC_Nor_BurstLen4,
kSEMC_Nor_BurstLen8,
kSEMC_Nor_BurstLen16,
kSEMC_Nor_BurstLen32,
kSEMC_Nor_BurstLen64 }
```

SEMC nor/sram burst length.

- enum `semc_dbi_column_bit_num_t` {


```
kSEMC_Dbi_Colum_12bit = 0x0U,
kSEMC_Dbi_Colum_11bit,
kSEMC_Dbi_Colum_10bit,
kSEMC_Dbi_Colum_9bit,
kSEMC_Dbi_Colum_8bit,
kSEMC_Dbi_Colum_7bit,
kSEMC_Dbi_Colum_6bit,
kSEMC_Dbi_Colum_5bit,
kSEMC_Dbi_Colum_4bit,
kSEMC_Dbi_Colum_3bit,
kSEMC_Dbi_Colum_2bit }
```

SEMC dbi column address bit number.

- enum `sem_dbi_burst_len_t` {

- ```

kSEMC_Dbi_BurstLen1 = 0,
kSEMC_Dbi_BurstLen2,
kSEMC_Dbi_Dbi_BurstLen4,
kSEMC_Dbi_BurstLen8,
kSEMC_Dbi_BurstLen16,
kSEMC_Dbi_BurstLen32,
kSEMC_Dbi_BurstLen64 }
 SEMC dbi burst length.

```
- enum `semc_iomux_pin` {

```

kSEMC_MUXA8 = SEMC_IOCRR_MUX_A8_SHIFT,
kSEMC_MUXCSX0 = SEMC_IOCRR_MUX_CSX0_SHIFT,
kSEMC_MUXCSX1 = SEMC_IOCRR_MUX_CSX1_SHIFT,
kSEMC_MUXCSX2 = SEMC_IOCRR_MUX_CSX2_SHIFT,
kSEMC_MUXCSX3 = SEMC_IOCRR_MUX_CSX3_SHIFT,
kSEMC_MUXRDY = SEMC_IOCRR_MUX_RDY_SHIFT }
 SEMC IOMUXC.

```
  - enum `semc_iomux_nora27_pin` {

```

kSEMC_MORA27_NONE = 0,
kSEMC_NORA27_MUXCSX3 = SEMC_IOCRR_MUX_CSX3_SHIFT,
kSEMC_NORA27_MUXRDY = SEMC_IOCRR_MUX_RDY_SHIFT }
 SEMC NOR/PSRAM Address bit 27 A27.

```
  - enum `semc_port_size_t` {

```

kSEMC_PortSize8Bit = 0,
kSEMC_PortSize16Bit }
 SEMC port size.

```
  - enum `semc_addr_mode_t` {

```

kSEMC_AddrDataMux = 0,
kSEMC_AdvAddrdataMux,
kSEMC_AddrDataNonMux }
 SEMC address mode.

```
  - enum `semc_dqs_mode_t` {

```

kSEMC_Loopbackinternal = 0,
kSEMC_Loopbackdqspad }
 SEMC DQS read strobe mode.

```
  - enum `semc_adv_polarity_t` {

```

kSEMC_AdvActiveLow = 0,
kSEMC_AdvActiveHigh }
 SEMC ADV signal active polarity.

```
  - enum `semc_sync_mode_t` {

```

kSEMC_AsyncMode = 0,
kSEMC_SyncMode }
 SEMC sync mode.

```
  - enum `semc_adv_level_control_t` {

```

kSEMC_AdvHigh = 0,
kSEMC_AdvLow }
 SEMC ADV signal level control.

```
  - enum `semc_rdy_polarity_t` {

- ```
kSEMC_RdyActiveLow = 0,
kSEMC_RdyActivehigh }
```
- SEMC RDY signal active polarity.*
- enum `semc_ipcmd_nand_addrmode_t` {

```
kSEMC_NANDAM_ColumnRow = 0x0U,
kSEMC_NANDAM_ColumnCA0,
kSEMC_NANDAM_ColumnCA0CA1,
kSEMC_NANDAM_RawRA0,
kSEMC_NANDAM_RawRA0RA1,
kSEMC_NANDAM_RawRA0RA1RA2 }
```

SEMC IP command for NAND: address mode.
 - enum `semc_ipcmd_nand_cmdmode_t` {

```
kSEMC_NANDCM_Command = 0x2U,
kSEMC_NANDCM_CommandHold,
kSEMC_NANDCM_CommandAddress,
kSEMC_NANDCM_CommandAddressHold,
kSEMC_NANDCM_CommandAddressRead,
kSEMC_NANDCM_CommandAddressWrite,
kSEMC_NANDCM_CommandRead,
kSEMC_NANDCM_CommandWrite,
kSEMC_NANDCM_Read,
kSEMC_NANDCM_Write }
```

SEMC IP command for NAND command mode.
 - enum `semc_nand_address_option_t` {

```
kSEMC_NandAddrOption_5byte_CA2RA3 = 0U,
kSEMC_NandAddrOption_4byte_CA2RA2 = 2U,
kSEMC_NandAddrOption_3byte_CA2RA1 = 4U,
kSEMC_NandAddrOption_4byte_CA1RA3 = 1U,
kSEMC_NandAddrOption_3byte_CA1RA2 = 3U,
kSEMC_NandAddrOption_2byte_CA1RA1 = 7U }
```

SEMC NAND address option.
 - enum `semc_ipcmd_nor_dbi_t` {

```
kSEMC_NORDBICM_Read = 0x2U,
kSEMC_NORDBICM_Write }
```

SEMC IP command for NOR.
 - enum `semc_ipcmd_sram_t` {

```
kSEMC_SRAMCM_ArrayRead = 0x2U,
kSEMC_SRAMCM_ArrayWrite,
kSEMC_SRAMCM_RegRead,
kSEMC_SRAMCM_RegWrite }
```

SEMC IP command for SRAM.
 - enum `semc_ipcmd_sdram_t` {

```

kSEMC_SDRAMCM_Read = 0x8U,
kSEMC_SDRAMCM_Write,
kSEMC_SDRAMCM_Modeset,
kSEMC_SDRAMCM_Active,
kSEMC_SDRAMCM_AutoRefresh,
kSEMC_SDRAMCM_SelfRefresh,
kSEMC_SDRAMCM_Precharge,
kSEMC_SDRAMCM_Prechargeall }
SEMC IP command for SDARM.

```

Driver version

- #define `FSL_SEMC_DRIVER_VERSION` (`MAKE_VERSION(2, 4, 3)`)
SEMC driver version.

SEMC Initialization and De-initialization

- void `SEMC_GetDefaultConfig` (`semc_config_t *config`)
Gets the SEMC default basic configuration structure.
- void `SEMC_Init` (`SEMC_Type *base, semc_config_t *configure`)
Initializes SEMC.
- void `SEMC_Deinit` (`SEMC_Type *base`)
Deinitializes the SEMC module and gates the clock.

SEMC Configuration Operation For Each Memory Type

- `status_t SEMC_ConfigureSDRAM` (`SEMC_Type *base, semc_sdram_cs_t cs, semc_sdram_config_t *config, uint32_t clkSrc_Hz`)
Configures SDRAM controller in SEMC.
- `status_t SEMC_ConfigureNAND` (`SEMC_Type *base, semc_nand_config_t *config, uint32_t clkSrc_Hz`)
Configures NAND controller in SEMC.
- `status_t SEMC_ConfigureNOR` (`SEMC_Type *base, semc_nor_config_t *config, uint32_t clkSrc_Hz`)
Configures NOR controller in SEMC.
- `status_t SEMC_ConfigureSRAMWithChipSelection` (`SEMC_Type *base, semc_sram_cs_t cs, semc_sram_config_t *config, uint32_t clkSrc_Hz`)
Configures SRAM controller in SEMC.
- `status_t SEMC_ConfigureSRAM` (`SEMC_Type *base, semc_sram_config_t *config, uint32_t clkSrc_Hz`)
Configures SRAM controller in SEMC.
- `status_t SEMC_ConfigureDBI` (`SEMC_Type *base, semc_dbi_config_t *config, uint32_t clkSrc_Hz`)
Configures DBI controller in SEMC.

SEMC Interrupt Operation

- static void `SEMC_EnableInterrupts` (`SEMC_Type *base, uint32_t mask`)
Enables the SEMC interrupt.

- static void [SEMC_DisableInterrupts](#) (SEMC_Type *base, uint32_t mask)
Disables the SEMC interrupt.
- static bool [SEMC_GetStatusFlag](#) (SEMC_Type *base)
Gets the SEMC status.
- static void [SEMC_ClearStatusFlags](#) (SEMC_Type *base, uint32_t mask)
Clears the SEMC status flag state.

SEMC Memory Access Operation

- static bool [SEMC_IsInIdle](#) (SEMC_Type *base)
Check if SEMC is in idle.
- [status_t SEMC_SendIPCommand](#) (SEMC_Type *base, [semc_mem_type_t](#) memType, uint32_t address, uint32_t command, uint32_t write, uint32_t *read)
SEMC IP command access.
- static uint16_t [SEMC_BuildNandIPCommand](#) (uint8_t userCommand, [semc_ipcmd_nand_addrmode_t](#) addrMode, [semc_ipcmd_nand_cmdmode_t](#) cmdMode)
Build SEMC IP command for NAND.
- static bool [SEMC_IsNandReady](#) (SEMC_Type *base)
Check if the NAND device is ready.
- [status_t SEMC_IPCommandNandWrite](#) (SEMC_Type *base, uint32_t address, uint8_t *data, uint32_t size_bytes)
SEMC NAND device memory write through IP command.
- [status_t SEMC_IPCommandNandRead](#) (SEMC_Type *base, uint32_t address, uint8_t *data, uint32_t size_bytes)
SEMC NAND device memory read through IP command.
- [status_t SEMC_IPCommandNorWrite](#) (SEMC_Type *base, uint32_t address, uint8_t *data, uint32_t size_bytes)
SEMC NOR device memory write through IP command.
- [status_t SEMC_IPCommandNorRead](#) (SEMC_Type *base, uint32_t address, uint8_t *data, uint32_t size_bytes)
SEMC NOR device memory read through IP command.

39.4 Data Structure Documentation

39.4.1 struct [semc_sdram_config_t](#)

1. The memory size in the configuration is in the unit of KB. So memsize_kbytes should be set as 2^2 , 2^3 , 2^4 .etc which is base 2KB exponential function. Take refer to BR0~BR3 register in RM for details.
2. The prescalePeriod_N16Cycle is in unit of 16 clock cycle. It is a exception for prescaleTimer_n16cycle = 0, it means the prescaler timer period is $256 * 16$ clock cycles. For precalerIf precalerTimer_n16cycle not equal to 0, The prescaler timer period is prescalePeriod_N16Cycle * 16 clock cycles. idleTimeout_NprescalePeriod, refreshUrgThreshold_NprescalePeriod, refreshPeriod_NprescalePeriod are similar to prescalePeriod_N16Cycle.

Data Fields

- [semc_iomux_pin csxPinMux](#)

- *CS pin mux.*
- `uint32_t address`
The base address.
- `uint32_t memsize_kbytes`
The memory size in unit of kbytes.
- `smec_port_size_t portSize`
Port size.
- `sem_sdram_burst_len_t burstLen`
Burst length.
- `semc_sdram_column_bit_num_t columnAddrBitNum`
Column address bit number.
- `semc_caslatency_t casLatency`
CAS latency.
- `uint8_t tPrecharge2Act_Ns`
Precharge to active wait time in unit of nanosecond.
- `uint8_t tAct2ReadWrite_Ns`
Act to read/write wait time in unit of nanosecond.
- `uint8_t tRefreshRecovery_Ns`
Refresh recovery time in unit of nanosecond.
- `uint8_t tWriteRecovery_Ns`
write recovery time in unit of nanosecond.
- `uint8_t tCkeOff_Ns`
CKE off minimum time in unit of nanosecond.
- `uint8_t tAct2Prechage_Ns`
Active to precharge in unit of nanosecond.
- `uint8_t tSelfRefRecovery_Ns`
Self refresh recovery time in unit of nanosecond.
- `uint8_t tRefresh2Refresh_Ns`
Refresh to refresh wait time in unit of nanosecond.
- `uint8_t tAct2Act_Ns`
Active to active wait time in unit of nanosecond.
- `uint32_t tPrescalePeriod_Ns`
*Prescaler timer period should not be larger than $256 * 16 * \text{clock cycle}$.*
- `uint32_t tIdleTimeout_Ns`
Idle timeout in unit of prescale time period.
- `uint32_t refreshPeriod_nsPerRow`
*Refresh timer period like $64\text{ms} * 1000000/8192$.*
- `uint32_t refreshUrgThreshold`
Refresh urgent threshold.
- `uint8_t refreshBurstLen`
Refresh burst length.

Field Documentation

(1) `semc_iomux_pin semc_sdram_config_t::csxPinMux`

The `kSEMC_MUXA8` is not valid in sdram pin mux setting.

(2) `uint32_t semc_sdram_config_t::address`

(3) `uint32_t semc_sdram_config_t::memsize_kbytes`

- (4) `smec_port_size_t semc_sdram_config_t::portSize`
- (5) `sem_sdram_burst_len_t semc_sdram_config_t::burstLen`
- (6) `semc_sdram_column_bit_num_t semc_sdram_config_t::columnAddrBitNum`
- (7) `semc_caslatency_t semc_sdram_config_t::casLatency`
- (8) `uint8_t semc_sdram_config_t::tPrecharge2Act_Ns`
- (9) `uint8_t semc_sdram_config_t::tAct2ReadWrite_Ns`
- (10) `uint8_t semc_sdram_config_t::tRefreshRecovery_Ns`
- (11) `uint8_t semc_sdram_config_t::tWriteRecovery_Ns`
- (12) `uint8_t semc_sdram_config_t::tCkeOff_Ns`
- (13) `uint8_t semc_sdram_config_t::tAct2Prechage_Ns`
- (14) `uint8_t semc_sdram_config_t::tSelfRefRecovery_Ns`
- (15) `uint8_t semc_sdram_config_t::tRefresh2Refresh_Ns`
- (16) `uint8_t semc_sdram_config_t::tAct2Act_Ns`
- (17) `uint32_t semc_sdram_config_t::tPrescalePeriod_Ns`
- (18) `uint32_t semc_sdram_config_t::tIdleTimeout_Ns`
- (19) `uint32_t semc_sdram_config_t::refreshPeriod_nsPerRow`
- (20) `uint32_t semc_sdram_config_t::refreshUrgThreshold`
- (21) `uint8_t semc_sdram_config_t::refreshBurstLen`

39.4.2 struct `semc_nand_timing_config_t`

Data Fields

- `uint8_t tCeSetup_Ns`
CE setup time: tCS.
- `uint8_t tCeHold_Ns`
CE hold time: tCH.
- `uint8_t tCeInterval_Ns`
CE interval time: tCEITV.
- `uint8_t tWeLow_Ns`
WE low time: tWP.
- `uint8_t tWeHigh_Ns`
WE high time: tWH.

- `uint8_t tReLow_Ns`
RE low time: tRP.
- `uint8_t tReHigh_Ns`
RE high time: tREH.
- `uint8_t tTurnAround_Ns`
Turnaround time for async mode: tTA.
- `uint8_t tWehigh2Relow_Ns`
WE# high to RE# wait time: tWHR.
- `uint8_t tRehigh2Welow_Ns`
RE# high to WE# low wait time: tRHW.
- `uint8_t tAle2WriteStart_Ns`
ALE to write start wait time: tADL.
- `uint8_t tReady2Relow_Ns`
Ready to RE# low min wait time: tRR.
- `uint8_t tWehigh2Busy_Ns`
WE# high to busy wait time: tWB.

Field Documentation

- (1) `uint8_t semc_nand_timing_config_t::tCeSetup_Ns`
- (2) `uint8_t semc_nand_timing_config_t::tCeHold_Ns`
- (3) `uint8_t semc_nand_timing_config_t::tCeInterval_Ns`
- (4) `uint8_t semc_nand_timing_config_t::tWeLow_Ns`
- (5) `uint8_t semc_nand_timing_config_t::tWeHigh_Ns`
- (6) `uint8_t semc_nand_timing_config_t::tReLow_Ns`
- (7) `uint8_t semc_nand_timing_config_t::tReHigh_Ns`
- (8) `uint8_t semc_nand_timing_config_t::tTurnAround_Ns`
- (9) `uint8_t semc_nand_timing_config_t::tWehigh2Relow_Ns`
- (10) `uint8_t semc_nand_timing_config_t::tRehigh2Welow_Ns`
- (11) `uint8_t semc_nand_timing_config_t::tAle2WriteStart_Ns`
- (12) `uint8_t semc_nand_timing_config_t::tReady2Relow_Ns`
- (13) `uint8_t semc_nand_timing_config_t::tWehigh2Busy_Ns`

39.4.3 struct semc_nand_config_t

Data Fields

- `semc_iomux_pin cePinMux`

- *The CE pin mux setting.*
uint32_t [axiAddress](#)
- *The base address for AXI nand.*
uint32_t [axiMemsize_kbytes](#)
- *The memory size in unit of kbytes for AXI nand.*
uint32_t [ipgAddress](#)
- *The base address for IPG nand .*
uint32_t [ipgMemsize_kbytes](#)
- *The memory size in unit of kbytes for IPG nand.*
[semc_rdy_polarity_t rdyactivePolarity](#)
- *Wait ready polarity.*
bool [edoModeEnabled](#)
- *EDO mode enabled.*
[semc_nand_column_bit_num_t columnAddrBitNum](#)
- *Column address bit number.*
[semc_nand_address_option_t arrayAddrOption](#)
- *Address option.*
[sem_nand_burst_len_t burstLen](#)
- *Burst length.*
[smec_port_size_t portSize](#)
- *Port size.*
[semc_nand_timing_config_t * timingConfig](#)
- *SEMC nand timing configuration.*

Field Documentation

(1) [semc_iomux_pin semc_nand_config_t::cePinMux](#)

The kSEMC_MUXRDY is not valid for CE pin setting.

(2) [uint32_t semc_nand_config_t::axiAddress](#)

(3) [uint32_t semc_nand_config_t::axiMemsize_kbytes](#)

(4) [uint32_t semc_nand_config_t::ipgAddress](#)

(5) [uint32_t semc_nand_config_t::ipgMemsize_kbytes](#)

(6) [semc_rdy_polarity_t semc_nand_config_t::rdyactivePolarity](#)

(7) [bool semc_nand_config_t::edoModeEnabled](#)

(8) [semc_nand_column_bit_num_t semc_nand_config_t::columnAddrBitNum](#)

(9) [semc_nand_address_option_t semc_nand_config_t::arrayAddrOption](#)

(10) [sem_nand_burst_len_t semc_nand_config_t::burstLen](#)

(11) [smec_port_size_t semc_nand_config_t::portSize](#)

(12) [semc_nand_timing_config_t* semc_nand_config_t::timingConfig](#)

39.4.4 struct semc_nor_config_t

Data Fields

- [semc_iomux_pin cePinMux](#)
The CE# pin mux setting.
- [semc_iomux_nora27_pin addr27](#)
The Addr bit 27 pin mux setting.
- [uint32_t address](#)
The base address.
- [uint32_t memsize_kbytes](#)
The memory size in unit of kbytes.
- [uint8_t addrPortWidth](#)
The address port width.
- [semc_rdy_polarity_t rdyactivePolarity](#)
Wait ready polarity.
- [semc_adv_polarity_t advActivePolarity](#)
ADV# polarity.
- [semc_norsram_column_bit_num_t columnAddrBitNum](#)
Column address bit number.
- [semc_addr_mode_t addrMode](#)
Address mode.
- [sem_norsram_burst_len_t burstLen](#)
Burst length.
- [smec_port_size_t portSize](#)
Port size.
- [uint8_t tCeSetup_Ns](#)
The CE setup time.
- [uint8_t tCeHold_Ns](#)
The CE hold time.
- [uint8_t tCeInterval_Ns](#)
CE interval minimum time.
- [uint8_t tAddrSetup_Ns](#)
The address setup time.
- [uint8_t tAddrHold_Ns](#)
The address hold time.
- [uint8_t tWeLow_Ns](#)
WE low time for async mode.
- [uint8_t tWeHigh_Ns](#)
WE high time for async mode.
- [uint8_t tReLow_Ns](#)
RE low time for async mode.
- [uint8_t tReHigh_Ns](#)
RE high time for async mode.
- [uint8_t tTurnAround_Ns](#)
Turnaround time for async mode.
- [uint8_t tAddr2WriteHold_Ns](#)
Address to write data hold time for async mode.

Field Documentation

- (1) `semc_iomux_pin semc_nor_config_t::cePinMux`
- (2) `semc_iomux_nora27_pin semc_nor_config_t::addr27`
- (3) `uint32_t semc_nor_config_t::address`
- (4) `uint32_t semc_nor_config_t::memsize_kbytes`
- (5) `uint8_t semc_nor_config_t::addrPortWidth`
- (6) `semc_rdy_polarity_t semc_nor_config_t::rdyactivePolarity`
- (7) `semc_adv_polarity_t semc_nor_config_t::advActivePolarity`
- (8) `semc_norsram_column_bit_num_t semc_nor_config_t::columnAddrBitNum`
- (9) `semc_addr_mode_t semc_nor_config_t::addrMode`
- (10) `sem_norsram_burst_len_t semc_nor_config_t::burstLen`
- (11) `smec_port_size_t semc_nor_config_t::portSize`
- (12) `uint8_t semc_nor_config_t::tCeSetup_Ns`
- (13) `uint8_t semc_nor_config_t::tCeHold_Ns`
- (14) `uint8_t semc_nor_config_t::tCeInterval_Ns`
- (15) `uint8_t semc_nor_config_t::tAddrSetup_Ns`
- (16) `uint8_t semc_nor_config_t::tAddrHold_Ns`
- (17) `uint8_t semc_nor_config_t::tWeLow_Ns`
- (18) `uint8_t semc_nor_config_t::tWeHigh_Ns`
- (19) `uint8_t semc_nor_config_t::tReLow_Ns`
- (20) `uint8_t semc_nor_config_t::tReHigh_Ns`
- (21) `uint8_t semc_nor_config_t::tTurnAround_Ns`
- (22) `uint8_t semc_nor_config_t::tAddr2WriteHold_Ns`

39.4.5 struct `semc_sram_config_t`

Data Fields

- [semc_iomux_pin cePinMux](#)
The CE# pin mux setting.

- [semc_iomux_nora27_pin addr27](#)
The Addr bit 27 pin mux setting.
- [uint32_t address](#)
The base address.
- [uint32_t memsize_kbytes](#)
The memory size in unit of kbytes.
- [uint8_t addrPortWidth](#)
The address port width.
- [semc_adv_polarity_t advActivePolarity](#)
ADV# polarity 1: active high, 0: active low.
- [semc_addr_mode_t addrMode](#)
Address mode.
- [sem_norsram_burst_len_t burstLen](#)
Burst length.
- [smec_port_size_t portSize](#)
Port size.
- [uint8_t tCeSetup_Ns](#)
The CE setup time.
- [uint8_t tCeHold_Ns](#)
The CE hold time.
- [uint8_t tCeInterval_Ns](#)
CE interval minimum time.
- [uint8_t tAddrSetup_Ns](#)
The address setup time.
- [uint8_t tAddrHold_Ns](#)
The address hold time.
- [uint8_t tWeLow_Ns](#)
WE low time for async mode.
- [uint8_t tWeHigh_Ns](#)
WE high time for async mode.
- [uint8_t tReLow_Ns](#)
RE low time for async mode.
- [uint8_t tReHigh_Ns](#)
RE high time for async mode.
- [uint8_t tTurnAround_Ns](#)
Turnaround time for async mode.
- [uint8_t tAddr2WriteHold_Ns](#)
Address to write data hold time for async mode.

Field Documentation

- (1) `semc_iomux_pin semc_sram_config_t::cePinMux`
- (2) `semc_iomux_nora27_pin semc_sram_config_t::addr27`
- (3) `uint32_t semc_sram_config_t::address`
- (4) `uint32_t semc_sram_config_t::memsize_kbytes`
- (5) `uint8_t semc_sram_config_t::addrPortWidth`

- (6) `semc_adv_polarity_t semc_sram_config_t::advActivePolarity`
- (7) `semc_addr_mode_t semc_sram_config_t::addrMode`
- (8) `sem_norsram_burst_len_t semc_sram_config_t::burstLen`
- (9) `smec_port_size_t semc_sram_config_t::portSize`
- (10) `uint8_t semc_sram_config_t::tCeSetup_Ns`
- (11) `uint8_t semc_sram_config_t::tCeHold_Ns`
- (12) `uint8_t semc_sram_config_t::tCeInterval_Ns`
- (13) `uint8_t semc_sram_config_t::tAddrSetup_Ns`
- (14) `uint8_t semc_sram_config_t::tAddrHold_Ns`
- (15) `uint8_t semc_sram_config_t::tWeLow_Ns`
- (16) `uint8_t semc_sram_config_t::tWeHigh_Ns`
- (17) `uint8_t semc_sram_config_t::tReLow_Ns`
- (18) `uint8_t semc_sram_config_t::tReHigh_Ns`
- (19) `uint8_t semc_sram_config_t::tTurnAround_Ns`
- (20) `uint8_t semc_sram_config_t::tAddr2WriteHold_Ns`

39.4.6 struct `semc_dbi_config_t`

Data Fields

- [semc_iomux_pin csxPinMux](#)
The CE# pin mux.
- [uint32_t address](#)
The base address.
- [uint32_t memsize_kbytes](#)
The memory size in unit of 4kbytes.
- [semc_dbi_column_bit_num_t columnAddrBitNum](#)
Column address bit number.
- [sem_dbi_burst_len_t burstLen](#)
Burst length.
- [smec_port_size_t portSize](#)
Port size.
- [uint8_t tCsxSetup_Ns](#)
The CSX setup time.
- [uint8_t tCsxHold_Ns](#)
The CSX hold time.

- `uint8_t tWexLow_Ns`
WEX low time.
- `uint8_t tWexHigh_Ns`
WEX high time.
- `uint8_t tRdxLow_Ns`
RDX low time.
- `uint8_t tRdxHigh_Ns`
RDX high time.
- `uint8_t tCsxInterval_Ns`
Write data setup time.

Field Documentation

- (1) `semc_iomux_pin semc_dbi_config_t::csxPinMux`
- (2) `uint32_t semc_dbi_config_t::address`
- (3) `uint32_t semc_dbi_config_t::memsize_kbytes`
- (4) `semc_dbi_column_bit_num_t semc_dbi_config_t::columnAddrBitNum`
- (5) `sem_dbi_burst_len_t semc_dbi_config_t::burstLen`
- (6) `smec_port_size_t semc_dbi_config_t::portSize`
- (7) `uint8_t semc_dbi_config_t::tCsxSetup_Ns`
- (8) `uint8_t semc_dbi_config_t::tCsxHold_Ns`
- (9) `uint8_t semc_dbi_config_t::tWexLow_Ns`
- (10) `uint8_t semc_dbi_config_t::tWexHigh_Ns`
- (11) `uint8_t semc_dbi_config_t::tRdxLow_Ns`
- (12) `uint8_t semc_dbi_config_t::tRdxHigh_Ns`
- (13) `uint8_t semc_dbi_config_t::tCsxInterval_Ns`

39.4.7 struct semc_queuea_weight_struct_t

Data Fields

- `uint32_t qos`: 4
weight of qos for queue 0.
- `uint32_t aging`: 4
weight of aging for queue 0.
- `uint32_t slaveHitSwitth`: 8
weight of read/write switch for queue 0.
- `uint32_t slaveHitNoswitch`: 8

weight of read/write no switch for queue 0 .

Field Documentation

- (1) `uint32_t semc_queuea_weight_struct_t::qos`
- (2) `uint32_t semc_queuea_weight_struct_t::aging`
- (3) `uint32_t semc_queuea_weight_struct_t::slaveHitSwith`
- (4) `uint32_t semc_queuea_weight_struct_t::slaveHitNoswitch`

39.4.8 union semc_queuea_weight_t

Data Fields

- [semc_queuea_weight_struct_t queueaConfig](#)
Structure configuration for queueA.
- `uint32_t queueaValue`
Configuration value for queueA which could directly write to the reg.

Field Documentation

- (1) `semc_queuea_weight_struct_t semc_queuea_weight_t::queueaConfig`
- (2) `uint32_t semc_queuea_weight_t::queueaValue`

39.4.9 struct semc_queueb_weight_struct_t

Data Fields

- `uint32_t qos`: 4
weight of qos for queue 1.
- `uint32_t aging`: 4
weight of aging for queue 1.
- `uint32_t slaveHitSwith`: 8
weight of read/write switch for queue 1.
- `uint32_t weightPagehit`: 8
weight of page hit for queue 1 only .
- `uint32_t bankRotation`: 8
weight of bank rotation for queue 1 only .

Field Documentation

- (1) `uint32_t semc_queueb_weight_struct_t::qos`
- (2) `uint32_t semc_queueb_weight_struct_t::aging`
- (3) `uint32_t semc_queueb_weight_struct_t::slaveHitSwith`

(4) `uint32_t semc_queueb_weight_struct_t::weightPagehit`

(5) `uint32_t semc_queueb_weight_struct_t::bankRotation`

39.4.10 union `semc_queueb_weight_t`

Data Fields

- `semc_queueb_weight_struct_t queuebConfig`
Structure configuration for queueB.
- `uint32_t queuebValue`
Configuration value for queueB which could directly write to the reg.

Field Documentation

(1) `semc_queueb_weight_struct_t semc_queueb_weight_t::queuebConfig`

(2) `uint32_t semc_queueb_weight_t::queuebValue`

39.4.11 struct `semc_axi_queueweight_t`

Data Fields

- `bool queueaEnable`
Enable queue a.
- `semc_queuea_weight_t queueaWeight`
Weight settings for queue a.
- `bool queuebEnable`
Enable queue b.
- `semc_queueb_weight_t queuebWeight`
Weight settings for queue b.

Field Documentation

(1) `bool semc_axi_queueweight_t::queueaEnable`

(2) `semc_queuea_weight_t semc_axi_queueweight_t::queueaWeight`

(3) `bool semc_axi_queueweight_t::queuebEnable`

(4) `semc_queueb_weight_t semc_axi_queueweight_t::queuebWeight`

39.4.12 struct `semc_config_t`

`busTimeoutCycles`: when `busTimeoutCycles` is zero, the bus timeout cycle is 255×1024 . otherwise the bus timeout cycles is `busTimeoutCycles` $\times 1024$. `cmdTimeoutCycles`: is used for command execution timeout cycles. it's similar to the `busTimeoutCycles`.

Data Fields

- [semc_dqs_mode_t dqsMode](#)
Dummy read strobe mode: use enum in "semc_dqs_mode_t".
- [uint8_t cmdTimeoutCycles](#)
Command execution timeout cycles.
- [uint8_t busTimeoutCycles](#)
Bus timeout cycles.
- [semc_axi_queueweight_t queueWeight](#)
AXI queue weight.

Field Documentation

- (1) `semc_dqs_mode_t semc_config_t::dqsMode`
- (2) `uint8_t semc_config_t::cmdTimeoutCycles`
- (3) `uint8_t semc_config_t::busTimeoutCycles`
- (4) `semc_axi_queueweight_t semc_config_t::queueWeight`

39.5 Macro Definition Documentation

39.5.1 #define FSL_SEMC_DRIVER_VERSION (MAKE_VERSION(2, 4, 3))

39.6 Enumeration Type Documentation

39.6.1 anonymous enum

Enumerator

- kStatus_SEMC_InvalidDeviceType* Invalid device type.
- kStatus_SEMC_IpCommandExecutionError* IP command execution error.
- kStatus_SEMC_AxiCommandExecutionError* AXI command execution error.
- kStatus_SEMC_InvalidMemorySize* Invalid memory size.
- kStatus_SEMC_InvalidIpcmdDataSize* Invalid IP command data size.
- kStatus_SEMC_InvalidAddressPortWidth* Invalid address port width.
- kStatus_SEMC_InvalidDataPortWidth* Invalid data port width.
- kStatus_SEMC_InvalidSwPinmuxSelection* Invalid SW pinmux selection.
- kStatus_SEMC_InvalidBurstLength* Invalid burst length.
- kStatus_SEMC_InvalidColumnAddressBitWidth* Invalid column address bit width.
- kStatus_SEMC_InvalidBaseAddress* Invalid base address.
- kStatus_SEMC_InvalidTimerSetting* Invalid timer setting.

39.6.2 enum semc_mem_type_t

Enumerator

kSEMC_MemType_SDRAM SDRAM.
kSEMC_MemType_SRAM SRAM.
kSEMC_MemType_NOR NOR.
kSEMC_MemType_NAND NAND.
kSEMC_MemType_8080 1.

39.6.3 enum semc_waitready_polarity_t

Enumerator

kSEMC_LowActive Low active.
kSEMC_HighActive High active.

39.6.4 enum semc_sdram_cs_t

Enumerator

kSEMC_SDRAM_CS0 SEMC SDRAM CS0.
kSEMC_SDRAM_CS1 SEMC SDRAM CS1.
kSEMC_SDRAM_CS2 SEMC SDRAM CS2.
kSEMC_SDRAM_CS3 SEMC SDRAM CS3.

39.6.5 enum semc_sram_cs_t

Enumerator

kSEMC_SRAM_CS0 SEMC SRAM CS0.

39.6.6 enum semc_nand_access_type_t

Enumerator

kSEMC_NAND_ACCESS_BY_AXI Access to NAND flash by AXI bus.
kSEMC_NAND_ACCESS_BY_IPCMD Access to NAND flash by IP bus.

39.6.7 enum semc_interrupt_enable_t

Enumerator

- kSEMC_IPCmdDoneInterrupt* Ip command done interrupt.
- kSEMC_IPCmdErrInterrupt* Ip command error interrupt.
- kSEMC_AXICmdErrInterrupt* AXI command error interrupt.
- kSEMC_AXIBusErrInterrupt* AXI bus error interrupt.

39.6.8 enum semc_ipcmd_datasize_t

Enumerator

- kSEMC_IPcmdDataSize_1bytes* The IP command data size 1 byte.
- kSEMC_IPcmdDataSize_2bytes* The IP command data size 2 byte.
- kSEMC_IPcmdDataSize_3bytes* The IP command data size 3 byte.
- kSEMC_IPcmdDataSize_4bytes* The IP command data size 4 byte.

39.6.9 enum semc_refresh_time_t

Enumerator

- kSEMC_RefreshThreeClocks* The refresh timing with three bus clocks.
- kSEMC_RefreshSixClocks* The refresh timing with six bus clocks.
- kSEMC_RefreshNineClocks* The refresh timing with nine bus clocks.

39.6.10 enum semc_caslatency_t

Enumerator

- kSEMC_LatencyOne* Latency 1.
- kSEMC_LatencyTwo* Latency 2.
- kSEMC_LatencyThree* Latency 3.

39.6.11 enum semc_sdram_column_bit_num_t

Enumerator

- kSEMC_SdramColumn_12bit* 12 bit.
- kSEMC_SdramColumn_11bit* 11 bit.
- kSEMC_SdramColumn_10bit* 10 bit.
- kSEMC_SdramColumn_9bit* 9 bit.

39.6.12 enum sem_sdram_burst_len_t

Enumerator

kSEMC_Sdram_BurstLen1 According to ERR050577, Auto-refresh command may possibly fail to be triggered during long time back-to-back write (or read) when SDRAM controller's burst length is greater than 1. Burst length 1

39.6.13 enum semc_nand_column_bit_num_t

Enumerator

kSEMC_NandColum_16bit 16 bit.
kSEMC_NandColum_15bit 15 bit.
kSEMC_NandColum_14bit 14 bit.
kSEMC_NandColum_13bit 13 bit.
kSEMC_NandColum_12bit 12 bit.
kSEMC_NandColum_11bit 11 bit.
kSEMC_NandColum_10bit 10 bit.
kSEMC_NandColum_9bit 9 bit.

39.6.14 enum sem_nand_burst_len_t

Enumerator

kSEMC_Nand_BurstLen1 Burst length 1.
kSEMC_Nand_BurstLen2 Burst length 2.
kSEMC_Nand_BurstLen4 Burst length 4.
kSEMC_Nand_BurstLen8 Burst length 8.
kSEMC_Nand_BurstLen16 Burst length 16.
kSEMC_Nand_BurstLen32 Burst length 32.
kSEMC_Nand_BurstLen64 Burst length 64.

39.6.15 enum semc_norsram_column_bit_num_t

Enumerator

kSEMC_NorColum_12bit 12 bit.
kSEMC_NorColum_11bit 11 bit.
kSEMC_NorColum_10bit 10 bit.
kSEMC_NorColum_9bit 9 bit.
kSEMC_NorColum_8bit 8 bit.

kSEMC_NorColum_7bit 7 bit.
kSEMC_NorColum_6bit 6 bit.
kSEMC_NorColum_5bit 5 bit.
kSEMC_NorColum_4bit 4 bit.
kSEMC_NorColum_3bit 3 bit.
kSEMC_NorColum_2bit 2 bit.

39.6.16 enum sem_norsram_burst_len_t

Enumerator

kSEMC_Nor_BurstLen1 Burst length 1.
kSEMC_Nor_BurstLen2 Burst length 2.
kSEMC_Nor_BurstLen4 Burst length 4.
kSEMC_Nor_BurstLen8 Burst length 8.
kSEMC_Nor_BurstLen16 Burst length 16.
kSEMC_Nor_BurstLen32 Burst length 32.
kSEMC_Nor_BurstLen64 Burst length 64.

39.6.17 enum semc_dbi_column_bit_num_t

Enumerator

kSEMC_Dbi_Colum_12bit 12 bit.
kSEMC_Dbi_Colum_11bit 11 bit.
kSEMC_Dbi_Colum_10bit 10 bit.
kSEMC_Dbi_Colum_9bit 9 bit.
kSEMC_Dbi_Colum_8bit 8 bit.
kSEMC_Dbi_Colum_7bit 7 bit.
kSEMC_Dbi_Colum_6bit 6 bit.
kSEMC_Dbi_Colum_5bit 5 bit.
kSEMC_Dbi_Colum_4bit 4 bit.
kSEMC_Dbi_Colum_3bit 3 bit.
kSEMC_Dbi_Colum_2bit 2 bit.

39.6.18 enum sem_dbi_burst_len_t

Enumerator

kSEMC_Dbi_BurstLen1 Burst length 1.
kSEMC_Dbi_BurstLen2 Burst length 2.

kSEMC_Dbi_Dbi_BurstLen4 Burst length 4.
kSEMC_Dbi_BurstLen8 Burst length 8.
kSEMC_Dbi_BurstLen16 Burst length 16.
kSEMC_Dbi_BurstLen32 Burst length 32.
kSEMC_Dbi_BurstLen64 Burst length 64.

39.6.19 enum semc_iomux_pin

Enumerator

kSEMC_MUXA8 MUX A8 pin.
kSEMC_MUXCSX0 MUX CSX0 pin.
kSEMC_MUXCSX1 MUX CSX1 Pin.
kSEMC_MUXCSX2 MUX CSX2 Pin.
kSEMC_MUXCSX3 MUX CSX3 Pin.
kSEMC_MUXRDY MUX RDY pin.

39.6.20 enum semc_iomux_nora27_pin

Enumerator

kSEMC_MORA27_NONE No NOR/SRAM A27 pin.
kSEMC_NORA27_MUXCSX3 MUX CSX3 Pin.
kSEMC_NORA27_MUXRDY MUX RDY pin.

39.6.21 enum smec_port_size_t

Enumerator

kSEMC_PortSize8Bit 8-Bit port size.
kSEMC_PortSize16Bit 16-Bit port size.

39.6.22 enum semc_addr_mode_t

Enumerator

kSEMC_AddrDataMux SEMC address/data mux mode.
kSEMC_AdvAddrdataMux Advanced address/data mux mode.
kSEMC_AddrDataNonMux Address/data non-mux mode.

39.6.23 enum semc_dqs_mode_t

Enumerator

kSEMC_Loopbackinternal Dummy read strobe loopbacked internally.

kSEMC_Loopbackdqspad Dummy read strobe loopbacked from DQS pad.

39.6.24 enum semc_adv_polarity_t

Enumerator

kSEMC_AdvActiveLow Adv active low.

kSEMC_AdvActiveHigh Adv active high.

39.6.25 enum semc_sync_mode_t

Enumerator

kSEMC_AsyncMode Async mode.

kSEMC_SyncMode Sync mode.

39.6.26 enum semc_adv_level_control_t

Enumerator

kSEMC_AdvHigh Adv is high during address hold state.

kSEMC_AdvLow Adv is low during address hold state.

39.6.27 enum semc_rdy_polarity_t

Enumerator

kSEMC_RdyActiveLow Adv active low.

kSEMC_RdyActivehigh Adv active low.

39.6.28 enum semc_ipcmd_nand_addrmode_t

Enumerator

- kSEMC_NANDAM_ColumnRow* Address mode: column and row address(5Byte-CA0/CA1/RA0/-RA1/RA2).
- kSEMC_NANDAM_ColumnCA0* Address mode: column address only(1 Byte-CA0).
- kSEMC_NANDAM_ColumnCA0CA1* Address mode: column address only(2 Byte-CA0/CA1).
- kSEMC_NANDAM_RawRA0* Address mode: row address only(1 Byte-RA0).
- kSEMC_NANDAM_RawRA0RA1* Address mode: row address only(2 Byte-RA0/RA1).
- kSEMC_NANDAM_RawRA0RA1RA2* Address mode: row address only(3 Byte-RA0).

39.6.29 enum semc_ipcmd_nand_cmdmode_t

Enumerator

- kSEMC_NANDCM_Command* command.
- kSEMC_NANDCM_CommandHold* Command hold.
- kSEMC_NANDCM_CommandAddress* Command address.
- kSEMC_NANDCM_CommandAddressHold* Command address hold.
- kSEMC_NANDCM_CommandAddressRead* Command address read.
- kSEMC_NANDCM_CommandAddressWrite* Command address write.
- kSEMC_NANDCM_CommandRead* Command read.
- kSEMC_NANDCM_CommandWrite* Command write.
- kSEMC_NANDCM_Read* Read.
- kSEMC_NANDCM_Write* Write.

39.6.30 enum semc_nand_address_option_t

Enumerator

- kSEMC_NandAddrOption_5byte_CA2RA3* CA0+CA1+RA0+RA1+RA2.
- kSEMC_NandAddrOption_4byte_CA2RA2* CA0+CA1+RA0+RA1.
- kSEMC_NandAddrOption_3byte_CA2RA1* CA0+CA1+RA0.
- kSEMC_NandAddrOption_4byte_CA1RA3* CA0+RA0+RA1+RA2.
- kSEMC_NandAddrOption_3byte_CA1RA2* CA0+RA0+RA1.
- kSEMC_NandAddrOption_2byte_CA1RA1* CA0+RA0.

39.6.31 enum semc_ipcmd_nor_dbi_t

Enumerator

- kSEMC_NORDBICM_Read* NOR read.

kSEMC_NORDBICM_Write NOR write.

39.6.32 enum semc_ipcmd_sram_t

Enumerator

kSEMC_SRAMCM_ArrayRead SRAM memory array read.
kSEMC_SRAMCM_ArrayWrite SRAM memory array write.
kSEMC_SRAMCM_RegRead SRAM memory register read.
kSEMC_SRAMCM_RegWrite SRAM memory register write.

39.6.33 enum semc_ipcmd_sdram_t

Enumerator

kSEMC_SDRAMCM_Read SDRAM memory read.
kSEMC_SDRAMCM_Write SDRAM memory write.
kSEMC_SDRAMCM_Modeset SDRAM MODE SET.
kSEMC_SDRAMCM_Active SDRAM active.
kSEMC_SDRAMCM_AutoRefresh SDRAM auto-refresh.
kSEMC_SDRAMCM_SelfRefresh SDRAM self-refresh.
kSEMC_SDRAMCM_Precharge SDRAM precharge.
kSEMC_SDRAMCM_Prechargeall SDRAM precharge all.

39.7 Function Documentation

39.7.1 void SEMC_GetDefaultConfig (semc_config_t * config)

The purpose of this API is to get the default SEMC configure structure for [SEMC_Init\(\)](#). User may use the initialized structure unchanged in [SEMC_Init\(\)](#), or modify some fields of the structure before calling [SEMC_Init\(\)](#). Example:

```
semc_config_t config;
SEMC_GetDefaultConfig(&config);
```

Parameters

<i>config</i>	The SEMC configuration structure pointer.
---------------	---

39.7.2 void SEMC_Init (SEMC_Type * *base*, semc_config_t * *configure*)

This function ungates the SEMC clock and initializes SEMC. This function must be called before calling any other SEMC driver functions.

Parameters

<i>base</i>	SEMC peripheral base address.
<i>configure</i>	The SEMC configuration structure pointer.

39.7.3 void SEMC_Deinit (SEMC_Type * *base*)

This function gates the SEMC clock. As a result, the SEMC module doesn't work after calling this function, for some IDE, calling this API may cause the next downloading operation failed. so, please call this API cautiously. Additional, users can using "#define FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL (1)" to disable the clock control operation in drivers.

Parameters

<i>base</i>	SEMC peripheral base address.
-------------	-------------------------------

39.7.4 status_t SEMC_ConfigureSDRAM (SEMC_Type * *base*, semc_sdram_cs_t *cs*, semc_sdram_config_t * *config*, uint32_t *clkSrc_Hz*)

Parameters

<i>base</i>	SEMC peripheral base address.
<i>cs</i>	The chip selection.
<i>config</i>	The sdram configuration.
<i>clkSrc_Hz</i>	The SEMC clock frequency.

39.7.5 status_t SEMC_ConfigureNAND (SEMC_Type * *base*, semc_nand_config_t * *config*, uint32_t *clkSrc_Hz*)

Parameters

<i>base</i>	SEMC peripheral base address.
<i>config</i>	The nand configuration.
<i>clkSrc_Hz</i>	The SEMC clock frequency.

39.7.6 `status_t SEMC_ConfigureNOR (SEMC_Type * base, semc_nor_config_t * config, uint32_t clkSrc_Hz)`

Parameters

<i>base</i>	SEMC peripheral base address.
<i>config</i>	The nor configuration.
<i>clkSrc_Hz</i>	The SEMC clock frequency.

39.7.7 `status_t SEMC_ConfigureSRAMWithChipSelection (SEMC_Type * base, semc_sram_cs_t cs, semc_sram_config_t * config, uint32_t clkSrc_Hz)`

Parameters

<i>base</i>	SEMC peripheral base address.
<i>cs</i>	The chip selection.
<i>config</i>	The sram configuration.
<i>clkSrc_Hz</i>	The SEMC clock frequency.

39.7.8 `status_t SEMC_ConfigureSRAM (SEMC_Type * base, semc_sram_config_t * config, uint32_t clkSrc_Hz)`

Deprecated Do not use this function. It has been superceded by [SEMC_ConfigureSRAMWithChipSelection](#).

Parameters

<i>base</i>	SEMC peripheral base address.
<i>config</i>	The sram configuration.
<i>clkSrc_Hz</i>	The SEMC clock frequency.

39.7.9 `status_t SEMC_ConfigureDBI (SEMC_Type * base, semc_dbi_config_t * config, uint32_t clkSrc_Hz)`

Parameters

<i>base</i>	SEMC peripheral base address.
<i>config</i>	The dbi configuration.
<i>clkSrc_Hz</i>	The SEMC clock frequency.

39.7.10 `static void SEMC_EnableInterrupts (SEMC_Type * base, uint32_t mask) [inline], [static]`

This function enables the SEMC interrupts according to the provided mask. The mask is a logical OR of enumeration members. See [semc_interrupt_enable_t](#). For example, to enable the IP command done and error interrupt, do the following.

```
* SEMC_EnableInterrupts(ENET, kSEMC_IPCmdDoneInterrupt |
* kSEMC_IPCmdErrInterrupt);
```

Parameters

<i>base</i>	SEMC peripheral base address.
<i>mask</i>	SEMC interrupts to enable. This is a logical OR of the enumeration :: semc_interrupt_enable_t .

39.7.11 `static void SEMC_DisableInterrupts (SEMC_Type * base, uint32_t mask) [inline], [static]`

This function disables the SEMC interrupts according to the provided mask. The mask is a logical OR of enumeration members. See [semc_interrupt_enable_t](#). For example, to disable the IP command done and error interrupt, do the following.

```
* SEMC_DisableInterrupts (ENET,
* kSEMC_IPCmdDoneInterrupt | kSEMC_IPCmdErrInterrupt);
```

Parameters

<i>base</i>	SEMC peripheral base address.
<i>mask</i>	SEMC interrupts to disable. This is a logical OR of the enumeration :: <code>semc_interrupt_enable_t</code> .

39.7.12 static bool SEMC_GetStatusFlag (SEMC_Type * *base*) [inline], [static]

This function gets the SEMC interrupts event status. User can use the a logical OR of enumeration member as a mask. See [semc_interrupt_enable_t](#).

Parameters

<i>base</i>	SEMC peripheral base address.
-------------	-------------------------------

Returns

status flag, use status flag in `semc_interrupt_enable_t` to get the related status.

39.7.13 static void SEMC_ClearStatusFlags (SEMC_Type * *base*, uint32_t *mask*) [inline], [static]

The following status register flags can be cleared SEMC interrupt status.

Parameters

<i>base</i>	SEMC base pointer
<i>mask</i>	The status flag mask, a logical OR of enumeration member semc_interrupt_enable_t .

39.7.14 static bool SEMC_IsInIdle (SEMC_Type * *base*) [inline], [static]

Parameters

<i>base</i>	SEMC peripheral base address.
-------------	-------------------------------

Returns

True SEMC is in idle, false is not in idle.

39.7.15 `status_t SEMC_SendIPCommand (SEMC_Type * base, semc_mem_type_t memType, uint32_t address, uint32_t command, uint32_t write, uint32_t * read)`

Parameters

<i>base</i>	SEMC peripheral base address.
<i>memType</i>	SEMC memory type. refer to "semc_mem_type_t"
<i>address</i>	SEMC device address.
<i>command</i>	SEMC IP command. For NAND device, we should use the SEMC_BuildNandIP-Command to get the right nand command. For NOR/DBI device, take refer to "semc_ipcmd_nor_dbi_t". For SRAM device, take refer to "semc_ipcmd_sram_t". For SDRAM device, take refer to "semc_ipcmd_sdram_t".
<i>write</i>	Data for write access.
<i>read</i>	Data pointer for read data out.

39.7.16 `static uint16_t SEMC_BuildNandIPCommand (uint8_t userCommand, semc_ipcmd_nand_addrmode_t addrMode, semc_ipcmd_nand_cmdmode_t cmdMode) [inline], [static]`

This function build SEMC NAND IP command. The command is build of user command code, SEMC address mode and SEMC command mode.

Parameters

<i>userCommand</i>	NAND device normal command.
--------------------	-----------------------------

<i>addrMode</i>	NAND address mode. Refer to "semc_ipcmd_nand_addrmode_t".
<i>cmdMode</i>	NAND command mode. Refer to "semc_ipcmd_nand_cmdmode_t".

39.7.17 static bool SEMC_IsNandReady (SEMC_Type * *base*) [inline], [static]

Parameters

<i>base</i>	SEMC peripheral base address.
-------------	-------------------------------

Returns

True NAND is ready, false NAND is not ready.

39.7.18 status_t SEMC_IPCommandNandWrite (SEMC_Type * *base*, uint32_t *address*, uint8_t * *data*, uint32_t *size_bytes*)

Parameters

<i>base</i>	SEMC peripheral base address.
<i>address</i>	SEMC NAND device address.
<i>data</i>	Data for write access.
<i>size_bytes</i>	Data length.

39.7.19 status_t SEMC_IPCommandNandRead (SEMC_Type * *base*, uint32_t *address*, uint8_t * *data*, uint32_t *size_bytes*)

Parameters

<i>base</i>	SEMC peripheral base address.
<i>address</i>	SEMC NAND device address.

<i>data</i>	Data pointer for data read out.
<i>size_bytes</i>	Data length.

39.7.20 `status_t SEMC_IPCommandNorWrite (SEMC_Type * base, uint32_t address, uint8_t * data, uint32_t size_bytes)`

Parameters

<i>base</i>	SEMC peripheral base address.
<i>address</i>	SEMC NOR device address.
<i>data</i>	Data for write access.
<i>size_bytes</i>	Data length.

39.7.21 `status_t SEMC_IPCommandNorRead (SEMC_Type * base, uint32_t address, uint8_t * data, uint32_t size_bytes)`

Parameters

<i>base</i>	SEMC peripheral base address.
<i>address</i>	SEMC NOR device address.
<i>data</i>	Data pointer for data read out.
<i>size_bytes</i>	Data length.

Chapter 40

SNVS: Secure Non-Volatile Storage

40.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Secure Non-Volatile Storage (SNVS) module. The SNVS module is designed to safely hold security-related data such as cryptographic key, time counter, monotonic counter, and general purpose security information. The SNVS includes a low power section, namely SNVS_LP, that is battery backed by the SVNS (or VBAT) power domain. This enables it to keep this data valid and continue to increment the time counter when the power goes down in the rest of the SoC. The always-powered-up part of the module is isolated from the rest of the logic to ensure that it does not get corrupted when the SoC is powered down. The SNVS is designed to comply with Digital Rights Management (DRM) and other security application rules and requirements. This trusted hardware provides features that allow the system software designer to ensure that the data kept by the device is certifiable. Specially, it incorporates a security monitor that checks for various security conditions. If a security violation is indicated then it invalidates access to its sensitive data, and the secret data, for instance, Zeroizable Secret Key, is zeroized. the SNVS can be also configured to bypass its security features and protection mechanism. In this case it can be used by systems that do not require security.

Modules

- [Secure Non-Volatile Storage High-Power](#)
- [Secure Non-Volatile Storage Low-Power](#)

40.2 Secure Non-Volatile Storage High-Power

40.2.1 Overview

The MCUXpresso SDK provides a Peripheral driver for the Secure Non-Volatile Storage High-Power(S-NVS-HP) module.

The SNVS_HP is in the chip's power-supply domain and thus receives the power along with the rest of the chip. The SNVS_HP provides an interface between the SNVS_LP and the rest of the system; there is no way to access the SNVS_LP registers except through the SNVS_HP. For access to the SNVS_LP registers, the SNVS_HP must be powered up. It uses a register access permission policy to determine whether the access to the particular registers is permitted.

Data Structures

- struct `snvs_hp_rtc_datetime_t`
Structure is used to hold the date and time. [More...](#)
- struct `snvs_hp_rtc_config_t`
SNVS config structure. [More...](#)

Macros

- #define `SNVS_MAKE_HP_SV_FLAG(x)` ($1U \ll (SNVS_HPSVSR_SV0_SHIFT + (x))$)
Macro to make security violation flag.

Enumerations

- enum `snvs_hp_interrupts_t` {
 `kSNVS_RTC_AlarmInterrupt` = `SNVS_HPCR_HPTA_EN_MASK`,
 `kSNVS_RTC_PeriodicInterrupt` = `SNVS_HPCR_PI_EN_MASK` }
List of SNVS interrupts.
- enum `snvs_hp_status_flags_t` {
 `kSNVS_RTC_AlarmInterruptFlag` = `SNVS_HPSR_HPTA_MASK`,
 `kSNVS_RTC_PeriodicInterruptFlag` = `SNVS_HPSR_PI_MASK`,
 `kSNVS_ZMK_ZeroFlag` = `(int)SNVS_HPSR_ZMK_ZERO_MASK`,
 `kSNVS_OTPMK_ZeroFlag` = `SNVS_HPSR_OTPMK_ZERO_MASK` }
List of SNVS flags.
- enum `snvs_hp_sv_status_flags_t` {

```

kSNVS_LP_ViolationFlag = SNVS_HPSVSR_SW_LPSV_MASK,
kSNVS_ZMK_EccFailFlag = SNVS_HPSVSR_ZMK_ECC_FAIL_MASK,
kSNVS_LP_SoftwareViolationFlag = SNVS_HPSVSR_SW_LPSV_MASK,
kSNVS_FatalSoftwareViolationFlag = SNVS_HPSVSR_SW_FSV_MASK,
kSNVS_SoftwareViolationFlag = SNVS_HPSVSR_SW_SV_MASK,
kSNVS_Violation0Flag = SNVS_HPSVSR_SV0_MASK,
kSNVS_Violation1Flag = SNVS_HPSVSR_SV1_MASK,
kSNVS_Violation2Flag = SNVS_HPSVSR_SV2_MASK,
kSNVS_Violation4Flag = SNVS_HPSVSR_SV4_MASK,
kSNVS_Violation5Flag = SNVS_HPSVSR_SV5_MASK }

```

List of SNVS security violation flags.

- enum `snvs_hp_ssm_state_t` {


```

kSNVS_SSMInit = 0x00,
kSNVS_SSMHardFail = 0x01,
kSNVS_SSMSoftFail = 0x03,
kSNVS_SSMInitInter = 0x08,
kSNVS_SSMCheck = 0x09,
kSNVS_SSMNonSecure = 0x0B,
kSNVS_SSMTrusted = 0x0D,
kSNVS_SSMSecure = 0x0F }

```

List of SNVS Security State Machine State.

Functions

- static void `SNVS_HP_EnableMasterKeySelection` (SNVS_Type *base, bool enable)

Enable or disable master key selection.
- static void `SNVS_HP_ProgramZeroizableMasterKey` (SNVS_Type *base)

Trigger to program Zeroizable Master Key.
- static void `SNVS_HP_ChangeSSMState` (SNVS_Type *base)

Trigger SSM State Transition.
- static void `SNVS_HP_SetSoftwareFatalSecurityViolation` (SNVS_Type *base)

Trigger Software Fatal Security Violation.
- static void `SNVS_HP_SetSoftwareSecurityViolation` (SNVS_Type *base)

Trigger Software Security Violation.
- static `snvs_hp_ssm_state_t` `SNVS_HP_GetSSMState` (SNVS_Type *base)

Get current SSM State.
- static void `SNVS_HP_ResetLP` (SNVS_Type *base)

Reset the SNVS LP section.
- static `uint32_t` `SNVS_HP_GetStatusFlags` (SNVS_Type *base)

Get the SNVS HP status flags.
- static void `SNVS_HP_ClearStatusFlags` (SNVS_Type *base, `uint32_t` mask)

Clear the SNVS HP status flags.
- static `uint32_t` `SNVS_HP_GetSecurityViolationStatusFlags` (SNVS_Type *base)

Get the SNVS HP security violation status flags.
- static void `SNVS_HP_ClearSecurityViolationStatusFlags` (SNVS_Type *base, `uint32_t` mask)

Clear the SNVS HP security violation status flags.

Driver version

- #define `FSL_SNVS_HP_DRIVER_VERSION` (`MAKE_VERSION(2, 3, 2)`)
Version 2.3.2.

Initialization and deinitialization

- void `SNVS_HP_Init` (`SNVS_Type *base`)
Initialize the SNVS.
- void `SNVS_HP_Deinit` (`SNVS_Type *base`)
Deinitialize the SNVS.
- void `SNVS_HP_RTC_Init` (`SNVS_Type *base`, const `snvs_hp_rtc_config_t *config`)
Ungates the SNVS clock and configures the peripheral for basic operation.
- void `SNVS_HP_RTC_Deinit` (`SNVS_Type *base`)
Stops the RTC and SRTC timers.
- void `SNVS_HP_RTC_GetDefaultConfig` (`snvs_hp_rtc_config_t *config`)
Fills in the SNVS config struct with the default settings.

Non secure RTC current Time & Alarm

- `status_t SNVS_HP_RTC_SetDatetime` (`SNVS_Type *base`, const `snvs_hp_rtc_datetime_t *datetime`)
Sets the SNVS RTC date and time according to the given time structure.
- void `SNVS_HP_RTC_GetDatetime` (`SNVS_Type *base`, `snvs_hp_rtc_datetime_t *datetime`)
Gets the SNVS RTC time and stores it in the given time structure.
- `status_t SNVS_HP_RTC_SetAlarm` (`SNVS_Type *base`, const `snvs_hp_rtc_datetime_t *alarm-Time`)
Sets the SNVS RTC alarm time.
- void `SNVS_HP_RTC_GetAlarm` (`SNVS_Type *base`, `snvs_hp_rtc_datetime_t *datetime`)
Returns the SNVS RTC alarm time.
- void `SNVS_HP_RTC_TimeSynchronize` (`SNVS_Type *base`)
The function synchronizes RTC counter value with SRTC.

Interrupt Interface

- static void `SNVS_HP_RTC_EnableInterrupts` (`SNVS_Type *base`, `uint32_t mask`)
Enables the selected SNVS interrupts.
- static void `SNVS_HP_RTC_DisableInterrupts` (`SNVS_Type *base`, `uint32_t mask`)
Disables the selected SNVS interrupts.
- `uint32_t SNVS_HP_RTC_GetEnabledInterrupts` (`SNVS_Type *base`)
Gets the enabled SNVS interrupts.

Status Interface

- `uint32_t SNVS_HP_RTC_GetStatusFlags` (`SNVS_Type *base`)

Gets the SNVS status flags.

- static void [SNVS_HP_RTC_ClearStatusFlags](#) (SNVS_Type *base, uint32_t mask)
Clears the SNVS status flags.

Timer Start and Stop

- static void [SNVS_HP_RTC_StartTimer](#) (SNVS_Type *base)
Starts the SNVS RTC time counter.
- static void [SNVS_HP_RTC_StopTimer](#) (SNVS_Type *base)
Stops the SNVS RTC time counter.

High Assurance Counter (HAC)

- static void [SNVS_HP_EnableHighAssuranceCounter](#) (SNVS_Type *base, bool enable)
Enable or disable the High Assurance Counter (HAC)
- static void [SNVS_HP_StartHighAssuranceCounter](#) (SNVS_Type *base, bool start)
Start or stop the High Assurance Counter (HAC)
- static void [SNVS_HP_SetHighAssuranceCounterInitialValue](#) (SNVS_Type *base, uint32_t value)
Set the High Assurance Counter (HAC) initialize value.
- static void [SNVS_HP_LoadHighAssuranceCounter](#) (SNVS_Type *base)
Load the High Assurance Counter (HAC)
- static uint32_t [SNVS_HP_GetHighAssuranceCounter](#) (SNVS_Type *base)
Get the current High Assurance Counter (HAC) value.
- static void [SNVS_HP_ClearHighAssuranceCounter](#) (SNVS_Type *base)
Clear the High Assurance Counter (HAC)
- static void [SNVS_HP_LockHighAssuranceCounter](#) (SNVS_Type *base)
Lock the High Assurance Counter (HAC)

40.2.2 Data Structure Documentation

40.2.2.1 struct snvs_hp_rtc_datetime_t

Data Fields

- 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.

Field Documentation

- (1) `uint16_t snvs_hp_rtc_datetime_t::year`
- (2) `uint8_t snvs_hp_rtc_datetime_t::month`
- (3) `uint8_t snvs_hp_rtc_datetime_t::day`
- (4) `uint8_t snvs_hp_rtc_datetime_t::hour`
- (5) `uint8_t snvs_hp_rtc_datetime_t::minute`
- (6) `uint8_t snvs_hp_rtc_datetime_t::second`

40.2.2.2 struct snvs_hp_rtc_config_t

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

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

Data Fields

- bool `rtcCalEnable`
true: RTC calibration mechanism is enabled; false: No calibration is used
- `uint32_t rtcCalValue`
Defines signed calibration value for nonsecure RTC; This is a 5-bit 2's complement value, range from -16 to +15.
- `uint32_t periodicInterruptFreq`
Defines frequency of the periodic interrupt; Range from 0 to 15.

40.2.3 Macro Definition Documentation

40.2.3.1 #define SNVS_MAKE_HP_SV_FLAG(x) (1U << (SNVS_HPSVSR_SV0_SHIFT + (x)))

Macro help to make security violation flag `kSNVS_Violation0Flag` to `kSNVS_Violation5Flag`, For example, `SNVS_MAKE_HP_SV_FLAG(0)` is `kSNVS_Violation0Flag`.

40.2.4 Enumeration Type Documentation

40.2.4.1 enum snvs_hp_interrupts_t

Enumerator

- kSNVS_RTC_AlarmInterrupt* RTC time alarm.
- kSNVS_RTC_PeriodicInterrupt* RTC periodic interrupt.

40.2.4.2 enum snvs_hp_status_flags_t

Enumerator

- kSNVS_RTC_AlarmInterruptFlag* RTC time alarm flag.
- kSNVS_RTC_PeriodicInterruptFlag* RTC periodic interrupt flag.
- kSNVS_ZMK_ZeroFlag* The ZMK is zero.
- kSNVS_OTPMK_ZeroFlag* The OTPMK is zero.

40.2.4.3 enum snvs_hp_sv_status_flags_t

Enumerator

- kSNVS_LP_ViolationFlag* Low Power section Security Violation.
- kSNVS_ZMK_EccFailFlag* Zeroizable Master Key Error Correcting Code Check Failure.
- kSNVS_LP_SoftwareViolationFlag* LP Software Security Violation.
- kSNVS_FatalSoftwareViolationFlag* Software Fatal Security Violation.
- kSNVS_SoftwareViolationFlag* Software Security Violation.
- kSNVS_Violation0Flag* Security Violation 0.
- kSNVS_Violation1Flag* Security Violation 1.
- kSNVS_Violation2Flag* Security Violation 2.
- kSNVS_Violation4Flag* Security Violation 4.
- kSNVS_Violation5Flag* Security Violation 5.

40.2.4.4 enum snvs_hp_ssm_state_t

Enumerator

- kSNVS_SSMInit* Init.
- kSNVS_SSMHardFail* Hard Fail.
- kSNVS_SSMSoftFail* Soft Fail.
- kSNVS_SSMInitInter* Init Intermediate (transition state between Init and Check)
- kSNVS_SSMCheck* Check.
- kSNVS_SSMNonSecure* Non-Secure.
- kSNVS_SSMTrusted* Trusted.
- kSNVS_SSMSecure* Secure.

40.2.5 Function Documentation

40.2.5.1 void SNVS_HP_Init (SNVS_Type * *base*)

Note

This API should be called at the beginning of the application using the SNVS driver.

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.2 void SNVS_HP_Deinit (SNVS_Type * *base*)

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.3 void SNVS_HP_RTC_Init (SNVS_Type * *base*, const snvs_hp_rtc_config_t * *config*)

Note

This API should be called at the beginning of the application using the SNVS driver.

Parameters

<i>base</i>	SNVS peripheral base address
<i>config</i>	Pointer to the user's SNVS configuration structure.

40.2.5.4 void SNVS_HP_RTC_Deinit (SNVS_Type * *base*)

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.5 void SNVS_HP_RTC_GetDefaultConfig (snvs_hp_rtc_config_t * *config*)

The default values are as follows.


```

*   config->rtccalenable = false;
*   config->rtccalvalue = 0U;
*   config->PIFreq = 0U;
*

```

Parameters

<i>config</i>	Pointer to the user's SNVS configuration structure.
---------------	---

40.2.5.6 `status_t SNVS_HP_RTC_SetDatetime (SNVS_Type * base, const snvs_hp_rtc_datetime_t * datetime)`

Parameters

<i>base</i>	SNVS peripheral base address
<i>datetime</i>	Pointer to the structure where the date and time details are stored.

Returns

kStatus_Success: Success in setting the time and starting the SNVS RTC
kStatus_InvalidArgument: Error because the datetime format is incorrect

40.2.5.7 `void SNVS_HP_RTC_GetDatetime (SNVS_Type * base, snvs_hp_rtc_datetime_t * datetime)`

Parameters

<i>base</i>	SNVS peripheral base address
<i>datetime</i>	Pointer to the structure where the date and time details are stored.

40.2.5.8 `status_t SNVS_HP_RTC_SetAlarm (SNVS_Type * base, const snvs_hp_rtc_datetime_t * alarmTime)`

The function sets the RTC alarm. It also checks whether the specified alarm time is greater than the present time. If not, the function does not set the alarm and returns an error.

Parameters

<i>base</i>	SNVS peripheral base address
<i>alarmTime</i>	Pointer to the structure where the alarm time is stored.

Returns

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

40.2.5.9 void SNVS_HP_RTC_GetAlarm (SNVS_Type * *base*, snvs_hp_rtc_datetime_t * *datetime*)

Parameters

<i>base</i>	SNVS peripheral base address
<i>datetime</i>	Pointer to the structure where the alarm date and time details are stored.

40.2.5.10 void SNVS_HP_RTC_TimeSynchronize (SNVS_Type * *base*)

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.11 static void SNVS_HP_RTC_EnableInterrupts (SNVS_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

<i>base</i>	SNVS peripheral base address
<i>mask</i>	The interrupts to enable. This is a logical OR of members of the enumeration :: <code>_snvs_hp_interrupts_t</code>

40.2.5.12 static void SNVS_HP_RTC_DisableInterrupts (SNVS_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

<i>base</i>	SNVS peripheral base address
<i>mask</i>	The interrupts to disable. This is a logical OR of members of the enumeration :: <code>_snvs_hp_interrupts_t</code>

40.2.5.13 `uint32_t SNVS_HP_RTC_GetEnabledInterrupts (SNVS_Type * base)`

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

Returns

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

40.2.5.14 `uint32_t SNVS_HP_RTC_GetStatusFlags (SNVS_Type * base)`

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

Returns

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

40.2.5.15 `static void SNVS_HP_RTC_ClearStatusFlags (SNVS_Type * base, uint32_t mask) [inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
<i>mask</i>	The status flags to clear. This is a logical OR of members of the enumeration :: <code>_snvs_hp_status_flags_t</code>

40.2.5.16 `static void SNVS_HP_RTC_StartTimer (SNVS_Type * base) [inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.17 `static void SNVS_HP_RTC_StopTimer (SNVS_Type * base) [inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.18 `static void SNVS_HP_EnableMasterKeySelection (SNVS_Type * base, bool enable) [inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
<i>enable</i>	Pass true to enable, false to disable.

40.2.5.19 `static void SNVS_HP_ProgramZeroizableMasterKey (SNVS_Type * base) [inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.20 `static void SNVS_HP_ChangeSSMState (SNVS_Type * base) [inline], [static]`

Trigger state transition of the system security monitor (SSM). It results only the following transitions of the SSM:

- Check State -> Non-Secure (when Non-Secure Boot and not in Fab Configuration)
- Check State -> Trusted (when Secure Boot or in Fab Configuration)
- Trusted State -> Secure
- Secure State -> Trusted
- Soft Fail -> Non-Secure

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.21 static void SNVS_HP_SetSoftwareFatalSecurityViolation (SNVS_Type * *base*)
[inline], [static]

The result SSM state transition is:

- Check State -> Soft Fail
- Non-Secure State -> Soft Fail
- Trusted State -> Soft Fail
- Secure State -> Soft Fail

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.22 static void SNVS_HP_SetSoftwareSecurityViolation (SNVS_Type * *base*)
[inline], [static]

The result SSM state transition is:

- Check -> Non-Secure
- Trusted -> Soft Fail
- Secure -> Soft Fail

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.23 static snvs_hp_ssm_state_t SNVS_HP_GetSSMState (SNVS_Type * *base*)
[inline], [static]

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

Returns

Current SSM state

40.2.5.24 `static void SNVS_HP_ResetLP (SNVS_Type * base) [inline], [static]`

Reset the LP section except SRTC and Time alarm.

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.25 `static void SNVS_HP_EnableHighAssuranceCounter (SNVS_Type * base, bool enable) [inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
<i>enable</i>	Pass true to enable, false to disable.

40.2.5.26 `static void SNVS_HP_StartHighAssuranceCounter (SNVS_Type * base, bool start) [inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
<i>start</i>	Pass true to start, false to stop.

40.2.5.27 `static void SNVS_HP_SetHighAssuranceCounterInitialValue (SNVS_Type * base, uint32_t value) [inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
<i>value</i>	The initial value to set.

40.2.5.28 `static void SNVS_HP_LoadHighAssuranceCounter (SNVS_Type * base) [inline], [static]`

This function loads the HAC initialize value to counter register.

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.29 `static uint32_t SNVS_HP_GetHighAssuranceCounter (SNVS_Type * base)
[inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

Returns

HAC current value.

40.2.5.30 `static void SNVS_HP_ClearHighAssuranceCounter (SNVS_Type * base)
[inline], [static]`

This function can be called in a functional or soft fail state. When the HAC is enabled:

- If the HAC is cleared in the soft fail state, the SSM transitions to the hard fail state immediately;
- If the HAC is cleared in functional state, the SSM will transition to hard fail immediately after transitioning to soft fail.

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.31 `static void SNVS_HP_LockHighAssuranceCounter (SNVS_Type * base)
[inline], [static]`

Once locked, the HAC initialize value could not be changed, the HAC enable status could not be changed. This could only be unlocked by system reset.

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.2.5.32 `static uint32_t SNVS_HP_GetStatusFlags (SNVS_Type * base) [inline],
[static]`

The flags are returned as the OR'ed value of the enumeration :: `_snvs_hp_status_flags_t`.

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

Returns

The OR'ed value of status flags.

40.2.5.33 **static void SNVS_HP_ClearStatusFlags (SNVS_Type * *base*, uint32_t *mask*) [inline], [static]**

The flags to clear are passed in as the OR'ed value of the enumeration :: `_snvs_hp_status_flags_t`. Only these flags could be cleared using this API.

- [kSNVS_RTC_PeriodicInterruptFlag](#)
- [kSNVS_RTC_AlarmInterruptFlag](#)

Parameters

<i>base</i>	SNVS peripheral base address
<i>mask</i>	OR'ed value of the flags to clear.

40.2.5.34 **static uint32_t SNVS_HP_GetSecurityViolationStatusFlags (SNVS_Type * *base*) [inline], [static]**

The flags are returned as the OR'ed value of the enumeration :: `_snvs_hp_sv_status_flags_t`.

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

Returns

The OR'ed value of security violation status flags.

40.2.5.35 **static void SNVS_HP_ClearSecurityViolationStatusFlags (SNVS_Type * *base*, uint32_t *mask*) [inline], [static]**

The flags to clear are passed in as the OR'ed value of the enumeration :: `_snvs_hp_sv_status_flags_t`. Only these flags could be cleared using this API.

- [kSNVS_ZMK_EccFailFlag](#)
- [kSNVS_Violation0Flag](#)

- [kSNVS_Violation1Flag](#)
- [kSNVS_Violation2Flag](#)
- [kSNVS_Violation3Flag](#)
- [kSNVS_Violation4Flag](#)
- [kSNVS_Violation5Flag](#)

Parameters

<i>base</i>	SNVS peripheral base address
<i>mask</i>	OR'ed value of the flags to clear.

40.3 Secure Non-Volatile Storage Low-Power

40.3.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Secure Non-Volatile Storage Low-Power (SNVS-LP) module.

The SNVS_LP is a data storage subsystem. Its purpose is to store and protect system data, regardless of the main system power state. The SNVS_LP is in the always-powered-up domain, which is a separate power domain with its own power supply.

Data Structures

- struct [snvs_lp_passive_tamper_t](#)
Structure is used to configure SNVS LP passive tamper pins. [More...](#)
- struct [snvs_lp_srtc_datetime_t](#)
Structure is used to hold the date and time. [More...](#)
- struct [snvs_lp_srtc_config_t](#)
SNVS_LP config structure. [More...](#)

Macros

- #define [SNVS_ZMK_REG_COUNT](#) 8U /* 8 Zeroizable Master Key registers. */
Define of SNVS_LP Zeroizable Master Key registers.
- #define [SNVS_LP_MAX_TAMPER](#) kSNVS_ExternalTamper1
Define of SNVS_LP Max possible tamper.

Enumerations

- enum [snvs_lp_srtc_interrupts_t](#) { [kSNVS_SRTC_AlarmInterrupt](#) = SNVS_LPCR_LPTA_EN_MASK }
- enum [snvs_lp_srtc_status_flags_t](#) { [kSNVS_SRTC_AlarmInterruptFlag](#) = SNVS_LPSR_LPTA_MASK }
- enum [snvs_lp_external_tamper_status_t](#)
List of SNVS_LP interrupts.
- enum [snvs_lp_external_tamper_polarity_t](#)
List of SNVS_LP flags.
- enum [snvs_lp_zmk_program_mode_t](#) { [kSNVS_ZMKSoftwareProgram](#), [kSNVS_ZMKHardwareProgram](#) }
SNVS_LP external tamper polarity.
- enum [snvs_lp_master_key_mode_t](#) { [kSNVS_OTPMK](#) = 0, [kSNVS_ZMK](#) = 2, }
SNVS_LP Zeroizable Master Key programming mode.

```
kSNVS_CMK = 3 }
SNVS_LP Master Key mode.
```

Functions

- void [SNVS_LP_SRTC_Init](#) (SNVS_Type *base, const [snvs_lp_srtc_config_t](#) *config)
Ungates the SNVS clock and configures the peripheral for basic operation.
- void [SNVS_LP_SRTC_Deinit](#) (SNVS_Type *base)
Stops the SRTC timer.
- void [SNVS_LP_SRTC_GetDefaultConfig](#) ([snvs_lp_srtc_config_t](#) *config)
Fills in the SNVS_LP config struct with the default settings.

Driver version

- #define [FSL_SNVS_LP_DRIVER_VERSION](#) ([MAKE_VERSION](#)(2, 4, 4))
Version 2.4.4.

Initialization and deinitialization

- void [SNVS_LP_Init](#) (SNVS_Type *base)
Ungates the SNVS clock and configures the peripheral for basic operation.
- void [SNVS_LP_Deinit](#) (SNVS_Type *base)
Deinit the SNVS LP section.

Secure RTC (SRTC) current Time & Alarm

- [status_t](#) [SNVS_LP_SRTC_SetDatetime](#) (SNVS_Type *base, const [snvs_lp_srtc_datetime_t](#) *datetime)
Sets the SNVS SRTC date and time according to the given time structure.
- void [SNVS_LP_SRTC_GetDatetime](#) (SNVS_Type *base, [snvs_lp_srtc_datetime_t](#) *datetime)
Gets the SNVS SRTC time and stores it in the given time structure.
- [status_t](#) [SNVS_LP_SRTC_SetAlarm](#) (SNVS_Type *base, const [snvs_lp_srtc_datetime_t](#) *alarm-Time)
Sets the SNVS SRTC alarm time.
- void [SNVS_LP_SRTC_GetAlarm](#) (SNVS_Type *base, [snvs_lp_srtc_datetime_t](#) *datetime)
Returns the SNVS SRTC alarm time.

Interrupt Interface

- static void [SNVS_LP_SRTC_EnableInterrupts](#) (SNVS_Type *base, uint32_t mask)
Enables the selected SNVS interrupts.
- static void [SNVS_LP_SRTC_DisableInterrupts](#) (SNVS_Type *base, uint32_t mask)
Disables the selected SNVS interrupts.
- uint32_t [SNVS_LP_SRTC_GetEnabledInterrupts](#) (SNVS_Type *base)

Gets the enabled SNVS interrupts.

Status Interface

- uint32_t [SNVS_LP_SRTC_GetStatusFlags](#) (SNVS_Type *base)
Gets the SNVS status flags.
- static void [SNVS_LP_SRTC_ClearStatusFlags](#) (SNVS_Type *base, uint32_t mask)
Clears the SNVS status flags.

Timer Start and Stop

- static void [SNVS_LP_SRTC_StartTimer](#) (SNVS_Type *base)
Starts the SNVS SRTC time counter.
- static void [SNVS_LP_SRTC_StopTimer](#) (SNVS_Type *base)
Stops the SNVS SRTC time counter.

External tampering

- void [SNVS_LP_PassiveTamperPin_GetDefaultConfig](#) (snvs_lp_passive_tamper_t *config)
Fills in the SNVS tamper pin config struct with the default settings.

Monotonic Counter (MC)

- static void [SNVS_LP_EnableMonotonicCounter](#) (SNVS_Type *base, bool enable)
Enable or disable the Monotonic Counter.
- uint64_t [SNVS_LP_GetMonotonicCounter](#) (SNVS_Type *base)
Get the current Monotonic Counter.
- static void [SNVS_LP_IncreaseMonotonicCounter](#) (SNVS_Type *base)
Increase the Monotonic Counter.

Zeroizable Master Key (ZMK)

- void [SNVS_LP_WriteZeroizableMasterKey](#) (SNVS_Type *base, uint32_t ZMKey[[SNVS_ZMK_REG_COUNT](#)])
Write Zeroizable Master Key (ZMK) to the SNVS registers.
- static void [SNVS_LP_SetZeroizableMasterKeyValid](#) (SNVS_Type *base, bool valid)
Set Zeroizable Master Key valid.
- static bool [SNVS_LP_GetZeroizableMasterKeyValid](#) (SNVS_Type *base)
Get Zeroizable Master Key valid status.
- static void [SNVS_LP_SetZeroizableMasterKeyProgramMode](#) (SNVS_Type *base, [snvs_lp_zmk_program_mode_t](#) mode)
Set Zeroizable Master Key programming mode.
- static void [SNVS_LP_EnableZeroizableMasterKeyECC](#) (SNVS_Type *base, bool enable)
Enable or disable Zeroizable Master Key ECC.

- static void `SNVS_LP_SetMasterKeyMode` (SNVS_Type *base, `snvs_lp_master_key_mode_t` mode)
Set SNVS Master Key mode.

40.3.2 Data Structure Documentation

40.3.2.1 struct `snvs_lp_passive_tamper_t`

40.3.2.2 struct `snvs_lp_srtc_datetime_t`

Data Fields

- `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.

Field Documentation

- (1) `uint16_t snvs_lp_srtc_datetime_t::year`
- (2) `uint8_t snvs_lp_srtc_datetime_t::month`
- (3) `uint8_t snvs_lp_srtc_datetime_t::day`
- (4) `uint8_t snvs_lp_srtc_datetime_t::hour`
- (5) `uint8_t snvs_lp_srtc_datetime_t::minute`
- (6) `uint8_t snvs_lp_srtc_datetime_t::second`

40.3.2.3 struct `snvs_lp_srtc_config_t`

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

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

Data Fields

- bool `srtcCalEnable`
true: SRTC calibration mechanism is enabled; false: No calibration is used
- uint32_t `srtcCalValue`
Defines signed calibration value for SRTC; This is a 5-bit 2's complement value, range from -16 to +15.

40.3.3 Enumeration Type Documentation

40.3.3.1 enum `snvs_lp_srtc_interrupts_t`

Enumerator

kSNVS_SRTC_AlarmInterrupt SRTC time alarm.

40.3.3.2 enum `snvs_lp_srtc_status_flags_t`

Enumerator

kSNVS_SRTC_AlarmInterruptFlag SRTC time alarm flag.

40.3.3.3 enum `snvs_lp_zmk_program_mode_t`

Enumerator

kSNVS_ZMKSoftwareProgram Software programming mode.
kSNVS_ZMKHardwareProgram Hardware programming mode.

40.3.3.4 enum `snvs_lp_master_key_mode_t`

Enumerator

kSNVS_OTPMK One Time Programmable Master Key.
kSNVS_ZMK Zeroizable Master Key.
kSNVS_CMK Combined Master Key, it is XOR of OPTMK and ZMK.

40.3.4 Function Documentation

40.3.4.1 void `SNVS_LP_Init (SNVS_Type * base)`

Note

This API should be called at the beginning of the application using the SNVS driver.

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.3.4.2 void SNVS_LP_Deinit (SNVS_Type * *base*)

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.3.4.3 void SNVS_LP_SRTC_Init (SNVS_Type * *base*, const snvs_lp_srtc_config_t * *config*)

Note

This API should be called at the beginning of the application using the SNVS driver.

Parameters

<i>base</i>	SNVS peripheral base address
<i>config</i>	Pointer to the user's SNVS configuration structure.

40.3.4.4 void SNVS_LP_SRTC_Deinit (SNVS_Type * *base*)

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.3.4.5 void SNVS_LP_SRTC_GetDefaultConfig (snvs_lp_srtc_config_t * *config*)

The default values are as follows.

```
*   config->srtccalenable = false;
*   config->srtccalvalue = 0U;
*
```


Parameters

<i>config</i>	Pointer to the user's SNVS configuration structure.
---------------	---

40.3.4.6 **status_t SNVS_LP_SRTC_SetDatetime (SNVS_Type * *base*, const snvs_lp_srtc_datetime_t * *datetime*)**

Parameters

<i>base</i>	SNVS peripheral base address
<i>datetime</i>	Pointer to the structure where the date and time details are stored.

Returns

kStatus_Success: Success in setting the time and starting the SNVS SRTC
 kStatus_InvalidArgument: Error because the datetime format is incorrect

40.3.4.7 **void SNVS_LP_SRTC_GetDatetime (SNVS_Type * *base*, snvs_lp_srtc_datetime_t * *datetime*)**

Parameters

<i>base</i>	SNVS peripheral base address
<i>datetime</i>	Pointer to the structure where the date and time details are stored.

40.3.4.8 **status_t SNVS_LP_SRTC_SetAlarm (SNVS_Type * *base*, const snvs_lp_srtc_datetime_t * *alarmTime*)**

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

Parameters

<i>base</i>	SNVS peripheral base address
<i>alarmTime</i>	Pointer to the structure where the alarm time is stored.

Returns

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

40.3.4.9 void SNVS_LP_SRTC_GetAlarm (SNVS_Type * *base*, snvs_lp_srtc_datetime_t * *datetime*)

Parameters

<i>base</i>	SNVS peripheral base address
<i>datetime</i>	Pointer to the structure where the alarm date and time details are stored.

40.3.4.10 static void SNVS_LP_SRTC_EnableInterrupts (SNVS_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

<i>base</i>	SNVS peripheral base address
<i>mask</i>	The interrupts to enable. This is a logical OR of members of the enumeration :: <code>_snvs_lp_srtc_interrupts</code>

40.3.4.11 static void SNVS_LP_SRTC_DisableInterrupts (SNVS_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

<i>base</i>	SNVS peripheral base address
<i>mask</i>	The interrupts to enable. This is a logical OR of members of the enumeration :: <code>_snvs_lp_srtc_interrupts</code>

40.3.4.12 uint32_t SNVS_LP_SRTC_GetEnabledInterrupts (SNVS_Type * *base*)

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

Returns

The enabled interrupts. This is the logical OR of members of the enumeration :: `_snvs_lp_srtc_`-`interrupts`

40.3.4.13 `uint32_t SNVS_LP_SRTC_GetStatusFlags (SNVS_Type * base)`

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

Returns

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

40.3.4.14 `static void SNVS_LP_SRTC_ClearStatusFlags (SNVS_Type * base, uint32_t mask) [inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
<i>mask</i>	The status flags to clear. This is a logical OR of members of the enumeration :: <code>_snvs_lp_srtc_status_flags</code>

40.3.4.15 `static void SNVS_LP_SRTC_StartTimer (SNVS_Type * base) [inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.3.4.16 `static void SNVS_LP_SRTC_StopTimer (SNVS_Type * base) [inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.3.4.17 void SNVS_LP_PassiveTamperPin_GetDefaultConfig (snvs_lp_passive_tamper_t * *config*)

The default values are as follows. code config->polarity = 0U; config->filterenable = 0U; if available on SoC config->filter = 0U; if available on SoC endcode

Parameters

<i>config</i>	Pointer to the user's SNVS configuration structure.
---------------	---

40.3.4.18 static void SNVS_LP_EnableMonotonicCounter (SNVS_Type * *base*, bool *enable*) [inline], [static]

Parameters

<i>base</i>	SNVS peripheral base address
<i>enable</i>	Pass true to enable, false to disable.

40.3.4.19 uint64_t SNVS_LP_GetMonotonicCounter (SNVS_Type * *base*)

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

Returns

Current Monotonic Counter value.

40.3.4.20 static void SNVS_LP_IncreaseMonotonicCounter (SNVS_Type * *base*) [inline], [static]

Increase the Monotonic Counter by 1.

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

40.3.4.21 void SNVS_LP_WriteZeroizableMasterKey (SNVS_Type * *base*, uint32_t *ZMKey*[SNVS_ZMK_REG_COUNT])

Parameters

<i>base</i>	SNVS peripheral base address
<i>ZMKey</i>	The ZMK write to the SNVS register.

40.3.4.22 static void SNVS_LP_SetZeroizableMasterKeyValid (SNVS_Type * *base*, bool *valid*) [inline], [static]

This API could only be called when using software programming mode. After writing ZMK using [SNVS_LP_WriteZeroizableMasterKey](#), call this API to make the ZMK valid.

Parameters

<i>base</i>	SNVS peripheral base address
<i>valid</i>	Pass true to set valid, false to set invalid.

40.3.4.23 static bool SNVS_LP_GetZeroizableMasterKeyValid (SNVS_Type * *base*) [inline], [static]

In hardware programming mode, call this API to check whether the ZMK is valid.

Parameters

<i>base</i>	SNVS peripheral base address
-------------	------------------------------

Returns

true if valid, false if invalid.

40.3.4.24 static void SNVS_LP_SetZeroizableMasterKeyProgramMode (SNVS_Type * *base*, snvs_lp_zmk_program_mode_t *mode*) [inline], [static]

Parameters

<i>base</i>	SNVS peripheral base address
<i>mode</i>	ZMK programming mode.

40.3.4.25 `static void SNVS_LP_EnableZeroizableMasterKeyECC (SNVS_Type * base,
bool enable) [inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
<i>enable</i>	Pass true to enable, false to disable.

40.3.4.26 `static void SNVS_LP_SetMasterKeyMode (SNVS_Type * base,
snvs_lp_master_key_mode_t mode) [inline], [static]`

Parameters

<i>base</i>	SNVS peripheral base address
<i>mode</i>	Master Key mode.

Note

When [kSNVS_ZMK](#) or [kSNVS_CMK](#) used, the SNVS_HP must be configured to enable the master key selection.

Chapter 41

SPDIF: Sony/Philips Digital Interface

41.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Sony/Philips Digital Interface (SPDIF) module of MCUXpresso SDK devices.

SPDIF driver includes functional APIs and transactional APIs.

Functional APIs target low-level APIs. Functional APIs can be used for SPDIF initialization/configuration/operation for optimization/customization purpose. Using the functional API requires the knowledge of the SPDIF peripheral and how to organize functional APIs to meet the application requirements. All functional API use the peripheral base address as the first parameter. SPDIF functional operation groups provide the functional API set.

Transactional APIs target high-level APIs. Transactional APIs can be used to enable the peripheral and in the application if the code size and performance of transactional APIs satisfy the requirements. If the code size and performance are a critical requirement, see the transactional API implementation and write a custom code. All transactional APIs use the `spdif_handle_t` as the first parameter. Initialize the handle by calling the [SPDIF_TransferTxCreateHandle\(\)](#) or [SPDIF_TransferRxCreateHandle\(\)](#) API.

Transactional APIs support asynchronous transfer. This means that the functions [SPDIF_TransferSendNonBlocking\(\)](#) and [SPDIF_TransferReceiveNonBlocking\(\)](#) set up the interrupt for data transfer. When the transfer completes, the upper layer is notified through a callback function with the `kStatus_SPDIF_TxIdle` and `kStatus_SPDIF_RxIdle` status.

41.2 Typical use case

41.2.1 SPDIF Send/receive using an interrupt method

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/spdif`

41.2.2 SPDIF Send/receive using a DMA method

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/spdif`

Modules

- [SPDIF eDMA Driver](#)

Data Structures

- struct [spdif_config_t](#)

- *SPDIF user configuration structure. [More...](#)*
- struct [spdif_transfer_t](#)
SPDIF transfer structure. [More...](#)
- struct [spdif_handle_t](#)
SPDIF handle structure. [More...](#)

Macros

- #define [SPDIF_XFER_QUEUE_SIZE](#) (4U)
SPDIF transfer queue size, user can refine it according to use case.

Typedefs

- typedef void(* [spdif_transfer_callback_t](#))(SPDIF_Type *base, spdif_handle_t *handle, [status_t](#) status, void *userData)
SPDIF transfer callback prototype.

Enumerations

- enum {
[kStatus_SPDIF_RxDPLLLocked](#) = MAKE_STATUS(kStatusGroup_SPDIF, 0),
[kStatus_SPDIF_TxFIFOError](#) = MAKE_STATUS(kStatusGroup_SPDIF, 1),
[kStatus_SPDIF_TxFIFOResync](#) = MAKE_STATUS(kStatusGroup_SPDIF, 2),
[kStatus_SPDIF_RxCnew](#) = MAKE_STATUS(kStatusGroup_SPDIF, 3),
[kStatus_SPDIF_ValidatyNoGood](#) = MAKE_STATUS(kStatusGroup_SPDIF, 4),
[kStatus_SPDIF_RxIllegalSymbol](#) = MAKE_STATUS(kStatusGroup_SPDIF, 5),
[kStatus_SPDIF_RxParityBitError](#) = MAKE_STATUS(kStatusGroup_SPDIF, 6),
[kStatus_SPDIF_UChannelOverrun](#) = MAKE_STATUS(kStatusGroup_SPDIF, 7),
[kStatus_SPDIF_QChannelOverrun](#) = MAKE_STATUS(kStatusGroup_SPDIF, 8),
[kStatus_SPDIF_UQChannelSync](#) = MAKE_STATUS(kStatusGroup_SPDIF, 9),
[kStatus_SPDIF_UQChannelFrameError](#) = MAKE_STATUS(kStatusGroup_SPDIF, 10),
[kStatus_SPDIF_RxFIFOError](#) = MAKE_STATUS(kStatusGroup_SPDIF, 11),
[kStatus_SPDIF_RxFIFOResync](#) = MAKE_STATUS(kStatusGroup_SPDIF, 12),
[kStatus_SPDIF_LockLoss](#) = MAKE_STATUS(kStatusGroup_SPDIF, 13),
[kStatus_SPDIF_TxIdle](#) = MAKE_STATUS(kStatusGroup_SPDIF, 14),
[kStatus_SPDIF_RxIdle](#) = MAKE_STATUS(kStatusGroup_SPDIF, 15),
[kStatus_SPDIF_QueueFull](#) = MAKE_STATUS(kStatusGroup_SPDIF, 16) }
SPDIF return status.
- enum [spdif_rxfull_select_t](#) {
[kSPDIF_RxFull1Sample](#) = 0x0u,
[kSPDIF_RxFull4Samples](#),
[kSPDIF_RxFull8Samples](#),
[kSPDIF_RxFull16Samples](#) }
SPDIF Rx FIFO full flag select, it decides when assert the rx full flag.
- enum [spdif_txempty_select_t](#) {
[kSPDIF_TxEmpty0Sample](#) = 0x0u,
[kSPDIF_TxEmpty4Samples](#),
[kSPDIF_TxEmpty8Samples](#),

- ```
kSPDIF_TxEmpty12Samples }
```
- SPDIF tx FIFO EMPTY flag select, it decides when assert the tx empty flag.*

    - enum `spdif_uchannel_source_t` {
      - `kSPDIF_NoUChannel = 0x0U,`
      - `kSPDIF_UChannelFromRx = 0x1U,`
      - `kSPDIF_UChannelFromTx = 0x3U }`

*SPDIF U channel source.*
    - enum `spdif_gain_select_t` {
      - `kSPDIF_GAIN_24 = 0x0U,`
      - `kSPDIF_GAIN_16,`
      - `kSPDIF_GAIN_12,`
      - `kSPDIF_GAIN_8,`
      - `kSPDIF_GAIN_6,`
      - `kSPDIF_GAIN_4,`
      - `kSPDIF_GAIN_3 }`

*SPDIF clock gain.*
    - enum `spdif_tx_source_t` {
      - `kSPDIF_txFromReceiver = 0x1U,`
      - `kSPDIF_txNormal = 0x5U }`

*SPDIF tx data source.*
    - enum `spdif_validity_config_t` {
      - `kSPDIF_validityFlagAlwaysSet = 0x0U,`
      - `kSPDIF_validityFlagAlwaysClear }`

*SPDIF tx data source.*
    - enum {
      - `kSPDIF_RxDPLLLocked = SPDIF_SIE_LOCK_MASK,`
      - `kSPDIF_TxFIFOError = SPDIF_SIE_TXUNOV_MASK,`
      - `kSPDIF_TxFIFOResync = SPDIF_SIE_TXRESYN_MASK,`
      - `kSPDIF_RxControlChannelChange = SPDIF_SIE_CNEW_MASK,`
      - `kSPDIF_VValidityFlagNoGood = SPDIF_SIE_VALNOGOOD_MASK,`
      - `kSPDIF_RxIllegalSymbol = SPDIF_SIE_SYMERR_MASK,`
      - `kSPDIF_RxParityBitError = SPDIF_SIE_BITERR_MASK,`
      - `kSPDIF_UChannelReceiveRegisterFull = SPDIF_SIE_URXFUL_MASK,`
      - `kSPDIF_UChannelReceiveRegisterOverrun = SPDIF_SIE_URXOV_MASK,`
      - `kSPDIF_QChannelReceiveRegisterFull = SPDIF_SIE_QRXFUL_MASK,`
      - `kSPDIF_QChannelReceiveRegisterOverrun = SPDIF_SIE_QRXOV_MASK,`
      - `kSPDIF_UQChannelSync = SPDIF_SIE_UQSYNC_MASK,`
      - `kSPDIF_UQChannelFrameError = SPDIF_SIE_UQERR_MASK,`
      - `kSPDIF_RxFIFOError = SPDIF_SIE_RXFIFOUNOV_MASK,`
      - `kSPDIF_RxFIFOResync = SPDIF_SIE_RXFIFORESYN_MASK,`
      - `kSPDIF_LockLoss = SPDIF_SIE_LOCKLOSS_MASK,`
      - `kSPDIF_TxFIFOEmpty = SPDIF_SIE_TXEM_MASK,`
      - `kSPDIF_RxFIFOFull = SPDIF_SIE_RXFIFOFUL_MASK,`
      - `kSPDIF_AllInterrupt }`

*The SPDIF interrupt enable flag.*
    - enum {

```
kSPDIF_RxDMAEnable = SPDIF_SCR_DMA_RX_EN_MASK,
kSPDIF_TxDMAEnable = SPDIF_SCR_DMA_TX_EN_MASK }
```

*The DMA request sources.*

## Driver version

- #define `FSL_SPDIF_DRIVER_VERSION` (`MAKE_VERSION(2, 0, 6)`)  
*Version 2.0.6.*

## Initialization and deinitialization

- void `SPDIF_Init` (`SPDIF_Type *base`, const `spdif_config_t *config`)  
*Initializes the SPDIF peripheral.*
- void `SPDIF_GetDefaultConfig` (`spdif_config_t *config`)  
*Sets the SPDIF configuration structure to default values.*
- void `SPDIF_Deinit` (`SPDIF_Type *base`)  
*De-initializes the SPDIF peripheral.*
- uint32\_t `SPDIF_GetInstance` (`SPDIF_Type *base`)  
*Get the instance number for SPDIF.*
- static void `SPDIF_TxFIFOReset` (`SPDIF_Type *base`)  
*Resets the SPDIF Tx.*
- static void `SPDIF_RxFIFOReset` (`SPDIF_Type *base`)  
*Resets the SPDIF Rx.*
- void `SPDIF_TxEnable` (`SPDIF_Type *base`, bool enable)  
*Enables/disables the SPDIF Tx.*
- static void `SPDIF_RxEnable` (`SPDIF_Type *base`, bool enable)  
*Enables/disables the SPDIF Rx.*

## Status

- static uint32\_t `SPDIF_GetStatusFlag` (`SPDIF_Type *base`)  
*Gets the SPDIF status flag state.*
- static void `SPDIF_ClearStatusFlags` (`SPDIF_Type *base`, uint32\_t mask)  
*Clears the SPDIF status flag state.*

## Interrupts

- static void `SPDIF_EnableInterrupts` (`SPDIF_Type *base`, uint32\_t mask)  
*Enables the SPDIF Tx interrupt requests.*
- static void `SPDIF_DisableInterrupts` (`SPDIF_Type *base`, uint32\_t mask)  
*Disables the SPDIF Tx interrupt requests.*

## DMA Control

- static void `SPDIF_EnableDMA` (`SPDIF_Type *base`, uint32\_t mask, bool enable)  
*Enables/disables the SPDIF DMA requests.*
- static uint32\_t `SPDIF_TxGetLeftDataRegisterAddress` (`SPDIF_Type *base`)  
*Gets the SPDIF Tx left data register address.*
- static uint32\_t `SPDIF_TxGetRightDataRegisterAddress` (`SPDIF_Type *base`)  
*Gets the SPDIF Tx right data register address.*

- static uint32\_t [SPDIF\\_RxGetLeftDataRegisterAddress](#) (SPDIF\_Type \*base)  
*Gets the SPDIF Rx left data register address.*
- static uint32\_t [SPDIF\\_RxGetRightDataRegisterAddress](#) (SPDIF\_Type \*base)  
*Gets the SPDIF Rx right data register address.*

## Bus Operations

- void [SPDIF\\_TxSetSampleRate](#) (SPDIF\_Type \*base, uint32\_t sampleRate\_Hz, uint32\_t sourceClockFreq\_Hz)  
*Configures the SPDIF Tx sample rate.*
- uint32\_t [SPDIF\\_GetRxSampleRate](#) (SPDIF\_Type \*base, uint32\_t clockSourceFreq\_Hz)  
*Configures the SPDIF Rx audio format.*
- void [SPDIF\\_WriteBlocking](#) (SPDIF\_Type \*base, uint8\_t \*buffer, uint32\_t size)  
*Sends data using a blocking method.*
- static void [SPDIF\\_WriteLeftData](#) (SPDIF\_Type \*base, uint32\_t data)  
*Writes data into SPDIF FIFO.*
- static void [SPDIF\\_WriteRightData](#) (SPDIF\_Type \*base, uint32\_t data)  
*Writes data into SPDIF FIFO.*
- static void [SPDIF\\_WriteChannelStatusHigh](#) (SPDIF\_Type \*base, uint32\_t data)  
*Writes data into SPDIF FIFO.*
- static void [SPDIF\\_WriteChannelStatusLow](#) (SPDIF\_Type \*base, uint32\_t data)  
*Writes data into SPDIF FIFO.*
- void [SPDIF\\_ReadBlocking](#) (SPDIF\_Type \*base, uint8\_t \*buffer, uint32\_t size)  
*Receives data using a blocking method.*
- static uint32\_t [SPDIF\\_ReadLeftData](#) (SPDIF\_Type \*base)  
*Reads data from the SPDIF FIFO.*
- static uint32\_t [SPDIF\\_ReadRightData](#) (SPDIF\_Type \*base)  
*Reads data from the SPDIF FIFO.*
- static uint32\_t [SPDIF\\_ReadChannelStatusHigh](#) (SPDIF\_Type \*base)  
*Reads data from the SPDIF FIFO.*
- static uint32\_t [SPDIF\\_ReadChannelStatusLow](#) (SPDIF\_Type \*base)  
*Reads data from the SPDIF FIFO.*
- static uint32\_t [SPDIF\\_ReadQChannel](#) (SPDIF\_Type \*base)  
*Reads data from the SPDIF FIFO.*
- static uint32\_t [SPDIF\\_ReadUChannel](#) (SPDIF\_Type \*base)  
*Reads data from the SPDIF FIFO.*

## Transactional

- void [SPDIF\\_TransferTxCreateHandle](#) (SPDIF\_Type \*base, spdif\_handle\_t \*handle, [spdif\\_transfer\\_callback\\_t](#) callback, void \*userData)  
*Initializes the SPDIF Tx handle.*
- void [SPDIF\\_TransferRxCreateHandle](#) (SPDIF\_Type \*base, spdif\_handle\_t \*handle, [spdif\\_transfer\\_callback\\_t](#) callback, void \*userData)  
*Initializes the SPDIF Rx handle.*
- [status\\_t](#) [SPDIF\\_TransferSendNonBlocking](#) (SPDIF\_Type \*base, spdif\_handle\_t \*handle, [spdif\\_transfer\\_t](#) \*xfer)  
*Performs an interrupt non-blocking send transfer on SPDIF.*
- [status\\_t](#) [SPDIF\\_TransferReceiveNonBlocking](#) (SPDIF\_Type \*base, spdif\_handle\_t \*handle, [spdif\\_transfer\\_t](#) \*xfer)

- *Performs an interrupt non-blocking receive transfer on SPDIF.*
- [status\\_t SPDIF\\_TransferGetSendCount](#) (SPDIF\_Type \*base, spdif\_handle\_t \*handle, size\_t \*count)  
*Gets a set byte count.*
- [status\\_t SPDIF\\_TransferGetReceiveCount](#) (SPDIF\_Type \*base, spdif\_handle\_t \*handle, size\_t \*count)  
*Gets a received byte count.*
- [void SPDIF\\_TransferAbortSend](#) (SPDIF\_Type \*base, spdif\_handle\_t \*handle)  
*Aborts the current send.*
- [void SPDIF\\_TransferAbortReceive](#) (SPDIF\_Type \*base, spdif\_handle\_t \*handle)  
*Aborts the current IRQ receive.*
- [void SPDIF\\_TransferTxHandleIRQ](#) (SPDIF\_Type \*base, spdif\_handle\_t \*handle)  
*Tx interrupt handler.*
- [void SPDIF\\_TransferRxHandleIRQ](#) (SPDIF\_Type \*base, spdif\_handle\_t \*handle)  
*Rx interrupt handler.*

## 41.3 Data Structure Documentation

### 41.3.1 struct spdif\_config\_t

#### Data Fields

- [bool isTxAutoSync](#)  
*If auto sync mechanism open.*
- [bool isRxAutoSync](#)  
*If auto sync mechanism open.*
- [uint8\\_t DPLLClkSource](#)  
*SPDIF DPLL clock source, range from 0~15, meaning is chip-specific.*
- [uint8\\_t txClkSource](#)  
*SPDIF tx clock source, range from 0~7, meaning is chip-specific.*
- [spdif\\_rxfull\\_select\\_t rxFullSelect](#)  
*SPDIF rx buffer full select.*
- [spdif\\_txempty\\_select\\_t txFullSelect](#)  
*SPDIF tx buffer empty select.*
- [spdif\\_uchannel\\_source\\_t uChannelSrc](#)  
*U channel source.*
- [spdif\\_tx\\_source\\_t txSource](#)  
*SPDIF tx data source.*
- [spdif\\_validity\\_config\\_t validityConfig](#)  
*Validity flag config.*
- [spdif\\_gain\\_select\\_t gain](#)  
*Rx receive clock measure gain parameter.*

#### Field Documentation

##### (1) [spdif\\_gain\\_select\\_t spdif\\_config\\_t::gain](#)

### 41.3.2 struct spdif\_transfer\_t

#### Data Fields

- uint8\_t \* [data](#)  
*Data start address to transfer.*
- uint8\_t \* [qdata](#)  
*Data buffer for Q channel.*
- uint8\_t \* [udata](#)  
*Data buffer for C channel.*
- size\_t [dataSize](#)  
*Transfer size.*

#### Field Documentation

(1) [uint8\\_t\\* spdif\\_transfer\\_t::data](#)

(2) [size\\_t spdif\\_transfer\\_t::dataSize](#)

### 41.3.3 struct \_spdif\_handle

#### Data Fields

- uint32\_t [state](#)  
*Transfer status.*
- [spdif\\_transfer\\_callback\\_t](#) [callback](#)  
*Callback function called at transfer event.*
- void \* [userData](#)  
*Callback parameter passed to callback function.*
- [spdif\\_transfer\\_t](#) [spdifQueue](#) [[SPDIF\\_XFER\\_QUEUE\\_SIZE](#)]  
*Transfer queue storing queued transfer.*
- size\_t [transferSize](#) [[SPDIF\\_XFER\\_QUEUE\\_SIZE](#)]  
*Data bytes need to transfer.*
- volatile uint8\_t [queueUser](#)  
*Index for user to queue transfer.*
- volatile uint8\_t [queueDriver](#)  
*Index for driver to get the transfer data and size.*
- uint8\_t [watermark](#)  
*Watermark value.*

## 41.4 Macro Definition Documentation

### 41.4.1 #define SPDIF\_XFER\_QUEUE\_SIZE (4U)

## 41.5 Enumeration Type Documentation

### 41.5.1 anonymous enum

Enumerator

*kStatus\_SPDIF\_RxDPLLLocked* SPDIF Rx PLL locked.  
*kStatus\_SPDIF\_TxFIFOError* SPDIF Tx FIFO error.  
*kStatus\_SPDIF\_TxFIFOResync* SPDIF Tx left and right FIFO resync.  
*kStatus\_SPDIF\_RxCnew* SPDIF Rx status channel value updated.  
*kStatus\_SPDIF\_ValidityNoGood* SPDIF validity flag not good.  
*kStatus\_SPDIF\_RxIllegalSymbol* SPDIF Rx receive illegal symbol.  
*kStatus\_SPDIF\_RxParityBitError* SPDIF Rx parity bit error.  
*kStatus\_SPDIF\_UChannelOverrun* SPDIF receive U channel overrun.  
*kStatus\_SPDIF\_QChannelOverrun* SPDIF receive Q channel overrun.  
*kStatus\_SPDIF\_UQChannelSync* SPDIF U/Q channel sync found.  
*kStatus\_SPDIF\_UQChannelFrameError* SPDIF U/Q channel frame error.  
*kStatus\_SPDIF\_RxFIFOError* SPDIF Rx FIFO error.  
*kStatus\_SPDIF\_RxFIFOResync* SPDIF Rx left and right FIFO resync.  
*kStatus\_SPDIF\_LockLoss* SPDIF Rx PLL clock lock loss.  
*kStatus\_SPDIF\_TxIdle* SPDIF Tx is idle.  
*kStatus\_SPDIF\_RxIdle* SPDIF Rx is idle.  
*kStatus\_SPDIF\_QueueFull* SPDIF queue full.

### 41.5.2 enum spdif\_rxfull\_select\_t

Enumerator

*kSPDIF\_RxFull1Sample* Rx full at least 1 sample in left and right FIFO.  
*kSPDIF\_RxFull4Samples* Rx full at least 4 sample in left and right FIFO.  
*kSPDIF\_RxFull8Samples* Rx full at least 8 sample in left and right FIFO.  
*kSPDIF\_RxFull16Samples* Rx full at least 16 sample in left and right FIFO.

### 41.5.3 enum spdif\_txempty\_select\_t

Enumerator

*kSPDIF\_TxEmpty0Sample* Tx empty at most 0 sample in left and right FIFO.  
*kSPDIF\_TxEmpty4Samples* Tx empty at most 4 sample in left and right FIFO.  
*kSPDIF\_TxEmpty8Samples* Tx empty at most 8 sample in left and right FIFO.  
*kSPDIF\_TxEmpty12Samples* Tx empty at most 12 sample in left and right FIFO.

#### 41.5.4 enum spdif\_uchannel\_source\_t

Enumerator

- kSPDIF\_NoUChannel* No embedded U channel.
- kSPDIF\_UChannelFromRx* U channel from receiver, it is CD mode.
- kSPDIF\_UChannelFromTx* U channel from on chip tx.

#### 41.5.5 enum spdif\_gain\_select\_t

Enumerator

- kSPDIF\_GAIN\_24* Gain select is 24.
- kSPDIF\_GAIN\_16* Gain select is 16.
- kSPDIF\_GAIN\_12* Gain select is 12.
- kSPDIF\_GAIN\_8* Gain select is 8.
- kSPDIF\_GAIN\_6* Gain select is 6.
- kSPDIF\_GAIN\_4* Gain select is 4.
- kSPDIF\_GAIN\_3* Gain select is 3.

#### 41.5.6 enum spdif\_tx\_source\_t

Enumerator

- kSPDIF\_txFromReceiver* Tx data directly through SPDIF receiver.
- kSPDIF\_txNormal* Normal operation, data from processor.

#### 41.5.7 enum spdif\_validity\_config\_t

Enumerator

- kSPDIF\_validityFlagAlwaysSet* Outgoing validity flags always set.
- kSPDIF\_validityFlagAlwaysClear* Outgoing validity flags always clear.

#### 41.5.8 anonymous enum

Enumerator

- kSPDIF\_RxDPLLLocked* SPDIF DPLL locked.
- kSPDIF\_TxFIFOError* Tx FIFO underrun or overrun.
- kSPDIF\_TxFIFOResync* Tx FIFO left and right channel resync.

*kSPDIF\_RxControlChannelChange* SPDIF Rx control channel value changed.  
*kSPDIF\_ValidityFlagNoGood* SPDIF validity flag no good.  
*kSPDIF\_RxIllegalSymbol* SPDIF receiver found illegal symbol.  
*kSPDIF\_RxParityBitError* SPDIF receiver found parity bit error.  
*kSPDIF\_UChannelReceiveRegisterFull* SPDIF U channel receive register full.  
*kSPDIF\_UChannelReceiveRegisterOverrun* SPDIF U channel receive register overrun.  
*kSPDIF\_QChannelReceiveRegisterFull* SPDIF Q channel receive register full.  
*kSPDIF\_QChannelReceiveRegisterOverrun* SPDIF Q channel receive register overrun.  
*kSPDIF\_UQChannelSync* SPDIF U/Q channel sync found.  
*kSPDIF\_UQChannelFrameError* SPDIF U/Q channel frame error.  
*kSPDIF\_RxFIFOError* SPDIF Rx FIFO underrun/overrun.  
*kSPDIF\_RxFIFOResync* SPDIF Rx left and right FIFO resync.  
*kSPDIF\_LockLoss* SPDIF receiver loss of lock.  
*kSPDIF\_TxFIFOEmpty* SPDIF Tx FIFO empty.  
*kSPDIF\_RxFIFOFull* SPDIF Rx FIFO full.  
*kSPDIF\_AllInterrupt* all interrupt

### 41.5.9 anonymous enum

Enumerator

*kSPDIF\_RxDMAEnable* Rx FIFO full.  
*kSPDIF\_TxDMAEnable* Tx FIFO empty.

## 41.6 Function Documentation

### 41.6.1 void SPDIF\_Init ( SPDIF\_Type \* *base*, const spdif\_config\_t \* *config* )

Un-gates the SPDIF clock, resets the module, and configures SPDIF with a configuration structure. The configuration structure can be custom filled or set with default values by [SPDIF\\_GetDefaultConfig\(\)](#).

Note

This API should be called at the beginning of the application to use the SPDIF driver. Otherwise, accessing the SPDIF module can cause a hard fault because the clock is not enabled.

Parameters

|             |                    |
|-------------|--------------------|
| <i>base</i> | SPDIF base pointer |
|-------------|--------------------|



|               |                                |
|---------------|--------------------------------|
| <i>config</i> | SPDIF configuration structure. |
|---------------|--------------------------------|

#### 41.6.2 void SPDIF\_GetDefaultConfig ( spdif\_config\_t \* config )

This API initializes the configuration structure for use in SPDIF\_Init. The initialized structure can remain unchanged in SPDIF\_Init, or it can be modified before calling SPDIF\_Init. This is an example.

```
spdif_config_t config;
SPDIF_GetDefaultConfig(&config);
```

Parameters

|               |                                           |
|---------------|-------------------------------------------|
| <i>config</i> | pointer to master configuration structure |
|---------------|-------------------------------------------|

#### 41.6.3 void SPDIF\_Deinit ( SPDIF\_Type \* base )

This API gates the SPDIF clock. The SPDIF module can't operate unless SPDIF\_Init is called to enable the clock.

Parameters

|             |                    |
|-------------|--------------------|
| <i>base</i> | SPDIF base pointer |
|-------------|--------------------|

#### 41.6.4 uint32\_t SPDIF\_GetInstance ( SPDIF\_Type \* base )

Parameters

|             |                     |
|-------------|---------------------|
| <i>base</i> | SPDIF base pointer. |
|-------------|---------------------|

#### 41.6.5 static void SPDIF\_TxFIFOReset ( SPDIF\_Type \* base ) [inline], [static]

This function makes Tx FIFO in reset mode.

Parameters

|             |                    |
|-------------|--------------------|
| <i>base</i> | SPDIF base pointer |
|-------------|--------------------|

**41.6.6 static void SPDIF\_RxFIFOReset ( SPDIF\_Type \* *base* ) [inline], [static]**

This function enables the software reset and FIFO reset of SPDIF Rx. After reset, clear the reset bit.

Parameters

|             |                    |
|-------------|--------------------|
| <i>base</i> | SPDIF base pointer |
|-------------|--------------------|

**41.6.7 void SPDIF\_TxEnable ( SPDIF\_Type \* *base*, bool *enable* )**

Parameters

|               |                                                  |
|---------------|--------------------------------------------------|
| <i>base</i>   | SPDIF base pointer                               |
| <i>enable</i> | True means enable SPDIF Tx, false means disable. |

**41.6.8 static void SPDIF\_RxEnable ( SPDIF\_Type \* *base*, bool *enable* ) [inline], [static]**

Parameters

|               |                                                  |
|---------------|--------------------------------------------------|
| <i>base</i>   | SPDIF base pointer                               |
| <i>enable</i> | True means enable SPDIF Rx, false means disable. |

**41.6.9 static uint32\_t SPDIF\_GetStatusFlag ( SPDIF\_Type \* *base* ) [inline], [static]**

Parameters

---

|             |                    |
|-------------|--------------------|
| <i>base</i> | SPDIF base pointer |
|-------------|--------------------|

## Returns

SPDIF status flag value. Use the `_spdif_interrupt_enable_t` to get the status value needed.

**41.6.10 static void SPDIF\_ClearStatusFlags ( SPDIF\_Type \* *base*, uint32\_t *mask* )  
[inline], [static]**

## Parameters

|             |                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i> | SPDIF base pointer                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <i>mask</i> | State mask. It can be a combination of the <code>_spdif_interrupt_enable_t</code> member. Notice these members cannot be included, as these flags cannot be cleared by writing 1 to these bits: <ul style="list-style-type: none"> <li>• <code>kSPDIF_UChannelReceiveRegisterFull</code></li> <li>• <code>kSPDIF_QChannelReceiveRegisterFull</code></li> <li>• <code>kSPDIF_TxFIFOEmpty</code></li> <li>• <code>kSPDIF_RxFIFOFull</code></li> </ul> |

**41.6.11 static void SPDIF\_EnableInterrupts ( SPDIF\_Type \* *base*, uint32\_t *mask* )  
[inline], [static]**

## Parameters

|             |                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i> | SPDIF base pointer                                                                                                                                                                                                                                                                                                                                                                                                            |
| <i>mask</i> | interrupt source The parameter can be a combination of the following sources if defined. <ul style="list-style-type: none"> <li>• <code>kSPDIF_WordStartInterruptEnable</code></li> <li>• <code>kSPDIF_SyncErrorInterruptEnable</code></li> <li>• <code>kSPDIF_FIFOWarningInterruptEnable</code></li> <li>• <code>kSPDIF_FIFORequestInterruptEnable</code></li> <li>• <code>kSPDIF_FIFOErrorInterruptEnable</code></li> </ul> |

**41.6.12 static void SPDIF\_DisableInterrupts ( SPDIF\_Type \* *base*, uint32\_t *mask* )  
[inline], [static]**

## Parameters

|             |                                                                                                                                                                                                                                                                                                                                                              |
|-------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i> | SPDIF base pointer                                                                                                                                                                                                                                                                                                                                           |
| <i>mask</i> | interrupt source The parameter can be a combination of the following sources if defined. <ul style="list-style-type: none"> <li>• kSPDIF_WordStartInterruptEnable</li> <li>• kSPDIF_SyncErrorInterruptEnable</li> <li>• kSPDIF_FIFOWarningInterruptEnable</li> <li>• kSPDIF_FIFORequestInterruptEnable</li> <li>• kSPDIF_FIFOErrorInterruptEnable</li> </ul> |

#### 41.6.13 static void SPDIF\_EnabledDMA ( SPDIF\_Type \* *base*, uint32\_t *mask*, bool *enable* ) [inline], [static]

## Parameters

|               |                                                                                                                                                                                                    |
|---------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>   | SPDIF base pointer                                                                                                                                                                                 |
| <i>mask</i>   | SPDIF DMA enable mask, The parameter can be a combination of the following sources if defined <ul style="list-style-type: none"> <li>• kSPDIF_RxDMAEnable</li> <li>• kSPDIF_TxDMAEnable</li> </ul> |
| <i>enable</i> | True means enable DMA, false means disable DMA.                                                                                                                                                    |

#### 41.6.14 static uint32\_t SPDIF\_TxGetLeftDataRegisterAddress ( SPDIF\_Type \* *base* ) [inline], [static]

This API is used to provide a transfer address for the SPDIF DMA transfer configuration.

## Parameters

|             |                     |
|-------------|---------------------|
| <i>base</i> | SPDIF base pointer. |
|-------------|---------------------|

## Returns

data register address.

**41.6.15** `static uint32_t SPDIF_TxGetRightDataRegisterAddress ( SPDIF_Type *  
base ) [inline], [static]`

This API is used to provide a transfer address for the SPDIF DMA transfer configuration.

Parameters

|             |                     |
|-------------|---------------------|
| <i>base</i> | SPDIF base pointer. |
|-------------|---------------------|

Returns

data register address.

**41.6.16** `static uint32_t SPDIF_RxGetLeftDataRegisterAddress ( SPDIF_Type * base ) [inline], [static]`

This API is used to provide a transfer address for the SPDIF DMA transfer configuration.

Parameters

|             |                     |
|-------------|---------------------|
| <i>base</i> | SPDIF base pointer. |
|-------------|---------------------|

Returns

data register address.

**41.6.17** `static uint32_t SPDIF_RxGetRightDataRegisterAddress ( SPDIF_Type * base ) [inline], [static]`

This API is used to provide a transfer address for the SPDIF DMA transfer configuration.

Parameters

|             |                     |
|-------------|---------------------|
| <i>base</i> | SPDIF base pointer. |
|-------------|---------------------|

Returns

data register address.

**41.6.18** `void SPDIF_TxSetSampleRate ( SPDIF_Type * base, uint32_t sampleRate_Hz, uint32_t sourceClockFreq_Hz )`

The audio format can be changed at run-time. This function configures the sample rate.

## Parameters

|                            |                                        |
|----------------------------|----------------------------------------|
| <i>base</i>                | SPDIF base pointer.                    |
| <i>sampleRate_Hz</i>       | SPDIF sample rate frequency in Hz.     |
| <i>sourceClock-Freq_Hz</i> | SPDIF tx clock source frequency in Hz. |

#### 41.6.19 `uint32_t SPDIF_GetRxSampleRate ( SPDIF_Type * base, uint32_t clockSourceFreq_Hz )`

The audio format can be changed at run-time. This function configures the sample rate and audio data format to be transferred.

## Parameters

|                            |                                     |
|----------------------------|-------------------------------------|
| <i>base</i>                | SPDIF base pointer.                 |
| <i>clockSource-Freq_Hz</i> | SPDIF system clock frequency in hz. |

#### 41.6.20 `void SPDIF_WriteBlocking ( SPDIF_Type * base, uint8_t * buffer, uint32_t size )`

## Note

This function blocks by polling until data is ready to be sent.

## Parameters

|               |                                    |
|---------------|------------------------------------|
| <i>base</i>   | SPDIF base pointer.                |
| <i>buffer</i> | Pointer to the data to be written. |
| <i>size</i>   | Bytes to be written.               |

#### 41.6.21 `static void SPDIF_WriteLeftData ( SPDIF_Type * base, uint32_t data )` `[inline], [static]`

Parameters

|             |                           |
|-------------|---------------------------|
| <i>base</i> | SPDIF base pointer.       |
| <i>data</i> | Data needs to be written. |

**41.6.22 static void SPDIF\_WriteRightData ( SPDIF\_Type \* *base*, uint32\_t *data* )**  
**[inline], [static]**

Parameters

|             |                           |
|-------------|---------------------------|
| <i>base</i> | SPDIF base pointer.       |
| <i>data</i> | Data needs to be written. |

**41.6.23 static void SPDIF\_WriteChannelStatusHigh ( SPDIF\_Type \* *base*, uint32\_t *data* )**  
**[inline], [static]**

Parameters

|             |                           |
|-------------|---------------------------|
| <i>base</i> | SPDIF base pointer.       |
| <i>data</i> | Data needs to be written. |

**41.6.24 static void SPDIF\_WriteChannelStatusLow ( SPDIF\_Type \* *base*, uint32\_t *data* )**  
**[inline], [static]**

Parameters

|             |                           |
|-------------|---------------------------|
| <i>base</i> | SPDIF base pointer.       |
| <i>data</i> | Data needs to be written. |

**41.6.25 void SPDIF\_ReadBlocking ( SPDIF\_Type \* *base*, uint8\_t \* *buffer*, uint32\_t *size* )**

Note

This function blocks by polling until data is ready to be sent.



Parameters

|               |                                 |
|---------------|---------------------------------|
| <i>base</i>   | SPDIF base pointer.             |
| <i>buffer</i> | Pointer to the data to be read. |
| <i>size</i>   | Bytes to be read.               |

**41.6.26** `static uint32_t SPDIF_ReadLeftData ( SPDIF_Type * base ) [inline], [static]`

Parameters

|             |                     |
|-------------|---------------------|
| <i>base</i> | SPDIF base pointer. |
|-------------|---------------------|

Returns

Data in SPDIF FIFO.

**41.6.27** `static uint32_t SPDIF_ReadRightData ( SPDIF_Type * base ) [inline], [static]`

Parameters

|             |                     |
|-------------|---------------------|
| <i>base</i> | SPDIF base pointer. |
|-------------|---------------------|

Returns

Data in SPDIF FIFO.

**41.6.28** `static uint32_t SPDIF_ReadChannelStatusHigh ( SPDIF_Type * base ) [inline], [static]`

Parameters

|             |                     |
|-------------|---------------------|
| <i>base</i> | SPDIF base pointer. |
|-------------|---------------------|

Returns

Data in SPDIF FIFO.

**41.6.29** `static uint32_t SPDIF_ReadChannelStatusLow ( SPDIF_Type * base )`  
**[inline], [static]**

Parameters

|             |                     |
|-------------|---------------------|
| <i>base</i> | SPDIF base pointer. |
|-------------|---------------------|

Returns

Data in SPDIF FIFO.

**41.6.30** `static uint32_t SPDIF_ReadQChannel ( SPDIF_Type * base )` **[inline],**  
**[static]**

Parameters

|             |                     |
|-------------|---------------------|
| <i>base</i> | SPDIF base pointer. |
|-------------|---------------------|

Returns

Data in SPDIF FIFO.

**41.6.31** `static uint32_t SPDIF_ReadUChannel ( SPDIF_Type * base )` **[inline],**  
**[static]**

Parameters

|             |                     |
|-------------|---------------------|
| <i>base</i> | SPDIF base pointer. |
|-------------|---------------------|

Returns

Data in SPDIF FIFO.

**41.6.32 void SPDIF\_TransferTxCreateHandle ( SPDIF\_Type \* *base*, spdif\_handle\_t \* *handle*, spdif\_transfer\_callback\_t *callback*, void \* *userData* )**

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

## Parameters

|                 |                                                |
|-----------------|------------------------------------------------|
| <i>base</i>     | SPDIF base pointer                             |
| <i>handle</i>   | SPDIF handle pointer.                          |
| <i>callback</i> | Pointer to the user callback function.         |
| <i>userData</i> | User parameter passed to the callback function |

### 41.6.33 void SPDIF\_TransferRxCreateHandle ( SPDIF\_Type \* *base*, spdif\_handle\_t \* *handle*, spdif\_transfer\_callback\_t *callback*, void \* *userData* )

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

## Parameters

|                 |                                                 |
|-----------------|-------------------------------------------------|
| <i>base</i>     | SPDIF base pointer.                             |
| <i>handle</i>   | SPDIF handle pointer.                           |
| <i>callback</i> | Pointer to the user callback function.          |
| <i>userData</i> | User parameter passed to the callback function. |

### 41.6.34 status\_t SPDIF\_TransferSendNonBlocking ( SPDIF\_Type \* *base*, spdif\_handle\_t \* *handle*, spdif\_transfer\_t \* *xfer* )

## Note

This API returns immediately after the transfer initiates. Call the SPDIF\_TxGetTransferStatusIRQ to poll the transfer status and check whether the transfer is finished. If the return status is not kStatus\_SPDIF\_Busy, the transfer is finished.

## Parameters

|               |                                                                          |
|---------------|--------------------------------------------------------------------------|
| <i>base</i>   | SPDIF base pointer.                                                      |
| <i>handle</i> | Pointer to the spdif_handle_t structure which stores the transfer state. |
| <i>xfer</i>   | Pointer to the <a href="#">spdif_transfer_t</a> structure.               |

## Return values

|                                |                                        |
|--------------------------------|----------------------------------------|
| <i>kStatus_Success</i>         | Successfully started the data receive. |
| <i>kStatus_SPDIF_TxBusy</i>    | Previous receive still not finished.   |
| <i>kStatus_InvalidArgument</i> | The input parameter is invalid.        |

#### 41.6.35 `status_t SPDIF_TransferReceiveNonBlocking ( SPDIF_Type * base, spdif_handle_t * handle, spdif_transfer_t * xfer )`

## Note

This API returns immediately after the transfer initiates. Call the `SPDIF_RxGetTransferStatusIRQ` to poll the transfer status and check whether the transfer is finished. If the return status is not `kStatus_SPDIF_Busy`, the transfer is finished.

## Parameters

|               |                                                                                       |
|---------------|---------------------------------------------------------------------------------------|
| <i>base</i>   | SPDIF base pointer                                                                    |
| <i>handle</i> | Pointer to the <code>spdif_handle_t</code> structure which stores the transfer state. |
| <i>xfer</i>   | Pointer to the <code>spdif_transfer_t</code> structure.                               |

## Return values

|                                |                                        |
|--------------------------------|----------------------------------------|
| <i>kStatus_Success</i>         | Successfully started the data receive. |
| <i>kStatus_SPDIF_RxBusy</i>    | Previous receive still not finished.   |
| <i>kStatus_InvalidArgument</i> | The input parameter is invalid.        |

#### 41.6.36 `status_t SPDIF_TransferGetSendCount ( SPDIF_Type * base, spdif_handle_t * handle, size_t * count )`

## Parameters

|             |                     |
|-------------|---------------------|
| <i>base</i> | SPDIF base pointer. |
|-------------|---------------------|

|               |                                                                                       |
|---------------|---------------------------------------------------------------------------------------|
| <i>handle</i> | Pointer to the <code>spdif_handle_t</code> structure which stores the transfer state. |
| <i>count</i>  | Bytes count sent.                                                                     |

Return values

|                                     |                                                                |
|-------------------------------------|----------------------------------------------------------------|
| <i>kStatus_Success</i>              | Succeed get the transfer count.                                |
| <i>kStatus_NoTransferInProgress</i> | There is not a non-blocking transaction currently in progress. |

#### 41.6.37 `status_t SPDIF_TransferGetReceiveCount ( SPDIF_Type * base, spdif_handle_t * handle, size_t * count )`

Parameters

|               |                                                                                       |
|---------------|---------------------------------------------------------------------------------------|
| <i>base</i>   | SPDIF base pointer.                                                                   |
| <i>handle</i> | Pointer to the <code>spdif_handle_t</code> structure which stores the transfer state. |
| <i>count</i>  | Bytes count received.                                                                 |

Return values

|                                     |                                                                |
|-------------------------------------|----------------------------------------------------------------|
| <i>kStatus_Success</i>              | Succeed get the transfer count.                                |
| <i>kStatus_NoTransferInProgress</i> | There is not a non-blocking transaction currently in progress. |

#### 41.6.38 `void SPDIF_TransferAbortSend ( SPDIF_Type * base, spdif_handle_t * handle )`

Note

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

Parameters

|               |                                                                                       |
|---------------|---------------------------------------------------------------------------------------|
| <i>base</i>   | SPDIF base pointer.                                                                   |
| <i>handle</i> | Pointer to the <code>spdif_handle_t</code> structure which stores the transfer state. |

### 41.6.39 void SPDIF\_TransferAbortReceive ( SPDIF\_Type \* *base*, spdif\_handle\_t \* *handle* )

Note

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

Parameters

|               |                                                                          |
|---------------|--------------------------------------------------------------------------|
| <i>base</i>   | SPDIF base pointer                                                       |
| <i>handle</i> | Pointer to the spdif_handle_t structure which stores the transfer state. |

### 41.6.40 void SPDIF\_TransferTxHandleIRQ ( SPDIF\_Type \* *base*, spdif\_handle\_t \* *handle* )

Parameters

|               |                                          |
|---------------|------------------------------------------|
| <i>base</i>   | SPDIF base pointer.                      |
| <i>handle</i> | Pointer to the spdif_handle_t structure. |

### 41.6.41 void SPDIF\_TransferRxHandleIRQ ( SPDIF\_Type \* *base*, spdif\_handle\_t \* *handle* )

Parameters

|               |                                          |
|---------------|------------------------------------------|
| <i>base</i>   | SPDIF base pointer.                      |
| <i>handle</i> | Pointer to the spdif_handle_t structure. |

## 41.7 SPDIF eDMA Driver

### 41.7.1 Overview

#### Data Structures

- struct `spdif_edma_transfer_t`  
*SPDIF transfer structure. [More...](#)*
- struct `spdif_edma_handle_t`  
*SPDIF DMA transfer handle, users should not touch the content of the handle. [More...](#)*

#### Typedefs

- typedef `void(* spdif_edma_callback_t)(SPDIF_Type *base, spdif_edma_handle_t *handle, status_t status, void *userData)`  
*SPDIF eDMA transfer callback function for finish and error.*

#### Driver version

- `#define FSL_SPDIF_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 0, 5))`  
*Version 2.0.5.*

#### eDMA Transactional

- void `SPDIF_TransferTxCreateHandleEDMA` (SPDIF\_Type \*base, spdif\_edma\_handle\_t \*handle, `spdif_edma_callback_t` callback, void \*userData, `edma_handle_t` \*dmaLeftHandle, `edma_handle_t` \*dmaRightHandle)  
*Initializes the SPDIF eDMA handle.*
- void `SPDIF_TransferRxCreateHandleEDMA` (SPDIF\_Type \*base, spdif\_edma\_handle\_t \*handle, `spdif_edma_callback_t` callback, void \*userData, `edma_handle_t` \*dmaLeftHandle, `edma_handle_t` \*dmaRightHandle)  
*Initializes the SPDIF Rx eDMA handle.*
- `status_t SPDIF_TransferSendEDMA` (SPDIF\_Type \*base, spdif\_edma\_handle\_t \*handle, `spdif_edma_transfer_t` \*xfer)  
*Performs a non-blocking SPDIF transfer using DMA.*
- `status_t SPDIF_TransferReceiveEDMA` (SPDIF\_Type \*base, spdif\_edma\_handle\_t \*handle, `spdif_edma_transfer_t` \*xfer)  
*Performs a non-blocking SPDIF receive using eDMA.*
- void `SPDIF_TransferAbortSendEDMA` (SPDIF\_Type \*base, spdif\_edma\_handle\_t \*handle)  
*Aborts a SPDIF transfer using eDMA.*
- void `SPDIF_TransferAbortReceiveEDMA` (SPDIF\_Type \*base, spdif\_edma\_handle\_t \*handle)  
*Aborts a SPDIF receive using eDMA.*
- `status_t SPDIF_TransferGetSendCountEDMA` (SPDIF\_Type \*base, spdif\_edma\_handle\_t \*handle, `size_t` \*count)  
*Gets byte count sent by SPDIF.*



- `status_t SPDIF_TransferGetReceiveCountEDMA` (`SPDIF_Type *base, spdif_edma_handle_t *handle, size_t *count`)  
*Gets byte count received by SPDIF.*

## 41.7.2 Data Structure Documentation

### 41.7.2.1 struct `spdif_edma_transfer_t`

#### Data Fields

- `uint8_t * leftData`  
*Data start address to transfer.*
- `uint8_t * rightData`  
*Data start address to transfer.*
- `size_t dataSize`  
*Transfer size.*

#### Field Documentation

- (1) `uint8_t* spdif_edma_transfer_t::leftData`
- (2) `uint8_t* spdif_edma_transfer_t::rightData`
- (3) `size_t spdif_edma_transfer_t::dataSize`

### 41.7.2.2 struct `_spdif_edma_handle`

#### Data Fields

- `edma_handle_t * dmaLeftHandle`  
*DMA handler for SPDIF left channel.*
- `edma_handle_t * dmaRightHandle`  
*DMA handler for SPDIF right channel.*
- `uint8_t nbytes`  
*eDMA minor byte transfer count initially configured.*
- `uint8_t count`  
*The transfer data count in a DMA request.*
- `uint32_t state`  
*Internal state for SPDIF eDMA transfer.*
- `spdif_edma_callback_t callback`  
*Callback for users while transfer finish or error occurs.*
- `void * userData`  
*User callback parameter.*
- `edma_tcd_t leftTcd [SPDIF_XFER_QUEUE_SIZE+1U]`  
*TCD pool for eDMA transfer.*
- `edma_tcd_t rightTcd [SPDIF_XFER_QUEUE_SIZE+1U]`  
*TCD pool for eDMA transfer.*
- `spdif_edma_transfer_t spdifQueue [SPDIF_XFER_QUEUE_SIZE]`  
*Transfer queue storing queued transfer.*

- `size_t transferSize` [SPDIF\_XFER\_QUEUE\_SIZE]  
Data bytes need to transfer, left and right are the same, so use one.
- `volatile uint8_t queueUser`  
Index for user to queue transfer.
- `volatile uint8_t queueDriver`  
Index for driver to get the transfer data and size.

### Field Documentation

- (1) `uint8_t spdif_edma_handle_t::nbytes`
- (2) `edma_tcd_t spdif_edma_handle_t::leftTcd[SPDIF_XFER_QUEUE_SIZE+1U]`
- (3) `edma_tcd_t spdif_edma_handle_t::rightTcd[SPDIF_XFER_QUEUE_SIZE+1U]`
- (4) `spdif_edma_transfer_t spdif_edma_handle_t::spdifQueue[SPDIF_XFER_QUEUE_SIZE]`
- (5) `volatile uint8_t spdif_edma_handle_t::queueUser`

### 41.7.3 Function Documentation

**41.7.3.1 void SPDIF\_TransferTxCreateHandleEDMA ( SPDIF\_Type \* *base*,  
spdif\_edma\_handle\_t \* *handle*, spdif\_edma\_callback\_t *callback*, void \*  
*userData*, edma\_handle\_t \* *dmaLeftHandle*, edma\_handle\_t \* *dmaRightHandle* )**

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

Parameters

|                        |                                                                                        |
|------------------------|----------------------------------------------------------------------------------------|
| <i>base</i>            | SPDIF base pointer.                                                                    |
| <i>handle</i>          | SPDIF eDMA handle pointer.                                                             |
| <i>base</i>            | SPDIF peripheral base address.                                                         |
| <i>callback</i>        | Pointer to user callback function.                                                     |
| <i>userData</i>        | User parameter passed to the callback function.                                        |
| <i>dmaLeftHandle</i>   | eDMA handle pointer for left channel, this handle shall be static allocated by users.  |
| <i>dmaRight-Handle</i> | eDMA handle pointer for right channel, this handle shall be static allocated by users. |

**41.7.3.2 void SPDIF\_TransferRxCreateHandleEDMA ( SPDIF\_Type \* *base*,  
spdif\_edma\_handle\_t \* *handle*, spdif\_edma\_callback\_t *callback*, void \*  
*userData*, edma\_handle\_t \* *dmaLeftHandle*, edma\_handle\_t \* *dmaRightHandle* )**

This function initializes the SPDIF slave DMA handle, which can be used for other SPDIF master transactional APIs. Usually, for a specified SPDIF instance, call this API once to get the initialized handle.

## Parameters

|                        |                                                                                        |
|------------------------|----------------------------------------------------------------------------------------|
| <i>base</i>            | SPDIF base pointer.                                                                    |
| <i>handle</i>          | SPDIF eDMA handle pointer.                                                             |
| <i>base</i>            | SPDIF peripheral base address.                                                         |
| <i>callback</i>        | Pointer to user callback function.                                                     |
| <i>userData</i>        | User parameter passed to the callback function.                                        |
| <i>dmaLeftHandle</i>   | eDMA handle pointer for left channel, this handle shall be static allocated by users.  |
| <i>dmaRight-Handle</i> | eDMA handle pointer for right channel, this handle shall be static allocated by users. |

#### 41.7.3.3 status\_t SPDIF\_TransferSendEDMA ( SPDIF\_Type \* *base*, spdif\_edma\_handle\_t \* *handle*, spdif\_edma\_transfer\_t \* *xfer* )

## Note

This interface returns immediately after the transfer initiates. Call SPDIF\_GetTransferStatus to poll the transfer status and check whether the SPDIF transfer is finished.

## Parameters

|               |                                        |
|---------------|----------------------------------------|
| <i>base</i>   | SPDIF base pointer.                    |
| <i>handle</i> | SPDIF eDMA handle pointer.             |
| <i>xfer</i>   | Pointer to the DMA transfer structure. |

## Return values

|                                |                                       |
|--------------------------------|---------------------------------------|
| <i>kStatus_Success</i>         | Start a SPDIF eDMA send successfully. |
| <i>kStatus_InvalidArgument</i> | The input argument is invalid.        |
| <i>kStatus_TxBusy</i>          | SPDIF is busy sending data.           |

#### 41.7.3.4 status\_t SPDIF\_TransferReceiveEDMA ( SPDIF\_Type \* *base*, spdif\_edma\_handle\_t \* *handle*, spdif\_edma\_transfer\_t \* *xfer* )

## Note

This interface returns immediately after the transfer initiates. Call the SPDIF\_GetReceive-RemainingBytes to poll the transfer status and check whether the SPDIF transfer is finished.

## Parameters

|               |                                    |
|---------------|------------------------------------|
| <i>base</i>   | SPDIF base pointer                 |
| <i>handle</i> | SPDIF eDMA handle pointer.         |
| <i>xfer</i>   | Pointer to DMA transfer structure. |

## Return values

|                                |                                          |
|--------------------------------|------------------------------------------|
| <i>kStatus_Success</i>         | Start a SPDIF eDMA receive successfully. |
| <i>kStatus_InvalidArgument</i> | The input argument is invalid.           |
| <i>kStatus_RxBusy</i>          | SPDIF is busy receiving data.            |

#### 41.7.3.5 void SPDIF\_TransferAbortSendEDMA ( SPDIF\_Type \* *base*, spdif\_edma\_handle\_t \* *handle* )

## Parameters

|               |                            |
|---------------|----------------------------|
| <i>base</i>   | SPDIF base pointer.        |
| <i>handle</i> | SPDIF eDMA handle pointer. |

#### 41.7.3.6 void SPDIF\_TransferAbortReceiveEDMA ( SPDIF\_Type \* *base*, spdif\_edma\_handle\_t \* *handle* )

## Parameters

|               |                            |
|---------------|----------------------------|
| <i>base</i>   | SPDIF base pointer         |
| <i>handle</i> | SPDIF eDMA handle pointer. |

#### 41.7.3.7 status\_t SPDIF\_TransferGetSendCountEDMA ( SPDIF\_Type \* *base*, spdif\_edma\_handle\_t \* *handle*, size\_t \* *count* )

## Parameters

---

|               |                            |
|---------------|----------------------------|
| <i>base</i>   | SPDIF base pointer.        |
| <i>handle</i> | SPDIF eDMA handle pointer. |
| <i>count</i>  | Bytes count sent by SPDIF. |

Return values

|                                     |                                                   |
|-------------------------------------|---------------------------------------------------|
| <i>kStatus_Success</i>              | Succeed get the transfer count.                   |
| <i>kStatus_NoTransferInProgress</i> | There is no non-blocking transaction in progress. |

#### 41.7.3.8 **status\_t SPDIF\_TransferGetReceiveCountEDMA ( SPDIF\_Type \* *base*, spdif\_edma\_handle\_t \* *handle*, size\_t \* *count* )**

Parameters

|               |                                |
|---------------|--------------------------------|
| <i>base</i>   | SPDIF base pointer             |
| <i>handle</i> | SPDIF eDMA handle pointer.     |
| <i>count</i>  | Bytes count received by SPDIF. |

Return values

|                                     |                                                   |
|-------------------------------------|---------------------------------------------------|
| <i>kStatus_Success</i>              | Succeed get the transfer count.                   |
| <i>kStatus_NoTransferInProgress</i> | There is no non-blocking transaction in progress. |

## Chapter 42

# SRC: System Reset Controller Driver

### 42.1 Overview

The MCUXpresso SDK provides a peripheral driver for the System Reset Controller (SRC) module.

The System Reset Controller (SRC) controls the reset and boot operation of the SoC. It is responsible for the generation of all reset signals and boot decoding. The reset controller determines the source and the type of reset, such as POR, WARM, COLD, and performs the necessary reset qualification and stretching sequences. Based on the type of reset, the reset logic generates the reset sequence for the entire IC.

### Enumerations

- enum `_src_reset_status_flags` {  
    `kSRC_TemperatureSensorResetFlag` = SRC\_SRSR\_TSR\_MASK,  
    `kSRC_Wdog3ResetFlag` = SRC\_SRSR\_WDOG3\_RST\_B\_MASK,  
    `kSRC_JTAGSystemResetFlag`,  
    `kSRC_JTAGSoftwareResetFlag` = SRC\_SRSR\_SJC\_MASK,  
    `kSRC_JTAGGeneratedResetFlag` = SRC\_SRSR\_JTAG\_MASK,  
    `kSRC_WatchdogResetFlag` = SRC\_SRSR\_WDOG\_MASK,  
    `kSRC_IppUserResetFlag` = SRC\_SRSR\_IPP\_USER\_RESET\_B\_MASK,  
    `kSRC_CsuResetFlag` = SRC\_SRSR\_CSU\_RESET\_B\_MASK,  
    `kSRC_CoreLockupResetFlag` = SRC\_SRSR\_LOCKUP\_MASK,  
    `kSRC_IppResetPinFlag` = SRC\_SRSR\_IPP\_RESET\_B\_MASK }  
    *SRC reset status flags.*
- enum `src_warm_reset_bypass_count_t` {  
    `kSRC_WarmResetWaitAlways` = 0U,  
    `kSRC_WarmResetWaitClk16` = 1U,  
    `kSRC_WarmResetWaitClk32` = 2U,  
    `kSRC_WarmResetWaitClk64` = 3U }  
    *Selection of WARM reset bypass count.*

### Functions

- static void `SRC_EnableWDOG3Reset` (SRC\_Type \*base, bool enable)  
    *Enable the WDOG3 reset.*
- static void `SRC_EnableCoreDebugResetAfterPowerGate` (SRC\_Type \*base, bool enable)  
    *Debug reset would be asserted after power gating event.*
- static void `SRC_DoSoftwareResetARMCore0` (SRC\_Type \*base)  
    *Do software reset the ARM core0 only.*
- static bool `SRC_GetSoftwareResetARMCore0Done` (SRC\_Type \*base)  
    *Check if the software for ARM core0 is done.*
- static void `SRC_EnableWDOGReset` (SRC\_Type \*base, bool enable)  
    *Enable the WDOG Reset in SRC.*

- static void [SRC\\_EnableLockupReset](#) (SRC\_Type \*base, bool enable)  
*Enable the lockup reset.*
- static uint32\_t [SRC\\_GetBootModeWord1](#) (SRC\_Type \*base)  
*Get the boot mode register 1 value.*
- static uint32\_t [SRC\\_GetBootModeWord2](#) (SRC\_Type \*base)  
*Get the boot mode register 2 value.*
- static uint32\_t [SRC\\_GetResetStatusFlags](#) (SRC\_Type \*base)  
*Get the status flags of SRC.*
- void [SRC\\_ClearResetStatusFlags](#) (SRC\_Type \*base, uint32\_t flags)  
*Clear the status flags of SRC.*
- static void [SRC\\_SetGeneralPurposeRegister](#) (SRC\_Type \*base, uint32\_t index, uint32\_t value)  
*Set value to general purpose registers.*
- static uint32\_t [SRC\\_GetGeneralPurposeRegister](#) (SRC\_Type \*base, uint32\_t index)  
*Get the value from general purpose registers.*

### Driver version

- #define [FSL\\_SRC\\_DRIVER\\_VERSION](#) ([MAKE\\_VERSION](#)(2, 0, 1))  
*SRC driver version 2.0.1.*

## 42.2 Macro Definition Documentation

### 42.2.1 #define FSL\_SRC\_DRIVER\_VERSION (MAKE\_VERSION(2, 0, 1))

## 42.3 Enumeration Type Documentation

### 42.3.1 enum \_src\_reset\_status\_flags

Enumerator

***kSRC\_TemperatureSensorResetFlag*** Indicates whether the reset was the result of software reset from on-chip Temperature Sensor. Temperature Sensor Interrupt needs to be served before this bit can be cleaned.

***kSRC\_Wdog3ResetFlag*** IC Watchdog3 Time-out reset. Indicates whether the reset was the result of the watchdog3 time-out event.

***kSRC\_JTAGSystemResetFlag*** Indicates whether the reset was the result of software reset form JTAG.

***kSRC\_JTAGSoftwareResetFlag*** Indicates whether the reset was the result of setting SJC\_GPCCR bit 31.

***kSRC\_JTAGGeneratedResetFlag*** Indicates a reset has been caused by JTAG selection of certain IR codes: EXTEST or HIGHZ.

***kSRC\_WatchdogResetFlag*** Indicates a reset has been caused by the watchdog timer timing out. This reset source can be blocked by disabling the watchdog.

***kSRC\_IppUserResetFlag*** Indicates whether the reset was the result of the ipp\_user\_reset\_b qualified reset.

***kSRC\_CsuResetFlag*** Indicates whether the reset was the result of the csu\_reset\_b input.

***kSRC\_CoreLockupResetFlag*** Indicates a reset has been caused by the ARM core indication of a LOCKUP event.



***kSRC\_IppResetPinFlag*** Indicates whether reset was the result of `ipp_reset_b` pin (Power-up sequence).

### 42.3.2 enum `src_warm_reset_bypass_count_t`

This type defines the 32KHz clock cycles to count before bypassing the MMDC acknowledge for WARM reset. If the MMDC acknowledge is not asserted before this counter is elapsed, a COLD reset will be initiated.

Enumerator

- kSRC\_WarmResetWaitAlways*** System will wait until MMDC acknowledge is asserted.
- kSRC\_WarmResetWaitClk16*** Wait 16 32KHz clock cycles before switching the reset.
- kSRC\_WarmResetWaitClk32*** Wait 32 32KHz clock cycles before switching the reset.
- kSRC\_WarmResetWaitClk64*** Wait 64 32KHz clock cycles before switching the reset.

## 42.4 Function Documentation

### 42.4.1 static void `SRC_EnableWDOG3Reset ( SRC_Type * base, bool enable ) [inline], [static]`

The WDOG3 reset is enabled by default.

Parameters

|               |                              |
|---------------|------------------------------|
| <i>base</i>   | SRC peripheral base address. |
| <i>enable</i> | Enable the reset or not.     |

### 42.4.2 static void `SRC_EnableCoreDebugResetAfterPowerGate ( SRC_Type * base, bool enable ) [inline], [static]`

Parameters

|               |                              |
|---------------|------------------------------|
| <i>base</i>   | SRC peripheral base address. |
| <i>enable</i> | Enable the reset or not.     |

### 42.4.3 static void `SRC_DoSoftwareResetARMCore0 ( SRC_Type * base ) [inline], [static]`

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | SRC peripheral base address. |
|-------------|------------------------------|

#### 42.4.4 **static bool SRC\_GetSoftwareResetARMCore0Done ( SRC\_Type \* *base* ) [inline], [static]**

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | SRC peripheral base address. |
|-------------|------------------------------|

Returns

If the reset is done.

#### 42.4.5 **static void SRC\_EnableWDOGReset ( SRC\_Type \* *base*, bool *enable* ) [inline], [static]**

WDOG Reset is enabled in SRC by default. If the WDOG event to SRC is masked, it would not create a reset to the chip. During the time the WDOG event is masked, when the WDOG event flag is asserted, it would remain asserted regardless of servicing the WDOG module. The only way to clear that bit is the hardware reset.

Parameters

|               |                              |
|---------------|------------------------------|
| <i>base</i>   | SRC peripheral base address. |
| <i>enable</i> | Enable the reset or not.     |

#### 42.4.6 **static void SRC\_EnableLockupReset ( SRC\_Type \* *base*, bool *enable* ) [inline], [static]**

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | SRC peripheral base address. |
|-------------|------------------------------|

|               |                          |
|---------------|--------------------------|
| <i>enable</i> | Enable the reset or not. |
|---------------|--------------------------|

#### 42.4.7 `static uint32_t SRC_GetBootModeWord1 ( SRC_Type * base ) [inline], [static]`

The Boot Mode register contains bits that reflect the status of BOOT\_CFGx pins of the chip. See to chip-specific document for detail information about value.

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | SRC peripheral base address. |
|-------------|------------------------------|

Returns

status of BOOT\_CFGx pins of the chip.

#### 42.4.8 `static uint32_t SRC_GetBootModeWord2 ( SRC_Type * base ) [inline], [static]`

The Boot Mode register contains bits that reflect the status of BOOT\_MODEEx Pins and fuse values that controls boot of the chip. See to chip-specific document for detail information about value.

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | SRC peripheral base address. |
|-------------|------------------------------|

Returns

status of BOOT\_MODEEx Pins and fuse values that controls boot of the chip.

#### 42.4.9 `static uint32_t SRC_GetResetStatusFlags ( SRC_Type * base ) [inline], [static]`

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | SRC peripheral base address. |
|-------------|------------------------------|

Returns

Mask value of status flags, see to [\\_src\\_reset\\_status\\_flags](#).

**42.4.10 void SRC\_ClearResetStatusFlags ( SRC\_Type \* *base*, uint32\_t *flags* )**

## Parameters

|              |                                                                                    |
|--------------|------------------------------------------------------------------------------------|
| <i>base</i>  | SRC peripheral base address.                                                       |
| <i>flags</i> | value of status flags to be cleared, see to <code>_src_reset_status_flags</code> . |

#### 42.4.11 `static void SRC_SetGeneralPurposeRegister ( SRC_Type * base, uint32_t index, uint32_t value ) [inline], [static]`

General purpose registers (GPRx) would hold the value during reset process. Wakeup function could be kept in these register. For example, the GPR1 holds the entry function for waking-up from Partial SLEEP mode while the GPR2 holds the argument. Other GPRx register would store the arbitray values.

## Parameters

|              |                                                                            |
|--------------|----------------------------------------------------------------------------|
| <i>base</i>  | SRC peripheral base address.                                               |
| <i>index</i> | The index of GPRx register array. Note index 0 reponses the GPR1 register. |
| <i>value</i> | Setting value for GPRx register.                                           |

#### 42.4.12 `static uint32_t SRC_GetGeneralPurposeRegister ( SRC_Type * base, uint32_t index ) [inline], [static]`

## Parameters

|              |                                                                            |
|--------------|----------------------------------------------------------------------------|
| <i>base</i>  | SRC peripheral base address.                                               |
| <i>index</i> | The index of GPRx register array. Note index 0 reponses the GPR1 register. |

## Returns

The setting value for GPRx register.

## Chapter 43

# TEMPMON: Temperature Monitor Module

### 43.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Temperature Monitor Module (TEMPMON) module of MCUXpresso SDK devices.

### 43.2 TEMPMON: Temperature Monitor Module

#### 43.2.1 TEMPMON Operations

The function [TEMPMON\\_Init\(\)](#) will initialize the TEMPMON peripheral operation.

The function [TEMPMON\\_Deinit\(\)](#) will deinitialize the TEMPMON peripheral operation.

The function [TEMPMON\\_GetDefaultConfig\(\)](#) will get default configuration.

The function [TEMPMON\\_StartMeasure\(\)](#) will start the temperature measurement process.

The function [TEMPMON\\_StopMeasure\(\)](#) will stop the temperature measurement process.

The function [TEMPMON\\_GetCurrentTemp\(\)](#) will get the current temperature.

The function [TEMPMON\\_SetTempAlarm\(\)](#) will set the temperature count that will generate an alarm interrupt.

### Files

- file [fsl\\_tempmon.h](#)

### Data Structures

- struct [tempmon\\_config\\_t](#)  
*TEMPMON temperature structure. [More...](#)*

### Enumerations

- enum [tempmon\\_alarm\\_mode](#) {  
    [kTEMPMON\\_HighAlarmMode](#) = 0U,  
    [kTEMPMON\\_PanicAlarmMode](#) = 1U,  
    [kTEMPMON\\_LowAlarmMode](#) = 2U }  
*TEMPMON alarm mode.*

### Functions

- void [TEMPMON\\_Init](#) (TEMPMON\_Type \*base, const [tempmon\\_config\\_t](#) \*config)

- *Initializes the TEMPMON module.*  
void [TEMPMON\\_Deinit](#) (TEMPMON\_Type \*base)
- *Deinitializes the TEMPMON module.*  
void [TEMPMON\\_GetDefaultConfig](#) ([tempmon\\_config\\_t](#) \*config)
- *Gets the default configuration structure.*  
static void [TEMPMON\\_StartMeasure](#) (TEMPMON\_Type \*base)
- *start the temperature measurement process.*  
static void [TEMPMON\\_StopMeasure](#) (TEMPMON\_Type \*base)
- *stop the measurement process.*  
float [TEMPMON\\_GetCurrentTemperature](#) (TEMPMON\_Type \*base)
- *Get current temperature with the fused temperature calibration data.*  
void [TEMPMON\\_SetTempAlarm](#) (TEMPMON\_Type \*base, int8\_t tempVal, [tempmon\\_alarm\\_mode](#) alarmMode)
- *Set the temperature count (raw sensor output) that will generate an alarm interrupt.*

### Driver version

- #define [FSL\\_TEMPMON\\_DRIVER\\_VERSION](#) ([MAKE\\_VERSION](#)(2, 1, 1))  
*TEMPMON driver version.*

## 43.3 Data Structure Documentation

### 43.3.1 struct tempmon\_config\_t

#### Data Fields

- uint16\_t [frequency](#)  
*The temperature measure frequency.*
- int8\_t [highAlarmTemp](#)  
*The high alarm temperature.*
- int8\_t [panicAlarmTemp](#)  
*The panic alarm temperature.*
- int8\_t [lowAlarmTemp](#)  
*The low alarm temperature.*

#### Field Documentation

- (1) uint16\_t tempmon\_config\_t::frequency
- (2) int8\_t tempmon\_config\_t::highAlarmTemp
- (3) int8\_t tempmon\_config\_t::panicAlarmTemp
- (4) int8\_t tempmon\_config\_t::lowAlarmTemp

## 43.4 Macro Definition Documentation

### 43.4.1 #define FSL\_TEMPMON\_DRIVER\_VERSION (MAKE\_VERSION(2, 1, 1))

## 43.5 Enumeration Type Documentation

### 43.5.1 enum tempmon\_alarm\_mode

Enumerator

- kTEMPMON\_HighAlarmMode* The high alarm temperature interrupt mode.
- kTEMPMON\_PanicAlarmMode* The panic alarm temperature interrupt mode.
- kTEMPMON\_LowAlarmMode* The low alarm temperature interrupt mode.

## 43.6 Function Documentation

### 43.6.1 void TEMPMON\_Init ( TEMPMON\_Type \* *base*, const tempmon\_config\_t \* *config* )

Parameters

|               |                                     |
|---------------|-------------------------------------|
| <i>base</i>   | TEMPMON base pointer                |
| <i>config</i> | Pointer to configuration structure. |

### 43.6.2 void TEMPMON\_Deinit ( TEMPMON\_Type \* *base* )

Parameters

|             |                      |
|-------------|----------------------|
| <i>base</i> | TEMPMON base pointer |
|-------------|----------------------|

### 43.6.3 void TEMPMON\_GetDefaultConfig ( tempmon\_config\_t \* *config* )

This function initializes the TEMPMON configuration structure to a default value. The default values are: tempmonConfig->frequency = 0x02U; tempmonConfig->highAlarmTemp = 44U; tempmonConfig->panicAlarmTemp = 90U; tempmonConfig->lowAlarmTemp = 39U;

Parameters

|               |                                       |
|---------------|---------------------------------------|
| <i>config</i> | Pointer to a configuration structure. |
|---------------|---------------------------------------|

### 43.6.4 static void TEMPMON\_StartMeasure ( TEMPMON\_Type \* *base* ) [inline], [static]



Parameters

|             |                       |
|-------------|-----------------------|
| <i>base</i> | TEMPMON base pointer. |
|-------------|-----------------------|

**43.6.5 static void TEMPMON\_StopMeasure ( TEMPMON\_Type \* *base* )  
[inline], [static]**

Parameters

|             |                      |
|-------------|----------------------|
| <i>base</i> | TEMPMON base pointer |
|-------------|----------------------|

**43.6.6 float TEMPMON\_GetCurrentTemperature ( TEMPMON\_Type \* *base* )**

Parameters

|             |                      |
|-------------|----------------------|
| <i>base</i> | TEMPMON base pointer |
|-------------|----------------------|

Returns

current temperature with degrees Celsius.

**43.6.7 void TEMPMON\_SetTempAlarm ( TEMPMON\_Type \* *base*, int8\_t *tempVal*,  
tempmon\_alarm\_mode *alarmMode* )**

Parameters

|                  |                                            |
|------------------|--------------------------------------------|
| <i>base</i>      | TEMPMON base pointer                       |
| <i>tempVal</i>   | The alarm temperature with degrees Celsius |
| <i>alarmMode</i> | The alarm mode.                            |

## Chapter 44

# TRNG: True Random Number Generator

### 44.1 Overview

The MCUXpresso SDK provides a peripheral driver for the True Random Number Generator (TRNG) module of MCUXpresso SDK devices.

The True Random Number Generator is a hardware accelerator module that generates a 512-bit entropy as needed by an entropy consuming module or by other post processing functions. A typical entropy consumer is a pseudo random number generator (PRNG) which can be implemented to achieve both true randomness and cryptographic strength random numbers using the TRNG output as its entropy seed. The entropy generated by a TRNG is intended for direct use by functions that generate secret keys, per-message secrets, random challenges, and other similar quantities used in cryptographic algorithms.

### 44.2 TRNG Initialization

1. Define the TRNG user configuration structure. Use `TRNG_InitUserConfigDefault()` function to set it to default TRNG configuration values.
2. Initialize the TRNG module, call the `TRNG_Init()` function, and pass the user configuration structure. This function automatically enables the TRNG module and its clock. After that, the TRNG is enabled and the entropy generation starts working.
3. To disable the TRNG module, call the `TRNG_Deinit()` function.

### 44.3 Get random data from TRNG

1. `TRNG_GetRandomData()` function gets random data from the TRNG module.

This example code shows how to initialize and get random data from the TRNG driver.

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/trng`

### Data Structures

- struct `trng_statistical_check_limit_t`  
*Data structure for definition of statistical check limits. [More...](#)*
- struct `trng_config_t`  
*Data structure for the TRNG initialization. [More...](#)*

### Enumerations

- enum `trng_sample_mode_t` {  
`kTRNG_SampleModeVonNeumann` = 0U,  
`kTRNG_SampleModeRaw` = 1U,  
`kTRNG_SampleModeVonNeumannRaw` }  
*TRNG sample mode.*

- enum `trng_clock_mode_t` {  
`kTRNG_ClockModeRingOscillator` = 0U,  
`kTRNG_ClockModeSystem` = 1U }  
*TRNG clock mode.*
- enum `trng_ring_osc_div_t` {  
`kTRNG_RingOscDiv0` = 0U,  
`kTRNG_RingOscDiv2` = 1U,  
`kTRNG_RingOscDiv4` = 2U,  
`kTRNG_RingOscDiv8` = 3U }  
*TRNG ring oscillator divide.*

## Functions

- `status_t TRNG_GetDefaultConfig` (`trng_config_t *userConfig`)  
*Initializes the user configuration structure to default values.*
- `status_t TRNG_Init` (`TRNG_Type *base`, `const trng_config_t *userConfig`)  
*Initializes the TRNG.*
- `void TRNG_Deinit` (`TRNG_Type *base`)  
*Shuts down the TRNG.*
- `status_t TRNG_GetRandomData` (`TRNG_Type *base`, `void *data`, `size_t dataSize`)  
*Gets random data.*

## Driver version

- `#define FSL_TRNG_DRIVER_VERSION` (`MAKE_VERSION(2, 0, 13)`)  
*TRNG driver version 2.0.13.*

## 44.4 Data Structure Documentation

### 44.4.1 struct `trng_statistical_check_limit_t`

Used by `trng_config_t`.

## Data Fields

- `uint32_t maximum`  
*Maximum limit.*
- `uint32_t minimum`  
*Minimum limit.*

## Field Documentation

(1) `uint32_t trng_statistical_check_limit_t::maximum`

(2) `uint32_t trng_statistical_check_limit_t::minimum`

#### 44.4.2 struct trng\_config\_t

This structure initializes the TRNG by calling the `TRNG_Init()` function. It contains all TRNG configurations.

##### Data Fields

- bool `lock`  
*Disable programmability of TRNG registers.*
- `trng_clock_mode_t` `clockMode`  
*Clock mode used to operate TRNG.*
- `trng_ring_osc_div_t` `ringOscDiv`  
*Ring oscillator divide used by TRNG.*
- `trng_sample_mode_t` `sampleMode`  
*Sample mode of the TRNG ring oscillator.*
- `uint16_t` `entropyDelay`  
*Entropy Delay.*
- `uint16_t` `sampleSize`  
*Sample Size.*
- `uint16_t` `sparseBitLimit`  
*Sparse Bit Limit which defines the maximum number of consecutive samples that may be discarded before an error is generated.*
- `uint8_t` `retryCount`  
*Retry count.*
- `uint8_t` `longRunMaxLimit`  
*Largest allowable number of consecutive samples of all 1, or all 0, that is allowed during the Entropy generation.*
- `trng_statistical_check_limit_t` `monobitLimit`  
*Maximum and minimum limits for statistical check of number of ones/zero detected during entropy generation.*
- `trng_statistical_check_limit_t` `runBit1Limit`  
*Maximum and minimum limits for statistical check of number of runs of length 1 detected during entropy generation.*
- `trng_statistical_check_limit_t` `runBit2Limit`  
*Maximum and minimum limits for statistical check of number of runs of length 2 detected during entropy generation.*
- `trng_statistical_check_limit_t` `runBit3Limit`  
*Maximum and minimum limits for statistical check of number of runs of length 3 detected during entropy generation.*
- `trng_statistical_check_limit_t` `runBit4Limit`  
*Maximum and minimum limits for statistical check of number of runs of length 4 detected during entropy generation.*
- `trng_statistical_check_limit_t` `runBit5Limit`  
*Maximum and minimum limits for statistical check of number of runs of length 5 detected during entropy generation.*
- `trng_statistical_check_limit_t` `runBit6PlusLimit`  
*Maximum and minimum limits for statistical check of number of runs of length 6 or more detected during entropy generation.*
- `trng_statistical_check_limit_t` `pokerLimit`

- Maximum and minimum limits for statistical check of "Poker Test".*
  - [trng\\_statistical\\_check\\_limit\\_t frequencyCountLimit](#)  
*Maximum and minimum limits for statistical check of entropy sample frequency count.*

### Field Documentation

(1) **bool trng\_config\_t::lock**

(2) **trng\_clock\_mode\_t trng\_config\_t::clockMode**

(3) **trng\_ring\_osc\_div\_t trng\_config\_t::ringOscDiv**

(4) **trng\_sample\_mode\_t trng\_config\_t::sampleMode**

(5) **uint16\_t trng\_config\_t::entropyDelay**

Defines the length (in system clocks) of each Entropy sample taken.

(6) **uint16\_t trng\_config\_t::sampleSize**

Defines the total number of Entropy samples that will be taken during Entropy generation.

(7) **uint16\_t trng\_config\_t::sparseBitLimit**

This limit is used only for during von Neumann sampling (enabled by TRNG\_HAL\_SetSampleMode()). Samples are discarded if two consecutive raw samples are both 0 or both 1. If this discarding occurs for a long period of time, it indicates that there is insufficient Entropy.

(8) **uint8\_t trng\_config\_t::retryCount**

It defines the number of times a statistical check may fails during the TRNG Entropy Generation before generating an error.

(9) **uint8\_t trng\_config\_t::longRunMaxLimit**

(10) **trng\_statistical\_check\_limit\_t trng\_config\_t::monobitLimit**

(11) **trng\_statistical\_check\_limit\_t trng\_config\_t::runBit1Limit**

(12) **trng\_statistical\_check\_limit\_t trng\_config\_t::runBit2Limit**

(13) **trng\_statistical\_check\_limit\_t trng\_config\_t::runBit3Limit**

(14) **trng\_statistical\_check\_limit\_t trng\_config\_t::runBit4Limit**

(15) **trng\_statistical\_check\_limit\_t trng\_config\_t::runBit5Limit**

(16) **trng\_statistical\_check\_limit\_t trng\_config\_t::runBit6PlusLimit**

(17) **trng\_statistical\_check\_limit\_t trng\_config\_t::pokerLimit**

(18) `trng_statistical_check_limit_t trng_config_t::frequencyCountLimit`

## 44.5 Macro Definition Documentation

### 44.5.1 `#define FSL_TRNG_DRIVER_VERSION (MAKE_VERSION(2, 0, 13))`

Current version: 2.0.13

Change log:

- version 2.0.13
  - After deepsleep it might return error, added clearing bits in [TRNG\\_GetRandomData\(\)](#) and generating new entropy.
  - Modified reloading entropy in [TRNG\\_GetRandomData\(\)](#), for some data length it doesn't reloading entropy correctly.
- version 2.0.12
  - For KW34A4\_SERIES, KW35A4\_SERIES, KW36A4\_SERIES set `TRNG_USER_CONFIG_DEFAULT_OSC_DIV` to `kTRNG_RingOscDiv8`.
- version 2.0.11
  - Add clearing pending errors in [TRNG\\_Init\(\)](#).
- version 2.0.10
  - Fixed doxygen issues.
- version 2.0.9
  - Fix HIS\_CCM metrics issues.
- version 2.0.8
  - For K32L2A41A\_SERIES set `TRNG_USER_CONFIG_DEFAULT_OSC_DIV` to `kTRNG_RingOscDiv4`.
- version 2.0.7
  - Fix MISRA 2004 issue rule 12.5.
- version 2.0.6
  - For KW35Z4\_SERIES set `TRNG_USER_CONFIG_DEFAULT_OSC_DIV` to `kTRNG_RingOscDiv8`.
- version 2.0.5
  - Add possibility to define default TRNG configuration by device specific preprocessor macros for `FRQMIN`, `FRQMAX` and `OSCDIV`.
- version 2.0.4
  - Fix MISRA-2012 issues.
- Version 2.0.3
  - update `TRNG_Init` to restart entropy generation
- Version 2.0.2
  - fix MISRA issues
- Version 2.0.1
  - add support for KL8x and KL28Z
  - update default `OSCDIV` for K81 to divide by 2

## 44.6 Enumeration Type Documentation

### 44.6.1 enum trng\_sample\_mode\_t

Used by [trng\\_config\\_t](#).

Enumerator

***kTRNG\_SampleModeVonNeumann*** Use von Neumann data in both Entropy shifter and Statistical Checker.

***kTRNG\_SampleModeRaw*** Use raw data into both Entropy shifter and Statistical Checker.

***kTRNG\_SampleModeVonNeumannRaw*** Use von Neumann data in Entropy shifter. Use raw data into Statistical Checker.

### 44.6.2 enum trng\_clock\_mode\_t

Used by [trng\\_config\\_t](#).

Enumerator

***kTRNG\_ClockModeRingOscillator*** Ring oscillator is used to operate the TRNG (default).

***kTRNG\_ClockModeSystem*** System clock is used to operate the TRNG. This is for test use only, and indeterminate results may occur.

### 44.6.3 enum trng\_ring\_osc\_div\_t

Used by [trng\\_config\\_t](#).

Enumerator

***kTRNG\_RingOscDiv0*** Ring oscillator with no divide.

***kTRNG\_RingOscDiv2*** Ring oscillator divided-by-2.

***kTRNG\_RingOscDiv4*** Ring oscillator divided-by-4.

***kTRNG\_RingOscDiv8*** Ring oscillator divided-by-8.

## 44.7 Function Documentation

### 44.7.1 status\_t TRNG\_GetDefaultConfig ( trng\_config\_t \* userConfig )

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

```
* userConfig->lock = 0;
* userConfig->clockMode = kTRNG_ClockModeRingOscillator;
* userConfig->ringOscDiv = kTRNG_RingOscDiv0; Or to other kTRNG_RingOscDiv[2|8]
 depending on the platform.
* userConfig->sampleMode = kTRNG_SampleModeRaw;
* userConfig->entropyDelay = 3200;
```

```

* userConfig->sampleSize = 2500;
* userConfig->sparseBitLimit = TRNG_USER_CONFIG_DEFAULT_SPARSE_BIT_LIMIT;
* userConfig->retryCount = 63;
* userConfig->longRunMaxLimit = 34;
* userConfig->monobitLimit.maximum = 1384;
* userConfig->monobitLimit.minimum = 1116;
* userConfig->runBit1Limit.maximum = 405;
* userConfig->runBit1Limit.minimum = 227;
* userConfig->runBit2Limit.maximum = 220;
* userConfig->runBit2Limit.minimum = 98;
* userConfig->runBit3Limit.maximum = 125;
* userConfig->runBit3Limit.minimum = 37;
* userConfig->runBit4Limit.maximum = 75;
* userConfig->runBit4Limit.minimum = 11;
* userConfig->runBit5Limit.maximum = 47;
* userConfig->runBit5Limit.minimum = 1;
* userConfig->runBit6PlusLimit.maximum = 47;
* userConfig->runBit6PlusLimit.minimum = 1;
* userConfig->pokerLimit.maximum = 26912;
* userConfig->pokerLimit.minimum = 24445;
* userConfig->frequencyCountLimit.maximum = 25600;
* userConfig->frequencyCountLimit.minimum = 1600;
*

```

Parameters

|                   |                               |
|-------------------|-------------------------------|
| <i>userConfig</i> | User configuration structure. |
|-------------------|-------------------------------|

Returns

If successful, returns the `kStatus_TRNG_Success`. Otherwise, it returns an error.

**44.7.2 status\_t TRNG\_Init ( TRNG\_Type \* base, const trng\_config\_t \* userConfig )**

This function initializes the TRNG. When called, the TRNG entropy generation starts immediately.

Parameters

|                   |                                                        |
|-------------------|--------------------------------------------------------|
| <i>base</i>       | TRNG base address                                      |
| <i>userConfig</i> | Pointer to the initialization configuration structure. |

Returns

If successful, returns the `kStatus_TRNG_Success`. Otherwise, it returns an error.

**44.7.3 void TRNG\_Deinit ( TRNG\_Type \* base )**

This function shuts down the TRNG.



Parameters

|             |                    |
|-------------|--------------------|
| <i>base</i> | TRNG base address. |
|-------------|--------------------|

#### 44.7.4 **status\_t TRNG\_GetRandomData ( TRNG\_Type \* *base*, void \* *data*, size\_t *dataSize* )**

This function gets random data from the TRNG.

Parameters

|                 |                                                   |
|-----------------|---------------------------------------------------|
| <i>base</i>     | TRNG base address.                                |
| <i>data</i>     | Pointer address used to store random data.        |
| <i>dataSize</i> | Size of the buffer pointed by the data parameter. |

Returns

random data

## Chapter 45

# USDHC: Ultra Secured Digital Host Controller Driver

### 45.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Ultra Secured Digital Host Controller (USDHC) module of MCUXpresso SDK/i.MX devices.

### 45.2 Typical use case

#### 45.2.1 USDHC Operation

Refer to the driver examples codes located at `<SDK_ROOT>/boards/<BOARD>/driver_examples/usdhc`.

#### Cache maintain capability

The uSDHC host controller is intergrated with ADMA to have better transfer performance, so to maintain data integrity during DMA operations on the platform that has cache, USDHC driver provide a cache maintain functionality by define: `FSL_SDK_ENABLE_DRIVER_CACHE_CONTROL = 1` It is suggest that the address of buffer used for read/write is align with cache line size.

#### Scatter gather transfer capability

The USDHC driver implement scatter gather transfer functionality, so application can submit uncontinuous data buffer in one transfer request by the scatter gather api, to have this feature, USDHC driver has below api `USDHC_TransferScatterGatherADMANonBlocking` This function support scatter gather transfer and cover the functionality of `USDHC_TransferNonBlocking` also, but if application would like to use the function, please enable function macro firstly, since the scatter gather functionality is disabled by default.

```
#define FSL_USDHC_ENABLE_SCATTER_GATHER_TRANSFER 1
```

Please note that once the macro is defined, the `USDHC_TransferNonBlocking` will be removed automatically.

#### Data Structures

- struct `usdhc_adma2_descriptor_t`  
*Defines the ADMA2 descriptor structure. [More...](#)*
- struct `usdhc_capability_t`  
*USDHC capability information. [More...](#)*
- struct `usdhc_boot_config_t`  
*Data structure to configure the MMC boot feature. [More...](#)*
- struct `usdhc_config_t`  
*Data structure to initialize the USDHC. [More...](#)*
- struct `usdhc_command_t`  
*Card command descriptor. [More...](#)*

- struct `usdhc_adma_config_t`  
*ADMA configuration. [More...](#)*
- struct `usdhc_scatter_gather_data_list_t`  
*Card scatter gather data list. [More...](#)*
- struct `usdhc_scatter_gather_data_t`  
*Card scatter gather data descriptor. [More...](#)*
- struct `usdhc_scatter_gather_transfer_t`  
*usdhc scatter gather transfer. [More...](#)*
- struct `usdhc_data_t`  
*Card data descriptor. [More...](#)*
- struct `usdhc_transfer_t`  
*Transfer state. [More...](#)*
- struct `usdhc_transfer_callback_t`  
*USDHC callback functions. [More...](#)*
- struct `usdhc_handle_t`  
*USDHC handle. [More...](#)*
- struct `usdhc_host_t`  
*USDHC host descriptor. [More...](#)*

## Macros

- #define `USDHC_MAX_BLOCK_COUNT` (`USDHC_BLK_ATT_BLKCNT_MASK >> USDHC_BLK_ATT_BLKCNT_SHIFT`)  
*Maximum block count can be set one time.*
- #define `FSL_USDHC_ENABLE_SCATTER_GATHER_TRANSFER` 0U  
*USDHC scatter gather feature control macro.*
- #define `USDHC_ADMA1_ADDRESS_ALIGN` (4096U)  
*The alignment size for ADDRESS filed in ADMA1's descriptor.*
- #define `USDHC_ADMA1_LENGTH_ALIGN` (4096U)  
*The alignment size for LENGTH field in ADMA1's descriptor.*
- #define `USDHC_ADMA2_ADDRESS_ALIGN` (4U)  
*The alignment size for ADDRESS field in ADMA2's descriptor.*
- #define `USDHC_ADMA2_LENGTH_ALIGN` (4U)  
*The alignment size for LENGTH filed in ADMA2's descriptor.*
- #define `USDHC_ADMA1_DESCRIPTOR_ADDRESS_SHIFT` (12U)  
*The bit shift for ADDRESS filed in ADMA1's descriptor.*
- #define `USDHC_ADMA1_DESCRIPTOR_ADDRESS_MASK` (0xFFFFFU)  
*The bit mask for ADDRESS field in ADMA1's descriptor.*
- #define `USDHC_ADMA1_DESCRIPTOR_LENGTH_SHIFT` (12U)  
*The bit shift for LENGTH filed in ADMA1's descriptor.*
- #define `USDHC_ADMA1_DESCRIPTOR_LENGTH_MASK` (0xFFFFU)  
*The mask for LENGTH field in ADMA1's descriptor.*
- #define `USDHC_ADMA1_DESCRIPTOR_MAX_LENGTH_PER_ENTRY` (`USDHC_ADMA1_DESCRIPTOR_LENGTH_MASK + 1U - 4096U`)  
*The maximum value of LENGTH filed in ADMA1's descriptor.*
- #define `USDHC_ADMA2_DESCRIPTOR_LENGTH_SHIFT` (16U)  
*The bit shift for LENGTH field in ADMA2's descriptor.*
- #define `USDHC_ADMA2_DESCRIPTOR_LENGTH_MASK` (0xFFFFU)  
*The bit mask for LENGTH field in ADMA2's descriptor.*
- #define `USDHC_ADMA2_DESCRIPTOR_MAX_LENGTH_PER_ENTRY` (`USDHC_ADMA2_DESCRIPTOR_LENGTH_MASK - 3U`)

The maximum value of *LENGTH* field in ADMA2's descriptor.

## Typedefs

- typedef uint32\_t `usdhc_adma1_descriptor_t`  
*Defines the ADMA1 descriptor structure.*
- typedef `status_t`(\* `usdhc_transfer_function_t`)(USDHC\_Type \*base, `usdhc_transfer_t` \*content)  
*USDHC transfer function.*

## Enumerations

- enum {  
`kStatus_USDHC_BusyTransferring` = MAKE\_STATUS(kStatusGroup\_USDHC, 0U),  
`kStatus_USDHC_PrepareAdmaDescriptorFailed` = MAKE\_STATUS(kStatusGroup\_USDHC, 1U),  
`kStatus_USDHC_SendCommandFailed` = MAKE\_STATUS(kStatusGroup\_USDHC, 2U),  
`kStatus_USDHC_TransferDataFailed` = MAKE\_STATUS(kStatusGroup\_USDHC, 3U),  
`kStatus_USDHC_DMADDataAddrNotAlign` = MAKE\_STATUS(kStatusGroup\_USDHC, 4U),  
`kStatus_USDHC_ReTuningRequest` = MAKE\_STATUS(kStatusGroup\_USDHC, 5U),  
`kStatus_USDHC_TuningError` = MAKE\_STATUS(kStatusGroup\_USDHC, 6U),  
`kStatus_USDHC_NotSupport` = MAKE\_STATUS(kStatusGroup\_USDHC, 7U),  
`kStatus_USDHC_TransferDataComplete` = MAKE\_STATUS(kStatusGroup\_USDHC, 8U),  
`kStatus_USDHC_SendCommandSuccess` = MAKE\_STATUS(kStatusGroup\_USDHC, 9U),  
`kStatus_USDHC_TransferDMACComplete` = MAKE\_STATUS(kStatusGroup\_USDHC, 10U) }  
*Enum \_usdhc\_status.*
- enum {  
`kUSDHC_SupportAdmaFlag` = USDHC\_HOST\_CTRL\_CAP\_ADMAS\_MASK,  
`kUSDHC_SupportHighSpeedFlag` = USDHC\_HOST\_CTRL\_CAP\_HSS\_MASK,  
`kUSDHC_SupportDmaFlag` = USDHC\_HOST\_CTRL\_CAP\_DMAS\_MASK,  
`kUSDHC_SupportSuspendResumeFlag` = USDHC\_HOST\_CTRL\_CAP\_SRS\_MASK,  
`kUSDHC_SupportV330Flag` = USDHC\_HOST\_CTRL\_CAP\_VS33\_MASK,  
`kUSDHC_SupportV300Flag` = USDHC\_HOST\_CTRL\_CAP\_VS30\_MASK,  
`kUSDHC_SupportV180Flag` = USDHC\_HOST\_CTRL\_CAP\_VS18\_MASK,  
`kUSDHC_Support4BitFlag` = (USDHC\_HOST\_CTRL\_CAP\_MBL\_SHIFT << 0U),  
`kUSDHC_Support8BitFlag` = (USDHC\_HOST\_CTRL\_CAP\_MBL\_SHIFT << 1U),  
`kUSDHC_SupportDDR50Flag` = USDHC\_HOST\_CTRL\_CAP\_DDR50\_SUPPORT\_MASK,  
`kUSDHC_SupportSDR104Flag` = USDHC\_HOST\_CTRL\_CAP\_SDR104\_SUPPORT\_MASK,  
`kUSDHC_SupportSDR50Flag` = USDHC\_HOST\_CTRL\_CAP\_SDR50\_SUPPORT\_MASK }  
*Enum \_usdhc\_capability\_flag.*
- enum {  
`kUSDHC_WakeupEventOnCardInt` = USDHC\_PROT\_CTRL\_WECINT\_MASK,  
`kUSDHC_WakeupEventOnCardInsert` = USDHC\_PROT\_CTRL\_WECINS\_MASK,  
`kUSDHC_WakeupEventOnCardRemove` = USDHC\_PROT\_CTRL\_WECRM\_MASK,  
`kUSDHC_WakeupEventsAll` }  
*Enum \_usdhc\_wakeup\_event.*
- enum {

```

kUSDHC_ResetAll = USDHC_SYS_CTRL_RSTA_MASK,
kUSDHC_ResetCommand = USDHC_SYS_CTRL_RSTC_MASK,
kUSDHC_ResetData = USDHC_SYS_CTRL_RSTD_MASK,
kUSDHC_ResetTuning = USDHC_SYS_CTRL_RSTT_MASK,
kUSDHC_ResetsAll = (kUSDHC_ResetAll | kUSDHC_ResetCommand | kUSDHC_ResetData |
kUSDHC_ResetTuning) }

```

*Enum \_usdhc\_reset.*

- enum {

```

kUSDHC_EnableDmaFlag = USDHC_MIX_CTRL_DMAEN_MASK,
kUSDHC_CommandTypeSuspendFlag = USDHC_CMD_XFR_TYP_CMDTYP(1U),
kUSDHC_CommandTypeResumeFlag = USDHC_CMD_XFR_TYP_CMDTYP(2U),
kUSDHC_CommandTypeAbortFlag = USDHC_CMD_XFR_TYP_CMDTYP(3U),
kUSDHC_EnableBlockCountFlag = USDHC_MIX_CTRL_BCEN_MASK,
kUSDHC_EnableAutoCommand12Flag = USDHC_MIX_CTRL_AC12EN_MASK,
kUSDHC_DataReadFlag = USDHC_MIX_CTRL_DTDSEL_MASK,
kUSDHC_MultipleBlockFlag = USDHC_MIX_CTRL_MSBSSEL_MASK,
kUSDHC_EnableAutoCommand23Flag = USDHC_MIX_CTRL_AC23EN_MASK,
kUSDHC_ResponseLength136Flag = USDHC_CMD_XFR_TYP_RSPTYP(1U),
kUSDHC_ResponseLength48Flag = USDHC_CMD_XFR_TYP_RSPTYP(2U),
kUSDHC_ResponseLength48BusyFlag = USDHC_CMD_XFR_TYP_RSPTYP(3U),
kUSDHC_EnableCrcCheckFlag = USDHC_CMD_XFR_TYP_CCCEN_MASK,
kUSDHC_EnableIndexCheckFlag = USDHC_CMD_XFR_TYP_CICEN_MASK,
kUSDHC_DataPresentFlag = USDHC_CMD_XFR_TYP_DPSEL_MASK }

```

*Enum \_usdhc\_transfer\_flag.*

- enum {

```

kUSDHC_CommandInhibitFlag = USDHC_PRES_STATE_CIHB_MASK,
kUSDHC_DataInhibitFlag = USDHC_PRES_STATE_CDIHB_MASK,
kUSDHC_DataLineActiveFlag = USDHC_PRES_STATE_DLA_MASK,
kUSDHC_SdClockStableFlag = USDHC_PRES_STATE_SDSTB_MASK,
kUSDHC_WriteTransferActiveFlag = USDHC_PRES_STATE_WTA_MASK,
kUSDHC_ReadTransferActiveFlag = USDHC_PRES_STATE_RTA_MASK,
kUSDHC_BufferWriteEnableFlag = USDHC_PRES_STATE_BWEN_MASK,
kUSDHC_BufferReadEnableFlag = USDHC_PRES_STATE_BREN_MASK,
kUSDHC_ReTuningRequestFlag = USDHC_PRES_STATE_RTR_MASK,
kUSDHC_DelaySettingFinishedFlag = USDHC_PRES_STATE_TSCD_MASK,
kUSDHC_CardInsertedFlag = USDHC_PRES_STATE_CINST_MASK,
kUSDHC_CommandLineLevelFlag = USDHC_PRES_STATE_CLSL_MASK,
kUSDHC_Data0LineLevelFlag = 1U << USDHC_PRES_STATE_DLSSL_SHIFT,
kUSDHC_Data1LineLevelFlag = 1U << (USDHC_PRES_STATE_DLSSL_SHIFT + 1U),
kUSDHC_Data2LineLevelFlag = 1U << (USDHC_PRES_STATE_DLSSL_SHIFT + 2U),
kUSDHC_Data3LineLevelFlag = 1U << (USDHC_PRES_STATE_DLSSL_SHIFT + 3U),
kUSDHC_Data4LineLevelFlag = 1U << (USDHC_PRES_STATE_DLSSL_SHIFT + 4U),
kUSDHC_Data5LineLevelFlag = 1U << (USDHC_PRES_STATE_DLSSL_SHIFT + 5U),
kUSDHC_Data6LineLevelFlag = 1U << (USDHC_PRES_STATE_DLSSL_SHIFT + 6U),
kUSDHC_Data7LineLevelFlag = (int)(1U << (USDHC_PRES_STATE_DLSSL_SHIFT + 7U)) }

```

- Enum \_usdhc\_present\_status\_flag.*

  - enum {
    - kUSDHC\_CommandCompleteFlag = USDHC\_INT\_STATUS\_CC\_MASK,
    - kUSDHC\_DataCompleteFlag = USDHC\_INT\_STATUS\_TC\_MASK,
    - kUSDHC\_BlockGapEventFlag = USDHC\_INT\_STATUS\_BGE\_MASK,
    - kUSDHC\_DmaCompleteFlag = USDHC\_INT\_STATUS\_DINT\_MASK,
    - kUSDHC\_BufferWriteReadyFlag = USDHC\_INT\_STATUS\_BWR\_MASK,
    - kUSDHC\_BufferReadReadyFlag = USDHC\_INT\_STATUS\_BRR\_MASK,
    - kUSDHC\_CardInsertionFlag = USDHC\_INT\_STATUS\_CINS\_MASK,
    - kUSDHC\_CardRemovalFlag = USDHC\_INT\_STATUS\_CRM\_MASK,
    - kUSDHC\_CardInterruptFlag = USDHC\_INT\_STATUS\_CINT\_MASK,
    - kUSDHC\_ReTuningEventFlag = USDHC\_INT\_STATUS\_RTE\_MASK,
    - kUSDHC\_TuningPassFlag = USDHC\_INT\_STATUS\_TP\_MASK,
    - kUSDHC\_TuningErrorFlag = USDHC\_INT\_STATUS\_TNE\_MASK,
    - kUSDHC\_CommandTimeoutFlag = USDHC\_INT\_STATUS\_CTOE\_MASK,
    - kUSDHC\_CommandCrcErrorFlag = USDHC\_INT\_STATUS\_CCE\_MASK,
    - kUSDHC\_CommandEndBitErrorFlag = USDHC\_INT\_STATUS\_CEBE\_MASK,
    - kUSDHC\_CommandIndexErrorFlag = USDHC\_INT\_STATUS\_CIE\_MASK,
    - kUSDHC\_DataTimeoutFlag = USDHC\_INT\_STATUS\_DTOE\_MASK,
    - kUSDHC\_DataCrcErrorFlag = USDHC\_INT\_STATUS\_DCE\_MASK,
    - kUSDHC\_DataEndBitErrorFlag = USDHC\_INT\_STATUS\_DEBE\_MASK,
    - kUSDHC\_AutoCommand12ErrorFlag = USDHC\_INT\_STATUS\_AC12E\_MASK,
    - kUSDHC\_DmaErrorFlag = USDHC\_INT\_STATUS\_DMAE\_MASK,
    - kUSDHC\_CommandErrorFlag,
    - kUSDHC\_DataErrorFlag,
    - kUSDHC\_ErrorFlag = (kUSDHC\_CommandErrorFlag | kUSDHC\_DataErrorFlag | kUSDHC\_DmaErrorFlag),
    - kUSDHC\_DataFlag,
    - kUSDHC\_DataDMAFlag = (kUSDHC\_DataCompleteFlag | kUSDHC\_DataErrorFlag | kUSDHC\_DmaErrorFlag),
    - kUSDHC\_CommandFlag = (kUSDHC\_CommandErrorFlag | kUSDHC\_CommandCompleteFlag),
    - kUSDHC\_CardDetectFlag = (kUSDHC\_CardInsertionFlag | kUSDHC\_CardRemovalFlag),
    - kUSDHC\_SDR104TuningFlag = (kUSDHC\_TuningErrorFlag | kUSDHC\_TuningPassFlag | kUSDHC\_ReTuningEventFlag),
    - kUSDHC\_AllInterruptFlags }
- Enum \_usdhc\_interrupt\_status\_flag.*

  - enum {
    - kUSDHC\_AutoCommand12NotExecutedFlag = USDHC\_AUTOCMD12\_ERR\_STATUS\_AC12NE\_MASK,
    - kUSDHC\_AutoCommand12TimeoutFlag = USDHC\_AUTOCMD12\_ERR\_STATUS\_AC12TOE\_MASK,
    - kUSDHC\_AutoCommand12EndBitErrorFlag = USDHC\_AUTOCMD12\_ERR\_STATUS\_AC12EBE\_MASK,
    - kUSDHC\_AutoCommand12CrcErrorFlag = USDHC\_AUTOCMD12\_ERR\_STATUS\_AC12CE\_



```

MASK,
kUSDHC_AutoCommand12IndexErrorFlag = USDHC_AUTOCMD12_ERR_STATUS_AC12IE-
_MASK,
kUSDHC_AutoCommand12NotIssuedFlag = USDHC_AUTOCMD12_ERR_STATUS_CNIBA-
C12E_MASK }
 Enum _usdhc_auto_command12_error_status_flag.
• enum {
kUSDHC_ExecuteTuning = USDHC_AUTOCMD12_ERR_STATUS_EXECUTE_TUNING_M-
ASK,
kUSDHC_TuningSampleClockSel }
 Enum _usdhc_standard_tuning.
• enum {
kUSDHC_AdmaLenghMismatchFlag = USDHC_ADMA_ERR_STATUS_ADMALME_MASK,
kUSDHC_AdmaDescriptorErrorFlag = USDHC_ADMA_ERR_STATUS_ADMADCE_MASK }
 Enum _usdhc_adma_error_status_flag.
• enum {
kUSDHC_AdmaErrorStateStopDma = 0x00U,
kUSDHC_AdmaErrorStateFetchDescriptor = 0x01U,
kUSDHC_AdmaErrorStateChangeAddress = 0x02U,
kUSDHC_AdmaErrorStateTransferData = 0x03U,
kUSDHC_AdmaErrorStateInvalidLength = 0x04U,
kUSDHC_AdmaErrorStateInvalidDescriptor = 0x08U,
kUSDHC_AdmaErrorState }
 Enum _usdhc_adma_error_state.
• enum {
kUSDHC_ForceEventAutoCommand12NotExecuted,
kUSDHC_ForceEventAutoCommand12Timeout = USDHC_FORCE_EVENT_FEVTAC12TOE_-
MASK,
kUSDHC_ForceEventAutoCommand12CrcError = USDHC_FORCE_EVENT_FEVTAC12CE_-
MASK,
kUSDHC_ForceEventEndBitError = USDHC_FORCE_EVENT_FEVTAC12EBE_MASK,
kUSDHC_ForceEventAutoCommand12IndexError = USDHC_FORCE_EVENT_FEVTAC12IE_-
MASK,
kUSDHC_ForceEventAutoCommand12NotIssued = USDHC_FORCE_EVENT_FEVTCNIBA-
C12E_MASK,
kUSDHC_ForceEventCommandTimeout = USDHC_FORCE_EVENT_FEVTC12TOE_MASK,
kUSDHC_ForceEventCommandCrcError = USDHC_FORCE_EVENT_FEVTC12CCE_MASK,
kUSDHC_ForceEventCommandEndBitError = USDHC_FORCE_EVENT_FEVTC12CEBE_MASK,
kUSDHC_ForceEventCommandIndexError = USDHC_FORCE_EVENT_FEVTC12CIE_MASK,
kUSDHC_ForceEventDataTimeout = USDHC_FORCE_EVENT_FEVTD12TOE_MASK,
kUSDHC_ForceEventDataCrcError = USDHC_FORCE_EVENT_FEVTD12CCE_MASK,
kUSDHC_ForceEventDataEndBitError = USDHC_FORCE_EVENT_FEVTD12EBE_MASK,
kUSDHC_ForceEventAutoCommand12Error = USDHC_FORCE_EVENT_FEVTAC12E_MAS-

```

- K,
- kUSDHC\_ForceEventCardInt = (int)USDHC\_FORCE\_EVENT\_FEVTCINT\_MASK,
  - kUSDHC\_ForceEventDmaError = USDHC\_FORCE\_EVENT\_FEVTDMAE\_MASK,
  - kUSDHC\_ForceEventTuningError = USDHC\_FORCE\_EVENT\_FEVTTNE\_MASK,
  - kUSDHC\_ForceEventsAll }
- Enum \_usdhc\_force\_event.*
- enum usdhc\_transfer\_direction\_t {
    - kUSDHC\_TransferDirectionReceive = 1U,
    - kUSDHC\_TransferDirectionSend = 0U }

*Data transfer direction.*
  - enum usdhc\_data\_bus\_width\_t {
    - kUSDHC\_DataBusWidth1Bit = 0U,
    - kUSDHC\_DataBusWidth4Bit = 1U,
    - kUSDHC\_DataBusWidth8Bit = 2U }

*Data transfer width.*
  - enum usdhc\_endian\_mode\_t {
    - kUSDHC\_EndianModeBig = 0U,
    - kUSDHC\_EndianModeHalfWordBig = 1U,
    - kUSDHC\_EndianModeLittle = 2U }

*Endian mode.*
  - enum usdhc\_dma\_mode\_t {
    - kUSDHC\_DmaModeSimple = 0U,
    - kUSDHC\_DmaModeAdma1 = 1U,
    - kUSDHC\_DmaModeAdma2 = 2U,
    - kUSDHC\_ExternalDMA = 3U }

*DMA mode.*
  - enum {
    - kUSDHC\_StopAtBlockGapFlag = USDHC\_PROT\_CTRL\_SABGREQ\_MASK,
    - kUSDHC\_ReadWaitControlFlag = USDHC\_PROT\_CTRL\_RWCTL\_MASK,
    - kUSDHC\_InterruptAtBlockGapFlag = USDHC\_PROT\_CTRL\_IABG\_MASK,
    - kUSDHC\_ReadDoneNo8CLK = USDHC\_PROT\_CTRL\_RD\_DONE\_NO\_8CLK\_MASK,
    - kUSDHC\_ExactBlockNumberReadFlag = USDHC\_PROT\_CTRL\_NON\_EXACT\_BLK\_RD\_MASK }

*Enum \_usdhc\_sdio\_control\_flag.*
  - enum usdhc\_boot\_mode\_t {
    - kUSDHC\_BootModeNormal = 0U,
    - kUSDHC\_BootModeAlternative = 1U }

*MMC card boot mode.*
  - enum usdhc\_card\_command\_type\_t {
    - kCARD\_CommandTypeNormal = 0U,
    - kCARD\_CommandTypeSuspend = 1U,
    - kCARD\_CommandTypeResume = 2U,
    - kCARD\_CommandTypeAbort = 3U,
    - kCARD\_CommandTypeEmpty = 4U }

*The command type.*
  - enum usdhc\_card\_response\_type\_t {



```
kCARD_ResponseTypeNone = 0U,
kCARD_ResponseTypeR1 = 1U,
kCARD_ResponseTypeR1b = 2U,
kCARD_ResponseTypeR2 = 3U,
kCARD_ResponseTypeR3 = 4U,
kCARD_ResponseTypeR4 = 5U,
kCARD_ResponseTypeR5 = 6U,
kCARD_ResponseTypeR5b = 7U,
kCARD_ResponseTypeR6 = 8U,
kCARD_ResponseTypeR7 = 9U }
```

*The command response type.*

- enum {
 

```
kUSDHC_Adma1DescriptorValidFlag = (1U << 0U),
kUSDHC_Adma1DescriptorEndFlag = (1U << 1U),
kUSDHC_Adma1DescriptorInterruptFlag = (1U << 2U),
kUSDHC_Adma1DescriptorActivity1Flag = (1U << 4U),
kUSDHC_Adma1DescriptorActivity2Flag = (1U << 5U),
kUSDHC_Adma1DescriptorTypeNop = (kUSDHC_Adma1DescriptorValidFlag),
kUSDHC_Adma1DescriptorTypeTransfer = (kUSDHC_Adma1DescriptorActivity2Flag | kUSDH-
C_Adma1DescriptorValidFlag),
kUSDHC_Adma1DescriptorTypeLink,
kUSDHC_Adma1DescriptorTypeSetLength = (kUSDHC_Adma1DescriptorActivity1Flag | kUSD-
HC_Adma1DescriptorValidFlag) }
```

*Enum \_usdhc\_adma1\_descriptor\_flag.*

- enum {
 

```
kUSDHC_Adma2DescriptorValidFlag = (1U << 0U),
kUSDHC_Adma2DescriptorEndFlag = (1U << 1U),
kUSDHC_Adma2DescriptorInterruptFlag = (1U << 2U),
kUSDHC_Adma2DescriptorActivity1Flag = (1U << 4U),
kUSDHC_Adma2DescriptorActivity2Flag = (1U << 5U),
kUSDHC_Adma2DescriptorTypeNop = (kUSDHC_Adma2DescriptorValidFlag),
kUSDHC_Adma2DescriptorTypeReserved = (kUSDHC_Adma2DescriptorActivity1Flag | kUSD-
HC_Adma2DescriptorValidFlag),
kUSDHC_Adma2DescriptorTypeTransfer = (kUSDHC_Adma2DescriptorActivity2Flag | kUSDH-
C_Adma2DescriptorValidFlag),
kUSDHC_Adma2DescriptorTypeLink }
```

*Enum \_usdhc\_adma2\_descriptor\_flag.*

- enum {
 

```
kUSDHC_AdmaDescriptorSingleFlag = 0U,
kUSDHC_AdmaDescriptorMultipleFlag }
```

*Enum \_usdhc\_adma\_flag.*

- enum usdhc\_burst\_len\_t {
 

```
kUSDHC_EnBurstLenForINCR = 0x01U,
kUSDHC_EnBurstLenForINCR4816 = 0x02U,
kUSDHC_EnBurstLenForINCR4816WRAP = 0x04U }
```

*DMA transfer burst len config.*

- enum {  
   kUSDHC\_TransferDataNormal = 0U,  
   kUSDHC\_TransferDataTuning = 1U,  
   kUSDHC\_TransferDataBoot = 2U,  
   kUSDHC\_TransferDataBootcontinuous = 3U }  
   Enum\_usdhc\_transfer\_data\_type.

## Driver version

- #define FSL\_USDHC\_DRIVER\_VERSION (MAKE\_VERSION(2U, 8U, 1U))  
   Driver version 2.8.1.

## Initialization and deinitialization

- void USDHC\_Init (USDHC\_Type \*base, const usdhc\_config\_t \*config)  
   *USDHC module initialization function.*
- void USDHC\_Deinit (USDHC\_Type \*base)  
   *Deinitializes the USDHC.*
- bool USDHC\_Reset (USDHC\_Type \*base, uint32\_t mask, uint32\_t timeout)  
   *Resets the USDHC.*

## DMA Control

- status\_t USDHC\_SetAdmaTableConfig (USDHC\_Type \*base, usdhc\_adma\_config\_t \*dmaConfig, usdhc\_data\_t \*dataConfig, uint32\_t flags)  
   *Sets the DMA descriptor table configuration.*
- status\_t USDHC\_SetInternalDmaConfig (USDHC\_Type \*base, usdhc\_adma\_config\_t \*dmaConfig, const uint32\_t \*dataAddr, bool enAutoCmd23)  
   *Internal DMA configuration.*
- status\_t USDHC\_SetADMA2Descriptor (uint32\_t \*admaTable, uint32\_t admaTableWords, const uint32\_t \*dataBufferAddr, uint32\_t dataBytes, uint32\_t flags)  
   *Sets the ADMA2 descriptor table configuration.*
- status\_t USDHC\_SetADMA1Descriptor (uint32\_t \*admaTable, uint32\_t admaTableWords, const uint32\_t \*dataBufferAddr, uint32\_t dataBytes, uint32\_t flags)  
   *Sets the ADMA1 descriptor table configuration.*
- static void USDHC\_EnableInternalDMA (USDHC\_Type \*base, bool enable)  
   *Enables internal DMA.*

## Interrupts

- static void USDHC\_EnableInterruptStatus (USDHC\_Type \*base, uint32\_t mask)  
   *Enables the interrupt status.*
- static void USDHC\_DisableInterruptStatus (USDHC\_Type \*base, uint32\_t mask)  
   *Disables the interrupt status.*
- static void USDHC\_EnableInterruptSignal (USDHC\_Type \*base, uint32\_t mask)  
   *Enables the interrupt signal corresponding to the interrupt status flag.*
- static void USDHC\_DisableInterruptSignal (USDHC\_Type \*base, uint32\_t mask)  
   *Disables the interrupt signal corresponding to the interrupt status flag.*

## Status

- static uint32\_t [USDHC\\_GetEnabledInterruptStatusFlags](#) (USDHC\_Type \*base)  
*Gets the enabled interrupt status.*
- static uint32\_t [USDHC\\_GetInterruptStatusFlags](#) (USDHC\_Type \*base)  
*Gets the current interrupt status.*
- static void [USDHC\\_ClearInterruptStatusFlags](#) (USDHC\_Type \*base, uint32\_t mask)  
*Clears a specified interrupt status.*
- static uint32\_t [USDHC\\_GetAutoCommand12ErrorStatusFlags](#) (USDHC\_Type \*base)  
*Gets the status of auto command 12 error.*
- static uint32\_t [USDHC\\_GetAdmaErrorStatusFlags](#) (USDHC\_Type \*base)  
*Gets the status of the ADMA error.*
- static uint32\_t [USDHC\\_GetPresentStatusFlags](#) (USDHC\_Type \*base)  
*Gets a present status.*

## Bus Operations

- void [USDHC\\_GetCapability](#) (USDHC\_Type \*base, [usdhc\\_capability\\_t](#) \*capability)  
*Gets the capability information.*
- static void [USDHC\\_ForceClockOn](#) (USDHC\_Type \*base, bool enable)  
*Forces the card clock on.*
- uint32\_t [USDHC\\_SetSdClock](#) (USDHC\_Type \*base, uint32\_t srcClock\_Hz, uint32\_t busClock\_Hz)  
*Sets the SD bus clock frequency.*
- bool [USDHC\\_SetCardActive](#) (USDHC\_Type \*base, uint32\_t timeout)  
*Sends 80 clocks to the card to set it to the active state.*
- static void [USDHC\\_AssertHardwareReset](#) (USDHC\_Type \*base, bool high)  
*Triggers a hardware reset.*
- static void [USDHC\\_SetDataBusWidth](#) (USDHC\_Type \*base, [usdhc\\_data\\_bus\\_width\\_t](#) width)  
*Sets the data transfer width.*
- static void [USDHC\\_WriteData](#) (USDHC\_Type \*base, uint32\_t data)  
*Fills the data port.*
- static uint32\_t [USDHC\\_ReadData](#) (USDHC\_Type \*base)  
*Retrieves the data from the data port.*
- void [USDHC\\_SendCommand](#) (USDHC\_Type \*base, [usdhc\\_command\\_t](#) \*command)  
*Sends command function.*
- static void [USDHC\\_EnableWakeupEvent](#) (USDHC\_Type \*base, uint32\_t mask, bool enable)  
*Enables or disables a wakeup event in low-power mode.*
- static void [USDHC\\_CardDetectByData3](#) (USDHC\_Type \*base, bool enable)  
*Detects card insert status.*
- static bool [USDHC\\_DetectCardInsert](#) (USDHC\_Type \*base)  
*Detects card insert status.*
- static void [USDHC\\_EnableSdioControl](#) (USDHC\_Type \*base, uint32\_t mask, bool enable)  
*Enables or disables the SDIO card control.*
- static void [USDHC\\_SetContinueRequest](#) (USDHC\_Type \*base)  
*Restarts a transaction which has stopped at the block GAP for the SDIO card.*
- static void [USDHC\\_RequestStopAtBlockGap](#) (USDHC\_Type \*base, bool enable)  
*Request stop at block gap function.*
- void [USDHC\\_SetMmcBootConfig](#) (USDHC\_Type \*base, const [usdhc\\_boot\\_config\\_t](#) \*config)  
*Configures the MMC boot feature.*
- static void [USDHC\\_EnableMmcBoot](#) (USDHC\_Type \*base, bool enable)  
*Enables or disables the mmc boot mode.*

- static void [USDHC\\_SetForceEvent](#) (USDHC\_Type \*base, uint32\_t mask)  
*Forces generating events according to the given mask.*
- static void [USDHC\\_SelectVoltage](#) (USDHC\_Type \*base, bool en18v)  
*Selects the USDHC output voltage.*
- static bool [USDHC\\_RequestTuningForSDR50](#) (USDHC\_Type \*base)  
*Checks the SDR50 mode request tuning bit.*
- static bool [USDHC\\_RequestReTuning](#) (USDHC\_Type \*base)  
*Checks the request re-tuning bit.*
- static void [USDHC\\_EnableAutoTuning](#) (USDHC\_Type \*base, bool enable)  
*The SDR104 mode auto tuning enable and disable.*
- void [USDHC\\_EnableAutoTuningForCmdAndData](#) (USDHC\_Type \*base)  
*The auto tuning enable for CMD/DATA line.*
- void [USDHC\\_EnableManualTuning](#) (USDHC\_Type \*base, bool enable)  
*Manual tuning trigger or abort.*
- static uint32\_t [USDHC\\_GetTuningDelayStatus](#) (USDHC\_Type \*base)  
*Get the tuning delay cell setting.*
- [status\\_t USDHC\\_SetTuningDelay](#) (USDHC\_Type \*base, uint32\_t preDelay, uint32\_t outDelay, uint32\_t postDelay)  
*The tuning delay cell setting.*
- [status\\_t USDHC\\_AdjustDelayForManualTuning](#) (USDHC\_Type \*base, uint32\_t delay)  
*Adjusts delay for manual tuning.*
- static void [USDHC\\_SetStandardTuningCounter](#) (USDHC\_Type \*base, uint8\_t counter)  
*set tuning counter tuning.*
- void [USDHC\\_EnableStandardTuning](#) (USDHC\_Type \*base, uint32\_t tuningStartTap, uint32\_t step, bool enable)  
*The enable standard tuning function.*
- static uint32\_t [USDHC\\_GetExecuteStdTuningStatus](#) (USDHC\_Type \*base)  
*Gets execute STD tuning status.*
- static uint32\_t [USDHC\\_CheckStdTuningResult](#) (USDHC\_Type \*base)  
*Checks STD tuning result.*
- static uint32\_t [USDHC\\_CheckTuningError](#) (USDHC\_Type \*base)  
*Checks tuning error.*
- void [USDHC\\_EnableDDRMMode](#) (USDHC\_Type \*base, bool enable, uint32\_t nibblePos)  
*The enable/disable DDR mode.*
- void [USDHC\\_SetDataConfig](#) (USDHC\_Type \*base, [usdhc\\_transfer\\_direction\\_t](#) dataDirection, uint32\_t blockCount, uint32\_t blockSize)  
*USDHC data configuration.*

## Transactional functions

- void [USDHC\\_TransferCreateHandle](#) (USDHC\_Type \*base, usdhc\_handle\_t \*handle, const [usdhc\\_transfer\\_callback\\_t](#) \*callback, void \*userData)  
*Creates the USDHC handle.*
- [status\\_t USDHC\\_TransferNonBlocking](#) (USDHC\_Type \*base, usdhc\_handle\_t \*handle, [usdhc\\_adma\\_config\\_t](#) \*dmaConfig, [usdhc\\_transfer\\_t](#) \*transfer)  
*Transfers the command/data using an interrupt and an asynchronous method.*
- [status\\_t USDHC\\_TransferBlocking](#) (USDHC\_Type \*base, [usdhc\\_adma\\_config\\_t](#) \*dmaConfig, [usdhc\\_transfer\\_t](#) \*transfer)  
*Transfers the command/data using a blocking method.*
- void [USDHC\\_TransferHandleIRQ](#) (USDHC\_Type \*base, usdhc\_handle\_t \*handle)

*IRQ handler for the USDHC.*

## 45.3 Data Structure Documentation

### 45.3.1 struct usdhc\_adma2\_descriptor\_t

#### Data Fields

- uint32\_t [attribute](#)  
*The control and status field.*
- const uint32\_t \* [address](#)  
*The address field.*

#### Field Documentation

- (1) `uint32_t usdhc_adma2_descriptor_t::attribute`
- (2) `const uint32_t* usdhc_adma2_descriptor_t::address`

### 45.3.2 struct usdhc\_capability\_t

Defines a structure to save the capability information of USDHC.

#### Data Fields

- uint32\_t [sdVersion](#)  
*Support SD card/sdio version.*
- uint32\_t [mmcVersion](#)  
*Support EMMC card version.*
- uint32\_t [maxBlockLength](#)  
*Maximum block length united as byte.*
- uint32\_t [maxBlockCount](#)  
*Maximum block count can be set one time.*
- uint32\_t [flags](#)  
*Capability flags to indicate the support information([\\_usdhc\\_capability\\_flag](#)).*

#### Field Documentation

- (1) `uint32_t usdhc_capability_t::sdVersion`
- (2) `uint32_t usdhc_capability_t::mmcVersion`
- (3) `uint32_t usdhc_capability_t::maxBlockLength`
- (4) `uint32_t usdhc_capability_t::maxBlockCount`
- (5) `uint32_t usdhc_capability_t::flags`

### 45.3.3 struct usdhc\_boot\_config\_t

#### Data Fields

- uint32\_t [ackTimeoutCount](#)  
*Timeout value for the boot ACK.*
- [usdhc\\_boot\\_mode\\_t](#) [bootMode](#)  
*Boot mode selection.*
- uint32\_t [blockCount](#)  
*Stop at block gap value of automatic mode.*
- size\_t [blockSize](#)  
*Block size.*
- bool [enableBootAck](#)  
*Enable or disable boot ACK.*
- bool [enableAutoStopAtBlockGap](#)  
*Enable or disable auto stop at block gap function in boot period.*

#### Field Documentation

##### (1) uint32\_t usdhc\_boot\_config\_t::ackTimeoutCount

The available range is 0 ~ 15.

##### (2) usdhc\_boot\_mode\_t usdhc\_boot\_config\_t::bootMode

##### (3) uint32\_t usdhc\_boot\_config\_t::blockCount

Available range is 0 ~ 65535.

##### (4) size\_t usdhc\_boot\_config\_t::blockSize

##### (5) bool usdhc\_boot\_config\_t::enableBootAck

##### (6) bool usdhc\_boot\_config\_t::enableAutoStopAtBlockGap

### 45.3.4 struct usdhc\_config\_t

#### Data Fields

- uint32\_t [dataTimeout](#)  
*Data timeout value.*
- [usdhc\\_endian\\_mode\\_t](#) [endianMode](#)  
*Endian mode.*
- uint8\_t [readWatermarkLevel](#)  
*Watermark level for DMA read operation.*
- uint8\_t [writeWatermarkLevel](#)  
*Watermark level for DMA write operation.*
- uint8\_t [readBurstLen](#)  
*Read burst len.*

- `uint8_t writeBurstLen`  
*Write burst len.*

#### Field Documentation

- (1) `uint32_t usdhc_config_t::dataTimeout`
- (2) `usdhc_endian_mode_t usdhc_config_t::endianMode`
- (3) `uint8_t usdhc_config_t::readWatermarkLevel`  
Available range is 1 ~ 128.
- (4) `uint8_t usdhc_config_t::writeWatermarkLevel`  
Available range is 1 ~ 128.
- (5) `uint8_t usdhc_config_t::readBurstLen`
- (6) `uint8_t usdhc_config_t::writeBurstLen`

### 45.3.5 struct `usdhc_command_t`

Defines card command-related attribute.

#### Data Fields

- `uint32_t index`  
*Command index.*
- `uint32_t argument`  
*Command argument.*
- `usdhc_card_command_type_t type`  
*Command type.*
- `usdhc_card_response_type_t responseType`  
*Command response type.*
- `uint32_t response [4U]`  
*Response for this command.*
- `uint32_t responseErrorFlags`  
*Response error flag, which need to check the command reponse.*
- `uint32_t flags`  
*Cmd flags.*

#### Field Documentation

- (1) `uint32_t usdhc_command_t::index`
- (2) `uint32_t usdhc_command_t::argument`



- (3) `usdhc_card_command_type_t usdhc_command_t::type`
- (4) `usdhc_card_response_type_t usdhc_command_t::responseType`
- (5) `uint32_t usdhc_command_t::response[4U]`
- (6) `uint32_t usdhc_command_t::responseErrorFlags`
- (7) `uint32_t usdhc_command_t::flags`

### 45.3.6 struct `usdhc_adma_config_t`

#### Data Fields

- `usdhc_dma_mode_t dmaMode`  
*DMA mode.*
- `usdhc_burst_len_t burstLen`  
*Burst len config.*
- `uint32_t * admaTable`  
*ADMA table address, can't be null if transfer way is ADMA1/ADMA2.*
- `uint32_t admaTableWords`  
*ADMA table length united as words, can't be 0 if transfer way is ADMA1/ADMA2.*

#### Field Documentation

- (1) `usdhc_dma_mode_t usdhc_adma_config_t::dmaMode`
- (2) `usdhc_burst_len_t usdhc_adma_config_t::burstLen`
- (3) `uint32_t* usdhc_adma_config_t::admaTable`
- (4) `uint32_t usdhc_adma_config_t::admaTableWords`

### 45.3.7 struct `usdhc_scatter_gather_data_list_t`

Allow application register uncontinuous data buffer for data transfer.

### 45.3.8 struct `usdhc_scatter_gather_data_t`

Defines a structure to contain data-related attribute. The 'enableIgnoreError' is used when upper card driver wants to ignore the error event to read/write all the data and not to stop read/write immediately when an error event happens. For example, bus testing procedure for MMC card.

#### Data Fields

- bool `enableAutoCommand12`



- *Enable auto CMD12.*
- bool [enableAutoCommand12](#)
- *Enable auto CMD23.*
- bool [enableIgnoreError](#)
- *Enable to ignore error event to read/write all the data.*
- [usdhc\\_transfer\\_direction\\_t](#) [dataDirection](#)
- *data direction*
- [uint8\\_t](#) [dataType](#)
- *this is used to distinguish the normal/tuning/boot data.*
- [size\\_t](#) [blockSize](#)
- *Block size.*
- [usdhc\\_scatter\\_gather\\_data\\_list\\_t](#) [sgData](#)
- *scatter gather data*

### Field Documentation

- (1) **bool** [usdhc\\_scatter\\_gather\\_data\\_t::enableAutoCommand12](#)
- (2) **bool** [usdhc\\_scatter\\_gather\\_data\\_t::enableAutoCommand23](#)
- (3) **bool** [usdhc\\_scatter\\_gather\\_data\\_t::enableIgnoreError](#)
- (4) **uint8\_t** [usdhc\\_scatter\\_gather\\_data\\_t::dataType](#)
- (5) **size\_t** [usdhc\\_scatter\\_gather\\_data\\_t::blockSize](#)

### 45.3.9 struct [usdhc\\_scatter\\_gather\\_transfer\\_t](#)

#### Data Fields

- [usdhc\\_scatter\\_gather\\_data\\_t](#) \* [data](#)
- *Data to transfer.*
- [usdhc\\_command\\_t](#) \* [command](#)
- *Command to send.*

### Field Documentation

- (1) **[usdhc\\_scatter\\_gather\\_data\\_t](#)**\* **[usdhc\\_scatter\\_gather\\_transfer\\_t::data](#)**
- (2) **[usdhc\\_command\\_t](#)**\* **[usdhc\\_scatter\\_gather\\_transfer\\_t::command](#)**

### 45.3.10 struct [usdhc\\_data\\_t](#)

Defines a structure to contain data-related attribute. The 'enableIgnoreError' is used when upper card driver wants to ignore the error event to read/write all the data and not to stop read/write immediately when an error event happens. For example, bus testing procedure for MMC card.

## Data Fields

- bool [enableAutoCommand12](#)  
*Enable auto CMD12.*
- bool [enableAutoCommand23](#)  
*Enable auto CMD23.*
- bool [enableIgnoreError](#)  
*Enable to ignore error event to read/write all the data.*
- uint8\_t [dataType](#)  
*this is used to distinguish the normal/tuning/boot data.*
- size\_t [blockSize](#)  
*Block size.*
- uint32\_t [blockCount](#)  
*Block count.*
- uint32\_t \* [rxData](#)  
*Buffer to save data read.*
- const uint32\_t \* [txData](#)  
*Data buffer to write.*

### Field Documentation

- (1) **bool** `usdhc_data_t::enableAutoCommand12`
- (2) **bool** `usdhc_data_t::enableAutoCommand23`
- (3) **bool** `usdhc_data_t::enableIgnoreError`
- (4) **uint8\_t** `usdhc_data_t::dataType`
- (5) **size\_t** `usdhc_data_t::blockSize`
- (6) **uint32\_t** `usdhc_data_t::blockCount`
- (7) **uint32\_t\*** `usdhc_data_t::rxData`
- (8) **const uint32\_t\*** `usdhc_data_t::txData`

### 45.3.11 struct usdhc\_transfer\_t

## Data Fields

- [usdhc\\_data\\_t](#) \* `data`  
*Data to transfer.*
- [usdhc\\_command\\_t](#) \* `command`  
*Command to send.*

### Field Documentation

- (1) **usdhc\_data\_t\*** `usdhc_transfer_t::data`

(2) `usdhc_command_t* usdhc_transfer_t::command`

### 45.3.12 struct `usdhc_transfer_callback_t`

#### Data Fields

- `void(* CardInserted)(USDHC_Type *base, void *userData)`  
*Card inserted occurs when DAT3/CD pin is for card detect.*
- `void(* CardRemoved)(USDHC_Type *base, void *userData)`  
*Card removed occurs.*
- `void(* SdioInterrupt)(USDHC_Type *base, void *userData)`  
*SDIO card interrupt occurs.*
- `void(* BlockGap)(USDHC_Type *base, void *userData)`  
*stopped at block gap event*
- `void(* TransferComplete)(USDHC_Type *base, usdhc_handle_t *handle, status_t status, void *userData)`  
*Transfer complete callback.*
- `void(* ReTuning)(USDHC_Type *base, void *userData)`  
*Handle the re-tuning.*

#### Field Documentation

(1) `void(* usdhc_transfer_callback_t::TransferComplete)(USDHC_Type *base, usdhc_handle_t *handle, status_t status, void *userData)`

(2) `void(* usdhc_transfer_callback_t::ReTuning)(USDHC_Type *base, void *userData)`

### 45.3.13 struct `_usdhc_handle`

USDHC handle typedef.

Defines the structure to save the USDHC state information and callback function.

Note

All the fields except `interruptFlags` and `transferredWords` must be allocated by the user.

#### Data Fields

- `usdhc_data_t *volatile data`  
*Transfer parameter.*
- `usdhc_command_t *volatile command`  
*Transfer parameter.*
- `volatile uint32_t transferredWords`  
*Transfer status.*
- `usdhc_transfer_callback_t callback`  
*Callback function.*
- `void * userData`  
*Parameter for transfer complete callback.*

**Field Documentation****(1) `usdhc_data_t* volatile usdhc_handle_t::data`**

Data to transfer.

**(2) `usdhc_command_t* volatile usdhc_handle_t::command`**

Command to send.

**(3) `volatile uint32_t usdhc_handle_t::transferredWords`**

Words transferred by DATAPORT way.

**(4) `usdhc_transfer_callback_t usdhc_handle_t::callback`****(5) `void* usdhc_handle_t::userData`****45.3.14 struct `usdhc_host_t`****Data Fields**

- `USDHC_Type * base`  
*USDHC peripheral base address.*
- `uint32_t sourceClock_Hz`  
*USDHC source clock frequency united in Hz.*
- `usdhc_config_t config`  
*USDHC configuration.*
- `usdhc_capability_t capability`  
*USDHC capability information.*
- `usdhc_transfer_function_t transfer`  
*USDHC transfer function.*

**Field Documentation****(1) `USDHC_Type* usdhc_host_t::base`****(2) `uint32_t usdhc_host_t::sourceClock_Hz`****(3) `usdhc_config_t usdhc_host_t::config`****(4) `usdhc_capability_t usdhc_host_t::capability`****(5) `usdhc_transfer_function_t usdhc_host_t::transfer`****45.4 Macro Definition Documentation****45.4.1 `#define FSL_USDHC_DRIVER_VERSION (MAKE_VERSION(2U, 8U, 1U))`**

45.4.2 #define USDHC\_ADMA1\_ADDRESS\_ALIGN (4096U)

45.4.3 #define USDHC\_ADMA1\_LENGTH\_ALIGN (4096U)

45.4.4 #define USDHC\_ADMA2\_ADDRESS\_ALIGN (4U)

45.4.5 #define USDHC\_ADMA2\_LENGTH\_ALIGN (4U)

45.4.6 #define USDHC\_ADMA1\_DESCRIPTOR\_ADDRESS\_SHIFT (12U)

| Address/page field     | Reserved | Attribute |      |    |     |    |
|------------------------|----------|-----------|------|----|-----|----|
| 31 12                  | 11 6     | 05        | 04   | 03 | 02  | 01 |
| address or data length | 000000   | Act2      | Act1 | 0  | Int | 0  |

ADMA1 descriptor table

| Act2 | Act1 | Comment         | 31-28              | 27-12       |
|------|------|-----------------|--------------------|-------------|
| 0    | 0    | No op           | Don't care         |             |
| 0    | 1    | Set data length | 0000               | Data Length |
| 1    | 0    | Transfer data   | Data address       |             |
| 1    | 1    | Link descriptor | Descriptor address |             |

ADMA2 action

45.4.7 #define USDHC\_ADMA1\_DESCRIPTOR\_ADDRESS\_MASK (0xFFFFFU)

45.4.8 #define USDHC\_ADMA1\_DESCRIPTOR\_LENGTH\_SHIFT (12U)

45.4.9 #define USDHC\_ADMA1\_DESCRIPTOR\_LENGTH\_MASK (0xFFFFFU)

**45.4.10 #define USDHC\_ADMA1\_DESCRIPTOR\_MAX\_LENGTH\_PER\_ENTRY (USDHC\_ADMA1\_DESCRIPTOR\_LENGTH\_MASK + 1U - 4096U)**

Since the max transfer size ADMA1 support is 65535 which is indivisible by 4096, so to make sure a large data load transfer (>64KB) continuously (require the data address be always align with 4096), software will set the maximum data length for ADMA1 to (64 - 4)KB.

**45.4.11 #define USDHC\_ADMA2\_DESCRIPTOR\_LENGTH\_SHIFT (16U)**

| Address field  | Length        | Reserved   | Attribute |      |    |     |
|----------------|---------------|------------|-----------|------|----|-----|
| 63 32          | 31 16         | 15 06      | 05        | 04   | 03 | 02  |
| 32-bit address | 16-bit length | 0000000000 | Act2      | Act1 | 0  | Int |

**ADMA2 descriptor table**

| Act2 | Act1 | Comment         | Operation                                                         |
|------|------|-----------------|-------------------------------------------------------------------|
| 0    | 0    | No op           | Don't care                                                        |
| 0    | 1    | Reserved        | Read this line and go to next one                                 |
| 1    | 0    | Transfer data   | Transfer data with address and length set in this descriptor line |
| 1    | 1    | Link descriptor | Link to another descriptor                                        |

**ADMA2 action**

**45.4.12 #define USDHC\_ADMA2\_DESCRIPTOR\_LENGTH\_MASK (0xFFFFU)**

**45.4.13 #define USDHC\_ADMA2\_DESCRIPTOR\_MAX\_LENGTH\_PER\_ENTRY (USDHC\_ADMA2\_DESCRIPTOR\_LENGTH\_MASK - 3U)**

**45.5 Typedef Documentation**

### 45.5.1 typedef uint32\_t usdhc\_adma1\_descriptor\_t

### 45.5.2 typedef status\_t(\* usdhc\_transfer\_function\_t)(USDHC\_Type \*base, usdhc\_transfer\_t \*content)

## 45.6 Enumeration Type Documentation

### 45.6.1 anonymous enum

USDHC status.

Enumerator

- kStatus\_USDHC\_BusyTransferring* Transfer is on-going.
- kStatus\_USDHC\_PrepareAdmaDescriptorFailed* Set DMA descriptor failed.
- kStatus\_USDHC\_SendCommandFailed* Send command failed.
- kStatus\_USDHC\_TransferDataFailed* Transfer data failed.
- kStatus\_USDHC\_DMADDataAddrNotAlign* Data address not aligned.
- kStatus\_USDHC\_ReTuningRequest* Re-tuning request.
- kStatus\_USDHC\_TuningError* Tuning error.
- kStatus\_USDHC\_NotSupport* Not support.
- kStatus\_USDHC\_TransferDataComplete* Transfer data complete.
- kStatus\_USDHC\_SendCommandSuccess* Transfer command complete.
- kStatus\_USDHC\_TransferDMAComplete* Transfer DMA complete.

### 45.6.2 anonymous enum

Host controller capabilities flag mask.

Enumerator

- kUSDHC\_SupportAdmaFlag* Support ADMA.
- kUSDHC\_SupportHighSpeedFlag* Support high-speed.
- kUSDHC\_SupportDmaFlag* Support DMA.
- kUSDHC\_SupportSuspendResumeFlag* Support suspend/resume.
- kUSDHC\_SupportV330Flag* Support voltage 3.3V.
- kUSDHC\_SupportV300Flag* Support voltage 3.0V.
- kUSDHC\_SupportV180Flag* Support voltage 1.8V.
- kUSDHC\_Support4BitFlag* Flag in HTCAPBLT\_MBL's position, supporting 4-bit mode.
- kUSDHC\_Support8BitFlag* Flag in HTCAPBLT\_MBL's position, supporting 8-bit mode.
- kUSDHC\_SupportDDR50Flag* SD version 3.0 new feature, supporting DDR50 mode.
- kUSDHC\_SupportSDR104Flag* Support SDR104 mode.
- kUSDHC\_SupportSDR50Flag* Support SDR50 mode.

### 45.6.3 anonymous enum

Wakeup event mask.

Enumerator

*kUSDHC\_WakeupEventOnCardInt* Wakeup on card interrupt.  
*kUSDHC\_WakeupEventOnCardInsert* Wakeup on card insertion.  
*kUSDHC\_WakeupEventOnCardRemove* Wakeup on card removal.  
*kUSDHC\_WakeupEventsAll* All wakeup events.

### 45.6.4 anonymous enum

Reset type mask.

Enumerator

*kUSDHC\_ResetAll* Reset all except card detection.  
*kUSDHC\_ResetCommand* Reset command line.  
*kUSDHC\_ResetData* Reset data line.  
*kUSDHC\_ResetTuning* Reset tuning circuit.  
*kUSDHC\_ResetsAll* All reset types.

### 45.6.5 anonymous enum

Transfer flag mask.

Enumerator

*kUSDHC\_EnableDmaFlag* Enable DMA.  
*kUSDHC\_CommandTypeSuspendFlag* Suspend command.  
*kUSDHC\_CommandTypeResumeFlag* Resume command.  
*kUSDHC\_CommandTypeAbortFlag* Abort command.  
*kUSDHC\_EnableBlockCountFlag* Enable block count.  
*kUSDHC\_EnableAutoCommand12Flag* Enable auto CMD12.  
*kUSDHC\_DataReadFlag* Enable data read.  
*kUSDHC\_MultipleBlockFlag* Multiple block data read/write.  
*kUSDHC\_EnableAutoCommand23Flag* Enable auto CMD23.  
*kUSDHC\_ResponseLength136Flag* 136-bit response length.  
*kUSDHC\_ResponseLength48Flag* 48-bit response length.  
*kUSDHC\_ResponseLength48BusyFlag* 48-bit response length with busy status.  
*kUSDHC\_EnableCrcCheckFlag* Enable CRC check.  
*kUSDHC\_EnableIndexCheckFlag* Enable index check.  
*kUSDHC\_DataPresentFlag* Data present flag.



### 45.6.6 anonymous enum

Present status flag mask.

Enumerator

*kUSDHC\_CommandInhibitFlag* Command inhibit.  
*kUSDHC\_DataInhibitFlag* Data inhibit.  
*kUSDHC\_DataLineActiveFlag* Data line active.  
*kUSDHC\_SdClockStableFlag* SD bus clock stable.  
*kUSDHC\_WriteTransferActiveFlag* Write transfer active.  
*kUSDHC\_ReadTransferActiveFlag* Read transfer active.  
*kUSDHC\_BufferWriteEnableFlag* Buffer write enable.  
*kUSDHC\_BufferReadEnableFlag* Buffer read enable.  
*kUSDHC\_ReTuningRequestFlag* Re-tuning request flag, only used for SDR104 mode.  
*kUSDHC\_DelaySettingFinishedFlag* Delay setting finished flag.  
*kUSDHC\_CardInsertedFlag* Card inserted.  
*kUSDHC\_CommandLineLevelFlag* Command line signal level.  
*kUSDHC\_Data0LineLevelFlag* Data0 line signal level.  
*kUSDHC\_Data1LineLevelFlag* Data1 line signal level.  
*kUSDHC\_Data2LineLevelFlag* Data2 line signal level.  
*kUSDHC\_Data3LineLevelFlag* Data3 line signal level.  
*kUSDHC\_Data4LineLevelFlag* Data4 line signal level.  
*kUSDHC\_Data5LineLevelFlag* Data5 line signal level.  
*kUSDHC\_Data6LineLevelFlag* Data6 line signal level.  
*kUSDHC\_Data7LineLevelFlag* Data7 line signal level.

### 45.6.7 anonymous enum

Interrupt status flag mask.

Enumerator

*kUSDHC\_CommandCompleteFlag* Command complete.  
*kUSDHC\_DataCompleteFlag* Data complete.  
*kUSDHC\_BlockGapEventFlag* Block gap event.  
*kUSDHC\_DmaCompleteFlag* DMA interrupt.  
*kUSDHC\_BufferWriteReadyFlag* Buffer write ready.  
*kUSDHC\_BufferReadReadyFlag* Buffer read ready.  
*kUSDHC\_CardInsertionFlag* Card inserted.  
*kUSDHC\_CardRemovalFlag* Card removed.  
*kUSDHC\_CardInterruptFlag* Card interrupt.  
*kUSDHC\_ReTuningEventFlag* Re-Tuning event, only for SD3.0 SDR104 mode.  
*kUSDHC\_TuningPassFlag* SDR104 mode tuning pass flag.  
*kUSDHC\_TuningErrorFlag* SDR104 tuning error flag.

*kUSDHC\_CommandTimeoutFlag* Command timeout error.  
*kUSDHC\_CommandCrcErrorFlag* Command CRC error.  
*kUSDHC\_CommandEndBitErrorFlag* Command end bit error.  
*kUSDHC\_CommandIndexErrorFlag* Command index error.  
*kUSDHC\_DataTimeoutFlag* Data timeout error.  
*kUSDHC\_DataCrcErrorFlag* Data CRC error.  
*kUSDHC\_DataEndBitErrorFlag* Data end bit error.  
*kUSDHC\_AutoCommand12ErrorFlag* Auto CMD12 error.  
*kUSDHC\_DmaErrorFlag* DMA error.  
*kUSDHC\_CommandErrorFlag* Command error.  
*kUSDHC\_DataErrorFlag* Data error.  
*kUSDHC\_ErrorFlag* All error.  
*kUSDHC\_DataFlag* Data interrupts.  
*kUSDHC\_DataDMAFlag* Data interrupts.  
*kUSDHC\_CommandFlag* Command interrupts.  
*kUSDHC\_CardDetectFlag* Card detection interrupts.  
*kUSDHC\_SDR104TuningFlag* SDR104 tuning flag.  
*kUSDHC\_AllInterruptFlags* All flags mask.

#### 45.6.8 anonymous enum

Auto CMD12 error status flag mask.

Enumerator

*kUSDHC\_AutoCommand12NotExecutedFlag* Not executed error.  
*kUSDHC\_AutoCommand12TimeoutFlag* Timeout error.  
*kUSDHC\_AutoCommand12EndBitErrorFlag* End bit error.  
*kUSDHC\_AutoCommand12CrcErrorFlag* CRC error.  
*kUSDHC\_AutoCommand12IndexErrorFlag* Index error.  
*kUSDHC\_AutoCommand12NotIssuedFlag* Not issued error.

#### 45.6.9 anonymous enum

Standard tuning flag.

Enumerator

*kUSDHC\_ExecuteTuning* Used to start tuning procedure.  
*kUSDHC\_TuningSampleClockSel* When `std_tuning_en` bit is set, this bit is used to select sampling clock.

### 45.6.10 anonymous enum

ADMA error status flag mask.

Enumerator

*kUSDHC\_AdmaLenghMismatchFlag* Length mismatch error.  
*kUSDHC\_AdmaDescriptorErrorFlag* Descriptor error.

### 45.6.11 anonymous enum

ADMA error state.

This state is the detail state when ADMA error has occurred.

Enumerator

*kUSDHC\_AdmaErrorStateStopDma* Stop DMA, previous location set in the ADMA system address is errored address.  
*kUSDHC\_AdmaErrorStateFetchDescriptor* Fetch descriptor, current location set in the ADMA system address is errored address.  
*kUSDHC\_AdmaErrorStateChangeAddress* Change address, no DMA error has occurred.  
*kUSDHC\_AdmaErrorStateTransferData* Transfer data, previous location set in the ADMA system address is errored address.  
*kUSDHC\_AdmaErrorStateInvalidLength* Invalid length in ADMA descriptor.  
*kUSDHC\_AdmaErrorStateInvalidDescriptor* Invalid descriptor fetched by ADMA.  
*kUSDHC\_AdmaErrorState* ADMA error state.

### 45.6.12 anonymous enum

Force event bit position.

Enumerator

*kUSDHC\_ForceEventAutoCommand12NotExecuted* Auto CMD12 not executed error.  
*kUSDHC\_ForceEventAutoCommand12Timeout* Auto CMD12 timeout error.  
*kUSDHC\_ForceEventAutoCommand12CrcError* Auto CMD12 CRC error.  
*kUSDHC\_ForceEventEndBitError* Auto CMD12 end bit error.  
*kUSDHC\_ForceEventAutoCommand12IndexError* Auto CMD12 index error.  
*kUSDHC\_ForceEventAutoCommand12NotIssued* Auto CMD12 not issued error.  
*kUSDHC\_ForceEventCommandTimeout* Command timeout error.  
*kUSDHC\_ForceEventCommandCrcError* Command CRC error.  
*kUSDHC\_ForceEventCommandEndBitError* Command end bit error.  
*kUSDHC\_ForceEventCommandIndexError* Command index error.  
*kUSDHC\_ForceEventDataTimeout* Data timeout error.

*kUSDHC\_ForceEventDataCrcError* Data CRC error.  
*kUSDHC\_ForceEventDataEndBitError* Data end bit error.  
*kUSDHC\_ForceEventAutoCommand12Error* Auto CMD12 error.  
*kUSDHC\_ForceEventCardInt* Card interrupt.  
*kUSDHC\_ForceEventDmaError* Dma error.  
*kUSDHC\_ForceEventTuningError* Tuning error.  
*kUSDHC\_ForceEventsAll* All force event flags mask.

#### 45.6.13 enum usdhc\_transfer\_direction\_t

Enumerator

*kUSDHC\_TransferDirectionReceive* USDHC transfer direction receive.  
*kUSDHC\_TransferDirectionSend* USDHC transfer direction send.

#### 45.6.14 enum usdhc\_data\_bus\_width\_t

Enumerator

*kUSDHC\_DataBusWidth1Bit* 1-bit mode  
*kUSDHC\_DataBusWidth4Bit* 4-bit mode  
*kUSDHC\_DataBusWidth8Bit* 8-bit mode

#### 45.6.15 enum usdhc\_endian\_mode\_t

Enumerator

*kUSDHC\_EndianModeBig* Big endian mode.  
*kUSDHC\_EndianModeHalfWordBig* Half word big endian mode.  
*kUSDHC\_EndianModeLittle* Little endian mode.

#### 45.6.16 enum usdhc\_dma\_mode\_t

Enumerator

*kUSDHC\_DmaModeSimple* External DMA.  
*kUSDHC\_DmaModeAdma1* ADMA1 is selected.  
*kUSDHC\_DmaModeAdma2* ADMA2 is selected.  
*kUSDHC\_ExternalDMA* External DMA mode selected.

### 45.6.17 anonymous enum

SDIO control flag mask.

Enumerator

*kUSDHC\_StopAtBlockGapFlag* Stop at block gap.  
*kUSDHC\_ReadWaitControlFlag* Read wait control.  
*kUSDHC\_InterruptAtBlockGapFlag* Interrupt at block gap.  
*kUSDHC\_ReadDoneNo8CLK* Read done without 8 clk for block gap.  
*kUSDHC\_ExactBlockNumberReadFlag* Exact block number read.

### 45.6.18 enum usdhc\_boot\_mode\_t

Enumerator

*kUSDHC\_BootModeNormal* Normal boot.  
*kUSDHC\_BootModeAlternative* Alternative boot.

### 45.6.19 enum usdhc\_card\_command\_type\_t

Enumerator

*kCARD\_CommandTypeNormal* Normal command.  
*kCARD\_CommandTypeSuspend* Suspend command.  
*kCARD\_CommandTypeResume* Resume command.  
*kCARD\_CommandTypeAbort* Abort command.  
*kCARD\_CommandTypeEmpty* Empty command.

### 45.6.20 enum usdhc\_card\_response\_type\_t

Defines the command response type from card to host controller.

Enumerator

*kCARD\_ResponseTypeNone* Response type: none.  
*kCARD\_ResponseTypeR1* Response type: R1.  
*kCARD\_ResponseTypeR1b* Response type: R1b.  
*kCARD\_ResponseTypeR2* Response type: R2.  
*kCARD\_ResponseTypeR3* Response type: R3.  
*kCARD\_ResponseTypeR4* Response type: R4.  
*kCARD\_ResponseTypeR5* Response type: R5.

*kCARD\_ResponseTypeR5b* Response type: R5b.  
*kCARD\_ResponseTypeR6* Response type: R6.  
*kCARD\_ResponseTypeR7* Response type: R7.

### 45.6.21 anonymous enum

The mask for the control/status field in ADMA1 descriptor.

Enumerator

*kUSDHC\_Adma1DescriptorValidFlag* Valid flag.  
*kUSDHC\_Adma1DescriptorEndFlag* End flag.  
*kUSDHC\_Adma1DescriptorInterruptFlag* Interrupt flag.  
*kUSDHC\_Adma1DescriptorActivity1Flag* Activity 1 flag.  
*kUSDHC\_Adma1DescriptorActivity2Flag* Activity 2 flag.  
*kUSDHC\_Adma1DescriptorTypeNop* No operation.  
*kUSDHC\_Adma1DescriptorTypeTransfer* Transfer data.  
*kUSDHC\_Adma1DescriptorTypeLink* Link descriptor.  
*kUSDHC\_Adma1DescriptorTypeSetLength* Set data length.

### 45.6.22 anonymous enum

ADMA1 descriptor control and status mask.

Enumerator

*kUSDHC\_Adma2DescriptorValidFlag* Valid flag.  
*kUSDHC\_Adma2DescriptorEndFlag* End flag.  
*kUSDHC\_Adma2DescriptorInterruptFlag* Interrupt flag.  
*kUSDHC\_Adma2DescriptorActivity1Flag* Activity 1 mask.  
*kUSDHC\_Adma2DescriptorActivity2Flag* Activity 2 mask.  
*kUSDHC\_Adma2DescriptorTypeNop* No operation.  
*kUSDHC\_Adma2DescriptorTypeReserved* Reserved.  
*kUSDHC\_Adma2DescriptorTypeTransfer* Transfer type.  
*kUSDHC\_Adma2DescriptorTypeLink* Link type.

### 45.6.23 anonymous enum

ADMA descriptor configuration flag.

Enumerator

*kUSDHC\_AdmaDescriptorSingleFlag* Try to finish the transfer in a single ADMA descriptor. If transfer size is bigger than one ADMA descriptor's ability, new another descriptor for data transfer.

***kUSDHC\_AdmaDescriptorMultipleFlag*** Create multiple ADMA descriptors within the ADMA table, this is used for mmc boot mode specifically, which need to modify the ADMA descriptor on the fly, so the flag should be used combining with stop at block gap feature.

#### 45.6.24 enum usdhc\_burst\_len\_t

Enumerator

***kUSDHC\_EnBurstLenForINCR*** Enable burst len for INCR.

***kUSDHC\_EnBurstLenForINCR4816*** Enable burst len for INCR4/INCR8/INCR16.

***kUSDHC\_EnBurstLenForINCR4816WRAP*** Enable burst len for INCR4/8/16 WRAP.

#### 45.6.25 anonymous enum

Transfer data type definition.

Enumerator

***kUSDHC\_TransferDataNormal*** Transfer normal read/write data.

***kUSDHC\_TransferDataTuning*** Transfer tuning data.

***kUSDHC\_TransferDataBoot*** Transfer boot data.

***kUSDHC\_TransferDataBootcontinuous*** Transfer boot data continuously.

### 45.7 Function Documentation

#### 45.7.1 void USDHC\_Init ( USDHC\_Type \* *base*, const usdhc\_config\_t \* *config* )

Configures the USDHC according to the user configuration.

Example:

```
usdhc_config_t config;
config.cardDetectDat3 = false;
config.endianMode = kUSDHC_EndianModeLittle;
config.dmaMode = kUSDHC_DmaModeAdma2;
config.readWatermarkLevel = 128U;
config.writeWatermarkLevel = 128U;
USDHC_Init(USDHC, &config);
```

Parameters

---

|               |                                  |
|---------------|----------------------------------|
| <i>base</i>   | USDHC peripheral base address.   |
| <i>config</i> | USDHC configuration information. |

Return values

|                        |                       |
|------------------------|-----------------------|
| <i>kStatus_Success</i> | Operate successfully. |
|------------------------|-----------------------|

#### 45.7.2 void USDHC\_Deinit ( USDHC\_Type \* *base* )

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

#### 45.7.3 bool USDHC\_Reset ( USDHC\_Type \* *base*, uint32\_t *mask*, uint32\_t *timeout* )

Parameters

|                |                                                      |
|----------------|------------------------------------------------------|
| <i>base</i>    | USDHC peripheral base address.                       |
| <i>mask</i>    | The reset type mask( <a href="#">_usdhc_reset</a> ). |
| <i>timeout</i> | Timeout for reset.                                   |

Return values

|              |                     |
|--------------|---------------------|
| <i>true</i>  | Reset successfully. |
| <i>false</i> | Reset failed.       |

#### 45.7.4 status\_t USDHC\_SetAdmaTableConfig ( USDHC\_Type \* *base*, usdhc\_adma\_config\_t \* *dmaConfig*, usdhc\_data\_t \* *dataConfig*, uint32\_t *flags* )

A high level DMA descriptor configuration function.



## Parameters

|                   |                                                                                                                                         |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i>       | USDHC peripheral base address.                                                                                                          |
| <i>dmaConfig</i>  | ADMA configuration                                                                                                                      |
| <i>dataConfig</i> | Data descriptor                                                                                                                         |
| <i>flags</i>      | ADAM descriptor flag, used to indicate to create multiple or single descriptor, please refer to enum <a href="#">_usdhc_adma_flag</a> . |

## Return values

|                                    |                                                             |
|------------------------------------|-------------------------------------------------------------|
| <a href="#">kStatus_OutOfRange</a> | ADMA descriptor table length isn't enough to describe data. |
| <a href="#">kStatus_Success</a>    | Operate successfully.                                       |

**45.7.5 status\_t USDHC\_SetInternalDmaConfig ( USDHC\_Type \* *base*, usdhc\_adma\_config\_t \* *dmaConfig*, const uint32\_t \* *dataAddr*, bool *enAutoCmd23* )**

This function is used to config the USDHC DMA related registers.

## Parameters

|                    |                                                                                                           |
|--------------------|-----------------------------------------------------------------------------------------------------------|
| <i>base</i>        | USDHC peripheral base address.                                                                            |
| <i>dmaConfig</i>   | ADMA configuration.                                                                                       |
| <i>dataAddr</i>    | Transfer data address, a simple DMA parameter, if ADMA is used, leave it to NULL.                         |
| <i>enAutoCmd23</i> | Flag to indicate Auto CMD23 is enable or not, a simple DMA parameter, if ADMA is used, leave it to false. |

## Return values

|                                    |                                                             |
|------------------------------------|-------------------------------------------------------------|
| <a href="#">kStatus_OutOfRange</a> | ADMA descriptor table length isn't enough to describe data. |
| <a href="#">kStatus_Success</a>    | Operate successfully.                                       |

**45.7.6 status\_t USDHC\_SetADMA2Descriptor ( uint32\_t \* *admaTable*, uint32\_t *admaTableWords*, const uint32\_t \* *dataBufferAddr*, uint32\_t *dataBytes*, uint32\_t *flags* )**

## Parameters

|                             |                                                                                                                                         |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| <i>admaTable</i>            | ADMA table address.                                                                                                                     |
| <i>admaTable-<br/>Words</i> | ADMA table length.                                                                                                                      |
| <i>dataBufferAddr</i>       | Data buffer address.                                                                                                                    |
| <i>dataBytes</i>            | Data Data length.                                                                                                                       |
| <i>flags</i>                | ADAM descriptor flag, used to indicate to create multiple or single descriptor, please refer to enum <a href="#">_usdhc_adma_flag</a> . |

## Return values

|                           |                                                             |
|---------------------------|-------------------------------------------------------------|
| <i>kStatus_OutOfRange</i> | ADMA descriptor table length isn't enough to describe data. |
| <i>kStatus_Success</i>    | Operate successfully.                                       |

**45.7.7** `status_t USDHC_SetADMA1Descriptor ( uint32_t * admaTable, uint32_t admaTableWords, const uint32_t * dataBufferAddr, uint32_t dataBytes, uint32_t flags )`

## Parameters

|                             |                                                                                                                                         |
|-----------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| <i>admaTable</i>            | ADMA table address.                                                                                                                     |
| <i>admaTable-<br/>Words</i> | ADMA table length.                                                                                                                      |
| <i>dataBufferAddr</i>       | Data buffer address.                                                                                                                    |
| <i>dataBytes</i>            | Data length.                                                                                                                            |
| <i>flags</i>                | ADAM descriptor flag, used to indicate to create multiple or single descriptor, please refer to enum <a href="#">_usdhc_adma_flag</a> . |

## Return values

|                           |                                                             |
|---------------------------|-------------------------------------------------------------|
| <i>kStatus_OutOfRange</i> | ADMA descriptor table length isn't enough to describe data. |
| <i>kStatus_Success</i>    | Operate successfully.                                       |

**45.7.8** `static void USDHC_EnableInternalDMA ( USDHC_Type * base, bool enable ) [inline], [static]`

Parameters

|               |                                |
|---------------|--------------------------------|
| <i>base</i>   | USDHC peripheral base address. |
| <i>enable</i> | enable or disable flag         |

**45.7.9 static void USDHC\_EnableInterruptStatus ( USDHC\_Type \* *base*, uint32\_t *mask* ) [inline], [static]**

Parameters

|             |                                                                              |
|-------------|------------------------------------------------------------------------------|
| <i>base</i> | USDHC peripheral base address.                                               |
| <i>mask</i> | Interrupt status flags mask( <a href="#">_usdhc_interrupt_status_flag</a> ). |

**45.7.10 static void USDHC\_DisableInterruptStatus ( USDHC\_Type \* *base*, uint32\_t *mask* ) [inline], [static]**

Parameters

|             |                                                                                  |
|-------------|----------------------------------------------------------------------------------|
| <i>base</i> | USDHC peripheral base address.                                                   |
| <i>mask</i> | The interrupt status flags mask( <a href="#">_usdhc_interrupt_status_flag</a> ). |

**45.7.11 static void USDHC\_EnableInterruptSignal ( USDHC\_Type \* *base*, uint32\_t *mask* ) [inline], [static]**

Parameters

|             |                                                                                  |
|-------------|----------------------------------------------------------------------------------|
| <i>base</i> | USDHC peripheral base address.                                                   |
| <i>mask</i> | The interrupt status flags mask( <a href="#">_usdhc_interrupt_status_flag</a> ). |

**45.7.12 static void USDHC\_DisableInterruptSignal ( USDHC\_Type \* *base*, uint32\_t *mask* ) [inline], [static]**

Parameters

|             |                                                                                  |
|-------------|----------------------------------------------------------------------------------|
| <i>base</i> | USDHC peripheral base address.                                                   |
| <i>mask</i> | The interrupt status flags mask( <a href="#">_usdhc_interrupt_status_flag</a> ). |

**45.7.13** `static uint32_t USDHC_GetEnabledInterruptStatusFlags ( USDHC_Type * base ) [inline], [static]`

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

Returns

Current interrupt status flags mask([\\_usdhc\\_interrupt\\_status\\_flag](#)).

**45.7.14** `static uint32_t USDHC_GetInterruptStatusFlags ( USDHC_Type * base ) [inline], [static]`

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

Returns

Current interrupt status flags mask([\\_usdhc\\_interrupt\\_status\\_flag](#)).

**45.7.15** `static void USDHC_ClearInterruptStatusFlags ( USDHC_Type * base, uint32_t mask ) [inline], [static]`

write 1 clears

Parameters

---

|             |                                                                                  |
|-------------|----------------------------------------------------------------------------------|
| <i>base</i> | USDHC peripheral base address.                                                   |
| <i>mask</i> | The interrupt status flags mask( <a href="#">_usdhc_interrupt_status_flag</a> ). |

#### 45.7.16 **static uint32\_t USDHC\_GetAutoCommand12ErrorStatusFlags ( USDHC\_Type \* *base* ) [inline], [static]**

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

Returns

Auto command 12 error status flags mask([\\_usdhc\\_auto\\_command12\\_error\\_status\\_flag](#)).

#### 45.7.17 **static uint32\_t USDHC\_GetAdmaErrorStatusFlags ( USDHC\_Type \* *base* ) [inline], [static]**

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

Returns

ADMA error status flags mask([\\_usdhc\\_adma\\_error\\_status\\_flag](#)).

#### 45.7.18 **static uint32\_t USDHC\_GetPresentStatusFlags ( USDHC\_Type \* *base* ) [inline], [static]**

This function gets the present USDHC's status except for an interrupt status and an error status.

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

Returns

Present USDHC's status flags mask([\\_usdhc\\_present\\_status\\_flag](#)).

**45.7.19** void USDHC\_GetCapability ( USDHC\_Type \* *base*, usdhc\_capability\_t \* *capability* )

Parameters

|                   |                                           |
|-------------------|-------------------------------------------|
| <i>base</i>       | USDHC peripheral base address.            |
| <i>capability</i> | Structure to save capability information. |

**45.7.20 static void USDHC\_ForceClockOn ( USDHC\_Type \* *base*, bool *enable* )**  
**[inline], [static]**

Parameters

|               |                                |
|---------------|--------------------------------|
| <i>base</i>   | USDHC peripheral base address. |
| <i>enable</i> | enable/disable flag            |

**45.7.21 uint32\_t USDHC\_SetSdClock ( USDHC\_Type \* *base*, uint32\_t *srcClock\_Hz*,  
uint32\_t *busClock\_Hz* )**

Parameters

|                    |                                            |
|--------------------|--------------------------------------------|
| <i>base</i>        | USDHC peripheral base address.             |
| <i>srcClock_Hz</i> | USDHC source clock frequency united in Hz. |
| <i>busClock_Hz</i> | SD bus clock frequency united in Hz.       |

Returns

The nearest frequency of *busClock\_Hz* configured for SD bus.

**45.7.22 bool USDHC\_SetCardActive ( USDHC\_Type \* *base*, uint32\_t *timeout* )**

This function must be called each time the card is inserted to ensure that the card can receive the command correctly.

Parameters

---

|                |                                |
|----------------|--------------------------------|
| <i>base</i>    | USDHC peripheral base address. |
| <i>timeout</i> | Timeout to initialize card.    |

Return values

|              |                               |
|--------------|-------------------------------|
| <i>true</i>  | Set card active successfully. |
| <i>false</i> | Set card active failed.       |

**45.7.23 static void USDHC\_AssertHardwareReset ( USDHC\_Type \* *base*, bool *high* ) [inline], [static]**

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
| <i>high</i> | 1 or 0 level                   |

**45.7.24 static void USDHC\_SetDataBusWidth ( USDHC\_Type \* *base*, usdhc\_data\_bus\_width\_t *width* ) [inline], [static]**

Parameters

|              |                                |
|--------------|--------------------------------|
| <i>base</i>  | USDHC peripheral base address. |
| <i>width</i> | Data transfer width.           |

**45.7.25 static void USDHC\_WriteData ( USDHC\_Type \* *base*, uint32\_t *data* ) [inline], [static]**

This function is used to implement the data transfer by Data Port instead of DMA.

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
| <i>data</i> | The data about to be sent.     |



**45.7.26** `static uint32_t USDHC_ReadData ( USDHC_Type * base ) [inline],  
[static]`

This function is used to implement the data transfer by Data Port instead of DMA.

## Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

## Returns

The data has been read.

**45.7.27 void USDHC\_SendCommand ( USDHC\_Type \* *base*, usdhc\_command\_t \* *command* )**

## Parameters

|                |                                |
|----------------|--------------------------------|
| <i>base</i>    | USDHC peripheral base address. |
| <i>command</i> | configuration                  |

**45.7.28 static void USDHC\_EnableWakeupEvent ( USDHC\_Type \* *base*, uint32\_t *mask*, bool *enable* ) [inline], [static]**

## Parameters

|               |                                                            |
|---------------|------------------------------------------------------------|
| <i>base</i>   | USDHC peripheral base address.                             |
| <i>mask</i>   | Wakeup events mask( <a href="#">_usdhc_wakeup_event</a> ). |
| <i>enable</i> | True to enable, false to disable.                          |

**45.7.29 static void USDHC\_CardDetectByData3 ( USDHC\_Type \* *base*, bool *enable* ) [inline], [static]**

## Parameters

|               |                                |
|---------------|--------------------------------|
| <i>base</i>   | USDHC peripheral base address. |
| <i>enable</i> | enable/disable flag            |

**45.7.30 static bool USDHC\_DetectCardInsert ( USDHC\_Type \* *base* ) [inline], [static]**

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

**45.7.31** `static void USDHC_EnableSdioControl ( USDHC_Type * base, uint32_t mask, bool enable ) [inline], [static]`

Parameters

|               |                                                                        |
|---------------|------------------------------------------------------------------------|
| <i>base</i>   | USDHC peripheral base address.                                         |
| <i>mask</i>   | SDIO card control flags mask( <code>_usdhc_sdio_control_flag</code> ). |
| <i>enable</i> | True to enable, false to disable.                                      |

**45.7.32** `static void USDHC_SetContinueRequest ( USDHC_Type * base ) [inline], [static]`

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

**45.7.33** `static void USDHC_RequestStopAtBlockGap ( USDHC_Type * base, bool enable ) [inline], [static]`

Parameters

|               |                                                      |
|---------------|------------------------------------------------------|
| <i>base</i>   | USDHC peripheral base address.                       |
| <i>enable</i> | True to stop at block gap, false to normal transfer. |

**45.7.34** `void USDHC_SetMmcBootConfig ( USDHC_Type * base, const usdhc_boot_config_t * config )`

Example:

```
usdhc_boot_config_t config;
config.ackTimeoutCount = 4;
config.bootMode = kUSDHC_BootModeNormal;
config.blockCount = 5;
config.enableBootAck = true;
```

```
config.enableBoot = true;
config.enableAutoStopAtBlockGap = true;
USDHC_SetMmcBootConfig(USDHC, &config);
```

## Parameters

|               |                                         |
|---------------|-----------------------------------------|
| <i>base</i>   | USDHC peripheral base address.          |
| <i>config</i> | The MMC boot configuration information. |

#### 45.7.35 static void USDHC\_EnableMmcBoot ( USDHC\_Type \* *base*, bool *enable* ) [inline], [static]

## Parameters

|               |                                   |
|---------------|-----------------------------------|
| <i>base</i>   | USDHC peripheral base address.    |
| <i>enable</i> | True to enable, false to disable. |

#### 45.7.36 static void USDHC\_SetForceEvent ( USDHC\_Type \* *base*, uint32\_t *mask* ) [inline], [static]

## Parameters

|             |                                                     |
|-------------|-----------------------------------------------------|
| <i>base</i> | USDHC peripheral base address.                      |
| <i>mask</i> | The force events bit position (_usdhc_force_event). |

#### 45.7.37 static void UDSHC\_SelectVoltage ( USDHC\_Type \* *base*, bool *en18v* ) [inline], [static]

## Parameters

|              |                                    |
|--------------|------------------------------------|
| <i>base</i>  | USDHC peripheral base address.     |
| <i>en18v</i> | True means 1.8V, false means 3.0V. |

#### 45.7.38 static bool USDHC\_RequestTuningForSDR50 ( USDHC\_Type \* *base* ) [inline], [static]

When this bit set, application shall perform tuning for SDR50 mode.

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

**45.7.39 static bool USDHC\_RequestReTuning ( USDHC\_Type \* *base* ) [inline], [static]**

When this bit is set, user should do manual tuning or standard tuning function.

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

**45.7.40 static void USDHC\_EnableAutoTuning ( USDHC\_Type \* *base*, bool *enable* ) [inline], [static]**

This function should be called after tuning function execute pass, auto tuning will handle by hardware.

Parameters

|               |                                |
|---------------|--------------------------------|
| <i>base</i>   | USDHC peripheral base address. |
| <i>enable</i> | enable/disable flag            |

**45.7.41 void USDHC\_EnableAutoTuningForCmdAndData ( USDHC\_Type \* *base* )**

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

**45.7.42 void USDHC\_EnableManualTuning ( USDHC\_Type \* *base*, bool *enable* )**

User should handle the tuning cmd and find the boundary of the delay then calculate a average value which will be configured to the **CLK\_TUNE\_CTRL\_STATUS** This function should be called before function [USDHC\\_AdjustDelayForManualTuning](#).

## Parameters

|               |                                |
|---------------|--------------------------------|
| <i>base</i>   | USDHC peripheral base address. |
| <i>enable</i> | tuning enable flag             |

**45.7.43** `static uint32_t USDHC_GetTuningDelayStatus ( USDHC_Type * base )`  
**[inline], [static]**

## Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

## Return values

|            |                                           |
|------------|-------------------------------------------|
| <i>CLK</i> | Tuning Control and Status register value. |
|------------|-------------------------------------------|

**45.7.44** `status_t USDHC_SetTuningDelay ( USDHC_Type * base, uint32_t preDelay,  
uint32_t outDelay, uint32_t postDelay )`

## Parameters

|                  |                                                                                             |
|------------------|---------------------------------------------------------------------------------------------|
| <i>base</i>      | USDHC peripheral base address.                                                              |
| <i>preDelay</i>  | Set the number of delay cells on the feedback clock between the feedback clock and CLK_PRE. |
| <i>outDelay</i>  | Set the number of delay cells on the feedback clock between CLK_PRE and CLK_OUT.            |
| <i>postDelay</i> | Set the number of delay cells on the feedback clock between CLK_OUT and CLK_POST.           |

## Return values

|                        |                                  |
|------------------------|----------------------------------|
| <i>kStatus_Fail</i>    | config the delay setting fail    |
| <i>kStatus_Success</i> | config the delay setting success |

**45.7.45** `status_t USDHC_AdjustDelayForManualTuning ( USDHC_Type * base,  
uint32_t delay )`

**Deprecated** Do not use this function. It has been superseded by USDHC\_SetTuningDelay

## Parameters

|              |                                |
|--------------|--------------------------------|
| <i>base</i>  | USDHC peripheral base address. |
| <i>delay</i> | setting configuration          |

## Return values

|                        |                                  |
|------------------------|----------------------------------|
| <i>kStatus_Fail</i>    | config the delay setting fail    |
| <i>kStatus_Success</i> | config the delay setting success |

**45.7.46** `static void USDHC_SetStandardTuningCounter ( USDHC_Type * base,  
uint8_t counter ) [inline], [static]`

## Parameters

|                |                                |
|----------------|--------------------------------|
| <i>base</i>    | USDHC peripheral base address. |
| <i>counter</i> | tuning counter                 |

## Return values

|                        |                                  |
|------------------------|----------------------------------|
| <i>kStatus_Fail</i>    | config the delay setting fail    |
| <i>kStatus_Success</i> | config the delay setting success |

**45.7.47** `void USDHC_EnableStandardTuning ( USDHC_Type * base, uint32_t  
tuningStartTap, uint32_t step, bool enable )`

The standard tuning window and tuning counter using the default config tuning cmd is sent by the software, user need to check whether the tuning result can be used for SDR50, SDR104, and HS200 mode tuning.

## Parameters

|                       |                                |
|-----------------------|--------------------------------|
| <i>base</i>           | USDHC peripheral base address. |
| <i>tuningStartTap</i> | start tap                      |
| <i>step</i>           | tuning step                    |

|               |                     |
|---------------|---------------------|
| <i>enable</i> | enable/disable flag |
|---------------|---------------------|

**45.7.48** `static uint32_t USDHC_GetExecuteStdTuningStatus ( USDHC_Type * base ) [inline], [static]`

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

**45.7.49** `static uint32_t USDHC_CheckStdTuningResult ( USDHC_Type * base ) [inline], [static]`

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

**45.7.50** `static uint32_t USDHC_CheckTuningError ( USDHC_Type * base ) [inline], [static]`

Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

**45.7.51** `void USDHC_EnableDDRMMode ( USDHC_Type * base, bool enable, uint32_t nibblePos )`

Parameters

|                  |                                |
|------------------|--------------------------------|
| <i>base</i>      | USDHC peripheral base address. |
| <i>enable</i>    | enable/disable flag            |
| <i>nibblePos</i> | nibble position                |



**45.7.52** void USDHC\_SetDataConfig ( USDHC\_Type \* *base*, usdhc\_transfer-  
\_direction\_t *dataDirection*, uint32\_t *blockCount*, uint32\_t *blockSize*  
)

## Parameters

|                      |                                |
|----------------------|--------------------------------|
| <i>base</i>          | USDHC peripheral base address. |
| <i>dataDirection</i> | Data direction, tx or rx.      |
| <i>blockCount</i>    | Data block count.              |
| <i>blockSize</i>     | Data block size.               |

**45.7.53 void USDHC\_TransferCreateHandle ( USDHC\_Type \* *base*,  
 usdhc\_handle\_t \* *handle*, const usdhc\_transfer\_callback\_t \* *callback*,  
 void \* *userData* )**

## Parameters

|                 |                                                      |
|-----------------|------------------------------------------------------|
| <i>base</i>     | USDHC peripheral base address.                       |
| <i>handle</i>   | USDHC handle pointer.                                |
| <i>callback</i> | Structure pointer to contain all callback functions. |
| <i>userData</i> | Callback function parameter.                         |

**45.7.54 status\_t USDHC\_TransferNonBlocking ( USDHC\_Type \* *base*,  
 usdhc\_handle\_t \* *handle*, usdhc\_adma\_config\_t \* *dmaConfig*,  
 usdhc\_transfer\_t \* *transfer* )**

This function sends a command and data and returns immediately. It doesn't wait for the transfer to complete or to encounter an error. The application must not call this API in multiple threads at the same time. Because of that this API doesn't support the re-entry mechanism.

## Note

Call API [USDHC\\_TransferCreateHandle](#) when calling this API.

## Parameters

|             |                                |
|-------------|--------------------------------|
| <i>base</i> | USDHC peripheral base address. |
|-------------|--------------------------------|

|                  |                     |
|------------------|---------------------|
| <i>handle</i>    | USDHC handle.       |
| <i>dmaConfig</i> | ADMA configuration. |
| <i>transfer</i>  | Transfer content.   |

Return values

|                                                    |                                 |
|----------------------------------------------------|---------------------------------|
| <i>kStatus_InvalidArgument</i>                     | Argument is invalid.            |
| <i>kStatus_USDHC_Busy-Transferring</i>             | Busy transferring.              |
| <i>kStatus_USDHC_-PrepareAdmaDescriptor-Failed</i> | Prepare ADMA descriptor failed. |
| <i>kStatus_Success</i>                             | Operate successfully.           |

#### 45.7.55 **status\_t USDHC\_TransferBlocking ( USDHC\_Type \* *base*, usdhc\_adma\_config\_t \* *dmaConfig*, usdhc\_transfer\_t \* *transfer* )**

This function waits until the command response/data is received or the USDHC encounters an error by polling the status flag.

The application must not call this API in multiple threads at the same time. Because this API doesn't support the re-entry mechanism.

Note

There is no need to call API [USDHC\\_TransferCreateHandle](#) when calling this API.

Parameters

|                  |                                |
|------------------|--------------------------------|
| <i>base</i>      | USDHC peripheral base address. |
| <i>dmaConfig</i> | adma configuration             |
| <i>transfer</i>  | Transfer content.              |

Return values

|                                |                      |
|--------------------------------|----------------------|
| <i>kStatus_InvalidArgument</i> | Argument is invalid. |
|--------------------------------|----------------------|

|                                                   |                                 |
|---------------------------------------------------|---------------------------------|
| <i>kStatus_USDHC_-PrepareAdmaDescriptorFailed</i> | Prepare ADMA descriptor failed. |
| <i>kStatus_USDHC_SendCommandFailed</i>            | Send command failed.            |
| <i>kStatus_USDHC_-TransferDataFailed</i>          | Transfer data failed.           |
| <i>kStatus_Success</i>                            | Operate successfully.           |

**45.7.56 void USDHC\_TransferHandleIRQ ( USDHC\_Type \* *base*, usdhc\_handle\_t \* *handle* )**

This function deals with the IRQs on the given host controller.

Parameters

|               |                                |
|---------------|--------------------------------|
| <i>base</i>   | USDHC peripheral base address. |
| <i>handle</i> | USDHC handle.                  |

## Chapter 46

# WDOG: Watchdog Timer Driver

### 46.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Watchdog module (WDOG) of MCUXpresso SDK devices.

### 46.2 Typical use case

Refer to the driver examples codes located at <SDK\_ROOT>/boards/<BOARD>/driver\_examples/wdog

### Data Structures

- struct `wdog_work_mode_t`  
*Defines WDOG work mode. [More...](#)*
- struct `wdog_config_t`  
*Describes WDOG configuration structure. [More...](#)*

### Enumerations

- enum `_wdog_interrupt_enable` { `kWDOG_InterruptEnable` = `WDOG_WICR_WIE_MASK` }  
*WDOG interrupt configuration structure, default settings all disabled.*
- enum `_wdog_status_flags` {  
`kWDOG_RunningFlag` = `WDOG_WCR_WDE_MASK`,  
`kWDOG_PowerOnResetFlag` = `WDOG_WRSR_POR_MASK`,  
`kWDOG_TimeoutResetFlag` = `WDOG_WRSR_TOUT_MASK`,  
`kWDOG_SoftwareResetFlag` = `WDOG_WRSR_SFTW_MASK`,  
`kWDOG_InterruptFlag` = `WDOG_WICR_WTIS_MASK` }  
*WDOG status flags.*

### Driver version

- `#define FSL_WDOG_DRIVER_VERSION (MAKE_VERSION(2, 1, 1))`  
*Defines WDOG driver version.*

### Refresh sequence

- `#define WDOG_REFRESH_KEY (0xAAAA5555U)`

### WDOG Initialization and De-initialization.

- void `WDOG_GetDefaultConfig` (`wdog_config_t *config`)  
*Initializes the WDOG configuration structure.*
- void `WDOG_Init` (`WDOG_Type *base`, const `wdog_config_t *config`)

- *Initializes the WDOG.*  
void [WDOG\\_Deinit](#) (WDOG\_Type \*base)
- *Shuts down the WDOG.*  
static void [WDOG\\_Enable](#) (WDOG\_Type \*base)
- *Enables the WDOG module.*  
static void [WDOG\\_Disable](#) (WDOG\_Type \*base)
- *Disables the WDOG module.*  
static void [WDOG\\_TriggerSystemSoftwareReset](#) (WDOG\_Type \*base)
- *Trigger the system software reset.*  
static void [WDOG\\_TriggerSoftwareSignal](#) (WDOG\_Type \*base)
- *Trigger an output assertion.*  
static void [WDOG\\_EnableInterrupts](#) (WDOG\_Type \*base, uint16\_t mask)
- *Enables the WDOG interrupt.*  
uint16\_t [WDOG\\_GetStatusFlags](#) (WDOG\_Type \*base)
- *Gets the WDOG all reset status flags.*  
void [WDOG\\_ClearInterruptStatus](#) (WDOG\_Type \*base, uint16\_t mask)
- *Clears the WDOG flag.*  
static void [WDOG\\_SetTimeoutValue](#) (WDOG\_Type \*base, uint16\_t timeoutCount)
- *Sets the WDOG timeout value.*  
static void [WDOG\\_SetInterruptTimeoutValue](#) (WDOG\_Type \*base, uint16\_t timeoutCount)
- *Sets the WDOG interrupt count timeout value.*  
static void [WDOG\\_DisablePowerDownEnable](#) (WDOG\_Type \*base)
- *Disable the WDOG power down enable bit.*  
void [WDOG\\_Refresh](#) (WDOG\_Type \*base)
- *Refreshes the WDOG timer.*

## 46.3 Data Structure Documentation

### 46.3.1 struct wdog\_work\_mode\_t

#### Data Fields

- bool [enableWait](#)  
*continue or suspend WDOG in wait mode*
- bool [enableStop](#)  
*continue or suspend WDOG in stop mode*
- bool [enableDebug](#)  
*continue or suspend WDOG in debug mode*

### 46.3.2 struct wdog\_config\_t

#### Data Fields

- bool [enableWdog](#)  
*Enables or disables WDOG.*
- [wdog\\_work\\_mode\\_t](#) [workMode](#)  
*Configures WDOG work mode in debug stop and wait mode.*
- bool [enableInterrupt](#)

- *Enables or disables WDOG interrupt.*  
uint16\_t `timeoutValue`  
*Timeout value.*
- uint16\_t `interruptTimeValue`  
*Interrupt count timeout value.*
- bool `softwareResetExtension`  
*software reset extension*
- bool `enablePowerDown`  
*power down enable bit*
- bool `enableTimeOutAssert`  
*Enable WDOG\_B timeout assertion.*

## Field Documentation

(1) bool `wdog_config_t::enableTimeOutAssert`

## 46.4 Enumeration Type Documentation

### 46.4.1 enum `_wdog_interrupt_enable`

This structure contains the settings for all of the WDOG interrupt configurations.

Enumerator

***kWDOG\_InterruptEnable*** WDOG timeout generates an interrupt before reset.

### 46.4.2 enum `_wdog_status_flags`

This structure contains the WDOG status flags for use in the WDOG functions.

Enumerator

***kWDOG\_RunningFlag*** Running flag, set when WDOG is enabled.

***kWDOG\_PowerOnResetFlag*** Power On flag, set when reset is the result of a powerOnReset.

***kWDOG\_TimeoutResetFlag*** Timeout flag, set when reset is the result of a timeout.

***kWDOG\_SoftwareResetFlag*** Software flag, set when reset is the result of a software.

***kWDOG\_InterruptFlag*** interrupt flag, whether interrupt has occurred or not

## 46.5 Function Documentation

### 46.5.1 void `WDOG_GetDefaultConfig ( wdog_config_t * config )`

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

```
* wdogConfig->enableWdog = true;
* wdogConfig->workMode.enableWait = true;
* wdogConfig->workMode.enableStop = false;
```

```
* wdogConfig->workMode.enableDebug = false;
* wdogConfig->enableInterrupt = false;
* wdogConfig->enablePowerdown = false;
* wdogConfig->resetExtension = false;
* wdogConfig->timeoutValue = 0xFFU;
* wdogConfig->interruptTimeValue = 0x04u;
*
```

Parameters

|               |                                              |
|---------------|----------------------------------------------|
| <i>config</i> | Pointer to the WDOG configuration structure. |
|---------------|----------------------------------------------|

See Also

[wdog\\_config\\_t](#)

**46.5.2 void WDOG\_Init ( WDOG\_Type \* *base*, const wdog\_config\_t \* *config* )**

This function initializes the WDOG. When called, the WDOG runs according to the configuration.

This is an example.

```
* wdog_config_t config;
* WDOG_GetDefaultConfig(&config);
* config.timeoutValue = 0xffU;
* config->interruptTimeValue = 0x04u;
* WDOG_Init(wdog_base, &config);
*
```

Parameters

|               |                              |
|---------------|------------------------------|
| <i>base</i>   | WDOG peripheral base address |
| <i>config</i> | The configuration of WDOG    |

**46.5.3 void WDOG\_Deinit ( WDOG\_Type \* *base* )**

This function shuts down the WDOG. Watchdog Enable bit is a write one once only bit. It is not possible to clear this bit by a software write, once the bit is set. This bit(WDE) can be set/reset only in debug mode(exception).

**46.5.4 static void WDOG\_Enable ( WDOG\_Type \* *base* ) [inline], [static]**

This function writes a value into the WDOG\_WCR register to enable the WDOG. This is a write one once only bit. It is not possible to clear this bit by a software write, once the bit is set. only debug mode exception.



Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | WDOG peripheral base address |
|-------------|------------------------------|

#### 46.5.5 static void WDOG\_Disable ( WDOG\_Type \* *base* ) [inline], [static]

This function writes a value into the WDOG\_WCR register to disable the WDOG. This is a write one once only bit. It is not possible to clear this bit by a software write, once the bit is set. only debug mode exception

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | WDOG peripheral base address |
|-------------|------------------------------|

#### 46.5.6 static void WDOG\_TriggerSystemSoftwareReset ( WDOG\_Type \* *base* ) [inline], [static]

This function will write to the WCR[SRS] bit to trigger a software system reset. This bit will automatically resets to "1" after it has been asserted to "0". Note: Calling this API will reset the system right now, please using it with more attention.

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | WDOG peripheral base address |
|-------------|------------------------------|

#### 46.5.7 static void WDOG\_TriggerSoftwareSignal ( WDOG\_Type \* *base* ) [inline], [static]

This function will write to the WCR[WDA] bit to trigger WDOG\_B signal assertion. The WDOG\_B signal can be routed to external pin of the chip, the output pin will turn to assertion along with WDOG\_B signal. Note: The WDOG\_B signal will remain assert until a power on reset occurred, so, please take more attention while calling it.

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | WDOG peripheral base address |
|-------------|------------------------------|

**46.5.8 static void WDOG\_EnableInterrupts ( WDOG\_Type \* *base*, uint16\_t *mask* )**  
**[inline], [static]**

This bit is a write once only bit. Once the software does a write access to this bit, it will get locked and cannot be reprogrammed until the next system reset assertion

## Parameters

|             |                                                                                                                                                                         |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>base</i> | WDOG peripheral base address                                                                                                                                            |
| <i>mask</i> | The interrupts to enable The parameter can be combination of the following source if defined. <ul style="list-style-type: none"> <li>• kWDOG_InterruptEnable</li> </ul> |

### 46.5.9 uint16\_t WDOG\_GetStatusFlags ( WDOG\_Type \* *base* )

This function gets all reset status flags.

```
* uint16_t status;
* status = WDOG_GetStatusFlags (wdog_base);
*
```

## Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | WDOG peripheral base address |
|-------------|------------------------------|

## Returns

State of the status flag: asserted (true) or not-asserted (false).

## See Also

[\\_wdog\\_status\\_flags](#)

- true: a related status flag has been set.
- false: a related status flag is not set.

### 46.5.10 void WDOG\_ClearInterruptStatus ( WDOG\_Type \* *base*, uint16\_t *mask* )

This function clears the WDOG status flag.

This is an example for clearing the interrupt flag.

```
* WDOG_ClearStatusFlags (wdog_base, kWDOG_InterruptFlag);
*
```

## Parameters

|             |                                                                                                              |
|-------------|--------------------------------------------------------------------------------------------------------------|
| <i>base</i> | WDOG peripheral base address                                                                                 |
| <i>mask</i> | The status flags to clear. The parameter could be any combination of the following values. kWDOG_TimeoutFlag |

#### 46.5.11 static void WDOG\_SetTimeoutValue ( WDOG\_Type \* *base*, uint16\_t *timeoutCount* ) [*inline*], [*static*]

This function sets the timeout value. This function writes a value into WCR registers. The time-out value can be written at any point of time but it is loaded to the counter at the time when WDOG is enabled or after the service routine has been performed.

## Parameters

|                     |                                               |
|---------------------|-----------------------------------------------|
| <i>base</i>         | WDOG peripheral base address                  |
| <i>timeoutCount</i> | WDOG timeout value; count of WDOG clock tick. |

#### 46.5.12 static void WDOG\_SetInterruptTimeoutValue ( WDOG\_Type \* *base*, uint16\_t *timeoutCount* ) [*inline*], [*static*]

This function sets the interrupt count timeout value. This function writes a value into WIC registers which are write-once. This field is write once only. Once the software does a write access to this field, it will get locked and cannot be reprogrammed until the next system reset assertion.

## Parameters

|                     |                                               |
|---------------------|-----------------------------------------------|
| <i>base</i>         | WDOG peripheral base address                  |
| <i>timeoutCount</i> | WDOG timeout value; count of WDOG clock tick. |

#### 46.5.13 static void WDOG\_DisablePowerDownEnable ( WDOG\_Type \* *base* ) [*inline*], [*static*]

This function disable the WDOG power down enable(PDE). This function writes a value into WMCR registers which are write-once. This field is write once only. Once software sets this bit it cannot be reset until the next system reset.

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | WDOG peripheral base address |
|-------------|------------------------------|

#### 46.5.14 void WDOG\_Refresh ( WDOG\_Type \* *base* )

This function feeds the WDOG. This function should be called before the WDOG timer is in timeout. Otherwise, a reset is asserted.

Parameters

|             |                              |
|-------------|------------------------------|
| <i>base</i> | WDOG peripheral base address |
|-------------|------------------------------|

## Chapter 47

# XBARA: Inter-Peripheral Crossbar Switch

### 47.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Inter-Peripheral Crossbar Switch (XBARA) block of MCUXpresso SDK devices.

The XBARA peripheral driver configures the XBARA (Inter-Peripheral Crossbar Switch) and handles initialization and configuration of the XBARA module.

XBARA driver has two parts:

- Signal connection interconnects input and output signals.
- Active edge feature - Some of the outputs provide an active edge detection. If an active edge occurs, an interrupt or a DMA request can be called. APIs handle user callbacks for the interrupts. The driver also includes API for clearing and reading status bits.

### 47.2 Function

#### 47.2.1 XBARA Initialization

To initialize the XBARA driver, a state structure has to be passed into the initialization function. This block of memory keeps pointers to user's callback functions and parameters to these functions. The XBARA module is initialized by calling the [XBARA\\_Init\(\)](#) function.

#### 47.2.2 Call diagram

1. Call the "XBARA\_Init()" function to initialize the XBARA module.
2. Optionally, call the "XBARA\_SetSignalsConnection()" function to Set connection between the selected XBARA\_IN[\*] input and the XBARA\_OUT[\*] output signal. It connects the XBARA input to the selected XBARA output. A configuration structure of the "xbara\_input\_signal\_t" type and "xbara\_output\_signal\_t" type is required.
3. Call the "XBARA\_SetOutputSignalConfig" function to set the active edge features, such interrupts or DMA requests. A configuration structure of the "xbara\_control\_config\_t" type is required to point to structure that keeps configuration of control register.
4. Finally, the XBARA works properly.

### 47.3 Typical use case

#### Data Structures

- struct [xbara\\_control\\_config\\_t](#)  
*Defines the configuration structure of the XBARA control register. [More...](#)*

## Enumerations

- enum `xbara_active_edge_t` {  
`kXBARA_EdgeNone` = 0U,  
`kXBARA_EdgeRising` = 1U,  
`kXBARA_EdgeFalling` = 2U,  
`kXBARA_EdgeRisingAndFalling` = 3U }  
*XBARA active edge for detection.*
- enum `xbara_request_t` {  
`kXBARA_RequestDisable` = 0U,  
`kXBARA_RequestDMAEnable` = 1U,  
`kXBARA_RequestInterruptEnable` = 2U }  
*Defines the XBARA DMA and interrupt configurations.*
- enum `xbara_status_flag_t` {  
`kXBARA_EdgeDetectionOut0`,  
`kXBARA_EdgeDetectionOut1`,  
`kXBARA_EdgeDetectionOut2`,  
`kXBARA_EdgeDetectionOut3` }  
*XBARA status flags.*

## XBARA functional Operation.

- void `XBARA_Init` (`XBARA_Type *base`)  
*Initializes the XBARA module.*
- void `XBARA_Deinit` (`XBARA_Type *base`)  
*Shuts down the XBARA module.*
- void `XBARA_SetSignalsConnection` (`XBARA_Type *base`, `xbar_input_signal_t input`, `xbar_output_signal_t output`)  
*Sets a connection between the selected XBARA\_IN[\*] input and the XBARA\_OUT[\*] output signal.*
- `uint32_t XBARA_GetStatusFlags` (`XBARA_Type *base`)  
*Gets the active edge detection status.*
- void `XBARA_ClearStatusFlags` (`XBARA_Type *base`, `uint32_t mask`)  
*Clears the edge detection status flags of relative mask.*
- void `XBARA_SetOutputSignalConfig` (`XBARA_Type *base`, `xbar_output_signal_t output`, `const xbara_control_config_t *controlConfig`)  
*Configures the XBARA control register.*

## 47.4 Data Structure Documentation

### 47.4.1 struct `xbara_control_config_t`

This structure keeps the configuration of XBARA control register for one output. Control registers are available only for a few outputs. Not every XBARA module has control registers.

## Data Fields

- `xbara_active_edge_t activeEdge`

- *Active edge to be detected.*  
**xbara\_request\_t requestType**  
*Selects DMA/Interrupt request.*

### Field Documentation

- (1) **xbara\_active\_edge\_t xbara\_control\_config\_t::activeEdge**
- (2) **xbara\_request\_t xbara\_control\_config\_t::requestType**

## 47.5 Enumeration Type Documentation

### 47.5.1 enum xbara\_active\_edge\_t

Enumerator

- kXBARA\_EdgeNone*** Edge detection status bit never asserts.
- kXBARA\_EdgeRising*** Edge detection status bit asserts on rising edges.
- kXBARA\_EdgeFalling*** Edge detection status bit asserts on falling edges.
- kXBARA\_EdgeRisingAndFalling*** Edge detection status bit asserts on rising and falling edges.

### 47.5.2 enum xbara\_request\_t

Enumerator

- kXBARA\_RequestDisable*** Interrupt and DMA are disabled.
- kXBARA\_RequestDMAEnable*** DMA enabled, interrupt disabled.
- kXBARA\_RequestInterruptEnable*** Interrupt enabled, DMA disabled.

### 47.5.3 enum xbara\_status\_flag\_t

This provides constants for the XBARA status flags for use in the XBARA functions.

Enumerator

- kXBARA\_EdgeDetectionOut0*** XBAR\_OUT0 active edge interrupt flag, sets when active edge detected.
- kXBARA\_EdgeDetectionOut1*** XBAR\_OUT1 active edge interrupt flag, sets when active edge detected.
- kXBARA\_EdgeDetectionOut2*** XBAR\_OUT2 active edge interrupt flag, sets when active edge detected.
- kXBARA\_EdgeDetectionOut3*** XBAR\_OUT3 active edge interrupt flag, sets when active edge detected.



## **47.6 Function Documentation**

### **47.6.1 void XBARA\_Init ( XBARA\_Type \* *base* )**

This function un-gates the XBARA clock.

Parameters

|             |                           |
|-------------|---------------------------|
| <i>base</i> | XBARA peripheral address. |
|-------------|---------------------------|

#### 47.6.2 void XBARA\_Deinit ( XBARA\_Type \* *base* )

This function disables XBARA clock.

Parameters

|             |                           |
|-------------|---------------------------|
| <i>base</i> | XBARA peripheral address. |
|-------------|---------------------------|

#### 47.6.3 void XBARA\_SetSignalsConnection ( XBARA\_Type \* *base*, xbar\_input\_signal\_t *input*, xbar\_output\_signal\_t *output* )

This function connects the XBARA input to the selected XBARA output. If more than one XBARA module is available, only the inputs and outputs from the same module can be connected.

Example:

```
XBARA_SetSignalsConnection(XBARA, kXBARA_InputPIT_TRG0, kXBARA_OutputDMAMUX18);
```

Parameters

|               |                           |
|---------------|---------------------------|
| <i>base</i>   | XBARA peripheral address. |
| <i>input</i>  | XBARA input signal.       |
| <i>output</i> | XBARA output signal.      |

#### 47.6.4 uint32\_t XBARA\_GetStatusFlags ( XBARA\_Type \* *base* )

This function gets the active edge detect status of all XBARA\_OUTs. If the active edge occurs, the return value is asserted. When the interrupt or the DMA functionality is enabled for the XBARA\_OUTx, this field is 1 when the interrupt or DMA request is asserted and 0 when the interrupt or DMA request has been cleared.

## Parameters

|             |                           |
|-------------|---------------------------|
| <i>base</i> | XBARA peripheral address. |
|-------------|---------------------------|

## Returns

the mask of these status flag bits.

#### 47.6.5 void XBARA\_ClearStatusFlags ( XBARA\_Type \* *base*, uint32\_t *mask* )

## Parameters

|             |                            |
|-------------|----------------------------|
| <i>base</i> | XBARA peripheral address.  |
| <i>mask</i> | the status flags to clear. |

#### 47.6.6 void XBARA\_SetOutputSignalConfig ( XBARA\_Type \* *base*, xbar\_output\_signal\_t *output*, const xbara\_control\_config\_t \* *controlConfig* )

This function configures an XBARA control register. The active edge detection and the DMA/IRQ function on the corresponding XBARA output can be set.

## Example:

```
xbara_control_config_t userConfig;
userConfig.activeEdge = kXBARA_EdgeRising;
userConfig.requestType = kXBARA_RequestInterruptEnalbe;
XBARA_SetOutputSignalConfig(XBARA, kXBARA_OutputDMAMUX18, &userConfig);
```

## Parameters

|                      |                                                                    |
|----------------------|--------------------------------------------------------------------|
| <i>base</i>          | XBARA peripheral address.                                          |
| <i>output</i>        | XBARA output number.                                               |
| <i>controlConfig</i> | Pointer to structure that keeps configuration of control register. |

## Chapter 48

# XBARB: Inter-Peripheral Crossbar Switch

### 48.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Inter-Peripheral Crossbar Switch (XBARB) block of MCUXpresso SDK devices.

The XBARB peripheral driver configures the XBARB (Inter-Peripheral Crossbar Switch) and handles initialization and configuration of the XBARB module.

XBARB driver has two parts:

- Signal connection interconnects input and output signals.

### 48.2 Function groups

#### 48.2.1 XBARB Initialization

To initialize the XBARB driver, a state structure has to be passed into the initialization function. This block of memory keeps pointers to user's callback functions and parameters to these functions. The XBARB module is initialized by calling the [XBARB\\_Init\(\)](#) function.

#### 48.2.2 Call diagram

1. Call the "XBARB\_Init()" function to initialize the XBARB module.
2. Optionally, call the "XBARB\_SetSignalsConnection()" function to Set connection between the selected XBARB\_IN[\*] input and the XBARB\_OUT[\*] output signal. It connects the XBARB input to the selected XBARB output. A configuration structure of the "xbarb\_input\_signal\_t" type and "xbarb\_output\_signal\_t" type is required.
3. Finally, the XBARB works properly.

### 48.3 Typical use case

#### XBARB functional Operation.

- void [XBARB\\_Init](#) (XBARB\_Type \*base)  
*Initializes the XBARB module.*
- void [XBARB\\_Deinit](#) (XBARB\_Type \*base)  
*Shuts down the XBARB module.*
- void [XBARB\\_SetSignalsConnection](#) (XBARB\_Type \*base, xbarb\_input\_signal\_t input, xbarb\_output\_signal\_t output)  
*Configures a connection between the selected XBARB\_IN[\*] input and the XBARB\_OUT[\*] output signal.*

## **48.4 Function Documentation**

### **48.4.1 void XBARB\_Init ( XBARB\_Type \* *base* )**

This function un-gates the XBARB clock.

Parameters

|             |                           |
|-------------|---------------------------|
| <i>base</i> | XBARB peripheral address. |
|-------------|---------------------------|

#### 48.4.2 void XBARB\_Deinit ( XBARB\_Type \* *base* )

This function disables XBARB clock.

Parameters

|             |                           |
|-------------|---------------------------|
| <i>base</i> | XBARB peripheral address. |
|-------------|---------------------------|

#### 48.4.3 void XBARB\_SetSignalsConnection ( XBARB\_Type \* *base*, xbar\_input\_signal\_t *input*, xbar\_output\_signal\_t *output* )

This function configures which XBARB input is connected to the selected XBARB output. If more than one XBARB module is available, only the inputs and outputs from the same module can be connected.

Parameters

|               |                           |
|---------------|---------------------------|
| <i>base</i>   | XBARB peripheral address. |
| <i>input</i>  | XBARB input signal.       |
| <i>output</i> | XBARB output signal.      |

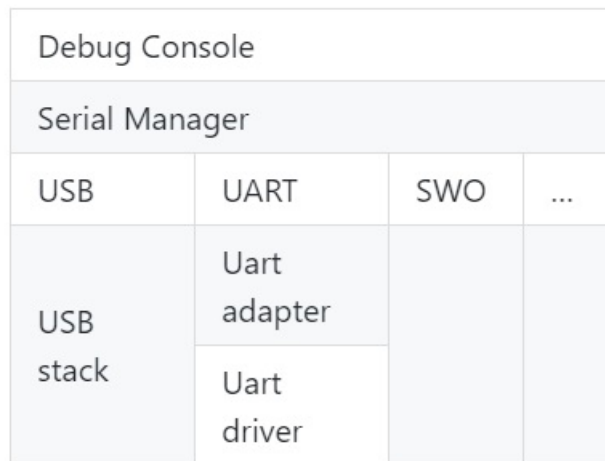
# Chapter 49

## Debug Console

### 49.1 Overview

This chapter describes the programming interface of the debug console driver.

The debug console enables debug log messages to be output via the specified peripheral with frequency of the peripheral source clock and base address at the specified baud rate. Additionally, it provides input and output functions to scan and print formatted data. The below picture shows the layout of debug console.



Debug console overview

### 49.2 Function groups

#### 49.2.1 Initialization

To initialize the debug console, call the `DbgConsole_Init()` function with these parameters. This function automatically enables the module and the clock.

```
status_t DbgConsole_Init(uint8_t instance, uint32_t baudRate,
 serial_port_type_t device, uint32_t clkSrcFreq);
```

Select the supported debug console hardware device type, such as

```
typedef enum _serial_port_type
{
 kSerialPort_Uart = 1U,
 kSerialPort_UsbCdc,
 kSerialPort_Swo,
} serial_port_type_t;
```

After the initialization is successful, stdout and stdin are connected to the selected peripheral. This example shows how to call the `DbgConsole_Init()` given the user configuration structure.

```
DbgConsole_Init (BOARD_DEBUG_UART_INSTANCE, BOARD_DEBUG_UART_BAUDRATE, BOARD_DEBUG_UART_TYPE,
 BOARD_DEBUG_UART_CLK_FREQ);
```

## 49.2.2 Advanced Feature

The debug console provides input and output functions to scan and print formatted data.

- Support a format specifier for PRINTF following this prototype " `%[flags][width][.precision][length]specifier`", which is explained below

| flags   | Description                                                                                                                                                                                                                                                                                                                                                                             |
|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| -       | Left-justified within the given field width. Right-justified is the default.                                                                                                                                                                                                                                                                                                            |
| +       | Forces to precede the result with a plus or minus sign (+ or -) even for positive numbers. By default, only negative numbers are preceded with a - sign.                                                                                                                                                                                                                                |
| (space) | If no sign is written, a blank space is inserted before the value.                                                                                                                                                                                                                                                                                                                      |
| #       | Used with o, x, or X specifiers the value is preceded with 0, 0x, or 0X respectively for values other than zero. Used with e, E and f, it forces the written output to contain a decimal point even if no digits would follow. By default, if no digits follow, no decimal point is written. Used with g or G the result is the same as with e or E but trailing zeros are not removed. |
| 0       | Left-pads the number with zeroes (0) instead of spaces, where padding is specified (see width sub-specifier).                                                                                                                                                                                                                                                                           |

| Width    | Description                                                                                                                                                                                            |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (number) | A minimum number of characters to be printed. If the value to be printed is shorter than this number, the result is padded with blank spaces. The value is not truncated even if the result is larger. |
| *        | The width is not specified in the format string, but as an additional integer value argument preceding the argument that has to be formatted.                                                          |



| <b>.precision</b> | <b>Description</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|-------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| .number           | For integer specifiers (d, i, o, u, x, X) precision specifies the minimum number of digits to be written. If the value to be written is shorter than this number, the result is padded with leading zeros. The value is not truncated even if the result is longer. A precision of 0 means that no character is written for the value 0. For e, E, and f specifiers this is the number of digits to be printed after the decimal point. For g and G specifiers This is the maximum number of significant digits to be printed. For s this is the maximum number of characters to be printed. By default, all characters are printed until the ending null character is encountered. For c type it has no effect. When no precision is specified, the default is 1. If the period is specified without an explicit value for precision, 0 is assumed. |
| .*                | The precision is not specified in the format string, but as an additional integer value argument preceding the argument that has to be formatted.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |

| <b>length</b>  | <b>Description</b> |
|----------------|--------------------|
| Do not support |                    |

| <b>specifier</b> | <b>Description</b>                           |
|------------------|----------------------------------------------|
| d or i           | Signed decimal integer                       |
| f                | Decimal floating point                       |
| F                | Decimal floating point capital letters       |
| x                | Unsigned hexadecimal integer                 |
| X                | Unsigned hexadecimal integer capital letters |
| o                | Signed octal                                 |
| b                | Binary value                                 |
| p                | Pointer address                              |
| u                | Unsigned decimal integer                     |
| c                | Character                                    |
| s                | String of characters                         |
| n                | Nothing printed                              |

- Support a format specifier for SCANF following this prototype " %[\*][width][length]specifier", which is explained below

| * | Description                                                                                                                                                      |
|---|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|   | An optional starting asterisk indicates that the data is to be read from the stream but ignored. In other words, it is not stored in the corresponding argument. |

| width | Description                                                                                  |
|-------|----------------------------------------------------------------------------------------------|
|       | This specifies the maximum number of characters to be read in the current reading operation. |

| length      | Description                                                                                                                                                                                             |
|-------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| hh          | The argument is interpreted as a signed character or unsigned character (only applies to integer specifiers: i, d, o, u, x, and X).                                                                     |
| h           | The argument is interpreted as a short integer or unsigned short integer (only applies to integer specifiers: i, d, o, u, x, and X).                                                                    |
| l           | The argument is interpreted as a long integer or unsigned long integer for integer specifiers (i, d, o, u, x, and X) and as a wide character or wide character string for specifiers c and s.           |
| ll          | The argument is interpreted as a long long integer or unsigned long long integer for integer specifiers (i, d, o, u, x, and X) and as a wide character or wide character string for specifiers c and s. |
| L           | The argument is interpreted as a long double (only applies to floating point specifiers: e, E, f, g, and G).                                                                                            |
| j or z or t | Not supported                                                                                                                                                                                           |

| specifier              | Qualifying Input                                                                                                                                                                                                                                 | Type of argument |
|------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| c                      | Single character: Reads the next character. If a width different from 1 is specified, the function reads width characters and stores them in the successive locations of the array passed as argument. No null character is appended at the end. | char *           |
| i                      | Integer: : Number optionally preceded with a + or - sign                                                                                                                                                                                         | int *            |
| d                      | Decimal integer: Number optionally preceded with a + or - sign                                                                                                                                                                                   | int *            |
| a, A, e, E, f, F, g, G | Floating point: Decimal number containing a decimal point, optionally preceded by a + or - sign and optionally followed by the e or E character and a decimal number. Two examples of valid entries are -732.103 and 7.12e4                      | float *          |
| o                      | Octal Integer:                                                                                                                                                                                                                                   | int *            |
| s                      | String of characters. This reads subsequent characters until a white space is found (white space characters are considered to be blank, newline, and tab).                                                                                       | char *           |
| u                      | Unsigned decimal integer.                                                                                                                                                                                                                        | unsigned int *   |

The debug console has its own printf/scanf/putchar/getchar functions which are defined in the header file.

```
int DbgConsole_Printf(const char *fmt_s, ...);
int DbgConsole_Putchar(int ch);
int DbgConsole_Scanf(char *fmt_ptr, ...);
int DbgConsole_Getchar(void);
```

This utility supports selecting toolchain's printf/scanf or the MCUXpresso SDK printf/scanf.

```
#if SDK_DEBUGCONSOLE == DEBUGCONSOLE_DISABLE /* Disable debug console */
#define PRINTF
#define SCANF
#define PUTCHAR
#define GETCHAR
#elif SDK_DEBUGCONSOLE == DEBUGCONSOLE_REDIRECT_TO_SDK /* Select printf, scanf, putchar, getchar of SDK
```

```

 version. */
#define PRINTF DbgConsole_Printf
#define SCANF DbgConsole_Scanf
#define PUTCHAR DbgConsole_Putchar
#define GETCHAR DbgConsole_Getchar
#elif SDK_DEBUGCONSOLE == DEBUGCONSOLE_REDIRECT_TO_TOOLCHAIN /* Select printf, scanf, putchar, getchar of
 toolchain. */
#define PRINTF printf
#define SCANF scanf
#define PUTCHAR putchar
#define GETCHAR getchar
#endif /* SDK_DEBUGCONSOLE */

```

### 49.2.3 SDK\_DEBUGCONSOLE and SDK\_DEBUGCONSOLE\_UART

There are two macros `SDK_DEBUGCONSOLE` and `SDK_DEBUGCONSOLE_UART` added to configure `PRINTF` and low level output perihperal.

- The macro `SDK_DEBUGCONSOLE` is used for forntend. Whether debug console redirect to toolchain or SDK or disabled, it decides which is the frontend of the debug console, Tool chain or SDK. The fuction can be set by the macro `SDK_DEBUGCONSOLE`.
- The macro `SDK_DEBUGCONSOLE_UART` is used for backend. It is use to decide whether provide low level IO implementation to toolchain `printf` and `scanf`. For example, within MCU-Xpresso, if the macro `SDK_DEBUGCONSOLE_UART` is defined, `__sys_write` and `__sys_readc` will be used when `__REDLIB__` is defined; `_write` and `_read` will be used in other cases. The macro does not specifically refer to the perihperal "UART". It refers to the external perihperal similar to UART, like as USB CDC, UART, SWO, etc. So if the macro `SDK_DEBUGCONSOLE_UART` is not defined when tool-chain `printf` is calling, the semihosting will be used.

The following the matrix show the effects of `SDK_DEBUGCONSOLE` and `SDK_DEBUGCONSOLE_UART` on `PRINTF` and `printf`. The green mark is the default setting of the debug console.

| <code>SDK_DEBUGCONSOLE</code>                     | <code>SDK_DEBUGCONSOLE_UART</code> | <code>PRINTF</code>   | <code>printf</code>  |
|---------------------------------------------------|------------------------------------|-----------------------|----------------------|
| <code>DEBUGCONSOLE_-REDIRECT_TO_SDK</code>        | defined                            | Low level peripheral* | Low level peripheral |
| <code>DEBUGCONSOLE_-REDIRECT_TO_SDK</code>        | undefined                          | Low level peripheral* | semihost             |
| <code>DEBUGCONSOLE_-REDIRECT_TO_TO-OLCHAIN</code> | defined                            | Low level peripheral* | Low level peripheral |
| <code>DEBUGCONSOLE_-REDIRECT_TO_TO-OLCHAIN</code> | undefined                          | semihost              | semihost             |
| <code>DEBUGCONSOLE_-DISABLE</code>                | defined                            | No ouput              | Low level peripheral |
| <code>DEBUGCONSOLE_-DISABLE</code>                | undefined                          | No ouput              | semihost             |

\* the **low level peripheral** could be USB CDC, UART, or SWO, and so on.

## 49.3 Typical use case

### Some examples use the PUTCHAR & GETCHAR function

```
ch = GETCHAR();
PUTCHAR(ch);
```

### Some examples use the PRINTF function

Statement prints the string format.

```
PRINTF("%s %s\r\n", "Hello", "world!");
```

Statement prints the hexadecimal format/

```
PRINTF("0x%02X hexadecimal number equivalent 255", 255);
```

Statement prints the decimal floating point and unsigned decimal.

```
PRINTF("Execution timer: %s\r\nTime: %u ticks %2.5f milliseconds\r\nDONE\r\n", "1 day", 86400, 86.4);
```

### Some examples use the SCANF function

```
PRINTF("Enter a decimal number: ");
SCANF("%d", &i);
PRINTF("\r\nYou have entered %d.\r\n", i, i);
PRINTF("Enter a hexadecimal number: ");
SCANF("%x", &i);
PRINTF("\r\nYou have entered 0x%X (%d).\r\n", i, i);
```

### Print out failure messages using MCUXpresso SDK `__assert_func`:

```
void __assert_func(const char *file, int line, const char *func, const char *failedExpr)
{
 PRINTF("ASSERT ERROR \" %s \": file \"%s\" Line \"%d\" function name \"%s\" \n", failedExpr, file
, line, func);
 for (;;)
 {}
}
```

#### Note:

To use 'printf' and 'scanf' for GNUC Base, add file 'fsl\_sbrk.c' in path: `..\{package}\devices\{subset}\utilities\fsl-sbrk.c` to your project.

## Modules

- [SWO](#)
- [Semihosting](#)

## Macros

- #define [DEBUGCONSOLE\\_REDIRECT\\_TO\\_TOOLCHAIN](#) 0U  
*Definition select redirect toolchain printf, scanf to uart or not.*
- #define [DEBUGCONSOLE\\_REDIRECT\\_TO\\_SDK](#) 1U  
*Select SDK version printf, scanf.*
- #define [DEBUGCONSOLE\\_DISABLE](#) 2U  
*Disable debugconsole function.*
- #define [SDK\\_DEBUGCONSOLE](#) [DEBUGCONSOLE\\_REDIRECT\\_TO\\_SDK](#)  
*Definition to select sdk or toolchain printf, scanf.*
- #define [PRINTF](#) [DbgConsole\\_Printf](#)  
*Definition to select redirect toolchain printf, scanf to uart or not.*

## Typedefs

- typedef void(\* [printfCb](#) )(char \*buf, int32\_t \*indicator, char val, int len)  
*A function pointer which is used when format printf log.*

## Functions

- int [StrFormatPrintf](#) (const char \*fmt, va\_list ap, char \*buf, [printfCb](#) cb)  
*This function outputs its parameters according to a formatted string.*
- int [StrFormatScanf](#) (const char \*line\_ptr, char \*format, va\_list args\_ptr)  
*Converts an input line of ASCII characters based upon a provided string format.*

## Variables

- [serial\\_handle\\_t g\\_serialHandle](#)  
*serial manager handle*

## Initialization

- [status\\_t DbgConsole\\_Init](#) (uint8\_t instance, uint32\_t baudRate, [serial\\_port\\_type\\_t](#) device, uint32\_t clkSrcFreq)  
*Initializes the peripheral used for debug messages.*
- [status\\_t DbgConsole\\_Deinit](#) (void)  
*De-initializes the peripheral used for debug messages.*
- [status\\_t DbgConsole\\_EnterLowpower](#) (void)  
*Prepares to enter low power consumption.*
- [status\\_t DbgConsole\\_ExitLowpower](#) (void)  
*Restores from low power consumption.*
- int [DbgConsole\\_Printf](#) (const char \*fmt\_s,...)  
*Writes formatted output to the standard output stream.*
- int [DbgConsole\\_Vprintf](#) (const char \*fmt\_s, va\_list formatStringArg)  
*Writes formatted output to the standard output stream.*
- int [DbgConsole\\_Putchar](#) (int ch)

- *Writes a character to stdout.*
- int [DbgConsole\\_Scanf](#) (char \*fmt\_s,...)  
*Reads formatted data from the standard input stream.*
- int [DbgConsole\\_Getchar](#) (void)  
*Reads a character from standard input.*
- int [DbgConsole\\_BlockingPrintf](#) (const char \*fmt\_s,...)  
*Writes formatted output to the standard output stream with the blocking mode.*
- int [DbgConsole\\_BlockingVprintf](#) (const char \*fmt\_s, va\_list formatStringArg)  
*Writes formatted output to the standard output stream with the blocking mode.*
- [status\\_t DbgConsole\\_Flush](#) (void)  
*Debug console flush.*

## 49.4 Macro Definition Documentation

### 49.4.1 #define DEBUGCONSOLE\_REDIRECT\_TO\_TOOLCHAIN 0U

Select toolchain printf and scanf.

### 49.4.2 #define DEBUGCONSOLE\_REDIRECT\_TO\_SDK 1U

### 49.4.3 #define DEBUGCONSOLE\_DISABLE 2U

### 49.4.4 #define SDK\_DEBUGCONSOLE\_DEBUGCONSOLE\_REDIRECT\_TO\_SDK

The macro only support to be redefined in project setting.

### 49.4.5 #define PRINTF DbgConsole\_Printf

if SDK\_DEBUGCONSOLE defined to 0,it represents select toolchain printf, scanf. if SDK\_DEBUGCONSOLE defined to 1,it represents select SDK version printf, scanf. if SDK\_DEBUGCONSOLE defined to 2,it represents disable debugconsole function.

## 49.5 Function Documentation

### 49.5.1 status\_t DbgConsole\_Init ( uint8\_t instance, uint32\_t baudRate, serial\_port\_type\_t device, uint32\_t clkSrcFreq )

Call this function to enable debug log messages to be output via the specified peripheral initialized by the serial manager module. After this function has returned, stdout and stdin are connected to the selected peripheral.

Parameters

|                   |                                                                                                                                                                                                                                                                                                                                                                                           |
|-------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>instance</i>   | The instance of the module.If the device is kSerialPort_Uart, the instance is UART peripheral instance. The UART hardware peripheral type is determined by UART adapter. For example, if the instance is 1, if the lpuart_adapter.c is added to the current project, the UART peripheral is LPUART1. If the uart_adapter.c is added to the current project, the UART peripheral is UART1. |
| <i>baudRate</i>   | The desired baud rate in bits per second.                                                                                                                                                                                                                                                                                                                                                 |
| <i>device</i>     | Low level device type for the debug console, can be one of the following. <ul style="list-style-type: none"> <li>• kSerialPort_Uart,</li> <li>• kSerialPort_UsbCdc</li> </ul>                                                                                                                                                                                                             |
| <i>clkSrcFreq</i> | Frequency of peripheral source clock.                                                                                                                                                                                                                                                                                                                                                     |

Returns

Indicates whether initialization was successful or not.

Return values

|                        |                        |
|------------------------|------------------------|
| <i>kStatus_Success</i> | Execution successfully |
|------------------------|------------------------|

### 49.5.2 status\_t DbgConsole\_Deinit ( void )

Call this function to disable debug log messages to be output via the specified peripheral initialized by the serial manager module.

Returns

Indicates whether de-initialization was successful or not.

### 49.5.3 status\_t DbgConsole\_EnterLowpower ( void )

This function is used to prepare to enter low power consumption.

Returns

Indicates whether de-initialization was successful or not.



**49.5.4 status\_t DbgConsole\_ExitLowpower ( void )**

This function is used to restore from low power consumption.

Returns

Indicates whether de-initialization was successful or not.

**49.5.5 int DbgConsole\_Printf ( const char \* *fmt\_s*, ... )**

Call this function to write a formatted output to the standard output stream.

Parameters

|              |                        |
|--------------|------------------------|
| <i>fmt_s</i> | Format control string. |
|--------------|------------------------|

Returns

Returns the number of characters printed or a negative value if an error occurs.

**49.5.6 int DbgConsole\_Vprintf ( const char \* *fmt\_s*, va\_list *formatStringArg* )**

Call this function to write a formatted output to the standard output stream.

Parameters

|                         |                        |
|-------------------------|------------------------|
| <i>fmt_s</i>            | Format control string. |
| <i>formatString-Arg</i> | Format arguments.      |

Returns

Returns the number of characters printed or a negative value if an error occurs.

**49.5.7 int DbgConsole\_Putchar ( int *ch* )**

Call this function to write a character to stdout.

## Parameters

|           |                          |
|-----------|--------------------------|
| <i>ch</i> | Character to be written. |
|-----------|--------------------------|

## Returns

Returns the character written.

**49.5.8 int DbgConsole\_Scanf ( char \* *fmt\_s*, ... )**

Call this function to read formatted data from the standard input stream.

## Note

Due the limitation in the BM OSA environment (CPU is blocked in the function, other tasks will not be scheduled), the function cannot be used when the `DEBUG_CONSOLE_TRANSFER_NON_BLOCKING` is set in the BM OSA environment. And an error is returned when the function called in this case. The suggestion is that polling the non-blocking function `DbgConsole_TryGetchar` to get the input char.

## Parameters

|              |                        |
|--------------|------------------------|
| <i>fmt_s</i> | Format control string. |
|--------------|------------------------|

## Returns

Returns the number of fields successfully converted and assigned.

**49.5.9 int DbgConsole\_Getchar ( void )**

Call this function to read a character from standard input.

## Note

Due the limitation in the BM OSA environment (CPU is blocked in the function, other tasks will not be scheduled), the function cannot be used when the `DEBUG_CONSOLE_TRANSFER_NON_BLOCKING` is set in the BM OSA environment. And an error is returned when the function called in this case. The suggestion is that polling the non-blocking function `DbgConsole_TryGetchar` to get the input char.

## Returns

Returns the character read.

### 49.5.10 int DbgConsole\_BlockingPrintf ( const char \* *fmt\_s*, ... )

Call this function to write a formatted output to the standard output stream with the blocking mode. The function will send data with blocking mode no matter the DEBUG\_CONSOLE\_TRANSFER\_NON\_BLOCKING set or not. The function could be used in system ISR mode with DEBUG\_CONSOLE\_TRANSFER\_NON\_BLOCKING set.

Parameters

|              |                        |
|--------------|------------------------|
| <i>fmt_s</i> | Format control string. |
|--------------|------------------------|

Returns

Returns the number of characters printed or a negative value if an error occurs.

### 49.5.11 int DbgConsole\_BlockingVprintf ( const char \* *fmt\_s*, va\_list *formatStringArg* )

Call this function to write a formatted output to the standard output stream with the blocking mode. The function will send data with blocking mode no matter the DEBUG\_CONSOLE\_TRANSFER\_NON\_BLOCKING set or not. The function could be used in system ISR mode with DEBUG\_CONSOLE\_TRANSFER\_NON\_BLOCKING set.

Parameters

|                        |                        |
|------------------------|------------------------|
| <i>fmt_s</i>           | Format control string. |
| <i>formatStringArg</i> | Format arguments.      |

Returns

Returns the number of characters printed or a negative value if an error occurs.

### 49.5.12 status\_t DbgConsole\_Flush ( void )

Call this function to wait the tx buffer empty. If interrupt transfer is using, make sure the global IRQ is enable before call this function This function should be called when 1, before enter power down mode 2, log is required to print to terminal immediately

Returns

Indicates whether wait idle was successful or not.

**49.5.13 int StrFormatPrintf ( const char \* *fmt*, va\_list *ap*, char \* *buf*, printfCb *cb* )**

Note

I/O is performed by calling given function pointer using following (\*func\_ptr)(c);

Parameters

|    |            |                                |
|----|------------|--------------------------------|
| in | <i>fmt</i> | Format string for printf.      |
| in | <i>ap</i>  | Arguments to printf.           |
| in | <i>buf</i> | pointer to the buffer          |
|    | <i>cb</i>  | print callbck function pointer |

Returns

Number of characters to be print

**49.5.14 int StrFormatScanf ( const char \* *line\_ptr*, char \* *format*, va\_list *args\_ptr* )**

Parameters

|    |                 |                                           |
|----|-----------------|-------------------------------------------|
| in | <i>line_ptr</i> | The input line of ASCII data.             |
| in | <i>format</i>   | Format first points to the format string. |
| in | <i>args_ptr</i> | The list of parameters.                   |

Returns

Number of input items converted and assigned.

Return values

|               |                                          |
|---------------|------------------------------------------|
| <i>IO_EOF</i> | When <i>line_ptr</i> is empty string "". |
|---------------|------------------------------------------|

## 49.6 Semihosting

Semihosting is a mechanism for ARM targets to communicate input/output requests from application code to a host computer running a debugger. This mechanism can be used, for example, to enable functions in the C library, such as `printf()` and `scanf()`, to use the screen and keyboard of the host rather than having a screen and keyboard on the target system.

### 49.6.1 Guide Semihosting for IAR

**NOTE:** After the setting both "printf" and "scanf" are available for debugging, if you want use PRINTF with semihosting, please make sure the `SDK_DEBUGCONSOLE` is `DEBUGCONSOLE_REDIRECT_TO_TOOLCHAIN`.

#### Step 1: Setting up the environment

1. To set debugger options, choose Project>Options. In the Debugger category, click the Setup tab.
2. Select Run to main and click OK. This ensures that the debug session starts by running the main function.
3. The project is now ready to be built.

#### Step 2: Building the project

1. Compile and link the project by choosing Project>Make or F7.
2. Alternatively, click the Make button on the tool bar. The Make command compiles and links those files that have been modified.

#### Step 3: Starting semihosting

1. Choose "Semihosting\_IAR" project -> "Options" -> "Debugger" -> "J-Link/J-Trace".
2. Choose tab "J-Link/J-Trace" -> "Connection" tab -> "SWD".
3. Choose tab "General Options" -> "Library Configurations", select Semihosted, select Via semihosting. Please Make sure the `SDK_DEBUGCONSOLE_UART` is not defined in project settings.
4. Start the project by choosing Project>Download and Debug.
5. Choose View>Terminal I/O to display the output from the I/O operations.

### 49.6.2 Guide Semihosting for Keil $\mu$ Vision

**NOTE:** Semihosting is not support by MDK-ARM, use the retargeting functionality of MDK-ARM instead.

### 49.6.3 Guide Semihosting for MCUXpresso IDE

#### Step 1: Setting up the environment

1. To set debugger options, choose Project>Properties. select the setting category.
2. Select Tool Settings, unfold MCU C Compile.
3. Select Preprocessor item.
4. Set SDK\_DEBUGCONSOLE=0, if set SDK\_DEBUGCONSOLE=1, the log will be redirect to the UART.

#### Step 2: Building the project

1. Compile and link the project.

#### Step 3: Starting semihosting

1. Download and debug the project.
2. When the project runs successfully, the result can be seen in the Console window.

Semihosting can also be selected through the "Quick settings" menu in the left bottom window, Quick settings->SDK Debug Console->Semihost console.

### 49.6.4 Guide Semihosting for ARMGCC

#### Step 1: Setting up the environment

1. Turn on "J-LINK GDB Server" -> Select suitable "Target device" -> "OK".
2. Turn on "PuTTY". Set up as follows.
  - "Host Name (or IP address)" : localhost
  - "Port" :2333
  - "Connection type" : Telet.
  - Click "Open".
3. Increase "Heap/Stack" for GCC to 0x2000:

#### Add to "CMakeLists.txt"

```
SET(CMAKE_EXE_LINKER_FLAGS_RELEASE "${CMAKE_EXE_LINKER_FLAGS_RELEASE}
--defsym=__stack_size__=0x2000")
```

```
SET(CMAKE_EXE_LINKER_FLAGS_DEBUG "${CMAKE_EXE_LINKER_FLAGS_DEBUG} --
defsym=__stack_size__=0x2000")
```

```
SET(CMAKE_EXE_LINKER_FLAGS_DEBUG "${CMAKE_EXE_LINKER_FLAGS_DEBUG} --
defsym=__heap_size__=0x2000")
```

```
SET(CMAKE_EXE_LINKER_FLAGS_RELEASE "${CMAKE_EXE_LINKER_FLAGS_RELEASE}
--defsym=__heap_size__=0x2000")
```

**Step 2: Building the project**

1. Change "CMakeLists.txt":

**Change** "SET(CMAKE\_EXE\_LINKER\_FLAGS\_RELEASE "\${CMAKE\_EXE\_LINKER\_FLAGS\_RELEASE} -specs=nano.specs")"

**to** "SET(CMAKE\_EXE\_LINKER\_FLAGS\_RELEASE "\${CMAKE\_EXE\_LINKER\_FLAGS\_RELEASE} -specs=rdimon.specs")"

**Replace paragraph**

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} -fno-common")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} -ffunction-sections")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} -fdata-sections")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} -ffreestanding")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} -fno-builtin")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} -mthumb")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} -mapcs")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} -Xlinker")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} --gc-sections")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} -Xlinker")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} -static")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} -Xlinker")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} -z")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} -Xlinker")

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} muldefs")

**To**

SET(CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG "\${CMAKE\_EXE\_LINKER\_FLAGS\_DEBUG} --specs=rdimon.specs ")

**Remove**

target\_link\_libraries(semihosting\_ARMGCC.elf debug nosys)

2. Run "build\_debug.bat" to build project

### Step 3: Starting semihosting

1. Download the image and set as follows.

```
cd D:\mcu-sdk-2.0-origin\boards\twrk64f120m\driver_examples\semihosting\armgcc\debug
d:
C:\PROGRA~2\GNUTOO~1\4BD65~1.920\bin\arm-none-eabi-gdb.exe
target remote localhost:2331
monitor reset
monitor semihosting enable
monitor semihosting thumbSWI 0xAB
monitor semihosting IOClient 1
monitor flash device = MK64FN1M0xxx12
load semihosting_ARMGCC.elf
monitor reg pc = (0x00000004)
monitor reg sp = (0x00000000)
continue
```

2. After the setting, press "enter". The PuTTY window now shows the printf() output.



## 49.7 SWO

Serial wire output is a mechanism for ARM targets to output signal from core through a single pin. Some IDEs also support SWO, such IAR and KEIL, both input and output are supported, see below for details.

### 49.7.1 Guide SWO for SDK

**NOTE:** After the setting both "printf" and "PRINTF" are available for debugging, JlinkSWOViewer can be used to capture the output log.

#### Step 1: Setting up the environment

1. Define SERIAL\_PORT\_TYPE\_SWO in your project settings.
2. Prepare code, the port and baudrate can be decided by application, clkSrcFreq should be mcu core clock frequency:

```
DbgConsole_Init(instance, baudRate, kSerialPort_Swo, clkSrcFreq);
```

3. Use PRINTF or printf to print some thing in application.

#### Step 2: Building the project

#### Step 3: Download and run project

##### 49.7.1.1 Guide SWO for IAR

**NOTE:** After the setting both "printf" and "scanf" are available for debugging.

#### Step 1: Setting up the environment

1. Choose project -> "Options" -> "Debugger" -> "J-Link/J-Trace".
2. Choose tab "J-Link/J-Trace" -> "Connection" tab -> "SWD".
3. Choose tab "General Options" -> "Library Configurations", select Semihosted, select Via SWO.
4. To configure the hardware's generation of trace data, click the SWO Configuration button available in the SWO Configuration dialog box. The value of the CPU clock option must reflect the frequency of the CPU clock speed at which the application executes. Note also that the settings you make are preserved between debug sessions. To decrease the amount of transmissions on the communication channel, you can disable the Timestamp option. Alternatively, set a lower rate for PC Sampling or use a higher SWO clock frequency.
5. Open the SWO Trace window from J-LINK, and click the Activate button to enable trace data collection.
6. There are three cases for this SDK\_DEBUGCONSOLE\_UART whether or not defined. a: if use uppercase PRINTF to output log, The SDK\_DEBUGCONSOLE\_UART defined or not defined will not effect debug function. b: if use lowercase printf to output log and defined SDK\_DEBUGCONSOLE\_UART to zero, then debug function ok. c: if use lowercase printf to output log and defined SDK\_DEBUGCONSOLE\_UART to one, then debug function ok.

**NOTE:** Case a or c only apply at example which enable swo function,the SDK\_DEBUGCONSOLE\_UART definition in fsl\_debug\_console.h. For case a and c, Do and not do the above third step will be not affect function.

1. Start the project by choosing Project>Download and Debug.

### **Step 2: Building the project**

### **Step 3: Starting swo**

1. Download and debug application.
2. Choose View -> Terminal I/O to display the output from the I/O operations.
3. Run application.

## **49.7.2 Guide SWO for Keil $\mu$ Vision**

**NOTE:** After the setting both "printf" and "scanf" are available for debugging.

### **Step 1: Setting up the environment**

1. There are three cases for this SDK\_DEBUGCONSOLE\_UART whether or not defined. a: if use uppercase PRINTF to output log,the SDK\_DEBUGCONSOLE\_UART definition does not affect the functionality and skip the second step directly. b: if use lowercase printf to output log and defined SDK\_DEBUGCONSOLE\_UART to zero,then start the second step. c: if use lowercase printf to output log and defined SDK\_DEBUGCONSOLE\_UART to one,then skip the second step directly.

**NOTE:** Case a or c only apply at example which enable swo function,the SDK\_DEBUGCONSOLE\_UART definition in fsl\_debug\_console.h.

1. In menu bar, click Management Run-Time Environment icon, select Compiler, unfold I/O, enable STDERR/STDIN/STDOUT and set the variant to ITM.
2. Open Project>Options for target or using Alt+F7 or click.
3. Select "Debug" tab, select "J-Link/J-Trace Cortex" and click "Setting button".
4. Select "Debug" tab and choose Port:SW, then select "Trace" tab, choose "Enable" and click O-K, please make sure the Core clock is set correctly, enable autodetect max SWO clk, enable ITM Stimulus Ports 0.

### **Step 3: Building the project**

1. Compile and link the project by choosing Project>Build Target or using F7.

### **Step 4: Run the project**

1. Choose "Debug" on menu bar or Ctrl F5.
2. In menu bar, choose "Serial Window" and click to "Debug (printf) Viewer".
3. Run line by line to see result in Console Window.

### 49.7.3 Guide SWO for MCUXpresso IDE

**NOTE:** MCUX support SWO for LPC-Link2 debug probe only.

### 49.7.4 Guide SWO for ARMGCC

**NOTE:** ARMGCC has no library support SWO.

# Chapter 50

## Notification Framework

### 50.1 Overview

This section describes the programming interface of the Notifier driver.

### 50.2 Notifier Overview

The Notifier provides a configuration dynamic change service. Based on this service, applications can switch between pre-defined configurations. The Notifier enables drivers and applications to register callback functions to this framework. Each time that the configuration is changed, drivers and applications receive a notification and change their settings. To simplify, the Notifier only supports the static callback registration. This means that, for applications, all callback functions are collected into a static table and passed to the Notifier.

These are the steps for the configuration transition.

1. Before configuration transition, the Notifier sends a "BEFORE" message to the callback table. When this message is received, IP drivers should check whether any current processes can be stopped and stop them. If the processes cannot be stopped, the callback function returns an error.  
The Notifier supports two types of transition policies, a graceful policy and a forceful policy. When the graceful policy is used, if some callbacks return an error while sending a "BEFORE" message, the configuration transition stops and the Notifier sends a "RECOVER" message to all drivers that have stopped. Then, these drivers can recover the previous status and continue to work. When the forceful policy is used, drivers are stopped forcefully.
2. After the "BEFORE" message is processed successfully, the system switches to the new configuration.
3. After the configuration changes, the Notifier sends an "AFTER" message to the callback table to notify drivers that the configuration transition is finished.

This example shows how to use the Notifier in the Power Manager application.

```
#include "fsl_notifier.h"

// Definition of the Power Manager callback.
status_t callback0(notifier_notification_block_t *notify, void *data)
{
 status_t ret = kStatus_Success;

 ...
 ...
 ...

 return ret;
}

// Definition of the Power Manager user function.
status_t APP_PowerModeSwitch(notifier_user_config_t *targetConfig, void *
 userData)
```

```

{
 ...
 ...
 ...
}
...
...
...
...
...
// Main function.
int main(void)
{
 // Define a notifier handle.
 notifier_handle_t powerModeHandle;

 // Callback configuration.
 user_callback_data_t callbackData0;

 notifier_callback_config_t callbackCfg0 = {callback0,
 kNOTIFIER_CallbackBeforeAfter,
 (void *)&callbackData0};

 notifier_callback_config_t callbacks[] = {callbackCfg0};

 // Power mode configurations.
 power_user_config_t vlprConfig;
 power_user_config_t stopConfig;

 notifier_user_config_t *powerConfigs[] = {&vlprConfig, &stopConfig};

 // Definition of a transition to and out the power modes.
 vlprConfig.mode = kAPP_PowerModeVlpr;
 vlprConfig.enableLowPowerWakeUpOnInterrupt = false;

 stopConfig = vlprConfig;
 stopConfig.mode = kAPP_PowerModeStop;

 // Create Notifier handle.
 NOTIFIER_CreateHandle(&powerModeHandle, powerConfigs, 2U, callbacks, 1U,
 APP_PowerModeSwitch, NULL);
 ...
 ...
 // Power mode switch.
 NOTIFIER_switchConfig(&powerModeHandle, targetConfigIndex,
 kNOTIFIER_PolicyAgreement);
}

```

## Data Structures

- struct [notifier\\_notification\\_block\\_t](#)  
*notification block passed to the registered callback function. [More...](#)*
- struct [notifier\\_callback\\_config\\_t](#)  
*Callback configuration structure. [More...](#)*
- struct [notifier\\_handle\\_t](#)  
*Notifier handle structure. [More...](#)*

## Typedefs

- typedef void [notifier\\_user\\_config\\_t](#)  
*Notifier user configuration type.*
- typedef [status\\_t](#)(\* [notifier\\_user\\_function\\_t](#))([notifier\\_user\\_config\\_t](#) \*targetConfig, void \*userData)

- Notifier user function prototype Use this function to execute specific operations in configuration switch.
- typedef `status_t(* notifier_callback_t)(notifier_notification_block_t *notify, void *data)`  
Callback prototype.

## Enumerations

- enum `_notifier_status` {  
  `kStatus_NOTIFIER_ErrorNotificationBefore`,  
  `kStatus_NOTIFIER_ErrorNotificationAfter` }  
  Notifier error codes.
- enum `notifier_policy_t` {  
  `kNOTIFIER_PolicyAgreement`,  
  `kNOTIFIER_PolicyForcible` }  
  Notifier policies.
- enum `notifier_notification_type_t` {  
  `kNOTIFIER_NotifyRecover` = 0x00U,  
  `kNOTIFIER_NotifyBefore` = 0x01U,  
  `kNOTIFIER_NotifyAfter` = 0x02U }  
  Notification type.
- enum `notifier_callback_type_t` {  
  `kNOTIFIER_CallbackBefore` = 0x01U,  
  `kNOTIFIER_CallbackAfter` = 0x02U,  
  `kNOTIFIER_CallbackBeforeAfter` = 0x03U }  
  The callback type, which indicates kinds of notification the callback handles.

## Functions

- `status_t NOTIFIER_CreateHandle` (`notifier_handle_t *notifierHandle`, `notifier_user_config_t **configs`, `uint8_t configsNumber`, `notifier_callback_config_t *callbacks`, `uint8_t callbacksNumber`, `notifier_user_function_t userFunction`, `void *userData`)  
  Creates a Notifier handle.
- `status_t NOTIFIER_SwitchConfig` (`notifier_handle_t *notifierHandle`, `uint8_t configIndex`, `notifier_policy_t policy`)  
  Switches the configuration according to a pre-defined structure.
- `uint8_t NOTIFIER_GetErrorCallbackIndex` (`notifier_handle_t *notifierHandle`)  
  This function returns the last failed notification callback.

## 50.3 Data Structure Documentation

### 50.3.1 struct `notifier_notification_block_t`

#### Data Fields

- `notifier_user_config_t * targetConfig`  
  Pointer to target configuration.
- `notifier_policy_t policy`  
  Configure transition policy.
- `notifier_notification_type_t notifyType`

*Configure notification type.*

#### Field Documentation

- (1) `notifier_user_config_t* notifier_notification_block_t::targetConfig`
- (2) `notifier_policy_t notifier_notification_block_t::policy`
- (3) `notifier_notification_type_t notifier_notification_block_t::notifyType`

### 50.3.2 struct `notifier_callback_config_t`

This structure holds the configuration of callbacks. Callbacks of this type are expected to be statically allocated. This structure contains the following application-defined data. `callback` - pointer to the callback function `callbackType` - specifies when the callback is called `callbackData` - pointer to the data passed to the callback.

#### Data Fields

- `notifier_callback_t callback`  
*Pointer to the callback function.*
- `notifier_callback_type_t callbackType`  
*Callback type.*
- `void * callbackData`  
*Pointer to the data passed to the callback.*

#### Field Documentation

- (1) `notifier_callback_t notifier_callback_config_t::callback`
- (2) `notifier_callback_type_t notifier_callback_config_t::callbackType`
- (3) `void* notifier_callback_config_t::callbackData`

### 50.3.3 struct `notifier_handle_t`

Notifier handle structure. Contains data necessary for the Notifier proper function. Stores references to registered configurations, callbacks, information about their numbers, user function, user data, and other internal data. `NOTIFIER_CreateHandle()` must be called to initialize this handle.

#### Data Fields

- `notifier_user_config_t ** configsTable`  
*Pointer to configure table.*
- `uint8_t configsNumber`  
*Number of configurations.*

- [notifier\\_callback\\_config\\_t](#) \* [callbacksTable](#)  
*Pointer to callback table.*
- [uint8\\_t](#) [callbacksNumber](#)  
*Maximum number of callback configurations.*
- [uint8\\_t](#) [errorCallbackIndex](#)  
*Index of callback returns error.*
- [uint8\\_t](#) [currentConfigIndex](#)  
*Index of current configuration.*
- [notifier\\_user\\_function\\_t](#) [userFunction](#)  
*User function.*
- [void](#) \* [userData](#)  
*User data passed to user function.*

### Field Documentation

- (1) [notifier\\_user\\_config\\_t](#)\*\* [notifier\\_handle\\_t::configsTable](#)
- (2) [uint8\\_t](#) [notifier\\_handle\\_t::configsNumber](#)
- (3) [notifier\\_callback\\_config\\_t](#)\* [notifier\\_handle\\_t::callbacksTable](#)
- (4) [uint8\\_t](#) [notifier\\_handle\\_t::callbacksNumber](#)
- (5) [uint8\\_t](#) [notifier\\_handle\\_t::errorCallbackIndex](#)
- (6) [uint8\\_t](#) [notifier\\_handle\\_t::currentConfigIndex](#)
- (7) [notifier\\_user\\_function\\_t](#) [notifier\\_handle\\_t::userFunction](#)
- (8) [void](#)\* [notifier\\_handle\\_t::userData](#)

## 50.4 Typedef Documentation

### 50.4.1 typedef void [notifier\\_user\\_config\\_t](#)

Reference of the user defined configuration is stored in an array; the notifier switches between these configurations based on this array.

### 50.4.2 typedef [status\\_t](#)(\* [notifier\\_user\\_function\\_t](#))([notifier\\_user\\_config\\_t](#) \*[targetConfig](#), [void](#) \*[userData](#))

Before and after this function execution, different notification is sent to registered callbacks. If this function returns any error code, [NOTIFIER\\_SwitchConfig\(\)](#) exits.



### Parameters

|                     |                                                        |
|---------------------|--------------------------------------------------------|
| <i>targetConfig</i> | target Configuration.                                  |
| <i>userData</i>     | Refers to other specific data passed to user function. |

### Returns

An error code or `kStatus_Success`.

### 50.4.3 `typedef status_t(* notifier_callback_t)(notifier_notification_block_t *notify, void *data)`

Declaration of a callback. It is common for registered callbacks. Reference to function of this type is part of the `notifier_callback_config_t` callback configuration structure. Depending on callback type, function of this prototype is called (see `NOTIFIER_SwitchConfig()`) before configuration switch, after it or in both use cases to notify about the switch progress (see `notifier_callback_type_t`). When called, the type of the notification is passed as a parameter along with the reference to the target configuration structure (see `notifier_notification_block_t`) and any data passed during the callback registration. When notified before the configuration switch, depending on the configuration switch policy (see `notifier_policy_t`), the callback may deny the execution of the user function by returning an error code different than `kStatus_Success` (see `NOTIFIER_SwitchConfig()`).

### Parameters

|               |                                                                                                                                                            |
|---------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>notify</i> | Notification block.                                                                                                                                        |
| <i>data</i>   | Callback data. Refers to the data passed during callback registration. Intended to pass any driver or application data such as internal state information. |

### Returns

An error code or `kStatus_Success`.

## 50.5 Enumeration Type Documentation

### 50.5.1 `enum _notifier_status`

Used as return value of Notifier functions.

### Enumerator

**`kStatus_NOTIFIER_ErrorNotificationBefore`** An error occurs during send "BEFORE" notification.

**`kStatus_NOTIFIER_ErrorNotificationAfter`** An error occurs during send "AFTER" notification.

### 50.5.2 enum notifier\_policy\_t

Defines whether the user function execution is forced or not. For `kNOTIFIER_PolicyForcible`, the user function is executed regardless of the callback results, while `kNOTIFIER_PolicyAgreement` policy is used to exit `NOTIFIER_SwitchConfig()` when any of the callbacks returns error code. See also `NOTIFIER_SwitchConfig()` description.

Enumerator

*kNOTIFIER\_PolicyAgreement* `NOTIFIER_SwitchConfig()` method is exited when any of the callbacks returns error code.

*kNOTIFIER\_PolicyForcible* The user function is executed regardless of the results.

### 50.5.3 enum notifier\_notification\_type\_t

Used to notify registered callbacks

Enumerator

*kNOTIFIER\_NotifyRecover* Notify IP to recover to previous work state.

*kNOTIFIER\_NotifyBefore* Notify IP that configuration setting is going to change.

*kNOTIFIER\_NotifyAfter* Notify IP that configuration setting has been changed.

### 50.5.4 enum notifier\_callback\_type\_t

Used in the callback configuration structure (`notifier_callback_config_t`) to specify when the registered callback is called during configuration switch initiated by the `NOTIFIER_SwitchConfig()`. Callback can be invoked in following situations.

- Before the configuration switch (Callback return value can affect `NOTIFIER_SwitchConfig()` execution. See the `NOTIFIER_SwitchConfig()` and `notifier_policy_t` documentation).
- After an unsuccessful attempt to switch configuration
- After a successful configuration switch

Enumerator

*kNOTIFIER\_CallbackBefore* Callback handles BEFORE notification.

*kNOTIFIER\_CallbackAfter* Callback handles AFTER notification.

*kNOTIFIER\_CallbackBeforeAfter* Callback handles BEFORE and AFTER notification.

## 50.6 Function Documentation

**50.6.1** `status_t NOTIFIER_CreateHandle ( notifier_handle_t * notifierHandle,  
notifier_user_config_t ** configs, uint8_t configsNumber, notifier_callback-  
_config_t * callbacks, uint8_t callbacksNumber, notifier_user_function_t  
userFunction, void * userData )`

## Parameters

|                         |                                                                                                                                         |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| <i>notifierHandle</i>   | A pointer to the notifier handle.                                                                                                       |
| <i>configs</i>          | A pointer to an array with references to all configurations which is handled by the Notifier.                                           |
| <i>configsNumber</i>    | Number of configurations. Size of the configuration array.                                                                              |
| <i>callbacks</i>        | A pointer to an array of callback configurations. If there are no callbacks to register during Notifier initialization, use NULL value. |
| <i>callbacks-Number</i> | Number of registered callbacks. Size of the callbacks array.                                                                            |
| <i>userFunction</i>     | User function.                                                                                                                          |
| <i>userData</i>         | User data passed to user function.                                                                                                      |

## Returns

An error Code or kStatus\_Success.

### 50.6.2 **status\_t NOTIFIER\_SwitchConfig ( notifier\_handle\_t \* *notifierHandle*, uint8\_t *configIndex*, notifier\_policy\_t *policy* )**

This function sets the system to the target configuration. Before transition, the Notifier sends notifications to all callbacks registered to the callback table. Callbacks are invoked in the following order: All registered callbacks are notified ordered by index in the callbacks array. The same order is used for before and after switch notifications. The notifications before the configuration switch can be used to obtain confirmation about the change from registered callbacks. If any registered callback denies the configuration change, further execution of this function depends on the notifier policy: the configuration change is either forced (kNOTIFIER\_PolicyForcible) or exited (kNOTIFIER\_PolicyAgreement). When configuration change is forced, the result of the before switch notifications are ignored. If an agreement is required, if any callback returns an error code, further notifications before switch notifications are cancelled and all already notified callbacks are re-invoked. The index of the callback which returned error code during pre-switch notifications is stored (any error codes during callbacks re-invocation are ignored) and NOTIFIER\_GetErrorCallback() can be used to get it. Regardless of the policies, if any callback returns an error code, an error code indicating in which phase the error occurred is returned when [NOTIFIER\\_SwitchConfig\(\)](#) exits.

## Parameters

|                       |                                                                            |
|-----------------------|----------------------------------------------------------------------------|
| <i>notifierHandle</i> | pointer to notifier handle                                                 |
| <i>configIndex</i>    | Index of the target configuration.                                         |
| <i>policy</i>         | Transaction policy, kNOTIFIER_PolicyAgreement or kNOTIFIER_PolicyForcible. |

Returns

An error code or kStatus\_Success.

### 50.6.3 uint8\_t NOTIFIER\_GetErrorCallbackIndex ( notifier\_handle\_t \* *notifierHandle* )

This function returns an index of the last callback that failed during the configuration switch while the last [NOTIFIER\\_SwitchConfig\(\)](#) was called. If the last [NOTIFIER\\_SwitchConfig\(\)](#) call ended successfully value equal to callbacks number is returned. The returned value represents an index in the array of static call-backs.

Parameters

|                       |                                |
|-----------------------|--------------------------------|
| <i>notifierHandle</i> | Pointer to the notifier handle |
|-----------------------|--------------------------------|

Returns

Callback Index of the last failed callback or value equal to callbacks count.

# Chapter 51

## Shell

### 51.1 Overview

This section describes the programming interface of the Shell middleware.

Shell controls MCUs by commands via the specified communication peripheral based on the debug console driver.

### 51.2 Function groups

#### 51.2.1 Initialization

To initialize the Shell middleware, call the [SHELL\\_Init\(\)](#) function with these parameters. This function automatically enables the middleware.

```
shell_status_t SHELL_Init(shell_handle_t shellHandle,
 serial_handle_t serialHandle, char *prompt);
```

Then, after the initialization was successful, call a command to control MCUs.

This example shows how to call the [SHELL\\_Init\(\)](#) given the user configuration structure.

```
SHELL_Init(s_shellHandle, s_serialHandle, "Test@SHELL>");
```

#### 51.2.2 Advanced Feature

- Support to get a character from standard input devices.

```
static shell_status_t SHELL_GetChar(shell_context_handle_t *shellContextHandle, uint8_t *ch);
```

| Commands | Description                       |
|----------|-----------------------------------|
| help     | List all the registered commands. |
| exit     | Exit program.                     |

#### 51.2.3 Shell Operation

```
SHELL_Init(s_shellHandle, s_serialHandle, "Test@SHELL>");
SHELL_Task((s_shellHandle);
```

## Data Structures

- struct `shell_command_t`  
User command data configuration structure. *More...*

## Macros

- #define `SHELL_NON_BLOCKING_MODE SERIAL_MANAGER_NON_BLOCKING_MODE`  
Whether use non-blocking mode.
- #define `SHELL_AUTO_COMPLETE` (1U)  
Macro to set on/off auto-complete feature.
- #define `SHELL_BUFFER_SIZE` (64U)  
Macro to set console buffer size.
- #define `SHELL_MAX_ARGS` (8U)  
Macro to set maximum arguments in command.
- #define `SHELL_HISTORY_COUNT` (3U)  
Macro to set maximum count of history commands.
- #define `SHELL_IGNORE_PARAMETER_COUNT` (0xFF)  
Macro to bypass arguments check.
- #define `SHELL_HANDLE_SIZE`  
The handle size of the shell module.
- #define `SHELL_USE_COMMON_TASK` (0U)  
Macro to determine whether use common task.
- #define `SHELL_TASK_PRIORITY` (2U)  
Macro to set shell task priority.
- #define `SHELL_TASK_STACK_SIZE` (1000U)  
Macro to set shell task stack size.
- #define `SHELL_HANDLE_DEFINE`(name) uint32\_t name[((SHELL\_HANDLE\_SIZE + sizeof(uint32\_t) - 1U) / sizeof(uint32\_t))]  
Defines the shell handle.
- #define `SHELL_COMMAND_DEFINE`(command, descriptor, callback, paramCount)  
Defines the shell command structure.
- #define `SHELL_COMMAND`(command) &g\_shellCommand##command  
Gets the shell command pointer.

## Typedefs

- typedef void \* `shell_handle_t`  
The handle of the shell module.
- typedef `shell_status_t(* cmd_function_t)(shell_handle_t shellHandle, int32_t argc, char **argv)`  
User command function prototype.

## Enumerations

- enum `shell_status_t` {  
`kStatus_SHELL_Success` = `kStatus_Success`,  
`kStatus_SHELL_Error` = `MAKE_STATUS(kStatusGroup_SHELL, 1)`,  
`kStatus_SHELL_OpenWriteHandleFailed` = `MAKE_STATUS(kStatusGroup_SHELL, 2)`,  
`kStatus_SHELL_OpenReadHandleFailed` = `MAKE_STATUS(kStatusGroup_SHELL, 3)` }  
*Shell status.*

## Shell functional operation

- `shell_status_t SHELL_Init` (`shell_handle_t shellHandle`, `serial_handle_t serialHandle`, `char *prompt`)  
*Initializes the shell module.*
- `shell_status_t SHELL_RegisterCommand` (`shell_handle_t shellHandle`, `shell_command_t *shellCommand`)  
*Registers the shell command.*
- `shell_status_t SHELL_UnregisterCommand` (`shell_command_t *shellCommand`)  
*Unregisters the shell command.*
- `shell_status_t SHELL_Write` (`shell_handle_t shellHandle`, `const char *buffer`, `uint32_t length`)  
*Sends data to the shell output stream.*
- `int SHELL_Printf` (`shell_handle_t shellHandle`, `const char *formatString`,...)  
*Writes formatted output to the shell output stream.*
- `shell_status_t SHELL_WriteSynchronization` (`shell_handle_t shellHandle`, `const char *buffer`, `uint32_t length`)  
*Sends data to the shell output stream with OS synchronization.*
- `int SHELL_PrintfSynchronization` (`shell_handle_t shellHandle`, `const char *formatString`,...)  
*Writes formatted output to the shell output stream with OS synchronization.*
- `void SHELL_ChangePrompt` (`shell_handle_t shellHandle`, `char *prompt`)  
*Change shell prompt.*
- `void SHELL_PrintPrompt` (`shell_handle_t shellHandle`)  
*Print shell prompt.*
- `void SHELL_Task` (`shell_handle_t shellHandle`)  
*The task function for Shell.*
- `static bool SHELL_checkRunningInIsr` (`void`)  
*Check if code is running in ISR.*

## 51.3 Data Structure Documentation

### 51.3.1 struct shell\_command\_t

#### Data Fields

- `const char * pcCommand`  
*The command that is executed.*
- `char * pcHelpString`  
*String that describes how to use the command.*
- `const cmd_function_t pFuncCallBack`  
*A pointer to the callback function that returns the output generated by the command.*
- `uint8_t cExpectedNumberOfParameters`  
*Commands expect a fixed number of parameters, which may be zero.*
- `list_element_t link`  
*link of the element*

#### Field Documentation

##### (1) `const char* shell_command_t::pcCommand`

For example "help". It must be all lower case.



**(2) char\* shell\_command\_t::pcHelpString**

It should start with the command itself, and end with "\r\n". For example "help: Returns a list of all the commands\r\n".

**(3) const cmd\_function\_t shell\_command\_t::pFuncCallback****(4) uint8\_t shell\_command\_t::cExpectedNumberOfParameters****51.4 Macro Definition Documentation****51.4.1 #define SHELL\_NON\_BLOCKING\_MODE SERIAL\_MANAGER\_NON\_BLOCKING\_MODE****51.4.2 #define SHELL\_AUTO\_COMPLETE (1U)****51.4.3 #define SHELL\_BUFFER\_SIZE (64U)****51.4.4 #define SHELL\_MAX\_ARGS (8U)****51.4.5 #define SHELL\_HISTORY\_COUNT (3U)****51.4.6 #define SHELL\_HANDLE\_SIZE****Value:**

```
(160U + SHELL_HISTORY_COUNT * SHELL_BUFFER_SIZE +
SHELL_BUFFER_SIZE + SERIAL_MANAGER_READ_HANDLE_SIZE + \
SERIAL_MANAGER_WRITE_HANDLE_SIZE)
```

It is the sum of the SHELL\_HISTORY\_COUNT \* SHELL\_BUFFER\_SIZE + SHELL\_BUFFER\_SIZE + SERIAL\_MANAGER\_READ\_HANDLE\_SIZE + SERIAL\_MANAGER\_WRITE\_HANDLE\_SIZE

**51.4.7 #define SHELL\_USE\_COMMON\_TASK (0U)****51.4.8 #define SHELL\_TASK\_PRIORITY (2U)****51.4.9 #define SHELL\_TASK\_STACK\_SIZE (1000U)**

**51.4.10 #define SHELL\_HANDLE\_DEFINE( *name* ) uint32\_t  
name[((SHELL\_HANDLE\_SIZE + sizeof(uint32\_t) - 1U) / sizeof(uint32\_t))]**

This macro is used to define a 4 byte aligned shell handle. Then use "(shell\_handle\_t)name" to get the shell handle.

The macro should be global and could be optional. You could also define shell handle by yourself.

This is an example,

```
* SHELL_HANDLE_DEFINE(shellHandle);
*
```

Parameters

|             |                                      |
|-------------|--------------------------------------|
| <i>name</i> | The name string of the shell handle. |
|-------------|--------------------------------------|

**51.4.11 #define SHELL\_COMMAND\_DEFINE( *command*, *descriptor*, *callback*,  
*paramCount* )**

**Value:**

```
\
shell_command_t g_shellCommand##command = {
 (#command), (descriptor), (callback), (paramCount), {0},
}
\
```

This macro is used to define the shell command structure [shell\\_command\\_t](#). And then uses the macro SHELL\_COMMAND to get the command structure pointer. The macro should not be used in any function.

This is a example,

```
* SHELL_COMMAND_DEFINE(exit, "\r\n\"exit\": Exit program\r\n", SHELL_ExitCommand, 0);
* SHELL_RegisterCommand(s_shellHandle, SHELL_COMMAND(exit));
*
```

Parameters

|                |                                                                                                                              |
|----------------|------------------------------------------------------------------------------------------------------------------------------|
| <i>command</i> | The command string of the command. The double quotes do not need. Such as exit for "exit", help for "Help", read for "read". |
|----------------|------------------------------------------------------------------------------------------------------------------------------|

|                   |                                                                                                   |
|-------------------|---------------------------------------------------------------------------------------------------|
| <i>descriptor</i> | The description of the command is used for showing the command usage when "help" is typing.       |
| <i>callback</i>   | The callback of the command is used to handle the command line when the input command is matched. |
| <i>paramCount</i> | The max parameter count of the current command.                                                   |

#### 51.4.12 #define SHELL\_COMMAND( *command* ) &g\_shellCommand##command

This macro is used to get the shell command pointer. The macro should not be used before the macro SHELL\_COMMAND\_DEFINE is used.

Parameters

|                |                                                                                                                              |
|----------------|------------------------------------------------------------------------------------------------------------------------------|
| <i>command</i> | The command string of the command. The double quotes do not need. Such as exit for "exit", help for "Help", read for "read". |
|----------------|------------------------------------------------------------------------------------------------------------------------------|

### 51.5 Typedef Documentation

#### 51.5.1 typedef shell\_status\_t(\* cmd\_function\_t)(shell\_handle\_t shellHandle, int32\_t argc, char \*\*argv)

### 51.6 Enumeration Type Documentation

#### 51.6.1 enum shell\_status\_t

Enumerator

- kStatus\_SHELL\_Success* Success.
- kStatus\_SHELL\_Error* Failed.
- kStatus\_SHELL\_OpenWriteHandleFailed* Open write handle failed.
- kStatus\_SHELL\_OpenReadHandleFailed* Open read handle failed.

### 51.7 Function Documentation

#### 51.7.1 shell\_status\_t SHELL\_Init ( shell\_handle\_t *shellHandle*, serial\_handle\_t *serialHandle*, char \* *prompt* )

This function must be called before calling all other Shell functions. Call operation the Shell commands with user-defined settings. The example below shows how to set up the Shell and how to call the SHELL\_Init function by passing in these parameters. This is an example.

```
* static SHELL_HANDLE_DEFINE(s_shellHandle);
* SHELL_Init((shell_handle_t)s_shellHandle, (
* serial_handle_t)s_serialHandle, "Test@SHELL>");
*
```

## Parameters

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                      |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>shellHandle</i>  | Pointer to point to a memory space of size <code>SHELL_HANDLE_SIZE</code> allocated by the caller. The handle should be 4 byte aligned, because unaligned access doesn't be supported on some devices. You can define the handle in the following two ways: <code>SHELL_HANDLE_DEFINE(shellHandle)</code> ; or <code>uint32_t shellHandle[((SHELL_HANDLE_SIZE + sizeof(uint32_t) - 1U) / sizeof(uint32_t))]</code> ; |
| <i>serialHandle</i> | The serial manager module handle pointer.                                                                                                                                                                                                                                                                                                                                                                            |
| <i>prompt</i>       | The string prompt pointer of Shell. Only the global variable can be passed.                                                                                                                                                                                                                                                                                                                                          |

## Return values

|                                             |                                                  |
|---------------------------------------------|--------------------------------------------------|
| <i>kStatus_SHELL_Success</i>                | The shell initialization succeed.                |
| <i>kStatus_SHELL_Error</i>                  | An error occurred when the shell is initialized. |
| <i>kStatus_SHELL_Open-WriteHandleFailed</i> | Open the write handle failed.                    |
| <i>kStatus_SHELL_Open-ReadHandleFailed</i>  | Open the read handle failed.                     |

### 51.7.2 `shell_status_t` `SHELL_RegisterCommand` ( `shell_handle_t` *shellHandle*, `shell_command_t` \* *shellCommand* )

This function is used to register the shell command by using the command configuration `shell_command_config_t`. This is a example,

```
* SHELL_COMMAND_DEFINE (exit, "\r\n\"exit\": Exit program\r\n", SHELL_ExitCommand, 0);
* SHELL_RegisterCommand(s_shellHandle, SHELL_COMMAND(exit));
*
```

## Parameters

|                     |                                  |
|---------------------|----------------------------------|
| <i>shellHandle</i>  | The shell module handle pointer. |
| <i>shellCommand</i> | The command element.             |

## Return values

|                              |                                    |
|------------------------------|------------------------------------|
| <i>kStatus_SHELL_Success</i> | Successfully register the command. |
| <i>kStatus_SHELL_Error</i>   | An error occurred.                 |

### 51.7.3 shell\_status\_t SHELL\_UnregisterCommand ( shell\_command\_t \* *shellCommand* )

This function is used to unregister the shell command.

Parameters

|                     |                      |
|---------------------|----------------------|
| <i>shellCommand</i> | The command element. |
|---------------------|----------------------|

Return values

|                              |                                      |
|------------------------------|--------------------------------------|
| <i>kStatus_SHELL_Success</i> | Successfully unregister the command. |
|------------------------------|--------------------------------------|

### 51.7.4 shell\_status\_t SHELL\_Write ( shell\_handle\_t *shellHandle*, const char \* *buffer*, uint32\_t *length* )

This function is used to send data to the shell output stream.

Parameters

|                    |                                     |
|--------------------|-------------------------------------|
| <i>shellHandle</i> | The shell module handle pointer.    |
| <i>buffer</i>      | Start address of the data to write. |
| <i>length</i>      | Length of the data to write.        |

Return values

|                              |                         |
|------------------------------|-------------------------|
| <i>kStatus_SHELL_Success</i> | Successfully send data. |
| <i>kStatus_SHELL_Error</i>   | An error occurred.      |

### 51.7.5 int SHELL\_Printf ( shell\_handle\_t *shellHandle*, const char \* *formatString*, ... )

Call this function to write a formatted output to the shell output stream.

Parameters

|                     |                                  |
|---------------------|----------------------------------|
| <i>shellHandle</i>  | The shell module handle pointer. |
| <i>formatString</i> | Format string.                   |

Returns

Returns the number of characters printed or a negative value if an error occurs.

**51.7.6 shell\_status\_t SHELL\_WriteSynchronization ( shell\_handle\_t *shellHandle*, const char \* *buffer*, uint32\_t *length* )**

This function is used to send data to the shell output stream with OS synchronization, note the function could not be called in ISR.

Parameters

|                    |                                     |
|--------------------|-------------------------------------|
| <i>shellHandle</i> | The shell module handle pointer.    |
| <i>buffer</i>      | Start address of the data to write. |
| <i>length</i>      | Length of the data to write.        |

Return values

|                              |                         |
|------------------------------|-------------------------|
| <i>kStatus_SHELL_Success</i> | Successfully send data. |
| <i>kStatus_SHELL_Error</i>   | An error occurred.      |

**51.7.7 int SHELL\_PrintfSynchronization ( shell\_handle\_t *shellHandle*, const char \* *formatString*, ... )**

Call this function to write a formatted output to the shell output stream with OS synchronization, note the function could not be called in ISR.

Parameters

|                    |                                  |
|--------------------|----------------------------------|
| <i>shellHandle</i> | The shell module handle pointer. |
|--------------------|----------------------------------|

|                     |                |
|---------------------|----------------|
| <i>formatString</i> | Format string. |
|---------------------|----------------|

Returns

Returns the number of characters printed or a negative value if an error occurs.

### 51.7.8 void SHELL\_ChangePrompt ( shell\_handle\_t *shellHandle*, char \* *prompt* )

Call this function to change shell prompt.

Parameters

|                    |                                                  |
|--------------------|--------------------------------------------------|
| <i>shellHandle</i> | The shell module handle pointer.                 |
| <i>prompt</i>      | The string which will be used for command prompt |

Returns

NULL.

### 51.7.9 void SHELL\_PrintPrompt ( shell\_handle\_t *shellHandle* )

Call this function to print shell prompt.

Parameters

|                    |                                  |
|--------------------|----------------------------------|
| <i>shellHandle</i> | The shell module handle pointer. |
|--------------------|----------------------------------|

Returns

NULL.

### 51.7.10 void SHELL\_Task ( shell\_handle\_t *shellHandle* )

The task function for Shell; The function should be polled by upper layer. This function does not return until Shell command exit was called.

## Parameters

|                    |                                  |
|--------------------|----------------------------------|
| <i>shellHandle</i> | The shell module handle pointer. |
|--------------------|----------------------------------|

**51.7.11 static bool SHELL\_checkRunningInIsr ( void ) [inline], [static]**

This function is used to check if code running in ISR.

## Return values

|             |                         |
|-------------|-------------------------|
| <i>TRUE</i> | if code running in ISR. |
|-------------|-------------------------|

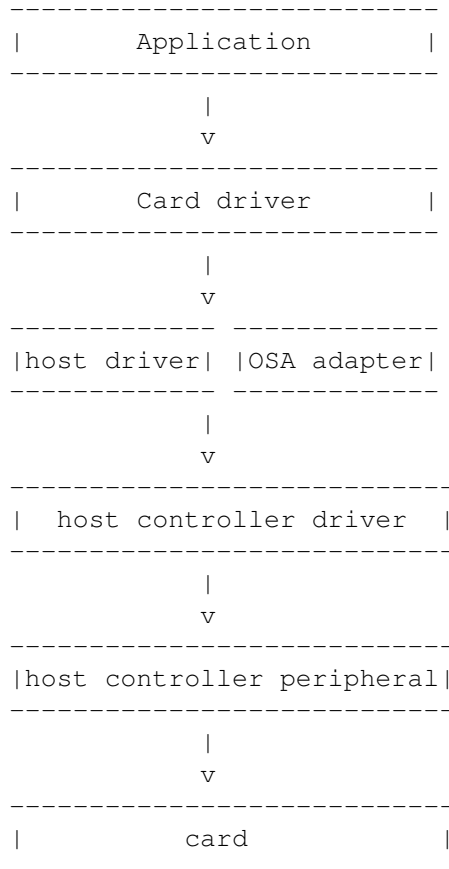


## Chapter 52

# Cards: Secure Digital Card/Embedded MultiMedia Card/SD-IO Card

### 52.1 Overview

The MCUXpresso SDK provides drivers to access the Secure Digital Card(up to v3.0), Embedded Multi-Media Card(up to v5.0) and sdio card(up to v3.0) based on the SDHC/USDHC/SDIF driver. Here is a simple block diagram about the drivers:



### Modules

- [MMC Card Driver](#)
- [SD Card Driver](#)
- [SDIO Card Driver](#)
- [SDMMC Common](#)
- [SDMMC HOST Driver](#)
- [SDMMC OSA](#)

## 52.2 SDIO Card Driver

### 52.2.1 Overview

The SDIO card driver provide card initialization/IO direct and extend command interface.

### 52.2.2 SDIO CARD Operation

#### error log support

Not supported yet.

#### User configurable

#### Board dependency

#### Mutual exclusive access support for RTOS

SDIO driver has added mutual exclusive access support for init/deinit/write/read/erase function. Please note that the card init function will create the mutex lock dynamically by default, so to avoid the mutex create redundantly, application must follow bellow sequence for card re-initialization

```
SDIO_Deinit(card); /* This function will destroy the created mutex */
SDIO_Init(card);
```

#### Typical use case

Refer to the driver examples codes located at <SDK\_ROOT>/boards/<BOARD>/sdmmc\_examples/

#### Data Structures

- struct `sdio_card_t`  
*SDIO card state. [More...](#)*

#### Macros

- #define `FSL_SDIO_DRIVER_VERSION` (`MAKE_VERSION(2U, 4U, 0U)`) /\*2.4.0\*/  
*Middleware version.*
- #define `FSL_SDIO_MAX_IO_NUMS` (7U)  
*sdio device support maximum IO number*

## Typedefs

- typedef void(\* [sdio\\_io\\_irq\\_handler\\_t](#))(sdio\_card\_t \*card, uint32\_t func)  
*sdio io handler*

## Enumerations

- enum [sdio\\_io\\_direction\\_t](#) {  
  [kSDIO\\_IORead](#) = 0U,  
  [kSDIO\\_IOWrite](#) = 1U }  
*sdio io read/write direction*

## Initialization and deinitialization

- [status\\_t SDIO\\_Init](#) (sdio\_card\_t \*card)  
*SDIO card init function.*
- void [SDIO\\_Deinit](#) (sdio\_card\_t \*card)  
*SDIO card deinit, include card and host deinit.*
- [status\\_t SDIO\\_CardInit](#) (sdio\_card\_t \*card)  
*Initializes the card.*
- void [SDIO\\_CardDeinit](#) (sdio\_card\_t \*card)  
*Deinitializes the card.*
- [status\\_t SDIO\\_HostInit](#) (sdio\_card\_t \*card)  
*initialize the host.*
- void [SDIO\\_HostDeinit](#) (sdio\_card\_t \*card)  
*Deinitializes the host.*
- void [SDIO\\_HostDoReset](#) (sdio\_card\_t \*card)  
*reset the host.*
- void [SDIO\\_SetCardPower](#) (sdio\_card\_t \*card, bool enable)  
*set card power.*
- [status\\_t SDIO\\_CardInactive](#) (sdio\_card\_t \*card)  
*set SDIO card to inactive state*
- [status\\_t SDIO\\_GetCardCapability](#) (sdio\_card\_t \*card, [sdio\\_func\\_num\\_t](#) func)  
*get SDIO card capability*
- [status\\_t SDIO\\_SetBlockSize](#) (sdio\_card\_t \*card, [sdio\\_func\\_num\\_t](#) func, uint32\_t blockSize)  
*set SDIO card block size*
- [status\\_t SDIO\\_CardReset](#) (sdio\_card\_t \*card)  
*set SDIO card reset*
- [status\\_t SDIO\\_SetDataBusWidth](#) (sdio\_card\_t \*card, [sdio\\_bus\\_width\\_t](#) busWidth)  
*set SDIO card data bus width*
- [status\\_t SDIO\\_SwitchToHighSpeed](#) (sdio\_card\_t \*card)  
*switch the card to high speed*
- [status\\_t SDIO\\_ReadCIS](#) (sdio\_card\_t \*card, [sdio\\_func\\_num\\_t](#) func, const uint32\_t \*tupleList, uint32\_t tupleNum)  
*read SDIO card CIS for each function*
- [status\\_t SDIO\\_PollingCardInsert](#) (sdio\_card\_t \*card, uint32\_t status)  
*sdio wait card detect function.*
- bool [SDIO\\_IsCardPresent](#) (sdio\_card\_t \*card)

*sdio card present check function.*

## IO operations

- `status_t SDIO_IO_Write_Direct` (`sdio_card_t *card`, `sdio_func_num_t func`, `uint32_t regAddr`, `uint8_t *data`, `bool raw`)  
*IO direct write transfer function.*
- `status_t SDIO_IO_Read_Direct` (`sdio_card_t *card`, `sdio_func_num_t func`, `uint32_t regAddr`, `uint8_t *data`)  
*IO direct read transfer function.*
- `status_t SDIO_IO_RW_Direct` (`sdio_card_t *card`, `sdio_io_direction_t direction`, `sdio_func_num_t func`, `uint32_t regAddr`, `uint8_t dataIn`, `uint8_t *dataOut`)  
*IO direct read/write transfer function.*
- `status_t SDIO_IO_Write_Extended` (`sdio_card_t *card`, `sdio_func_num_t func`, `uint32_t regAddr`, `uint8_t *buffer`, `uint32_t count`, `uint32_t flags`)  
*IO extended write transfer function.*
- `status_t SDIO_IO_Read_Extended` (`sdio_card_t *card`, `sdio_func_num_t func`, `uint32_t regAddr`, `uint8_t *buffer`, `uint32_t count`, `uint32_t flags`)  
*IO extended read transfer function.*
- `status_t SDIO_EnableIOInterrupt` (`sdio_card_t *card`, `sdio_func_num_t func`, `bool enable`)  
*enable IO interrupt*
- `status_t SDIO_EnableIO` (`sdio_card_t *card`, `sdio_func_num_t func`, `bool enable`)  
*enable IO and wait IO ready*
- `status_t SDIO_SelectIO` (`sdio_card_t *card`, `sdio_func_num_t func`)  
*select IO*
- `status_t SDIO_AbortIO` (`sdio_card_t *card`, `sdio_func_num_t func`)  
*Abort IO transfer.*
- `status_t SDIO_SetDriverStrength` (`sdio_card_t *card`, `sd_driver_strength_t driverStrength`)  
*Set driver strength.*
- `status_t SDIO_EnableAsyncInterrupt` (`sdio_card_t *card`, `bool enable`)  
*Enable/Disable Async interrupt.*
- `status_t SDIO_GetPendingInterrupt` (`sdio_card_t *card`, `uint8_t *pendingInt`)  
*Get pending interrupt.*
- `status_t SDIO_IO_Transfer` (`sdio_card_t *card`, `sdio_command_t cmd`, `uint32_t argument`, `uint32_t blockSize`, `uint8_t *txData`, `uint8_t *rxData`, `uint16_t dataSize`, `uint32_t *response`)  
*sdio card io transfer function.*
- `void SDIO_SetIOIRQHandler` (`sdio_card_t *card`, `sdio_func_num_t func`, `sdio_io_irq_handler_t handler`)  
*sdio set io IRQ handler.*
- `status_t SDIO_HandlePendingIOInterrupt` (`sdio_card_t *card`)  
*sdio card io pending interrupt handle function.*

### 52.2.3 Data Structure Documentation

#### 52.2.3.1 struct \_sdio\_card

sdio card descriptor

Define the card structure including the necessary fields to identify and describe the card.

## Data Fields

- `sdrmchost_t * host`  
*Host information.*
- `sdio_usr_param_t usrParam`  
*user parameter*
- `bool noInternalAlign`  
*use this flag to disable sdmmc align.*
- `uint8_t internalBuffer [FSL_SDMMC_CARD_INTERNAL_BUFFER_SIZE]`  
*internal buffer*
- `bool isHostReady`  
*use this flag to indicate if need host re-init or not*
- `bool memPresentFlag`  
*indicate if memory present*
- `uint32_t busClock_Hz`  
*SD bus clock frequency united in Hz.*
- `uint32_t relativeAddress`  
*Relative address of the card.*
- `uint8_t sdVersion`  
*SD version.*
- `sd_timing_mode_t currentTiming`  
*current timing mode*
- `sd_driver_strength_t driverStrength`  
*driver strength*
- `sd_max_current_t maxCurrent`  
*card current limit*
- `sdmmc_operation_voltage_t operationVoltage`  
*card operation voltage*
- `uint8_t sdioVersion`  
*SDIO version.*
- `uint8_t cccrVersion`  
*CCCR version.*
- `uint8_t ioTotalNumber`  
*total number of IO function*
- `uint32_t cccrflags`  
*Flags in \_sd\_card\_flag.*
- `uint32_t io0blockSize`  
*record the io0 block size*
- `uint32_t ocr`  
*Raw OCR content, only 24bit available for SDIO card.*
- `uint32_t commonCISPointer`  
*point to common CIS*
- `sdio_common_cis_t commonCIS`  
*CIS table.*
- `sdio_fbr_t ioFBR [FSL_SDIO_MAX_IO_NUMS]`  
*FBR table.*
- `sdio_func_cis_t funcCIS [FSL_SDIO_MAX_IO_NUMS]`  
*function CIS table*
- `sdio_io_irq_handler_t ioIRQHandler [FSL_SDIO_MAX_IO_NUMS]`

- *io IRQ handler*
- `uint8_t ioIntIndex`  
*used to record current enabled io interrupt index*
- `uint8_t ioIntNums`  
*used to record total enabled io interrupt numbers*
- `sdmhc_osa_mutex_t lock`  
*card access lock*

## Field Documentation

### (1) `bool sdio_card_t::noInternalAlign`

If disable, sdmhc will not make sure the data buffer address is word align, otherwise all the transfer are align to low level driver

## 52.2.4 Macro Definition Documentation

**52.2.4.1** `#define FSL_SDIO_DRIVER_VERSION (MAKE_VERSION(2U, 4U, 0U)) /*2.4.0*/`

## 52.2.5 Enumeration Type Documentation

### 52.2.5.1 `enum sdio_io_direction_t`

Enumerator

`kSDIO_IORead` io read  
`kSDIO_IOWrite` io write

## 52.2.6 Function Documentation

### 52.2.6.1 `status_t SDIO_Init ( sdio_card_t * card )`

Thread safe function, please note that the function will create the mutex lock dynamically by default, so to avoid the mutex create redundantly, application must follow bellow sequence for card re-initialization

```
* SDIO_Deinit (card);
* SDIO_Init (card);
*
```

Parameters

---

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

Return values

|                                                          |  |
|----------------------------------------------------------|--|
| <i>kStatus_SDMMC_Go-IdleFailed</i>                       |  |
| <i>kStatus_SDMMC_Hand-ShakeOperation-ConditionFailed</i> |  |
| <i>kStatus_SDMMC_SDIO-InvalidCard</i>                    |  |
| <i>kStatus_SDMMC_SDIO-InvalidVoltage</i>                 |  |
| <i>kStatus_SDMMC_Send-RelativeAddressFailed</i>          |  |
| <i>kStatus_SDMMC_Select-CardFailed</i>                   |  |
| <i>kStatus_SDMMC_SDIO-SwitchHighSpeedFail</i>            |  |
| <i>kStatus_SDMMC_SDIO-ReadCISFail</i>                    |  |
| <i>kStatus_SDMMC_-TransferFailed</i>                     |  |
| <i>kStatus_Success</i>                                   |  |

### 52.2.6.2 void SDIO\_Deinit ( sdio\_card\_t \* card )

Please note it is a thread safe function.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

### 52.2.6.3 status\_t SDIO\_CardInit ( sdio\_card\_t \* card )

This function initializes the card only, make sure the host is ready when call this function, otherwise it will return *kStatus\_SDMMC\_HostNotReady*.

Thread safe function, please note that the function will create the mutex lock dynamically by default, so to avoid the mutex create redundantly, application must follow bellow sequence for card re-initialization

```

* SDIO_CardDeinit (card);
* SDIO_CardInit (card);
*

```

## Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

## Return values

|                                                     |                                  |
|-----------------------------------------------------|----------------------------------|
| <i>kStatus_SDMMC_Host-NotReady</i>                  | host is not ready.               |
| <i>kStatus_SDMMC_Go-IdleFailed</i>                  | Go idle failed.                  |
| <i>kStatus_SDMMC_Not-SupportYet</i>                 | Card not support.                |
| <i>kStatus_SDMMC_Send-OperationCondition-Failed</i> | Send operation condition failed. |
| <i>kStatus_SDMMC_All-SendCidFailed</i>              | Send CID failed.                 |
| <i>kStatus_SDMMC_Send-RelativeAddressFailed</i>     | Send relative address failed.    |
| <i>kStatus_SDMMC_Send-CsdFailed</i>                 | Send CSD failed.                 |
| <i>kStatus_SDMMC_Select-CardFailed</i>              | Send SELECT_CARD command failed. |
| <i>kStatus_SDMMC_Send-ScrFailed</i>                 | Send SCR failed.                 |
| <i>kStatus_SDMMC_SetBus-WidthFailed</i>             | Set bus width failed.            |
| <i>kStatus_SDMMC_Switch-HighSpeedFailed</i>         | Switch high speed failed.        |



|                                              |                             |
|----------------------------------------------|-----------------------------|
| <i>kStatus_SDMMC_Set-CardBlockSizeFailed</i> | Set card block size failed. |
| <i>kStatus_Success</i>                       | Operate successfully.       |

#### 52.2.6.4 void SDIO\_CardDeinit ( sdio\_card\_t \* card )

This function deinitializes the specific card.

Please note it is a thread safe function.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

#### 52.2.6.5 status\_t SDIO\_HostInit ( sdio\_card\_t \* card )

This function deinitializes the specific host.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

#### 52.2.6.6 void SDIO\_HostDeinit ( sdio\_card\_t \* card )

This function deinitializes the host.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

#### 52.2.6.7 void SDIO\_HostDoReset ( sdio\_card\_t \* card )

This function reset the specific host.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

#### 52.2.6.8 void SDIO\_SetCardPower ( sdio\_card\_t \* card, bool enable )

The power off operation depend on host or the user define power on function.

Parameters

|               |                                       |
|---------------|---------------------------------------|
| <i>card</i>   | card descriptor.                      |
| <i>enable</i> | true is power on, false is power off. |

#### 52.2.6.9 status\_t SDIO\_CardIsActive ( sdio\_card\_t \* card )

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

Return values

|                                           |  |
|-------------------------------------------|--|
| <i>kStatus_SDMMC_-<br/>TransferFailed</i> |  |
| <i>kStatus_Success</i>                    |  |

#### 52.2.6.10 status\_t SDIO\_GetCardCapability ( sdio\_card\_t \* card, sdio\_func\_num\_t func )

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
| <i>func</i> | IO number        |

Return values

|                                           |  |
|-------------------------------------------|--|
| <i>kStatus_SDMMC_-<br/>TransferFailed</i> |  |
| <i>kStatus_Success</i>                    |  |

#### 52.2.6.11 status\_t SDIO\_SetBlockSize ( sdio\_card\_t \* card, sdio\_func\_num\_t func, uint32\_t blockSize )

Parameters

\_\_\_\_\_

|                  |                  |
|------------------|------------------|
| <i>card</i>      | Card descriptor. |
| <i>func</i>      | io number        |
| <i>blockSize</i> | block size       |

Return values

|                                              |  |
|----------------------------------------------|--|
| <i>kStatus_SDMMC_Set-CardBlockSizeFailed</i> |  |
| <i>kStatus_SDMMC_SDIO-InvalidArgument</i>    |  |
| <i>kStatus_Success</i>                       |  |

#### 52.2.6.12 status\_t SDIO\_CardReset ( sdio\_card\_t \* card )

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

Return values

|                                      |  |
|--------------------------------------|--|
| <i>kStatus_SDMMC_-TransferFailed</i> |  |
| <i>kStatus_Success</i>               |  |

#### 52.2.6.13 status\_t SDIO\_SetDataBusWidth ( sdio\_card\_t \* card, sdio\_bus\_width\_t busWidth )

Parameters

|                 |                  |
|-----------------|------------------|
| <i>card</i>     | Card descriptor. |
| <i>busWidth</i> | bus width        |

Return values

|                                      |  |
|--------------------------------------|--|
| <i>kStatus_SDMMC_-TransferFailed</i> |  |
| <i>kStatus_Success</i>               |  |

52.2.6.14 `status_t SDIO_SwitchToHighSpeed ( sdio_card_t * card )`

## Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

## Return values

|                                               |  |
|-----------------------------------------------|--|
| <i>kStatus_SDMMC_-TransferFailed</i>          |  |
| <i>kStatus_SDMMC_SDIO-SwitchHighSpeedFail</i> |  |
| <i>kStatus_Success</i>                        |  |

### 52.2.6.15 `status_t SDIO_ReadCIS ( sdio_card_t * card, sdio_func_num_t func, const uint32_t * tupleList, uint32_t tupleNum )`

## Parameters

|                  |                  |
|------------------|------------------|
| <i>card</i>      | Card descriptor. |
| <i>func</i>      | io number        |
| <i>tupleList</i> | code list        |
| <i>tupleNum</i>  | code number      |

## Return values

|                                       |  |
|---------------------------------------|--|
| <i>kStatus_SDMMC_SDIO-ReadCISFail</i> |  |
| <i>kStatus_SDMMC_-TransferFailed</i>  |  |
| <i>kStatus_Success</i>                |  |

### 52.2.6.16 `status_t SDIO_PollingCardInsert ( sdio_card_t * card, uint32_t status )`

Detect card through GPIO, CD, DATA3.

## Parameters

\_\_\_\_\_

|               |                                             |
|---------------|---------------------------------------------|
| <i>card</i>   | card descriptor.                            |
| <i>status</i> | detect status, kSD_Inserted or kSD_Removed. |

#### 52.2.6.17 bool SDIO\_IsCardPresent ( sdio\_card\_t \* *card* )

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | card descriptor. |
|-------------|------------------|

#### 52.2.6.18 status\_t SDIO\_IO\_Write\_Direct ( sdio\_card\_t \* *card*, sdio\_func\_num\_t *func*, uint32\_t *regAddr*, uint8\_t \* *data*, bool *raw* )

Please note it is a thread safe function.

Parameters

|                |                                               |
|----------------|-----------------------------------------------|
| <i>card</i>    | Card descriptor.                              |
| <i>func</i>    | IO numner                                     |
| <i>regAddr</i> | register address                              |
| <i>data</i>    | the data pinter to write                      |
| <i>raw</i>     | flag, indicate read after write or write only |

Return values

|                                                |  |
|------------------------------------------------|--|
| <i>kStatus_SDMMC_</i><br><i>TransferFailed</i> |  |
| <i>kStatus_Success</i>                         |  |

#### 52.2.6.19 status\_t SDIO\_IO\_Read\_Direct ( sdio\_card\_t \* *card*, sdio\_func\_num\_t *func*, uint32\_t *regAddr*, uint8\_t \* *data* )

Please note it is a thread safe function.

Parameters

|                |                  |
|----------------|------------------|
| <i>card</i>    | Card descriptor. |
| <i>func</i>    | IO number        |
| <i>regAddr</i> | register address |
| <i>data</i>    | pointer to read  |

Return values

|                                      |  |
|--------------------------------------|--|
| <i>kStatus_SDMMC_-TransferFailed</i> |  |
| <i>kStatus_Success</i>               |  |

**52.2.6.20** `status_t SDIO_IO_RW_Direct ( sdio_card_t * card, sdio_io_direction_t direction, sdio_func_num_t func, uint32_t regAddr, uint8_t dataIn, uint8_t * dataOut )`

Please note it is a thread safe function.

Parameters

|                  |                                                                                                                                                                        |
|------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>card</i>      | Card descriptor.                                                                                                                                                       |
| <i>direction</i> | io access direction, please reference <code>sdio_io_direction_t</code> .                                                                                               |
| <i>func</i>      | IO number                                                                                                                                                              |
| <i>regAddr</i>   | register address                                                                                                                                                       |
| <i>dataIn</i>    | data to write                                                                                                                                                          |
| <i>dataOut</i>   | data pointer for readback data, support both for read and write, when application want readback the data after write command, <code>dataOut</code> should not be NULL. |

Return values

|                                      |  |
|--------------------------------------|--|
| <i>kStatus_SDMMC_-TransferFailed</i> |  |
| <i>kStatus_Success</i>               |  |

**52.2.6.21** `status_t SDIO_IO_Write_Extended ( sdio_card_t * card, sdio_func_num_t func, uint32_t regAddr, uint8_t * buffer, uint32_t count, uint32_t flags )`

Please note it is a thread safe function.

Parameters

|                |                      |
|----------------|----------------------|
| <i>card</i>    | Card descriptor.     |
| <i>func</i>    | IO number            |
| <i>regAddr</i> | register address     |
| <i>buffer</i>  | data buffer to write |
| <i>count</i>   | data count           |
| <i>flags</i>   | write flags          |

Return values

|                                            |  |
|--------------------------------------------|--|
| <i>kStatus_SDMMC_-TransferFailed</i>       |  |
| <i>kStatus_SDMMC_SDIO-_InvalidArgument</i> |  |
| <i>kStatus_Success</i>                     |  |

**52.2.6.22** `status_t SDIO_IO_Read_Extended ( sdio_card_t * card, sdio_func_num_t func, uint32_t regAddr, uint8_t * buffer, uint32_t count, uint32_t flags )`

Please note it is a thread safe function.

Parameters

|                |                     |
|----------------|---------------------|
| <i>card</i>    | Card descriptor.    |
| <i>func</i>    | IO number           |
| <i>regAddr</i> | register address    |
| <i>buffer</i>  | data buffer to read |
| <i>count</i>   | data count          |
| <i>flags</i>   | write flags         |

Return values

|                                            |  |
|--------------------------------------------|--|
| <i>kStatus_SDMMC_-TransferFailed</i>       |  |
| <i>kStatus_SDMMC_SDIO-_InvalidArgument</i> |  |
| <i>kStatus_Success</i>                     |  |

**52.2.6.23** `status_t SDIO_EnableInterrupt ( sdio_card_t * card, sdio_func_num_t func, bool enable )`

Parameters

---



|               |                     |
|---------------|---------------------|
| <i>card</i>   | Card descriptor.    |
| <i>func</i>   | IO number           |
| <i>enable</i> | enable/disable flag |

Return values

|                                           |  |
|-------------------------------------------|--|
| <i>kStatus_SDMMC_-<br/>TransferFailed</i> |  |
| <i>kStatus_Success</i>                    |  |

#### 52.2.6.24 **status\_t SDIO\_EnableIO ( sdio\_card\_t \* *card*, sdio\_func\_num\_t *func*, bool *enable* )**

Parameters

|               |                     |
|---------------|---------------------|
| <i>card</i>   | Card descriptor.    |
| <i>func</i>   | IO number           |
| <i>enable</i> | enable/disable flag |

Return values

|                                           |  |
|-------------------------------------------|--|
| <i>kStatus_SDMMC_-<br/>TransferFailed</i> |  |
| <i>kStatus_Success</i>                    |  |

#### 52.2.6.25 **status\_t SDIO\_SelectIO ( sdio\_card\_t \* *card*, sdio\_func\_num\_t *func* )**

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
| <i>func</i> | IO number        |

Return values

|                                           |  |
|-------------------------------------------|--|
| <i>kStatus_SDMMC_-<br/>TransferFailed</i> |  |
| <i>kStatus_Success</i>                    |  |

**52.2.6.26** `status_t SDIO_AbortIO ( sdio_card_t * card, sdio_func_num_t func )`

## Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
| <i>func</i> | IO number        |

## Return values

|                                      |  |
|--------------------------------------|--|
| <i>kStatus_SDMMC_-TransferFailed</i> |  |
| <i>kStatus_Success</i>               |  |

### 52.2.6.27 **status\_t SDIO\_SetDriverStrength ( sdio\_card\_t \* *card*, sd\_driver\_strength\_t *driverStrength* )**

## Parameters

|                       |                         |
|-----------------------|-------------------------|
| <i>card</i>           | Card descriptor.        |
| <i>driverStrength</i> | target driver strength. |

## Return values

|                                      |  |
|--------------------------------------|--|
| <i>kStatus_SDMMC_-TransferFailed</i> |  |
| <i>kStatus_Success</i>               |  |

### 52.2.6.28 **status\_t SDIO\_EnableAsyncInterrupt ( sdio\_card\_t \* *card*, bool *enable* )**

## Parameters

|               |                                   |
|---------------|-----------------------------------|
| <i>card</i>   | Card descriptor.                  |
| <i>enable</i> | true is enable, false is disable. |

## Return values

|                                      |  |
|--------------------------------------|--|
| <i>kStatus_SDMMC_-TransferFailed</i> |  |
|--------------------------------------|--|

|                        |  |
|------------------------|--|
| <i>kStatus_Success</i> |  |
|------------------------|--|

### 52.2.6.29 status\_t SDIO\_GetPendingInterrupt ( sdio\_card\_t \* card, uint8\_t \* pendingInt )

Parameters

|                   |                                 |
|-------------------|---------------------------------|
| <i>card</i>       | Card descriptor.                |
| <i>pendingInt</i> | pointer store pending interrupt |

Return values

|                                                |  |
|------------------------------------------------|--|
| <i>kStatus_SDMMC_</i><br><i>TransferFailed</i> |  |
| <i>kStatus_Success</i>                         |  |

### 52.2.6.30 status\_t SDIO\_IO\_Transfer ( sdio\_card\_t \* card, sdio\_command\_t cmd, uint32\_t argument, uint32\_t blockSize, uint8\_t \* txData, uint8\_t \* rxData, uint16\_t dataSize, uint32\_t \* response )

This function can be used for transfer direct/extend command. Please pay attention to the non-align data buffer address transfer, if data buffer address can not meet host controller internal DMA requirement, sdio driver will try to use internal align buffer if data size is not bigger than internal buffer size, Align address transfer always can get a better performance, so if application want sdio driver make sure buffer address align,

Please note it is a thread safe function.

Parameters

|                  |                           |
|------------------|---------------------------|
| <i>card</i>      | card descriptor.          |
| <i>cmd</i>       | command to transfer       |
| <i>argument</i>  | argument to transfer      |
| <i>blockSize</i> | used for block mode.      |
| <i>txData</i>    | tx buffer pointer or NULL |

|                 |                                                                                               |
|-----------------|-----------------------------------------------------------------------------------------------|
| <i>rxData</i>   | rx buffer pointer or NULL                                                                     |
| <i>dataSize</i> | transfer data size                                                                            |
| <i>response</i> | reponse pointer, if application want read response back, please set it to a NON-NULL pointer. |

### 52.2.6.31 void SDIO\_SetIOIRQHandler ( sdio\_card\_t \* card, sdio\_func\_num\_t func, sdio\_io\_irq\_handler\_t handler )

Parameters

|                |                     |
|----------------|---------------------|
| <i>card</i>    | card descriptor.    |
| <i>func</i>    | function io number. |
| <i>handler</i> | io IRQ handler.     |

### 52.2.6.32 status\_t SDIO\_HandlePendingIOInterrupt ( sdio\_card\_t \* card )

This function is used to handle the pending io interrupt. To reigster a IO IRQ handler,

```
* SDIO_EnableIOInterrupt(card, 0, true);
* SDIO_SetIOIRQHandler(card, 0, func0_handler);
*
```

call it in interrupt callback

```
* SDIO_HandlePendingIOInterrupt(card);
*
```

To releae a IO IRQ handler,

```
* SDIO_EnableIOInterrupt(card, 0, false);
* SDIO_SetIOIRQHandler(card, 0, NULL);
*
```

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | card descriptor. |
|-------------|------------------|

## Return values

|                                           |  |
|-------------------------------------------|--|
| <i>kStatus_SDMMC_-<br/>TransferFailed</i> |  |
| <i>kStatus_Success</i>                    |  |

## 52.3 SD Card Driver

### 52.3.1 Overview

The SDCARD driver provide card initialization/read/write/erase interface.

### 52.3.2 SD CARD Operation

#### error log support

Lots of error log has been added to sd relate functions, if error occurs during initial/read/write, please enable the error log print functionality with `#define SDMMC_ENABLE_LOG_PRINT 1` And rerun the project then user can check what kind of error happened.

#### User configurable

```
typedef struct _sd_card
{
 sdmmc_host_t *host;
 sd_usr_param_t usrParam;
 bool isHostReady;
 bool noInternalAlign;
 uint32_t busClock_Hz;
 uint32_t relativeAddress;
 uint32_t version;
 uint32_t flags;
 uint8_t internalBuffer[FSL_SDMMC_CARD_INTERNAL_BUFFER_SIZE];
 uint32_t ocr;
 sd_cid_t cid;
 sd_csd_t csd;
 sd_scr_t scr;
 sd_status_t stat;
 uint32_t blockCount;
 uint32_t blockSize;
 sd_timing_mode_t currentTiming;
 sd_driver_strength_t driverStrength;
 sd_max_current_t maxCurrent;
 sdmmc_operation_voltage_t operationVoltage;
 sdmmc_osa_mutex_t lock;
} sd_card_t;
```

Part of The variables above is user configurable,

#### 1. host

Application need to provide host controller base address and the host's source clock frequency, etc.  
For example:

```
/* allocate dma descriptor buffer for host controller */
s_host.dmaDesBuffer = s_sdmmcHostDmaBuffer;
s_host.dmaDesBufferWordsNum = xxx;
/* */
((sd_card_t *)card)->host = &s_host;
((sd_card_t *)card)->host->hostController.base = BOARD_SDMMC_SD_HOST_BASEADDR;
((sd_card_t *)card)->host->hostController.sourceClock_Hz = BOARD_USDHClClockConfiguration();

/* allocate resource for sdmmc osa layer */
((sd_card_t *)card)->host->hostEvent = &s_event;
```

## 2. sdcard\_usr\_param\_t usrParam

```
/* board layer configuration register */
(sd_card_t *)card->usrParam.cd = &s_cd;
(sd_card_t *)card->usrParam.pwr = BOARD_SDCardPowerControl;
(sd_card_t *)card->usrParam.ioStrength = BOARD_SD_Pin_Config;
(sd_card_t *)card->usrParam.ioVoltage = &s_ioVoltage;
(sd_card_t *)card->usrParam.maxFreq = BOARD_SDMMC_SD_HOST_SUPPORT_SDR104_FREQ;
```

- cd-which allow application define the card insert/remove callback function, redefine the card detect timeout ms and also allow application determine how to detect card.
- pwr-which allow application redefine the card power on/off function.
- ioStrength-which is used to switch the signal pin configurations include driver strength/speed mode dynamically for different timing (SDR/HS timing) mode, reference the function defined sdmmc\_config.c
- ioVoltage-which allow application register io voltage switch function instead of using the function host driver provided for SDR/HS200/HS400 timing.
- maxFreq-which allow application set the maximum bus clock that the board support.

### 1. bool noInternalAlign

Sdmmc include an address align internal buffer(to use host controller internal DMA), to improve read/write performance while application cannot make sure the data address used to read/write is align, set it to true will achieve a better performance.

### 2. sd\_timing\_mode\_t currentTiming

It is used to indicate the currentTiming the card is working on, however sdmmc also support preset timing mode, then sdmmc will try to switch to this timing first, if failed, a valid timing will switch to automatically. Generally, user may not set this variable if you don't know what kind of timing the card support, sdmmc will switch to the highest timing which the card support.

### 3. sd\_driver\_strength\_t driverStrength

Choose a valid card driver strength if application required and call SD\_SetDriverStrength in application.

### 4. sd\_max\_current\_t maxCurrent

Choose a valid card current if application required and call SD\_SetMaxCurrent in application.

## Mutual exclusive access support for RTOS

SDCARD driver has added mutual exclusive access support for init/deinit/write/read/erase function. Please note that the card init function will create the mutex lock dynamically by default, so to avoid the mutex create redundantly, application must follow bellow sequence for card re-initialization

```
SD_Deinit(card); /* This function will destroy the created mutex */
SD_Init(card);
```

## Typical use case

Refer to the driver examples codes located at <SDK\_ROOT>/boards/<BOARD>/sdmmc\_examples/

## Data Structures

- struct [sd\\_card\\_t](#)  
SD card state. [More...](#)



## Macros

- #define `FSL_SD_DRIVER_VERSION` (`MAKE_VERSION(2U, 4U, 0U)`) /\*2.4.0\*/  
*Driver version.*

## Enumerations

- enum {  
`kSD_SupportHighCapacityFlag` = (1U << 1U),  
`kSD_Support4BitWidthFlag` = (1U << 2U),  
`kSD_SupportSdhcFlag` = (1U << 3U),  
`kSD_SupportSdxcFlag` = (1U << 4U),  
`kSD_SupportVoltage180v` = (1U << 5U),  
`kSD_SupportSetBlockCountCmd` = (1U << 6U),  
`kSD_SupportSpeedClassControlCmd` = (1U << 7U) }  
*SD card flags.*

## SDCARD Function

- `status_t SD_Init` (`sd_card_t *card`)  
*Initializes the card on a specific host controller.*
- `void SD_Deinit` (`sd_card_t *card`)  
*Deinitializes the card.*
- `status_t SD_CardInit` (`sd_card_t *card`)  
*Initializes the card.*
- `void SD_CardDeinit` (`sd_card_t *card`)  
*Deinitializes the card.*
- `status_t SD_HostInit` (`sd_card_t *card`)  
*initialize the host.*
- `void SD_HostDeinit` (`sd_card_t *card`)  
*Deinitializes the host.*
- `void SD_HostDoReset` (`sd_card_t *card`)  
*reset the host.*
- `void SD_SetCardPower` (`sd_card_t *card`, `bool enable`)  
*set card power.*
- `status_t SD_PollingCardInsert` (`sd_card_t *card`, `uint32_t status`)  
*sd wait card detect function.*
- `bool SD_IsCardPresent` (`sd_card_t *card`)  
*sd card present check function.*
- `bool SD_CheckReadOnly` (`sd_card_t *card`)  
*Checks whether the card is write-protected.*
- `status_t SD_SelectCard` (`sd_card_t *card`, `bool isSelected`)  
*Send SELECT\_CARD command to set the card to be transfer state or not.*
- `status_t SD_ReadStatus` (`sd_card_t *card`)  
*Send ACMD13 to get the card current status.*
- `status_t SD_ReadBlocks` (`sd_card_t *card`, `uint8_t *buffer`, `uint32_t startBlock`, `uint32_t block-Count`)

- *Reads blocks from the specific card.*
- `status_t SD_WriteBlocks (sd_card_t *card, const uint8_t *buffer, uint32_t startBlock, uint32_t blockCount)`
- *Writes blocks of data to the specific card.*
- `status_t SD_EraseBlocks (sd_card_t *card, uint32_t startBlock, uint32_t blockCount)`
- *Erases blocks of the specific card.*
- `status_t SD_SetDriverStrength (sd_card_t *card, sd_driver_strength_t driverStrength)`  
*select card driver strength select card driver strength*
- `status_t SD_SetMaxCurrent (sd_card_t *card, sd_max_current_t maxCurrent)`  
*select max current select max operation current*
- `status_t SD_PollingCardStatusBusy (sd_card_t *card, uint32_t timeoutMs)`  
*Polling card idle status.*

### 52.3.3 Data Structure Documentation

#### 52.3.3.1 struct sd\_card\_t

Define the card structure including the necessary fields to identify and describe the card.

#### Data Fields

- `sdtmmchost_t * host`  
*Host configuration.*
- `sd_usr_param_t usrParam`  
*user parameter*
- `bool isHostReady`  
*use this flag to indicate if need host re-init or not*
- `bool noInternalAlign`  
*used to enable/disable the functionality of the exchange buffer*
- `uint32_t busClock_Hz`  
*SD bus clock frequency united in Hz.*
- `uint32_t relativeAddress`  
*Relative address of the card.*
- `uint32_t version`  
*Card version.*
- `uint32_t flags`  
*Flags in \_sd\_card\_flag.*
- `uint8_t internalBuffer [FSL_SDMMC_CARD_INTERNAL_BUFFER_SIZE]`  
*internal buffer*
- `uint32_t ocr`  
*Raw OCR content.*
- `sd_cid_t cid`  
*CID.*
- `sd_csd_t csd`  
*CSD.*
- `sd_scr_t scr`  
*SCR.*
- `sd_status_t stat`

- *sd 512 bit status*
- uint32\_t **blockCount**  
*Card total block number.*
- uint32\_t **blockSize**  
*Card block size.*
- sd\_timing\_mode\_t **currentTiming**  
*current timing mode*
- sd\_driver\_strength\_t **driverStrength**  
*driver strength*
- sd\_max\_current\_t **maxCurrent**  
*card current limit*
- sdmmc\_operation\_voltage\_t **operationVoltage**  
*card operation voltage*
- sdmmc\_osa\_mutex\_t **lock**  
*card access lock*

## 52.3.4 Macro Definition Documentation

52.3.4.1 #define FSL\_SD\_DRIVER\_VERSION (MAKE\_VERSION(2U, 4U, 0U)) /\*2.4.0\*/

## 52.3.5 Enumeration Type Documentation

### 52.3.5.1 anonymous enum

Enumerator

*kSD\_SupportHighCapacityFlag* Support high capacity.  
*kSD\_Support4BitWidthFlag* Support 4-bit data width.  
*kSD\_SupportSdhcFlag* Card is SDHC.  
*kSD\_SupportSdxcFlag* Card is SDXC.  
*kSD\_SupportVoltage180v* card support 1.8v voltage  
*kSD\_SupportSetBlockCountCmd* card support cmd23 flag  
*kSD\_SupportSpeedClassControlCmd* card support speed class control flag

## 52.3.6 Function Documentation

### 52.3.6.1 status\_t SD\_Init ( sd\_card\_t \* card )

This function initializes the card on a specific host controller, it is consist of host init, card detect, card init function, however user can ignore this high level function, instead of use the low level function, such as SD\_CardInit, SD\_HostInit, SD\_CardDetect.

Thread safe function, please note that the function will create the mutex lock dynamically by default, so to avoid the mutex create redundantly, application must follow bellow sequence for card re-initialization

\* `SD_Deinit(card);`

```
* SD_Init(card);
*
```

## Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

## Return values

|                                                          |                                  |
|----------------------------------------------------------|----------------------------------|
| <i>kStatus_SDMMC_Host-NotReady</i>                       | host is not ready.               |
| <i>kStatus_SDMMC_Go-IdleFailed</i>                       | Go idle failed.                  |
| <i>kStatus_SDMMC_Not-SupportYet</i>                      | Card not support.                |
| <i>kStatus_SDMMC_Hand-ShakeOperation-ConditionFailed</i> | Send operation condition failed. |
| <i>kStatus_SDMMC_All-SendCidFailed</i>                   | Send CID failed.                 |
| <i>kStatus_SDMMC_Send-RelativeAddressFailed</i>          | Send relative address failed.    |
| <i>kStatus_SDMMC_Send-CsdFailed</i>                      | Send CSD failed.                 |
| <i>kStatus_SDMMC_Select-CardFailed</i>                   | Send SELECT_CARD command failed. |
| <i>kStatus_SDMMC_Send-ScrFailed</i>                      | Send SCR failed.                 |
| <i>kStatus_SDMMC_Set-DataBusWidthFailed</i>              | Set bus width failed.            |
| <i>kStatus_SDMMC_Switch-BusTimingFailed</i>              | Switch high speed failed.        |
| <i>kStatus_SDMMC_Set-CardBlockSizeFailed</i>             | Set card block size failed.      |

|                        |                       |
|------------------------|-----------------------|
| <i>kStatus_Success</i> | Operate successfully. |
|------------------------|-----------------------|

### 52.3.6.2 void SD\_Deinit ( sd\_card\_t \* card )

This function deinitializes the specific card and host. Please note it is a thread safe function.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

### 52.3.6.3 status\_t SD\_CardInit ( sd\_card\_t \* card )

This function initializes the card only, make sure the host is ready when call this function, otherwise it will return *kStatus\_SDMMC\_HostNotReady*.

Thread safe function, please note that the function will create the mutex lock dynamically by default, so to avoid the mutex create redundantly, application must follow bellow sequence for card re-initialization

```
* SD_CardDeinit (card);
* SD_CardInit (card);
*
```

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

Return values

|                                                          |                                  |
|----------------------------------------------------------|----------------------------------|
| <i>kStatus_SDMMC_Host-NotReady</i>                       | host is not ready.               |
| <i>kStatus_SDMMC_Go-IdleFailed</i>                       | Go idle failed.                  |
| <i>kStatus_SDMMC_Not-SupportYet</i>                      | Card not support.                |
| <i>kStatus_SDMMC_Hand-ShakeOperation-ConditionFailed</i> | Send operation condition failed. |

|                                                 |                                  |
|-------------------------------------------------|----------------------------------|
| <i>kStatus_SDMMC_All-SendCidFailed</i>          | Send CID failed.                 |
| <i>kStatus_SDMMC_Send-RelativeAddressFailed</i> | Send relative address failed.    |
| <i>kStatus_SDMMC_Send-CsdFailed</i>             | Send CSD failed.                 |
| <i>kStatus_SDMMC_Select-CardFailed</i>          | Send SELECT_CARD command failed. |
| <i>kStatus_SDMMC_Send-ScrFailed</i>             | Send SCR failed.                 |
| <i>kStatus_SDMMC_Set-DataBusWidthFailed</i>     | Set bus width failed.            |
| <i>kStatus_SDMMC_Switch-BusTimingFailed</i>     | Switch high speed failed.        |
| <i>kStatus_SDMMC_Set-CardBlockSizeFailed</i>    | Set card block size failed.      |
| <i>kStatus_Success</i>                          | Operate successfully.            |

#### 52.3.6.4 void SD\_CardDeinit ( sd\_card\_t \* card )

This function deinitializes the specific card. Please note it is a thread safe function.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

#### 52.3.6.5 status\_t SD\_HostInit ( sd\_card\_t \* card )

This function deinitializes the specific host.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

#### 52.3.6.6 void SD\_HostDeinit ( sd\_card\_t \* card )

This function deinitializes the host.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

### 52.3.6.7 void SD\_HostDoReset ( sd\_card\_t \* *card* )

This function reset the specific host.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

### 52.3.6.8 void SD\_SetCardPower ( sd\_card\_t \* *card*, bool *enable* )

The power off operation depend on host or the user define power on function.

Parameters

|               |                                       |
|---------------|---------------------------------------|
| <i>card</i>   | card descriptor.                      |
| <i>enable</i> | true is power on, false is power off. |

### 52.3.6.9 status\_t SD\_PollingCardInsert ( sd\_card\_t \* *card*, uint32\_t *status* )

Detect card through GPIO, CD, DATA3.

Parameters

|               |                                             |
|---------------|---------------------------------------------|
| <i>card</i>   | card descriptor.                            |
| <i>status</i> | detect status, kSD_Inserted or kSD_Removed. |

### 52.3.6.10 bool SD\_IsCardPresent ( sd\_card\_t \* *card* )

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | card descriptor. |
|-------------|------------------|

### 52.3.6.11 bool SD\_CheckReadOnly ( sd\_card\_t \* *card* )

This function checks if the card is write-protected via the CSD register.

## Parameters

|             |                    |
|-------------|--------------------|
| <i>card</i> | The specific card. |
|-------------|--------------------|

## Return values

|              |                       |
|--------------|-----------------------|
| <i>true</i>  | Card is read only.    |
| <i>false</i> | Card isn't read only. |

**52.3.6.12 status\_t SD\_SelectCard ( sd\_card\_t \* card, bool isSelected )**

## Parameters

|                   |                                                               |
|-------------------|---------------------------------------------------------------|
| <i>card</i>       | Card descriptor.                                              |
| <i>isSelected</i> | True to set the card into transfer state, false to disselect. |

## Return values

|                                      |                       |
|--------------------------------------|-----------------------|
| <i>kStatus_SDMMC_-TransferFailed</i> | Transfer failed.      |
| <i>kStatus_Success</i>               | Operate successfully. |

**52.3.6.13 status\_t SD\_ReadStatus ( sd\_card\_t \* card )**

## Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

## Return values

|                                                     |                                  |
|-----------------------------------------------------|----------------------------------|
| <i>kStatus_SDMMC_-TransferFailed</i>                | Transfer failed.                 |
| <i>kStatus_SDMMC_Send-ApplicationCommand-Failed</i> | send application command failed. |



|                        |                       |
|------------------------|-----------------------|
| <i>kStatus_Success</i> | Operate successfully. |
|------------------------|-----------------------|

#### 52.3.6.14 **status\_t SD\_ReadBlocks ( sd\_card\_t \* card, uint8\_t \* buffer, uint32\_t startBlock, uint32\_t blockCount )**

This function reads blocks from the specific card with default block size defined by the SDHC\_CARD\_DEFAULT\_BLOCK\_SIZE.

Please note it is a thread safe function.

Parameters

|                   |                                             |
|-------------------|---------------------------------------------|
| <i>card</i>       | Card descriptor.                            |
| <i>buffer</i>     | The buffer to save the data read from card. |
| <i>startBlock</i> | The start block index.                      |
| <i>blockCount</i> | The number of blocks to read.               |

Return values

|                                               |                           |
|-----------------------------------------------|---------------------------|
| <i>kStatus_InvalidArgument</i>                | Invalid argument.         |
| <i>kStatus_SDMMC_Card-NotSupport</i>          | Card not support.         |
| <i>kStatus_SDMMC_Not-SupportYet</i>           | Not support now.          |
| <i>kStatus_SDMMC_Wait-WriteCompleteFailed</i> | Send status failed.       |
| <i>kStatus_SDMMC_-TransferFailed</i>          | Transfer failed.          |
| <i>kStatus_SDMMC_Stop-TransmissionFailed</i>  | Stop transmission failed. |
| <i>kStatus_Success</i>                        | Operate successfully.     |

#### 52.3.6.15 **status\_t SD\_WriteBlocks ( sd\_card\_t \* card, const uint8\_t \* buffer, uint32\_t startBlock, uint32\_t blockCount )**

This function writes blocks to the specific card with default block size 512 bytes.

Please note,

1. It is a thread safe function.
2. It is a async write function which means that the card status may still busy after the function return.

Application can call function `SD_PollingCardStatusBusy` to wait card status idle after the write operation.

Parameters

|                   |                                                        |
|-------------------|--------------------------------------------------------|
| <i>card</i>       | Card descriptor.                                       |
| <i>buffer</i>     | The buffer holding the data to be written to the card. |
| <i>startBlock</i> | The start block index.                                 |
| <i>blockCount</i> | The number of blocks to write.                         |

Return values

|                                               |                           |
|-----------------------------------------------|---------------------------|
| <i>kStatus_InvalidArgument</i>                | Invalid argument.         |
| <i>kStatus_SDMMC_Not-SupportYet</i>           | Not support now.          |
| <i>kStatus_SDMMC_Card-NotSupport</i>          | Card not support.         |
| <i>kStatus_SDMMC_Wait-WriteCompleteFailed</i> | Send status failed.       |
| <i>kStatus_SDMMC_-TransferFailed</i>          | Transfer failed.          |
| <i>kStatus_SDMMC_Stop-TransmissionFailed</i>  | Stop transmission failed. |
| <i>kStatus_Success</i>                        | Operate successfully.     |

#### 52.3.6.16 `status_t SD_EraseBlocks ( sd_card_t * card, uint32_t startBlock, uint32_t blockCount )`

This function erases blocks of the specific card with default block size 512 bytes.

Please note,

1. It is a thread safe function.
2. It is a async erase function which means that the card status may still busy after the function return. Application can call function `SD_PollingCardStatusBusy` to wait card status idle after the erase operation.

Parameters

---

|                   |                                |
|-------------------|--------------------------------|
| <i>card</i>       | Card descriptor.               |
| <i>startBlock</i> | The start block index.         |
| <i>blockCount</i> | The number of blocks to erase. |

Return values

|                                               |                       |
|-----------------------------------------------|-----------------------|
| <i>kStatus_InvalidArgument</i>                | Invalid argument.     |
| <i>kStatus_SDMMC_Wait-WriteCompleteFailed</i> | Send status failed.   |
| <i>kStatus_SDMMC_-TransferFailed</i>          | Transfer failed.      |
| <i>kStatus_SDMMC_Wait-WriteCompleteFailed</i> | Send status failed.   |
| <i>kStatus_Success</i>                        | Operate successfully. |

#### 52.3.6.17 **status\_t SD\_SetDriverStrength ( sd\_card\_t \* *card*, sd\_driver\_strength\_t *driverStrength* )**

Parameters

|                       |                  |
|-----------------------|------------------|
| <i>card</i>           | Card descriptor. |
| <i>driverStrength</i> | Driver strength  |

#### 52.3.6.18 **status\_t SD\_SetMaxCurrent ( sd\_card\_t \* *card*, sd\_max\_current\_t *maxCurrent* )**

Parameters

|                   |                  |
|-------------------|------------------|
| <i>card</i>       | Card descriptor. |
| <i>maxCurrent</i> | Max current      |

#### 52.3.6.19 **status\_t SD\_PollingCardStatusBusy ( sd\_card\_t \* *card*, uint32\_t *timeoutMs* )**

This function can be used to polling the status from busy to Idle, the function will return if the card status idle or timeout.

## Parameters

|                  |                                    |
|------------------|------------------------------------|
| <i>card</i>      | Card descriptor.                   |
| <i>timeoutMs</i> | polling card status timeout value. |

## Return values

|                                                      |                        |
|------------------------------------------------------|------------------------|
| <i>kStatus_Success</i>                               | Operate successfully.  |
| <i>kStatus_SDMMC_Wait-WriteCompleteFailed</i>        | CMD13 transfer failed. |
| <i>kStatus_SDMMC_-PollingCardIdle-Failed,polling</i> | card DAT0 idle failed. |

## 52.4 MMC Card Driver

### 52.4.1 Overview

The MMCCARD driver provide card initialization/read/write/erase interface.

### 52.4.2 MMC CARD Operation

#### error log support

Not support yet

#### User configurable

#### Board dependency

#### Mutual exclusive access support for RTOS

MMCCARD driver has added mutual exclusive access support for init/deinit/write/read/erase function. Please note that the card init function will create the mutex lock dynamically by default, so to avoid the mutex create redundantly, application must follow bellow sequence for card re-initialization.

```
MMC_Deinit(card); /* This function will destroy the created mutex */
MMC_Init(card);
```

#### Typical use case

Refer to the driver examples codes located at <SDK\_ROOT>/boards/<BOARD>/sdmmc\_examples/

#### Data Structures

- struct `mmc_usr_param_t`  
*card user parameter [More...](#)*
- struct `mmc_card_t`  
*mmc card state [More...](#)*

#### Macros

- #define `FSL_MMC_DRIVER_VERSION` (`MAKE_VERSION(2U, 5U, 0U)`) /\*2.5.0\*/  
*Middleware mmc version.*

## Typedefs

- typedef void(\* [mmc\\_io\\_strength\\_t](#))(uint32\_t busFreq)  
*card io strength control*

## Enumerations

- enum {  
[kMMC\\_SupportHighSpeed26MHZFlag](#) = (1U << 0U),  
[kMMC\\_SupportHighSpeed52MHZFlag](#) = (1U << 1U),  
[kMMC\\_SupportHighSpeedDDR52MHZ180V300VFlag](#) = (1 << 2U),  
[kMMC\\_SupportHighSpeedDDR52MHZ120VFlag](#) = (1 << 3U),  
[kMMC\\_SupportHS200200MHZ180VFlag](#) = (1 << 4U),  
[kMMC\\_SupportHS200200MHZ120VFlag](#) = (1 << 5U),  
[kMMC\\_SupportHS400DDR200MHZ180VFlag](#) = (1 << 6U),  
[kMMC\\_SupportHS400DDR200MHZ120VFlag](#) = (1 << 7U),  
[kMMC\\_SupportHighCapacityFlag](#) = (1U << 8U),  
[kMMC\\_SupportAlternateBootFlag](#) = (1U << 9U),  
[kMMC\\_SupportDDRBootFlag](#) = (1U << 10U),  
[kMMC\\_SupportHighSpeedBootFlag](#) = (1U << 11U),  
[kMMC\\_SupportEnhanceHS400StrobeFlag](#) = (1U << 12U) }  
*MMC card flags.*
- enum [mmc\\_sleep\\_awake\\_t](#) {  
[kMMC\\_Sleep](#) = 1U,  
[kMMC\\_Awake](#) = 0U }  
*mmccard sleep/awake state*

## MMCCARD Function

- [status\\_t MMC\\_Init](#) ([mmc\\_card\\_t](#) \*card)  
*Initializes the MMC card and host.*
- void [MMC\\_Deinit](#) ([mmc\\_card\\_t](#) \*card)  
*Deinitializes the card and host.*
- [status\\_t MMC\\_CardInit](#) ([mmc\\_card\\_t](#) \*card)  
*Initializes the card.*
- void [MMC\\_CardDeinit](#) ([mmc\\_card\\_t](#) \*card)  
*Deinitializes the card.*
- [status\\_t MMC\\_HostInit](#) ([mmc\\_card\\_t](#) \*card)  
*initialize the host.*
- void [MMC\\_HostDeinit](#) ([mmc\\_card\\_t](#) \*card)  
*Deinitializes the host.*
- void [MMC\\_HostDoReset](#) ([mmc\\_card\\_t](#) \*card)  
*Resets the host.*
- void [MMC\\_HostReset](#) (SDMMCHOST\_CONFIG \*host)  
*Resets the host.*
- void [MMC\\_SetCardPower](#) ([mmc\\_card\\_t](#) \*card, bool enable)

- *Sets card power.*
- `bool MMC_CheckReadOnly (mmc_card_t *card)`  
*Checks if the card is read-only.*
- `status_t MMC_ReadBlocks (mmc_card_t *card, uint8_t *buffer, uint32_t startBlock, uint32_t blockCount)`  
*Reads data blocks from the card.*
- `status_t MMC_WriteBlocks (mmc_card_t *card, const uint8_t *buffer, uint32_t startBlock, uint32_t blockCount)`  
*Writes data blocks to the card.*
- `status_t MMC_EraseGroups (mmc_card_t *card, uint32_t startGroup, uint32_t endGroup)`  
*Erases groups of the card.*
- `status_t MMC_SelectPartition (mmc_card_t *card, mmc_access_partition_t partitionNumber)`  
*Selects the partition to access.*
- `status_t MMC_SetBootConfig (mmc_card_t *card, const mmc_boot_config_t *config)`  
*Configures the boot activity of the card.*
- `status_t MMC_StartBoot (mmc_card_t *card, const mmc_boot_config_t *mmcConfig, uint8_t *buffer, sdmmchost_boot_config_t *hostConfig)`  
*MMC card start boot.*
- `status_t MMC_SetBootConfigWP (mmc_card_t *card, uint8_t wp)`  
*MMC card set boot configuration write protect.*
- `status_t MMC_ReadBootData (mmc_card_t *card, uint8_t *buffer, sdmmchost_boot_config_t *hostConfig)`  
*MMC card continuous read boot data.*
- `status_t MMC_StopBoot (mmc_card_t *card, uint32_t bootMode)`  
*MMC card stop boot mode.*
- `status_t MMC_SetBootPartitionWP (mmc_card_t *card, mmc_boot_partition_wp_t bootPartitionWP)`  
*MMC card set boot partition write protect.*
- `status_t MMC_EnableCacheControl (mmc_card_t *card, bool enable)`  
*MMC card cache control function.*
- `status_t MMC_FlushCache (mmc_card_t *card)`  
*MMC card cache flush function.*
- `status_t MMC_SetSleepAwake (mmc_card_t *card, mmc_sleep_awake_t state)`  
*MMC sets card sleep awake state.*
- `status_t MMC_PollingCardStatusBusy (mmc_card_t *card, bool checkStatus, uint32_t timeoutMs)`  
*Polling card idle status.*

### 52.4.3 Data Structure Documentation

#### 52.4.3.1 struct mmc\_usr\_param\_t

##### Data Fields

- `mmc_io_strength_t ioStrength`  
*switch sd io strength*
- `uint32_t maxFreq`  
*board support maximum frequency*
- `uint32_t capability`  
*board capability flag*

### 52.4.3.2 struct mmc\_card\_t

Defines the card structure including the necessary fields to identify and describe the card.

#### Data Fields

- `sdmchost_t * host`  
*Host information.*
- `mmc_usr_param_t usrParam`  
*user parameter*
- `bool isHostReady`  
*Use this flag to indicate if host re-init needed or not.*
- `bool noInternalAlign`  
*Use this flag to disable sdmmc align.*
- `uint32_t busClock_Hz`  
*MMC bus clock united in Hz.*
- `uint32_t relativeAddress`  
*Relative address of the card.*
- `bool enablePreDefinedBlockCount`  
*Enable PRE-DEFINED block count when read/write.*
- `uint32_t flags`  
*Capability flag in `_mmc_card_flag`.*
- `uint8_t internalBuffer [FSL_SDMMC_CARD_INTERNAL_BUFFER_SIZE]`  
*raw buffer used for mmc driver internal*
- `uint32_t ocr`  
*Raw OCR content.*
- `mmc_cid_t cid`  
*CID.*
- `mmc_csd_t csd`  
*CSD.*
- `mmc_extended_csd_t extendedCsd`  
*Extended CSD.*
- `uint32_t blockSize`  
*Card block size.*
- `uint32_t userPartitionBlocks`  
*Card total block number in user partition.*
- `uint32_t bootPartitionBlocks`  
*Boot partition size united as block size.*
- `uint32_t eraseGroupBlocks`  
*Erase group size united as block size.*
- `mmc_access_partition_t currentPartition`  
*Current access partition.*
- `mmc_voltage_window_t hostVoltageWindowVCCQ`  
*application must set this value according to board specific*
- `mmc_voltage_window_t hostVoltageWindowVCC`  
*application must set this value according to board specific*
- `mmc_high_speed_timing_t busTiming`  
*indicates the current work timing mode*
- `mmc_data_bus_width_t busWidth`  
*indicates the current work bus width*



- `sdmmc_osa_mutex_t lock`  
card access lock

## Field Documentation

### (1) `bool mmc_card_t::noInterAlAlign`

If disabled, `sdmmc` will not make sure the data buffer address is word align, otherwise all the transfer are aligned to low level driver.

## 52.4.4 Macro Definition Documentation

**52.4.4.1** `#define FSL_MMC_DRIVER_VERSION (MAKE_VERSION(2U, 5U, 0U)) /*2.5.0*/`

## 52.4.5 Enumeration Type Documentation

### 52.4.5.1 anonymous enum

Enumerator

*kMMC\_SupportHighSpeed26MHZFlag* Support high speed 26MHZ.  
*kMMC\_SupportHighSpeed52MHZFlag* Support high speed 52MHZ.  
*kMMC\_SupportHighSpeedDDR52MHZ180V300VFlag* ddr 52MHZ 1.8V or 3.0V  
*kMMC\_SupportHighSpeedDDR52MHZ120VFlag* DDR 52MHZ 1.2V.  
*kMMC\_SupportHS200200MHZ180VFlag* HS200 ,200MHZ,1.8V.  
*kMMC\_SupportHS200200MHZ120VFlag* HS200, 200MHZ, 1.2V.  
*kMMC\_SupportHS400DDR200MHZ180VFlag* HS400, DDR, 200MHZ,1.8V.  
*kMMC\_SupportHS400DDR200MHZ120VFlag* HS400, DDR, 200MHZ,1.2V.  
*kMMC\_SupportHighCapacityFlag* Support high capacity.  
*kMMC\_SupportAlternateBootFlag* Support alternate boot.  
*kMMC\_SupportDDRBootFlag* support DDR boot flag  
*kMMC\_SupportHighSpeedBootFlag* support high speed boot flag  
*kMMC\_SupportEnhanceHS400StrobeFlag* support enhance HS400 strobe

### 52.4.5.2 `enum mmc_sleep_aware_t`

Enumerator

*kMMC\_Sleep* MMC card sleep.  
*kMMC\_Awake* MMC card awake.

## 52.4.6 Function Documentation

**52.4.6.1** `status_t MMC_Init ( mmc_card_t * card )`

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

Thread safe function, please note that the function will create the mutex lock dynamically by default, so to avoid the mutex to be created redundantly, application must follow bellow sequence for card re-initialization:

```
MMC_Deinit(card);
MMC_Init(card);
*
```

Return values

|                                                          |                                     |
|----------------------------------------------------------|-------------------------------------|
| <i>kStatus_SDMMC_Host-NotReady</i>                       | Host is not ready.                  |
| <i>kStatus_SDMMC_Go-IdleFailed</i>                       | Going idle failed.                  |
| <i>kStatus_SDMMC_Hand-ShakeOperation-ConditionFailed</i> | Sending operation condition failed. |
| <i>kStatus_SDMMC_All-SendCidFailed</i>                   | Sending CID failed.                 |
| <i>kStatus_SDMMC_Set-RelativeAddressFailed</i>           | Setging relative address failed.    |
| <i>kStatus_SDMMC_Send-CsdFailed</i>                      | Sending CSD failed.                 |
| <i>kStatus_SDMMC_Card-NotSupport</i>                     | Card not support.                   |
| <i>kStatus_SDMMC_Select-CardFailed</i>                   | Sending SELECT_CARD command failed. |
| <i>kStatus_SDMMC_Send-ExtendedCsdFailed</i>              | Sending EXT_CSD failed.             |
| <i>kStatus_SDMMC_Set-DataBusWidthFailed</i>              | Setting bus width failed.           |

|                                              |                                  |
|----------------------------------------------|----------------------------------|
| <i>kStatus_SDMMC_Switch-BusTimingFailed</i>  | Switching high speed failed.     |
| <i>kStatus_SDMMC_Set-CardBlockSizeFailed</i> | Setting card block size failed.  |
| <i>kStatus_SDMMC_Set-PowerClassFail</i>      | Setting card power class failed. |
| <i>kStatus_Success</i>                       | Operation succeeded.             |

### 52.4.6.2 void MMC\_Deinit ( mmc\_card\_t \* card )

Note

It is a thread safe function.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

### 52.4.6.3 status\_t MMC\_CardInit ( mmc\_card\_t \* card )

Thread safe function, please note that the function will create the mutex lock dynamically by default, so to avoid the mutex to be created redundantly, application must follow bellow sequence for card re-initialization:

```

MMC_CardDeinit (card);
MMC_CardInit (card);
*
```

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

Return values

|                                    |                    |
|------------------------------------|--------------------|
| <i>kStatus_SDMMC_Host-NotReady</i> | Host is not ready. |
|------------------------------------|--------------------|

|                                                        |                                     |
|--------------------------------------------------------|-------------------------------------|
| <i>kStatus_SDMMC_GoIdleFailed</i>                      | Going idle failed.                  |
| <i>kStatus_SDMMC_HandShakeOperationConditionFailed</i> | Sending operation condition failed. |
| <i>kStatus_SDMMC_AllSendCidFailed</i>                  | Sending CID failed.                 |
| <i>kStatus_SDMMC_SetRelativeAddressFailed</i>          | Setting relative address failed.    |
| <i>kStatus_SDMMC_SendCsdFailed</i>                     | Sending CSD failed.                 |
| <i>kStatus_SDMMC_CardNotSupport</i>                    | Card not support.                   |
| <i>kStatus_SDMMC_SelectCardFailed</i>                  | Sending SELECT_CARD command failed. |
| <i>kStatus_SDMMC_SendExtendedCsdFailed</i>             | Sending EXT_CSD failed.             |
| <i>kStatus_SDMMC_SetDataBusWidthFailed</i>             | Setting bus width failed.           |
| <i>kStatus_SDMMC_SwitchBusTimingFailed</i>             | Switching high speed failed.        |
| <i>kStatus_SDMMC_SetCardBlockSizeFailed</i>            | Setting card block size failed.     |
| <i>kStatus_SDMMC_SetPowerClassFail</i>                 | Setting card power class failed.    |
| <i>kStatus_Success</i>                                 | Operation succeeded.                |

#### 52.4.6.4 void MMC\_CardDeinit ( mmc\_card\_t \* card )

Note

It is a thread safe function.

Parameters

---

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

#### 52.4.6.5 `status_t MMC_HostInit ( mmc_card_t * card )`

This function deinitializes the specific host.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

#### 52.4.6.6 `void MMC_HostDeinit ( mmc_card_t * card )`

This function deinitializes the host.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

#### 52.4.6.7 `void MMC_HostDoReset ( mmc_card_t * card )`

This function resets the specific host.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

#### 52.4.6.8 `void MMC_HostReset ( SDMMCHOST_CONFIG * host )`

**Deprecated** Do not use this function. It has been superseded by [MMC\\_HostDoReset](#). This function resets the specific host.

Parameters

|             |                  |
|-------------|------------------|
| <i>host</i> | Host descriptor. |
|-------------|------------------|

#### 52.4.6.9 `void MMC_SetCardPower ( mmc_card_t * card, bool enable )`

## Parameters

|               |                                             |
|---------------|---------------------------------------------|
| <i>card</i>   | Card descriptor.                            |
| <i>enable</i> | True is powering on, false is powering off. |

**52.4.6.10 bool MMC\_CheckReadOnly ( mmc\_card\_t \* *card* )**

## Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

## Return values

|              |                       |
|--------------|-----------------------|
| <i>true</i>  | Card is read only.    |
| <i>false</i> | Card isn't read only. |

**52.4.6.11 status\_t MMC\_ReadBlocks ( mmc\_card\_t \* *card*, uint8\_t \* *buffer*, uint32\_t *startBlock*, uint32\_t *blockCount* )**

## Note

It is a thread safe function.

## Parameters

|                   |                               |
|-------------------|-------------------------------|
| <i>card</i>       | Card descriptor.              |
| <i>buffer</i>     | The buffer to save data.      |
| <i>startBlock</i> | The start block index.        |
| <i>blockCount</i> | The number of blocks to read. |

## Return values

|                                      |                   |
|--------------------------------------|-------------------|
| <i>kStatus_InvalidArgument</i>       | Invalid argument. |
| <i>kStatus_SDMMC_Card-NotSupport</i> | Card not support. |

|                                              |                               |
|----------------------------------------------|-------------------------------|
| <i>kStatus_SDMMC_Set-BlockCountFailed</i>    | Setting block count failed.   |
| <i>kStatus_SDMMC_-TransferFailed</i>         | Transfer failed.              |
| <i>kStatus_SDMMC_Stop-TransmissionFailed</i> | Stopping transmission failed. |
| <i>kStatus_Success</i>                       | Operation succeeded.          |

#### 52.4.6.12 `status_t MMC_WriteBlocks ( mmc_card_t * card, const uint8_t * buffer, uint32_t startBlock, uint32_t blockCount )`

Note

1. It is a thread safe function.
2. It is an async write function which means that the card status may still be busy after the function returns. Application can call function `MMC_PollingCardStatusBusy` to wait for the card status to be idle after the write operation.

Parameters

|                   |                                 |
|-------------------|---------------------------------|
| <i>card</i>       | Card descriptor.                |
| <i>buffer</i>     | The buffer to save data blocks. |
| <i>startBlock</i> | Start block number to write.    |
| <i>blockCount</i> | Block count.                    |

Return values

|                                               |                             |
|-----------------------------------------------|-----------------------------|
| <i>kStatus_InvalidArgument</i>                | Invalid argument.           |
| <i>kStatus_SDMMC_Not-SupportYet</i>           | Not support now.            |
| <i>kStatus_SDMMC_Set-BlockCountFailed</i>     | Setting block count failed. |
| <i>kStatus_SDMMC_Wait-WriteCompleteFailed</i> | Sending status failed.      |



|                                             |                           |
|---------------------------------------------|---------------------------|
| <i>kStatus_SDMMC_-TransferFailed</i>        | Transfer failed.          |
| <i>kStatus_SDMMC_StopTransmissionFailed</i> | Stop transmission failed. |
| <i>kStatus_Success</i>                      | Operation succeeded.      |

**52.4.6.13 status\_t MMC\_EraseGroups ( mmc\_card\_t \* card, uint32\_t startGroup, uint32\_t endGroup )**

The erase command is best used to erase the entire device or a partition. Erase group is the smallest erase unit in MMC card. The erase range is [startGroup, endGroup].

Note

1. It is a thread safe function.
2. This function always polls card busy status according to the timeout value defined in the card register after all the erase command sent out.

Parameters

|                   |                     |
|-------------------|---------------------|
| <i>card</i>       | Card descriptor.    |
| <i>startGroup</i> | Start group number. |
| <i>endGroup</i>   | End group number.   |

Return values

|                                              |                      |
|----------------------------------------------|----------------------|
| <i>kStatus_InvalidArgument</i>               | Invalid argument.    |
| <i>kStatus_SDMMC_WaitWriteCompleteFailed</i> | Send status failed.  |
| <i>kStatus_SDMMC_-TransferFailed</i>         | Transfer failed.     |
| <i>kStatus_Success</i>                       | Operation succeeded. |

**52.4.6.14 status\_t MMC\_SelectPartition ( mmc\_card\_t \* card, mmc\_access\_partition\_t partitionNumber )**

Note

It is a thread safe function.

## Parameters

|                         |                       |
|-------------------------|-----------------------|
| <i>card</i>             | Card descriptor.      |
| <i>partition-Number</i> | The partition number. |

## Return values

|                                                   |                             |
|---------------------------------------------------|-----------------------------|
| <i>kStatus_SDMMC_-ConfigureExtendedCsd-Failed</i> | Configuring EXT_CSD failed. |
| <i>kStatus_Success</i>                            | Operation succeeded.        |

#### 52.4.6.15 `status_t MMC_SetBootConfig ( mmc_card_t * card, const mmc_boot_config_t * config )`

## Parameters

|               |                               |
|---------------|-------------------------------|
| <i>card</i>   | Card descriptor.              |
| <i>config</i> | Boot configuration structure. |

## Return values

|                                                   |                             |
|---------------------------------------------------|-----------------------------|
| <i>kStatus_SDMMC_Not-SupportYet</i>               | Not support now.            |
| <i>kStatus_SDMMC_-ConfigureExtendedCsd-Failed</i> | Configuring EXT_CSD failed. |
| <i>kStatus_SDMMC_-ConfigureBootFailed</i>         | Configuring boot failed.    |
| <i>kStatus_Success</i>                            | Operation succeeded.        |

#### 52.4.6.16 `status_t MMC_StartBoot ( mmc_card_t * card, const mmc_boot_config_t * mmcConfig, uint8_t * buffer, sdmmchost_boot_config_t * hostConfig )`

Parameters

|                   |                                       |
|-------------------|---------------------------------------|
| <i>card</i>       | Card descriptor.                      |
| <i>mmcConfig</i>  | The mmc Boot configuration structure. |
| <i>buffer</i>     | Address to receive data.              |
| <i>hostConfig</i> | Host boot configurations.             |

Return values

|                                        |                        |
|----------------------------------------|------------------------|
| <i>kStatus_Fail</i>                    | Failed.                |
| <i>kStatus_SDMMC_ - TransferFailed</i> | Transfer failed.       |
| <i>kStatus_SDMMC_ Go- IdleFailed</i>   | Resetting card failed. |
| <i>kStatus_Success</i>                 | Operation succeeded.   |

**52.4.6.17 status\_t MMC\_SetBootConfigWP ( mmc\_card\_t \* *card*, uint8\_t *wp* )**

Parameters

|             |                      |
|-------------|----------------------|
| <i>card</i> | Card descriptor.     |
| <i>wp</i>   | Write protect value. |

**52.4.6.18 status\_t MMC\_ReadBootData ( mmc\_card\_t \* *card*, uint8\_t \* *buffer*, sdmmchost\_boot\_config\_t \* *hostConfig* )**

Parameters

|                   |                           |
|-------------------|---------------------------|
| <i>card</i>       | Card descriptor.          |
| <i>buffer</i>     | Buffer address.           |
| <i>hostConfig</i> | Host boot configurations. |

**52.4.6.19 status\_t MMC\_StopBoot ( mmc\_card\_t \* *card*, uint32\_t *bootMode* )**

Parameters

|                 |                  |
|-----------------|------------------|
| <i>card</i>     | Card descriptor. |
| <i>bootMode</i> | Boot mode.       |

**52.4.6.20 status\_t MMC\_SetBootPartitionWP ( mmc\_card\_t \* *card*, mmc\_boot\_partition\_wp\_t *bootPartitionWP* )**

Parameters

|                              |                                     |
|------------------------------|-------------------------------------|
| <i>card</i>                  | Card descriptor.                    |
| <i>bootPartition-<br/>WP</i> | Boot partition write protect value. |

**52.4.6.21 status\_t MMC\_EnableCacheControl ( mmc\_card\_t \* *card*, bool *enable* )**

The mmc device's cache is enabled by the driver by default. The cache should in typical case reduce the access time (compared to an access to the main nonvolatile storage) for both write and read.

Parameters

|               |                                                           |
|---------------|-----------------------------------------------------------|
| <i>card</i>   | Card descriptor.                                          |
| <i>enable</i> | True is enabling the cache, false is disabling the cache. |

**52.4.6.22 status\_t MMC\_FlushCache ( mmc\_card\_t \* *card* )**

A Flush operation refers to the requirement, from the host to the device, to write the cached data to the nonvolatile memory. Prior to a flush, the device may autonomously write data to the nonvolatile memory, but after the flush operation all data in the volatile area must be written to nonvolatile memory. There is no requirement for flush due to switching between the partitions. (Note: This also implies that the cache data shall not be lost when switching between partitions). Cached data may be lost in SLEEP state, so host should flush the cache before placing the device into SLEEP state.

Parameters

|             |                  |
|-------------|------------------|
| <i>card</i> | Card descriptor. |
|-------------|------------------|

### 52.4.6.23 `status_t MMC_SetSleepAwake ( mmc_card_t * card, mmc_sleep_awake_t state )`

The Sleep/Awake command is used to initiate the state transition between Standby state and Sleep state. The memory device indicates the transition phase busy by pulling down the DAT0 line. The Sleep/Standby state is reached when the memory device stops pulling down the DAT0 line, then the function returns.

Parameters

|              |                                                                                |
|--------------|--------------------------------------------------------------------------------|
| <i>card</i>  | Card descriptor.                                                               |
| <i>state</i> | The sleep/awake command argument, refer to <a href="#">mmc_sleep_awake_t</a> . |

Return values

|                                             |                                                                      |
|---------------------------------------------|----------------------------------------------------------------------|
| <i>kStatus_SDMMC_Not-SupportYet</i>         | Indicates the memory device doesn't support the Sleep/Awake command. |
| <i>kStatus_SDMMC_-TransferFailed</i>        | Indicates command transferred fail.                                  |
| <i>kStatus_SDMMC_-PollingCardIdleFailed</i> | Indicates polling DAT0 busy timeout.                                 |
| <i>kStatus_SDMMC_-DeselectCardFailed</i>    | Indicates deselect card command failed.                              |
| <i>kStatus_SDMMC_Select-CardFailed</i>      | Indicates select card command failed.                                |
| <i>kStatus_Success</i>                      | Indicates the card state switched successfully.                      |

### 52.4.6.24 `status_t MMC_PollingCardStatusBusy ( mmc_card_t * card, bool checkStatus, uint32_t timeoutMs )`

This function can be used to poll the status from busy to idle, the function will return with the card status being idle or timeout or command failed.

Parameters

|                    |                                                                                             |
|--------------------|---------------------------------------------------------------------------------------------|
| <i>card</i>        | Card descriptor.                                                                            |
| <i>checkStatus</i> | True is send CMD and read DAT0 status to check card status, false is read DAT0 status only. |
| <i>timeoutMs</i>   | Polling card status timeout value.                                                          |

## Return values

|                                           |                                      |
|-------------------------------------------|--------------------------------------|
| <i>kStatus_SDMMC_Card-<br/>StatusIdle</i> | Card is idle.                        |
| <i>kStatus_SDMMC_Card-<br/>StatusBusy</i> | Card is busy.                        |
| <i>kStatus_SDMMC_-<br/>TransferFailed</i> | Command transfer failed.             |
| <i>kStatus_SDMMC_Switch-<br/>Failed</i>   | Status command reports switch error. |

## **52.5 SDMMC HOST Driver**

### **52.5.1 Overview**

The host adapter driver provide adapter for blocking/non\_blocking mode.

#### **Modules**

- [USDHC HOST adapter Driver](#)

## 52.6 SDMMC OSA

### 52.6.1 Overview

The sdmmc osa adapter provide interface of os adapter.

#### Data Structures

- struct [sdmmc\\_osa\\_event\\_t](#)  
*sdmmc osa event More...*
- struct [sdmmc\\_osa\\_mutex\\_t](#)  
*sdmmc osa mutex More...*

#### Macros

- #define [SDMMC\\_OSA\\_EVENT\\_TRANSFER\\_CMD\\_SUCCESS](#) (1UL << 0U)  
*transfer event*
- #define [SDMMC\\_OSA\\_EVENT\\_CARD\\_INSERTED](#) (1UL << 8U)  
*card detect event, start from index 8*
- #define [SDMMC\\_OSA\\_POLLING\\_EVENT\\_BY\\_SEMPHORE](#) 1  
*enable semaphore by default*

#### sdmmc osa Function

- void [SDMMC\\_OSAInit](#) (void)  
*Initialize OSA.*
- [status\\_t SDMMC\\_OSAEventCreate](#) (void \*eventHandle)  
*OSA Create event.*
- [status\\_t SDMMC\\_OSAEventWait](#) (void \*eventHandle, uint32\_t eventType, uint32\_t timeout-Milliseconds, uint32\_t \*event)  
*Wait event.*
- [status\\_t SDMMC\\_OSAEventSet](#) (void \*eventHandle, uint32\_t eventType)  
*set event.*
- [status\\_t SDMMC\\_OSAEventGet](#) (void \*eventHandle, uint32\_t eventType, uint32\_t \*flag)  
*Get event flag.*
- [status\\_t SDMMC\\_OSAEventClear](#) (void \*eventHandle, uint32\_t eventType)  
*clear event flag.*
- [status\\_t SDMMC\\_OSAEventDestroy](#) (void \*eventHandle)  
*Delete event.*
- [status\\_t SDMMC\\_OSAMutexCreate](#) (void \*mutexHandle)  
*Create a mutex.*
- [status\\_t SDMMC\\_OSAMutexLock](#) (void \*mutexHandle, uint32\_t millisec)  
*set event.*
- [status\\_t SDMMC\\_OSAMutexUnlock](#) (void \*mutexHandle)  
*Get event flag.*
- [status\\_t SDMMC\\_OSAMutexDestroy](#) (void \*mutexHandle)  
*Delete mutex.*



- void **SDMMC\_OSADelay** (uint32\_t milliseconds)  
*sdmmc delay.*
- uint32\_t **SDMMC\_OSADelayUs** (uint32\_t microseconds)  
*sdmmc delay us.*

## 52.6.2 Data Structure Documentation

### 52.6.2.1 struct sdmmc\_osa\_event\_t

### 52.6.2.2 struct sdmmc\_osa\_mutex\_t

## 52.6.3 Function Documentation

### 52.6.3.1 status\_t SDMMC\_OSAEventCreate ( void \* *eventHandle* )

Parameters

|                    |               |
|--------------------|---------------|
| <i>eventHandle</i> | event handle. |
|--------------------|---------------|

Return values

|                     |                     |
|---------------------|---------------------|
| <i>kStatus_Fail</i> | or kStatus_Success. |
|---------------------|---------------------|

### 52.6.3.2 status\_t SDMMC\_OSAEventWait ( void \* *eventHandle*, uint32\_t *eventType*, uint32\_t *timeoutMilliseconds*, uint32\_t \* *event* )

Parameters

|                             |                               |
|-----------------------------|-------------------------------|
| <i>eventHandle</i>          | The event type                |
| <i>eventType</i>            | Timeout time in milliseconds. |
| <i>timeout-Milliseconds</i> | timeout value in ms.          |
| <i>event</i>                | event flags.                  |

Return values

---

|                     |                     |
|---------------------|---------------------|
| <i>kStatus_Fail</i> | or kStatus_Success. |
|---------------------|---------------------|

### 52.6.3.3 status\_t SDMMC\_OSAEventSet ( void \* eventHandle, uint32\_t eventType )

Parameters

|                    |                |
|--------------------|----------------|
| <i>eventHandle</i> | event handle.  |
| <i>eventType</i>   | The event type |

Return values

|                     |                     |
|---------------------|---------------------|
| <i>kStatus_Fail</i> | or kStatus_Success. |
|---------------------|---------------------|

### 52.6.3.4 status\_t SDMMC\_OSAEventGet ( void \* eventHandle, uint32\_t eventType, uint32\_t \* flag )

Parameters

|                    |                               |
|--------------------|-------------------------------|
| <i>eventHandle</i> | event handle.                 |
| <i>eventType</i>   | event type.                   |
| <i>flag</i>        | pointer to store event value. |

Return values

|                     |                     |
|---------------------|---------------------|
| <i>kStatus_Fail</i> | or kStatus_Success. |
|---------------------|---------------------|

### 52.6.3.5 status\_t SDMMC\_OSAEventClear ( void \* eventHandle, uint32\_t eventType )

Parameters

|                    |                |
|--------------------|----------------|
| <i>eventHandle</i> | event handle.  |
| <i>eventType</i>   | The event type |

Return values

|                     |                     |
|---------------------|---------------------|
| <i>kStatus_Fail</i> | or kStatus_Success. |
|---------------------|---------------------|

### 52.6.3.6 status\_t SDMMC\_OSAEventDestroy ( void \* *eventHandle* )

Parameters

|                    |                   |
|--------------------|-------------------|
| <i>eventHandle</i> | The event handle. |
|--------------------|-------------------|

### 52.6.3.7 status\_t SDMMC\_OSAMutexCreate ( void \* *mutexHandle* )

Parameters

|                    |               |
|--------------------|---------------|
| <i>mutexHandle</i> | mutex handle. |
|--------------------|---------------|

Return values

|                     |                     |
|---------------------|---------------------|
| <i>kStatus_Fail</i> | or kStatus_Success. |
|---------------------|---------------------|

### 52.6.3.8 status\_t SDMMC\_OSAMutexLock ( void \* *mutexHandle*, uint32\_t *millisec* )

Parameters

|                    |                                                                                                                                                                                                                        |
|--------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>mutexHandle</i> | mutex handle.                                                                                                                                                                                                          |
| <i>millisec</i>    | The maximum number of milliseconds to wait for the mutex. If the mutex is locked, Pass the value <code>osaWaitForever_c</code> will wait indefinitely, pass 0 will return <code>KOSA_StatusTimeout</code> immediately. |

Return values

|                     |                     |
|---------------------|---------------------|
| <i>kStatus_Fail</i> | or kStatus_Success. |
|---------------------|---------------------|

### 52.6.3.9 status\_t SDMMC\_OSAMutexUnlock ( void \* *mutexHandle* )

## Parameters

|                    |               |
|--------------------|---------------|
| <i>mutexHandle</i> | mutex handle. |
|--------------------|---------------|

## Return values

|                     |                     |
|---------------------|---------------------|
| <i>kStatus_Fail</i> | or kStatus_Success. |
|---------------------|---------------------|

**52.6.3.10 status\_t SDMMC\_OSAMutexDestroy ( void \* *mutexHandle* )**

## Parameters

|                    |                   |
|--------------------|-------------------|
| <i>mutexHandle</i> | The mutex handle. |
|--------------------|-------------------|

**52.6.3.11 void SDMMC\_OSADelay ( uint32\_t *milliseconds* )**

## Parameters

|                     |               |
|---------------------|---------------|
| <i>milliseconds</i> | time to delay |
|---------------------|---------------|

**52.6.3.12 uint32\_t SDMMC\_OSADelayUs ( uint32\_t *microseconds* )**

## Parameters

|                     |               |
|---------------------|---------------|
| <i>microseconds</i> | time to delay |
|---------------------|---------------|

## Returns

actual delayed microseconds

## 52.6.4 USDHC HOST adapter Driver

### 52.6.4.1 Overview

The USDHC host adapter driver provide adapter for blocking/non\_blocking mode.

#### Cache maintain capability

To maintain data integrity during DMA operations on the platform that has cache, host driver provide a cache maintain functionality by set: `host.enableCacheControl = kSDMMCHOST_CacheControlRW-Buffer` This is used for only when the low level driver cache maintain functionality is disabled. It is suggest that the address of buffer used for read/write is align with cache line size.

#### Cache line alignment maintain capability

when application submit a transfer request that the data buffer address is not align with cache line size, the potential data loss may happen during driver maintain the data cache, to avoid such issue happens, `sdmmc usdhc` host driver provides support on convert the unalign data transfer into align data transfer, if application would like to use the feature, please enable this functionality by define below macro firstly, `#define SDMMCHOST_ENABLE_CACHE_LINE_ALIGN_TRANSFER 1` And then call `SDMMCHOST_InstallCacheAlignBuffer` to install a cache line size align buffer, please note the installed buffer size must not small than  $2 * \text{cache line size}$ . Please note that this functionality is support by the non blocking adapter only.

#### Data Structures

- struct `sdmmchost_t`  
*sdmmc host handler [More...](#)*

#### Macros

- `#define FSL_SDMMC_HOST_ADAPTER_VERSION (MAKE_VERSION(2U, 6U, 2U)) /*2.6.-2*/`  
*Middleware adapter version.*
- `#define SDMMCHOST_SUPPORT_HIGH_SPEED (1U)`  
*sdmmc host misc capability*
- `#define SDMMCHOST_SUPPORT_DDR50 (SDMMCHOST_SUPPORT_DDR_MODE)`  
*sdmmc host sdcard DDR50 mode capability*
- `#define SDMMCHOST_SUPPORT_SDR104 (1U)`  
*sdmmc host sdcard SDR50 mode capability*
- `#define SDMMCHOST_SUPPORT_SDR50 (1U)`  
*sdmmc host sdcard SDR104/mmccard HS200 mode capability*
- `#define SDMMCHOST_SUPPORT_HS400 (0U)`  
*sdmmc host mmccard HS400 mode capability*

- #define `SDMMCHOST_INSTANCE_SUPPORT_8_BIT_WIDTH`(host) `FSL_FEATURE_USDHC_INSTANCE_SUPPORT_8_BIT_WIDTHn`(host->hostController.base)  
*sdmmc host instance capability*
- #define `SDMMCHOST_DATA3_DETECT_CARD_DELAY` (10U)  
*sdmmchost delay for DAT3 detect card*
- #define `SDMMCHOST_DMA_DESCRIPTOR_BUFFER_ALIGN_SIZE` (4U)  
*SDMMC host dma descriptor buffer address align size.*
- #define `SDMMCHOST_STANDARD_TUNING_START` (10U)  
*tuning configuration*
- #define `SDMMCHOST_TUINIG_STEP` (2U)  
*standard tuning stBep*

## Typedefs

- typedef `usdhc_transfer_t` `sdmmchost_transfer_t`  
*sdmmc host transfer function*

## Enumerations

- enum {  
`kSDMMCHOST_SupportHighSpeed` = 1U << 0U,  
`kSDMMCHOST_SupportSuspendResume` = 1U << 1U,  
`kSDMMCHOST_SupportVoltage3v3` = 1U << 2U,  
`kSDMMCHOST_SupportVoltage3v0` = 1U << 3U,  
`kSDMMCHOST_SupportVoltage1v8` = 1U << 4U,  
`kSDMMCHOST_SupportVoltage1v2` = 1U << 5U,  
`kSDMMCHOST_Support4BitDataWidth` = 1U << 6U,  
`kSDMMCHOST_Support8BitDataWidth` = 1U << 7U,  
`kSDMMCHOST_SupportDDRMMode` = 1U << 8U,  
`kSDMMCHOST_SupportDetectCardByData3` = 1U << 9U,  
`kSDMMCHOST_SupportDetectCardByCD` = 1U << 10U,  
`kSDMMCHOST_SupportAutoCmd12` = 1U << 11U,  
`kSDMMCHOST_SupportSDR104` = 1U << 12U,  
`kSDMMCHOST_SupportSDR50` = 1U << 13U,  
`kSDMMCHOST_SupportHS200` = 1U << 14U,  
`kSDMMCHOST_SupportHS400` = 1U << 15U }  
*sdmmc host capability*
- enum {  
`kSDMMCHOST_EndianModeBig` = 0U,  
`kSDMMCHOST_EndianModeHalfWordBig` = 1U,  
`kSDMMCHOST_EndianModeLittle` = 2U }  
*host Endian mode corresponding to driver define*
- enum {  
`kSDMMCHOST_StandardTuning` = 0U,  
`kSDMMCHOST_ManualTuning` = 1U }  
*sdmmc host tuning type*

- enum {  
   **kSDMMCHOST\_NoCacheControl** = 0U,  
   **kSDMMCHOST\_CacheControlRWBuffer** = 1U }  
   *sdmmc host maintain cache flag*

## USDHC host controller function

- void **SDMMCHOST\_SetCardBusWidth** (sdmmchost\_t \*host, uint32\_t dataBusWidth)  
   *set data bus width.*
- static void **SDMMCHOST\_SendCardActive** (sdmmchost\_t \*host)  
   *Send initialization active 80 clocks to card.*
- static uint32\_t **SDMMCHOST\_SetCardClock** (sdmmchost\_t \*host, uint32\_t targetClock)  
   *Set card bus clock.*
- static bool **SDMMCHOST\_IsCardBusy** (sdmmchost\_t \*host)  
   *check card status by DATA0.*
- static uint32\_t **SDMMCHOST\_GetSignalLineStatus** (sdmmchost\_t \*host, uint32\_t signalLine)  
   *Get signal line status.*
- static void **SDMMCHOST\_EnableCardInt** (sdmmchost\_t \*host, bool enable)  
   *enable card interrupt.*
- static void **SDMMCHOST\_EnableDDRMode** (sdmmchost\_t \*host, bool enable, uint32\_t nibble-Pos)  
   *enable DDR mode.*
- static void **SDMMCHOST\_EnableHS400Mode** (sdmmchost\_t \*host, bool enable)  
   *enable HS400 mode.*
- static void **SDMMCHOST\_EnableStrobeDll** (sdmmchost\_t \*host, bool enable)  
   *enable STROBE DLL.*
- **status\_t SDMMCHOST\_StartBoot** (sdmmchost\_t \*host, sdmmchost\_boot\_config\_t \*hostConfig, sdmmchost\_cmd\_t \*cmd, uint8\_t \*buffer)  
   *start read boot data.*
- **status\_t SDMMCHOST\_ReadBootData** (sdmmchost\_t \*host, sdmmchost\_boot\_config\_t \*host-Config, uint8\_t \*buffer)  
   *read boot data.*
- static void **SDMMCHOST\_EnableBoot** (sdmmchost\_t \*host, bool enable)  
   *enable boot mode.*
- **status\_t SDMMCHOST\_CardIntInit** (sdmmchost\_t \*host, void \*sdioInt)  
   *card interrupt function.*
- static void **SDMMCHOST\_ForceClockOn** (sdmmchost\_t \*host, bool enable)  
   *force card clock on.*
- void **SDMMCHOST\_SwitchToVoltage** (sdmmchost\_t \*host, uint32\_t voltage)  
   *switch to voltage.*
- **status\_t SDMMCHOST\_CardDetectInit** (sdmmchost\_t \*host, void \*cd)  
   *card detect init function.*
- **status\_t SDMMCHOST\_PollingCardDetectStatus** (sdmmchost\_t \*host, uint32\_t waitCardStatus, uint32\_t timeout)  
   *Detect card insert, only need for SD cases.*
- uint32\_t **SDMMCHOST\_CardDetectStatus** (sdmmchost\_t \*host)  
   *card detect status.*
- **status\_t SDMMCHOST\_Init** (sdmmchost\_t \*host)  
   *Init host controller.*
- void **SDMMCHOST\_Deinit** (sdmmchost\_t \*host)

- *Deinit host controller.*
- void [SDMMCHOST\\_SetCardPower](#) (sdmmchost\_t \*host, bool enable)  
*host power off card function.*
- [status\\_t SDMMCHOST\\_TransferFunction](#) (sdmmchost\_t \*host, [sdmmchost\\_transfer\\_t](#) \*content)  
*host transfer function.*
- [status\\_t SDMMCHOST\\_ExecuteTuning](#) (sdmmchost\_t \*host, uint32\_t tuningCmd, uint32\_t \*revBuf, uint32\_t blockSize)  
*sdmmc host excute tuning.*
- void [SDMMCHOST\\_Reset](#) (sdmmchost\_t \*host)  
*host reset function.*
- void [SDMMCHOST\\_ConvertDataToLittleEndian](#) (sdmmchost\_t \*host, uint32\_t \*data, uint32\_t wordSize, uint32\_t format)  
*sdmmc host convert data sequence to little endian sequence*

## 52.6.4.2 Data Structure Documentation

### 52.6.4.2.1 struct sdmmchost\_t

#### Data Fields

- [usdhc\\_host\\_t](#) hostController  
*host configuration*
- void \* [dmaDesBuffer](#)  
*DMA descriptor buffer address.*
- uint32\_t [dmaDesBufferWordsNum](#)  
*DMA descriptor buffer size in byte.*
- [usdhc\\_handle\\_t](#) handle  
*host controller handler*
- uint32\_t [capability](#)  
*host controller capability*
- uint32\_t [maxBlockCount](#)  
*host controller maximum block count*
- uint32\_t [maxBlockSize](#)  
*host controller maximum block size*
- uint8\_t [tuningType](#)  
*host tuning type*
- [sdmmc\\_osa\\_event\\_t](#) hostEvent  
*host event handler*
- void \* [cd](#)  
*card detect*
- void \* [cardInt](#)  
*call back function for card interrupt*
- [sdmmc\\_osa\\_mutex\\_t](#) lock  
*host access lock*

### 52.6.4.3 Macro Definition Documentation



**52.6.4.3.1 #define FSL\_SDMMC\_HOST\_ADAPTER\_VERSION (MAKE\_VERSION(2U, 6U, 2U))**  
 /\*2.6.2\*/

**52.6.4.3.2 #define SDMMCHOST\_STANDARD\_TUNING\_START (10U)**

standard tuning start point

## 52.6.4.4 Enumeration Type Documentation

### 52.6.4.4.1 anonymous enum

Enumerator

*kSDMMCHOST\_SupportHighSpeed* high speed capability  
*kSDMMCHOST\_SupportSuspendResume* suspend resume capability  
*kSDMMCHOST\_SupportVoltage3v3* 3V3 capability  
*kSDMMCHOST\_SupportVoltage3v0* 3V0 capability  
*kSDMMCHOST\_SupportVoltage1v8* 1V8 capability  
*kSDMMCHOST\_SupportVoltage1v2* 1V2 capability  
*kSDMMCHOST\_Support4BitDataWidth* 4 bit data width capability  
*kSDMMCHOST\_Support8BitDataWidth* 8 bit data width capability  
*kSDMMCHOST\_SupportDDRMode* DDR mode capability.  
*kSDMMCHOST\_SupportDetectCardByData3* data3 detect card capability  
*kSDMMCHOST\_SupportDetectCardByCD* CD detect card capability.  
*kSDMMCHOST\_SupportAutoCmd12* auto command 12 capability  
*kSDMMCHOST\_SupportSDR104* SDR104 capability.  
*kSDMMCHOST\_SupportSDR50* SDR50 capability.  
*kSDMMCHOST\_SupportHS200* HS200 capability.  
*kSDMMCHOST\_SupportHS400* HS400 capability.

### 52.6.4.4.2 anonymous enum

Enumerator

*kSDMMCHOST\_EndianModeBig* Big endian mode.  
*kSDMMCHOST\_EndianModeHalfWordBig* Half word big endian mode.  
*kSDMMCHOST\_EndianModeLittle* Little endian mode.

### 52.6.4.4.3 anonymous enum

Enumerator

*kSDMMCHOST\_StandardTuning* standard tuning type  
*kSDMMCHOST\_ManualTuning* manual tuning type

#### 52.6.4.4.4 anonymous enum

Enumerator

*kSDMMCHOST\_NoCacheControl* sdmmc host cache control disabled  
*kSDMMCHOST\_CacheControlRWBuffer* sdmmc host cache control read/write buffer

#### 52.6.4.5 Function Documentation

##### 52.6.4.5.1 void SDMMCHOST\_SetCardBusWidth ( sdmmchost\_t \* *host*, uint32\_t *dataBusWidth* )

Parameters

|                     |                |
|---------------------|----------------|
| <i>host</i>         | host handler   |
| <i>dataBusWidth</i> | data bus width |

##### 52.6.4.5.2 static void SDMMCHOST\_SendCardActive ( sdmmchost\_t \* *host* ) [inline], [static]

Parameters

|             |              |
|-------------|--------------|
| <i>host</i> | host handler |
|-------------|--------------|

##### 52.6.4.5.3 static uint32\_t SDMMCHOST\_SetCardClock ( sdmmchost\_t \* *host*, uint32\_t *targetClock* ) [inline], [static]

Parameters

|                    |                        |
|--------------------|------------------------|
| <i>host</i>        | host handler           |
| <i>targetClock</i> | target clock frequency |

Return values

|               |                               |
|---------------|-------------------------------|
| <i>actual</i> | clock frequency can be reach. |
|---------------|-------------------------------|

##### 52.6.4.5.4 static bool SDMMCHOST\_IsCardBusy ( sdmmchost\_t \* *host* ) [inline], [static]

## Parameters

|             |              |
|-------------|--------------|
| <i>host</i> | host handler |
|-------------|--------------|

## Return values

|             |                         |
|-------------|-------------------------|
| <i>true</i> | is busy, false is idle. |
|-------------|-------------------------|

**52.6.4.5.5** `static uint32_t SDMMCHOST_GetSignalLineStatus ( sdmmchost_t * host, uint32_t signalLine ) [inline], [static]`

## Parameters

|                   |                                                             |
|-------------------|-------------------------------------------------------------|
| <i>host</i>       | host handler                                                |
| <i>signalLine</i> | signal line type, reference <code>_sdmmc_signal_line</code> |

**52.6.4.5.6** `static void SDMMCHOST_EnableCardInt ( sdmmchost_t * host, bool enable ) [inline], [static]`

## Parameters

|               |                                   |
|---------------|-----------------------------------|
| <i>host</i>   | host handler                      |
| <i>enable</i> | true is enable, false is disable. |

**52.6.4.5.7** `static void SDMMCHOST_EnableDDRMode ( sdmmchost_t * host, bool enable, uint32_t nibblePos ) [inline], [static]`

## Parameters

|                  |                                                                                                                                                                                                                           |
|------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>host</i>      | host handler                                                                                                                                                                                                              |
| <i>enable</i>    | true is enable, false is disable.                                                                                                                                                                                         |
| <i>nibblePos</i> | nibble position indication. 0- the sequence is 'odd high nibble -> even high nibble -> odd low nibble -> even low nibble'; 1- the sequence is 'odd high nibble -> odd low nibble -> even high nibble -> even low nibble'. |

**52.6.4.5.8** `static void SDMMCHOST_EnableHS400Mode ( sdmmchost_t * host, bool enable ) [inline], [static]`

Parameters

|               |                                   |
|---------------|-----------------------------------|
| <i>host</i>   | host handler                      |
| <i>enable</i> | true is enable, false is disable. |

**52.6.4.5.9** `static void SDMMCHOST_EnableStrobeDII ( sdmmchost_t * host, bool enable )`  
`[inline], [static]`

Parameters

|               |                                   |
|---------------|-----------------------------------|
| <i>host</i>   | host handler                      |
| <i>enable</i> | true is enable, false is disable. |

**52.6.4.5.10** `status_t SDMMCHOST_StartBoot ( sdmmchost_t * host, sdmmchost_boot_config_t * hostConfig, sdmmchost_cmd_t * cmd, uint8_t * buffer )`

Parameters

|                   |                    |
|-------------------|--------------------|
| <i>host</i>       | host handler       |
| <i>hostConfig</i> | boot configuration |
| <i>cmd</i>        | boot command       |
| <i>buffer</i>     | buffer address     |

**52.6.4.5.11** `status_t SDMMCHOST_ReadBootData ( sdmmchost_t * host, sdmmchost_boot_config_t * hostConfig, uint8_t * buffer )`

Parameters

|                   |                    |
|-------------------|--------------------|
| <i>host</i>       | host handler       |
| <i>hostConfig</i> | boot configuration |
| <i>buffer</i>     | buffer address     |

**52.6.4.5.12** `static void SDMMCHOST_EnableBoot ( sdmmchost_t * host, bool enable )`  
`[inline], [static]`

Parameters

|               |                                  |
|---------------|----------------------------------|
| <i>host</i>   | host handler                     |
| <i>enable</i> | true is enable, false is disable |

**52.6.4.5.13** `status_t SDMMCHOST_CardIntInit ( sdmmchost_t * host, void * sdiInt )`

Parameters

|               |                              |
|---------------|------------------------------|
| <i>host</i>   | host handler                 |
| <i>sdiInt</i> | card interrupt configuration |

**52.6.4.5.14** `static void SDMMCHOST_ForceClockOn ( sdmmchost_t * host, bool enable )`  
`[inline], [static]`

Parameters

|               |                                   |
|---------------|-----------------------------------|
| <i>host</i>   | host handler                      |
| <i>enable</i> | true is enable, false is disable. |

**52.6.4.5.15** `void SDMMCHOST_SwitchToVoltage ( sdmmchost_t * host, uint32_t voltage )`

Parameters

|                |                          |
|----------------|--------------------------|
| <i>host</i>    | host handler             |
| <i>voltage</i> | switch to voltage level. |

**52.6.4.5.16** `status_t SDMMCHOST_CardDetectInit ( sdmmchost_t * host, void * cd )`

Parameters

|             |              |
|-------------|--------------|
| <i>host</i> | host handler |
|-------------|--------------|

|           |                           |
|-----------|---------------------------|
| <i>cd</i> | card detect configuration |
|-----------|---------------------------|

#### 52.6.4.5.17 `status_t SDMMCHOST_PollingCardDetectStatus ( sdmmchost_t * host, uint32_t waitCardStatus, uint32_t timeout )`

Parameters

|                       |                                |
|-----------------------|--------------------------------|
| <i>host</i>           | host handler                   |
| <i>waitCardStatus</i> | status which user want to wait |
| <i>timeout</i>        | wait time out.                 |

Return values

|                        |                        |
|------------------------|------------------------|
| <i>kStatus_Success</i> | detect card insert     |
| <i>kStatus_Fail</i>    | card insert event fail |

#### 52.6.4.5.18 `uint32_t SDMMCHOST_CardDetectStatus ( sdmmchost_t * host )`

Parameters

|             |              |
|-------------|--------------|
| <i>host</i> | host handler |
|-------------|--------------|

Return values

|                                  |  |
|----------------------------------|--|
| <i>kSD_Inserted, kSD_Removed</i> |  |
|----------------------------------|--|

#### 52.6.4.5.19 `status_t SDMMCHOST_Init ( sdmmchost_t * host )`

Thread safe function, please note that the function will create the mutex lock dynamically by default, so to avoid the mutex create redundantly, application must follow bellow sequence for card re-initialization

```
* SDMMCHOST_Deinit (host);
* SDMMCHOST_Init (host);
*
```

## Parameters

|             |              |
|-------------|--------------|
| <i>host</i> | host handler |
|-------------|--------------|

## Return values

|                        |                   |
|------------------------|-------------------|
| <i>kStatus_Success</i> | host init success |
| <i>kStatus_Fail</i>    | event fail        |

**52.6.4.5.20 void SDMMCHOST\_Deinit ( sdmmchost\_t \* *host* )**

Please note it is a thread safe function.

## Parameters

|             |              |
|-------------|--------------|
| <i>host</i> | host handler |
|-------------|--------------|

**52.6.4.5.21 void SDMMCHOST\_SetCardPower ( sdmmchost\_t \* *host*, bool *enable* )**

## Parameters

|               |                                        |
|---------------|----------------------------------------|
| <i>host</i>   | host handler                           |
| <i>enable</i> | true is power on, false is power down. |

**52.6.4.5.22 status\_t SDMMCHOST\_TransferFunction ( sdmmchost\_t \* *host*, sdmmchost\_transfer\_t \* *content* )**

Please note it is a thread safe function.

## Note

the host transfer function support below functionality,

1. Non-cache line size alignment check on the data buffer, it is means that no matter the data buffer used for data transfer is align with cache line size or not, sdmmc host driver will use the address directly.
2. Cache line size alignment check on the data buffer, sdmmc host driver will check the data buffer address, if the buffer is not align with cache line size, sdmmc host driver will convert it to cache line size align buffer, the functionality is enabled by #define SDMMCHOST\_ENABLE\_CACHE\_LINE\_ALIGN\_TRANSFER 1 #define FSL\_USDHC\_ENABLE\_SCATTER\_GATHER\_TRANSFER 1U If application would like to enable the cache line size align functionality, please make sure the SDMMCHOST\_InstallCacheAlignBuffer is called before

submit data transfer request and make sure the installing buffer size is not smaller than 2 \* cache line size.

## Parameters

|                |                   |
|----------------|-------------------|
| <i>host</i>    | host handler      |
| <i>content</i> | transfer content. |

**52.6.4.5.23** `status_t SDMMCHOST_ExecuteTuning ( sdmmchost_t * host, uint32_t tuningCmd, uint32_t * revBuf, uint32_t blockSize )`

## Parameters

|                  |                         |
|------------------|-------------------------|
| <i>host</i>      | host handler            |
| <i>tuningCmd</i> | tuning command.         |
| <i>revBuf</i>    | receive buffer pointer  |
| <i>blockSize</i> | tuning data block size. |

**52.6.4.5.24** `void SDMMCHOST_Reset ( sdmmchost_t * host )`

## Parameters

|             |              |
|-------------|--------------|
| <i>host</i> | host handler |
|-------------|--------------|

**52.6.4.5.25** `void SDMMCHOST_ConvertDataToLittleEndian ( sdmmchost_t * host, uint32_t * data, uint32_t wordSize, uint32_t format )`

## Parameters

|                 |                           |
|-----------------|---------------------------|
| <i>host</i>     | host handler.             |
| <i>data</i>     | data buffer address.      |
| <i>wordSize</i> | data buffer size in word. |
| <i>format</i>   | data packet format.       |



## 52.7 SDMMC Common

### 52.7.1 Overview

The sdmmc common function and definition.

#### Data Structures

- struct [sd\\_detect\\_card\\_t](#)  
*sd card detect More...*
- struct [sd\\_io\\_voltage\\_t](#)  
*io voltage control configuration More...*
- struct [sd\\_usr\\_param\\_t](#)  
*sdcard user parameter More...*
- struct [sdio\\_card\\_int\\_t](#)  
*card interrupt application callback More...*
- struct [sdio\\_usr\\_param\\_t](#)  
*sdio user parameter More...*
- struct [sdio\\_fbr\\_t](#)  
*sdio card FBR register More...*
- struct [sdio\\_common\\_cis\\_t](#)  
*sdio card common CIS More...*
- struct [sdio\\_func\\_cis\\_t](#)  
*sdio card function CIS More...*
- struct [sd\\_status\\_t](#)  
*SD card status. More...*
- struct [sd\\_cid\\_t](#)  
*SD card CID register. More...*
- struct [sd\\_csd\\_t](#)  
*SD card CSD register. More...*
- struct [sd\\_scr\\_t](#)  
*SD card SCR register. More...*
- struct [mmc\\_cid\\_t](#)  
*MMC card CID register. More...*
- struct [mmc\\_csd\\_t](#)  
*MMC card CSD register. More...*
- struct [mmc\\_extended\\_csd\\_t](#)  
*MMC card Extended CSD register (unit: byte). More...*
- struct [mmc\\_extended\\_csd\\_config\\_t](#)  
*MMC Extended CSD configuration. More...*
- struct [mmc\\_boot\\_config\\_t](#)  
*MMC card boot configuration definition. More...*

#### Macros

- #define [SWAP\\_WORD\\_BYTE\\_SEQUENCE\(x\) \(\\_\\_REV\(x\)\)](#)  
*Reverse byte sequence in uint32\_t.*
- #define [SWAP\\_HALF\\_WROD\\_BYTE\\_SEQUENCE\(x\) \(\\_\\_REV16\(x\)\)](#)

- *Reverse byte sequence for each half word in uint32\_t.*
- #define **FSL\_SDMMC\_MAX\_VOLTAGE\_RETRIES** (1000U)  
*Maximum loop count to check the card operation voltage range.*
- #define **FSL\_SDMMC\_MAX\_CMD\_RETRIES** (10U)  
*Maximum loop count to send the cmd.*
- #define **FSL\_SDMMC\_DEFAULT\_BLOCK\_SIZE** (512U)  
*Default block size.*
- #define **SDMMC\_DATA\_BUFFER\_ALIGN\_CACHE** FSL\_FEATURE\_L1DCACHE\_LINESIZE\_BYTE  
*make sure the internal buffer address is cache align*
- #define **FSL\_SDMMC\_CARD\_INTERNAL\_BUFFER\_SIZE** (FSL\_SDMMC\_DEFAULT\_BLOCK\_SIZE + SDMMC\_DATA\_BUFFER\_ALIGN\_CACHE)  
*sdmmc card internal buffer size*
- #define **FSL\_SDMMC\_CARD\_MAX\_BUS\_FREQ**(max, target) ((max) == 0U ? (target) : ((max) > (target) ? (target) : (max)))  
*get maximum freq*
- #define **SDMMC\_LOG**(format,...)  
*SD/MMC error log.*
- #define **SDMMC\_CLOCK\_400KHZ** (400000U)  
*SD/MMC card initialization clock frequency.*
- #define **SD\_CLOCK\_25MHZ** (25000000U)  
*SD card bus frequency 1 in high-speed mode.*
- #define **SD\_CLOCK\_50MHZ** (50000000U)  
*SD card bus frequency 2 in high-speed mode.*
- #define **SD\_CLOCK\_100MHZ** (100000000U)  
*SD card bus frequency in SDR50 mode.*
- #define **SD\_CLOCK\_208MHZ** (208000000U)  
*SD card bus frequency in SDR104 mode.*
- #define **MMC\_CLOCK\_26MHZ** (26000000U)  
*MMC card bus frequency 1 in high-speed mode.*
- #define **MMC\_CLOCK\_52MHZ** (52000000U)  
*MMC card bus frequency 2 in high-speed mode.*
- #define **MMC\_CLOCK\_DDR52** (52000000U)  
*MMC card bus frequency in high-speed DDR52 mode.*
- #define **MMC\_CLOCK\_HS200** (200000000U)  
*MMC card bus frequency in high-speed HS200 mode.*
- #define **MMC\_CLOCK\_HS400** (400000000U)  
*MMC card bus frequency in high-speed HS400 mode.*
- #define **SDMMC\_MASK**(bit) (1UL << (bit))  
*mask convert*
- #define **SDMMC\_R1\_ALL\_ERROR\_FLAG**  
*R1 all the error flag.*
- #define **SDMMC\_R1\_CURRENT\_STATE**(x) (((x)&0x00001E00U) >> 9U)  
*R1: current state.*
- #define **SDSPI\_R7\_VERSION\_SHIFT** (28U)  
*The bit mask for COMMAND VERSION field in R7.*
- #define **SDSPI\_R7\_VERSION\_MASK** (0xFU)  
*The bit mask for COMMAND VERSION field in R7.*
- #define **SDSPI\_R7\_VOLTAGE\_SHIFT** (8U)  
*The bit shift for VOLTAGE ACCEPTED field in R7.*
- #define **SDSPI\_R7\_VOLTAGE\_MASK** (0xFU)

- *The bit mask for VOLTAGE ACCEPTED field in R7.*  
#define **SDSPI\_R7\_VOLTAGE\_27\_36\_MASK** (0x1U << SDSPI\_R7\_VOLTAGE\_SHIFT)
- *The bit mask for VOLTAGE 2.7V to 3.6V field in R7.*  
#define **SDSPI\_R7\_ECHO\_SHIFT** (0U)
- *The bit shift for ECHO field in R7.*  
#define **SDSPI\_R7\_ECHO\_MASK** (0xFFU)
- *The bit mask for ECHO field in R7.*  
#define **SDSPI\_DATA\_ERROR\_TOKEN\_MASK** (0xFU)
- *Data error token mask.*  
#define **SDSPI\_DATA\_RESPONSE\_TOKEN\_MASK** (0x1FU)
- *Mask for data response bits.*  
#define **SDIO\_CCCR\_REG\_NUMBER** (0x16U)
- *sdio card cccr register number*  
#define **SDIO\_IO\_READY\_TIMEOUT\_UNIT** (10U)
- *sdio IO ready timeout steps*  
#define **SDIO\_CMD\_ARGUMENT\_RW\_POS** (31U)
- *read/write flag position*  
#define **SDIO\_CMD\_ARGUMENT\_FUNC\_NUM\_POS** (28U)
- *function number position*  
#define **SDIO\_DIRECT\_CMD\_ARGUMENT\_RAW\_POS** (27U)
- *direct raw flag position*  
#define **SDIO\_CMD\_ARGUMENT\_REG\_ADDR\_POS** (9U)
- *direct reg addr position*  
#define **SDIO\_CMD\_ARGUMENT\_REG\_ADDR\_MASK** (0x1FFFFU)
- *direct reg addr mask*  
#define **SDIO\_DIRECT\_CMD\_DATA\_MASK** (0xFFU)
- *data mask*  
#define **SDIO\_EXTEND\_CMD\_ARGUMENT\_BLOCK\_MODE\_POS** (27U)
- *extended command argument block mode bit position*  
#define **SDIO\_EXTEND\_CMD\_ARGUMENT\_OP\_CODE\_POS** (26U)
- *extended command argument OP Code bit position*  
#define **SDIO\_EXTEND\_CMD\_BLOCK\_MODE\_MASK** (0x08000000U)
- *block mode mask*  
#define **SDIO\_EXTEND\_CMD\_OP\_CODE\_MASK** (0x04000000U)
- *op code mask*  
#define **SDIO\_EXTEND\_CMD\_COUNT\_MASK** (0x1FFU)
- *byte/block count mask*  
#define **SDIO\_MAX\_BLOCK\_SIZE** (2048U)
- *max block size*  
#define **SDIO\_FBR\_BASE(x)** ((x)\*0x100U)
- *function basic register*  
#define **SDIO\_TPL\_CODE\_END** (0xFFU)
- *tuple end*  
#define **SDIO\_TPL\_CODE\_MANIFID** (0x20U)
- *manufacturer ID*  
#define **SDIO\_TPL\_CODE\_FUNCID** (0x21U)
- *function ID*  
#define **SDIO\_TPL\_CODE\_FUNCNCE** (0x22U)
- *function extension tuple*  
#define **SDIO\_OCR\_VOLTAGE\_WINDOW\_MASK** (0xFFFFU << 8U)
- *sdio ocr voltage window mask*

- #define **SDIO\_OCR\_IO\_NUM\_MASK** (7U << kSDIO\_OcrIONumber)  
*sdio ocr register IO NUMBER mask*
- #define **SDIO\_CCCR\_SUPPORT\_HIGHSPEED** (1UL << 9U)  
*UHS timing mode flag.*
- #define **SDIO\_CCCR\_DRIVER\_TYPE\_MASK** (3U << 4U)  
*Driver type flag.*
- #define **SDIO\_CCCR\_ASYNC\_INT\_MASK** (1U)  
*async interrupt flag*
- #define **SDIO\_CCCR\_SUPPORT\_8BIT\_BUS** (1UL << 18U)  
*8 bit data bus flag*
- #define **MMC\_OCR\_V170TO195\_SHIFT** (7U)  
*The bit mask for VOLTAGE WINDOW 1.70V to 1.95V field in OCR.*
- #define **MMC\_OCR\_V170TO195\_MASK** (0x00000080U)  
*The bit mask for VOLTAGE WINDOW 1.70V to 1.95V field in OCR.*
- #define **MMC\_OCR\_V200TO260\_SHIFT** (8U)  
*The bit shift for VOLTAGE WINDOW 2.00V to 2.60V field in OCR.*
- #define **MMC\_OCR\_V200TO260\_MASK** (0x00007F00U)  
*The bit mask for VOLTAGE WINDOW 2.00V to 2.60V field in OCR.*
- #define **MMC\_OCR\_V270TO360\_SHIFT** (15U)  
*The bit shift for VOLTAGE WINDOW 2.70V to 3.60V field in OCR.*
- #define **MMC\_OCR\_V270TO360\_MASK** (0x00FF8000U)  
*The bit mask for VOLTAGE WINDOW 2.70V to 3.60V field in OCR.*
- #define **MMC\_OCR\_ACCESS\_MODE\_SHIFT** (29U)  
*The bit shift for ACCESS MODE field in OCR.*
- #define **MMC\_OCR\_ACCESS\_MODE\_MASK** (0x60000000U)  
*The bit mask for ACCESS MODE field in OCR.*
- #define **MMC\_OCR\_BUSY\_SHIFT** (31U)  
*The bit shift for BUSY field in OCR.*
- #define **MMC\_OCR\_BUSY\_MASK** (1U << MMC\_OCR\_BUSY\_SHIFT)  
*The bit mask for BUSY field in OCR.*
- #define **MMC\_TRANSFER\_SPEED\_FREQUENCY\_UNIT\_SHIFT** (0U)  
*The bit shift for FREQUENCY UNIT field in TRANSFER SPEED(TRAN-SPEED in Extended CSD)*
- #define **MMC\_TRANSFER\_SPEED\_FREQUENCY\_UNIT\_MASK** (0x07U)  
*The bit mask for FREQUENCY UNIT in TRANSFER SPEED.*
- #define **MMC\_TRANSFER\_SPEED\_MULTIPLIER\_SHIFT** (3U)  
*The bit shift for MULTIPLIER field in TRANSFER SPEED.*
- #define **MMC\_TRANSFER\_SPEED\_MULTIPLIER\_MASK** (0x78U)  
*The bit mask for MULTIPLIER field in TRANSFER SPEED.*
- #define **READ\_MMC\_TRANSFER\_SPEED\_FREQUENCY\_UNIT(CSD)** (((CSD).transferSpeed) & **MMC\_TRANSFER\_SPEED\_FREQUENCY\_UNIT\_MASK**) >> **MMC\_TRANSFER\_SPEED\_FREQUENCY\_UNIT\_SHIFT**)  
*Read the value of FREQUENCY UNIT in TRANSFER SPEED.*
- #define **READ\_MMC\_TRANSFER\_SPEED\_MULTIPLIER(CSD)** (((CSD).transferSpeed) & **MMC\_TRANSFER\_SPEED\_MULTIPLIER\_MASK**) >> **MMC\_TRANSFER\_SPEED\_MULTIPLIER\_SHIFT**)  
*Read the value of MULTIPLIER field in TRANSFER SPEED.*
- #define **MMC\_POWER\_CLASS\_4BIT\_MASK** (0x0FU)  
*The power class value bit mask when bus in 4 bit mode.*
- #define **MMC\_POWER\_CLASS\_8BIT\_MASK** (0xF0U)  
*The power class current value bit mask when bus in 8 bit mode.*
- #define **MMC\_CACHE\_CONTROL\_ENABLE** (1U)

- *mmc cache control enable*
- #define **MMC\_CACHE\_TRIGGER\_FLUSH** (1U)
- *mmc cache flush*
- #define **MMC\_DATA\_BUS\_WIDTH\_TYPE\_NUMBER** (3U)
- *The number of data bus width type.*
- #define **MMC\_PARTITION\_CONFIG\_PARTITION\_ACCESS\_SHIFT** (0U)
- *The bit shift for PARTITION ACCESS field in BOOT CONFIG (BOOT\_CONFIG in Extend CSD)*
- #define **MMC\_PARTITION\_CONFIG\_PARTITION\_ACCESS\_MASK** (0x00000007U)
- *The bit mask for PARTITION ACCESS field in BOOT CONFIG.*
- #define **MMC\_PARTITION\_CONFIG\_PARTITION\_ENABLE\_SHIFT** (3U)
- *The bit shift for PARTITION ENABLE field in BOOT CONFIG.*
- #define **MMC\_PARTITION\_CONFIG\_PARTITION\_ENABLE\_MASK** (0x00000038U)
- *The bit mask for PARTITION ENABLE field in BOOT CONFIG.*
- #define **MMC\_PARTITION\_CONFIG\_BOOT\_ACK\_SHIFT** (6U)
- *The bit shift for ACK field in BOOT CONFIG.*
- #define **MMC\_PARTITION\_CONFIG\_BOOT\_ACK\_MASK** (0x00000040U)
- *The bit mask for ACK field in BOOT CONFIG.*
- #define **MMC\_BOOT\_BUS\_CONDITION\_BUS\_WIDTH\_SHIFT** (0U)
- *The bit shift for BOOT BUS WIDTH field in BOOT CONFIG.*
- #define **MMC\_BOOT\_BUS\_CONDITION\_BUS\_WIDTH\_MASK** (3U)
- *The bit mask for BOOT BUS WIDTH field in BOOT CONFIG.*
- #define **MMC\_BOOT\_BUS\_CONDITION\_RESET\_BUS\_CONDITION\_SHIFT** (2U)
- *The bit shift for BOOT BUS WIDTH RESET field in BOOT CONFIG.*
- #define **MMC\_BOOT\_BUS\_CONDITION\_RESET\_BUS\_CONDITION\_MASK** (4U)
- *The bit mask for BOOT BUS WIDTH RESET field in BOOT CONFIG.*
- #define **MMC\_BOOT\_BUS\_CONDITION\_BOOT\_MODE\_SHIFT** (3U)
- *The bit shift for BOOT MODE field in BOOT CONFIG.*
- #define **MMC\_BOOT\_BUS\_CONDITION\_BOOT\_MODE\_MASK** (0x18U)
- *The bit mask for BOOT MODE field in BOOT CONFIG.*
- #define **MMC\_EXTENDED\_CSD\_BYTES** (512U)
- *The length of Extended CSD register, unit as bytes.*
- #define **MMC\_DEFAULT\_RELATIVE\_ADDRESS** (2UL)
- *MMC card default relative address.*
- #define **SD\_PRODUCT\_NAME\_BYTES** (5U)
- *SD card product name length united as bytes.*
- #define **SD\_AU\_START\_VALUE** (1U)
- *SD AU start value.*
- #define **SD\_UHS\_AU\_START\_VALUE** (7U)
- *SD UHS AU start value.*
- #define **SD\_TRANSFER\_SPEED\_RATE\_UNIT\_SHIFT** (0U)
- *The bit shift for RATE UNIT field in TRANSFER SPEED.*
- #define **SD\_TRANSFER\_SPEED\_RATE\_UNIT\_MASK** (0x07U)
- *The bit mask for RATE UNIT field in TRANSFER SPEED.*
- #define **SD\_TRANSFER\_SPEED\_TIME\_VALUE\_SHIFT** (2U)
- *The bit shift for TIME VALUE field in TRANSFER SPEED.*
- #define **SD\_TRANSFER\_SPEED\_TIME\_VALUE\_MASK** (0x78U)
- *The bit mask for TIME VALUE field in TRANSFER SPEED.*
- #define **SD\_RD\_TRANSFER\_SPEED\_RATE\_UNIT(x)** (((x.transferSpeed) & SD\_TRANSFER\_SPEED\_RATE\_UNIT\_MASK) >> SD\_TRANSFER\_SPEED\_RATE\_UNIT\_SHIFT)
- *Read the value of FREQUENCY UNIT in TRANSFER SPEED field.*
- #define **SD\_RD\_TRANSFER\_SPEED\_TIME\_VALUE(x)** (((x.transferSpeed) & SD\_TRANSFER-

`_SPEED_TIME_VALUE_MASK) >> SD_TRANSFER_SPEED_TIME_VALUE_SHIFT)`

*Read the value of TIME VALUE in TRANSFER SPEED field.*

- #define `MMC_PRODUCT_NAME_BYTES` (6U)  
*MMC card product name length united as bytes.*
- #define `MMC_SWITCH_COMMAND_SET_SHIFT` (0U)  
*The bit shift for COMMAND SET field in SWITCH command.*
- #define `MMC_SWITCH_COMMAND_SET_MASK` (0x00000007U)  
*The bit mask for COMMAND set field in SWITCH command.*
- #define `MMC_SWITCH_VALUE_SHIFT` (8U)  
*The bit shift for VALUE field in SWITCH command.*
- #define `MMC_SWITCH_VALUE_MASK` (0x0000FF00U)  
*The bit mask for VALUE field in SWITCH command.*
- #define `MMC_SWITCH_BYTE_INDEX_SHIFT` (16U)  
*The bit shift for BYTE INDEX field in SWITCH command.*
- #define `MMC_SWITCH_BYTE_INDEX_MASK` (0x00FF0000U)  
*The bit mask for BYTE INDEX field in SWITCH command.*
- #define `MMC_SWITCH_ACCESS_MODE_SHIFT` (24U)  
*The bit shift for ACCESS MODE field in SWITCH command.*
- #define `MMC_SWITCH_ACCESS_MODE_MASK` (0x03000000U)  
*The bit mask for ACCESS MODE field in SWITCH command.*

## Typedefs

- typedef void(\* `sd_cd_t`)(bool isInserted, void \*userData)  
*card detect application callback definition*
- typedef bool(\* `sd_cd_status_t`)(void)  
*card detect status*
- typedef void(\* `sd_io_voltage_func_t`)(sdmmc\_operation\_voltage\_t voltage)  
*card switch voltage function pointer*
- typedef void(\* `sd_pwr_t`)(bool enable)  
*card power control function pointer*
- typedef void(\* `sd_io_strength_t`)(uint32\_t busFreq)  
*card io strength control*
- typedef void(\* `sdio_int_t`)(void \*userData)  
*card interrupt function pointer*



## Enumerations

- enum {
  - kStatus\_SDMMC\_NotSupportYet = MAKE\_STATUS(kStatusGroup\_SDMMC, 0U),
  - kStatus\_SDMMC\_TransferFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 1U),
  - kStatus\_SDMMC\_SetCardBlockSizeFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 2U),
  - kStatus\_SDMMC\_HostNotSupport = MAKE\_STATUS(kStatusGroup\_SDMMC, 3U),
  - kStatus\_SDMMC\_CardNotSupport = MAKE\_STATUS(kStatusGroup\_SDMMC, 4U),
  - kStatus\_SDMMC\_AllSendCidFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 5U),
  - kStatus\_SDMMC\_SendRelativeAddressFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 6U),
  - kStatus\_SDMMC\_SendCsdFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 7U),
  - kStatus\_SDMMC\_SelectCardFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 8U),
  - kStatus\_SDMMC\_SendScrFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 9U),
  - kStatus\_SDMMC\_SetDataBusWidthFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 10U),
  - kStatus\_SDMMC\_GoIdleFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 11U),
  - kStatus\_SDMMC\_HandShakeOperationConditionFailed,
  - kStatus\_SDMMC\_SendApplicationCommandFailed,
  - kStatus\_SDMMC\_SwitchFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 14U),
  - kStatus\_SDMMC\_StopTransmissionFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 15U),
  - kStatus\_SDMMC\_WaitWriteCompleteFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 16U),
  - kStatus\_SDMMC\_SetBlockCountFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 17U),
  - kStatus\_SDMMC\_SetRelativeAddressFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 18U),
  - kStatus\_SDMMC\_SwitchBusTimingFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 19U),
  - kStatus\_SDMMC\_SendExtendedCsdFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 20U),
  - kStatus\_SDMMC\_ConfigureBootFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 21U),
  - kStatus\_SDMMC\_ConfigureExtendedCsdFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 22-  
U),
  - kStatus\_SDMMC\_EnableHighCapacityEraseFailed,
  - kStatus\_SDMMC\_SendTestPatternFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 24U),
  - kStatus\_SDMMC\_ReceiveTestPatternFailed = MAKE\_STATUS(kStatusGroup\_SDMMC, 25U),
  - kStatus\_SDMMC\_SDIO\_ResponseError = MAKE\_STATUS(kStatusGroup\_SDMMC, 26U),
  - kStatus\_SDMMC\_SDIO\_InvalidArgument,
  - kStatus\_SDMMC\_SDIO\_SendOperationConditionFail,
  - kStatus\_SDMMC\_InvalidVoltage = MAKE\_STATUS(kStatusGroup\_SDMMC, 29U),
  - kStatus\_SDMMC\_SDIO\_SwitchHighSpeedFail = MAKE\_STATUS(kStatusGroup\_SDMMC, 30-  
U),
  - kStatus\_SDMMC\_SDIO\_ReadCISFail = MAKE\_STATUS(kStatusGroup\_SDMMC, 31U),
  - kStatus\_SDMMC\_SDIO\_InvalidCard = MAKE\_STATUS(kStatusGroup\_SDMMC, 32U),
  - kStatus\_SDMMC\_TuningFail = MAKE\_STATUS(kStatusGroup\_SDMMC, 33U),
  - kStatus\_SDMMC\_SwitchVoltageFail = MAKE\_STATUS(kStatusGroup\_SDMMC, 34U),
  - kStatus\_SDMMC\_SwitchVoltage18VFail33VSuccess = MAKE\_STATUS(kStatusGroup\_SDMMC-

```

C, 35U),
kStatus_SDMMC_ReTuningRequest = MAKE_STATUS(kStatusGroup_SDMMC, 36U),
kStatus_SDMMC_SetDriverStrengthFail = MAKE_STATUS(kStatusGroup_SDMMC, 37U),
kStatus_SDMMC_SetPowerClassFail = MAKE_STATUS(kStatusGroup_SDMMC, 38U),
kStatus_SDMMC_HostNotReady = MAKE_STATUS(kStatusGroup_SDMMC, 39U),
kStatus_SDMMC_CardDetectFailed = MAKE_STATUS(kStatusGroup_SDMMC, 40U),
kStatus_SDMMC_AuSizeNotSetProperly = MAKE_STATUS(kStatusGroup_SDMMC, 41U),
kStatus_SDMMC_PollingCardIdleFailed = MAKE_STATUS(kStatusGroup_SDMMC, 42U),
kStatus_SDMMC_DeselectCardFailed = MAKE_STATUS(kStatusGroup_SDMMC, 43U),
kStatus_SDMMC_CardStatusIdle = MAKE_STATUS(kStatusGroup_SDMMC, 44U),
kStatus_SDMMC_CardStatusBusy = MAKE_STATUS(kStatusGroup_SDMMC, 45U),
kStatus_SDMMC_CardInitFailed = MAKE_STATUS(kStatusGroup_SDMMC, 46U) }

```

*SD/MMC card API's running status.*

- enum {
 

```

kSDMMC_SignalLineCmd = 1U,
kSDMMC_SignalLineData0 = 2U,
kSDMMC_SignalLineData1 = 4U,
kSDMMC_SignalLineData2 = 8U,
kSDMMC_SignalLineData3 = 16U,
kSDMMC_SignalLineData4 = 32U,
kSDMMC_SignalLineData5 = 64U,
kSDMMC_SignalLineData6 = 128U,
kSDMMC_SignalLineData7 = 256U }

```

*sdmmc signal line*
- enum sdmmc\_operation\_voltage\_t {
 

```

kSDMMC_OperationVoltageNone = 0U,
kSDMMC_OperationVoltage330V = 1U,
kSDMMC_OperationVoltage300V = 2U,
kSDMMC_OperationVoltage180V = 3U }

```

*card operation voltage*
- enum {
 

```

kSDMMC_BusWidth1Bit = 0U,
kSDMMC_BusWidth4Bit = 1U,
kSDMMC_BusWidth8Bit = 2U }

```

*card bus width*
- enum { kSDMMC\_Support8BitWidth = 1U }
 

*sdmmc capability flag*
- enum {
 

```

kSDMMC_DataPacketFormatLSBFirst,
kSDMMC_DataPacketFormatMSBFirst }

```

*@ brief sdmmc data packet format*
- enum sd\_detect\_card\_type\_t {
 

```

kSD_DetectCardByGpioCD,
kSD_DetectCardByHostCD,
kSD_DetectCardByHostDATA3 }

```

*sd card detect type*



- enum {
  - kSD\_Inserted = 1U,
  - kSD\_Removed = 0U }
  - @ brief SD card detect status*
- enum {
  - kSD\_DAT3PullDown = 0U,
  - kSD\_DAT3PullUp = 1U }
  - @ brief SD card detect status*
- enum sd\_io\_voltage\_ctrl\_type\_t {
  - kSD\_IOVoltageCtrlNotSupport = 0U,
  - kSD\_IOVoltageCtrlByHost = 1U,
  - kSD\_IOVoltageCtrlByGpio = 2U }
  - io voltage control type*
- enum {
  - kSDMMC\_R1OutOfRangeFlag = 31,
  - kSDMMC\_R1AddressErrorFlag = 30,
  - kSDMMC\_R1BlockLengthErrorFlag = 29,
  - kSDMMC\_R1EraseSequenceErrorFlag = 28,
  - kSDMMC\_R1EraseParameterErrorFlag = 27,
  - kSDMMC\_R1WriteProtectViolationFlag = 26,
  - kSDMMC\_R1CardIsLockedFlag = 25,
  - kSDMMC\_R1LockUnlockFailedFlag = 24,
  - kSDMMC\_R1CommandCrcErrorFlag = 23,
  - kSDMMC\_R1IllegalCommandFlag = 22,
  - kSDMMC\_R1CardEccFailedFlag = 21,
  - kSDMMC\_R1CardControllerErrorFlag = 20,
  - kSDMMC\_R1ErrorFlag = 19,
  - kSDMMC\_R1CidCsdOverwriteFlag = 16,
  - kSDMMC\_R1WriteProtectEraseSkipFlag = 15,
  - kSDMMC\_R1CardEccDisabledFlag = 14,
  - kSDMMC\_R1EraseResetFlag = 13,
  - kSDMMC\_R1ReadyForDataFlag = 8,
  - kSDMMC\_R1SwitchErrorFlag = 7,
  - kSDMMC\_R1ApplicationCommandFlag = 5,
  - kSDMMC\_R1AuthenticationSequenceErrorFlag = 3 }
  - Card status bit in R1.*
- enum sdmmc\_r1\_current\_state\_t {
  - kSDMMC\_R1StateIdle = 0U,
  - kSDMMC\_R1StateReady = 1U,
  - kSDMMC\_R1StateIdentify = 2U,
  - kSDMMC\_R1StateStandby = 3U,
  - kSDMMC\_R1StateTransfer = 4U,
  - kSDMMC\_R1StateSendData = 5U,
  - kSDMMC\_R1StateReceiveData = 6U,
  - kSDMMC\_R1StateProgram = 7U,
  - kSDMMC\_R1StateDisconnect = 8U }

- CURRENT\_STATE* filed in R1.
  - enum {
    - kSDSPI\_R1IdleStateFlag = (1U << 0U),
    - kSDSPI\_R1EraseResetFlag = (1U << 1U),
    - kSDSPI\_R1IllegalCommandFlag = (1U << 2U),
    - kSDSPI\_R1CommandCrcErrorFlag = (1U << 3U),
    - kSDSPI\_R1EraseSequenceErrorFlag = (1U << 4U),
    - kSDSPI\_R1AddressErrorFlag = (1U << 5U),
    - kSDSPI\_R1ParameterErrorFlag = (1U << 6U) }
  - Error bit in SPI mode R1.*
    - enum {
      - kSDSPI\_R2CardLockedFlag = (1U << 0U),
      - kSDSPI\_R2WriteProtectEraseSkip = (1U << 1U),
      - kSDSPI\_R2LockUnlockFailed = (1U << 1U),
      - kSDSPI\_R2ErrorFlag = (1U << 2U),
      - kSDSPI\_R2CardControllerErrorFlag = (1U << 3U),
      - kSDSPI\_R2CardEccFailedFlag = (1U << 4U),
      - kSDSPI\_R2WriteProtectViolationFlag = (1U << 5U),
      - kSDSPI\_R2EraseParameterErrorFlag = (1U << 6U),
      - kSDSPI\_R2OutOfRangeFlag = (1U << 7U),
      - kSDSPI\_R2CsdOverwriteFlag = (1U << 7U) }
    - Error bit in SPI mode R2.*
      - enum {
        - kSDSPI\_DataErrorTokenError = (1U << 0U),
        - kSDSPI\_DataErrorTokenCardControllerError = (1U << 1U),
        - kSDSPI\_DataErrorTokenCardEccFailed = (1U << 2U),
        - kSDSPI\_DataErrorTokenOutOfRange = (1U << 3U) }
      - Data Error Token mask bit.*
        - enum sdspi\_data\_token\_t {
          - kSDSPI\_DataTokenBlockRead = 0xFEU,
          - kSDSPI\_DataTokenSingleBlockWrite = 0xFEU,
          - kSDSPI\_DataTokenMultipleBlockWrite = 0xFCU,
          - kSDSPI\_DataTokenStopTransfer = 0xFDU }
        - Data Token.*
          - enum sdspi\_data\_response\_token\_t {
            - kSDSPI\_DataResponseTokenAccepted = 0x05U,
            - kSDSPI\_DataResponseTokenCrcError = 0x0BU,
            - kSDSPI\_DataResponseTokenWriteError = 0x0DU }
          - Data Response Token.*
            - enum sd\_command\_t {

```

kSD_SendRelativeAddress = 3U,
kSD_Switch = 6U,
kSD_SendInterfaceCondition = 8U,
kSD_VoltageSwitch = 11U,
kSD_SpeedClassControl = 20U,
kSD_EraseWriteBlockStart = 32U,
kSD_EraseWriteBlockEnd = 33U,
kSD_SendTuningBlock = 19U }
 SD card individual commands.
• enum sdspi_command_t { kSDSPI_CommandCrc = 59U }
 SDSPI individual commands.
• enum sd_application_command_t {
kSD_ApplicationSetBusWidth = 6U,
kSD_ApplicationStatus = 13U,
kSD_ApplicationSendNumberWriteBlocks = 22U,
kSD_ApplicationSetWriteBlockEraseCount = 23U,
kSD_ApplicationSendOperationCondition = 41U,
kSD_ApplicationSetClearCardDetect = 42U,
kSD_ApplicationSendScr = 51U }
 SD card individual application commands.
• enum {
kSDMMC_CommandClassBasic = (1U << 0U),
kSDMMC_CommandClassBlockRead = (1U << 2U),
kSDMMC_CommandClassBlockWrite = (1U << 4U),
kSDMMC_CommandClassErase = (1U << 5U),
kSDMMC_CommandClassWriteProtect = (1U << 6U),
kSDMMC_CommandClassLockCard = (1U << 7U),
kSDMMC_CommandClassApplicationSpecific = (1U << 8U),
kSDMMC_CommandClassInputOutputMode = (1U << 9U),
kSDMMC_CommandClassSwitch = (1U << 10U) }
 SD card command class.
• enum {
kSD_OcrPowerUpBusyFlag = 31,
kSD_OcrHostCapacitySupportFlag = 30,
kSD_OcrCardCapacitySupportFlag = kSD_OcrHostCapacitySupportFlag,
kSD_OcrSwitch18RequestFlag = 24,
kSD_OcrSwitch18AcceptFlag = kSD_OcrSwitch18RequestFlag,
kSD_OcrVdd27_28Flag = 15,
kSD_OcrVdd28_29Flag = 16,
kSD_OcrVdd29_30Flag = 17,
kSD_OcrVdd30_31Flag = 18,
kSD_OcrVdd31_32Flag = 19,
kSD_OcrVdd32_33Flag = 20,
kSD_OcrVdd33_34Flag = 21,
kSD_OcrVdd34_35Flag = 22,
kSD_OcrVdd35_36Flag = 23 }

```

- OCR register in SD card.*
  - enum {
    - kSD\_SpecificationVersion1\_0 = (1U << 0U),
    - kSD\_SpecificationVersion1\_1 = (1U << 1U),
    - kSD\_SpecificationVersion2\_0 = (1U << 2U),
    - kSD\_SpecificationVersion3\_0 = (1U << 3U) }
  - SD card specification version number.*
  - enum sd\_switch\_mode\_t {
    - kSD\_SwitchCheck = 0U,
    - kSD\_SwitchSet = 1U }
    - SD card switch mode.*
    - enum {
      - kSD\_CsdReadBlockPartialFlag = (1U << 0U),
      - kSD\_CsdWriteBlockMisalignFlag = (1U << 1U),
      - kSD\_CsdReadBlockMisalignFlag = (1U << 2U),
      - kSD\_CsdDsrImplementedFlag = (1U << 3U),
      - kSD\_CsdEraseBlockEnabledFlag = (1U << 4U),
      - kSD\_CsdWriteProtectGroupEnabledFlag = (1U << 5U),
      - kSD\_CsdWriteBlockPartialFlag = (1U << 6U),
      - kSD\_CsdFileFormatGroupFlag = (1U << 7U),
      - kSD\_CsdCopyFlag = (1U << 8U),
      - kSD\_CsdPermanentWriteProtectFlag = (1U << 9U),
      - kSD\_CsdTemporaryWriteProtectFlag = (1U << 10U) }
      - SD card CSD register flags.*
      - enum {
        - kSD\_ScrDataStatusAfterErase = (1U << 0U),
        - kSD\_ScrSdSpecification3 = (1U << 1U) }
        - SD card SCR register flags.*
        - enum {
          - kSD\_FunctionSDR12Default = 0U,
          - kSD\_FunctionSDR25HighSpeed = 1U,
          - kSD\_FunctionSDR50 = 2U,
          - kSD\_FunctionSDR104 = 3U,
          - kSD\_FunctionDDR50 = 4U }
          - SD timing function number.*
          - enum {
            - kSD\_GroupTimingMode = 0U,
            - kSD\_GroupCommandSystem = 1U,
            - kSD\_GroupDriverStrength = 2U,
            - kSD\_GroupCurrentLimit = 3U }
            - SD group number.*
            - enum sd\_timing\_mode\_t {
              - kSD\_TimingSDR12DefaultMode = 0U,
              - kSD\_TimingSDR25HighSpeedMode = 1U,
              - kSD\_TimingSDR50Mode = 2U,
              - kSD\_TimingSDR104Mode = 3U,

- ```
kSD_TimingDDR50Mode = 4U }
```
- SD card timing mode flags.*
- enum `sd_driver_strength_t` {


```
kSD_DriverStrengthTypeB = 0U,
kSD_DriverStrengthTypeA = 1U,
kSD_DriverStrengthTypeC = 2U,
kSD_DriverStrengthTypeD = 3U }
```
- SD card driver strength.*
- enum `sd_max_current_t` {


```
kSD_CurrentLimit200MA = 0U,
kSD_CurrentLimit400MA = 1U,
kSD_CurrentLimit600MA = 2U,
kSD_CurrentLimit800MA = 3U }
```
- SD card current limit.*
- enum `sdmmc_command_t` {


```
kSDMMC_GoIdleState = 0U,
kSDMMC_AllSendCid = 2U,
kSDMMC_SetDsr = 4U,
kSDMMC_SelectCard = 7U,
kSDMMC_SendCsd = 9U,
kSDMMC_SendCid = 10U,
kSDMMC_StopTransmission = 12U,
kSDMMC_SendStatus = 13U,
kSDMMC_GoInactiveState = 15U,
kSDMMC_SetBlockLength = 16U,
kSDMMC_ReadSingleBlock = 17U,
kSDMMC_ReadMultipleBlock = 18U,
kSDMMC_SetBlockCount = 23U,
kSDMMC_WriteSingleBlock = 24U,
kSDMMC_WriteMultipleBlock = 25U,
kSDMMC_ProgramCsd = 27U,
kSDMMC_SetWriteProtect = 28U,
kSDMMC_ClearWriteProtect = 29U,
kSDMMC_SendWriteProtect = 30U,
kSDMMC_Erase = 38U,
kSDMMC_LockUnlock = 42U,
kSDMMC_ApplicationCommand = 55U,
kSDMMC_GeneralCommand = 56U,
kSDMMC_ReadOcr = 58U }
```
- SD/MMC card common commands.*
- enum {

- ```

kSDIO_RegCCCRSdioVer = 0x00U,
kSDIO_RegSDVersion = 0x01U,
kSDIO_RegIOEnable = 0x02U,
kSDIO_RegIOReady = 0x03U,
kSDIO_RegIOIntEnable = 0x04U,
kSDIO_RegIOIntPending = 0x05U,
kSDIO_RegIOAbort = 0x06U,
kSDIO_RegBusInterface = 0x07U,
kSDIO_RegCardCapability = 0x08U,
kSDIO_RegCommonCISPointer = 0x09U,
kSDIO_RegBusSuspend = 0x0C,
kSDIO_RegFunctionSelect = 0x0DU,
kSDIO_RegExecutionFlag = 0x0EU,
kSDIO_RegReadyFlag = 0x0FU,
kSDIO_RegFN0BlockSizeLow = 0x10U,
kSDIO_RegFN0BlockSizeHigh = 0x11U,
kSDIO_RegPowerControl = 0x12U,
kSDIO_RegBusSpeed = 0x13U,
kSDIO_RegUHSITimingSupport = 0x14U,
kSDIO_RegDriverStrength = 0x15U,
kSDIO_RegInterruptExtension = 0x16U }

```
- sdio card cccr register addr*

    - enum `sdio_command_t` {

```

kSDIO_SendRelativeAddress = 3U,
kSDIO_SendOperationCondition = 5U,
kSDIO_SendInterfaceCondition = 8U,
kSDIO_RWIODirect = 52U,
kSDIO_RWIOExtended = 53U }

```

*sdio card individual commands*

      - enum `sdio_func_num_t` {

```

kSDIO_FunctionNum0,
kSDIO_FunctionNum1,
kSDIO_FunctionNum2,
kSDIO_FunctionNum3,
kSDIO_FunctionNum4,
kSDIO_FunctionNum5,
kSDIO_FunctionNum6,
kSDIO_FunctionNum7,
kSDIO_FunctionMemory }

```

*sdio card individual commands*

        - enum {

```

kSDIO_StatusCmdCRCError = 0x8000U,
kSDIO_StatusIllegalCmd = 0x4000U,
kSDIO_StatusR6Error = 0x2000U,
kSDIO_StatusError = 0x0800U,
kSDIO_StatusFunctionNumError = 0x0200U,
kSDIO_StatusOutOfRange = 0x0100U }
 sdio command response flag
• enum {
kSDIO_OcrPowerUpBusyFlag = 31,
kSDIO_OcrIONumber = 28,
kSDIO_OcrMemPresent = 27,
kSDIO_OcrVdd20_21Flag = 8,
kSDIO_OcrVdd21_22Flag = 9,
kSDIO_OcrVdd22_23Flag = 10,
kSDIO_OcrVdd23_24Flag = 11,
kSDIO_OcrVdd24_25Flag = 12,
kSDIO_OcrVdd25_26Flag = 13,
kSDIO_OcrVdd26_27Flag = 14,
kSDIO_OcrVdd27_28Flag = 15,
kSDIO_OcrVdd28_29Flag = 16,
kSDIO_OcrVdd29_30Flag = 17,
kSDIO_OcrVdd30_31Flag = 18,
kSDIO_OcrVdd31_32Flag = 19,
kSDIO_OcrVdd32_33Flag = 20,
kSDIO_OcrVdd33_34Flag = 21,
kSDIO_OcrVdd34_35Flag = 22,
kSDIO_OcrVdd35_36Flag = 23 }
 sdio operation condition flag
• enum {
kSDIO_CCCRSupportDirectCmdDuringDataTrans = (1UL << 0U),
kSDIO_CCCRSupportMultiBlock = (1UL << 1U),
kSDIO_CCCRSupportReadWait = (1UL << 2U),
kSDIO_CCCRSupportSuspendResume = (1UL << 3U),
kSDIO_CCCRSupportIntDuring4BitDataTrans = (1UL << 4U),
kSDIO_CCCRSupportLowSpeed1Bit = (1UL << 6U),
kSDIO_CCCRSupportLowSpeed4Bit = (1UL << 7U),
kSDIO_CCCRSupportMasterPowerControl = (1UL << 8U),
kSDIO_CCCRSupportHighSpeed = (1UL << 9U),
kSDIO_CCCRSupportContinuousSPIInt = (1UL << 10U) }
 sdio capability flag
• enum {
kSDIO_FBRSupportCSA = (1U << 0U),
kSDIO_FBRSupportPowerSelection = (1U << 1U) }
 sdio fbr flag
• enum sdio_bus_width_t {

```

- ```

kSDIO_DataBus1Bit = 0x00U,
kSDIO_DataBus4Bit = 0x02U,
kSDIO_DataBus8Bit = 0x03U }
    sdio bus width

```
- enum `mmc_command_t` {

```

kMMC_SendOperationCondition = 1U,
kMMC_SetRelativeAddress = 3U,
kMMC_SleepAwake = 5U,
kMMC_Switch = 6U,
kMMC_SendExtendedCsd = 8U,
kMMC_ReadDataUntilStop = 11U,
kMMC_BusTestRead = 14U,
kMMC_SendingBusTest = 19U,
kMMC_WriteDataUntilStop = 20U,
kMMC_SendTuningBlock = 21U,
kMMC_ProgramCid = 26U,
kMMC_EraseGroupStart = 35U,
kMMC_EraseGroupEnd = 36U,
kMMC_FastInputOutput = 39U,
kMMC_GoInterruptState = 40U }
    MMC card individual commands.

```
 - enum `mmc_classified_voltage_t` {

```

kMMC_ClassifiedVoltageHigh = 0U,
kMMC_ClassifiedVoltageDual = 1U }
    MMC card classified as voltage range.

```
 - enum `mmc_classified_density_t` { `kMMC_ClassifiedDensityWithin2GB = 0U` }

```

    MMC card classified as density level.

```
 - enum `mmc_access_mode_t` {

```

kMMC_AccessModeByte = 0U,
kMMC_AccessModeSector = 2U }
    MMC card access mode(Access mode in OCR).

```
 - enum `mmc_voltage_window_t` {

```

kMMC_VoltageWindowNone = 0U,
kMMC_VoltageWindow120 = 0x01U,
kMMC_VoltageWindow170to195 = 0x02U,
kMMC_VoltageWindows270to360 = 0x1FFU }
    MMC card voltage window(VDD voltage window in OCR).

```
 - enum `mmc_csd_structure_version_t` {

```

kMMC_CsdStructureVersion10 = 0U,
kMMC_CsdStructureVersion11 = 1U,
kMMC_CsdStructureVersion12 = 2U,
kMMC_CsdStructureVersionInExtcsd = 3U }
    CSD structure version(CSD_STRUCTURE in CSD).

```
 - enum `mmc_specification_version_t` {

- kMMC_SpecificationVersion0 = 0U,
- kMMC_SpecificationVersion1 = 1U,
- kMMC_SpecificationVersion2 = 2U,
- kMMC_SpecificationVersion3 = 3U,
- kMMC_SpecificationVersion4 = 4U }
- MMC card specification version(SPEC_VERS in CSD).*
- enum {
 - kMMC_ExtendedCsdRevision10 = 0U,
 - kMMC_ExtendedCsdRevision11 = 1U,
 - kMMC_ExtendedCsdRevision12 = 2U,
 - kMMC_ExtendedCsdRevision13 = 3U,
 - kMMC_ExtendedCsdRevision14 = 4U,
 - kMMC_ExtendedCsdRevision15 = 5U,
 - kMMC_ExtendedCsdRevision16 = 6U,
 - kMMC_ExtendedCsdRevision17 = 7U }
 - MMC card Extended CSD fix version(EXT_CSD_REV in Extended CSD)*
- enum mmc_command_set_t {
 - kMMC_CommandSetStandard = 0U,
 - kMMC_CommandSet1 = 1U,
 - kMMC_CommandSet2 = 2U,
 - kMMC_CommandSet3 = 3U,
 - kMMC_CommandSet4 = 4U }
 - MMC card command set(COMMAND_SET in Extended CSD)*
- enum {
 - kMMC_SupportAlternateBoot = 1U,
 - kMMC_SupportDDRBoot = 2U,
 - kMMC_SupportHighSpeedBoot = 4U }
 - boot support(BOOT_INFO in Extended CSD)*
- enum mmc_high_speed_timing_t {
 - kMMC_HighSpeedTimingNone = 0U,
 - kMMC_HighSpeedTiming = 1U,
 - kMMC_HighSpeed200Timing = 2U,
 - kMMC_HighSpeed400Timing = 3U,
 - kMMC_EnhanceHighSpeed400Timing = 4U }
 - MMC card high-speed timing(HS_TIMING in Extended CSD)*
- enum mmc_data_bus_width_t {
 - kMMC_DataBusWidth1bit = 0U,
 - kMMC_DataBusWidth4bit = 1U,
 - kMMC_DataBusWidth8bit = 2U,
 - kMMC_DataBusWidth4bitDDR = 5U,
 - kMMC_DataBusWidth8bitDDR = 6U,
 - kMMC_DataBusWidth8bitDDRSTROBE = 0x86U }
 - MMC card data bus width(BUS_WIDTH in Extended CSD)*
- enum mmc_boot_partition_enable_t {

```

kMMC_BootPartitionEnableNot = 0U,
kMMC_BootPartitionEnablePartition1 = 1U,
kMMC_BootPartitionEnablePartition2 = 2U,
kMMC_BootPartitionEnableUserAera = 7U }

```

MMC card boot partition enabled(BOOT_PARTITION_ENABLE in Extended CSD)

- enum mmc_boot_timing_mode_t {

```

kMMC_BootModeSDRWithDefaultTiming = 0U,
kMMC_BootModeSDRWithHighSpeedTiming = 1U,
kMMC_BootModeDDRTiming = 2U }

```

boot mode configuration Note: HS200 & HS400 is not support during BOOT operation.

- enum mmc_boot_partition_wp_t {

```

kMMC_BootPartitionWPDisable = 0x50U,
kMMC_BootPartitionPwrWPToBothPartition,
kMMC_BootPartitionPermWPToBothPartition = 0x04U,
kMMC_BootPartitionPwrWPToPartition1 = (1U << 7U) | 1U,
kMMC_BootPartitionPwrWPToPartition2 = (1U << 7U) | 3U,
kMMC_BootPartitionPermWPToPartition1,
kMMC_BootPartitionPermWPToPartition2,
kMMC_BootPartitionPermWPToPartition1PwrWPToPartition2,
kMMC_BootPartitionPermWPToPartition2PwrWPToPartition1 }

```

MMC card boot partition write protect configurations All the bits in BOOT_WP register, except the two R/W bits B_PERM_WP_DIS and B_PERM_WP_EN, shall only be written once per power cycle. The protection mode intended for both boot areas will be set with a single write.

- enum {

```

kMMC_BootPartitionNotProtected = 0U,
kMMC_BootPartitionPwrProtected = 1U,
kMMC_BootPartitionPermProtected = 2U }

```

MMC card boot partition write protect status.

- enum mmc_access_partition_t {

```

kMMC_AccessPartitionUserAera = 0U,
kMMC_AccessPartitionBoot1 = 1U,
kMMC_AccessPartitionBoot2 = 2U,
kMMC_AccessRPMB = 3U,
kMMC_AccessGeneralPurposePartition1 = 4U,
kMMC_AccessGeneralPurposePartition2 = 5U,
kMMC_AccessGeneralPurposePartition3 = 6U,
kMMC_AccessGeneralPurposePartition4 = 7U }

```

MMC card partition to be accessed(BOOT_PARTITION_ACCESS in Extended CSD)

- enum {

```

kMMC_CsdReadBlockPartialFlag = (1U << 0U),
kMMC_CsdWriteBlockMisalignFlag = (1U << 1U),
kMMC_CsdReadBlockMisalignFlag = (1U << 2U),
kMMC_CsdDsrImplementedFlag = (1U << 3U),
kMMC_CsdWriteProtectGroupEnabledFlag = (1U << 4U),
kMMC_CsdWriteBlockPartialFlag = (1U << 5U),
kMMC_ContentProtectApplicationFlag = (1U << 6U),
kMMC_CsdFileFormatGroupFlag = (1U << 7U),
kMMC_CsdCopyFlag = (1U << 8U),
kMMC_CsdPermanentWriteProtectFlag = (1U << 9U),
kMMC_CsdTemporaryWriteProtectFlag = (1U << 10U) }

```

MMC card CSD register flags.

- enum mmc_extended_csd_access_mode_t {


```

kMMC_ExtendedCsdAccessModeCommandSet = 0U,
kMMC_ExtendedCsdAccessModeSetBits = 1U,
kMMC_ExtendedCsdAccessModeClearBits = 2U,
kMMC_ExtendedCsdAccessModeWriteBits = 3U }

```

Extended CSD register access mode(Access mode in CMD6).

- enum mmc_extended_csd_index_t {


```

kMMC_ExtendedCsdIndexFlushCache = 32U,
kMMC_ExtendedCsdIndexCacheControl = 33U,
kMMC_ExtendedCsdIndexBootPartitionWP = 173U,
kMMC_ExtendedCsdIndexEraseGroupDefinition = 175U,
kMMC_ExtendedCsdIndexBootBusConditions = 177U,
kMMC_ExtendedCsdIndexBootConfigWP = 178U,
kMMC_ExtendedCsdIndexPartitionConfig = 179U,
kMMC_ExtendedCsdIndexBusWidth = 183U,
kMMC_ExtendedCsdIndexHighSpeedTiming = 185U,
kMMC_ExtendedCsdIndexPowerClass = 187U,
kMMC_ExtendedCsdIndexCommandSet = 191U }

```

EXT CSD byte index.

- enum {


```

kMMC_DriverStrength0 = 0U,
kMMC_DriverStrength1 = 1U,
kMMC_DriverStrength2 = 2U,
kMMC_DriverStrength3 = 3U,
kMMC_DriverStrength4 = 4U }

```

mmc driver strength

- enum mmc_extended_csd_flags_t {


```

kMMC_ExtCsdExtPartitionSupport = (1 << 0U),
kMMC_ExtCsdEnhancePartitionSupport = (1 << 1U),
kMMC_ExtCsdPartitioningSupport = (1 << 2U),
kMMC_ExtCsdPrgCIDCSDInDDRModesSupport = (1 << 3U),
kMMC_ExtCsdBKOpsSupport = (1 << 4U),
kMMC_ExtCsdDataTagSupport = (1 << 5U),
kMMC_ExtCsdModeOperationCodeSupport = (1 << 6U) }

```

- mmc extended csd flags*
- enum `mmc_boot_mode_t` {
`kMMC_BootModeNormal` = 0U,
`kMMC_BootModeAlternative` = 1U }
MMC card boot mode.

common function

tuning pattern

- `status_t SDMMC_SelectCard` (`sdmmchost_t *host`, `uint32_t relativeAddress`, `bool isSelected`)
Selects the card to put it into transfer state.
- `status_t SDMMC_SendApplicationCommand` (`sdmmchost_t *host`, `uint32_t relativeAddress`)
Sends an application command.
- `status_t SDMMC_SetBlockCount` (`sdmmchost_t *host`, `uint32_t blockCount`)
Sets the block count.
- `status_t SDMMC_GoIdle` (`sdmmchost_t *host`)
Sets the card to be idle state.
- `status_t SDMMC_SetBlockSize` (`sdmmchost_t *host`, `uint32_t blockSize`)
Sets data block size.
- `status_t SDMMC_SetCardInactive` (`sdmmchost_t *host`)
Sets card to inactive status.

52.7.2 Data Structure Documentation

52.7.2.1 struct `sd_detect_card_t`

Data Fields

- `sd_detect_card_type_t` type
card detect type
- `uint32_t cdDebounce_ms`
card detect debounce delay ms
- `sd_cd_t` callback
card inserted callback which is meaningful for interrupt case
- `sd_cd_status_t` `cardDetected`
used to check sd cd status when card detect through GPIO
- `sd_dat3_pull_t` `dat3PullFunc`
function pointer of DATA3 pull up/down
- `void *` `userData`
user data

52.7.2.2 struct `sd_io_voltage_t`

Data Fields

- `sd_io_voltage_ctrl_type_t` type

- *io voltage switch type*
- `sd_io_voltage_func_t func`
io voltage switch function

52.7.2.3 struct `sd_usr_param_t`

Data Fields

- `sd_pwr_t pwr`
power control configuration pointer
- `uint32_t powerOnDelayMS`
power on delay time
- `uint32_t powerOffDelayMS`
power off delay time
- `sd_io_strength_t ioStrength`
swich sd io strength
- `sd_io_voltage_t * ioVoltage`
switch io voltage
- `sd_detect_card_t * cd`
card detect
- `uint32_t maxFreq`
board support maximum frequency
- `uint32_t capability`
board capability flag

52.7.2.4 struct `sdio_card_int_t`

Data Fields

- `void * userData`
user data
- `sdio_int_t cardInterrupt`
card int call back

52.7.2.5 struct `sdio_usr_param_t`

Data Fields

- `sd_pwr_t pwr`
power control configuration pointer
- `uint32_t powerOnDelayMS`
power on delay time
- `uint32_t powerOffDelayMS`
power off delay time
- `sd_io_strength_t ioStrength`
swich sd io strength
- `sd_io_voltage_t * ioVoltage`
switch io voltage

- `sd_detect_card_t * cd`
card detect
- `sdio_card_int_t * sdioInt`
card int
- `uint32_t maxFreq`
board support maximum frequency
- `uint32_t capability`
board capability flag

52.7.2.6 struct `sdio_fbr_t`

Data Fields

- `uint8_t flags`
current io flags
- `uint8_t ioStdFunctionCode`
current io standard function code
- `uint8_t ioExtFunctionCode`
current io extended function code
- `uint32_t ioPointerToCIS`
current io pointer to CIS
- `uint32_t ioPointerToCSA`
current io pointer to CSA
- `uint16_t ioBlockSize`
current io block size

52.7.2.7 struct `sdio_common_cis_t`

Data Fields

- `uint16_t mID`
manufacturer code
- `uint16_t mInfo`
manufacturer information
- `uint8_t funcID`
function ID
- `uint16_t fn0MaxBlkSize`
function 0 max block size
- `uint8_t maxTransSpeed`
max data transfer speed for all function

52.7.2.8 struct `sdio_func_cis_t`

Data Fields

- `uint8_t funcID`
function ID
- `uint8_t funcInfo`

- *function info*
- uint8_t [ioVersion](#)
level of application specification this io support
- uint32_t [cardPSN](#)
product serial number
- uint32_t [ioCSASize](#)
available CSA size for io
- uint8_t [ioCSAProperty](#)
CSA property.
- uint16_t [ioMaxBlockSize](#)
io max transfer data size
- uint32_t [ioOCR](#)
io ioeration condition
- uint8_t [ioOPMinPwr](#)
min current in operation mode
- uint8_t [ioOPAvgPwr](#)
average current in operation mode
- uint8_t [ioOPMaxPwr](#)
max current in operation mode
- uint8_t [ioSBMinPwr](#)
min current in standby mode
- uint8_t [ioSBAvgPwr](#)
average current in standby mode
- uint8_t [ioSBMaxPwr](#)
max current in standby mode
- uint16_t [ioMinBandWidth](#)
io min transfer bandwidth
- uint16_t [ioOptimumBandWidth](#)
io optimum transfer bandwidth
- uint16_t [ioReadyTimeout](#)
timeout value from enalbe to ready
- uint16_t [ioHighCurrentAvgCurrent](#)
*the average peak current (mA)
when IO operating in high current mode*
- uint16_t [ioHighCurrentMaxCurrent](#)
*the max peak current (mA)
when IO operating in high current mode*
- uint16_t [ioLowCurrentAvgCurrent](#)
*the average peak current (mA)
when IO operating in lower current mode*
- uint16_t [ioLowCurrentMaxCurrent](#)
*the max peak current (mA)
when IO operating in lower current mode*

52.7.2.9 struct sd_status_t

Data Fields

- uint8_t [busWidth](#)
current buswidth

- uint8_t `secureMode`
secured mode
- uint16_t `cardType`
sdcard type
- uint32_t `protectedSize`
size of protected area
- uint8_t `speedClass`
speed class of card
- uint8_t `performanceMove`
Performance of move indicated by 1[MB/S]step.
- uint8_t `auSize`
size of AU
- uint16_t `eraseSize`
number of AUs to be erased at a time
- uint8_t `eraseTimeout`
timeout value for erasing areas specified by UNIT OF ERASE AU
- uint8_t `eraseOffset`
fixed offset value added to erase time
- uint8_t `uhsSpeedGrade`
speed grade for UHS mode
- uint8_t `uhsAuSize`
size of AU for UHS mode

52.7.2.10 struct sd_cid_t

Data Fields

- uint8_t `manufacturerID`
Manufacturer ID [127:120].
- uint16_t `applicationID`
OEM/Application ID [119:104].
- uint8_t `productName` [`SD_PRODUCT_NAME_BYTES`]
Product name [103:64].
- uint8_t `productVersion`
Product revision [63:56].
- uint32_t `productSerialNumber`
Product serial number [55:24].
- uint16_t `manufacturerData`
Manufacturing date [19:8].

52.7.2.11 struct sd_csd_t

Data Fields

- uint8_t `csdStructure`
CSD structure [127:126].
- uint8_t `dataReadAccessTime1`
Data read access-time-1 [119:112].
- uint8_t `dataReadAccessTime2`

- *Data read access-time-2 in clock cycles (NSAC*100) [111:104].*
- uint8_t **transferSpeed**
Maximum data transfer rate [103:96].
- uint16_t **cardCommandClass**
Card command classes [95:84].
- uint8_t **readBlockLength**
Maximum read data block length [83:80].
- uint16_t **flags**
Flags in `_sd_csd_flag`.
- uint32_t **deviceSize**
Device size [73:62].
- uint8_t **readCurrentVddMin**
Maximum read current at VDD min [61:59].
- uint8_t **readCurrentVddMax**
Maximum read current at VDD max [58:56].
- uint8_t **writeCurrentVddMin**
Maximum write current at VDD min [55:53].
- uint8_t **writeCurrentVddMax**
Maximum write current at VDD max [52:50].
- uint8_t **deviceSizeMultiplier**
Device size multiplier [49:47].
- uint8_t **eraseSectorSize**
Erase sector size [45:39].
- uint8_t **writeProtectGroupSize**
Write protect group size [38:32].
- uint8_t **writeSpeedFactor**
Write speed factor [28:26].
- uint8_t **writeBlockLength**
Maximum write data block length [25:22].
- uint8_t **fileFormat**
File format [11:10].

52.7.2.12 struct sd_scr_t

Data Fields

- uint8_t **scrStructure**
SCR Structure [63:60].
- uint8_t **sdSpecification**
SD memory card specification version [59:56].
- uint16_t **flags**
SCR flags in `_sd_scr_flag`.
- uint8_t **sdSecurity**
Security specification supported [54:52].
- uint8_t **sdBusWidths**
Data bus widths supported [51:48].
- uint8_t **extendedSecurity**
Extended security support [46:43].
- uint8_t **commandSupport**
Command support bits [33:32] 33-support CMD23, 32-support cmd20.

- uint32_t `reservedForManufacturer`
reserved for manufacturer usage [31:0]

52.7.2.13 struct mmc_cid_t

Data Fields

- uint8_t `manufacturerID`
Manufacturer ID.
- uint16_t `applicationID`
OEM/Application ID.
- uint8_t `productName` [MMC_PRODUCT_NAME_BYTES]
Product name.
- uint8_t `productVersion`
Product revision.
- uint32_t `productSerialNumber`
Product serial number.
- uint8_t `manufacturerData`
Manufacturing date.

52.7.2.14 struct mmc_csd_t

Data Fields

- uint8_t `csdStructureVersion`
CSD structure [127:126].
- uint8_t `systemSpecificationVersion`
System specification version [125:122].
- uint8_t `dataReadAccessTime1`
Data read access-time 1 [119:112].
- uint8_t `dataReadAccessTime2`
*Data read access-time 2 in CLOCK cycles (NSAC*100) [111:104].*
- uint8_t `transferSpeed`
Max.
- uint16_t `cardCommandClass`
card command classes [95:84]
- uint8_t `readBlockLength`
Max.
- uint16_t `flags`
Contain flags in `_mmc_csd_flag`.
- uint16_t `deviceSize`
Device size [73:62].
- uint8_t `readCurrentVddMin`
Max.
- uint8_t `readCurrentVddMax`
Max.
- uint8_t `writeCurrentVddMin`
Max.
- uint8_t `writeCurrentVddMax`

- *Max.*
uint8_t [deviceSizeMultiplier](#)
Device size multiplier [49:47].
- uint8_t [eraseGroupSize](#)
Erase group size [46:42].
- uint8_t [eraseGroupSizeMultiplier](#)
Erase group size multiplier [41:37].
- uint8_t [writeProtectGroupSize](#)
Write protect group size [36:32].
- uint8_t [defaultEcc](#)
Manufacturer default ECC [30:29].
- uint8_t [writeSpeedFactor](#)
Write speed factor [28:26].
- uint8_t [maxWriteBlockLength](#)
Max.
- uint8_t [fileFormat](#)
File format [11:10].
- uint8_t [eccCode](#)
ECC code [9:8].

Field Documentation

(1) uint8_t mmc_csd_t::transferSpeed

bus clock frequency [103:96]

(2) uint8_t mmc_csd_t::readBlockLength

read data block length [83:80]

(3) uint8_t mmc_csd_t::readCurrentVddMin

read current @ VDD min [61:59]

(4) uint8_t mmc_csd_t::readCurrentVddMax

read current @ VDD max [58:56]

(5) uint8_t mmc_csd_t::writeCurrentVddMin

write current @ VDD min [55:53]

(6) uint8_t mmc_csd_t::writeCurrentVddMax

write current @ VDD max [52:50]

(7) uint8_t mmc_csd_t::maxWriteBlockLength

write data block length [25:22]

52.7.2.15 struct mmc_extended_csd_t

Data Fields

- uint8_t [cacheCtrl](#)
< secure removal type [16]
- uint8_t [partitionAttribute](#)
< power off notification [34]
- uint8_t [userWP](#)
< max enhance area size [159-157]
- uint8_t [bootPartitionWP](#)
boot write protect register [173]
- uint8_t [bootWPStatus](#)
boot write protect status register [174]
- uint8_t [highDensityEraseGroupDefinition](#)
High-density erase group definition [175].
- uint8_t [bootDataBusConditions](#)
Boot bus conditions [177].
- uint8_t [bootConfigProtect](#)
Boot config protection [178].
- uint8_t [partitionConfig](#)
Boot configuration [179].
- uint8_t [eraseMemoryContent](#)
Erased memory content [181].
- uint8_t [dataBusWidth](#)
Data bus width mode [183].
- uint8_t [highSpeedTiming](#)
High-speed interface timing [185].
- uint8_t [powerClass](#)
Power class [187].
- uint8_t [commandSetRevision](#)
Command set revision [189].
- uint8_t [commandSet](#)
Command set [191].
- uint8_t [extendedCsdVersion](#)
Extended CSD revision [192].
- uint8_t [csdStructureVersion](#)
CSD structure version [194].
- uint8_t [cardType](#)
Card Type [196].
- uint8_t [ioDriverStrength](#)
IO driver strength [197].
- uint8_t [partitionSwitchTimeout](#)
< out of interrupt busy timing [198]
- uint8_t [powerClass52MHz195V](#)
Power Class for 52MHz @ 1.95V [200].
- uint8_t [powerClass26MHz195V](#)
Power Class for 26MHz @ 1.95V [201].
- uint8_t [powerClass52MHz360V](#)
Power Class for 52MHz @ 3.6V [202].
- uint8_t [powerClass26MHz360V](#)

- *Power Class for 26MHz @ 3.6V [203].*
- uint8_t [minimumReadPerformance4Bit26MHz](#)
Minimum Read Performance for 4bit at 26MHz [205].
- uint8_t [minimumWritePerformance4Bit26MHz](#)
Minimum Write Performance for 4bit at 26MHz [206].
- uint8_t [minimumReadPerformance8Bit26MHz4Bit52MHz](#)
Minimum read Performance for 8bit at 26MHz/4bit @52MHz [207].
- uint8_t [minimumWritePerformance8Bit26MHz4Bit52MHz](#)
Minimum Write Performance for 8bit at 26MHz/4bit @52MHz [208].
- uint8_t [minimumReadPerformance8Bit52MHz](#)
Minimum Read Performance for 8bit at 52MHz [209].
- uint8_t [minimumWritePerformance8Bit52MHz](#)
Minimum Write Performance for 8bit at 52MHz [210].
- uint32_t [sectorCount](#)
Sector Count [215:212].
- uint8_t [sleepAwakeTimeout](#)
< sleep notification timeout [216]
- uint8_t [sleepCurrentVCCQ](#)
< Production state awareness timeout [218]
- uint8_t [sleepCurrentVCC](#)
Sleep current (VCC) [220].
- uint8_t [highCapacityWriteProtectGroupSize](#)
High-capacity write protect group size [221].
- uint8_t [reliableWriteSectorCount](#)
Reliable write sector count [222].
- uint8_t [highCapacityEraseTimeout](#)
High-capacity erase timeout [223].
- uint8_t [highCapacityEraseUnitSize](#)
High-capacity erase unit size [224].
- uint8_t [accessSize](#)
Access size [225].
- uint8_t [minReadPerformance8bitAt52MHZDDR](#)
< secure trim multiplier[229]
- uint8_t [minWritePerformance8bitAt52MHZDDR](#)
Minimum write performance for 8bit at DDR 52MHZ[235].
- uint8_t [powerClass200MHZVCCQ130VVCC360V](#)
power class for 200MHZ, at VCCQ= 1.3V,VCC=3.6V[236]
- uint8_t [powerClass200MHZVCCQ195VVCC360V](#)
power class for 200MHZ, at VCCQ= 1.95V,VCC=3.6V[237]
- uint8_t [powerClass52MHZDDR195V](#)
power class for 52MHZ,DDR at Vcc 1.95V[238]
- uint8_t [powerClass52MHZDDR360V](#)
power class for 52MHZ,DDR at Vcc 3.6V[239]
- uint32_t [genericCMD6Timeout](#)
< 1st initialization time after partitioning[241]
- uint32_t [cacheSize](#)
cache size[252-249]
- uint8_t [powerClass200MHZDDR360V](#)
power class for 200MHZ, DDR at VCC=2.6V[253]
- uint8_t [extPartitionSupport](#)
< fw VERSION [261-254]

- `uint8_t supportedCommandSet`
 < *large unit size*[495]

Field Documentation

(1) `uint8_t mmc_extended_csd_t::cacheCtrl`

- < product state awareness enablement[17]
- < max preload data size[21-18]
- < pre-load data size[25-22]
- < FFU status [26]
- < mode operation code[29]
- < mode config [30] control to turn on/off cache[33]

(2) `uint8_t mmc_extended_csd_t::partitionAttribute`

- < packed cmd fail index [35]
- < packed cmd status[36]
- < context configuration[51-37]
- < extended partitions attribut[53-52]
- < exception events status[55-54]
- < exception events control[57-56]
- < number of group to be released[58]
- < class 6 command control[59]
- < 1st initiallization after disabling sector size emu[60]
- < sector size[61]
- < sector size emulation[62]
- < native sector size[63]
- < period wakeup [131]
- < package case temperature is controlled[132]
- < production state awareness[133]
- < enhanced user data start addr [139-136]
- < enhanced user data area size[142-140]
- < general purpose partition size[154-143] partition attribute [156]

(3) `uint8_t mmc_extended_csd_t::userWP`

- < HPI management [161]

< write reliability parameter register[166]

< write reliability setting register[167]

< RPMB size multi [168]

< FW configuration[169] user write protect register[171]

(4) uint8_t mmc_extended_csd_t::partitionSwitchTimeout

partition switch timing [199]

(5) uint8_t mmc_extended_csd_t::sleepAwakeTimeout

Sleep/awake timeout [217]

(6) uint8_t mmc_extended_csd_t::sleepCurrentVCCQ

Sleep current (VCCQ) [219]

(7) uint8_t mmc_extended_csd_t::minReadPerformance8bitAt52MHZDDR

< secure erase multiplier[230]

< secure feature support[231]

< trim multiplier[232] Minimum read performance for 8bit at DDR 52MHZ[234]

(8) uint32_t mmc_extended_csd_t::genericCMD6Timeout

< correct prg sectors number[245-242]

< background operations status[246]

< power off notification timeout[247] generic CMD6 timeout[248]

(9) uint8_t mmc_extended_csd_t::extPartitionSupport

< device version[263-262]

< optimal trim size[264]

< optimal write size[265]

< optimal read size[266]

< pre EOL information[267]

< device life time estimation typeA[268]

< device life time estimation typeB[269]

< number of FW sectors correctly programmed[305-302]

< FFU argument[490-487]

< operation code timeout[491]

< support mode [493] extended partition attribute support[494]

(10) `uint8_t mmc_extended_csd_t::supportedCommandSet`

< context management capability[496]

< tag resource size[497]

< tag unit size[498]

< max packed write cmd[500]

< max packed read cmd[501]

< HPI feature[503] Supported Command Sets [504]

52.7.2.16 `struct mmc_extended_csd_config_t`

Data Fields

- `mmc_command_set_t` `commandSet`
Command set.
- `uint8_t` `ByteValue`
The value to set.
- `uint8_t` `ByteIndex`
The byte index in Extended CSD(`mmc_extended_csd_index_t`)
- `mmc_extended_csd_access_mode_t` `accessMode`
Access mode.

52.7.2.17 `struct mmc_boot_config_t`

Data Fields

- `mmc_boot_mode_t` `bootMode`
mmc boot mode
- `bool` `enableBootAck`
Enable boot ACK.
- `mmc_boot_partition_enable_t` `bootPartition`
Boot partition.
- `mmc_boot_timing_mode_t` `bootTimingMode`
boot mode
- `mmc_data_bus_width_t` `bootDataBusWidth`
Boot data bus width.
- `bool` `retainBootbusCondition`
If retain boot bus width and boot mode conditions.
- `bool` `pwrBootConfigProtection`
Disable the change of boot configuration register bits from at this point until next power cycle or next H/W reset operation
- `bool` `premBootConfigProtection`
Disable the change of boot configuration register bits permanently.
- `mmc_boot_partition_wp_t` `bootPartitionWP`

boot partition write protect configurations

52.7.3 Macro Definition Documentation

52.7.3.1 **#define SDMMC_LOG(*format*, ...)**

52.7.3.2 **#define READ_MMC_TRANSFER_SPEED_FREQUENCY_UNIT(*CSD*)** (((*(CSD).transferSpeed*) & MMC_TRANSFER_SPEED_FREQUENCY_UNIT_MASK) >> MMC_TRANSFER_SPEED_FREQUENCY_UNIT_SHIFT)

52.7.3.3 **#define READ_MMC_TRANSFER_SPEED_MULTIPLIER(*CSD*)** (((*(CSD).transferSpeed*) & MMC_TRANSFER_SPEED_MULTIPLIER_MASK) >> MMC_TRANSFER_SPEED_MULTIPLIER_SHIFT)

52.7.3.4 **#define MMC_EXTENDED_CSD_BYTES (512U)**

52.7.3.5 **#define SD_PRODUCT_NAME_BYTES (5U)**

52.7.3.6 **#define MMC_PRODUCT_NAME_BYTES (6U)**

52.7.3.7 **#define MMC_SWITCH_COMMAND_SET_SHIFT (0U)**

52.7.3.8 **#define MMC_SWITCH_COMMAND_SET_MASK (0x0000007U)**

52.7.4 Enumeration Type Documentation

52.7.4.1 anonymous enum

Enumerator

kStatus_SDMMC_NotSupportYet Haven't supported.
kStatus_SDMMC_TransferFailed Send command failed.
kStatus_SDMMC_SetCardBlockSizeFailed Set block size failed.
kStatus_SDMMC_HostNotSupport Host doesn't support.
kStatus_SDMMC_CardNotSupport Card doesn't support.
kStatus_SDMMC_AllSendCidFailed Send CID failed.
kStatus_SDMMC_SendRelativeAddressFailed Send relative address failed.
kStatus_SDMMC_SendCsdFailed Send CSD failed.
kStatus_SDMMC_SelectCardFailed Select card failed.
kStatus_SDMMC_SendScrFailed Send SCR failed.
kStatus_SDMMC_SetDataBusWidthFailed Set bus width failed.
kStatus_SDMMC_GoIdleFailed Go idle failed.
kStatus_SDMMC_HandShakeOperationConditionFailed Send Operation Condition failed.
kStatus_SDMMC_SendApplicationCommandFailed Send application command failed.

kStatus_SDMMC_SwitchFailed Switch command failed.
kStatus_SDMMC_StopTransmissionFailed Stop transmission failed.
kStatus_SDMMC_WaitWriteCompleteFailed Wait write complete failed.
kStatus_SDMMC_SetBlockCountFailed Set block count failed.
kStatus_SDMMC_SetRelativeAddressFailed Set relative address failed.
kStatus_SDMMC_SwitchBusTimingFailed Switch high speed failed.
kStatus_SDMMC_SendExtendedCsdFailed Send EXT_CSD failed.
kStatus_SDMMC_ConfigureBootFailed Configure boot failed.
kStatus_SDMMC_ConfigureExtendedCsdFailed Configure EXT_CSD failed.
kStatus_SDMMC_EnableHighCapacityEraseFailed Enable high capacity erase failed.
kStatus_SDMMC_SendTestPatternFailed Send test pattern failed.
kStatus_SDMMC_ReceiveTestPatternFailed Receive test pattern failed.
kStatus_SDMMC_SDIO_ResponseError sdio response error
kStatus_SDMMC_SDIO_InvalidArgument sdio invalid argument response error
kStatus_SDMMC_SDIO_SendOperationConditionFail sdio send operation condition fail
kStatus_SDMMC_InvalidVoltage invaild voltage
kStatus_SDMMC_SDIO_SwitchHighSpeedFail switch to high speed fail
kStatus_SDMMC_SDIO_ReadCISFail read CIS fail
kStatus_SDMMC_SDIO_InvalidCard invaild SDIO card
kStatus_SDMMC_TuningFail tuning fail
kStatus_SDMMC_SwitchVoltageFail switch voltage fail
kStatus_SDMMC_SwitchVoltage18VFail33VSuccess switch voltage fail
kStatus_SDMMC_ReTuningRequest retuning request
kStatus_SDMMC_SetDriverStrengthFail set driver strength fail
kStatus_SDMMC_SetPowerClassFail set power class fail
kStatus_SDMMC_HostNotReady host controller not ready
kStatus_SDMMC_CardDetectFailed card detect failed
kStatus_SDMMC_AuSizeNotSetProperly AU size not set properly.
kStatus_SDMMC_PollingCardIdleFailed polling card idle status failed
kStatus_SDMMC_DeselectCardFailed deselect card failed
kStatus_SDMMC_CardStatusIdle card idle
kStatus_SDMMC_CardStatusBusy card busy
kStatus_SDMMC_CardInitFailed card init failed

52.7.4.2 anonymous enum

Enumerator

kSDMMC_SignalLineCmd cmd line
kSDMMC_SignalLineData0 data line
kSDMMC_SignalLineData1 data line
kSDMMC_SignalLineData2 data line
kSDMMC_SignalLineData3 data line
kSDMMC_SignalLineData4 data line
kSDMMC_SignalLineData5 data line

kSDMMC_SignalLineData6 data line
kSDMMC_SignalLineData7 data line

52.7.4.3 enum sdmmc_operation_voltage_t

Enumerator

kSDMMC_OperationVoltageNone indicate current voltage setting is not setting by suser
kSDMMC_OperationVoltage330V card operation voltage around 3.3v
kSDMMC_OperationVoltage300V card operation voltage around 3.0v
kSDMMC_OperationVoltage180V card operation voltage around 1.8v

52.7.4.4 anonymous enum

Enumerator

kSDMMC_BusWdith1Bit card bus 1 width
kSDMMC_BusWdith4Bit card bus 4 width
kSDMMC_BusWdith8Bit card bus 8 width

52.7.4.5 anonymous enum

Enumerator

kSDMMC_Support8BitWidth 8 bit data width capability

52.7.4.6 anonymous enum

Enumerator

kSDMMC_DataPacketFormatLSBFirst usual data packet format LSB first, MSB last
kSDMMC_DataPacketFormatMSBFirst Wide width data packet format MSB first, LSB last.

52.7.4.7 enum sd_detect_card_type_t

Enumerator

kSD_DetectCardByGpioCD sd card detect by CD pin through GPIO
kSD_DetectCardByHostCD sd card detect by CD pin through host
kSD_DetectCardByHostDATA3 sd card detect by DAT3 pin through host

52.7.4.8 anonymous enum

Enumerator

kSD_Inserted card is inserted
kSD_Removed card is removed

52.7.4.9 anonymous enum

Enumerator

kSD_DAT3PullDown data3 pull down
kSD_DAT3PullUp data3 pull up

52.7.4.10 enum sd_io_voltage_ctrl_type_t

Enumerator

kSD_IOVoltageCtrlNotSupport io voltage control not support
kSD_IOVoltageCtrlByHost io voltage control by host
kSD_IOVoltageCtrlByGpio io voltage control by gpio

52.7.4.11 anonymous enum

Enumerator

kSDMMC_R1OutOfRangeFlag Out of range status bit.
kSDMMC_R1AddressErrorFlag Address error status bit.
kSDMMC_R1BlockLengthErrorFlag Block length error status bit.
kSDMMC_R1EraseSequenceErrorFlag Erase sequence error status bit.
kSDMMC_R1EraseParameterErrorFlag Erase parameter error status bit.
kSDMMC_R1WriteProtectViolationFlag Write protection violation status bit.
kSDMMC_R1CardIsLockedFlag Card locked status bit.
kSDMMC_R1LockUnlockFailedFlag lock/unlock error status bit
kSDMMC_R1CommandCrcErrorFlag CRC error status bit.
kSDMMC_R1IllegalCommandFlag Illegal command status bit.
kSDMMC_R1CardEccFailedFlag Card ecc error status bit.
kSDMMC_R1CardControllerErrorFlag Internal card controller error status bit.
kSDMMC_R1ErrorFlag A general or an unknown error status bit.
kSDMMC_R1CidCsdOverwriteFlag Cid/csd overwrite status bit.
kSDMMC_R1WriteProtectEraseSkipFlag Write protection erase skip status bit.
kSDMMC_R1CardEccDisabledFlag Card ecc disabled status bit.
kSDMMC_R1EraseResetFlag Erase reset status bit.
kSDMMC_R1ReadyForDataFlag Ready for data status bit.
kSDMMC_R1SwitchErrorFlag Switch error status bit.

kSDMMC_R1ApplicationCommandFlag Application command enabled status bit.

kSDMMC_R1AuthenticationSequenceErrorFlag error in the sequence of authentication process

52.7.4.12 enum sdmmc_r1_current_state_t

Enumerator

kSDMMC_R1StateIdle R1: current state: idle.

kSDMMC_R1StateReady R1: current state: ready.

kSDMMC_R1StateIdentify R1: current state: identification.

kSDMMC_R1StateStandby R1: current state: standby.

kSDMMC_R1StateTransfer R1: current state: transfer.

kSDMMC_R1StateSendData R1: current state: sending data.

kSDMMC_R1StateReceiveData R1: current state: receiving data.

kSDMMC_R1StateProgram R1: current state: programming.

kSDMMC_R1StateDisconnect R1: current state: disconnect.

52.7.4.13 anonymous enum

Enumerator

kSDSPI_R1InIdleStateFlag In idle state.

kSDSPI_R1EraseResetFlag Erase reset.

kSDSPI_R1IllegalCommandFlag Illegal command.

kSDSPI_R1CommandCrcErrorFlag Com crc error.

kSDSPI_R1EraseSequenceErrorFlag Erase sequence error.

kSDSPI_R1AddressErrorFlag Address error.

kSDSPI_R1ParameterErrorFlag Parameter error.

52.7.4.14 anonymous enum

Enumerator

kSDSPI_R2CardLockedFlag Card is locked.

kSDSPI_R2WriteProtectEraseSkip Write protect erase skip.

kSDSPI_R2LockUnlockFailed Lock/unlock command failed.

kSDSPI_R2ErrorFlag Unknown error.

kSDSPI_R2CardControllerErrorFlag Card controller error.

kSDSPI_R2CardEccFailedFlag Card ecc failed.

kSDSPI_R2WriteProtectViolationFlag Write protect violation.

kSDSPI_R2EraseParameterErrorFlag Erase parameter error.

kSDSPI_R2OutOfRangeFlag Out of range.

kSDSPI_R2CsdOverwriteFlag CSD overwrite.

52.7.4.15 anonymous enum

Enumerator

kSDSPI_DataErrorTokenError Data error.
kSDSPI_DataErrorTokenCardControllerError Card controller error.
kSDSPI_DataErrorTokenCardEccFailed Card ecc error.
kSDSPI_DataErrorTokenOutOfRange Out of range.

52.7.4.16 enum sdspi_data_token_t

Enumerator

kSDSPI_DataTokenBlockRead Single block read, multiple block read.
kSDSPI_DataTokenSingleBlockWrite Single block write.
kSDSPI_DataTokenMultipleBlockWrite Multiple block write.
kSDSPI_DataTokenStopTransfer Stop transmission.

52.7.4.17 enum sdspi_data_response_token_t

Enumerator

kSDSPI_DataResponseTokenAccepted Data accepted.
kSDSPI_DataResponseTokenCrcError Data rejected due to CRC error.
kSDSPI_DataResponseTokenWriteError Data rejected due to write error.

52.7.4.18 enum sd_command_t

Enumerator

kSD_SendRelativeAddress Send Relative Address.
kSD_Switch Switch Function.
kSD_SendInterfaceCondition Send Interface Condition.
kSD_VoltageSwitch Voltage Switch.
kSD_SpeedClassControl Speed Class control.
kSD_EraseWriteBlockStart Write Block Start.
kSD_EraseWriteBlockEnd Write Block End.
kSD_SendTuningBlock Send Tuning Block.

52.7.4.19 enum sdspi_command_t

Enumerator

kSDSPI_CommandCrc Command crc protection on/off.

52.7.4.20 enum sd_application_command_t

Enumerator

kSD_ApplicationSetBusWdith Set Bus Width.
kSD_ApplicationStatus Send SD status.
kSD_ApplicationSendNumberWriteBlocks Send Number Of Written Blocks.
kSD_ApplicationSetWriteBlockEraseCount Set Write Block Erase Count.
kSD_ApplicationSendOperationCondition Send Operation Condition.
kSD_ApplicationSetClearCardDetect Set Connect/Disconnect pull up on detect pin.
kSD_ApplicationSendScr Send Scr.

52.7.4.21 anonymous enum

Enumerator

kSDMMC_CommandClassBasic Card command class 0.
kSDMMC_CommandClassBlockRead Card command class 2.
kSDMMC_CommandClassBlockWrite Card command class 4.
kSDMMC_CommandClassErase Card command class 5.
kSDMMC_CommandClassWriteProtect Card command class 6.
kSDMMC_CommandClassLockCard Card command class 7.
kSDMMC_CommandClassApplicationSpecific Card command class 8.
kSDMMC_CommandClassInputOutputMode Card command class 9.
kSDMMC_CommandClassSwitch Card command class 10.

52.7.4.22 anonymous enum

Enumerator

kSD_OcrPowerUpBusyFlag Power up busy status.
kSD_OcrHostCapacitySupportFlag Card capacity status.
kSD_OcrCardCapacitySupportFlag Card capacity status.
kSD_OcrSwitch18RequestFlag Switch to 1.8V request.
kSD_OcrSwitch18AcceptFlag Switch to 1.8V accepted.
kSD_OcrVdd27_28Flag VDD 2.7-2.8.
kSD_OcrVdd28_29Flag VDD 2.8-2.9.
kSD_OcrVdd29_30Flag VDD 2.9-3.0.
kSD_OcrVdd30_31Flag VDD 2.9-3.0.
kSD_OcrVdd31_32Flag VDD 3.0-3.1.
kSD_OcrVdd32_33Flag VDD 3.1-3.2.
kSD_OcrVdd33_34Flag VDD 3.2-3.3.
kSD_OcrVdd34_35Flag VDD 3.3-3.4.
kSD_OcrVdd35_36Flag VDD 3.4-3.5.

52.7.4.23 anonymous enum

Enumerator

- kSD_SpecificationVersion1_0* SD card version 1.0-1.01.
- kSD_SpecificationVersion1_1* SD card version 1.10.
- kSD_SpecificationVersion2_0* SD card version 2.00.
- kSD_SpecificationVersion3_0* SD card version 3.0.

52.7.4.24 enum sd_switch_mode_t

Enumerator

- kSD_SwitchCheck* SD switch mode 0: check function.
- kSD_SwitchSet* SD switch mode 1: set function.

52.7.4.25 anonymous enum

Enumerator

- kSD_CsdReadBlockPartialFlag* Partial blocks for read allowed [79:79].
- kSD_CsdWriteBlockMisalignFlag* Write block misalignment [78:78].
- kSD_CsdReadBlockMisalignFlag* Read block misalignment [77:77].
- kSD_CsdDsrImplementedFlag* DSR implemented [76:76].
- kSD_CsdEraseBlockEnabledFlag* Erase single block enabled [46:46].
- kSD_CsdWriteProtectGroupEnabledFlag* Write protect group enabled [31:31].
- kSD_CsdWriteBlockPartialFlag* Partial blocks for write allowed [21:21].
- kSD_CsdFileFormatGroupFlag* File format group [15:15].
- kSD_CsdCopyFlag* Copy flag [14:14].
- kSD_CsdPermanentWriteProtectFlag* Permanent write protection [13:13].
- kSD_CsdTemporaryWriteProtectFlag* Temporary write protection [12:12].

52.7.4.26 anonymous enum

Enumerator

- kSD_ScrDataStatusAfterErase* Data status after erases [55:55].
- kSD_ScrSdSpecification3* Specification version 3.00 or higher [47:47].

52.7.4.27 anonymous enum

Enumerator

- kSD_FunctionSDR12Deafult* SDR12 mode & default.
- kSD_FunctionSDR25HighSpeed* SDR25 & high speed.

kSD_FunctionSDR50 SDR50 mode.
kSD_FunctionSDR104 SDR104 mode.
kSD_FunctionDDR50 DDR50 mode.

52.7.4.28 anonymous enum

Enumerator

kSD_GroupTimingMode access mode group
kSD_GroupCommandSystem command system group
kSD_GroupDriverStrength driver strength group
kSD_GroupCurrentLimit current limit group

52.7.4.29 enum sd_timing_mode_t

Enumerator

kSD_TimingSDR12DefaultMode Identification mode & SDR12.
kSD_TimingSDR25HighSpeedMode High speed mode & SDR25.
kSD_TimingSDR50Mode SDR50 mode.
kSD_TimingSDR104Mode SDR104 mode.
kSD_TimingDDR50Mode DDR50 mode.

52.7.4.30 enum sd_driver_strength_t

Enumerator

kSD_DriverStrengthTypeB default driver strength
kSD_DriverStrengthTypeA driver strength TYPE A
kSD_DriverStrengthTypeC driver strength TYPE C
kSD_DriverStrengthTypeD driver strength TYPE D

52.7.4.31 enum sd_max_current_t

Enumerator

kSD_CurrentLimit200MA default current limit
kSD_CurrentLimit400MA current limit to 400MA
kSD_CurrentLimit600MA current limit to 600MA
kSD_CurrentLimit800MA current limit to 800MA

52.7.4.32 enum sdmmc_command_t

Enumerator

kSDMMC_GoIdleState Go Idle State.
kSDMMC_AllSendCid All Send CID.
kSDMMC_SetDsr Set DSR.
kSDMMC_SelectCard Select Card.
kSDMMC_SendCsd Send CSD.
kSDMMC_SendCid Send CID.
kSDMMC_StopTransmission Stop Transmission.
kSDMMC_SendStatus Send Status.
kSDMMC_GoInactiveState Go Inactive State.
kSDMMC_SetBlockLength Set Block Length.
kSDMMC_ReadSingleBlock Read Single Block.
kSDMMC_ReadMultipleBlock Read Multiple Block.
kSDMMC_SetBlockCount Set Block Count.
kSDMMC_WriteSingleBlock Write Single Block.
kSDMMC_WriteMultipleBlock Write Multiple Block.
kSDMMC_ProgramCsd Program CSD.
kSDMMC_SetWriteProtect Set Write Protect.
kSDMMC_ClearWriteProtect Clear Write Protect.
kSDMMC_SendWriteProtect Send Write Protect.
kSDMMC_Erase Erase.
kSDMMC_LockUnlock Lock Unlock.
kSDMMC_ApplicationCommand Send Application Command.
kSDMMC_GeneralCommand General Purpose Command.
kSDMMC_ReadOcr Read OCR.

52.7.4.33 anonymous enum

Enumerator

kSDIO_RegCCCRSdioVer CCCR & SDIO version.
kSDIO_RegSDVersion SD version.
kSDIO_RegIOEnable io enable register
kSDIO_RegIOReady io ready register
kSDIO_RegIOIntEnable io interrupt enable register
kSDIO_RegIOIntPending io interrupt pending register
kSDIO_RegIOAbort io abort register
kSDIO_RegBusInterface bus interface register
kSDIO_RegCardCapability card capability register
kSDIO_RegCommonCISPointer common CIS pointer register
kSDIO_RegBusSuspend bus suspend register
kSDIO_RegFunctionSelect function select register
kSDIO_RegExecutionFlag execution flag register

kSDIO_RegReadyFlag ready flag register
kSDIO_RegFN0BlockSizeLow FN0 block size register.
kSDIO_RegFN0BlockSizeHigh FN0 block size register.
kSDIO_RegPowerControl power control register
kSDIO_RegBusSpeed bus speed register
kSDIO_RegUHSITimingSupport UHS-I timing support register.
kSDIO_RegDriverStrength Driver strength register.
kSDIO_RegInterruptExtension Interrupt extension register.

52.7.4.34 enum sdio_command_t

Enumerator

kSDIO_SendRelativeAddress send relative address
kSDIO_SendOperationCondition send operation condition
kSDIO_SendInterfaceCondition send interface condition
kSDIO_RWIODirect read/write IO direct command
kSDIO_RWIOExtended read/write IO extended command

52.7.4.35 enum sdio_func_num_t

Enumerator

kSDIO_FunctionNum0 sdio function0
kSDIO_FunctionNum1 sdio function1
kSDIO_FunctionNum2 sdio function2
kSDIO_FunctionNum3 sdio function3
kSDIO_FunctionNum4 sdio function4
kSDIO_FunctionNum5 sdio function5
kSDIO_FunctionNum6 sdio function6
kSDIO_FunctionNum7 sdio function7
kSDIO_FunctionMemory for combo card

52.7.4.36 anonymous enum

Enumerator

kSDIO_StatusCmdCRCError the CRC check of the previous cmd fail
kSDIO_StatusIllegalCmd cmd illegal for the card state
kSDIO_StatusR6Error special for R6 error status
kSDIO_StatusError A general or an unknown error occurred.
kSDIO_StatusFunctionNumError inval function error
kSDIO_StatusOutOfRange cmd argument was out of the allowed range

52.7.4.37 anonymous enum

Enumerator

kSDIO_OcrPowerUpBusyFlag Power up busy status.
kSDIO_OcrIONumber number of IO function
kSDIO_OcrMemPresent memory present flag
kSDIO_OcrVdd20_21Flag VDD 2.0-2.1.
kSDIO_OcrVdd21_22Flag VDD 2.1-2.2.
kSDIO_OcrVdd22_23Flag VDD 2.2-2.3.
kSDIO_OcrVdd23_24Flag VDD 2.3-2.4.
kSDIO_OcrVdd24_25Flag VDD 2.4-2.5.
kSDIO_OcrVdd25_26Flag VDD 2.5-2.6.
kSDIO_OcrVdd26_27Flag VDD 2.6-2.7.
kSDIO_OcrVdd27_28Flag VDD 2.7-2.8.
kSDIO_OcrVdd28_29Flag VDD 2.8-2.9.
kSDIO_OcrVdd29_30Flag VDD 2.9-3.0.
kSDIO_OcrVdd30_31Flag VDD 2.9-3.0.
kSDIO_OcrVdd31_32Flag VDD 3.0-3.1.
kSDIO_OcrVdd32_33Flag VDD 3.1-3.2.
kSDIO_OcrVdd33_34Flag VDD 3.2-3.3.
kSDIO_OcrVdd34_35Flag VDD 3.3-3.4.
kSDIO_OcrVdd35_36Flag VDD 3.4-3.5.

52.7.4.38 anonymous enum

Enumerator

kSDIO_CCCRSupportDirectCmdDuringDataTrans support direct cmd during data transfer
kSDIO_CCCRSupportMultiBlock support multi block mode
kSDIO_CCCRSupportReadWait support read wait
kSDIO_CCCRSupportSuspendResume support suspend resume
kSDIO_CCCRSupportIntDuring4BitDataTrans support interrupt during 4-bit data transfer
kSDIO_CCCRSupportLowSpeed1Bit support low speed 1bit mode
kSDIO_CCCRSupportLowSpeed4Bit support low speed 4bit mode
kSDIO_CCCRSupportMasterPowerControl support master power control
kSDIO_CCCRSupportHighSpeed support high speed
kSDIO_CCCRSupportContinuousSPIInt support continuous SPI interrupt

52.7.4.39 anonymous enum

Enumerator

kSDIO_FBRSupportCSA function support CSA
kSDIO_FBRSupportPowerSelection function support power selection

52.7.4.40 enum sdio_bus_width_t

Enumerator

kSDIO_DataBus1Bit 1 bit bus mode
kSDIO_DataBus4Bit 4 bit bus mode
kSDIO_DataBus8Bit 8 bit bus mode

52.7.4.41 enum mmc_command_t

Enumerator

kMMC_SendOperationCondition Send Operation Condition.
kMMC_SetRelativeAddress Set Relative Address.
kMMC_SleepAwake Sleep Awake.
kMMC_Switch Switch.
kMMC_SendExtendedCsd Send EXT_CSD.
kMMC_ReadDataUntilStop Read Data Until Stop.
kMMC_BusTestRead Test Read.
kMMC_SendingBusTest test bus width cmd
kMMC_WriteDataUntilStop Write Data Until Stop.
kMMC_SendTuningBlock MMC sending tuning block.
kMMC_ProgramCid Program CID.
kMMC_EraseGroupStart Erase Group Start.
kMMC_EraseGroupEnd Erase Group End.
kMMC_FastInputOutput Fast IO.
kMMC_GoInterruptState Go interrupt State.

52.7.4.42 enum mmc_classified_voltage_t

Enumerator

kMMC_ClassifiedVoltageHigh High-voltage MMC card.
kMMC_ClassifiedVoltageDual Dual-voltage MMC card.

52.7.4.43 enum mmc_classified_density_t

Enumerator

kMMC_ClassifiedDensityWithin2GB Density byte is less than or equal 2GB.

52.7.4.44 enum mmc_access_mode_t

Enumerator

- kMMC_AccessModeByte* The card should be accessed as byte.
- kMMC_AccessModeSector* The card should be accessed as sector.

52.7.4.45 enum mmc_voltage_window_t

Enumerator

- kMMC_VoltageWindowNone* voltage window is not define by user
- kMMC_VoltageWindow120* Voltage window is 1.20V.
- kMMC_VoltageWindow170to195* Voltage window is 1.70V to 1.95V.
- kMMC_VoltageWindows270to360* Voltage window is 2.70V to 3.60V.

52.7.4.46 enum mmc_csd_structure_version_t

Enumerator

- kMMC_CsdStrucureVersion10* CSD version No. 1.0
- kMMC_CsdStrucureVersion11* CSD version No. 1.1
- kMMC_CsdStrucureVersion12* CSD version No. 1.2
- kMMC_CsdStrucureVersionInExtcsd* Version coded in Extended CSD.

52.7.4.47 enum mmc_specification_version_t

Enumerator

- kMMC_SpecificationVersion0* Allocated by MMCA.
- kMMC_SpecificationVersion1* Allocated by MMCA.
- kMMC_SpecificationVersion2* Allocated by MMCA.
- kMMC_SpecificationVersion3* Allocated by MMCA.
- kMMC_SpecificationVersion4* Version 4.1/4.2/4.3/4.41-4.5-4.51-5.0.

52.7.4.48 anonymous enum

Enumerator

- kMMC_ExtendedCsdRevision10* Revision 1.0.
- kMMC_ExtendedCsdRevision11* Revision 1.1.
- kMMC_ExtendedCsdRevision12* Revision 1.2.
- kMMC_ExtendedCsdRevision13* Revision 1.3 MMC4.3.
- kMMC_ExtendedCsdRevision14* Revision 1.4 obsolete.

kMMC_ExtendedCsdRevision15 Revision 1.5 MMC4.41.
kMMC_ExtendedCsdRevision16 Revision 1.6 MMC4.5.
kMMC_ExtendedCsdRevision17 Revision 1.7 MMC5.0.

52.7.4.49 enum mmc_command_set_t

Enumerator

kMMC_CommandSetStandard Standard MMC.
kMMC_CommandSet1 Command set 1.
kMMC_CommandSet2 Command set 2.
kMMC_CommandSet3 Command set 3.
kMMC_CommandSet4 Command set 4.

52.7.4.50 anonymous enum

Enumerator

kMMC_SupportAlternateBoot support alternative boot mode
kMMC_SupportDDRBoot support DDR boot mode
kMMC_SupportHighSpeedBoot support high speed boot mode

52.7.4.51 enum mmc_high_speed_timing_t

Enumerator

kMMC_HighSpeedTimingNone MMC card using none high-speed timing.
kMMC_HighSpeedTiming MMC card using high-speed timing.
kMMC_HighSpeed200Timing MMC card high speed 200 timing.
kMMC_HighSpeed400Timing MMC card high speed 400 timing.
kMMC_EnhanceHighSpeed400Timing MMC card high speed 400 timing.

52.7.4.52 enum mmc_data_bus_width_t

Enumerator

kMMC_DataBusWidth1bit MMC data bus width is 1 bit.
kMMC_DataBusWidth4bit MMC data bus width is 4 bits.
kMMC_DataBusWidth8bit MMC data bus width is 8 bits.
kMMC_DataBusWidth4bitDDR MMC data bus width is 4 bits ddr.
kMMC_DataBusWidth8bitDDR MMC data bus width is 8 bits ddr.
kMMC_DataBusWidth8bitDDRSTROBE MMC data bus width is 8 bits ddr strobe mode.

52.7.4.53 enum mmc_boot_partition_enable_t

Enumerator

- kMMC_BootPartitionEnableNot* Device not boot enabled (default)
- kMMC_BootPartitionEnablePartition1* Boot partition 1 enabled for boot.
- kMMC_BootPartitionEnablePartition2* Boot partition 2 enabled for boot.
- kMMC_BootPartitionEnableUserAera* User area enabled for boot.

52.7.4.54 enum mmc_boot_timing_mode_t

Enumerator

- kMMC_BootModeSDRWithDefaultTiming* boot mode single data rate with backward compatible timings
- kMMC_BootModeSDRWithHighSpeedTiming* boot mode single data rate with high speed timing
- kMMC_BootModeDDRTiming* boot mode dual data rate

52.7.4.55 enum mmc_boot_partition_wp_t

Enumerator

- kMMC_BootPartitionWPDisable* boot partition write protection disable
- kMMC_BootPartitionPwrWPToBothPartition* power on period write protection apply to both boot partitions
- kMMC_BootPartitionPermWPToBothPartition* permanent write protection apply to both boot partitions
- kMMC_BootPartitionPwrWPToPartition1* power on period write protection apply to partition1
- kMMC_BootPartitionPwrWPToPartition2* power on period write protection apply to partition2
- kMMC_BootPartitionPermWPToPartition1* permanent write protection apply to partition1
- kMMC_BootPartitionPermWPToPartition2* permanent write protection apply to partition2
- kMMC_BootPartitionPermWPToPartition1PwrWPToPartition2* permanent write protection apply to partition1, power on period write protection apply to partition2
- kMMC_BootPartitionPermWPToPartition2PwrWPToPartition1* permanent write protection apply to partition2, power on period write protection apply to partition1

52.7.4.56 anonymous enum

Enumerator

- kMMC_BootPartitionNotProtected* boot partition not protected
- kMMC_BootPartitionPwrProtected* boot partition is power on period write protected
- kMMC_BootPartitionPermProtected* boot partition is permanently protected

52.7.4.57 enum mmc_access_partition_t

Enumerator

- kMMC_AccessPartitionUserAera* No access to boot partition (default), normal partition.
- kMMC_AccessPartitionBoot1* Read/Write boot partition 1.
- kMMC_AccessPartitionBoot2* Read/Write boot partition 2.
- kMMC_AccessRPMB* Replay protected mem block.
- kMMC_AccessGeneralPurposePartition1* access to general purpose partition 1
- kMMC_AccessGeneralPurposePartition2* access to general purpose partition 2
- kMMC_AccessGeneralPurposePartition3* access to general purpose partition 3
- kMMC_AccessGeneralPurposePartition4* access to general purpose partition 4

52.7.4.58 anonymous enum

Enumerator

- kMMC_CsdReadBlockPartialFlag* Partial blocks for read allowed.
- kMMC_CsdWriteBlockMisalignFlag* Write block misalignment.
- kMMC_CsdReadBlockMisalignFlag* Read block misalignment.
- kMMC_CsdDsrImplementedFlag* DSR implemented.
- kMMC_CsdWriteProtectGroupEnabledFlag* Write protect group enabled.
- kMMC_CsdWriteBlockPartialFlag* Partial blocks for write allowed.
- kMMC_ContentProtectApplicationFlag* Content protect application.
- kMMC_CsdFileFormatGroupFlag* File format group.
- kMMC_CsdCopyFlag* Copy flag.
- kMMC_CsdPermanentWriteProtectFlag* Permanent write protection.
- kMMC_CsdTemporaryWriteProtectFlag* Temporary write protection.

52.7.4.59 enum mmc_extended_csd_access_mode_t

Enumerator

- kMMC_ExtendedCsdAccessModeCommandSet* Command set related setting.
- kMMC_ExtendedCsdAccessModeSetBits* Set bits in specific byte in Extended CSD.
- kMMC_ExtendedCsdAccessModeClearBits* Clear bits in specific byte in Extended CSD.
- kMMC_ExtendedCsdAccessModeWriteBits* Write a value to specific byte in Extended CSD.

52.7.4.60 enum mmc_extended_csd_index_t

Enumerator

- kMMC_ExtendedCsdIndexFlushCache* flush cache
- kMMC_ExtendedCsdIndexCacheControl* cache control

kMMC_ExtendedCsdIndexBootPartitionWP Boot partition write protect.
kMMC_ExtendedCsdIndexEraseGroupDefinition Erase Group Def.
kMMC_ExtendedCsdIndexBootBusConditions Boot Bus conditions.
kMMC_ExtendedCsdIndexBootConfigWP Boot config write protect.
kMMC_ExtendedCsdIndexPartitionConfig Partition Config, before BOOT_CONFIG.
kMMC_ExtendedCsdIndexBusWidth Bus Width.
kMMC_ExtendedCsdIndexHighSpeedTiming High-speed Timing.
kMMC_ExtendedCsdIndexPowerClass Power Class.
kMMC_ExtendedCsdIndexCommandSet Command Set.

52.7.4.61 anonymous enum

Enumerator

kMMC_DriverStrength0 Driver type0 ,nominal impedance 50ohm.
kMMC_DriverStrength1 Driver type1 ,nominal impedance 33ohm.
kMMC_DriverStrength2 Driver type2 ,nominal impedance 66ohm.
kMMC_DriverStrength3 Driver type3 ,nominal impedance 100ohm.
kMMC_DriverStrength4 Driver type4 ,nominal impedance 40ohm.

52.7.4.62 enum mmc_extended_csd_flags_t

Enumerator

kMMC_ExtCsdExtPartitionSupport partitioning support[160]
kMMC_ExtCsdEnhancePartitionSupport partitioning support[160]
kMMC_ExtCsdPartitioningSupport partitioning support[160]
kMMC_ExtCsdPrgCIDCSDInDDRModesSupport CMD26 and CMD27 are support dual data rate [130].
kMMC_ExtCsdBKOpsSupport background operation feature support [502]
kMMC_ExtCsdDataTagSupport data tag support[499]
kMMC_ExtCsdModeOperationCodeSupport mode operation code support[493]

52.7.4.63 enum mmc_boot_mode_t

Enumerator

kMMC_BootModeNormal Normal boot.
kMMC_BootModeAlternative Alternative boot.

52.7.5 Function Documentation

52.7.5.1 `status_t SDMMC_SelectCard (sdrmmchost_t * host, uint32_t relativeAddress, bool isSelected)`

Parameters

<i>host</i>	host handler.
<i>relativeAddress</i>	Relative address.
<i>isSelected</i>	True to put card into transfer state.

Return values

<i>kStatus_SDMMC_-TransferFailed</i>	Transfer failed.
<i>kStatus_Success</i>	Operate successfully.

52.7.5.2 **status_t SDMMC_SendApplicationCommand (sdmmc_host_t * *host*, uint32_t *relativeAddress*)**

Parameters

<i>host</i>	host handler.
<i>relativeAddress</i>	Card relative address.

Return values

<i>kStatus_SDMMC_-TransferFailed</i>	Transfer failed.
<i>kStatus_SDMMC_Card-NotSupport</i>	Card doesn't support.
<i>kStatus_Success</i>	Operate successfully.

52.7.5.3 **status_t SDMMC_SetBlockCount (sdmmc_host_t * *host*, uint32_t *blockCount*)**

Parameters

<i>host</i>	host handler.
<i>blockCount</i>	Block count.

Return values

<i>kStatus_SDMMC_-TransferFailed</i>	Transfer failed.
<i>kStatus_Success</i>	Operate successfully.

52.7.5.4 status_t SDMMC_Goldle (sdmmc_host_t * host)

Parameters

<i>host</i>	host handler.
-------------	---------------

Return values

<i>kStatus_SDMMC_-TransferFailed</i>	Transfer failed.
<i>kStatus_Success</i>	Operate successfully.

52.7.5.5 status_t SDMMC_SetBlockSize (sdmmc_host_t * host, uint32_t blockSize)

Parameters

<i>host</i>	host handler.
<i>blockSize</i>	Block size.

Return values

<i>kStatus_SDMMC_-TransferFailed</i>	Transfer failed.
<i>kStatus_Success</i>	Operate successfully.

52.7.5.6 status_t SDMMC_SetCardInactive (sdmmc_host_t * host)

Parameters

<i>host</i>	host handler.
-------------	---------------

Return values

<i>kStatus_SDMMC_- TransferFailed</i>	Transfer failed.
<i>kStatus_Success</i>	Operate successfully.

Chapter 53

CODEC Driver

53.1 Overview

The MCUXpresso SDK provides a codec abstraction driver interface to access codec register.

Modules

- [CODEC Common Driver](#)
- [CODEC I2C Driver](#)
- [CS42888 Driver](#)
- [DA7212 Driver](#)
- [SGTL5000 Driver](#)
- [WM8904 Driver](#)
- [WM8960 Driver](#)

53.2 CODEC Common Driver

53.2.1 Overview

The codec common driver provides a codec control abstraction interface.

Modules

- [CODEC Adapter](#)
- [CS42888 Adapter](#)
- [DA7212 Adapter](#)
- [SGTL5000 Adapter](#)
- [WM8904 Adapter](#)
- [WM8960 Adapter](#)

Data Structures

- struct [codec_config_t](#)
Initialize structure of the codec. [More...](#)
- struct [codec_capability_t](#)
codec capability [More...](#)
- struct [codec_handle_t](#)
Codec handle definition. [More...](#)

Macros

- `#define CODEC_VOLUME_MAX_VALUE (100U)`
codec maximum volume range

Enumerations

- enum {
[kStatus_CODEC_NotSupport](#) = MAKE_STATUS(kStatusGroup_CODEC, 0U),
[kStatus_CODEC_DeviceNotRegistered](#) = MAKE_STATUS(kStatusGroup_CODEC, 1U),
[kStatus_CODEC_I2CBusInitialFailed](#),
[kStatus_CODEC_I2CCommandTransferFailed](#) }
CODEC status.
- enum [codec_audio_protocol_t](#) {
[kCODEC_BusI2S](#) = 0U,
[kCODEC_BusLeftJustified](#) = 1U,
[kCODEC_BusRightJustified](#) = 2U,
[kCODEC_BusPCMA](#) = 3U,
[kCODEC_BusPCMB](#) = 4U,
[kCODEC_BusTDM](#) = 5U }

- AUDIO format definition.*
 - enum {
 - kCODEC_AudioSampleRate8KHz = 8000U,
 - kCODEC_AudioSampleRate11025Hz = 11025U,
 - kCODEC_AudioSampleRate12KHz = 12000U,
 - kCODEC_AudioSampleRate16KHz = 16000U,
 - kCODEC_AudioSampleRate22050Hz = 22050U,
 - kCODEC_AudioSampleRate24KHz = 24000U,
 - kCODEC_AudioSampleRate32KHz = 32000U,
 - kCODEC_AudioSampleRate44100Hz = 44100U,
 - kCODEC_AudioSampleRate48KHz = 48000U,
 - kCODEC_AudioSampleRate96KHz = 96000U,
 - kCODEC_AudioSampleRate192KHz = 192000U,
 - kCODEC_AudioSampleRate384KHz = 384000U }
 - audio sample rate definition*
 - enum {
 - kCODEC_AudioBitWidth16bit = 16U,
 - kCODEC_AudioBitWidth20bit = 20U,
 - kCODEC_AudioBitWidth24bit = 24U,
 - kCODEC_AudioBitWidth32bit = 32U }
 - audio bit width*
 - enum codec_module_t {
 - kCODEC_ModuleADC = 0U,
 - kCODEC_ModuleDAC = 1U,
 - kCODEC_ModulePGA = 2U,
 - kCODEC_ModuleHeadphone = 3U,
 - kCODEC_ModuleSpeaker = 4U,
 - kCODEC_ModuleLinein = 5U,
 - kCODEC_ModuleLineout = 6U,
 - kCODEC_ModuleVref = 7U,
 - kCODEC_ModuleMicbias = 8U,
 - kCODEC_ModuleMic = 9U,
 - kCODEC_ModuleI2SIn = 10U,
 - kCODEC_ModuleI2SOut = 11U,
 - kCODEC_ModuleMixer = 12U }
 - audio codec module*
 - enum codec_module_ctrl_cmd_t { kCODEC_ModuleSwitchI2SInInterface = 0U }
 - audio codec module control cmd*
 - enum {
 - kCODEC_ModuleI2SInInterfacePCM = 0U,
 - kCODEC_ModuleI2SInInterfaceDSD = 1U }
 - audio codec module digital interface*
 - enum {

```

kCODEC_RecordSourceDifferentialLine = 1U,
kCODEC_RecordSourceLineInput = 2U,
kCODEC_RecordSourceDifferentialMic = 4U,
kCODEC_RecordSourceDigitalMic = 8U,
kCODEC_RecordSourceSingleEndMic = 16U }

```

audio codec module record source value

- enum {

```

kCODEC_RecordChannelLeft1 = 1U,
kCODEC_RecordChannelLeft2 = 2U,
kCODEC_RecordChannelLeft3 = 4U,
kCODEC_RecordChannelRight1 = 1U,
kCODEC_RecordChannelRight2 = 2U,
kCODEC_RecordChannelRight3 = 4U,
kCODEC_RecordChannelDifferentialPositive1 = 1U,
kCODEC_RecordChannelDifferentialPositive2 = 2U,
kCODEC_RecordChannelDifferentialPositive3 = 4U,
kCODEC_RecordChannelDifferentialNegative1 = 8U,
kCODEC_RecordChannelDifferentialNegative2 = 16U,
kCODEC_RecordChannelDifferentialNegative3 = 32U }

```

audio codec record channel

- enum {

```

kCODEC_PlaySourcePGA = 1U,
kCODEC_PlaySourceInput = 2U,
kCODEC_PlaySourceDAC = 4U,
kCODEC_PlaySourceMixerIn = 1U,
kCODEC_PlaySourceMixerInLeft = 2U,
kCODEC_PlaySourceMixerInRight = 4U,
kCODEC_PlaySourceAux = 8U }

```

audio codec module play source value

- enum {

```

kCODEC_PlayChannelHeadphoneLeft = 1U,
kCODEC_PlayChannelHeadphoneRight = 2U,
kCODEC_PlayChannelSpeakerLeft = 4U,
kCODEC_PlayChannelSpeakerRight = 8U,
kCODEC_PlayChannelLineOutLeft = 16U,
kCODEC_PlayChannelLineOutRight = 32U,
kCODEC_PlayChannelLeft0 = 1U,
kCODEC_PlayChannelRight0 = 2U,
kCODEC_PlayChannelLeft1 = 4U,
kCODEC_PlayChannelRight1 = 8U,
kCODEC_PlayChannelLeft2 = 16U,
kCODEC_PlayChannelRight2 = 32U,
kCODEC_PlayChannelLeft3 = 64U,
kCODEC_PlayChannelRight3 = 128U }

```

codec play channel

- enum {

```
kCODEC_VolumeHeadphoneLeft = 1U,  
kCODEC_VolumeHeadphoneRight = 2U,  
kCODEC_VolumeSpeakerLeft = 4U,  
kCODEC_VolumeSpeakerRight = 8U,  
kCODEC_VolumeLineOutLeft = 16U,  
kCODEC_VolumeLineOutRight = 32U,  
kCODEC_VolumeLeft0 = 1UL << 0U,  
kCODEC_VolumeRight0 = 1UL << 1U,  
kCODEC_VolumeLeft1 = 1UL << 2U,  
kCODEC_VolumeRight1 = 1UL << 3U,  
kCODEC_VolumeLeft2 = 1UL << 4U,  
kCODEC_VolumeRight2 = 1UL << 5U,  
kCODEC_VolumeLeft3 = 1UL << 6U,  
kCODEC_VolumeRight3 = 1UL << 7U,  
kCODEC_VolumeDAC = 1UL << 8U }
```

codec volume setting

- enum {

```

kCODEC_SupportModuleADC = 1U << 0U,
kCODEC_SupportModuleDAC = 1U << 1U,
kCODEC_SupportModulePGA = 1U << 2U,
kCODEC_SupportModuleHeadphone = 1U << 3U,
kCODEC_SupportModuleSpeaker = 1U << 4U,
kCODEC_SupportModuleLinein = 1U << 5U,
kCODEC_SupportModuleLineout = 1U << 6U,
kCODEC_SupportModuleVref = 1U << 7U,
kCODEC_SupportModuleMicbias = 1U << 8U,
kCODEC_SupportModuleMic = 1U << 9U,
kCODEC_SupportModuleI2SIn = 1U << 10U,
kCODEC_SupportModuleI2SOut = 1U << 11U,
kCODEC_SupportModuleMixer = 1U << 12U,
kCODEC_SupportModuleI2SInSwitchInterface = 1U << 13U,
kCODEC_SupportPlayChannelLeft0 = 1U << 0U,
kCODEC_SupportPlayChannelRight0 = 1U << 1U,
kCODEC_SupportPlayChannelLeft1 = 1U << 2U,
kCODEC_SupportPlayChannelRight1 = 1U << 3U,
kCODEC_SupportPlayChannelLeft2 = 1U << 4U,
kCODEC_SupportPlayChannelRight2 = 1U << 5U,
kCODEC_SupportPlayChannelLeft3 = 1U << 6U,
kCODEC_SupportPlayChannelRight3 = 1U << 7U,
kCODEC_SupportPlaySourcePGA = 1U << 8U,
kCODEC_SupportPlaySourceInput = 1U << 9U,
kCODEC_SupportPlaySourceDAC = 1U << 10U,
kCODEC_SupportPlaySourceMixerIn = 1U << 11U,
kCODEC_SupportPlaySourceMixerInLeft = 1U << 12U,
kCODEC_SupportPlaySourceMixerInRight = 1U << 13U,
kCODEC_SupportPlaySourceAux = 1U << 14U,
kCODEC_SupportRecordSourceDifferentialLine = 1U << 0U,
kCODEC_SupportRecordSourceLineInput = 1U << 1U,
kCODEC_SupportRecordSourceDifferentialMic = 1U << 2U,
kCODEC_SupportRecordSourceDigitalMic = 1U << 3U,
kCODEC_SupportRecordSourceSingleEndMic = 1U << 4U,
kCODEC_SupportRecordChannelLeft1 = 1U << 6U,
kCODEC_SupportRecordChannelLeft2 = 1U << 7U,
kCODEC_SupportRecordChannelLeft3 = 1U << 8U,
kCODEC_SupportRecordChannelRight1 = 1U << 9U,
kCODEC_SupportRecordChannelRight2 = 1U << 10U,
kCODEC_SupportRecordChannelRight3 = 1U << 11U }

```

audio codec capability

Functions

- `status_t CODEC_Init` (`codec_handle_t *handle`, `codec_config_t *config`)
Codec initialization.
- `status_t CODEC_Deinit` (`codec_handle_t *handle`)
Codec de-initialization.
- `status_t CODEC_SetFormat` (`codec_handle_t *handle`, `uint32_t mclk`, `uint32_t sampleRate`, `uint32_t bitWidth`)
set audio data format.
- `status_t CODEC_ModuleControl` (`codec_handle_t *handle`, `codec_module_ctrl_cmd_t cmd`, `uint32_t data`)
codec module control.
- `status_t CODEC_SetVolume` (`codec_handle_t *handle`, `uint32_t channel`, `uint32_t volume`)
set audio codec pl volume.
- `status_t CODEC_SetMute` (`codec_handle_t *handle`, `uint32_t channel`, `bool mute`)
set audio codec module mute.
- `status_t CODEC_SetPower` (`codec_handle_t *handle`, `codec_module_t module`, `bool powerOn`)
set audio codec power.
- `status_t CODEC_SetRecord` (`codec_handle_t *handle`, `uint32_t recordSource`)
codec set record source.
- `status_t CODEC_SetRecordChannel` (`codec_handle_t *handle`, `uint32_t leftRecordChannel`, `uint32_t rightRecordChannel`)
codec set record channel.
- `status_t CODEC_SetPlay` (`codec_handle_t *handle`, `uint32_t playSource`)
codec set play source.

Driver version

- `#define FSL_CODEC_DRIVER_VERSION (MAKE_VERSION(2, 3, 1))`
CLOCK driver version 2.3.1.

53.2.2 Data Structure Documentation

53.2.2.1 struct codec_config_t

Data Fields

- `uint32_t codecDevType`
codec type
- `void * codecDevConfig`
Codec device specific configuration.

53.2.2.2 struct codec_capability_t

Data Fields

- uint32_t [codecModuleCapability](#)
codec module capability
- uint32_t [codecPlayCapability](#)
codec play capability
- uint32_t [codecRecordCapability](#)
codec record capability
- uint32_t [codecVolumeCapability](#)
codec volume capability

53.2.2.3 struct _codec_handle

codec handle declaration

- Application should allocate a buffer with CODEC_HANDLE_SIZE for handle definition, such as uint8_t codecHandleBuffer[CODEC_HANDLE_SIZE]; codec_handle_t *codecHandle = codecHandleBuffer;

Data Fields

- [codec_config_t](#) * [codecConfig](#)
codec configuration function pointer
- const [codec_capability_t](#) * [codecCapability](#)
codec capability
- uint8_t [codecDevHandle](#) [HAL_CODEC_HANDLER_SIZE]
codec device handle

53.2.3 Macro Definition Documentation

53.2.3.1 #define FSL_CODEC_DRIVER_VERSION (MAKE_VERSION(2, 3, 1))

53.2.4 Enumeration Type Documentation

53.2.4.1 anonymous enum

Enumerator

kStatus_CODEC_NotSupport CODEC not support status.

kStatus_CODEC_DeviceNotRegistered CODEC device register failed status.

kStatus_CODEC_I2CBusInitialFailed CODEC i2c bus initialization failed status.

kStatus_CODEC_I2CCommandTransferFailed CODEC i2c bus command transfer failed status.

53.2.4.2 enum codec_audio_protocol_t

Enumerator

kCODEC_BusI2S I2S type.
kCODEC_BusLeftJustified Left justified mode.
kCODEC_BusRightJustified Right justified mode.
kCODEC_BusPCMA DSP/PCM A mode.
kCODEC_BusPCMB DSP/PCM B mode.
kCODEC_BusTDM TDM mode.

53.2.4.3 anonymous enum

Enumerator

kCODEC_AudioSampleRate8KHz Sample rate 8000 Hz.
kCODEC_AudioSampleRate11025Hz Sample rate 11025 Hz.
kCODEC_AudioSampleRate12KHz Sample rate 12000 Hz.
kCODEC_AudioSampleRate16KHz Sample rate 16000 Hz.
kCODEC_AudioSampleRate22050Hz Sample rate 22050 Hz.
kCODEC_AudioSampleRate24KHz Sample rate 24000 Hz.
kCODEC_AudioSampleRate32KHz Sample rate 32000 Hz.
kCODEC_AudioSampleRate44100Hz Sample rate 44100 Hz.
kCODEC_AudioSampleRate48KHz Sample rate 48000 Hz.
kCODEC_AudioSampleRate96KHz Sample rate 96000 Hz.
kCODEC_AudioSampleRate192KHz Sample rate 192000 Hz.
kCODEC_AudioSampleRate384KHz Sample rate 384000 Hz.

53.2.4.4 anonymous enum

Enumerator

kCODEC_AudioBitWidth16bit audio bit width 16
kCODEC_AudioBitWidth20bit audio bit width 20
kCODEC_AudioBitWidth24bit audio bit width 24
kCODEC_AudioBitWidth32bit audio bit width 32

53.2.4.5 enum codec_module_t

Enumerator

kCODEC_ModuleADC codec module ADC
kCODEC_ModuleDAC codec module DAC
kCODEC_ModulePGA codec module PGA
kCODEC_ModuleHeadphone codec module headphone

kCODEC_ModuleSpeaker codec module speaker
kCODEC_ModuleLinein codec module linein
kCODEC_ModuleLineout codec module lineout
kCODEC_ModuleVref codec module VREF
kCODEC_ModuleMicbias codec module MIC BIAS
kCODEC_ModuleMic codec module MIC
kCODEC_ModuleI2SIn codec module I2S in
kCODEC_ModuleI2SOut codec module I2S out
kCODEC_ModuleMixer codec module mixer

53.2.4.6 enum codec_module_ctrl_cmd_t

Enumerator

kCODEC_ModuleSwitchI2SInInterface module digital interface swtch.

53.2.4.7 anonymous enum

Enumerator

kCODEC_ModuleI2SInInterfacePCM Pcm interface.
kCODEC_ModuleI2SInInterfaceDSD DSD interface.

53.2.4.8 anonymous enum

Enumerator

kCODEC_RecordSourceDifferentialLine record source from differential line
kCODEC_RecordSourceLineInput record source from line input
kCODEC_RecordSourceDifferentialMic record source from differential mic
kCODEC_RecordSourceDigitalMic record source from digital microphone
kCODEC_RecordSourceSingleEndMic record source from single microphone

53.2.4.9 anonymous enum

Enumerator

kCODEC_RecordChannelLeft1 left record channel 1
kCODEC_RecordChannelLeft2 left record channel 2
kCODEC_RecordChannelLeft3 left record channel 3
kCODEC_RecordChannelRight1 right record channel 1
kCODEC_RecordChannelRight2 right record channel 2
kCODEC_RecordChannelRight3 right record channel 3
kCODEC_RecordChannelDifferentialPositive1 differential positive record channel 1

<i>kCODEC_RecordChannelDifferentialPositive2</i>	differential positive record channel 2
<i>kCODEC_RecordChannelDifferentialPositive3</i>	differential positive record channel 3
<i>kCODEC_RecordChannelDifferentialNegative1</i>	differential negative record channel 1
<i>kCODEC_RecordChannelDifferentialNegative2</i>	differential negative record channel 2
<i>kCODEC_RecordChannelDifferentialNegative3</i>	differential negative record channel 3

53.2.4.10 anonymous enum

Enumerator

<i>kCODEC_PlaySourcePGA</i>	play source PGA, bypass ADC
<i>kCODEC_PlaySourceInput</i>	play source Input3
<i>kCODEC_PlaySourceDAC</i>	play source DAC
<i>kCODEC_PlaySourceMixerIn</i>	play source mixer in
<i>kCODEC_PlaySourceMixerInLeft</i>	play source mixer in left
<i>kCODEC_PlaySourceMixerInRight</i>	play source mixer in right
<i>kCODEC_PlaySourceAux</i>	play source mixer in AUx

53.2.4.11 anonymous enum

Enumerator

<i>kCODEC_PlayChannelHeadphoneLeft</i>	play channel headphone left
<i>kCODEC_PlayChannelHeadphoneRight</i>	play channel headphone right
<i>kCODEC_PlayChannelSpeakerLeft</i>	play channel speaker left
<i>kCODEC_PlayChannelSpeakerRight</i>	play channel speaker right
<i>kCODEC_PlayChannelLineOutLeft</i>	play channel lineout left
<i>kCODEC_PlayChannelLineOutRight</i>	play channel lineout right
<i>kCODEC_PlayChannelLeft0</i>	play channel left0
<i>kCODEC_PlayChannelRight0</i>	play channel right0
<i>kCODEC_PlayChannelLeft1</i>	play channel left1
<i>kCODEC_PlayChannelRight1</i>	play channel right1
<i>kCODEC_PlayChannelLeft2</i>	play channel left2
<i>kCODEC_PlayChannelRight2</i>	play channel right2
<i>kCODEC_PlayChannelLeft3</i>	play channel left3
<i>kCODEC_PlayChannelRight3</i>	play channel right3

53.2.4.12 anonymous enum

Enumerator

<i>kCODEC_VolumeHeadphoneLeft</i>	headphone left volume
<i>kCODEC_VolumeHeadphoneRight</i>	headphone right volume
<i>kCODEC_VolumeSpeakerLeft</i>	speaker left volume
<i>kCODEC_VolumeSpeakerRight</i>	speaker right volume

kCODEC_VolumeLineOutLeft lineout left volume
kCODEC_VolumeLineOutRight lineout right volume
kCODEC_VolumeLeft0 left0 volume
kCODEC_VolumeRight0 right0 volume
kCODEC_VolumeLeft1 left1 volume
kCODEC_VolumeRight1 right1 volume
kCODEC_VolumeLeft2 left2 volume
kCODEC_VolumeRight2 right2 volume
kCODEC_VolumeLeft3 left3 volume
kCODEC_VolumeRight3 right3 volume
kCODEC_VolumeDAC dac volume

53.2.4.13 anonymous enum

Enumerator

kCODEC_SupportModuleADC codec capability of module ADC
kCODEC_SupportModuleDAC codec capability of module DAC
kCODEC_SupportModulePGA codec capability of module PGA
kCODEC_SupportModuleHeadphone codec capability of module headphone
kCODEC_SupportModuleSpeaker codec capability of module speaker
kCODEC_SupportModuleLinein codec capability of module linein
kCODEC_SupportModuleLineout codec capability of module lineout
kCODEC_SupportModuleVref codec capability of module vref
kCODEC_SupportModuleMicbias codec capability of module mic bias
kCODEC_SupportModuleMic codec capability of module mic bias
kCODEC_SupportModuleI2SIn codec capability of module I2S in
kCODEC_SupportModuleI2SOut codec capability of module I2S out
kCODEC_SupportModuleMixer codec capability of module mixer
kCODEC_SupportModuleI2SInSwitchInterface codec capability of module I2S in switch interface

kCODEC_SupportPlayChannelLeft0 codec capability of play channel left 0
kCODEC_SupportPlayChannelRight0 codec capability of play channel right 0
kCODEC_SupportPlayChannelLeft1 codec capability of play channel left 1
kCODEC_SupportPlayChannelRight1 codec capability of play channel right 1
kCODEC_SupportPlayChannelLeft2 codec capability of play channel left 2
kCODEC_SupportPlayChannelRight2 codec capability of play channel right 2
kCODEC_SupportPlayChannelLeft3 codec capability of play channel left 3
kCODEC_SupportPlayChannelRight3 codec capability of play channel right 3
kCODEC_SupportPlaySourcePGA codec capability of set playback source PGA
kCODEC_SupportPlaySourceInput codec capability of set playback source INPUT
kCODEC_SupportPlaySourceDAC codec capability of set playback source DAC
kCODEC_SupportPlaySourceMixerIn codec capability of set play source Mixer in
kCODEC_SupportPlaySourceMixerInLeft codec capability of set play source Mixer in left
kCODEC_SupportPlaySourceMixerInRight codec capability of set play source Mixer in right

kCODEC_SupportPlaySourceAux codec capability of set play source aux
kCODEC_SupportRecordSourceDifferentialLine codec capability of record source differential line

kCODEC_SupportRecordSourceLineInput codec capability of record source line input
kCODEC_SupportRecordSourceDifferentialMic codec capability of record source differential mic

kCODEC_SupportRecordSourceDigitalMic codec capability of record digital mic

kCODEC_SupportRecordSourceSingleEndMic codec capability of single end mic

kCODEC_SupportRecordChannelLeft1 left record channel 1

kCODEC_SupportRecordChannelLeft2 left record channel 2

kCODEC_SupportRecordChannelLeft3 left record channel 3

kCODEC_SupportRecordChannelRight1 right record channel 1

kCODEC_SupportRecordChannelRight2 right record channel 2

kCODEC_SupportRecordChannelRight3 right record channel 3

53.2.5 Function Documentation

53.2.5.1 `status_t CODEC_Init (codec_handle_t * handle, codec_config_t * config)`

Parameters

<i>handle</i>	codec handle.
<i>config</i>	codec configurations.

Returns

kStatus_Success is success, else de-initial failed.

53.2.5.2 `status_t CODEC_Deinit (codec_handle_t * handle)`

Parameters

<i>handle</i>	codec handle.
---------------	---------------

Returns

kStatus_Success is success, else de-initial failed.

53.2.5.3 `status_t CODEC_SetFormat (codec_handle_t * handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth)`

Parameters

<i>handle</i>	codec handle.
<i>mclk</i>	master clock frequency in HZ.
<i>sampleRate</i>	sample rate in HZ.
<i>bitWidth</i>	bit width.

Returns

kStatus_Success is success, else configure failed.

53.2.5.4 status_t CODEC_ModuleControl (codec_handle_t * handle, codec_module_ctrl_cmd_t cmd, uint32_t data)

This function is used for codec module control, support switch digital interface cmd, can be expand to support codec module specific feature.

Parameters

<i>handle</i>	codec handle.
<i>cmd</i>	module control cmd, reference _codec_module_ctrl_cmd.
<i>data</i>	value to write, when cmd is kCODEC_ModuleRecordSourceChannel, the data should be a value combine of channel and source, please reference macro CODEC_MODULE_RECORD_SOURCE_CHANNEL(source, LP, LN, RP, RN), reference codec specific driver for detail configurations.

Returns

kStatus_Success is success, else configure failed.

53.2.5.5 status_t CODEC_SetVolume (codec_handle_t * handle, uint32_t channel, uint32_t volume)

Parameters

<i>handle</i>	codec handle.
<i>channel</i>	audio codec volume channel, can be a value or combine value of <code>_codec_volume_capability</code> or <code>_codec_play_channel</code> .
<i>volume</i>	volume value, support 0 ~ 100, 0 is mute, 100 is the maximum volume value.

Returns

`kStatus_Success` is success, else configure failed.

53.2.5.6 `status_t CODEC_SetMute (codec_handle_t * handle, uint32_t channel, bool mute)`

Parameters

<i>handle</i>	codec handle.
<i>channel</i>	audio codec volume channel, can be a value or combine value of <code>_codec_volume_capability</code> or <code>_codec_play_channel</code> .
<i>mute</i>	true is mute, false is unmute.

Returns

`kStatus_Success` is success, else configure failed.

53.2.5.7 `status_t CODEC_SetPower (codec_handle_t * handle, codec_module_t module, bool powerOn)`

Parameters

<i>handle</i>	codec handle.
<i>module</i>	audio codec module.
<i>powerOn</i>	true is power on, false is power down.

Returns

`kStatus_Success` is success, else configure failed.

53.2.5.8 `status_t CODEC_SetRecord (codec_handle_t * handle, uint32_t recordSource)`

Parameters

<i>handle</i>	codec handle.
<i>recordSource</i>	audio codec record source, can be a value or combine value of <code>_codec_record_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.2.5.9 `status_t CODEC_SetRecordChannel (codec_handle_t * handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel)`

Parameters

<i>handle</i>	codec handle.
<i>leftRecord-Channel</i>	audio codec record channel, reference <code>_codec_record_channel</code> , can be a value combine of member in <code>_codec_record_channel</code> .
<i>rightRecord-Channel</i>	audio codec record channel, reference <code>_codec_record_channel</code> , can be a value combine of member in <code>_codec_record_channel</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.2.5.10 `status_t CODEC_SetPlay (codec_handle_t * handle, uint32_t playSource)`

Parameters

<i>handle</i>	codec handle.
<i>playSource</i>	audio codec play source, can be a value or combine value of <code>_codec_play_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.3 CODEC I2C Driver

53.3.1 Overview

The codec common driver provides a codec control abstraction interface.

Data Structures

- struct `codec_i2c_config_t`
CODEC I2C configurations structure. [More...](#)

Macros

- #define `CODEC_I2C_MASTER_HANDLER_SIZE` `HAL_I2C_MASTER_HANDLE_SIZE`
codec i2c handler

Enumerations

- enum `codec_reg_addr_t` {
 `kCODEC_RegAddr8Bit` = 1U,
 `kCODEC_RegAddr16Bit` = 2U }
CODEC device register address type.
- enum `codec_reg_width_t` {
 `kCODEC_RegWidth8Bit` = 1U,
 `kCODEC_RegWidth16Bit` = 2U,
 `kCODEC_RegWidth32Bit` = 4U }
CODEC device register width.

Functions

- `status_t CODEC_I2C_Init` (void *handle, uint32_t i2cInstance, uint32_t i2cBaudrate, uint32_t i2cSourceClockHz)
Codec i2c bus initialization.
- `status_t CODEC_I2C_Deinit` (void *handle)
Codec i2c de-initialization.
- `status_t CODEC_I2C_Send` (void *handle, uint8_t deviceAddress, uint32_t subAddress, uint8_t subaddressSize, uint8_t *txBuff, uint8_t txBuffSize)
codec i2c send function.
- `status_t CODEC_I2C_Receive` (void *handle, uint8_t deviceAddress, uint32_t subAddress, uint8_t subaddressSize, uint8_t *rxBuff, uint8_t rxBuffSize)
codec i2c receive function.

53.3.2 Data Structure Documentation

53.3.2.1 struct codec_i2c_config_t

Data Fields

- uint32_t [codecI2CInstance](#)
i2c bus instance
- uint32_t [codecI2CSourceClock](#)
i2c bus source clock frequency

53.3.3 Enumeration Type Documentation

53.3.3.1 enum codec_reg_addr_t

Enumerator

- kCODEC_RegAddr8Bit* 8-bit register address.
kCODEC_RegAddr16Bit 16-bit register address.

53.3.3.2 enum codec_reg_width_t

Enumerator

- kCODEC_RegWidth8Bit* 8-bit register width.
kCODEC_RegWidth16Bit 16-bit register width.
kCODEC_RegWidth32Bit 32-bit register width.

53.3.4 Function Documentation

53.3.4.1 status_t CODEC_I2C_Init (void * *handle*, uint32_t *i2cInstance*, uint32_t *i2cBaudrate*, uint32_t *i2cSourceClockHz*)

Parameters

<i>handle</i>	i2c master handle.
<i>i2cInstance</i>	instance number of the i2c bus, such as 0 is corresponding to I2C0.

<i>i2cBaudrate</i>	i2c baudrate.
<i>i2cSource-ClockHz</i>	i2c source clock frequency.

Returns

kStatus_HAL_I2cSuccess is success, else initial failed.

53.3.4.2 status_t CODEC_I2C_Deinit (void * *handle*)

Parameters

<i>handle</i>	i2c master handle.
---------------	--------------------

Returns

kStatus_HAL_I2cSuccess is success, else deinitial failed.

53.3.4.3 status_t CODEC_I2C_Send (void * *handle*, uint8_t *deviceAddress*, uint32_t *subAddress*, uint8_t *subaddressSize*, uint8_t * *txBuff*, uint8_t *txBuffSize*)

Parameters

<i>handle</i>	i2c master handle.
<i>deviceAddress</i>	codec device address.
<i>subAddress</i>	register address.
<i>subaddressSize</i>	register address width.
<i>txBuff</i>	tx buffer pointer.
<i>txBuffSize</i>	tx buffer size.

Returns

kStatus_HAL_I2cSuccess is success, else send failed.

53.3.4.4 status_t CODEC_I2C_Receive (void * *handle*, uint8_t *deviceAddress*, uint32_t *subAddress*, uint8_t *subaddressSize*, uint8_t * *rxBuff*, uint8_t *rxBuffSize*)

Parameters

<i>handle</i>	i2c master handle.
<i>deviceAddress</i>	codec device address.
<i>subAddress</i>	register address.
<i>subaddressSize</i>	register address width.
<i>rxBuff</i>	rx buffer pointer.
<i>rxBuffSize</i>	rx buffer size.

Returns

kStatus_HAL_I2cSuccess is success, else receive failed.

53.4 CS42888 Driver

53.4.1 Overview

The cs42888 driver provides a codec control interface.

Data Structures

- struct `cs42888_audio_format_t`
cs42888 audio format [More...](#)
- struct `cs42888_config_t`
Initialize structure of CS42888. [More...](#)
- struct `cs42888_handle_t`
cs42888 handler [More...](#)

Macros

- #define `CS42888_I2C_HANDLER_SIZE` `CODEC_I2C_MASTER_HANDLER_SIZE`
CS42888 handle size.
- #define `CS42888_ID` `0x01U`
Define the register address of CS42888.
- #define `CS42888_AOUT_MAX_VOLUME_VALUE` `0xFFU`
CS42888 volume setting range.
- #define `CS42888_CACHEREGNUM` `28U`
Cache register number.
- #define `CS42888_I2C_ADDR` `0x48U`
CS42888 I2C address.
- #define `CS42888_I2C_BITRATE` `(100000U)`
CS42888 I2C baudrate.

Typedefs

- typedef void(* `cs42888_reset`)(bool state)
cs42888 reset function pointer

Enumerations

- enum `cs42888_func_mode` {
`kCS42888_ModeMasterSSM = 0x0,`
`kCS42888_ModeMasterDSM = 0x1,`
`kCS42888_ModeMasterQSM = 0x2,`
`kCS42888_ModeSlave = 0x3 }`
CS42888 support modes.

- enum `cs42888_module_t` {
`kCS42888_ModuleDACPair1` = 0x2,
`kCS42888_ModuleDACPair2` = 0x4,
`kCS42888_ModuleDACPair3` = 0x8,
`kCS42888_ModuleDACPair4` = 0x10,
`kCS42888_ModuleADCPair1` = 0x20,
`kCS42888_ModuleADCPair2` = 0x40 }
Modules in CS42888 board.
- enum `cs42888_bus_t` {
`kCS42888_BusLeftJustified` = 0x0,
`kCS42888_BusI2S` = 0x1,
`kCS42888_BusRightJustified` = 0x2,
`kCS42888_BusOL1` = 0x4,
`kCS42888_BusOL2` = 0x5,
`kCS42888_BusTDM` = 0x6 }
CS42888 supported audio bus type.
- enum {
`kCS42888_AOUT1` = 1U,
`kCS42888_AOUT2` = 2U,
`kCS42888_AOUT3` = 3U,
`kCS42888_AOUT4` = 4U,
`kCS42888_AOUT5` = 5U,
`kCS42888_AOUT6` = 6U,
`kCS42888_AOUT7` = 7U,
`kCS42888_AOUT8` = 8U }
CS428888 play channel.

Functions

- `status_t CS42888_Init` (`cs42888_handle_t *handle`, `cs42888_config_t *config`)
CS42888 initialize function.
- `status_t CS42888_Deinit` (`cs42888_handle_t *handle`)
Deinit the CS42888 codec.
- `status_t CS42888_SetProtocol` (`cs42888_handle_t *handle`, `cs42888_bus_t` protocol, `uint32_t` bit-Width)
Set the audio transfer protocol.
- `void CS42888_SetFuncMode` (`cs42888_handle_t *handle`, `cs42888_func_mode` mode)
Set CS42888 to differernt working mode.
- `status_t CS42888_SelectFunctionalMode` (`cs42888_handle_t *handle`, `cs42888_func_mode` adc-Mode, `cs42888_func_mode` dacMode)
Set CS42888 to differernt functional mode.
- `status_t CS42888_SetAOUTVolume` (`cs42888_handle_t *handle`, `uint8_t` channel, `uint8_t` volume)
Set the volume of different modules in CS42888.
- `status_t CS42888_SetAINVolume` (`cs42888_handle_t *handle`, `uint8_t` channel, `uint8_t` volume)
Set the volume of different modules in CS42888.
- `uint8_t CS42888_GetAOUTVolume` (`cs42888_handle_t *handle`, `uint8_t` channel)

- *Get the volume of different AOUT channel in CS42888.*
 • `uint8_t CS42888_GetAINVolume (cs42888_handle_t *handle, uint8_t channel)`
- *Get the volume of different AIN channel in CS42888.*
 • `status_t CS42888_SetMute (cs42888_handle_t *handle, uint8_t channelMask)`
- *Mute modules in CS42888.*
 • `status_t CS42888_SetChannelMute (cs42888_handle_t *handle, uint8_t channel, bool isMute)`
- *Mute channel modules in CS42888.*
 • `status_t CS42888_SetModule (cs42888_handle_t *handle, cs42888_module_t module, bool isEnabled)`
- *Enable/disable expected devices.*
 • `status_t CS42888_ConfigDataFormat (cs42888_handle_t *handle, uint32_t mclk, uint32_t sampleRate, uint32_t bits)`
- *Configure the data format of audio data.*
 • `status_t CS42888_WriteReg (cs42888_handle_t *handle, uint8_t reg, uint8_t val)`
- *Write register to CS42888 using I2C.*
 • `status_t CS42888_ReadReg (cs42888_handle_t *handle, uint8_t reg, uint8_t *val)`
- *Read register from CS42888 using I2C.*
 • `status_t CS42888_ModifyReg (cs42888_handle_t *handle, uint8_t reg, uint8_t mask, uint8_t val)`
- *Modify some bits in the register using I2C.*

Driver version

- `#define FSL_CS42888_DRIVER_VERSION (MAKE_VERSION(2, 1, 3))`
cs42888 driver version 2.1.3.

53.4.2 Data Structure Documentation

53.4.2.1 struct cs42888_audio_format_t

Data Fields

- `uint32_t mclk_HZ`
master clock frequency
- `uint32_t sampleRate`
sample rate
- `uint32_t bitWidth`
bit width

53.4.2.2 struct cs42888_config_t

Data Fields

- `cs42888_bus_t bus`
Audio transfer protocol.
- `cs42888_audio_format_t format`
cs42888 audio format

- `cs42888_func_mode` ADCMode
CS42888 ADC function mode.
- `cs42888_func_mode` DACMode
CS42888 DAC function mode.
- `bool` `master`
true is master, false is slave
- `codec_i2c_config_t` `i2cConfig`
i2c bus configuration
- `uint8_t` `slaveAddress`
slave address
- `cs42888_reset` `reset`
reset function pointer

Field Documentation

(1) `cs42888_func_mode` `cs42888_config_t::ADCMode`

(2) `cs42888_func_mode` `cs42888_config_t::DACMode`

53.4.2.3 struct `cs42888_handle_t`

Data Fields

- `cs42888_config_t * config`
cs42888 config pointer
- `uint8_t i2cHandle` [`CS42888_I2C_HANDLER_SIZE`]
i2c handle pointer

53.4.3 Macro Definition Documentation

53.4.3.1 `#define FSL_CS42888_DRIVER_VERSION (MAKE_VERSION(2, 1, 3))`

53.4.3.2 `#define CS42888_ID 0x01U`

53.4.3.3 `#define CS42888_I2C_ADDR 0x48U`

53.4.4 Enumeration Type Documentation

53.4.4.1 enum `cs42888_func_mode`

Enumerator

- `kCS42888_ModeMasterSSM` master single speed mode
- `kCS42888_ModeMasterDSM` master dual speed mode
- `kCS42888_ModeMasterQSM` master quad speed mode
- `kCS42888_ModeSlave` master single speed mode

53.4.4.2 enum cs42888_module_t

Enumerator

kCS42888_ModuleDACPair1 DAC pair1 (AOUT1 and AOUT2) module in CS42888.
kCS42888_ModuleDACPair2 DAC pair2 (AOUT3 and AOUT4) module in CS42888.
kCS42888_ModuleDACPair3 DAC pair3 (AOUT5 and AOUT6) module in CS42888.
kCS42888_ModuleDACPair4 DAC pair4 (AOUT7 and AOUT8) module in CS42888.
kCS42888_ModuleADCPair1 ADC pair1 (AIN1 and AIN2) module in CS42888.
kCS42888_ModuleADCPair2 ADC pair2 (AIN3 and AIN4) module in CS42888.

53.4.4.3 enum cs42888_bus_t

Enumerator

kCS42888_BusLeftJustified Left justified format, up to 24 bits.
kCS42888_BusI2S I2S format, up to 24 bits.
kCS42888_BusRightJustified Right justified, can support 16bits and 24 bits.
kCS42888_BusOL1 One-Line #1 mode.
kCS42888_BusOL2 One-Line #2 mode.
kCS42888_BusTDM TDM mode.

53.4.4.4 anonymous enum

Enumerator

kCS42888_AOUT1 aout1
kCS42888_AOUT2 aout2
kCS42888_AOUT3 aout3
kCS42888_AOUT4 aout4
kCS42888_AOUT5 aout5
kCS42888_AOUT6 aout6
kCS42888_AOUT7 aout7
kCS42888_AOUT8 aout8

53.4.5 Function Documentation

53.4.5.1 status_t CS42888_Init (cs42888_handle_t * handle, cs42888_config_t * config)

The second parameter is NULL to CS42888 in this version. If users want to change the settings, they have to use `cs42888_write_reg()` or `cs42888_modify_reg()` to set the register value of CS42888. Note: If the `codec_config` is NULL, it would initialize CS42888 using default settings. The default setting: `codec_config->bus = kCS42888_BusI2S` `codec_config->ADCmode = kCS42888_ModeSlave` `codec_config->DACmode = kCS42888_ModeSlave`

Parameters

<i>handle</i>	CS42888 handle structure.
<i>config</i>	CS42888 configuration structure.

53.4.5.2 `status_t CS42888_Deinit (cs42888_handle_t * handle)`

This function close all modules in CS42888 to save power.

Parameters

<i>handle</i>	CS42888 handle structure pointer.
---------------	-----------------------------------

53.4.5.3 `status_t CS42888_SetProtocol (cs42888_handle_t * handle, cs42888_bus_t protocol, uint32_t bitWidth)`

CS42888 only supports I2S, left justified, right justified, PCM A, PCM B format.

Parameters

<i>handle</i>	CS42888 handle structure.
<i>protocol</i>	Audio data transfer protocol.
<i>bitWidth</i>	bit width

53.4.5.4 `void CS42888_SetFuncMode (cs42888_handle_t * handle, cs42888_func_mode mode)`

Deprecated api, Do not use it anymore. It has been superceded by [CS42888_SelectFunctionalMode](#).

Parameters

<i>handle</i>	CS42888 handle structure.
<i>mode</i>	differenht working mode of CS42888.

53.4.5.5 `status_t CS42888_SelectFunctionalMode (cs42888_handle_t * handle, cs42888_func_mode adcMode, cs42888_func_mode dacMode)`

Parameters

<i>handle</i>	CS42888 handle structure.
<i>adcMode</i>	different working mode of CS42888.
<i>dacMode</i>	different working mode of CS42888.

53.4.5.6 **status_t CS42888_SetAOUTVolume (cs42888_handle_t * *handle*, uint8_t *channel*, uint8_t *volume*)**

This function would set the volume of CS42888 modules. Uses need to appoint the module. The function assume that left channel and right channel has the same volume.

Parameters

<i>handle</i>	CS42888 handle structure.
<i>channel</i>	AOUT channel, it shall be 1~8.
<i>volume</i>	Volume value need to be set.

53.4.5.7 **status_t CS42888_SetAINVolume (cs42888_handle_t * *handle*, uint8_t *channel*, uint8_t *volume*)**

This function would set the volume of CS42888 modules. Uses need to appoint the module. The function assume that left channel and right channel has the same volume.

Parameters

<i>handle</i>	CS42888 handle structure.
<i>channel</i>	AIN channel, it shall be 1~4.
<i>volume</i>	Volume value need to be set.

53.4.5.8 **uint8_t CS42888_GetAOUTVolume (cs42888_handle_t * *handle*, uint8_t *channel*)**

This function gets the volume of CS42888 modules. Uses need to appoint the module. The function assume that left channel and right channel has the same volume.

Parameters

<i>handle</i>	CS42888 handle structure.
<i>channel</i>	AOUT channel, it shall be 1~8.

53.4.5.9 uint8_t CS42888_GetAINVolume (cs42888_handle_t * *handle*, uint8_t *channel*)

This function gets the volume of CS42888 modules. Uses need to appoint the module. The function assume that left channel and right channel has the same volume.

Parameters

<i>handle</i>	CS42888 handle structure.
<i>channel</i>	AIN channel, it shall be 1~4.

53.4.5.10 status_t CS42888_SetMute (cs42888_handle_t * *handle*, uint8_t *channelMask*)

Parameters

<i>handle</i>	CS42888 handle structure.
<i>channelMask</i>	Channel mask for mute. Mute channel 0, it shall be 0x1, while mute channel 0 and 1, it shall be 0x3. Mute all channel, it shall be 0xFF. Each bit represent one channel, 1 means mute, 0 means unmute.

53.4.5.11 status_t CS42888_SetChannelMute (cs42888_handle_t * *handle*, uint8_t *channel*, bool *isMute*)

Parameters

<i>handle</i>	CS42888 handle structure.
<i>channel</i>	reference <code>_cs42888_play_channel</code> .
<i>isMute</i>	true is mute, false is unmute.

53.4.5.12 status_t CS42888_SetModule (cs42888_handle_t * *handle*, cs42888_module_t *module*, bool *isEnabled*)

Parameters

<i>handle</i>	CS42888 handle structure.
<i>module</i>	Module expected to enable.
<i>isEnabled</i>	Enable or disable moudles.

53.4.5.13 `status_t CS42888_ConfigDataFormat (cs42888_handle_t * handle, uint32_t mclk, uint32_t sample_rate, uint32_t bits)`

This function would configure the registers about the sample rate, bit depths.

Parameters

<i>handle</i>	CS42888 handle structure pointer.
<i>mclk</i>	Master clock frequency of I2S.
<i>sample_rate</i>	Sample rate of audio file running in CS42888. CS42888 now supports 8k, 11.025k, 12k, 16k, 22.05k, 24k, 32k, 44.1k, 48k and 96k sample rate.
<i>bits</i>	Bit depth of audio file (CS42888 only supports 16bit, 20bit, 24bit and 32 bit in HW).

53.4.5.14 `status_t CS42888_WriteReg (cs42888_handle_t * handle, uint8_t reg, uint8_t val)`

Parameters

<i>handle</i>	CS42888 handle structure.
<i>reg</i>	The register address in CS42888.
<i>val</i>	Value needs to write into the register.

53.4.5.15 `status_t CS42888_ReadReg (cs42888_handle_t * handle, uint8_t reg, uint8_t * val)`

Parameters

<i>handle</i>	CS42888 handle structure.
<i>reg</i>	The register address in CS42888.
<i>val</i>	Value written to.

53.4.5.16 `status_t CS42888_ModifyReg (cs42888_handle_t * handle, uint8_t reg, uint8_t mask, uint8_t val)`

Parameters

<i>handle</i>	CS42888 handle structure.
<i>reg</i>	The register address in CS42888.
<i>mask</i>	The mask code for the bits want to write. The bit you want to write should be 0.
<i>val</i>	Value needs to write into the register.

53.4.6 CS42888 Adapter

53.4.6.1 Overview

The cs42888 adapter provides a codec unify control interface.

Macros

- #define `HAL_CODEC_CS42888_HANDLER_SIZE` (`CS42888_I2C_HANDLER_SIZE + 4`)
codec handler size

Functions

- `status_t HAL_CODEC_CS42888_Init` (void *handle, void *config)
Codec initialization.
- `status_t HAL_CODEC_CS42888_Deinit` (void *handle)
Codec de-initialization.
- `status_t HAL_CODEC_CS42888_SetFormat` (void *handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth)
set audio data format.
- `status_t HAL_CODEC_CS42888_SetVolume` (void *handle, uint32_t playChannel, uint32_t volume)
set audio codec module volume.
- `status_t HAL_CODEC_CS42888_SetMute` (void *handle, uint32_t playChannel, bool isMute)
set audio codec module mute.
- `status_t HAL_CODEC_CS42888_SetPower` (void *handle, uint32_t module, bool powerOn)
set audio codec module power.
- `status_t HAL_CODEC_CS42888_SetRecord` (void *handle, uint32_t recordSource)
codec set record source.
- `status_t HAL_CODEC_CS42888_SetRecordChannel` (void *handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel)
codec set record channel.
- `status_t HAL_CODEC_CS42888_SetPlay` (void *handle, uint32_t playSource)
codec set play source.
- `status_t HAL_CODEC_CS42888_ModuleControl` (void *handle, uint32_t cmd, uint32_t data)
codec module control.
- static `status_t HAL_CODEC_Init` (void *handle, void *config)
Codec initialization.
- static `status_t HAL_CODEC_Deinit` (void *handle)
Codec de-initialization.
- static `status_t HAL_CODEC_SetFormat` (void *handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth)
set audio data format.
- static `status_t HAL_CODEC_SetVolume` (void *handle, uint32_t playChannel, uint32_t volume)
set audio codec module volume.
- static `status_t HAL_CODEC_SetMute` (void *handle, uint32_t playChannel, bool isMute)
set audio codec module mute.
- static `status_t HAL_CODEC_SetPower` (void *handle, uint32_t module, bool powerOn)

- *set audio codec module power.*
static [status_t HAL_CODEC_SetRecord](#) (void *handle, uint32_t recordSource)
codec set record source.
- static [status_t HAL_CODEC_SetRecordChannel](#) (void *handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel)
codec set record channel.
- static [status_t HAL_CODEC_SetPlay](#) (void *handle, uint32_t playSource)
codec set play source.
- static [status_t HAL_CODEC_ModuleControl](#) (void *handle, uint32_t cmd, uint32_t data)
codec module control.

53.4.6.2 Function Documentation

53.4.6.2.1 status_t HAL_CODEC_CS42888_Init (void * handle, void * config)

Parameters

<i>handle</i>	codec handle.
<i>config</i>	codec configuration.

Returns

kStatus_Success is success, else initial failed.

53.4.6.2.2 status_t HAL_CODEC_CS42888_Deinit (void * handle)

Parameters

<i>handle</i>	codec handle.
---------------	---------------

Returns

kStatus_Success is success, else de-initial failed.

53.4.6.2.3 status_t HAL_CODEC_CS42888_SetFormat (void * handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth)

Parameters

<i>handle</i>	codec handle.
<i>mclk</i>	master clock frequency in HZ.
<i>sampleRate</i>	sample rate in HZ.
<i>bitWidth</i>	bit width.

Returns

kStatus_Success is success, else configure failed.

53.4.6.2.4 **status_t HAL_CODEC_CS42888_SetVolume (void * *handle*, uint32_t *playChannel*, uint32_t *volume*)**

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of _codec_play_channel.
<i>volume</i>	volume value, support 0 ~ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

53.4.6.2.5 **status_t HAL_CODEC_CS42888_SetMute (void * *handle*, uint32_t *playChannel*, bool *isMute*)**

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of _codec_play_channel.
<i>isMute</i>	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

53.4.6.2.6 **status_t HAL_CODEC_CS42888_SetPower (void * *handle*, uint32_t *module*, bool *powerOn*)**

Parameters

<i>handle</i>	codec handle.
<i>module</i>	audio codec module.
<i>powerOn</i>	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

53.4.6.2.7 status_t HAL_CODEC_CS42888_SetRecord (void * *handle*, uint32_t *recordSource*)

Parameters

<i>handle</i>	codec handle.
<i>recordSource</i>	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

53.4.6.2.8 status_t HAL_CODEC_CS42888_SetRecordChannel (void * *handle*, uint32_t *leftRecordChannel*, uint32_t *rightRecordChannel*)

Parameters

<i>handle</i>	codec handle.
<i>leftRecord-Channel</i>	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
<i>rightRecord-Channel</i>	audio codec record channel, reference _codec_record_channel, can be a value combine of member in _codec_record_channel.

Returns

kStatus_Success is success, else configure failed.

53.4.6.2.9 status_t HAL_CODEC_CS42888_SetPlay (void * *handle*, uint32_t *playSource*)

Parameters

<i>handle</i>	codec handle.
<i>playSource</i>	audio codec play source, can be a value or combine value of <code>_codec_play_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.4.6.2.10 `status_t HAL_CODEC_CS42888_ModuleControl (void * handle, uint32_t cmd, uint32_t data)`

This function is used for codec module control, support switch digital interface cmd, can be expand to support codec module specific feature

Parameters

<i>handle</i>	codec handle.
<i>cmd</i>	module control cmd, reference <code>_codec_module_ctrl_cmd</code> .
<i>data</i>	value to write, when cmd is <code>kCODEC_ModuleRecordSourceChannel</code> , the data should be a value combine of channel and source, please reference macro <code>CODEC_MODULE_RECORD_SOURCE_CHANNEL(source, LP, LN, RP, RN)</code> , reference codec specific driver for detail configurations.

Returns

`kStatus_Success` is success, else configure failed.

53.4.6.2.11 `static status_t HAL_CODEC_Init (void * handle, void * config) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>config</i>	codec configuration.

Returns

`kStatus_Success` is success, else initial failed.

53.4.6.2.12 `static status_t HAL_CODEC_Deinit (void * handle) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
---------------	---------------

Returns

kStatus_Success is success, else de-initial failed.

53.4.6.2.13 `static status_t HAL_CODEC_SetFormat (void * handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>mclk</i>	master clock frequency in HZ.
<i>sampleRate</i>	sample rate in HZ.
<i>bitWidth</i>	bit width.

Returns

kStatus_Success is success, else configure failed.

53.4.6.2.14 `static status_t HAL_CODEC_SetVolume (void * handle, uint32_t playChannel, uint32_t volume) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of <code>_codec_play_channel</code> .
<i>volume</i>	volume value, support 0 ~ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

53.4.6.2.15 `static status_t HAL_CODEC_SetMute (void * handle, uint32_t playChannel, bool isMute) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of <code>_codec_play_channel</code> .
<i>isMute</i>	true is mute, false is unmute.

Returns

`kStatus_Success` is success, else configure failed.

53.4.6.2.16 `static status_t HAL_CODEC_SetPower (void * handle, uint32_t module, bool powerOn) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>module</i>	audio codec module.
<i>powerOn</i>	true is power on, false is power down.

Returns

`kStatus_Success` is success, else configure failed.

53.4.6.2.17 `static status_t HAL_CODEC_SetRecord (void * handle, uint32_t recordSource) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>recordSource</i>	audio codec record source, can be a value or combine value of <code>_codec_record_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.4.6.2.18 `static status_t HAL_CODEC_SetRecordChannel (void * handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>leftRecord-Channel</i>	audio codec record channel, reference <code>_codec_record_channel</code> , can be a value or combine value of member in <code>_codec_record_channel</code> .
<i>rightRecord-Channel</i>	audio codec record channel, reference <code>_codec_record_channel</code> , can be a value or combine of member in <code>_codec_record_channel</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.4.6.2.19 `static status_t HAL_CODEC_SetPlay (void * handle, uint32_t playSource) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>playSource</i>	audio codec play source, can be a value or combine value of <code>_codec_play_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.4.6.2.20 `static status_t HAL_CODEC_ModuleControl (void * handle, uint32_t cmd, uint32_t data) [inline], [static]`

This function is used for codec module control, support switch digital interface cmd, can be expand to support codec module specific feature

Parameters

<i>handle</i>	codec handle.
<i>cmd</i>	module control cmd, reference <code>_codec_module_ctrl_cmd</code> .
<i>data</i>	value to write, when cmd is <code>kCODEC_ModuleRecordSourceChannel</code> , the data should be a value combine of channel and source, please reference macro <code>CODEC_MODULE_RECORD_SOURCE_CHANNEL(source, LP, LN, RP, RN)</code> , reference codec specific driver for detail configurations.

Returns

`kStatus_Success` is success, else configure failed.

53.5 DA7212 Driver

53.5.1 Overview

The da7212 driver provides a codec control interface.

Data Structures

- struct `da7212_pll_config_t`
da7212 pll configuration More...
- struct `da7212_audio_format_t`
da7212 audio format More...
- struct `da7212_config_t`
DA7212 configure structure. More...
- struct `da7212_handle_t`
da7212 codec handler More...

Macros

- #define `DA7212_I2C_HANDLER_SIZE` `CODEC_I2C_MASTER_HANDLER_SIZE`
da7212 handle size
- #define `DA7212_ADDRESS` `(0x1A)`
DA7212 I2C address.
- #define `DA7212_HEADPHONE_MAX_VOLUME_VALUE` `0x3FU`
da7212 volume setting range

Enumerations

- enum `da7212_input_t` {
`kDA7212_Input_AUX = 0x0,`
`kDA7212_Input_MIC1_Dig,`
`kDA7212_Input_MIC1_An,`
`kDA7212_Input_MIC2` }
DA7212 input source select.
- enum `_da7212_play_channel` {
`kDA7212_HeadphoneLeft = 1U,`
`kDA7212_HeadphoneRight = 2U,`
`kDA7212_Speaker = 4U` }
da7212 play channel
- enum `da7212_output_t` {
`kDA7212_Output_HP = 0x0,`
`kDA7212_Output_SP` }
DA7212 output device select.

- enum `_da7212_module` {
`kDA7212_ModuleADC`,
`kDA7212_ModuleDAC`,
`kDA7212_ModuleHeadphone`,
`kDA7212_ModuleSpeaker` }
DA7212 module.
- enum `da7212_dac_source_t` {
`kDA7212_DACSourceADC` = 0x0U,
`kDA7212_DACSourceInputStream` = 0x3U }
DA7212 functionality.
- enum `da7212_volume_t` {
`kDA7212_DACGainMute` = 0x7,
`kDA7212_DACGainM72DB` = 0x17,
`kDA7212_DACGainM60DB` = 0x1F,
`kDA7212_DACGainM54DB` = 0x27,
`kDA7212_DACGainM48DB` = 0x2F,
`kDA7212_DACGainM42DB` = 0x37,
`kDA7212_DACGainM36DB` = 0x3F,
`kDA7212_DACGainM30DB` = 0x47,
`kDA7212_DACGainM24DB` = 0x4F,
`kDA7212_DACGainM18DB` = 0x57,
`kDA7212_DACGainM12DB` = 0x5F,
`kDA7212_DACGainM6DB` = 0x67,
`kDA7212_DACGain0DB` = 0x6F,
`kDA7212_DACGain6DB` = 0x77,
`kDA7212_DACGain12DB` = 0x7F }
DA7212 volume.
- enum `da7212_protocol_t` {
`kDA7212_BusI2S` = 0x0,
`kDA7212_BusLeftJustified`,
`kDA7212_BusRightJustified`,
`kDA7212_BusDSPMode` }
The audio data transfer protocol choice.
- enum `da7212_sys_clk_source_t` {
`kDA7212_SysClkSourceMCLK` = 0U,
`kDA7212_SysClkSourcePLL` = 1U << 14 }
da7212 system clock source
- enum `da7212_pll_clk_source_t` { `kDA7212_PLLClkSourceMCLK` = 0U }
DA7212 pll clock source.
- enum `da7212_pll_out_clk_t` {
`kDA7212_PLLOutputClk11289600` = 11289600U,
`kDA7212_PLLOutputClk12288000` = 12288000U }
DA7212 output clock frequency.
- enum `da7212_master_bits_t` {

```

kDA7212_MasterBits32PerFrame = 0U,
kDA7212_MasterBits64PerFrame = 1U,
kDA7212_MasterBits128PerFrame = 2U,
kDA7212_MasterBits256PerFrame = 3U }
    master mode bits per frame

```

Functions

- `status_t DA7212_Init (da7212_handle_t *handle, da7212_config_t *codecConfig)`
DA7212 initialize function.
- `status_t DA7212_ConfigAudioFormat (da7212_handle_t *handle, uint32_t masterClock_Hz, uint32_t sampleRate_Hz, uint32_t dataBits)`
Set DA7212 audio format.
- `status_t DA7212_SetPLLConfig (da7212_handle_t *handle, da7212_pll_config_t *config)`
DA7212 set PLL configuration This function will enable the GPIO1 FLL clock output function, so user can see the generated fl output clock frequency from WM8904 GPIO1.
- `void DA7212_ChangeHPVolume (da7212_handle_t *handle, da7212_volume_t volume)`
Set DA7212 playback volume.
- `void DA7212_Mute (da7212_handle_t *handle, bool isMuted)`
Mute or unmute DA7212.
- `void DA7212_ChangeInput (da7212_handle_t *handle, da7212_input_t DA7212_Input)`
Set the input data source of DA7212.
- `void DA7212_ChangeOutput (da7212_handle_t *handle, da7212_output_t DA7212_Output)`
Set the output device of DA7212.
- `status_t DA7212_SetChannelVolume (da7212_handle_t *handle, uint32_t channel, uint32_t volume)`
Set module volume.
- `status_t DA7212_SetChannelMute (da7212_handle_t *handle, uint32_t channel, bool isMute)`
Set module mute.
- `status_t DA7212_SetProtocol (da7212_handle_t *handle, da7212_protocol_t protocol)`
Set protocol for DA7212.
- `status_t DA7212_SetMasterModeBits (da7212_handle_t *handle, uint32_t bitWidth)`
Set master mode bits per frame for DA7212.
- `status_t DA7212_WriteRegister (da7212_handle_t *handle, uint8_t u8Register, uint8_t u8RegisterData)`
Write a register for DA7212.
- `status_t DA7212_ReadRegister (da7212_handle_t *handle, uint8_t u8Register, uint8_t *pu8RegisterData)`
Get a register value of DA7212.
- `status_t DA7212_Deinit (da7212_handle_t *handle)`
Deinit DA7212.

Driver version

- `#define FSL_DA7212_DRIVER_VERSION (MAKE_VERSION(2, 2, 2))`
CLOCK driver version 2.2.2.

53.5.2 Data Structure Documentation

53.5.2.1 struct da7212_pll_config_t

Data Fields

- [da7212_pll_clk_source_t](#) *source*
pll reference clock source
- [uint32_t](#) [refClock_HZ](#)
pll reference clock frequency
- [da7212_pll_out_clk_t](#) [outputClock_HZ](#)
pll output clock frequency

53.5.2.2 struct da7212_audio_format_t

Data Fields

- [uint32_t](#) [mclk_HZ](#)
master clock frequency
- [uint32_t](#) [sampleRate](#)
sample rate
- [uint32_t](#) [bitWidth](#)
bit width
- [bool](#) [isBclkInvert](#)
bit clock intervnet

53.5.2.3 struct da7212_config_t

Data Fields

- [bool](#) [isMaster](#)
If DA7212 is master, true means master, false means slave.
- [da7212_protocol_t](#) [protocol](#)
Audio bus format, can be I2S, LJ, RJ or DSP mode.
- [da7212_dac_source_t](#) [dacSource](#)
DA7212 data source.
- [da7212_audio_format_t](#) [format](#)
audio format
- [uint8_t](#) [slaveAddress](#)
device address
- [codec_i2c_config_t](#) [i2cConfig](#)
i2c configuration
- [da7212_sys_clk_source_t](#) [sysClkSource](#)
system clock source
- [da7212_pll_config_t](#) * [pll](#)
pll configuration

Field Documentation

- (1) `bool da7212_config_t::isMaster`
- (2) `da7212_protocol_t da7212_config_t::protocol`
- (3) `da7212_dac_source_t da7212_config_t::dacSource`

53.5.2.4 struct da7212_handle_t

Data Fields

- `da7212_config_t * config`
da7212 config pointer
- `uint8_t i2cHandle [DA7212_I2C_HANDLER_SIZE]`
i2c handle

53.5.3 Macro Definition Documentation

53.5.3.1 `#define FSL_DA7212_DRIVER_VERSION (MAKE_VERSION(2, 2, 2))`

53.5.4 Enumeration Type Documentation

53.5.4.1 enum da7212_Input_t

Enumerator

kDA7212_Input_AUX Input from AUX.
kDA7212_Input_MIC1_Dig Input from MIC1 Digital.
kDA7212_Input_MIC1_An Input from Mic1 Analog.
kDA7212_Input_MIC2 Input from MIC2.

53.5.4.2 enum _da7212_play_channel

Enumerator

kDA7212_HeadphoneLeft headphone left
kDA7212_HeadphoneRight headphone right
kDA7212_Speaker speaker channel

53.5.4.3 enum da7212_Output_t

Enumerator

kDA7212_Output_HP Output to headphone.
kDA7212_Output_SP Output to speaker.

53.5.4.4 enum _da7212_module

Enumerator

kDA7212_ModuleADC module ADC
kDA7212_ModuleDAC module DAC
kDA7212_ModuleHeadphone module headphone
kDA7212_ModuleSpeaker module speaker

53.5.4.5 enum da7212_dac_source_t

Enumerator

kDA7212_DACSourceADC DAC source from ADC.
kDA7212_DACSourceInputStream DAC source from.

53.5.4.6 enum da7212_volume_t

Enumerator

kDA7212_DACGainMute Mute DAC.
kDA7212_DACGainM72DB DAC volume -72db.
kDA7212_DACGainM60DB DAC volume -60db.
kDA7212_DACGainM54DB DAC volume -54db.
kDA7212_DACGainM48DB DAC volume -48db.
kDA7212_DACGainM42DB DAC volume -42db.
kDA7212_DACGainM36DB DAC volume -36db.
kDA7212_DACGainM30DB DAC volume -30db.
kDA7212_DACGainM24DB DAC volume -24db.
kDA7212_DACGainM18DB DAC volume -18db.
kDA7212_DACGainM12DB DAC volume -12db.
kDA7212_DACGainM6DB DAC volume -6db.
kDA7212_DACGain0DB DAC volume +0db.
kDA7212_DACGain6DB DAC volume +6db.
kDA7212_DACGain12DB DAC volume +12db.

53.5.4.7 enum da7212_protocol_t

Enumerator

kDA7212_BusI2S I2S Type.
kDA7212_BusLeftJustified Left justified.
kDA7212_BusRightJustified Right Justified.
kDA7212_BusDSPMode DSP mode.

53.5.4.8 enum da7212_sys_clk_source_t

Enumerator

kDA7212_SysClkSourceMCLK da7212 system clock source from MCLK*kDA7212_SysClkSourcePLL* da7212 system clock source from PLL**53.5.4.9 enum da7212_pll_clk_source_t**

Enumerator

kDA7212_PLLClkSourceMCLK DA7212 PLL clock source from MCLK.**53.5.4.10 enum da7212_pll_out_clk_t**

Enumerator

kDA7212_PLLOutputClk11289600U output 112896000U*kDA7212_PLLOutputClk12288000U* output 12288000U**53.5.4.11 enum da7212_master_bits_t**

Enumerator

kDA7212_MasterBits32PerFrame master mode bits32 per frame*kDA7212_MasterBits64PerFrame* master mode bits64 per frame*kDA7212_MasterBits128PerFrame* master mode bits128 per frame*kDA7212_MasterBits256PerFrame* master mode bits256 per frame**53.5.5 Function Documentation****53.5.5.1 status_t DA7212_Init (da7212_handle_t * handle, da7212_config_t * codecConfig)**

Parameters

<i>handle</i>	DA7212 handle pointer.
---------------	------------------------

<i>codecConfig</i>	<p>Codec configure structure. This parameter can be NULL, if NULL, set as default settings. The default setting:</p> <pre> * sgtl_init_t codec_config * codec_config.route = kDA7212_RoutePlayback * codec_config.bus = kDA7212_BusI2S * codec_config.isMaster = false * </pre>
--------------------	---

53.5.5.2 **status_t DA7212_ConfigAudioFormat (da7212_handle_t * *handle*, uint32_t *masterClock_Hz*, uint32_t *sampleRate_Hz*, uint32_t *dataBits*)**

Parameters

<i>handle</i>	DA7212 handle pointer.
<i>masterClock_Hz</i>	Master clock frequency in Hz. If DA7212 is slave, use the frequency of master, if DA7212 as master, it should be 1228000 while sample rate frequency is 8k/12K/16K/24K/32K/48K/96K, 11289600 whie sample rate is 11.025K/22.05K/44.1K
<i>sampleRate_Hz</i>	Sample rate frequency in Hz.
<i>dataBits</i>	How many bits in a word of a audio frame, DA7212 only supports 16/20/24/32 bits.

53.5.5.3 **status_t DA7212_SetPLLConfig (da7212_handle_t * *handle*, da7212_pll_config_t * *config*)**

Parameters

<i>handle</i>	DA7212 handler pointer.
<i>config</i>	PLL configuration pointer.

53.5.5.4 **void DA7212_ChangeHPVolume (da7212_handle_t * *handle*, da7212_volume_t *volume*)**

Parameters

<i>handle</i>	DA7212 handle pointer.
<i>volume</i>	The volume of playback.

53.5.5.5 void DA7212_Mute (da7212_handle_t * *handle*, bool *isMuted*)

Parameters

<i>handle</i>	DA7212 handle pointer.
<i>isMuted</i>	True means mute, false means unmute.

53.5.5.6 void DA7212_ChangeInput (da7212_handle_t * *handle*, da7212_Input_t *DA7212_Input*)

Parameters

<i>handle</i>	DA7212 handle pointer.
<i>DA7212_Input</i>	Input data source.

53.5.5.7 void DA7212_ChangeOutput (da7212_handle_t * *handle*, da7212_Output_t *DA7212_Output*)

Parameters

<i>handle</i>	DA7212 handle pointer.
<i>DA7212_Output</i>	Output device of DA7212.

53.5.5.8 status_t DA7212_SetChannelVolume (da7212_handle_t * *handle*, uint32_t *channel*, uint32_t *volume*)

Parameters

<i>handle</i>	DA7212 handle pointer.
<i>channel</i>	shoule be a value of <code>_da7212_channel</code> .
<i>volume</i>	volume range 0 - 0x3F mapped to range -57dB - 6dB.

53.5.5.9 `status_t DA7212_SetChannelMute (da7212_handle_t * handle, uint32_t channel, bool isMute)`

Parameters

<i>handle</i>	DA7212 handle pointer.
<i>channel</i>	shoule be a value of <code>_da7212_channel</code> .
<i>isMute</i>	true is mute, false is unmute.

53.5.5.10 `status_t DA7212_SetProtocol (da7212_handle_t * handle, da7212_protocol_t protocol)`

Parameters

<i>handle</i>	DA7212 handle pointer.
<i>protocol</i>	<code>da7212_protocol_t</code> .

53.5.5.11 `status_t DA7212_SetMasterModeBits (da7212_handle_t * handle, uint32_t bitWidth)`

Parameters

<i>handle</i>	DA7212 handle pointer.
<i>bitWidth</i>	audio data bitwidth.

53.5.5.12 `status_t DA7212_WriteRegister (da7212_handle_t * handle, uint8_t u8Register, uint8_t u8RegisterData)`

Parameters

<i>handle</i>	DA7212 handle pointer.
<i>u8Register</i>	DA7212 register address to be written.
<i>u8RegisterData</i>	Data to be written into register

53.5.5.13 `status_t DA7212_ReadRegister (da7212_handle_t * handle, uint8_t u8Register, uint8_t * pu8RegisterData)`

Parameters

<i>handle</i>	DA7212 handle pointer.
<i>u8Register</i>	DA7212 register address to be read.
<i>pu8Register-Data</i>	Pointer where the read out value to be stored.

53.5.5.14 `status_t DA7212_Deinit (da7212_handle_t * handle)`

Parameters

<i>handle</i>	DA7212 handle pointer.
---------------	------------------------

53.5.6 DA7212 Adapter

53.5.6.1 Overview

The da7212 adapter provides a codec unify control interface.

Macros

- #define `HAL_CODEC_DA7212_HANDLER_SIZE` (`DA7212_I2C_HANDLER_SIZE + 4`)
codec handler size

Functions

- `status_t HAL_CODEC_DA7212_Init` (void *handle, void *config)
Codec initialization.
- `status_t HAL_CODEC_DA7212_Deinit` (void *handle)
Codec de-initialization.
- `status_t HAL_CODEC_DA7212_SetFormat` (void *handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth)
set audio data format.
- `status_t HAL_CODEC_DA7212_SetVolume` (void *handle, uint32_t playChannel, uint32_t volume)
set audio codec module volume.
- `status_t HAL_CODEC_DA7212_SetMute` (void *handle, uint32_t playChannel, bool isMute)
set audio codec module mute.
- `status_t HAL_CODEC_DA7212_SetPower` (void *handle, uint32_t module, bool powerOn)
set audio codec module power.
- `status_t HAL_CODEC_DA7212_SetRecord` (void *handle, uint32_t recordSource)
codec set record source.
- `status_t HAL_CODEC_DA7212_SetRecordChannel` (void *handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel)
codec set record channel.
- `status_t HAL_CODEC_DA7212_SetPlay` (void *handle, uint32_t playSource)
codec set play source.
- `status_t HAL_CODEC_DA7212_ModuleControl` (void *handle, uint32_t cmd, uint32_t data)
codec module control.
- static `status_t HAL_CODEC_Init` (void *handle, void *config)
Codec initialization.
- static `status_t HAL_CODEC_Deinit` (void *handle)
Codec de-initialization.
- static `status_t HAL_CODEC_SetFormat` (void *handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth)
set audio data format.
- static `status_t HAL_CODEC_SetVolume` (void *handle, uint32_t playChannel, uint32_t volume)
set audio codec module volume.
- static `status_t HAL_CODEC_SetMute` (void *handle, uint32_t playChannel, bool isMute)
set audio codec module mute.
- static `status_t HAL_CODEC_SetPower` (void *handle, uint32_t module, bool powerOn)

- *set audio codec module power.*
static [status_t HAL_CODEC_SetRecord](#) (void *handle, uint32_t recordSource)
codec set record source.
- static [status_t HAL_CODEC_SetRecordChannel](#) (void *handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel)
codec set record channel.
- static [status_t HAL_CODEC_SetPlay](#) (void *handle, uint32_t playSource)
codec set play source.
- static [status_t HAL_CODEC_ModuleControl](#) (void *handle, uint32_t cmd, uint32_t data)
codec module control.

53.5.6.2 Function Documentation

53.5.6.2.1 status_t HAL_CODEC_DA7212_Init (void * handle, void * config)

Parameters

<i>handle</i>	codec handle.
<i>config</i>	codec configuration.

Returns

kStatus_Success is success, else initial failed.

53.5.6.2.2 status_t HAL_CODEC_DA7212_Deinit (void * handle)

Parameters

<i>handle</i>	codec handle.
---------------	---------------

Returns

kStatus_Success is success, else de-initial failed.

53.5.6.2.3 status_t HAL_CODEC_DA7212_SetFormat (void * handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth)

Parameters

<i>handle</i>	codec handle.
<i>mclk</i>	master clock frequency in HZ.
<i>sampleRate</i>	sample rate in HZ.
<i>bitWidth</i>	bit width.

Returns

kStatus_Success is success, else configure failed.

53.5.6.2.4 status_t HAL_CODEC_DA7212_SetVolume (void * *handle*, uint32_t *playChannel*, uint32_t *volume*)

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of _codec_play_channel.
<i>volume</i>	volume value, support 0 ~ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

53.5.6.2.5 status_t HAL_CODEC_DA7212_SetMute (void * *handle*, uint32_t *playChannel*, bool *isMute*)

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of _codec_play_channel.
<i>isMute</i>	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

53.5.6.2.6 status_t HAL_CODEC_DA7212_SetPower (void * *handle*, uint32_t *module*, bool *powerOn*)

Parameters

<i>handle</i>	codec handle.
<i>module</i>	audio codec module.
<i>powerOn</i>	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

53.5.6.2.7 status_t HAL_CODEC_DA7212_SetRecord (void * *handle*, uint32_t *recordSource*)

Parameters

<i>handle</i>	codec handle.
<i>recordSource</i>	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

53.5.6.2.8 status_t HAL_CODEC_DA7212_SetRecordChannel (void * *handle*, uint32_t *leftRecordChannel*, uint32_t *rightRecordChannel*)

Parameters

<i>handle</i>	codec handle.
<i>leftRecord-Channel</i>	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
<i>rightRecord-Channel</i>	audio codec record channel, reference _codec_record_channel, can be a value combine of member in _codec_record_channel.

Returns

kStatus_Success is success, else configure failed.

53.5.6.2.9 status_t HAL_CODEC_DA7212_SetPlay (void * *handle*, uint32_t *playSource*)

Parameters

<i>handle</i>	codec handle.
<i>playSource</i>	audio codec play source, can be a value or combine value of <code>_codec_play_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.5.6.2.10 `status_t HAL_CODEC_DA7212_ModuleControl (void * handle, uint32_t cmd, uint32_t data)`

This function is used for codec module control, support switch digital interface cmd, can be expand to support codec module specific feature

Parameters

<i>handle</i>	codec handle.
<i>cmd</i>	module control cmd, reference <code>_codec_module_ctrl_cmd</code> .
<i>data</i>	value to write, when cmd is <code>kCODEC_ModuleRecordSourceChannel</code> , the data should be a value combine of channel and source, please reference macro <code>CODEC_MODULE_RECORD_SOURCE_CHANNEL(source, LP, LN, RP, RN)</code> , reference codec specific driver for detail configurations.

Returns

`kStatus_Success` is success, else configure failed.

53.5.6.2.11 `static status_t HAL_CODEC_Init (void * handle, void * config) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>config</i>	codec configuration.

Returns

`kStatus_Success` is success, else initial failed.

53.5.6.2.12 `static status_t HAL_CODEC_Deinit (void * handle) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
---------------	---------------

Returns

kStatus_Success is success, else de-initial failed.

53.5.6.2.13 `static status_t HAL_CODEC_SetFormat (void * handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>mclk</i>	master clock frequency in HZ.
<i>sampleRate</i>	sample rate in HZ.
<i>bitWidth</i>	bit width.

Returns

kStatus_Success is success, else configure failed.

53.5.6.2.14 `static status_t HAL_CODEC_SetVolume (void * handle, uint32_t playChannel, uint32_t volume) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of <code>_codec_play_channel</code> .
<i>volume</i>	volume value, support 0 ~ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

53.5.6.2.15 `static status_t HAL_CODEC_SetMute (void * handle, uint32_t playChannel, bool isMute) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of <code>_codec_play_channel</code> .
<i>isMute</i>	true is mute, false is unmute.

Returns

`kStatus_Success` is success, else configure failed.

53.5.6.2.16 `static status_t HAL_CODEC_SetPower (void * handle, uint32_t module, bool powerOn) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>module</i>	audio codec module.
<i>powerOn</i>	true is power on, false is power down.

Returns

`kStatus_Success` is success, else configure failed.

53.5.6.2.17 `static status_t HAL_CODEC_SetRecord (void * handle, uint32_t recordSource) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>recordSource</i>	audio codec record source, can be a value or combine value of <code>_codec_record_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.5.6.2.18 `static status_t HAL_CODEC_SetRecordChannel (void * handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>leftRecord-Channel</i>	audio codec record channel, reference <code>_codec_record_channel</code> , can be a value or combine value of member in <code>_codec_record_channel</code> .
<i>rightRecord-Channel</i>	audio codec record channel, reference <code>_codec_record_channel</code> , can be a value or combine value of member in <code>_codec_record_channel</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.5.6.2.19 `static status_t HAL_CODEC_SetPlay (void * handle, uint32_t playSource) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>playSource</i>	audio codec play source, can be a value or combine value of <code>_codec_play_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.5.6.2.20 `static status_t HAL_CODEC_ModuleControl (void * handle, uint32_t cmd, uint32_t data) [inline], [static]`

This function is used for codec module control, support switch digital interface cmd, can be expand to support codec module specific feature

Parameters

<i>handle</i>	codec handle.
<i>cmd</i>	module control cmd, reference <code>_codec_module_ctrl_cmd</code> .
<i>data</i>	value to write, when cmd is <code>kCODEC_ModuleRecordSourceChannel</code> , the data should be a value combine of channel and source, please reference macro <code>CODEC_MODULE_RECORD_SOURCE_CHANNEL(source, LP, LN, RP, RN)</code> , reference codec specific driver for detail configurations.

Returns

`kStatus_Success` is success, else configure failed.

53.6 SGTL5000 Driver

53.6.1 Overview

The sgtl5000 driver provides a codec control interface.

Data Structures

- struct `sgtl_audio_format_t`
Audio format configuration. [More...](#)
- struct `sgtl_config_t`
Initailize structure of sgtl5000. [More...](#)
- struct `sgtl_handle_t`
SGTL codec handler. [More...](#)

Macros

- #define `CHIP_ID` 0x0000U
Define the register address of sgtl5000.
- #define `SGTL5000_HEADPHONE_MAX_VOLUME_VALUE` 0x7FU
SGTL5000 volume setting range.
- #define `SGTL5000_I2C_ADDR` 0x0A
SGTL5000 I2C address.
- #define `SGTL_I2C_HANDLER_SIZE` `CODEC_I2C_MASTER_HANDLER_SIZE`
sgtl handle size
- #define `SGTL_I2C_BITRATE` 100000U
sgtl i2c baudrate

Enumerations

- enum `sgtl_module_t` {
 `kSGTL_ModuleADC` = 0x0,
 `kSGTL_ModuleDAC`,
 `kSGTL_ModuleDAP`,
 `kSGTL_ModuleHP`,
 `kSGTL_ModuleI2SIN`,
 `kSGTL_ModuleI2SOUT`,
 `kSGTL_ModuleLineIn`,
 `kSGTL_ModuleLineOut`,
 `kSGTL_ModuleMicin` }
Modules in Sgtl5000 board.
- enum `sgtl_route_t` {

- ```

kSGTL_RouteBypass = 0x0,
kSGTL_RoutePlayback,
kSGTL_RoutePlaybackandRecord,
kSGTL_RoutePlaybackwithDAP,
kSGTL_RoutePlaybackwithDAPandRecord,
kSGTL_RouteRecord }
 Sgtl5000 data route.
• enum sgtl_protocol_t {
 kSGTL_BusI2S = 0x0,
 kSGTL_BusLeftJustified,
 kSGTL_BusRightJustified,
 kSGTL_BusPCMA,
 kSGTL_BusPCMB }
 The audio data transfer protocol choice.
• enum {
 kSGTL_HeadphoneLeft = 0,
 kSGTL_HeadphoneRight = 1,
 kSGTL_LineoutLeft = 2,
 kSGTL_LineoutRight = 3 }
 sgtl play channel
• enum {
 kSGTL_RecordSourceLineIn = 0U,
 kSGTL_RecordSourceMic = 1U }
 sgtl record source _sgtl_record_source
• enum {
 kSGTL_PlaySourceLineIn = 0U,
 kSGTL_PlaySourceDAC = 1U }
 sgtl play source _sgtl_play_source
• enum sgtl_sclk_edge_t {
 kSGTL_SclkValidEdgeRising = 0U,
 kSGTL_SclkValidEdgeFalling = 1U }
 SGTL SCLK valid edge.

```

## Functions

- `status_t SGTL_Init (sgtl_handle_t *handle, sgtl_config_t *config)`  
*sgtl5000 initialize function.*
- `status_t SGTL_SetDataRoute (sgtl_handle_t *handle, sgtl_route_t route)`  
*Set audio data route in sgtl5000.*
- `status_t SGTL_SetProtocol (sgtl_handle_t *handle, sgtl_protocol_t protocol)`  
*Set the audio transfer protocol.*
- `void SGTL_SetMasterSlave (sgtl_handle_t *handle, bool master)`  
*Set sgtl5000 as master or slave.*
- `status_t SGTL_SetVolume (sgtl_handle_t *handle, sgtl_module_t module, uint32_t volume)`  
*Set the volume of different modules in sgtl5000.*
- `uint32_t SGTL_GetVolume (sgtl_handle_t *handle, sgtl_module_t module)`  
*Get the volume of different modules in sgtl5000.*

- `status_t SGTL_SetMute` (`sgtl_handle_t *handle`, `sgtl_module_t module`, `bool mute`)  
*Mute/unmute modules in sgtl5000.*
- `status_t SGTL_EnableModule` (`sgtl_handle_t *handle`, `sgtl_module_t module`)  
*Enable expected devices.*
- `status_t SGTL_DisableModule` (`sgtl_handle_t *handle`, `sgtl_module_t module`)  
*Disable expected devices.*
- `status_t SGTL_Deinit` (`sgtl_handle_t *handle`)  
*Deinit the sgtl5000 codec.*
- `status_t SGTL_ConfigDataFormat` (`sgtl_handle_t *handle`, `uint32_t mclk`, `uint32_t sample_rate`, `uint32_t bits`)  
*Configure the data format of audio data.*
- `status_t SGTL_SetPlay` (`sgtl_handle_t *handle`, `uint32_t playSource`)  
*select SGTL codec play source.*
- `status_t SGTL_SetRecord` (`sgtl_handle_t *handle`, `uint32_t recordSource`)  
*select SGTL codec record source.*
- `status_t SGTL_WriteReg` (`sgtl_handle_t *handle`, `uint16_t reg`, `uint16_t val`)  
*Write register to sgtl using I2C.*
- `status_t SGTL_ReadReg` (`sgtl_handle_t *handle`, `uint16_t reg`, `uint16_t *val`)  
*Read register from sgtl using I2C.*
- `status_t SGTL_ModifyReg` (`sgtl_handle_t *handle`, `uint16_t reg`, `uint16_t clr_mask`, `uint16_t val`)  
*Modify some bits in the register using I2C.*

## Driver version

- `#define FSL_SGTL5000_DRIVER_VERSION` (`MAKE_VERSION(2, 1, 1)`)  
*CLOCK driver version 2.1.1.*

## 53.6.2 Data Structure Documentation

### 53.6.2.1 struct sgtl\_audio\_format\_t

#### Data Fields

- `uint32_t mclk_HZ`  
*master clock*
- `uint32_t sampleRate`  
*Sample rate.*
- `uint32_t bitWidth`  
*Bit width.*
- `sgtl_sclk_edge_t sclkEdge`  
*sclk valid edge*

### 53.6.2.2 struct sgtl\_config\_t

#### Data Fields

- `sgtl_route_t route`

- *Audio data route.*  
sgtl\_protocol\_t bus
- *Audio transfer protocol.*  
bool master\_slave
- *Master or slave.*  
sgtl\_audio\_format\_t format
- *audio format*  
uint8\_t slaveAddress
- *code device slave address*  
codec\_i2c\_config\_t i2cConfig
- *i2c bus configuration*

### Field Documentation

(1) sgtl\_route\_t sgtl\_config\_t::route

(2) bool sgtl\_config\_t::master\_slave

True means master, false means slave.

### 53.6.2.3 struct sgtl\_handle\_t

#### Data Fields

- sgtl\_config\_t \* config  
*sgtl config pointer*
- uint8\_t i2cHandle [SGTL\_I2C\_HANDLER\_SIZE]  
*i2c handle*

### 53.6.3 Macro Definition Documentation

53.6.3.1 #define FSL\_SGTL5000\_DRIVER\_VERSION (MAKE\_VERSION(2, 1, 1))

53.6.3.2 #define CHIP\_ID 0x0000U

53.6.3.3 #define SGTL5000\_I2C\_ADDR 0x0A

### 53.6.4 Enumeration Type Documentation

53.6.4.1 enum sgtl\_module\_t

Enumerator

- kSGTL\_ModuleADC* ADC module in SGTL5000.
- kSGTL\_ModuleDAC* DAC module in SGTL5000.
- kSGTL\_ModuleDAP* DAP module in SGTL5000.
- kSGTL\_ModuleHP* Headphone module in SGTL5000.

*kSGTL\_ModuleI2SIN* I2S-IN module in SGTL5000.  
*kSGTL\_ModuleI2SOUT* I2S-OUT module in SGTL5000.  
*kSGTL\_ModuleLineIn* Line-in module in SGTL5000.  
*kSGTL\_ModuleLineOut* Line-out module in SGTL5000.  
*kSGTL\_ModuleMicin* Micphone module in SGTL5000.

#### 53.6.4.2 enum sgtl\_route\_t

Note

Only provide some typical data route, not all route listed. Users cannot combine any routes, once a new route is set, the previous one would be replaced.

Enumerator

*kSGTL\_RouteBypass* LINEIN->Headphone.  
*kSGTL\_RoutePlayback* I2SIN->DAC->Headphone.  
*kSGTL\_RoutePlaybackandRecord* I2SIN->DAC->Headphone, LINEIN->ADC->I2SOUT.  
*kSGTL\_RoutePlaybackwithDAP* I2SIN->DAP->DAC->Headphone.  
*kSGTL\_RoutePlaybackwithDAPandRecord* I2SIN->DAP->DAC->HP, LINEIN->ADC->I2SOUT.  
*kSGTL\_RouteRecord* LINEIN->ADC->I2SOUT.

#### 53.6.4.3 enum sgtl\_protocol\_t

Sgtl5000 only supports I2S format and PCM format.

Enumerator

*kSGTL\_BusI2S* I2S Type.  
*kSGTL\_BusLeftJustified* Left justified.  
*kSGTL\_BusRightJustified* Right Justified.  
*kSGTL\_BusPCMA* PCMA.  
*kSGTL\_BusPCMB* PCMB.

#### 53.6.4.4 anonymous enum

Enumerator

*kSGTL\_HeadphoneLeft* headphone left channel  
*kSGTL\_HeadphoneRight* headphone right channel  
*kSGTL\_LineoutLeft* lineout left channel  
*kSGTL\_LineoutRight* lineout right channel

### 53.6.4.5 anonymous enum

Enumerator

*kSGTL\_RecordSourceLineIn* record source line in  
*kSGTL\_RecordSourceMic* record source single end

### 53.6.4.6 anonymous enum

Enumerator

*kSGTL\_PlaySourceLineIn* play source line in  
*kSGTL\_PlaySourceDAC* play source line in

### 53.6.4.7 enum sgtl\_sclk\_edge\_t

Enumerator

*kSGTL\_SclkValidEdgeRising* SCLK valid edge.  
*kSGTL\_SclkValidEdgeFalling* SCLK falling edge.

## 53.6.5 Function Documentation

### 53.6.5.1 status\_t SGTL\_Init ( sgtl\_handle\_t \* *handle*, sgtl\_config\_t \* *config* )

This function calls SGTL\_I2CInit(), and in this function, some configurations are fixed. The second parameter can be NULL. If users want to change the SGTL5000 settings, a configure structure should be prepared.

Note

If the codec\_config is NULL, it would initialize sgtl5000 using default settings. The default setting:

```
* sgtl_init_t codec_config
* codec_config.route = kSGTL_RoutePlaybackandRecord
* codec_config.bus = kSGTL_BusI2S
* codec_config.master = slave
*
```

Parameters

---

|               |                                                                                                             |
|---------------|-------------------------------------------------------------------------------------------------------------|
| <i>handle</i> | Sgtl5000 handle structure.                                                                                  |
| <i>config</i> | sgtl5000 configuration structure. If this pointer equals to NULL, it means using the default configuration. |

Returns

Initialization status

### 53.6.5.2 **status\_t SGTL\_SetDataRoute ( sgtl\_handle\_t \* *handle*, sgtl\_route\_t *route* )**

This function would set the data route according to route. The route cannot be combined, as all route would enable different modules.

Note

If a new route is set, the previous route would not work.

Parameters

|               |                               |
|---------------|-------------------------------|
| <i>handle</i> | Sgtl5000 handle structure.    |
| <i>route</i>  | Audio data route in sgtl5000. |

### 53.6.5.3 **status\_t SGTL\_SetProtocol ( sgtl\_handle\_t \* *handle*, sgtl\_protocol\_t *protocol* )**

Sgtl5000 only supports I2S, I2S left, I2S right, PCM A, PCM B format.

Parameters

|                 |                               |
|-----------------|-------------------------------|
| <i>handle</i>   | Sgtl5000 handle structure.    |
| <i>protocol</i> | Audio data transfer protocol. |

### 53.6.5.4 **void SGTL\_SetMasterSlave ( sgtl\_handle\_t \* *handle*, bool *master* )**

Parameters

|               |                                        |
|---------------|----------------------------------------|
| <i>handle</i> | Sgtl5000 handle structure.             |
| <i>master</i> | 1 represent master, 0 represent slave. |

#### 53.6.5.5 **status\_t SGTL\_SetVolume ( sgtl\_handle\_t \* *handle*, sgtl\_module\_t *module*, uint32\_t *volume* )**

This function would set the volume of sgtl5000 modules. This interface set module volume. The function assume that left channel and right channel has the same volume.

kSGTL\_ModuleADC volume range: 0 - 0xF, 0dB - 22.5dB kSGTL\_ModuleDAC volume range: 0x3C - 0xF0, 0dB - -90dB kSGTL\_ModuleHP volume range: 0 - 0x7F, 12dB - -51.5dB kSGTL\_ModuleLineOut volume range: 0 - 0x1F, 0.5dB steps

Parameters

|               |                                                                        |
|---------------|------------------------------------------------------------------------|
| <i>handle</i> | Sgtl5000 handle structure.                                             |
| <i>module</i> | Sgtl5000 module, such as DAC, ADC and etc.                             |
| <i>volume</i> | Volume value need to be set. The value is the exact value in register. |

#### 53.6.5.6 **uint32\_t SGTL\_GetVolume ( sgtl\_handle\_t \* *handle*, sgtl\_module\_t *module* )**

This function gets the volume of sgtl5000 modules. This interface get DAC module volume. The function assume that left channel and right channel has the same volume.

Parameters

|               |                                            |
|---------------|--------------------------------------------|
| <i>handle</i> | Sgtl5000 handle structure.                 |
| <i>module</i> | Sgtl5000 module, such as DAC, ADC and etc. |

Returns

Module value, the value is exact value in register.

#### 53.6.5.7 **status\_t SGTL\_SetMute ( sgtl\_handle\_t \* *handle*, sgtl\_module\_t *module*, bool *mute* )**

Parameters

|               |                                            |
|---------------|--------------------------------------------|
| <i>handle</i> | Sgtl5000 handle structure.                 |
| <i>module</i> | Sgtl5000 module, such as DAC, ADC and etc. |
| <i>mute</i>   | True means mute, and false means unmute.   |

### 53.6.5.8 status\_t SGTL\_EnableModule ( sgtl\_handle\_t \* *handle*, sgtl\_module\_t *module* )

Parameters

|               |                            |
|---------------|----------------------------|
| <i>handle</i> | Sgtl5000 handle structure. |
| <i>module</i> | Module expected to enable. |

### 53.6.5.9 status\_t SGTL\_DisableModule ( sgtl\_handle\_t \* *handle*, sgtl\_module\_t *module* )

Parameters

|               |                            |
|---------------|----------------------------|
| <i>handle</i> | Sgtl5000 handle structure. |
| <i>module</i> | Module expected to enable. |

### 53.6.5.10 status\_t SGTL\_Deinit ( sgtl\_handle\_t \* *handle* )

Shut down Sglt5000 modules.

Parameters

|               |                                    |
|---------------|------------------------------------|
| <i>handle</i> | Sgtl5000 handle structure pointer. |
|---------------|------------------------------------|

### 53.6.5.11 status\_t SGTL\_ConfigDataFormat ( sgtl\_handle\_t \* *handle*, uint32\_t *mclk*, uint32\_t *sample\_rate*, uint32\_t *bits* )

This function would configure the registers about the sample rate, bit depths.

Parameters

---



|                    |                                                                                                                                               |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| <i>handle</i>      | Sgtl5000 handle structure pointer.                                                                                                            |
| <i>mclk</i>        | Master clock frequency of I2S.                                                                                                                |
| <i>sample_rate</i> | Sample rate of audio file running in sgtl5000. Sctl5000 now supports 8k, 11.025k, 12k, 16k, 22.05k, 24k, 32k, 44.1k, 48k and 96k sample rate. |
| <i>bits</i>        | Bit depth of audio file (Sctl5000 only supports 16bit, 20bit, 24bit and 32 bit in HW).                                                        |

**53.6.5.12 status\_t SGTL\_SetPlay ( sctl\_handle\_t \* *handle*, uint32\_t *playSource* )**

Parameters

|                   |                                                 |
|-------------------|-------------------------------------------------|
| <i>handle</i>     | Sctl5000 handle structure pointer.              |
| <i>playSource</i> | play source value, reference _sctl_play_source. |

Returns

kStatus\_Success, else failed.

**53.6.5.13 status\_t SGTL\_SetRecord ( sctl\_handle\_t \* *handle*, uint32\_t *recordSource* )**

Parameters

|                     |                                                     |
|---------------------|-----------------------------------------------------|
| <i>handle</i>       | Sctl5000 handle structure pointer.                  |
| <i>recordSource</i> | record source value, reference _sctl_record_source. |

Returns

kStatus\_Success, else failed.

**53.6.5.14 status\_t SGTL\_WriteReg ( sctl\_handle\_t \* *handle*, uint16\_t *reg*, uint16\_t *val* )**

Parameters

|               |                            |
|---------------|----------------------------|
| <i>handle</i> | Sctl5000 handle structure. |
|---------------|----------------------------|

|            |                                         |
|------------|-----------------------------------------|
| <i>reg</i> | The register address in sgtl.           |
| <i>val</i> | Value needs to write into the register. |

#### 53.6.5.15 `status_t SGTL_ReadReg ( sgtl_handle_t * handle, uint16_t reg, uint16_t * val )`

Parameters

|               |                               |
|---------------|-------------------------------|
| <i>handle</i> | Sgtl5000 handle structure.    |
| <i>reg</i>    | The register address in sgtl. |
| <i>val</i>    | Value written to.             |

#### 53.6.5.16 `status_t SGTL_ModifyReg ( sgtl_handle_t * handle, uint16_t reg, uint16_t clr_mask, uint16_t val )`

Parameters

|                 |                                                                                  |
|-----------------|----------------------------------------------------------------------------------|
| <i>handle</i>   | Sgtl5000 handle structure.                                                       |
| <i>reg</i>      | The register address in sgtl.                                                    |
| <i>clr_mask</i> | The mask code for the bits want to write. The bit you want to write should be 0. |
| <i>val</i>      | Value needs to write into the register.                                          |

## 53.6.6 SGTL5000 Adapter

### 53.6.6.1 Overview

The sgtl5000 adapter provides a codec unify control interface.

#### Macros

- #define `HAL_CODEC_SGTL_HANDLER_SIZE` (`SGTL_I2C_HANDLER_SIZE + 4`)  
*codec handler size*

#### Functions

- `status_t HAL_CODEC_SGTL5000_Init` (void \*handle, void \*config)  
*Codec initialization.*
- `status_t HAL_CODEC_SGTL5000_Deinit` (void \*handle)  
*Codec de-initialization.*
- `status_t HAL_CODEC_SGTL5000_SetFormat` (void \*handle, uint32\_t mclk, uint32\_t sampleRate, uint32\_t bitWidth)  
*set audio data format.*
- `status_t HAL_CODEC_SGTL5000_SetVolume` (void \*handle, uint32\_t playChannel, uint32\_t volume)  
*set audio codec module volume.*
- `status_t HAL_CODEC_SGTL5000_SetMute` (void \*handle, uint32\_t playChannel, bool isMute)  
*set audio codec module mute.*
- `status_t HAL_CODEC_SGTL5000_SetPower` (void \*handle, uint32\_t module, bool powerOn)  
*set audio codec module power.*
- `status_t HAL_CODEC_SGTL5000_SetRecord` (void \*handle, uint32\_t recordSource)  
*codec set record source.*
- `status_t HAL_CODEC_SGTL5000_SetRecordChannel` (void \*handle, uint32\_t leftRecordChannel, uint32\_t rightRecordChannel)  
*codec set record channel.*
- `status_t HAL_CODEC_SGTL5000_SetPlay` (void \*handle, uint32\_t playSource)  
*codec set play source.*
- `status_t HAL_CODEC_SGTL5000_ModuleControl` (void \*handle, uint32\_t cmd, uint32\_t data)  
*codec module control.*
- static `status_t HAL_CODEC_Init` (void \*handle, void \*config)  
*Codec initialization.*
- static `status_t HAL_CODEC_Deinit` (void \*handle)  
*Codec de-initialization.*
- static `status_t HAL_CODEC_SetFormat` (void \*handle, uint32\_t mclk, uint32\_t sampleRate, uint32\_t bitWidth)  
*set audio data format.*
- static `status_t HAL_CODEC_SetVolume` (void \*handle, uint32\_t playChannel, uint32\_t volume)  
*set audio codec module volume.*
- static `status_t HAL_CODEC_SetMute` (void \*handle, uint32\_t playChannel, bool isMute)  
*set audio codec module mute.*
- static `status_t HAL_CODEC_SetPower` (void \*handle, uint32\_t module, bool powerOn)

- *set audio codec module power.*  
static [status\\_t HAL\\_CODEC\\_SetRecord](#) (void \*handle, uint32\_t recordSource)  
*codec set record source.*
- static [status\\_t HAL\\_CODEC\\_SetRecordChannel](#) (void \*handle, uint32\_t leftRecordChannel, uint32\_t rightRecordChannel)  
*codec set record channel.*
- static [status\\_t HAL\\_CODEC\\_SetPlay](#) (void \*handle, uint32\_t playSource)  
*codec set play source.*
- static [status\\_t HAL\\_CODEC\\_ModuleControl](#) (void \*handle, uint32\_t cmd, uint32\_t data)  
*codec module control.*

### 53.6.6.2 Function Documentation

#### 53.6.6.2.1 status\_t HAL\_CODEC\_SGTL5000\_Init ( void \* handle, void \* config )

Parameters

|               |                      |
|---------------|----------------------|
| <i>handle</i> | codec handle.        |
| <i>config</i> | codec configuration. |

Returns

kStatus\_Success is success, else initial failed.

#### 53.6.6.2.2 status\_t HAL\_CODEC\_SGTL5000\_Deinit ( void \* handle )

Parameters

|               |               |
|---------------|---------------|
| <i>handle</i> | codec handle. |
|---------------|---------------|

Returns

kStatus\_Success is success, else de-initial failed.

#### 53.6.6.2.3 status\_t HAL\_CODEC\_SGTL5000\_SetFormat ( void \* handle, uint32\_t mclk, uint32\_t sampleRate, uint32\_t bitWidth )

## Parameters

|                   |                               |
|-------------------|-------------------------------|
| <i>handle</i>     | codec handle.                 |
| <i>mclk</i>       | master clock frequency in HZ. |
| <i>sampleRate</i> | sample rate in HZ.            |
| <i>bitWidth</i>   | bit width.                    |

## Returns

kStatus\_Success is success, else configure failed.

**53.6.6.2.4** `status_t HAL_CODEC_SGTL5000_SetVolume ( void * handle, uint32_t playChannel, uint32_t volume )`

## Parameters

|                    |                                                                                                 |
|--------------------|-------------------------------------------------------------------------------------------------|
| <i>handle</i>      | codec handle.                                                                                   |
| <i>playChannel</i> | audio codec play channel, can be a value or combine value of <code>_codec_play_channel</code> . |
| <i>volume</i>      | volume value, support 0 ~ 100, 0 is mute, 100 is the maximum volume value.                      |

## Returns

kStatus\_Success is success, else configure failed.

**53.6.6.2.5** `status_t HAL_CODEC_SGTL5000_SetMute ( void * handle, uint32_t playChannel, bool isMute )`

## Parameters

|                    |                                                                                                 |
|--------------------|-------------------------------------------------------------------------------------------------|
| <i>handle</i>      | codec handle.                                                                                   |
| <i>playChannel</i> | audio codec play channel, can be a value or combine value of <code>_codec_play_channel</code> . |
| <i>isMute</i>      | true is mute, false is unmute.                                                                  |

## Returns

kStatus\_Success is success, else configure failed.

**53.6.6.2.6** `status_t HAL_CODEC_SGTL5000_SetPower ( void * handle, uint32_t module, bool powerOn )`

## Parameters

|                |                                        |
|----------------|----------------------------------------|
| <i>handle</i>  | codec handle.                          |
| <i>module</i>  | audio codec module.                    |
| <i>powerOn</i> | true is power on, false is power down. |

## Returns

kStatus\_Success is success, else configure failed.

### 53.6.6.2.7 status\_t HAL\_CODEC\_SGTL5000\_SetRecord ( void \* *handle*, uint32\_t *recordSource* )

## Parameters

|                     |                                                                                     |
|---------------------|-------------------------------------------------------------------------------------|
| <i>handle</i>       | codec handle.                                                                       |
| <i>recordSource</i> | audio codec record source, can be a value or combine value of _codec_record_source. |

## Returns

kStatus\_Success is success, else configure failed.

### 53.6.6.2.8 status\_t HAL\_CODEC\_SGTL5000\_SetRecordChannel ( void \* *handle*, uint32\_t *leftRecordChannel*, uint32\_t *rightRecordChannel* )

## Parameters

|                            |                                                                                                                                  |
|----------------------------|----------------------------------------------------------------------------------------------------------------------------------|
| <i>handle</i>              | codec handle.                                                                                                                    |
| <i>leftRecord-Channel</i>  | audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel. |
| <i>rightRecord-Channel</i> | audio codec record channel, reference _codec_record_channel, can be a value combine of member in _codec_record_channel.          |

## Returns

kStatus\_Success is success, else configure failed.

### 53.6.6.2.9 status\_t HAL\_CODEC\_SGTL5000\_SetPlay ( void \* *handle*, uint32\_t *playSource* )

## Parameters

|                   |                                                                                               |
|-------------------|-----------------------------------------------------------------------------------------------|
| <i>handle</i>     | codec handle.                                                                                 |
| <i>playSource</i> | audio codec play source, can be a value or combine value of <code>_codec_play_source</code> . |

## Returns

`kStatus_Success` is success, else configure failed.

### 53.6.6.2.10 `status_t HAL_CODEC_SGTL5000_ModuleControl ( void * handle, uint32_t cmd, uint32_t data )`

This function is used for codec module control, support switch digital interface cmd, can be expand to support codec module specific feature

## Parameters

|               |                                                                                                                                                                                                                                                                                                   |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>handle</i> | codec handle.                                                                                                                                                                                                                                                                                     |
| <i>cmd</i>    | module control cmd, reference <code>_codec_module_ctrl_cmd</code> .                                                                                                                                                                                                                               |
| <i>data</i>   | value to write, when cmd is <code>kCODEC_ModuleRecordSourceChannel</code> , the data should be a value combine of channel and source, please reference macro <code>CODEC_MODULE_RECORD_SOURCE_CHANNEL(source, LP, LN, RP, RN)</code> , reference codec specific driver for detail configurations. |

## Returns

`kStatus_Success` is success, else configure failed.

### 53.6.6.2.11 `static status_t HAL_CODEC_Init ( void * handle, void * config ) [inline], [static]`

## Parameters

|               |                      |
|---------------|----------------------|
| <i>handle</i> | codec handle.        |
| <i>config</i> | codec configuration. |

## Returns

`kStatus_Success` is success, else initial failed.

### 53.6.6.2.12 `static status_t HAL_CODEC_Deinit ( void * handle ) [inline], [static]`

## Parameters

|               |               |
|---------------|---------------|
| <i>handle</i> | codec handle. |
|---------------|---------------|

## Returns

kStatus\_Success is success, else de-initial failed.

**53.6.6.2.13** `static status_t HAL_CODEC_SetFormat ( void * handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth ) [inline], [static]`

## Parameters

|                   |                               |
|-------------------|-------------------------------|
| <i>handle</i>     | codec handle.                 |
| <i>mclk</i>       | master clock frequency in HZ. |
| <i>sampleRate</i> | sample rate in HZ.            |
| <i>bitWidth</i>   | bit width.                    |

## Returns

kStatus\_Success is success, else configure failed.

**53.6.6.2.14** `static status_t HAL_CODEC_SetVolume ( void * handle, uint32_t playChannel, uint32_t volume ) [inline], [static]`

## Parameters

|                    |                                                                                                 |
|--------------------|-------------------------------------------------------------------------------------------------|
| <i>handle</i>      | codec handle.                                                                                   |
| <i>playChannel</i> | audio codec play channel, can be a value or combine value of <code>_codec_play_channel</code> . |
| <i>volume</i>      | volume value, support 0 ~ 100, 0 is mute, 100 is the maximum volume value.                      |

## Returns

kStatus\_Success is success, else configure failed.

**53.6.6.2.15** `static status_t HAL_CODEC_SetMute ( void * handle, uint32_t playChannel, bool isMute ) [inline], [static]`



## Parameters

|                    |                                                                                                 |
|--------------------|-------------------------------------------------------------------------------------------------|
| <i>handle</i>      | codec handle.                                                                                   |
| <i>playChannel</i> | audio codec play channel, can be a value or combine value of <code>_codec_play_channel</code> . |
| <i>isMute</i>      | true is mute, false is unmute.                                                                  |

## Returns

`kStatus_Success` is success, else configure failed.

**53.6.6.2.16** `static status_t HAL_CODEC_SetPower ( void * handle, uint32_t module, bool powerOn ) [inline], [static]`

## Parameters

|                |                                        |
|----------------|----------------------------------------|
| <i>handle</i>  | codec handle.                          |
| <i>module</i>  | audio codec module.                    |
| <i>powerOn</i> | true is power on, false is power down. |

## Returns

`kStatus_Success` is success, else configure failed.

**53.6.6.2.17** `static status_t HAL_CODEC_SetRecord ( void * handle, uint32_t recordSource ) [inline], [static]`

## Parameters

|                     |                                                                                                   |
|---------------------|---------------------------------------------------------------------------------------------------|
| <i>handle</i>       | codec handle.                                                                                     |
| <i>recordSource</i> | audio codec record source, can be a value or combine value of <code>_codec_record_source</code> . |

## Returns

`kStatus_Success` is success, else configure failed.

**53.6.6.2.18** `static status_t HAL_CODEC_SetRecordChannel ( void * handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel ) [inline], [static]`

## Parameters

|                            |                                                                                                                                                              |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>handle</i>              | codec handle.                                                                                                                                                |
| <i>leftRecord-Channel</i>  | audio codec record channel, reference <code>_codec_record_channel</code> , can be a value or combine value of member in <code>_codec_record_channel</code> . |
| <i>rightRecord-Channel</i> | audio codec record channel, reference <code>_codec_record_channel</code> , can be a value or combine value of member in <code>_codec_record_channel</code> . |

## Returns

`kStatus_Success` is success, else configure failed.

**53.6.6.2.19** `static status_t HAL_CODEC_SetPlay ( void * handle, uint32_t playSource ) [inline], [static]`

## Parameters

|                   |                                                                                               |
|-------------------|-----------------------------------------------------------------------------------------------|
| <i>handle</i>     | codec handle.                                                                                 |
| <i>playSource</i> | audio codec play source, can be a value or combine value of <code>_codec_play_source</code> . |

## Returns

`kStatus_Success` is success, else configure failed.

**53.6.6.2.20** `static status_t HAL_CODEC_ModuleControl ( void * handle, uint32_t cmd, uint32_t data ) [inline], [static]`

This function is used for codec module control, support switch digital interface cmd, can be expand to support codec module specific feature

## Parameters

|               |                                                                                                                                                                                                                                                                                                   |
|---------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>handle</i> | codec handle.                                                                                                                                                                                                                                                                                     |
| <i>cmd</i>    | module control cmd, reference <code>_codec_module_ctrl_cmd</code> .                                                                                                                                                                                                                               |
| <i>data</i>   | value to write, when cmd is <code>kCODEC_ModuleRecordSourceChannel</code> , the data should be a value combine of channel and source, please reference macro <code>CODEC_MODULE_RECORD_SOURCE_CHANNEL(source, LP, LN, RP, RN)</code> , reference codec specific driver for detail configurations. |

## Returns

`kStatus_Success` is success, else configure failed.

## 53.7 WM8960 Driver

### 53.7.1 Overview

The wm8960 driver provides a codec control interface.

### Data Structures

- struct [wm8960\\_audio\\_format\\_t](#)  
*wm8960 audio format [More...](#)*
- struct [wm8960\\_master\\_sysclk\\_config\\_t](#)  
*wm8960 master system clock configuration [More...](#)*
- struct [wm8960\\_config\\_t](#)  
*Initialize structure of WM8960. [More...](#)*
- struct [wm8960\\_handle\\_t](#)  
*wm8960 codec handler [More...](#)*

### Macros

- #define [WM8960\\_I2C\\_HANDLER\\_SIZE](#) [CODEC\\_I2C\\_MASTER\\_HANDLER\\_SIZE](#)  
*wm8960 handle size*
- #define [WM8960\\_LINVOL](#) 0x0U  
*Define the register address of WM8960.*
- #define [WM8960\\_CACHEREGNUM](#) 56U  
*Cache register number.*
- #define [WM8960\\_CLOCK2\\_BCLK\\_DIV\\_MASK](#) 0xFU  
*WM8960 CLOCK2 bits.*
- #define [WM8960\\_IFACE1\\_FORMAT\\_MASK](#) 0x03U  
*WM8960\_IFACE1 FORMAT bits.*
- #define [WM8960\\_IFACE1\\_WL\\_MASK](#) 0x0CU  
*WM8960\_IFACE1 WL bits.*
- #define [WM8960\\_IFACE1\\_LRP\\_MASK](#) 0x10U  
*WM8960\_IFACE1 LRP bit.*
- #define [WM8960\\_IFACE1\\_DLRSWAP\\_MASK](#) 0x20U  
*WM8960\_IFACE1 DLRSWAP bit.*
- #define [WM8960\\_IFACE1\\_MS\\_MASK](#) 0x40U  
*WM8960\_IFACE1 MS bit.*
- #define [WM8960\\_IFACE1\\_BCLKINV\\_MASK](#) 0x80U  
*WM8960\_IFACE1 BCLKINV bit.*
- #define [WM8960\\_IFACE1\\_ALRSWAP\\_MASK](#) 0x100U  
*WM8960\_IFACE1 ALRSWAP bit.*
- #define [WM8960\\_POWER1\\_VREF\\_MASK](#) 0x40U  
*WM8960\_POWER1.*
- #define [WM8960\\_POWER2\\_DACL\\_MASK](#) 0x100U  
*WM8960\_POWER2.*
- #define [WM8960\\_I2C\\_ADDR](#) 0x1A  
*WM8960 I2C address.*
- #define [WM8960\\_I2C\\_BAUDRATE](#) (100000U)

- *WM8960 I2C baudrate.*
- #define `WM8960_ADC_MAX_VOLUME_VALUE` `0xFFU`  
*WM8960 maximum volume value.*

## Enumerations

- enum `wm8960_module_t` {  
`kWM8960_ModuleADC` = 0,  
`kWM8960_ModuleDAC` = 1,  
`kWM8960_ModuleVREF` = 2,  
`kWM8960_ModuleHP` = 3,  
`kWM8960_ModuleMICB` = 4,  
`kWM8960_ModuleMIC` = 5,  
`kWM8960_ModuleLineIn` = 6,  
`kWM8960_ModuleLineOut` = 7,  
`kWM8960_ModuleSpeaker` = 8,  
`kWM8960_ModuleOMIX` = 9 }  
*Modules in WM8960 board.*
- enum {  
`kWM8960_HeadphoneLeft` = 1,  
`kWM8960_HeadphoneRight` = 2,  
`kWM8960_SpeakerLeft` = 4,  
`kWM8960_SpeakerRight` = 8 }  
*wm8960 play channel*
- enum `wm8960_play_source_t` {  
`kWM8960_PlaySourcePGA` = 1,  
`kWM8960_PlaySourceInput` = 2,  
`kWM8960_PlaySourceDAC` = 4 }  
*wm8960 play source*
- enum `wm8960_route_t` {  
`kWM8960_RouteBypass` = 0,  
`kWM8960_RoutePlayback` = 1,  
`kWM8960_RoutePlaybackandRecord` = 2,  
`kWM8960_RouteRecord` = 5 }  
*WM8960 data route.*
- enum `wm8960_protocol_t` {  
`kWM8960_BusI2S` = 2,  
`kWM8960_BusLeftJustified` = 1,  
`kWM8960_BusRightJustified` = 0,  
`kWM8960_BusPCMA` = 3,  
`kWM8960_BusPCMB` = 3 | (1 << 4) }  
*The audio data transfer protocol choice.*
- enum `wm8960_input_t` {

- ```

kWM8960_InputClosed = 0,
kWM8960_InputSingleEndedMic = 1,
kWM8960_InputDifferentialMicInput2 = 2,
kWM8960_InputDifferentialMicInput3 = 3,
kWM8960_InputLineINPUT2 = 4,
kWM8960_InputLineINPUT3 = 5 }
    wm8960 input source
• enum {
kWM8960_AudioSampleRate8KHz = 8000U,
kWM8960_AudioSampleRate11025Hz = 11025U,
kWM8960_AudioSampleRate12KHz = 12000U,
kWM8960_AudioSampleRate16KHz = 16000U,
kWM8960_AudioSampleRate22050Hz = 22050U,
kWM8960_AudioSampleRate24KHz = 24000U,
kWM8960_AudioSampleRate32KHz = 32000U,
kWM8960_AudioSampleRate44100Hz = 44100U,
kWM8960_AudioSampleRate48KHz = 48000U,
kWM8960_AudioSampleRate96KHz = 96000U,
kWM8960_AudioSampleRate192KHz = 192000U,
kWM8960_AudioSampleRate384KHz = 384000U }
    audio sample rate definition
• enum {
kWM8960_AudioBitWidth16bit = 16U,
kWM8960_AudioBitWidth20bit = 20U,
kWM8960_AudioBitWidth24bit = 24U,
kWM8960_AudioBitWidth32bit = 32U }
    audio bit width
• enum wm8960_sysclk_source_t {
kWM8960_SysClkSourceMclk = 0U,
kWM8960_SysClkSourceInternalPLL = 1U }
    wm8960 sysclk source

```

Functions

- `status_t WM8960_Init (wm8960_handle_t *handle, const wm8960_config_t *config)`
WM8960 initialize function.
- `status_t WM8960_Deinit (wm8960_handle_t *handle)`
Deinit the WM8960 codec.
- `status_t WM8960_SetDataRoute (wm8960_handle_t *handle, wm8960_route_t route)`
Set audio data route in WM8960.
- `status_t WM8960_SetLeftInput (wm8960_handle_t *handle, wm8960_input_t input)`
Set left audio input source in WM8960.
- `status_t WM8960_SetRightInput (wm8960_handle_t *handle, wm8960_input_t input)`
Set right audio input source in WM8960.
- `status_t WM8960_SetProtocol (wm8960_handle_t *handle, wm8960_protocol_t protocol)`
Set the audio transfer protocol.

- void `WM8960_SetMasterSlave` (`wm8960_handle_t *handle`, bool master)
Set WM8960 as master or slave.
- `status_t WM8960_SetVolume` (`wm8960_handle_t *handle`, `wm8960_module_t module`, `uint32_t volume`)
Set the volume of different modules in WM8960.
- `uint32_t WM8960_GetVolume` (`wm8960_handle_t *handle`, `wm8960_module_t module`)
Get the volume of different modules in WM8960.
- `status_t WM8960_SetMute` (`wm8960_handle_t *handle`, `wm8960_module_t module`, bool isEnabled)
Mute modules in WM8960.
- `status_t WM8960_SetModule` (`wm8960_handle_t *handle`, `wm8960_module_t module`, bool isEnabled)
Enable/disable expected devices.
- `status_t WM8960_SetPlay` (`wm8960_handle_t *handle`, `uint32_t playSource`)
SET the WM8960 play source.
- `status_t WM8960_ConfigDataFormat` (`wm8960_handle_t *handle`, `uint32_t sysclk`, `uint32_t sample_rate`, `uint32_t bits`)
Configure the data format of audio data.
- `status_t WM8960_SetJackDetect` (`wm8960_handle_t *handle`, bool isEnabled)
Enable/disable jack detect feature.
- `status_t WM8960_WriteReg` (`wm8960_handle_t *handle`, `uint8_t reg`, `uint16_t val`)
Write register to WM8960 using I2C.
- `status_t WM8960_ReadReg` (`uint8_t reg`, `uint16_t *val`)
Read register from WM8960 using I2C.
- `status_t WM8960_ModifyReg` (`wm8960_handle_t *handle`, `uint8_t reg`, `uint16_t mask`, `uint16_t val`)
Modify some bits in the register using I2C.

Driver version

- `#define FSL_WM8960_DRIVER_VERSION (MAKE_VERSION(2, 2, 1))`
CLOCK driver version 2.2.1.

53.7.2 Data Structure Documentation

53.7.2.1 struct `wm8960_audio_format_t`

Data Fields

- `uint32_t mclk_HZ`
master clock frequency
- `uint32_t sampleRate`
sample rate
- `uint32_t bitWidth`
bit width

53.7.2.2 struct wm8960_master_sysclk_config_t

Data Fields

- `wm8960_sysclk_source_t sysclkSource`
sysclk source
- `uint32_t sysclkFreq`
PLL output frequency value.

53.7.2.3 struct wm8960_config_t

Data Fields

- `wm8960_route_t route`
Audio data route.
- `wm8960_protocol_t bus`
Audio transfer protocol.
- `wm8960_audio_format_t format`
Audio format.
- `bool master_slave`
Master or slave.
- `wm8960_master_sysclk_config_t masterClock`
master clock configurations
- `bool enableSpeaker`
True means enable class D speaker as output, false means no.
- `wm8960_input_t leftInputSource`
Left input source for WM8960.
- `wm8960_input_t rightInputSource`
Right input source for wm8960.
- `wm8960_play_source_t playSource`
play source
- `uint8_t slaveAddress`
wm8960 device address
- `codec_i2c_config_t i2cConfig`
i2c configuration

Field Documentation

(1) `wm8960_route_t wm8960_config_t::route`

(2) `bool wm8960_config_t::master_slave`

53.7.2.4 struct wm8960_handle_t

Data Fields

- `const wm8960_config_t * config`
wm8904 config pointer
- `uint8_t i2cHandle [WM8960_I2C_HANDLER_SIZE]`
i2c handle

53.7.3 Macro Definition Documentation

53.7.3.1 `#define WM8960_LINVOL 0x0U`

53.7.3.2 `#define WM8960_I2C_ADDR 0x1A`

53.7.4 Enumeration Type Documentation

53.7.4.1 `enum wm8960_module_t`

Enumerator

kWM8960_ModuleADC ADC module in WM8960.

kWM8960_ModuleDAC DAC module in WM8960.

kWM8960_ModuleVREF VREF module.

kWM8960_ModuleHP Headphone.

kWM8960_ModuleMICB Mic bias.

kWM8960_ModuleMIC Input Mic.

kWM8960_ModuleLineIn Analog in PGA.

kWM8960_ModuleLineOut Line out module.

kWM8960_ModuleSpeaker Speaker module.

kWM8960_ModuleOMIX Output mixer.

53.7.4.2 `anonymous enum`

Enumerator

kWM8960_HeadphoneLeft wm8960 headphone left channel

kWM8960_HeadphoneRight wm8960 headphone right channel

kWM8960_SpeakerLeft wm8960 speaker left channel

kWM8960_SpeakerRight wm8960 speaker right channel

53.7.4.3 `enum wm8960_play_source_t`

Enumerator

kWM8960_PlaySourcePGA wm8960 play source PGA

kWM8960_PlaySourceInput wm8960 play source Input

kWM8960_PlaySourceDAC wm8960 play source DAC

53.7.4.4 `enum wm8960_route_t`

Only provide some typical data route, not all route listed. Note: Users cannot combine any routes, once a new route is set, the previous one would be replaced.

Enumerator

kWM8960_RouteBypass LINEIN->Headphone.
kWM8960_RoutePlayback I2SIN->DAC->Headphone.
kWM8960_RoutePlaybackandRecord I2SIN->DAC->Headphone, LINEIN->ADC->I2SOUT.
kWM8960_RouteRecord LINEIN->ADC->I2SOUT.

53.7.4.5 enum wm8960_protocol_t

WM8960 only supports I2S format and PCM format.

Enumerator

kWM8960_BusI2S I2S type.
kWM8960_BusLeftJustified Left justified mode.
kWM8960_BusRightJustified Right justified mode.
kWM8960_BusPCMA PCM A mode.
kWM8960_BusPCMB PCM B mode.

53.7.4.6 enum wm8960_input_t

Enumerator

kWM8960_InputClosed Input device is closed.
kWM8960_InputSingleEndedMic Input as single ended mic, only use L/RINPUT1.
kWM8960_InputDifferentialMicInput2 Input as differential mic, use L/RINPUT1 and L/RINPUT2.
kWM8960_InputDifferentialMicInput3 Input as differential mic, use L/RINPUT1 and L/RINPUT3.
kWM8960_InputLineINPUT2 Input as line input, only use L/RINPUT2.
kWM8960_InputLineINPUT3 Input as line input, only use L/RINPUT3.

53.7.4.7 anonymous enum

Enumerator

kWM8960_AudioSampleRate8KHz Sample rate 8000 Hz.
kWM8960_AudioSampleRate11025Hz Sample rate 11025 Hz.
kWM8960_AudioSampleRate12KHz Sample rate 12000 Hz.
kWM8960_AudioSampleRate16KHz Sample rate 16000 Hz.
kWM8960_AudioSampleRate22050Hz Sample rate 22050 Hz.
kWM8960_AudioSampleRate24KHz Sample rate 24000 Hz.
kWM8960_AudioSampleRate32KHz Sample rate 32000 Hz.
kWM8960_AudioSampleRate44100Hz Sample rate 44100 Hz.
kWM8960_AudioSampleRate48KHz Sample rate 48000 Hz.

kWM8960_AudioSampleRate96KHz Sample rate 96000 Hz.
kWM8960_AudioSampleRate192KHz Sample rate 192000 Hz.
kWM8960_AudioSampleRate384KHz Sample rate 384000 Hz.

53.7.4.8 anonymous enum

Enumerator

kWM8960_AudioBitWidth16bit audio bit width 16
kWM8960_AudioBitWidth20bit audio bit width 20
kWM8960_AudioBitWidth24bit audio bit width 24
kWM8960_AudioBitWidth32bit audio bit width 32

53.7.4.9 enum wm8960_sysclk_source_t

Enumerator

kWM8960_SysClkSourceMclk sysclk source from external MCLK
kWM8960_SysClkSourceInternalPLL sysclk source from internal PLL

53.7.5 Function Documentation

53.7.5.1 status_t WM8960_Init (wm8960_handle_t * *handle*, const wm8960_config_t * *config*)

The second parameter is NULL to WM8960 in this version. If users want to change the settings, they have to use `wm8960_write_reg()` or `wm8960_modify_reg()` to set the register value of WM8960. Note: If the `codec_config` is NULL, it would initialize WM8960 using default settings. The default setting: `codec_config->route = kWM8960_RoutePlaybackandRecord` `codec_config->bus = kWM8960_BusI2S` `codec_config->master = slave`

Parameters

<i>handle</i>	WM8960 handle structure.
<i>config</i>	WM8960 configuration structure.

53.7.5.2 status_t WM8960_Deinit (wm8960_handle_t * *handle*)

This function close all modules in WM8960 to save power.

Parameters

<i>handle</i>	WM8960 handle structure pointer.
---------------	----------------------------------

53.7.5.3 **status_t WM8960_SetDataRoute (wm8960_handle_t * *handle*, wm8960_route_t *route*)**

This function would set the data route according to route. The route cannot be combined, as all route would enable different modules. Note: If a new route is set, the previous route would not work.

Parameters

<i>handle</i>	WM8960 handle structure.
<i>route</i>	Audio data route in WM8960.

53.7.5.4 **status_t WM8960_SetLeftInput (wm8960_handle_t * *handle*, wm8960_input_t *input*)**

Parameters

<i>handle</i>	WM8960 handle structure.
<i>input</i>	Audio input source.

53.7.5.5 **status_t WM8960_SetRightInput (wm8960_handle_t * *handle*, wm8960_input_t *input*)**

Parameters

<i>handle</i>	WM8960 handle structure.
<i>input</i>	Audio input source.

53.7.5.6 **status_t WM8960_SetProtocol (wm8960_handle_t * *handle*, wm8960_protocol_t *protocol*)**

WM8960 only supports I2S, left justified, right justified, PCM A, PCM B format.

Parameters

<i>handle</i>	WM8960 handle structure.
<i>protocol</i>	Audio data transfer protocol.

53.7.5.7 void WM8960_SetMasterSlave (wm8960_handle_t * handle, bool master)

Parameters

<i>handle</i>	WM8960 handle structure.
<i>master</i>	1 represent master, 0 represent slave.

53.7.5.8 status_t WM8960_SetVolume (wm8960_handle_t * handle, wm8960_module_t module, uint32_t volume)

This function would set the volume of WM8960 modules. Uses need to appoint the module. The function assume that left channel and right channel has the same volume.

Module:kWM8960_ModuleADC, volume range value: 0 is mute, 1-255 is -97db to 30db
 Module:kWM8960_ModuleDAC, volume range value: 0 is mute, 1-255 is -127db to 0db
 Module:kWM8960_ModuleHP, volume range value: 0 - 2F is mute, 0x30 - 0x7F is -73db to 6db
 Module:kWM8960_ModuleLineIn, volume range value: 0 - 0x3F is -17.25db to 30db
 Module:kWM8960_ModuleSpeaker, volume range value: 0 - 2F is mute, 0x30 - 0x7F is -73db to 6db

Parameters

<i>handle</i>	WM8960 handle structure.
<i>module</i>	Module to set volume, it can be ADC, DAC, Headphone and so on.
<i>volume</i>	Volume value need to be set.

53.7.5.9 uint32_t WM8960_GetVolume (wm8960_handle_t * handle, wm8960_module_t module)

This function gets the volume of WM8960 modules. Uses need to appoint the module. The function assume that left channel and right channel has the same volume.

Parameters

<i>handle</i>	WM8960 handle structure.
<i>module</i>	Module to set volume, it can be ADC, DAC, Headphone and so on.

Returns

Volume value of the module.

53.7.5.10 `status_t WM8960_SetMute (wm8960_handle_t * handle, wm8960_module_t module, bool isEnabled)`

Parameters

<i>handle</i>	WM8960 handle structure.
<i>module</i>	Modules need to be mute.
<i>isEnabled</i>	Mute or unmute, 1 represent mute.

53.7.5.11 `status_t WM8960_SetModule (wm8960_handle_t * handle, wm8960_module_t module, bool isEnabled)`

Parameters

<i>handle</i>	WM8960 handle structure.
<i>module</i>	Module expected to enable.
<i>isEnabled</i>	Enable or disable moudles.

53.7.5.12 `status_t WM8960_SetPlay (wm8960_handle_t * handle, uint32_t playSource)`

Parameters

<i>handle</i>	WM8960 handle structure.
<i>playSource</i>	play source , can be a value combine of kWM8960_ModuleHeadphoneSourcePGA, kWM8960_ModuleHeadphoneSourceDAC, kWM8960_ModulePlaySourceInput, kWM8960_ModulePlayMonoRight, kWM8960_ModulePlayMonoLeft.

Returns

kStatus_WM8904_Success if successful, different code otherwise..

53.7.5.13 `status_t WM8960_ConfigDataFormat (wm8960_handle_t * handle, uint32_t sysclk, uint32_t sample_rate, uint32_t bits)`

This function would configure the registers about the sample rate, bit depths.

Parameters

<i>handle</i>	WM8960 handle structure pointer.
<i>sysclk</i>	system clock of the codec which can be generated by MCLK or PLL output.
<i>sample_rate</i>	Sample rate of audio file running in WM8960. WM8960 now supports 8k, 11.025k, 12k, 16k, 22.05k, 24k, 32k, 44.1k, 48k and 96k sample rate.
<i>bits</i>	Bit depth of audio file (WM8960 only supports 16bit, 20bit, 24bit and 32 bit in HW).

53.7.5.14 `status_t WM8960_SetJackDetect (wm8960_handle_t * handle, bool isEnabled)`

Parameters

<i>handle</i>	WM8960 handle structure.
<i>isEnabled</i>	Enable or disable moudles.

53.7.5.15 `status_t WM8960_WriteReg (wm8960_handle_t * handle, uint8_t reg, uint16_t val)`

Parameters

<i>handle</i>	WM8960 handle structure.
<i>reg</i>	The register address in WM8960.
<i>val</i>	Value needs to write into the register.

53.7.5.16 `status_t WM8960_ReadReg (uint8_t reg, uint16_t * val)`

Parameters

<i>reg</i>	The register address in WM8960.
<i>val</i>	Value written to.

53.7.5.17 `status_t WM8960_ModifyReg (wm8960_handle_t * handle, uint8_t reg, uint16_t mask, uint16_t val)`

Parameters

<i>handle</i>	WM8960 handle structure.
<i>reg</i>	The register address in WM8960.
<i>mask</i>	The mask code for the bits want to write. The bit you want to write should be 0.
<i>val</i>	Value needs to write into the register.

53.7.6 WM8960 Adapter

53.7.6.1 Overview

The wm8960 adapter provides a codec unify control interface.

Macros

- #define `HAL_CODEC_WM8960_HANDLER_SIZE` (`WM8960_I2C_HANDLER_SIZE + 4`)
codec handler size

Functions

- `status_t HAL_CODEC_WM8960_Init` (void *handle, void *config)
Codec initialization.
- `status_t HAL_CODEC_WM8960_Deinit` (void *handle)
Codec de-initialization.
- `status_t HAL_CODEC_WM8960_SetFormat` (void *handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth)
set audio data format.
- `status_t HAL_CODEC_WM8960_SetVolume` (void *handle, uint32_t playChannel, uint32_t volume)
set audio codec module volume.
- `status_t HAL_CODEC_WM8960_SetMute` (void *handle, uint32_t playChannel, bool isMute)
set audio codec module mute.
- `status_t HAL_CODEC_WM8960_SetPower` (void *handle, uint32_t module, bool powerOn)
set audio codec module power.
- `status_t HAL_CODEC_WM8960_SetRecord` (void *handle, uint32_t recordSource)
codec set record source.
- `status_t HAL_CODEC_WM8960_SetRecordChannel` (void *handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel)
codec set record channel.
- `status_t HAL_CODEC_WM8960_SetPlay` (void *handle, uint32_t playSource)
codec set play source.
- `status_t HAL_CODEC_WM8960_ModuleControl` (void *handle, uint32_t cmd, uint32_t data)
codec module control.
- static `status_t HAL_CODEC_Init` (void *handle, void *config)
Codec initialization.
- static `status_t HAL_CODEC_Deinit` (void *handle)
Codec de-initialization.
- static `status_t HAL_CODEC_SetFormat` (void *handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth)
set audio data format.
- static `status_t HAL_CODEC_SetVolume` (void *handle, uint32_t playChannel, uint32_t volume)
set audio codec module volume.
- static `status_t HAL_CODEC_SetMute` (void *handle, uint32_t playChannel, bool isMute)
set audio codec module mute.
- static `status_t HAL_CODEC_SetPower` (void *handle, uint32_t module, bool powerOn)

- *set audio codec module power.*
- static `status_t HAL_CODEC_SetRecord` (void *handle, uint32_t recordSource)
codec set record source.
- static `status_t HAL_CODEC_SetRecordChannel` (void *handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel)
codec set record channel.
- static `status_t HAL_CODEC_SetPlay` (void *handle, uint32_t playSource)
codec set play source.
- static `status_t HAL_CODEC_ModuleControl` (void *handle, uint32_t cmd, uint32_t data)
codec module control.

53.7.6.2 Function Documentation

53.7.6.2.1 `status_t HAL_CODEC_WM8960_Init (void * handle, void * config)`

Parameters

<i>handle</i>	codec handle.
<i>config</i>	codec configuration.

Returns

kStatus_Success is success, else initial failed.

53.7.6.2.2 `status_t HAL_CODEC_WM8960_Deinit (void * handle)`

Parameters

<i>handle</i>	codec handle.
---------------	---------------

Returns

kStatus_Success is success, else de-initial failed.

53.7.6.2.3 `status_t HAL_CODEC_WM8960_SetFormat (void * handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth)`

Parameters

<i>handle</i>	codec handle.
<i>mclk</i>	master clock frequency in HZ.
<i>sampleRate</i>	sample rate in HZ.
<i>bitWidth</i>	bit width.

Returns

kStatus_Success is success, else configure failed.

53.7.6.2.4 status_t HAL_CODEC_WM8960_SetVolume (void * *handle*, uint32_t *playChannel*, uint32_t *volume*)

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of _codec_play_channel.
<i>volume</i>	volume value, support 0 ~ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

53.7.6.2.5 status_t HAL_CODEC_WM8960_SetMute (void * *handle*, uint32_t *playChannel*, bool *isMute*)

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of _codec_play_channel.
<i>isMute</i>	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

53.7.6.2.6 status_t HAL_CODEC_WM8960_SetPower (void * *handle*, uint32_t *module*, bool *powerOn*)

Parameters

<i>handle</i>	codec handle.
<i>module</i>	audio codec module.
<i>powerOn</i>	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

53.7.6.2.7 status_t HAL_CODEC_WM8960_SetRecord (void * *handle*, uint32_t *recordSource*)

Parameters

<i>handle</i>	codec handle.
<i>recordSource</i>	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

53.7.6.2.8 status_t HAL_CODEC_WM8960_SetRecordChannel (void * *handle*, uint32_t *leftRecordChannel*, uint32_t *rightRecordChannel*)

Parameters

<i>handle</i>	codec handle.
<i>leftRecord-Channel</i>	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
<i>rightRecord-Channel</i>	audio codec record channel, reference _codec_record_channel, can be a value combine of member in _codec_record_channel.

Returns

kStatus_Success is success, else configure failed.

53.7.6.2.9 status_t HAL_CODEC_WM8960_SetPlay (void * *handle*, uint32_t *playSource*)

Parameters

<i>handle</i>	codec handle.
<i>playSource</i>	audio codec play source, can be a value or combine value of <code>_codec_play_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.7.6.2.10 `status_t HAL_CODEC_WM8960_ModuleControl (void * handle, uint32_t cmd, uint32_t data)`

This function is used for codec module control, support switch digital interface cmd, can be expand to support codec module specific feature

Parameters

<i>handle</i>	codec handle.
<i>cmd</i>	module control cmd, reference <code>_codec_module_ctrl_cmd</code> .
<i>data</i>	value to write, when cmd is <code>kCODEC_ModuleRecordSourceChannel</code> , the data should be a value combine of channel and source, please reference macro <code>CODEC_MODULE_RECORD_SOURCE_CHANNEL(source, LP, LN, RP, RN)</code> , reference codec specific driver for detail configurations.

Returns

`kStatus_Success` is success, else configure failed.

53.7.6.2.11 `static status_t HAL_CODEC_Init (void * handle, void * config) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>config</i>	codec configuration.

Returns

`kStatus_Success` is success, else initial failed.

53.7.6.2.12 `static status_t HAL_CODEC_Deinit (void * handle) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
---------------	---------------

Returns

kStatus_Success is success, else de-initial failed.

53.7.6.2.13 `static status_t HAL_CODEC_SetFormat (void * handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>mclk</i>	master clock frequency in HZ.
<i>sampleRate</i>	sample rate in HZ.
<i>bitWidth</i>	bit width.

Returns

kStatus_Success is success, else configure failed.

53.7.6.2.14 `static status_t HAL_CODEC_SetVolume (void * handle, uint32_t playChannel, uint32_t volume) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of <code>_codec_play_channel</code> .
<i>volume</i>	volume value, support 0 ~ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

53.7.6.2.15 `static status_t HAL_CODEC_SetMute (void * handle, uint32_t playChannel, bool isMute) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of <code>_codec_play_channel</code> .
<i>isMute</i>	true is mute, false is unmute.

Returns

`kStatus_Success` is success, else configure failed.

53.7.6.2.16 `static status_t HAL_CODEC_SetPower (void * handle, uint32_t module, bool powerOn) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>module</i>	audio codec module.
<i>powerOn</i>	true is power on, false is power down.

Returns

`kStatus_Success` is success, else configure failed.

53.7.6.2.17 `static status_t HAL_CODEC_SetRecord (void * handle, uint32_t recordSource) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>recordSource</i>	audio codec record source, can be a value or combine value of <code>_codec_record_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.7.6.2.18 `static status_t HAL_CODEC_SetRecordChannel (void * handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>leftRecord-Channel</i>	audio codec record channel, reference <code>_codec_record_channel</code> , can be a value or combine value of member in <code>_codec_record_channel</code> .
<i>rightRecord-Channel</i>	audio codec record channel, reference <code>_codec_record_channel</code> , can be a value or combine value of member in <code>_codec_record_channel</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.7.6.2.19 `static status_t HAL_CODEC_SetPlay (void * handle, uint32_t playSource) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>playSource</i>	audio codec play source, can be a value or combine value of <code>_codec_play_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.7.6.2.20 `static status_t HAL_CODEC_ModuleControl (void * handle, uint32_t cmd, uint32_t data) [inline], [static]`

This function is used for codec module control, support switch digital interface cmd, can be expand to support codec module specific feature

Parameters

<i>handle</i>	codec handle.
<i>cmd</i>	module control cmd, reference <code>_codec_module_ctrl_cmd</code> .
<i>data</i>	value to write, when cmd is <code>kCODEC_ModuleRecordSourceChannel</code> , the data should be a value combine of channel and source, please reference macro <code>CODEC_MODULE_RECORD_SOURCE_CHANNEL(source, LP, LN, RP, RN)</code> , reference codec specific driver for detail configurations.

Returns

`kStatus_Success` is success, else configure failed.

53.8 WM8904 Driver

53.8.1 Overview

The wm8904 driver provides a codec control interface.

Data Structures

- struct `wm8904_fl_config_t`
wm8904 fl configuration [More...](#)
- struct `wm8904_audio_format_t`
Audio format configuration. [More...](#)
- struct `wm8904_config_t`
Configuration structure of WM8904. [More...](#)
- struct `wm8904_handle_t`
wm8904 codec handler [More...](#)

Macros

- #define `WM8904_I2C_HANDLER_SIZE` (`CODEC_I2C_MASTER_HANDLER_SIZE`)
wm8904 handle size
- #define `WM8904_DEBUG_REGISTER` 0
wm8904 debug macro
- #define `WM8904_RESET` (0x00)
WM8904 register map.
- #define `WM8904_I2C_ADDRESS` (0x1A)
WM8904 I2C address.
- #define `WM8904_I2C_BITRATE` (400000U)
WM8904 I2C bit rate.
- #define `WM8904_MAP_HEADPHONE_LINEOUT_MAX_VOLUME` 0x3FU
WM8904 maximum volume.

Enumerations

- enum {
 `kStatus_WM8904_Success` = 0x0,
 `kStatus_WM8904_Fail` = 0x1 }
WM8904 status return codes.
- enum {
 `kWM8904_LRCPolarityNormal` = 0U,
 `kWM8904_LRCPolarityInverted` = 1U << 4U }
WM8904 lrc polarity.
- enum `wm8904_module_t` {

- ```

kWM8904_ModuleADC = 0,
kWM8904_ModuleDAC = 1,
kWM8904_ModulePGA = 2,
kWM8904_ModuleHeadphone = 3,
kWM8904_ModuleLineout = 4 }
 wm8904 module value

```
- enum
    - wm8904 play channel*
    - enum `wm8904_timeslot_t` {
 

```

kWM8904_TimeSlot0 = 0U,
kWM8904_TimeSlot1 = 1U }
 WM8904 time slot.

```
    - enum `wm8904_protocol_t` {
 

```

kWM8904_ProtocolI2S = 0x2,
kWM8904_ProtocolLeftJustified = 0x1,
kWM8904_ProtocolRightJustified = 0x0,
kWM8904_ProtocolPCMA = 0x3,
kWM8904_ProtocolPCMB = 0x3 | (1 << 4) }
 The audio data transfer protocol.

```
    - enum `wm8904_fs_ratio_t` {
 

```

kWM8904_FsRatio64X = 0x0,
kWM8904_FsRatio128X = 0x1,
kWM8904_FsRatio192X = 0x2,
kWM8904_FsRatio256X = 0x3,
kWM8904_FsRatio384X = 0x4,
kWM8904_FsRatio512X = 0x5,
kWM8904_FsRatio768X = 0x6,
kWM8904_FsRatio1024X = 0x7,
kWM8904_FsRatio1408X = 0x8,
kWM8904_FsRatio1536X = 0x9 }
 The SYSCLK / fs ratio.

```
    - enum `wm8904_sample_rate_t` {
 

```

kWM8904_SampleRate8kHz = 0x0,
kWM8904_SampleRate12kHz = 0x1,
kWM8904_SampleRate16kHz = 0x2,
kWM8904_SampleRate24kHz = 0x3,
kWM8904_SampleRate32kHz = 0x4,
kWM8904_SampleRate48kHz = 0x5,
kWM8904_SampleRate11025Hz = 0x6,
kWM8904_SampleRate22050Hz = 0x7,
kWM8904_SampleRate44100Hz = 0x8 }
 Sample rate.

```
    - enum `wm8904_bit_width_t` {
 

```

kWM8904_BitWidth16 = 0x0,
kWM8904_BitWidth20 = 0x1,
kWM8904_BitWidth24 = 0x2,

```

- ```

kWM8904_BitWidth32 = 0x3 }
    Bit width.
• enum {
    kWM8904_RecordSourceDifferentialLine = 1U,
    kWM8904_RecordSourceLineInput = 2U,
    kWM8904_RecordSourceDifferentialMic = 4U,
    kWM8904_RecordSourceDigitalMic = 8U }
    wm8904 record source
• enum {
    kWM8904_RecordChannelLeft1 = 1U,
    kWM8904_RecordChannelLeft2 = 2U,
    kWM8904_RecordChannelLeft3 = 4U,
    kWM8904_RecordChannelRight1 = 1U,
    kWM8904_RecordChannelRight2 = 2U,
    kWM8904_RecordChannelRight3 = 4U,
    kWM8904_RecordChannelDifferentialPositive1 = 1U,
    kWM8904_RecordChannelDifferentialPositive2 = 2U,
    kWM8904_RecordChannelDifferentialPositive3 = 4U,
    kWM8904_RecordChannelDifferentialNegative1 = 8U,
    kWM8904_RecordChannelDifferentialNegative2 = 16U,
    kWM8904_RecordChannelDifferentialNegative3 = 32U }
    wm8904 record channel
• enum {
    kWM8904_PlaySourcePGA = 1U,
    kWM8904_PlaySourceDAC = 4U }
    wm8904 play source
• enum wm8904_sys_clk_source_t {
    kWM8904_SysClkSourceMCLK = 0U,
    kWM8904_SysClkSourceFLL = 1U << 14 }
    wm8904 system clock source
• enum wm8904_fll_clk_source_t { kWM8904_FLLClkSourceMCLK = 0U }
    wm8904 fll clock source

```

Functions

- `status_t WM8904_WriteRegister (wm8904_handle_t *handle, uint8_t reg, uint16_t value)`
WM8904 write register.
- `status_t WM8904_ReadRegister (wm8904_handle_t *handle, uint8_t reg, uint16_t *value)`
WM8904 read register.
- `status_t WM8904_ModifyRegister (wm8904_handle_t *handle, uint8_t reg, uint16_t mask, uint16_t value)`
WM8904 modify register.
- `status_t WM8904_Init (wm8904_handle_t *handle, wm8904_config_t *wm8904Config)`
Initializes WM8904.
- `status_t WM8904_Deinit (wm8904_handle_t *handle)`
Deinitializes the WM8904 codec.
- `void WM8904_GetDefaultConfig (wm8904_config_t *config)`

- Fills the configuration structure with default values.*

 - `status_t WM8904_SetMasterSlave` (`wm8904_handle_t *handle`, `bool master`)
Sets WM8904 as master or slave.
 - `status_t WM8904_SetMasterClock` (`wm8904_handle_t *handle`, `uint32_t sysclk`, `uint32_t sampleRate`, `uint32_t bitWidth`)
Sets WM8904 master clock configuration.
 - `status_t WM8904_SetFLLConfig` (`wm8904_handle_t *handle`, `wm8904_fl_config_t *config`)
WM8904 set PLL configuration This function will enable the GPIO1 FLL clock output function, so user can see the generated fl output clock frequency from WM8904 GPIO1.
 - `status_t WM8904_SetProtocol` (`wm8904_handle_t *handle`, `wm8904_protocol_t protocol`)
Sets the audio data transfer protocol.
 - `status_t WM8904_SetAudioFormat` (`wm8904_handle_t *handle`, `uint32_t sysclk`, `uint32_t sampleRate`, `uint32_t bitWidth`)
Sets the audio data format.
 - `status_t WM8904_CheckAudioFormat` (`wm8904_handle_t *handle`, `wm8904_audio_format_t *format`, `uint32_t mclkFreq`)
check and update the audio data format.
 - `status_t WM8904_SetVolume` (`wm8904_handle_t *handle`, `uint16_t volumeLeft`, `uint16_t volumeRight`)
Sets the module output volume.
 - `status_t WM8904_SetMute` (`wm8904_handle_t *handle`, `bool muteLeft`, `bool muteRight`)
Sets the headphone output mute.
 - `status_t WM8904_SelectLRCPolarity` (`wm8904_handle_t *handle`, `uint32_t polarity`)
Select LRC polarity.
 - `status_t WM8904_EnableDACTDMMMode` (`wm8904_handle_t *handle`, `wm8904_timeslot_t timeSlot`)
Enable WM8904 DAC time slot.
 - `status_t WM8904_EnableADCTDMMMode` (`wm8904_handle_t *handle`, `wm8904_timeslot_t timeSlot`)
Enable WM8904 ADC time slot.
 - `status_t WM8904_SetModulePower` (`wm8904_handle_t *handle`, `wm8904_module_t module`, `bool isEnabled`)
SET the module output power.
 - `status_t WM8904_SetDACVolume` (`wm8904_handle_t *handle`, `uint8_t volume`)
SET the DAC module volume.
 - `status_t WM8904_SetChannelVolume` (`wm8904_handle_t *handle`, `uint32_t channel`, `uint32_t volume`)
Sets the channel output volume.
 - `status_t WM8904_SetRecord` (`wm8904_handle_t *handle`, `uint32_t recordSource`)
SET the WM8904 record source.
 - `status_t WM8904_SetRecordChannel` (`wm8904_handle_t *handle`, `uint32_t leftRecordChannel`, `uint32_t rightRecordChannel`)
SET the WM8904 record source.
 - `status_t WM8904_SetPlay` (`wm8904_handle_t *handle`, `uint32_t playSource`)
SET the WM8904 play source.
 - `status_t WM8904_SetChannelMute` (`wm8904_handle_t *handle`, `uint32_t channel`, `bool isMute`)
Sets the channel mute.

Driver version

- #define `FSL_WM8904_DRIVER_VERSION` (`MAKE_VERSION(2, 5, 1)`)
WM8904 driver version 2.5.1.

53.8.2 Data Structure Documentation

53.8.2.1 struct `wm8904_fll_config_t`

Data Fields

- `wm8904_fll_clk_source_t` `source`
fll reference clock source
- `uint32_t` `refClock_HZ`
fll reference clock frequency
- `uint32_t` `outputClock_HZ`
fll output clock frequency

53.8.2.2 struct `wm8904_audio_format_t`

Data Fields

- `wm8904_fs_ratio_t` `fsRatio`
SYSCLK / fs ratio.
- `wm8904_sample_rate_t` `sampleRate`
Sample rate.
- `wm8904_bit_width_t` `bitWidth`
Bit width.

53.8.2.3 struct `wm8904_config_t`

Data Fields

- `bool` `master`
Master or slave.
- `wm8904_sys_clk_source_t` `sysClkSource`
system clock source
- `wm8904_fll_config_t` * `fll`
fll configuration
- `wm8904_protocol_t` `protocol`
Audio transfer protocol.
- `wm8904_audio_format_t` `format`
Audio format.
- `uint32_t` `mclk_HZ`
MCLK frequency value.
- `uint16_t` `recordSource`
record source

- uint16_t `recordChannelLeft`
record channel
- uint16_t `recordChannelRight`
record channel
- uint16_t `playSource`
play source
- uint8_t `slaveAddress`
code device slave address
- `codec_i2c_config_t` `i2cConfig`
i2c bus configuration

53.8.2.4 struct `wm8904_handle_t`

Data Fields

- `wm8904_config_t * config`
wm8904 config pointer
- uint8_t `i2cHandle` [`WM8904_I2C_HANDLER_SIZE`]
i2c handle

53.8.3 Macro Definition Documentation

53.8.3.1 `#define FSL_WM8904_DRIVER_VERSION (MAKE_VERSION(2, 5, 1))`

53.8.3.2 `#define WM8904_I2C_ADDRESS (0x1A)`

53.8.3.3 `#define WM8904_I2C_BITRATE (400000U)`

53.8.4 Enumeration Type Documentation

53.8.4.1 anonymous enum

Enumerator

kStatus_WM8904_Success Success.
kStatus_WM8904_Fail Failure.

53.8.4.2 anonymous enum

Enumerator

kWM8904_LRCPolarityNormal LRC polarity normal.
kWM8904_LRCPolarityInverted LRC polarity inverted.

53.8.4.3 enum wm8904_module_t

Enumerator

kWM8904_ModuleADC module ADC
kWM8904_ModuleDAC module DAC
kWM8904_ModulePGA module PGA
kWM8904_ModuleHeadphone module headphone
kWM8904_ModuleLineout module line out

53.8.4.4 anonymous enum

53.8.4.5 enum wm8904_timeslot_t

Enumerator

kWM8904_TimeSlot0 time slot0
kWM8904_TimeSlot1 time slot1

53.8.4.6 enum wm8904_protocol_t

Enumerator

kWM8904_ProtocolI2S I2S type.
kWM8904_ProtocolLeftJustified Left justified mode.
kWM8904_ProtocolRightJustified Right justified mode.
kWM8904_ProtocolPCMA PCM A mode.
kWM8904_ProtocolPCMB PCM B mode.

53.8.4.7 enum wm8904_fs_ratio_t

Enumerator

kWM8904_FsRatio64X SYSCLK is 64 * sample rate * frame width.
kWM8904_FsRatio128X SYSCLK is 128 * sample rate * frame width.
kWM8904_FsRatio192X SYSCLK is 192 * sample rate * frame width.
kWM8904_FsRatio256X SYSCLK is 256 * sample rate * frame width.
kWM8904_FsRatio384X SYSCLK is 384 * sample rate * frame width.
kWM8904_FsRatio512X SYSCLK is 512 * sample rate * frame width.
kWM8904_FsRatio768X SYSCLK is 768 * sample rate * frame width.
kWM8904_FsRatio1024X SYSCLK is 1024 * sample rate * frame width.
kWM8904_FsRatio1408X SYSCLK is 1408 * sample rate * frame width.
kWM8904_FsRatio1536X SYSCLK is 1536 * sample rate * frame width.

53.8.4.8 enum wm8904_sample_rate_t

Enumerator

kWM8904_SampleRate8kHz 8 kHz
kWM8904_SampleRate12kHz 12kHz
kWM8904_SampleRate16kHz 16kHz
kWM8904_SampleRate24kHz 24kHz
kWM8904_SampleRate32kHz 32kHz
kWM8904_SampleRate48kHz 48kHz
kWM8904_SampleRate11025Hz 11.025kHz
kWM8904_SampleRate22050Hz 22.05kHz
kWM8904_SampleRate44100Hz 44.1kHz

53.8.4.9 enum wm8904_bit_width_t

Enumerator

kWM8904_BitWidth16 16 bits
kWM8904_BitWidth20 20 bits
kWM8904_BitWidth24 24 bits
kWM8904_BitWidth32 32 bits

53.8.4.10 anonymous enum

Enumerator

kWM8904_RecordSourceDifferentialLine record source from differential line
kWM8904_RecordSourceLineInput record source from line input
kWM8904_RecordSourceDifferentialMic record source from differential mic
kWM8904_RecordSourceDigitalMic record source from digital microphone

53.8.4.11 anonymous enum

Enumerator

kWM8904_RecordChannelLeft1 left record channel 1
kWM8904_RecordChannelLeft2 left record channel 2
kWM8904_RecordChannelLeft3 left record channel 3
kWM8904_RecordChannelRight1 right record channel 1
kWM8904_RecordChannelRight2 right record channel 2
kWM8904_RecordChannelRight3 right record channel 3
kWM8904_RecordChannelDifferentialPositive1 differential positive record channel 1
kWM8904_RecordChannelDifferentialPositive2 differential positive record channel 2
kWM8904_RecordChannelDifferentialPositive3 differential positive record channel 3

kWM8904_RecordChannelDifferentialNegative1 differential negative record channel 1
kWM8904_RecordChannelDifferentialNegative2 differential negative record channel 2
kWM8904_RecordChannelDifferentialNegative3 differential negative record channel 3

53.8.4.12 anonymous enum

Enumerator

kWM8904_PlaySourcePGA play source PGA, bypass ADC
kWM8904_PlaySourceDAC play source Input3

53.8.4.13 enum wm8904_sys_clk_source_t

Enumerator

kWM8904_SysClkSourceMCLK wm8904 system clock source from MCLK
kWM8904_SysClkSourceFLL wm8904 system clock source from FLL

53.8.4.14 enum wm8904_fl_clk_source_t

Enumerator

kWM8904_FLLClkSourceMCLK wm8904 FLL clock source from MCLK

53.8.5 Function Documentation

53.8.5.1 status_t WM8904_WriteRegister (wm8904_handle_t * handle, uint8_t reg, uint16_t value)

Parameters

<i>handle</i>	WM8904 handle structure.
<i>reg</i>	register address.
<i>value</i>	value to write.

Returns

kStatus_Success, else failed.

53.8.5.2 status_t WM8904_ReadRegister (wm8904_handle_t * handle, uint8_t reg, uint16_t * value)

Parameters

<i>handle</i>	WM8904 handle structure.
<i>reg</i>	register address.
<i>value</i>	value to read.

Returns

kStatus_Success, else failed.

53.8.5.3 status_t WM8904_ModifyRegister (wm8904_handle_t * *handle*, uint8_t *reg*, uint16_t *mask*, uint16_t *value*)

Parameters

<i>handle</i>	WM8904 handle structure.
<i>reg</i>	register address.
<i>mask</i>	register bits mask.
<i>value</i>	value to write.

Returns

kStatus_Success, else failed.

53.8.5.4 status_t WM8904_Init (wm8904_handle_t * *handle*, wm8904_config_t * *wm8904Config*)

Parameters

<i>handle</i>	WM8904 handle structure.
<i>wm8904Config</i>	WM8904 configuration structure.

53.8.5.5 status_t WM8904_Deinit (wm8904_handle_t * *handle*)

This function resets WM8904.

Parameters

<i>handle</i>	WM8904 handle structure.
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Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.5.6 void WM8904_GetDefaultConfig (wm8904_config_t * config)

The default values are:

master = false; protocol = kWM8904_ProtocolI2S; format.fsRatio = kWM8904_FsRatio64X; format.sampleRate = kWM8904_SampleRate48kHz; format.bitWidth = kWM8904_BitWidth16;

Parameters

<i>config</i>	default configurations of wm8904.
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53.8.5.7 status_t WM8904_SetMasterSlave (wm8904_handle_t * handle, bool master)

Deprecated DO NOT USE THIS API ANYMORE. IT HAS BEEN SUPERCEDED BY [WM8904_SetMasterClock](#)

Parameters

<i>handle</i>	WM8904 handle structure.
<i>master</i>	true for master, false for slave.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.5.8 status_t WM8904_SetMasterClock (wm8904_handle_t * handle, uint32_t sysclk, uint32_t sampleRate, uint32_t bitWidth)

User should pay attention to the sysclk parameter ,When using external MCLK as system clock source, the value should be frequency of MCLK, when using FLL as system clock source, the value should be frequency of the output of FLL.

Parameters

<i>handle</i>	WM8904 handle structure.
<i>sysclk</i>	system clock source frequency.
<i>sampleRate</i>	sample rate
<i>bitWidth</i>	bit width

Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.5.9 status_t WM8904_SetFLLConfig (wm8904_handle_t * *handle*, wm8904_fl_config_t * *config*)

Parameters

<i>handle</i>	wm8904 handler pointer.
<i>config</i>	FLL configuration pointer.

53.8.5.10 status_t WM8904_SetProtocol (wm8904_handle_t * *handle*, wm8904_protocol_t *protocol*)

Parameters

<i>handle</i>	WM8904 handle structure.
<i>protocol</i>	Audio transfer protocol.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.5.11 status_t WM8904_SetAudioFormat (wm8904_handle_t * *handle*, uint32_t *sysclk*, uint32_t *sampleRate*, uint32_t *bitWidth*)

User should pay attention to the *sysclk* parameter ,When using external MCLK as system clock source, the value should be frequency of MCLK, when using FLL as system clock source, the value should be frequency of the output of FLL.

Parameters

<i>handle</i>	WM8904 handle structure.
<i>sysclk</i>	system clock source frequency.
<i>sampleRate</i>	Sample rate frequency in Hz.
<i>bitWidth</i>	Audio data bit width.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.5.12 **status_t WM8904_CheckAudioFormat (wm8904_handle_t * *handle*, wm8904_audio_format_t * *format*, uint32_t *mclkFreq*)**

This api is used check the fsRatio setting based on the mclk and sample rate, if fsRatio setting is not correct, it will correct it according to mclk and sample rate.

Parameters

<i>handle</i>	WM8904 handle structure.
<i>format</i>	audio data format
<i>mclkFreq</i>	mclk frequency

Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.5.13 **status_t WM8904_SetVolume (wm8904_handle_t * *handle*, uint16_t *volumeLeft*, uint16_t *volumeRight*)**

The parameter should be from 0 to 63. The resulting volume will be. 0 for -57DB, 63 for 6DB.

Parameters

<i>handle</i>	WM8904 handle structure.
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<i>volumeLeft</i>	left channel volume.
<i>volumeRight</i>	right channel volume.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.5.14 **status_t WM8904_SetMute (wm8904_handle_t * *handle*, bool *muteLeft*, bool *muteRight*)**

Parameters

<i>handle</i>	WM8904 handle structure.
<i>muteLeft</i>	true to mute left channel, false to unmute.
<i>muteRight</i>	true to mute right channel, false to unmute.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.5.15 **status_t WM8904_SelectLRCPolarity (wm8904_handle_t * *handle*, uint32_t *polarity*)**

Parameters

<i>handle</i>	WM8904 handle structure.
<i>polarity</i>	LRC clock polarity.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.5.16 **status_t WM8904_EnableDACTDMMMode (wm8904_handle_t * *handle*, wm8904_timeslot_t *timeSlot*)**

Parameters

<i>handle</i>	WM8904 handle structure.
<i>timeSlot</i>	timeslot number.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.5.17 status_t WM8904_EnableADCTDMMMode (wm8904_handle_t * *handle*, wm8904_timeslot_t *timeSlot*)

Parameters

<i>handle</i>	WM8904 handle structure.
<i>timeSlot</i>	timeslot number.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.5.18 status_t WM8904_SetModulePower (wm8904_handle_t * *handle*, wm8904_module_t *module*, bool *isEnabled*)

Parameters

<i>handle</i>	WM8904 handle structure.
<i>module</i>	wm8904 module.
<i>isEnabled,true</i>	is power on, false is power down.

Returns

kStatus_WM8904_Success if successful, different code otherwise..

53.8.5.19 status_t WM8904_SetDACVolume (wm8904_handle_t * *handle*, uint8_t *volume*)

Parameters

<i>handle</i>	WM8904 handle structure.
<i>volume</i>	volume to be configured.

Returns

kStatus_WM8904_Success if successful, different code otherwise..

53.8.5.20 **status_t WM8904_SetChannelVolume (wm8904_handle_t * *handle*, uint32_t *channel*, uint32_t *volume*)**

The parameter should be from 0 to 63. The resulting volume will be. 0 for -57dB, 63 for 6DB.

Parameters

<i>handle</i>	codec handle structure.
<i>channel</i>	codec channel.
<i>volume</i>	volume value from 0 -63.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.5.21 **status_t WM8904_SetRecord (wm8904_handle_t * *handle*, uint32_t *recordSource*)**

Parameters

<i>handle</i>	WM8904 handle structure.
<i>recordSource</i>	record source , can be a value of kCODEC_ModuleRecordSourceDifferentialLine, kCODEC_ModuleRecordSourceDifferentialMic, kCODEC_ModuleRecordSourceSingleEndMic, kCODEC_ModuleRecordSourceDigitalMic.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.5.22 **status_t WM8904_SetRecordChannel (wm8904_handle_t * *handle*, uint32_t *leftRecordChannel*, uint32_t *rightRecordChannel*)**

Parameters

<i>handle</i>	WM8904 handle structure.
<i>leftRecord-Channel</i>	channel number of left record channel when using differential source, channel number of single end left channel when using single end source, channel number of digital mic when using digital mic source.
<i>rightRecord-Channel</i>	channel number of right record channel when using differential source, channel number of single end right channel when using single end source.

Returns

kStatus_WM8904_Success if successful, different code otherwise..

53.8.5.23 status_t WM8904_SetPlay (wm8904_handle_t * *handle*, uint32_t *playSource*)

Parameters

<i>handle</i>	WM8904 handle structure.
<i>playSource</i>	play source , can be a value of kCODEC_ModuleHeadphoneSourcePGA, kCODEC_ModuleHeadphoneSourceDAC, kCODEC_ModuleLineoutSourcePGA, kCODEC_ModuleLineoutSourceDAC.

Returns

kStatus_WM8904_Success if successful, different code otherwise..

53.8.5.24 status_t WM8904_SetChannelMute (wm8904_handle_t * *handle*, uint32_t *channel*, bool *isMute*)

Parameters

<i>handle</i>	codec handle structure.
<i>channel</i>	codec module name.
<i>isMute</i>	true is mute, false unmute.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

53.8.6 WM8904 Adapter

53.8.6.1 Overview

The wm8904 adapter provides a codec unify control interface.

Macros

- #define `HAL_CODEC_WM8904_HANDLER_SIZE` (`WM8904_I2C_HANDLER_SIZE + 4`)
codec handler size

Functions

- `status_t HAL_CODEC_WM8904_Init` (void *handle, void *config)
Codec initialization.
- `status_t HAL_CODEC_WM8904_Deinit` (void *handle)
Codec de-initialization.
- `status_t HAL_CODEC_WM8904_SetFormat` (void *handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth)
set audio data format.
- `status_t HAL_CODEC_WM8904_SetVolume` (void *handle, uint32_t playChannel, uint32_t volume)
set audio codec module volume.
- `status_t HAL_CODEC_WM8904_SetMute` (void *handle, uint32_t playChannel, bool isMute)
set audio codec module mute.
- `status_t HAL_CODEC_WM8904_SetPower` (void *handle, uint32_t module, bool powerOn)
set audio codec module power.
- `status_t HAL_CODEC_WM8904_SetRecord` (void *handle, uint32_t recordSource)
codec set record source.
- `status_t HAL_CODEC_WM8904_SetRecordChannel` (void *handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel)
codec set record channel.
- `status_t HAL_CODEC_WM8904_SetPlay` (void *handle, uint32_t playSource)
codec set play source.
- `status_t HAL_CODEC_WM8904_ModuleControl` (void *handle, uint32_t cmd, uint32_t data)
codec module control.
- static `status_t HAL_CODEC_Init` (void *handle, void *config)
Codec initialization.
- static `status_t HAL_CODEC_Deinit` (void *handle)
Codec de-initialization.
- static `status_t HAL_CODEC_SetFormat` (void *handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth)
set audio data format.
- static `status_t HAL_CODEC_SetVolume` (void *handle, uint32_t playChannel, uint32_t volume)
set audio codec module volume.
- static `status_t HAL_CODEC_SetMute` (void *handle, uint32_t playChannel, bool isMute)
set audio codec module mute.
- static `status_t HAL_CODEC_SetPower` (void *handle, uint32_t module, bool powerOn)

- *set audio codec module power.*
static [status_t HAL_CODEC_SetRecord](#) (void *handle, uint32_t recordSource)
codec set record source.
- static [status_t HAL_CODEC_SetRecordChannel](#) (void *handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel)
codec set record channel.
- static [status_t HAL_CODEC_SetPlay](#) (void *handle, uint32_t playSource)
codec set play source.
- static [status_t HAL_CODEC_ModuleControl](#) (void *handle, uint32_t cmd, uint32_t data)
codec module control.

53.8.6.2 Function Documentation

53.8.6.2.1 status_t HAL_CODEC_WM8904_Init (void * handle, void * config)

Parameters

<i>handle</i>	codec handle.
<i>config</i>	codec configuration.

Returns

kStatus_Success is success, else initial failed.

53.8.6.2.2 status_t HAL_CODEC_WM8904_Deinit (void * handle)

Parameters

<i>handle</i>	codec handle.
---------------	---------------

Returns

kStatus_Success is success, else de-initial failed.

53.8.6.2.3 status_t HAL_CODEC_WM8904_SetFormat (void * handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth)

Parameters

<i>handle</i>	codec handle.
<i>mclk</i>	master clock frequency in HZ.
<i>sampleRate</i>	sample rate in HZ.
<i>bitWidth</i>	bit width.

Returns

kStatus_Success is success, else configure failed.

53.8.6.2.4 status_t HAL_CODEC_WM8904_SetVolume (void * *handle*, uint32_t *playChannel*, uint32_t *volume*)

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of _codec_play_channel.
<i>volume</i>	volume value, support 0 ~ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

53.8.6.2.5 status_t HAL_CODEC_WM8904_SetMute (void * *handle*, uint32_t *playChannel*, bool *isMute*)

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of _codec_play_channel.
<i>isMute</i>	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

53.8.6.2.6 status_t HAL_CODEC_WM8904_SetPower (void * *handle*, uint32_t *module*, bool *powerOn*)

Parameters

<i>handle</i>	codec handle.
<i>module</i>	audio codec module.
<i>powerOn</i>	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

53.8.6.2.7 status_t HAL_CODEC_WM8904_SetRecord (void * *handle*, uint32_t *recordSource*)

Parameters

<i>handle</i>	codec handle.
<i>recordSource</i>	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

53.8.6.2.8 status_t HAL_CODEC_WM8904_SetRecordChannel (void * *handle*, uint32_t *leftRecordChannel*, uint32_t *rightRecordChannel*)

Parameters

<i>handle</i>	codec handle.
<i>leftRecord-Channel</i>	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
<i>rightRecord-Channel</i>	audio codec record channel, reference _codec_record_channel, can be a value combine of member in _codec_record_channel.

Returns

kStatus_Success is success, else configure failed.

53.8.6.2.9 status_t HAL_CODEC_WM8904_SetPlay (void * *handle*, uint32_t *playSource*)

Parameters

<i>handle</i>	codec handle.
<i>playSource</i>	audio codec play source, can be a value or combine value of <code>_codec_play_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.8.6.2.10 `status_t HAL_CODEC_WM8904_ModuleControl (void * handle, uint32_t cmd, uint32_t data)`

This function is used for codec module control, support switch digital interface cmd, can be expand to support codec module specific feature

Parameters

<i>handle</i>	codec handle.
<i>cmd</i>	module control cmd, reference <code>_codec_module_ctrl_cmd</code> .
<i>data</i>	value to write, when cmd is <code>kCODEC_ModuleRecordSourceChannel</code> , the data should be a value combine of channel and source, please reference macro <code>CODEC_MODULE_RECORD_SOURCE_CHANNEL(source, LP, LN, RP, RN)</code> , reference codec specific driver for detail configurations.

Returns

`kStatus_Success` is success, else configure failed.

53.8.6.2.11 `static status_t HAL_CODEC_Init (void * handle, void * config) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>config</i>	codec configuration.

Returns

`kStatus_Success` is success, else initial failed.

53.8.6.2.12 `static status_t HAL_CODEC_Deinit (void * handle) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
---------------	---------------

Returns

kStatus_Success is success, else de-initial failed.

53.8.6.2.13 `static status_t HAL_CODEC_SetFormat (void * handle, uint32_t mclk, uint32_t sampleRate, uint32_t bitWidth) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>mclk</i>	master clock frequency in HZ.
<i>sampleRate</i>	sample rate in HZ.
<i>bitWidth</i>	bit width.

Returns

kStatus_Success is success, else configure failed.

53.8.6.2.14 `static status_t HAL_CODEC_SetVolume (void * handle, uint32_t playChannel, uint32_t volume) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of <code>_codec_play_channel</code> .
<i>volume</i>	volume value, support 0 ~ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

53.8.6.2.15 `static status_t HAL_CODEC_SetMute (void * handle, uint32_t playChannel, bool isMute) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>playChannel</i>	audio codec play channel, can be a value or combine value of <code>_codec_play_channel</code> .
<i>isMute</i>	true is mute, false is unmute.

Returns

`kStatus_Success` is success, else configure failed.

53.8.6.2.16 `static status_t HAL_CODEC_SetPower (void * handle, uint32_t module, bool powerOn) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>module</i>	audio codec module.
<i>powerOn</i>	true is power on, false is power down.

Returns

`kStatus_Success` is success, else configure failed.

53.8.6.2.17 `static status_t HAL_CODEC_SetRecord (void * handle, uint32_t recordSource) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>recordSource</i>	audio codec record source, can be a value or combine value of <code>_codec_record_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.8.6.2.18 `static status_t HAL_CODEC_SetRecordChannel (void * handle, uint32_t leftRecordChannel, uint32_t rightRecordChannel) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>leftRecord-Channel</i>	audio codec record channel, reference <code>_codec_record_channel</code> , can be a value or combine value of member in <code>_codec_record_channel</code> .
<i>rightRecord-Channel</i>	audio codec record channel, reference <code>_codec_record_channel</code> , can be a value or combine value of member in <code>_codec_record_channel</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.8.6.2.19 `static status_t HAL_CODEC_SetPlay (void * handle, uint32_t playSource) [inline], [static]`

Parameters

<i>handle</i>	codec handle.
<i>playSource</i>	audio codec play source, can be a value or combine value of <code>_codec_play_source</code> .

Returns

`kStatus_Success` is success, else configure failed.

53.8.6.2.20 `static status_t HAL_CODEC_ModuleControl (void * handle, uint32_t cmd, uint32_t data) [inline], [static]`

This function is used for codec module control, support switch digital interface cmd, can be expand to support codec module specific feature

Parameters

<i>handle</i>	codec handle.
<i>cmd</i>	module control cmd, reference <code>_codec_module_ctrl_cmd</code> .
<i>data</i>	value to write, when cmd is <code>kCODEC_ModuleRecordSourceChannel</code> , the data should be a value combine of channel and source, please reference macro <code>CODEC_MODULE_RECORD_SOURCE_CHANNEL(source, LP, LN, RP, RN)</code> , reference codec specific driver for detail configurations.

Returns

`kStatus_Success` is success, else configure failed.

Chapter 54

Serial Manager

54.1 Overview

This chapter describes the programming interface of the serial manager component.

The serial manager component provides a series of APIs to operate different serial port types. The port types it supports are UART, USB CDC and SWO.

Modules

- [Serial Port SWO](#)
- [Serial Port USB](#)
- [Serial Port Uart](#)

Data Structures

- struct [serial_manager_config_t](#)
serial manager config structure [More...](#)
- struct [serial_manager_callback_message_t](#)
Callback message structure. [More...](#)

Macros

- #define [SERIAL_MANAGER_NON_BLOCKING_MODE](#) (0U)
Enable or disable serial manager non-blocking mode (1 - enable, 0 - disable)
- #define [SERIAL_MANAGER_RING_BUFFER_FLOWCONTROL](#) (0U)
Enable or ring buffer flow control (1 - enable, 0 - disable)
- #define [SERIAL_PORT_TYPE_UART](#) (0U)
Enable or disable uart port (1 - enable, 0 - disable)
- #define [SERIAL_PORT_TYPE_UART_DMA](#) (0U)
Enable or disable uart dma port (1 - enable, 0 - disable)
- #define [SERIAL_PORT_TYPE_USBCDC](#) (0U)
Enable or disable USB CDC port (1 - enable, 0 - disable)
- #define [SERIAL_PORT_TYPE_SWO](#) (0U)
Enable or disable SWO port (1 - enable, 0 - disable)
- #define [SERIAL_PORT_TYPE_VIRTUAL](#) (0U)
Enable or disable USB CDC virtual port (1 - enable, 0 - disable)
- #define [SERIAL_PORT_TYPE_RPMSG](#) (0U)
Enable or disable rPMSG port (1 - enable, 0 - disable)
- #define [SERIAL_PORT_TYPE_SPI_MASTER](#) (0U)
Enable or disable SPI Master port (1 - enable, 0 - disable)
- #define [SERIAL_PORT_TYPE_SPI_SLAVE](#) (0U)
Enable or disable SPI Slave port (1 - enable, 0 - disable)
- #define [SERIAL_MANAGER_TASK_HANDLE_TX](#) (0U)
Enable or disable SerialManager_Task() handle TX to prevent recursive calling.

- #define `SERIAL_MANAGER_WRITE_TIME_DELAY_DEFAULT_VALUE` (1U)
Set the default delay time in ms used by `SerialManager_WriteTimeDelay()`.
- #define `SERIAL_MANAGER_READ_TIME_DELAY_DEFAULT_VALUE` (1U)
Set the default delay time in ms used by `SerialManager_ReadTimeDelay()`.
- #define `SERIAL_MANAGER_TASK_HANDLE_RX_AVAILABLE_NOTIFY` (0U)
Enable or disable `SerialManager_Task()` handle RX data available notify.
- #define `SERIAL_MANAGER_WRITE_HANDLE_SIZE` (4U)
Set serial manager write handle size.
- #define `SERIAL_MANAGER_USE_COMMON_TASK` (0U)
SERIAL_PORT_UART_HANDLE_SIZE/SERIAL_PORT_USB_CDC_HANDLE_SIZE + serial manager dedicated size.
- #define `SERIAL_MANAGER_HANDLE_SIZE` (SERIAL_MANAGER_HANDLE_SIZE_TEMP + 12U)
Definition of serial manager handle size.
- #define `SERIAL_MANAGER_HANDLE_DEFINE`(name) uint32_t name[((SERIAL_MANAGER_HANDLE_SIZE + sizeof(uint32_t) - 1U) / sizeof(uint32_t))]
Defines the serial manager handle.
- #define `SERIAL_MANAGER_WRITE_HANDLE_DEFINE`(name) uint32_t name[((SERIAL_MANAGER_WRITE_HANDLE_SIZE + sizeof(uint32_t) - 1U) / sizeof(uint32_t))]
Defines the serial manager write handle.
- #define `SERIAL_MANAGER_READ_HANDLE_DEFINE`(name) uint32_t name[((SERIAL_MANAGER_READ_HANDLE_SIZE + sizeof(uint32_t) - 1U) / sizeof(uint32_t))]
Defines the serial manager read handle.
- #define `SERIAL_MANAGER_TASK_PRIORITY` (2U)
Macro to set serial manager task priority.
- #define `SERIAL_MANAGER_TASK_STACK_SIZE` (1000U)
Macro to set serial manager task stack size.

Typedefs

- typedef void * `serial_handle_t`
The handle of the serial manager module.
- typedef void * `serial_write_handle_t`
The write handle of the serial manager module.
- typedef void * `serial_read_handle_t`
The read handle of the serial manager module.
- typedef void(* `serial_manager_callback_t`)(void *callbackParam, `serial_manager_callback_message_t` *message, `serial_manager_status_t` status)
serial manager callback function
- typedef void(* `serial_manager_lowpower_critical_callback_t`)(void)
serial manager Lowpower Critical callback function

Enumerations

- enum `serial_port_type_t` {
`kSerialPort_None` = 0U,
`kSerialPort_Uart` = 1U,
`kSerialPort_UsbCdc`,
`kSerialPort_Swo`,
`kSerialPort_Virtual`,
`kSerialPort_Rpmsg`,
`kSerialPort_UartDma`,
`kSerialPort_SpiMaster`,
`kSerialPort_SpiSlave` }
serial port type
- enum `serial_manager_type_t` {
`kSerialManager_NonBlocking` = 0x0U,
`kSerialManager_Blocking` = 0x8F41U }
serial manager type
- enum `serial_manager_status_t` {
`kStatus_SerialManager_Success` = `kStatus_Success`,
`kStatus_SerialManager_Error` = `MAKE_STATUS(kStatusGroup_SERIALMANAGER, 1)`,
`kStatus_SerialManager_Busy` = `MAKE_STATUS(kStatusGroup_SERIALMANAGER, 2)`,
`kStatus_SerialManager_Notify` = `MAKE_STATUS(kStatusGroup_SERIALMANAGER, 3)`,
`kStatus_SerialManager_Canceled`,
`kStatus_SerialManager_HandleConflict` = `MAKE_STATUS(kStatusGroup_SERIALMANAGER, 5)`,
`kStatus_SerialManager_RingBufferOverflow`,
`kStatus_SerialManager_NotConnected` = `MAKE_STATUS(kStatusGroup_SERIALMANAGER, 7)` }
serial manager error code

Functions

- `serial_manager_status_t SerialManager_Init` (`serial_handle_t` serialHandle, const `serial_manager_config_t *config`)
Initializes a serial manager module with the serial manager handle and the user configuration structure.
- `serial_manager_status_t SerialManager_Deinit` (`serial_handle_t` serialHandle)
De-initializes the serial manager module instance.
- `serial_manager_status_t SerialManager_OpenWriteHandle` (`serial_handle_t` serialHandle, `serial_write_handle_t` writeHandle)
Opens a writing handle for the serial manager module.
- `serial_manager_status_t SerialManager_CloseWriteHandle` (`serial_write_handle_t` writeHandle)
Closes a writing handle for the serial manager module.
- `serial_manager_status_t SerialManager_OpenReadHandle` (`serial_handle_t` serialHandle, `serial_read_handle_t` readHandle)
Opens a reading handle for the serial manager module.
- `serial_manager_status_t SerialManager_CloseReadHandle` (`serial_read_handle_t` readHandle)
Closes a reading for the serial manager module.

- [serial_manager_status_t SerialManager_WriteBlocking](#) ([serial_write_handle_t](#) writeHandle, [uint8_t](#) *buffer, [uint32_t](#) length)
Transmits data with the blocking mode.
- [serial_manager_status_t SerialManager_ReadBlocking](#) ([serial_read_handle_t](#) readHandle, [uint8_t](#) *buffer, [uint32_t](#) length)
Reads data with the blocking mode.
- [serial_manager_status_t SerialManager_EnterLowpower](#) ([serial_handle_t](#) serialHandle)
Prepares to enter low power consumption.
- [serial_manager_status_t SerialManager_ExitLowpower](#) ([serial_handle_t](#) serialHandle)
Restores from low power consumption.
- void [SerialManager_SetLowpowerCriticalCb](#) (const [serial_manager_lowpower_critical_CBs_t](#) *pf-Callback)
This function performs initialization of the callbacks structure used to disable lowpower when serial manager is active.

54.2 Data Structure Documentation

54.2.1 struct serial_manager_config_t

Data Fields

- [uint8_t](#) * [ringBuffer](#)
Ring buffer address, it is used to buffer data received by the hardware.
- [uint32_t](#) [ringBufferSize](#)
The size of the ring buffer.
- [serial_port_type_t](#) type
Serial port type.
- [serial_manager_type_t](#) blockType
Serial manager port type.
- void * [portConfig](#)
Serial port configuration.

Field Documentation

(1) [uint8_t](#)* [serial_manager_config_t::ringBuffer](#)

Besides, the memory space cannot be free during the lifetime of the serial manager module.

54.2.2 struct serial_manager_callback_message_t

Data Fields

- [uint8_t](#) * [buffer](#)
Transferred buffer.
- [uint32_t](#) [length](#)
Transferred data length.

54.3 Macro Definition Documentation

54.3.1 #define SERIAL_MANAGER_WRITE_TIME_DELAY_DEFAULT_VALUE (1U)

54.3.2 #define SERIAL_MANAGER_READ_TIME_DELAY_DEFAULT_VALUE (1U)

54.3.3 #define SERIAL_MANAGER_USE_COMMON_TASK (0U)

Macro to determine whether use common task.

54.3.4 #define SERIAL_MANAGER_HANDLE_SIZE (SERIAL_MANAGER_HANDLE_SIZE_TEMP + 12U)

**54.3.5 #define SERIAL_MANAGER_HANDLE_DEFINE(*name*) uint32_t
name[(((SERIAL_MANAGER_HANDLE_SIZE + sizeof(uint32_t) - 1U) /
sizeof(uint32_t)))]**

This macro is used to define a 4 byte aligned serial manager handle. Then use "(serial_handle_t)name" to get the serial manager handle.

The macro should be global and could be optional. You could also define serial manager handle by yourself.

This is an example,

```
* SERIAL_MANAGER_HANDLE_DEFINE(serialManagerHandle);
*
```

Parameters

<i>name</i>	The name string of the serial manager handle.
-------------	---

**54.3.6 #define SERIAL_MANAGER_WRITE_HANDLE_DEFINE(*name*) uint32_t
name[(((SERIAL_MANAGER_WRITE_HANDLE_SIZE + sizeof(uint32_t) -
1U) / sizeof(uint32_t)))]**

This macro is used to define a 4 byte aligned serial manager write handle. Then use "(serial_write_handle_t)name" to get the serial manager write handle.

The macro should be global and could be optional. You could also define serial manager write handle by yourself.

This is an example,

```
* SERIAL_MANAGER_WRITE_HANDLE_DEFINE(serialManagerwriteHandle);
*
```

Parameters

<i>name</i>	The name string of the serial manager write handle.
-------------	---

**54.3.7 #define SERIAL_MANAGER_READ_HANDLE_DEFINE(*name*) uint32_t
name[(((SERIAL_MANAGER_READ_HANDLE_SIZE + sizeof(uint32_t) - 1U) /
sizeof(uint32_t))]**

This macro is used to define a 4 byte aligned serial manager read handle. Then use "(serial_read_handle-
_t)name" to get the serial manager read handle.

The macro should be global and could be optional. You could also define serial manager read handle by yourself.

This is an example,

```
* SERIAL_MANAGER_READ_HANDLE_DEFINE(serialManagerReadHandle);
*
```

Parameters

<i>name</i>	The name string of the serial manager read handle.
-------------	--

54.3.8 #define SERIAL_MANAGER_TASK_PRIORITY (2U)

54.3.9 #define SERIAL_MANAGER_TASK_STACK_SIZE (1000U)

54.4 Enumeration Type Documentation

54.4.1 enum serial_port_type_t

Enumerator

- kSerialPort_None* Serial port is none.
- kSerialPort_Uart* Serial port UART.
- kSerialPort_UsbCdc* Serial port USB CDC.
- kSerialPort_Swo* Serial port SWO.
- kSerialPort_Virtual* Serial port Virtual.
- kSerialPort_Rpmsg* Serial port RPMSG.
- kSerialPort_UartDma* Serial port UART DMA.

kSerialPort_SpiMaster Serial port SPIMASTER.

kSerialPort_SpiSlave Serial port SPISLAVE.

54.4.2 enum serial_manager_type_t

Enumerator

kSerialManager_NonBlocking None blocking handle.

kSerialManager_Blocking Blocking handle.

54.4.3 enum serial_manager_status_t

Enumerator

kStatus_SerialManager_Success Success.

kStatus_SerialManager_Error Failed.

kStatus_SerialManager_Busy Busy.

kStatus_SerialManager_Notify Ring buffer is not empty.

kStatus_SerialManager_Canceled the non-blocking request is canceled

kStatus_SerialManager_HandleConflict The handle is opened.

kStatus_SerialManager_RingBufferOverflow The ring buffer is overflowed.

kStatus_SerialManager_NotConnected The host is not connected.

54.5 Function Documentation

54.5.1 serial_manager_status_t SerialManager_Init (serial_handle_t serialHandle, const serial_manager_config_t * config)

This function configures the Serial Manager module with user-defined settings. The user can configure the configuration structure. The parameter serialHandle is a pointer to point to a memory space of size [SERIAL_MANAGER_HANDLE_SIZE](#) allocated by the caller. The Serial Manager module supports three types of serial port, UART (includes UART, USART, LPSCI, LPUART, etc), USB CDC and swo. Please refer to [serial_port_type_t](#) for serial port setting. These three types can be set by using [serial_manager_config_t](#).

Example below shows how to use this API to configure the Serial Manager. For UART,

```
* #define SERIAL_MANAGER_RING_BUFFER_SIZE (256U)
* static SERIAL_MANAGER_HANDLE_DEFINE(s_serialHandle);
* static uint8_t s_ringBuffer[SERIAL_MANAGER_RING_BUFFER_SIZE];
*
* serial_manager_config_t config;
* serial_port_uart_config_t uartConfig;
* config.type = kSerialPort_Uart;
* config.ringBuffer = &s_ringBuffer[0];
* config.ringBufferSize = SERIAL_MANAGER_RING_BUFFER_SIZE;
* uartConfig.instance = 0;
```



```

*   uartConfig.clockRate = 24000000;
*   uartConfig.baudRate = 115200;
*   uartConfig.parityMode = kSerialManager_UartParityDisabled;
*   uartConfig.stopBitCount = kSerialManager_UartOneStopBit;
*   uartConfig.enableRx = 1;
*   uartConfig.enableTx = 1;
*   uartConfig.enableRxRTS = 0;
*   uartConfig.enableTxCTS = 0;
*   config.portConfig = &uartConfig;
*   SerialManager_Init((serial_handle_t)s_serialHandle, &config);
*

```

For USB CDC,

```

*   #define SERIAL_MANAGER_RING_BUFFER_SIZE (256U)
*   static SERIAL_MANAGER_HANDLE_DEFINE(s_serialHandle);
*   static uint8_t s_ringBuffer[SERIAL_MANAGER_RING_BUFFER_SIZE];
*
*   serial_manager_config_t config;
*   serial_port_usb_cdc_config_t usbCdcConfig;
*   config.type = kSerialPort_UsbCdc;
*   config.ringBuffer = &s_ringBuffer[0];
*   config.ringBufferSize = SERIAL_MANAGER_RING_BUFFER_SIZE;
*   usbCdcConfig.controllerIndex =
*       kSerialManager_UsbControllerKhci0;
*   config.portConfig = &usbCdcConfig;
*   SerialManager_Init((serial_handle_t)s_serialHandle, &config);
*

```

Parameters

<i>serialHandle</i>	Pointer to point to a memory space of size SERIAL_MANAGER_HANDLE_SIZE allocated by the caller. The handle should be 4 byte aligned, because unaligned access doesn't be supported on some devices. You can define the handle in the following two ways: SERIAL_MANAGER_HANDLE_DEFINE(serialHandle) ; or <code>uint32_t serialHandle[((SERIAL_MANAGER_HANDLE_SIZE + sizeof(uint32_t) - 1U) / sizeof(uint32_t))];</code>
<i>config</i>	Pointer to user-defined configuration structure.

Return values

<i>kStatus_SerialManager_Error</i>	An error occurred.
<i>kStatus_SerialManager_Success</i>	The Serial Manager module initialization succeed.

54.5.2 serial_manager_status_t SerialManager_Deinit (serial_handle_t serialHandle)

This function de-initializes the serial manager module instance. If the opened writing or reading handle is not closed, the function will return `kStatus_SerialManager_Busy`.

Parameters

<i>serialHandle</i>	The serial manager module handle pointer.
---------------------	---

Return values

<i>kStatus_SerialManager_Success</i>	The serial manager de-initialization succeed.
<i>kStatus_SerialManager_Busy</i>	Opened reading or writing handle is not closed.

54.5.3 serial_manager_status_t SerialManager_OpenWriteHandle (serial_handle_t serialHandle, serial_write_handle_t writeHandle)

This function Opens a writing handle for the serial manager module. If the serial manager needs to be used in different tasks, the task should open a dedicated write handle for itself by calling [SerialManager_OpenWriteHandle](#). Since there can only one buffer for transmission for the writing handle at the same time, multiple writing handles need to be opened when the multiple transmission is needed for a task.

Parameters

<i>serialHandle</i>	The serial manager module handle pointer. The handle should be 4 byte aligned, because unaligned access doesn't be supported on some devices.
<i>writeHandle</i>	The serial manager module writing handle pointer. The handle should be 4 byte aligned, because unaligned access doesn't be supported on some devices. You can define the handle in the following two ways: SERIAL_MANAGER_WRITE_HANDLE_DEFINE(writeHandle) ; or <code>uint32_t writeHandle[((SERIAL_MANAGER_WRITE_HANDLE_SIZE + sizeof(uint32_t) - 1U) / sizeof(uint32_t))];</code>

Return values

<i>kStatus_SerialManager_Error</i>	An error occurred.
<i>kStatus_SerialManager_HandleConflict</i>	The writing handle was opened.

<i>kStatus_SerialManager_- Success</i>	The writing handle is opened.
--	-------------------------------

Example below shows how to use this API to write data. For task 1,

```
*  static SERIAL_MANAGER_WRITE_HANDLE_DEFINE(s_serialWriteHandle1);
*  static uint8_t s_nonBlockingWelcome1[] = "This is non-blocking writing log for task1!\r\n";
*  SerialManager_OpenWriteHandle((serial_handle_t)serialHandle
*    , (serial_write_handle_t)s_serialWriteHandle1);
*  SerialManager_InstallTxCallback((serial_write_handle_t)s_serialWriteHandle1,
*    Task1_SerialManagerTxCallback,
*    s_serialWriteHandle1);
*  SerialManager_WriteNonBlocking((serial_write_handle_t)s_serialWriteHandle1,
*    s_nonBlockingWelcome1,
*    sizeof(s_nonBlockingWelcome1) - 1U);
*
```

For task 2,

```
*  static SERIAL_MANAGER_WRITE_HANDLE_DEFINE(s_serialWriteHandle2);
*  static uint8_t s_nonBlockingWelcome2[] = "This is non-blocking writing log for task2!\r\n";
*  SerialManager_OpenWriteHandle((serial_handle_t)serialHandle
*    , (serial_write_handle_t)s_serialWriteHandle2);
*  SerialManager_InstallTxCallback((serial_write_handle_t)s_serialWriteHandle2,
*    Task2_SerialManagerTxCallback,
*    s_serialWriteHandle2);
*  SerialManager_WriteNonBlocking((serial_write_handle_t)s_serialWriteHandle2,
*    s_nonBlockingWelcome2,
*    sizeof(s_nonBlockingWelcome2) - 1U);
*
```

54.5.4 serial_manager_status_t SerialManager_CloseWriteHandle (serial_write_handle_t writeHandle)

This function Closes a writing handle for the serial manager module.

Parameters

<i>writeHandle</i>	The serial manager module writing handle pointer.
--------------------	---

Return values

<i>kStatus_SerialManager_- Success</i>	The writing handle is closed.
--	-------------------------------

54.5.5 serial_manager_status_t SerialManager_OpenReadHandle (serial_handle_t serialHandle, serial_read_handle_t readHandle)

This function Opens a reading handle for the serial manager module. The reading handle can not be opened multiple at the same time. The error code kStatus_SerialManager_Busy would be returned when

the previous reading handle is not closed. And there can only be one buffer for receiving for the reading handle at the same time.

Parameters

<i>serialHandle</i>	The serial manager module handle pointer. The handle should be 4 byte aligned, because unaligned access doesn't be supported on some devices.
<i>readHandle</i>	The serial manager module reading handle pointer. The handle should be 4 byte aligned, because unaligned access doesn't be supported on some devices. You can define the handle in the following two ways: SERIAL_MANAGER_READ_HANDLE_DEFINE(readHandle) ; or <code>uint32_t readHandle[((SERIAL_MANAGER_READ_HANDLE_SIZE + sizeof(uint32_t) - 1U) / sizeof(uint32_t))];</code>

Return values

<i>kStatus_SerialManager_Error</i>	An error occurred.
<i>kStatus_SerialManager_Success</i>	The reading handle is opened.
<i>kStatus_SerialManager_Busy</i>	Previous reading handle is not closed.

Example below shows how to use this API to read data.

```
*  static SERIAL_MANAGER_READ_HANDLE_DEFINE(s_serialReadHandle);
*  SerialManager_OpenReadHandle((serial_handle_t)serialHandle,
*    (serial_read_handle_t)s_serialReadHandle);
*  static uint8_t s_nonBlockingBuffer[64];
*  SerialManager_InstallRxCallback((serial_read_handle_t)s_serialReadHandle,
*    APP_SerialManagerRxCallback,
*    s_serialReadHandle);
*  SerialManager_ReadNonBlocking((serial_read_handle_t)s_serialReadHandle,
*    s_nonBlockingBuffer,
*    sizeof(s_nonBlockingBuffer));
*
```

54.5.6 serial_manager_status_t SerialManager_CloseReadHandle (serial_read_handle_t readHandle)

This function Closes a reading for the serial manager module.

Parameters

<i>readHandle</i>	The serial manager module reading handle pointer.
-------------------	---

Return values

<i>kStatus_SerialManager_- Success</i>	The reading handle is closed.
--	-------------------------------

54.5.7 serial_manager_status_t SerialManager_WriteBlocking (serial- _write_handle_t writeHandle, uint8_t * buffer, uint32_t length)

This is a blocking function, which polls the sending queue, waits for the sending queue to be empty. This function sends data using an interrupt method. The interrupt of the hardware could not be disabled. And There can only one buffer for transmission for the writing handle at the same time.

Note

The function [SerialManager_WriteBlocking](#) and the function [SerialManager_WriteNonBlocking](#) cannot be used at the same time. And, the function [SerialManager_CancelWriting](#) cannot be used to abort the transmission of this function.

Parameters

<i>writeHandle</i>	The serial manager module handle pointer.
<i>buffer</i>	Start address of the data to write.
<i>length</i>	Length of the data to write.

Return values

<i>kStatus_SerialManager_- Success</i>	Successfully sent all data.
<i>kStatus_SerialManager_- Busy</i>	Previous transmission still not finished; data not all sent yet.
<i>kStatus_SerialManager_- Error</i>	An error occurred.

54.5.8 serial_manager_status_t SerialManager_ReadBlocking (serial- _read_handle_t readHandle, uint8_t * buffer, uint32_t length)

This is a blocking function, which polls the receiving buffer, waits for the receiving buffer to be full. This function receives data using an interrupt method. The interrupt of the hardware could not be disabled. And There can only one buffer for receiving for the reading handle at the same time.

Note

The function [SerialManager_ReadBlocking](#) and the function `SerialManager_ReadNonBlocking` cannot be used at the same time. And, the function `SerialManager_CancelReading` cannot be used to abort the transmission of this function.

Parameters

<i>readHandle</i>	The serial manager module handle pointer.
<i>buffer</i>	Start address of the data to store the received data.
<i>length</i>	The length of the data to be received.

Return values

<i>kStatus_SerialManager_</i> <i>Success</i>	Successfully received all data.
<i>kStatus_SerialManager_</i> <i>Busy</i>	Previous transmission still not finished; data not all received yet.
<i>kStatus_SerialManager_</i> <i>Error</i>	An error occurred.

54.5.9 serial_manager_status_t SerialManager_EnterLowpower (serial_handle_t serialHandle)

This function is used to prepare to enter low power consumption.

Parameters

<i>serialHandle</i>	The serial manager module handle pointer.
---------------------	---

Return values

<i>kStatus_SerialManager_</i> <i>Success</i>	Successful operation.
---	-----------------------

54.5.10 serial_manager_status_t SerialManager_ExitLowpower (serial_handle_t serialHandle)

This function is used to restore from low power consumption.

Parameters

<i>serialHandle</i>	The serial manager module handle pointer.
---------------------	---

Return values

<i>kStatus_SerialManager_Success</i>	Successful operation.
--------------------------------------	-----------------------

54.5.11 void SerialManager_SetLowpowerCriticalCb (const serial_manager_lowpower_critical_CBs_t * *pfCallback*)

Parameters

<i>pfCallback</i>	Pointer to the function structure used to allow/disable lowpower.
-------------------	---

54.6 Serial Port Uart

54.6.1 Overview

Macros

- #define `SERIAL_PORT_UART_DMA_RECEIVE_DATA_LENGTH` (64U)
serial port uart handle size
- #define `SERIAL_USE_CONFIGURE_STRUCTURE` (0U)
Enable or disable the configure structure pointer.

Enumerations

- enum `serial_port_uart_parity_mode_t` {
 `kSerialManager_UartParityDisabled` = 0x0U,
 `kSerialManager_UartParityEven` = 0x2U,
 `kSerialManager_UartParityOdd` = 0x3U }
serial port uart parity mode
- enum `serial_port_uart_stop_bit_count_t` {
 `kSerialManager_UartOneStopBit` = 0U,
 `kSerialManager_UartTwoStopBit` = 1U }
serial port uart stop bit count

54.6.2 Enumeration Type Documentation

54.6.2.1 enum serial_port_uart_parity_mode_t

Enumerator

kSerialManager_UartParityDisabled Parity disabled.
kSerialManager_UartParityEven Parity even enabled.
kSerialManager_UartParityOdd Parity odd enabled.

54.6.2.2 enum serial_port_uart_stop_bit_count_t

Enumerator

kSerialManager_UartOneStopBit One stop bit.
kSerialManager_UartTwoStopBit Two stop bits.

54.7 Serial Port USB

54.7.1 Overview

Modules

- [USB Device Configuration](#)

Data Structures

- struct [serial_port_usb_cdc_config_t](#)
serial port usb config struct [More...](#)

Macros

- #define [SERIAL_PORT_USB_CDC_HANDLE_SIZE](#) (72U)
serial port usb handle size
- #define [USB_DEVICE_INTERRUPT_PRIORITY](#) (3U)
USB interrupt priority.

Enumerations

- enum [serial_port_usb_cdc_controller_index_t](#) {
[kSerialManager_UsbControllerKhci0](#) = 0U,
[kSerialManager_UsbControllerKhci1](#) = 1U,
[kSerialManager_UsbControllerEhci0](#) = 2U,
[kSerialManager_UsbControllerEhci1](#) = 3U,
[kSerialManager_UsbControllerLpcIp3511Fs0](#) = 4U,
[kSerialManager_UsbControllerLpcIp3511Fs1](#) = 5U,
[kSerialManager_UsbControllerLpcIp3511Hs0](#) = 6U,
[kSerialManager_UsbControllerLpcIp3511Hs1](#) = 7U,
[kSerialManager_UsbControllerOhci0](#) = 8U,
[kSerialManager_UsbControllerOhci1](#) = 9U,
[kSerialManager_UsbControllerIp3516Hs0](#) = 10U,
[kSerialManager_UsbControllerIp3516Hs1](#) = 11U }
USB controller ID.

54.7.2 Data Structure Documentation

54.7.2.1 struct serial_port_usb_cdc_config_t

Data Fields

- [serial_port_usb_cdc_controller_index_t controllerIndex](#)
controller index

54.7.3 Enumeration Type Documentation

54.7.3.1 enum serial_port_usb_cdc_controller_index_t

Enumerator

kSerialManager_UsbControllerKhci0 KHCI 0U.

kSerialManager_UsbControllerKhci1 KHCI 1U, Currently, there are no platforms which have two KHCI IPs, this is reserved to be used in the future.

kSerialManager_UsbControllerEhci0 EHCI 0U.

kSerialManager_UsbControllerEhci1 EHCI 1U, Currently, there are no platforms which have two EHCI IPs, this is reserved to be used in the future.

kSerialManager_UsbControllerLpcIp3511Fs0 LPC USB IP3511 FS controller 0.

kSerialManager_UsbControllerLpcIp3511Fs1 LPC USB IP3511 FS controller 1, there are no platforms which have two IP3511 IPs, this is reserved to be used in the future.

kSerialManager_UsbControllerLpcIp3511Hs0 LPC USB IP3511 HS controller 0.

kSerialManager_UsbControllerLpcIp3511Hs1 LPC USB IP3511 HS controller 1, there are no platforms which have two IP3511 IPs, this is reserved to be used in the future.

kSerialManager_UsbControllerOhci0 OHCI 0U.

kSerialManager_UsbControllerOhci1 OHCI 1U, Currently, there are no platforms which have two OHCI IPs, this is reserved to be used in the future.

kSerialManager_UsbControllerIp3516Hs0 IP3516HS 0U.

kSerialManager_UsbControllerIp3516Hs1 IP3516HS 1U, Currently, there are no platforms which have two IP3516HS IPs, this is reserved to be used in the future.

54.7.4 USB Device Configuration

54.8 Serial Port SWO

54.8.1 Overview

Data Structures

- struct [serial_port_swo_config_t](#)
serial port swo config struct [More...](#)

Macros

- #define [SERIAL_PORT_SWO_HANDLE_SIZE](#) (12U)
serial port swo handle size

Enumerations

- enum [serial_port_swo_protocol_t](#) {
 [kSerialManager_SwoProtocolManchester](#) = 1U,
 [kSerialManager_SwoProtocolNrz](#) = 2U }
serial port swo protocol

54.8.2 Data Structure Documentation

54.8.2.1 struct serial_port_swo_config_t

Data Fields

- uint32_t [clockRate](#)
clock rate
- uint32_t [baudRate](#)
baud rate
- uint32_t [port](#)
Port used to transfer data.
- [serial_port_swo_protocol_t](#) [protocol](#)
SWO protocol.

54.8.3 Enumeration Type Documentation

54.8.3.1 enum serial_port_swo_protocol_t

Enumerator

- [kSerialManager_SwoProtocolManchester](#)* SWO Manchester protocol.
- [kSerialManager_SwoProtocolNrz](#)* SWO UART/NRZ protocol.

54.8.4 CODEC Adapter

54.8.4.1 Overview

Enumerations

- enum {
 - `kCODEC_WM8904`,
 - `kCODEC_WM8960`,
 - `kCODEC_WM8524`,
 - `kCODEC_SGTL5000`,
 - `kCODEC_DA7212`,
 - `kCODEC_CS42888`,
 - `kCODEC_CS42448`,
 - `kCODEC_AK4497`,
 - `kCODEC_AK4458`,
 - `kCODEC_TFA9XXX`,
 - `kCODEC_TFA9896`,
 - `kCODEC_WM8962` }*codec type*

54.8.4.2 Enumeration Type Documentation

54.8.4.2.1 anonymous enum

Enumerator

kCODEC_WM8904 wm8904
kCODEC_WM8960 wm8960
kCODEC_WM8524 wm8524
kCODEC_SGTL5000 sgtl5000
kCODEC_DA7212 da7212
kCODEC_CS42888 CS42888.
kCODEC_CS42448 CS42448.
kCODEC_AK4497 AK4497.
kCODEC_AK4458 ak4458
kCODEC_TFA9XXX tfa9xxx
kCODEC_TFA9896 tfa9896
kCODEC_WM8962 wm8962

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