Document Number: MCUXSDKAPIRM
Rev 2.11.0
Jan 2022

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.

  All demo applications and driver examples are provided with projects for the following toolchains:
  - IAR Embedded Workbench
  - GNU Arm Embedded Toolchain

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/DMA 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 reimplementation 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_arm_pll_config_t
  PLL configuration for ARM. More...
- 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_video_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_ARM_OFFSET 0x00
  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
  clock1PN 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 CSI_CLOCKS

  Clock ip name array for CSI.
- #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 LCDIF_CLOCKS

  Clock ip name array for LCDIF.
- #define LCDIF_PERIPH_CLOCKS

  Clock ip name array for LCDIF PIXEL.
- #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 MQS_CLOCKS

  Clock ip name array for MQS.

- #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 PXP_CLOCKS
  Clock ip name array for PXP.
- #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 TSC_CLOCKS
  Clock ip name array for TSC.
- #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_ArmPllClk = 0x7U,
  kCLOCK_Usb1PllClk = 0x8U,
  kCLOCK_Usb1PllPfd0Clk = 0x9U,
  kCLOCK_Usb1PllPfd1Clk = 0xAU,
  kCLOCK_Usb1PllPfd2Clk = 0xBU,
  kCLOCK_Usb1PllPfd3Clk = 0xCU,
  kCLOCK_Usb1SwClk = 0x18U,
  kCLOCK_Usb1Sw120MClk = 0x19U,
  kCLOCK_Usb1Sw60MClk = 0x1AU,
  kCLOCK_Usb1Sw80MClk = 0x1BU,
  kCLOCK_Usb2PllClk = 0xDU,
  kCLOCK_SysPllClk = 0xEU,
  kCLOCK_SysPllPfd0Clk = 0xFU,
  kCLOCK_SysPllPfd1Clk = 0x10U,
  kCLOCK_SysPllPfd2Clk = 0x11U,
  kCLOCK_SysPllPfd3Clk = 0x12U,
  kCLOCK_EnetPll0Clk = 0x13U,
  kCLOCK_EnetPll1Clk = 0x14U,
  kCLOCK_EnetPll2Clk = 0x15U,
  kCLOCK_AudioPllClk = 0x16U,
  kCLOCK_VideoPllClk = 0x17U,
  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_FlexSpiExsc = (0U << 8U) | CCM_CCGR0_CG3_SHIFT,
kCLOCK_Sim_M_Main = (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_Aoi2 = (1U << 8U) | CCM_CCGR1_CG7_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_Csi = (2U << 8U) | CCM_CCGR2_CG1_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_Xbar3 = (2U << 8U) | CCM_CCGR2_CG7_SHIFT,
kCLOCK_Ipmux1 = (2U << 8U) | CCM_CCGR2_CG8_SHIFT,
kCLOCK_Ipmux2 = (2U << 8U) | CCM_CCGR2_CG9_SHIFT,
kCLOCK_Ipmux3 = (2U << 8U) | CCM_CCGR2_CG10_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_Lcd = (2U << 8U) | CCM_CCGR2_CG14_SHIFT,
kCLOCK_Pxp = (2U << 8U) | CCM_CCGR2_CG15_SHIFT,
kCLOCK_Flexio2 = (3U << 8U) | CCM_CCGR3_CG0_SHIFT,

kCLOCK_Flexio3 = (7U << 8U) | CCM_CCGR7_CG6_SHIFT }

CCM CCGR gate control for each module independently.

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

  OSC 24M sorce 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_Flexspi2Mux,
  kCLOCK_LpspiMux,
  kCLOCK_FlexspiMux,
  kCLOCK_Usdhc2Mux,
  kCLOCK_Usdhc1Mux,
  kCLOCK_Sai3Mux,
  kCLOCK_Sai2Mux,
  kCLOCK_Sai1Mux,
  kCLOCK_PerclkMux,
  kCLOCK_Flexio2Mux,
  kCLOCK_CanMux,
  kCLOCK_UartMux,
  kCLOCK_SpdifMux,
  kCLOCK_Flexio1Mux,
  kCLOCK_Lpi2cMux,
  kCLOCK_LcdifPreMux,
  kCLOCK_CsiMux }

  MUX control names for clock mux 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_Flexspi2DivBy1 = 0,
kCLOCK_Flexspi2DivBy2 = 1,
kCLOCK_Flexspi2DivBy3 = 2,
kCLOCK_Flexspi2DivBy4 = 3,
kCLOCK_Flexspi2DivBy5 = 4,
kCLOCK_Flexspi2DivBy6 = 5,
kCLOCK_Flexspi2DivBy7 = 6,
kCLOCK_Flexspi2DivBy8 = 7,
kCLOCK_LpspiDivBy1 = 0,
kCLOCK_LpspiDivBy2 = 1,
kCLOCK_LpspiDivBy3 = 2,
kCLOCK_LpspiDivBy4 = 3,
kCLOCK_LpspiDivBy5 = 4,

kCLOCK_MiscDivBy64 = 63 }

Clock divider value.

- enum clock_div_t {
  kCLOCK_ArmDiv,
  kCLOCK_PeriphClk2Div,
  kCLOCK_SemcDiv,
  kCLOCK_AhbDiv,
  kCLOCK_IpgDiv,
  kCLOCK_Flexspi2Div,
  kCLOCK_LpspiDiv,
  kCLOCK_LcdifDiv,
  kCLOCK_FlexspiDiv,
  kCLOCK_PerclkDiv,
  kCLOCK_CanDiv,
  kCLOCK_TraceDiv,
  kCLOCK_Usdhc2Div,
  kCLOCK_Usdhc1Div,
  kCLOCK_UartDiv,
  kCLOCK_Flexio2Div,
  kCLOCK_Sai3PreDiv,
  kCLOCK_Sai3Div,
  kCLOCK_Flexio2PreDiv,
  kCLOCK_Sai1PreDiv,
  kCLOCK_Sai1Div,
  kCLOCK_Sai2PreDiv,
  kCLOCK_Sai2Div,
  kCLOCK_Spdif0PreDiv,
  kCLOCK_Spdif0Div,
  kCLOCK_Flexio1PreDiv,
  kCLOCK_Flexio1Div,
  kCLOCK_Lpi2cDiv,
  kCLOCK_LcdifPreDiv,
  kCLOCK_CsiDiv,
  kCLOCK_NonePreDiv = CLOCK_ROOT_NONE_PRE_DIV }

  DIV control names for clock div setting.
- enum clock_usb_src_t {
  kCLOCK_Usb480M = 0,
  kCLOCK_UsbSrcUnused = (int)0xFFFFFFFFU }

  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_PllArm = CCM_ANALOG_TUPLE(PLL_ARM_OFFSET, CCM_ANALOG_PLL_ARM_ENABLE_SHIFT),
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_PllVideo = CCM_ANALOG_TUPLE(PLL_VIDEO_OFFSET, CCM_ANALOG_PLL_VIDEO_ENABLE_SHIFT),
kCLOCK_PllEnet = CCM_ANALOG_TUPLE(PLL_ENET_OFFSET, CCM_ANALOG_PLL_ENET_ENABLE_SHIFT),
kCLOCK_PllEnet2 = CCM_ANALOG_TUPLE(PLL_ENET_OFFSET, CCM_ANALOG_PLL_ENET_ENET2_REF_EN_SHIFT),
kCLOCK_PllEnet25M = CCM_ANALOG_TUPLE(PLL_ENET_OFFSET, CCM_ANALOG_PLL_ENET_ENET_25M_REF_EN_SHIFT),
kCLOCK_PllUsb2 = CCM_ANALOG_TUPLE(PLL_USB2_OFFSET, CCM_ANALOG_PLL_USB2_ENABLE_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_OutputPllUsb1 = 0U,
  kCLOCK_OutputPllSys = 1U,
  kCLOCK_OutputPllVideo = 3U,
  kCLOCK_OutputSemcClk = 5U,
  kCLOCK_OutputLcdifPixClk = 0xAU,
  kCLOCK_OutputAhbClk = 0xBU,
  kCLOCK_OutputIpgClk = 0xCU,
  kCLOCK_OutputPerClk = 0xDU,
  kCLOCK_OutputCkilSyncClk = 0xEU,
  kCLOCK_OutputPll4MainClk = 0xFU,
  kCLOCK_DisableClockOutput1 = 0x10U }

  The enumerater 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_OutputCsiClk = 0xBU,
kCLOCK_OutputOscClk = 0xEU,
kCLOCK_OutputUsdhc2Clk = 0x11U,
kCLOCK_OutputSai1Clk = 0x12U,
kCLOCK_OutputSai2Clk = 0x13U,
kCLOCK_OutputSai3Clk = 0x14U,
kCLOCK_OutputCanClk = 0x17U,
kCLOCK_OutputFlexspiClk = 0x1BU,
kCLOCK_OutputUartClk = 0x1CU,
kCLOCK_OutputSpdif0Clk = 0x1DU,
kCLOCK_DisableClockOutput2 = 0x1FU }

The enumerater of clock output2'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_Flexspi2ClkRoot,
  kCLOCK_CsiClkRoot,
  kCLOCK_LpspiClkRoot,
  kCLOCK_TraceClkRoot,
  kCLOCK_Sai1ClkRoot,
  kCLOCK_Sai2ClkRoot,
  kCLOCK_Sai3ClkRoot,
  kCLOCK_Lpi2cClkRoot,
  kCLOCK_CanClkRoot,
  kCLOCK_UartClkRoot,
  kCLOCK_LcdifClkRoot,
  kCLOCK_SpdifClkRoot,
  kCLOCK_Flexio1ClkRoot,
  kCLOCK_Flexio2ClkRoot }

  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.
- bool CLOCK_EnableUsbhs1Clock (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** (600000000UL)
- #define **CCM_ANALOG_PLL_BYPASS_SHIFT** (16U)

- #define **CCM_ANALOG_PLL_BYPASS_CLK_SRC_MASK** (0xC000U)
- #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_arm_pll_config_t

Data Fields

- uint32_t loopDivider
  PLL loop divider.
- uint8_t src
  Pll clock source, reference _clock_pll_clk_src.

Field Documentation

(1) uint32_t clock_arm_pll_config_t::loopDivider

Valid range for divider value: 54-108. Fout=Fin∗loopDivider/2.

4.2.2 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

4.2.3 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 - Fout=Fref∗20; 1 - Fout=Fref∗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

4.2.4 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

4.2.5 struct clock_video_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_video_pll_config_t::loopDivider

Valid range for DIV_SELECT divider value: 27∼54.

(2) uint8_t clock_video_pll_config_t::postDivider

(3) uint32_t clock_video_pll_config_t::numerator

4.2.6 struct clock_enet_pll_config_t

Data Fields

- bool enableClkOutput
  Power on and enable PLL clock output for ENET0 (ref_enetpll0).
- bool enableClkOutput25M
  Power on and enable PLL clock output for ENET2 (ref_enetpll2).
- uint8_t loopDivider
  Controls the frequency of the ENET0 reference clock.

- uint8_t src
  Pll clock source, reference _clock_pll_clk_src.
- bool enableClkOutput1
  Power on and enable PLL clock output for ENET1 (ref_enetpll1).
- uint8_t loopDivider1
  Controls the frequency of the ENET1 reference clock.

Field Documentation

(1) bool clock_enet_pll_config_t::enableClkOutput

(2) bool clock_enet_pll_config_t::enableClkOutput25M

(3) uint8_t clock_enet_pll_config_t::loopDivider

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

(4) bool clock_enet_pll_config_t::enableClkOutput1

(5) uint8_t clock_enet_pll_config_t::loopDivider1

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_IpInvalid, kCLOCK_Aoi1, kCLOCK_Aoi2 \
    }
```

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 CSI_CLOCKS

Value:

```
{                   \
        kCLOCK_Csi \
    }
```

4.3.8 #define DCDC_CLOCKS

Value:

```
{                   \
        kCLOCK_Dcdc \
    }
```

4.3.9 #define DCP_CLOCKS

Value:

```
{                \
        kCLOCK_Dcp \
    }
```

4.3.10 #define DMAMUX_CLOCKS

Value:

```
{                   \
        kCLOCK_Dma     \
    }
```

4.3.11 #define EDMA_CLOCKS

Value:

```
{                 \
        kCLOCK_Dma   \
    }
```

4.3.12 #define ENC_CLOCKS

Value:

```
{                                                                    \
        kCLOCK_IpInvalid, kCLOCK_Enc1, kCLOCK_Enc2,
      kCLOCK_Enc3, kCLOCK_Enc4 \
    }
```

4.3.13 #define ENET_CLOCKS

Value:

```
{                                              \
        kCLOCK_Enet, kCLOCK_IpInvalid, kCLOCK_Enet2 \
    }
```

4.3.14 #define EWM_CLOCKS

Value:

```
{                \
        kCLOCK_Ewm0 \
    }
```

4.3.15 #define FLEXCAN_CLOCKS

Value:

```
{                                                        \
        kCLOCK_IpInvalid, kCLOCK_Can1, kCLOCK_Can2,
      kCLOCK_Can3 \
    }
```

4.3.16 #define FLEXCAN_PERIPH_CLOCKS

Value:

```
{                                                          \
        kCLOCK_IpInvalid, kCLOCK_Can1S, kCLOCK_Can2S,
      kCLOCK_Can3S \
    }
```

4.3.17 #define FLEXIO_CLOCKS

Value:

```
{                                                              \
        kCLOCK_IpInvalid, kCLOCK_Flexio1, kCLOCK_Flexio2,
      kCLOCK_Flexio3 \
    }
```

4.3.18 #define FLEXRAM_CLOCKS

Value:

```
{                   \
        kCLOCK_FlexRam \
    }
```

4.3.19 #define FLEXSPI_CLOCKS

Value:

```
{                                                    \
        kCLOCK_FlexSpi, kCLOCK_IpInvalid, kCLOCK_FlexSpi2 \
    }
```

4.3.20 #define FLEXSPI_EXSC_CLOCKS

Value:

```
{                        \
        kCLOCK_FlexSpiExsc  \
    }
```

4.3.21 #define GPIO_CLOCKS

Value:

```
{                                                                                    \
        kCLOCK_IpInvalid, kCLOCK_Gpio1, kCLOCK_Gpio2,
      kCLOCK_Gpio3, kCLOCK_Gpio4, kCLOCK_Gpio5 \
    }
```

4.3.22 #define GPT_CLOCKS

Value:

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

4.3.23 #define KPP_CLOCKS

Value:

```
{              \
        kCLOCK_Kpp \
    }
```

4.3.24 #define LCDIF_CLOCKS

Value:

```
{                \
        kCLOCK_Lcd   \
    }
```

4.3.25 #define LCDIF_PERIPH_CLOCKS

Value:

```
{                      \
        kCLOCK_LcdPixel     \
    }
```

4.3.26 #define LPI2C_CLOCKS

Value:

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

4.3.27 #define LPSPI_CLOCKS

Value:

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

4.3.28 #define LPUART_CLOCKS

Value:

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

4.3.29 #define MQS_CLOCKS

Value:

```
{               \
        kCLOCK_Mqs \
    }
```

4.3.30 #define OCRAM_EXSC_CLOCKS

Value:

```
{                     \
        kCLOCK_OcramExsc  \
    }
```

4.3.31 #define PIT_CLOCKS

Value:

```
{               \
        kCLOCK_Pit \
    }
```

4.3.32 #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},
              \
            {kCLOCK_Pwm3, kCLOCK_Pwm3, kCLOCK_Pwm3, kCLOCK_Pwm3},
              \
        {
      \
            kCLOCK_Pwm4, kCLOCK_Pwm4,
      kCLOCK_Pwm4, kCLOCK_Pwm4                    \
        }                                                               \
    }
```

4.3.33 #define PXP_CLOCKS

Value:

```
{               \
        kCLOCK_Pxp \
    }
```

4.3.34 #define RTWDOG_CLOCKS

Value:

```
{                   \
        kCLOCK_Wdog3   \
    }
```

4.3.35 #define SAI_CLOCKS

Value:

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

4.3.36 #define SEMC_CLOCKS

Value:

```
{                \
        kCLOCK_Semc \
    }
```

4.3.37 #define SEMC_EXSC_CLOCKS

Value:

```
{                    \
        kCLOCK_SemcExsc   \
    }
```

4.3.38 #define TMR_CLOCKS

Value:

```
{                                                                                   \
        kCLOCK_IpInvalid, kCLOCK_Timer1, kCLOCK_Timer2,
      kCLOCK_Timer3, kCLOCK_Timer4 \
    }
```

4.3.39 #define TRNG_CLOCKS

Value:

```
{                \
        kCLOCK_Trng \
    }
```

4.3.40 #define TSC_CLOCKS

Value:

```
{               \
        kCLOCK_Tsc \
    }
```

4.3.41 #define WDOG_CLOCKS

Value:

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

4.3.42 #define USDHC_CLOCKS

Value:

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

4.3.43 #define SPDIF_CLOCKS

Value:

```
{                \
        kCLOCK_Spdif \
    }
```

4.3.44 #define XBARA_CLOCKS

Value:

```
{                                \
        kCLOCK_IpInvalid, kCLOCK_Xbar1 \
    }
```

4.3.45 #define XBARB_CLOCKS

Value:

```
{                                                                \
        kCLOCK_IpInvalid, kCLOCK_IpInvalid, kCLOCK_Xbar2,
      kCLOCK_Xbar3 \
    }
```

4.3.46 #define kCLOCK_CoreSysClk kCLOCK_CpuClk

4.3.47 #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_LOWPWR_CTRL[OSC_SEL].
kCLOCK_RtcClk RTC clock. (RTCCLK)

kCLOCK_ArmPllClk ARMPLLCLK.
kCLOCK_Usb1PllClk USB1PLLCLK.
kCLOCK_Usb1PllPfd0Clk USB1PLLPDF0CLK.
kCLOCK_Usb1PllPfd1Clk USB1PLLPFD1CLK.
kCLOCK_Usb1PllPfd2Clk USB1PLLPFD2CLK.
kCLOCK_Usb1PllPfd3Clk USB1PLLPFD3CLK.
kCLOCK_Usb1SwClk USB1PLLSWCLK.
kCLOCK_Usb1Sw120MClk USB1PLLSw120MCLK.
kCLOCK_Usb1Sw60MClk USB1PLLSw60MCLK.
kCLOCK_Usb1Sw80MClk USB1PLLSw80MCLK.
kCLOCK_Usb2PllClk USB2PLLCLK.
kCLOCK_SysPllClk SYSPLLCLK.
kCLOCK_SysPllPfd0Clk SYSPLLPDF0CLK.
kCLOCK_SysPllPfd1Clk SYSPLLPFD1CLK.
kCLOCK_SysPllPfd2Clk SYSPLLPFD2CLK.
kCLOCK_SysPllPfd3Clk SYSPLLPFD3CLK.
kCLOCK_EnetPll0Clk Enet PLLCLK ref_enetpll0.
kCLOCK_EnetPll1Clk Enet PLLCLK ref_enetpll1.
kCLOCK_EnetPll2Clk Enet PLLCLK ref_enetpll2.
kCLOCK_AudioPllClk Audio PLLCLK.
kCLOCK_VideoPllClk Video 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_FlexSpiExsc CCGR0, CG3.
kCLOCK_Sim_M_Main 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_Aoi2 CCGR1, CG7.
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_Csi CCGR2, CG1.
kCLOCK_IomuxcSnvs CCGR2, CG2.
kCLOCK_Lpi2c1 CCGR2, CG3.
kCLOCK_Lpi2c2 CCGR2, CG4.
kCLOCK_Lpi2c3 CCGR2, CG5.
kCLOCK_Ocotp CCGR2, CG6.
kCLOCK_Xbar3 CCGR2, CG7.
kCLOCK_Ipmux1 CCGR2, CG8.
kCLOCK_Ipmux2 CCGR2, CG9.
kCLOCK_Ipmux3 CCGR2, CG10.
kCLOCK_Xbar1 CCGR2, CG11.
kCLOCK_Xbar2 CCGR2, CG12.
kCLOCK_Gpio3 CCGR2, CG13.
kCLOCK_Lcd CCGR2, CG14.
kCLOCK_Pxp CCGR2, CG15.
kCLOCK_Flexio2 CCGR3, CG0.
kCLOCK_Lpuart5 CCGR3, CG1.
kCLOCK_Semc CCGR3, CG2.
kCLOCK_Lpuart6 CCGR3, CG3.
kCLOCK_Aoi1 CCGR3, CG4.
kCLOCK_LcdPixel CCGR3, CG5.
kCLOCK_Gpio4 CCGR3, CG6.
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_Ocram CCGR3, CG14.
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_Tsc CCGR4, CG5.
kCLOCK_SimM CCGR4, CG6.
kCLOCK_SimEms CCGR4, CG7.
kCLOCK_Pwm1 CCGR4, CG8.
kCLOCK_Pwm2 CCGR4, CG9.
kCLOCK_Pwm3 CCGR4, CG10.
kCLOCK_Pwm4 CCGR4, CG11.
kCLOCK_Enc1 CCGR4, CG12.
kCLOCK_Enc2 CCGR4, CG13.
kCLOCK_Enc3 CCGR4, CG14.
kCLOCK_Enc4 CCGR4, CG15.
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_SimMain CCGR5, CG8.
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.
kCLOCK_Timer3 CCGR6, CG15.
kCLOCK_Enet2 CCGR7, CG0.
kCLOCK_FlexSpi2 CCGR7, CG1.
kCLOCK_Axbs_l CCGR7, CG2.
kCLOCK_Can3 CCGR7, CG3.
kCLOCK_Can3S CCGR7, CG4.
kCLOCK_Aips_lite CCGR7, CG5.
kCLOCK_Flexio3 CCGR7, CG6.

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_Flexspi2Mux flexspi2 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_Flexio2Mux flexio2 mux name
kCLOCK_CanMux can mux name
kCLOCK_UartMux uart mux name
kCLOCK_SpdifMux spdif mux name
kCLOCK_Flexio1Mux flexio1 mux name
kCLOCK_Lpi2cMux lpi2c mux name
kCLOCK_LcdifPreMux lcdif pre mux name
kCLOCK_CsiMux csi mux name

4.4.7 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 clock divider set to divided by 1.
kCLOCK_SemcDivBy2 SEMC clock divider set to divided by 2.
kCLOCK_SemcDivBy3 SEMC clock divider set to divided by 3.
kCLOCK_SemcDivBy4 SEMC clock divider set to divided by 4.
kCLOCK_SemcDivBy5 SEMC clock divider set to divided by 5.
kCLOCK_SemcDivBy6 SEMC clock divider set to divided by 6.
kCLOCK_SemcDivBy7 SEMC clock divider set to divided by 7.
kCLOCK_SemcDivBy8 SEMC clock divider set to divided by 8.
kCLOCK_AhbDivBy1 AHB clock divider set to divided by 1.
kCLOCK_AhbDivBy2 AHB clock divider set to divided by 2.
kCLOCK_AhbDivBy3 AHB clock divider set to divided by 3.
kCLOCK_AhbDivBy4 AHB clock divider set to divided by 4.
kCLOCK_AhbDivBy5 AHB clock divider set to divided by 5.
kCLOCK_AhbDivBy6 AHB clock divider set to divided by 6.
kCLOCK_AhbDivBy7 AHB clock divider set to divided by 7.
kCLOCK_AhbDivBy8 AHB clock divider set to divided by 8.
kCLOCK_IpgDivBy1 IPG clock divider set to divided by 1.
kCLOCK_IpgDivBy2 IPG clock divider set to divided by 2.
kCLOCK_IpgDivBy3 IPG clock divider set to divided by 3.
kCLOCK_IpgDivBy4 IPG clock divider set to divided by 4.
kCLOCK_Flexspi2DivBy1 Flexspi2 divider set to divided by 1.
kCLOCK_Flexspi2DivBy2 Flexspi2 divider set to divided by 2.
kCLOCK_Flexspi2DivBy3 Flexspi2 divider set to divided by 3.
kCLOCK_Flexspi2DivBy4 Flexspi2 divider set to divided by 4.
kCLOCK_Flexspi2DivBy5 Flexspi2 divider set to divided by 5.
kCLOCK_Flexspi2DivBy6 Flexspi2 divider set to divided by 6.
kCLOCK_Flexspi2DivBy7 Flexspi2 divider set to divided by 7.
kCLOCK_Flexspi2DivBy8 Flexspi2 divider set to divided by 8.
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_LcdifDivBy1 Lcdif divider set to divided by 1.
kCLOCK_LcdifDivBy2 Lcdif divider set to divided by 2.

kCLOCK_LcdifDivBy3 Lcdif divider set to divided by 3.
kCLOCK_LcdifDivBy4 Lcdif divider set to divided by 4.
kCLOCK_LcdifDivBy5 Lcdif divider set to divided by 5.
kCLOCK_LcdifDivBy6 Lcdif divider set to divided by 6.
kCLOCK_LcdifDivBy7 Lcdif divider set to divided by 7.
kCLOCK_LcdifDivBy8 Lcdif 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.
kCLOCK_Usdhc2DivBy8 Usdhc2 divider set to divided by 8.
kCLOCK_Usdhc1DivBy1 Usdhc1 divider set to divided by 1.
kCLOCK_Usdhc1DivBy2 Usdhc1 divider set to divided by 2.
kCLOCK_Usdhc1DivBy3 Usdhc1 divider set to divided by 3.
kCLOCK_Usdhc1DivBy4 Usdhc1 divider set to divided by 4.
kCLOCK_Usdhc1DivBy5 Usdhc1 divider set to divided by 5.
kCLOCK_Usdhc1DivBy6 Usdhc1 divider set to divided by 6.
kCLOCK_Usdhc1DivBy7 Usdhc1 divider set to divided by 7.
kCLOCK_Usdhc1DivBy8 Usdhc1 divider set to divided by 8.
kCLOCK_Flexio2DivBy1 Flexio2 divider set to divided by 1.
kCLOCK_Flexio2DivBy2 Flexio2 divider set to divided by 2.
kCLOCK_Flexio2DivBy3 Flexio2 divider set to divided by 3.
kCLOCK_Flexio2DivBy4 Flexio2 divider set to divided by 4.
kCLOCK_Flexio2DivBy5 Flexio2 divider set to divided by 5.
kCLOCK_Flexio2DivBy6 Flexio2 divider set to divided by 6.
kCLOCK_Flexio2DivBy7 Flexio2 divider set to divided by 7.
kCLOCK_Flexio2DivBy8 Flexio2 divider set to divided by 8.
kCLOCK_Sai3PreDivBy1 Sai3Pre divider set to divided by 1.
kCLOCK_Sai3PreDivBy2 Sai3Pre divider set to divided by 2.
kCLOCK_Sai3PreDivBy3 Sai3Pre divider set to divided by 3.

kCLOCK_Sai3PreDivBy4 Sai3Pre divider set to divided by 4.
kCLOCK_Sai3PreDivBy5 Sai3Pre divider set to divided by 5.
kCLOCK_Sai3PreDivBy6 Sai3Pre divider set to divided by 6.
kCLOCK_Sai3PreDivBy7 Sai3Pre divider set to divided by 7.
kCLOCK_Sai3PreDivBy8 Sai3Pre divider set to divided by 8.
kCLOCK_Flexio2PreDivBy1 Flexio2Pre divider set to divided by 1.
kCLOCK_Flexio2PreDivBy2 Flexio2Pre divider set to divided by 2.
kCLOCK_Flexio2PreDivBy3 Flexio2Pre divider set to divided by 3.
kCLOCK_Flexio2PreDivBy4 Flexio2Pre divider set to divided by 4.
kCLOCK_Flexio2PreDivBy5 Flexio2Pre divider set to divided by 5.
kCLOCK_Flexio2PreDivBy6 Flexio2Pre divider set to divided by 6.
kCLOCK_Flexio2PreDivBy7 Flexio2Pre divider set to divided by 7.
kCLOCK_Flexio2PreDivBy8 Flexio2Pre divider set to divided by 8.
kCLOCK_Sai1PreDivBy1 Sai1Pre divider set to divided by 1.
kCLOCK_Sai1PreDivBy2 Sai1Pre divider set to divided by 2.
kCLOCK_Sai1PreDivBy3 Sai1Pre divider set to divided by 3.
kCLOCK_Sai1PreDivBy4 Sai1Pre divider set to divided by 4.
kCLOCK_Sai1PreDivBy5 Sai1Pre divider set to divided by 5.
kCLOCK_Sai1PreDivBy6 Sai1Pre divider set to divided by 6.
kCLOCK_Sai1PreDivBy7 Sai1Pre divider set to divided by 7.
kCLOCK_Sai1PreDivBy8 Sai1Pre divider set to divided by 8.
kCLOCK_Sai2PreDivBy1 Sai2Pre divider set to divided by 1.
kCLOCK_Sai2PreDivBy2 Sai2Pre divider set to divided by 2.
kCLOCK_Sai2PreDivBy3 Sai2Pre divider set to divided by 3.
kCLOCK_Sai2PreDivBy4 Sai2Pre divider set to divided by 4.
kCLOCK_Sai2PreDivBy5 Sai2Pre divider set to divided by 5.
kCLOCK_Sai2PreDivBy6 Sai2Pre divider set to divided by 6.
kCLOCK_Sai2PreDivBy7 Sai2Pre divider set to divided by 7.
kCLOCK_Sai2PreDivBy8 Sai2Pre divider set to divided by 8.
kCLOCK_Spdif0PreDivBy1 Spdif0Pre divider set to divided by 1.
kCLOCK_Spdif0PreDivBy2 Spdif0Pre divider set to divided by 2.
kCLOCK_Spdif0PreDivBy3 Spdif0Pre divider set to divided by 3.
kCLOCK_Spdif0PreDivBy4 Spdif0Pre divider set to divided by 4.
kCLOCK_Spdif0PreDivBy5 Spdif0Pre divider set to divided by 5.
kCLOCK_Spdif0PreDivBy6 Spdif0Pre divider set to divided by 6.
kCLOCK_Spdif0PreDivBy7 Spdif0Pre divider set to divided by 7.
kCLOCK_Spdif0PreDivBy8 Spdif0Pre divider set to divided by 8.
kCLOCK_Spdif0DivBy1 Spdif0 divider set to divided by 1.
kCLOCK_Spdif0DivBy2 Spdif0 divider set to divided by 2.
kCLOCK_Spdif0DivBy3 Spdif0 divider set to divided by 3.
kCLOCK_Spdif0DivBy4 Spdif0 divider set to divided by 4.
kCLOCK_Spdif0DivBy5 Spdif0 divider set to divided by 5.
kCLOCK_Spdif0DivBy6 Spdif0 divider set to divided by 6.
kCLOCK_Spdif0DivBy7 Spdif0 divider set to divided by 7.
kCLOCK_Spdif0DivBy8 Spdif0 divider set to divided by 8.

kCLOCK_Flexio1PreDivBy1 Flexio1Pre divider set to divided by 1.
kCLOCK_Flexio1PreDivBy2 Flexio1Pre divider set to divided by 2.
kCLOCK_Flexio1PreDivBy3 Flexio1Pre divider set to divided by 3.
kCLOCK_Flexio1PreDivBy8 Flexio1Pre divider set to divided by 8.
kCLOCK_Flexio1DivBy1 Flexio1 divider set to divided by 1.
kCLOCK_Flexio1DivBy2 Flexio1 divider set to divided by 2.
kCLOCK_Flexio1DivBy3 Flexio1 divider set to divided by 3.
kCLOCK_Flexio1DivBy4 Flexio1 divider set to divided by 4.
kCLOCK_Flexio1DivBy5 Flexio1 divider set to divided by 5.
kCLOCK_Flexio1DivBy6 Flexio1 divider set to divided by 6.
kCLOCK_Flexio1DivBy7 Flexio1 divider set to divided by 7.
kCLOCK_Flexio1DivBy8 Flexio1 divider set to divided by 8.
kCLOCK_LcdifPreDivBy1 LcdifPre divider set to divided by 1.
kCLOCK_LcdifPreDivBy2 LcdifPre divider set to divided by 2.
kCLOCK_LcdifPreDivBy3 LcdifPre divider set to divided by 3.
kCLOCK_LcdifPreDivBy4 LcdifPre divider set to divided by 4.
kCLOCK_LcdifPreDivBy5 LcdifPre divider set to divided by 5.
kCLOCK_LcdifPreDivBy6 LcdifPre divider set to divided by 6.
kCLOCK_LcdifPreDivBy7 LcdifPre divider set to divided by 7.
kCLOCK_LcdifPreDivBy8 LcdifPre divider set to divided by 8.
kCLOCK_CsiDivBy1 Csi divider set to divided by 1.
kCLOCK_CsiDivBy2 Csi divider set to divided by 2.
kCLOCK_CsiDivBy3 Csi divider set to divided by 3.
kCLOCK_CsiDivBy4 Csi divider set to divided by 4.
kCLOCK_CsiDivBy5 Csi divider set to divided by 5.
kCLOCK_CsiDivBy6 Csi divider set to divided by 6.
kCLOCK_CsiDivBy7 Csi divider set to divided by 7.
kCLOCK_CsiDivBy8 Csi 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.
kCLOCK_MiscDivBy26 Misc divider like LPI2C set to divided by 26.
kCLOCK_MiscDivBy27 Misc divider like LPI2C set to divided by 27.
kCLOCK_MiscDivBy28 Misc divider like LPI2C set to divided by 28.
kCLOCK_MiscDivBy29 Misc divider like LPI2C set to divided by 29.
kCLOCK_MiscDivBy30 Misc divider like LPI2C set to divided by 30.
kCLOCK_MiscDivBy31 Misc divider like LPI2C set to divided by 31.
kCLOCK_MiscDivBy32 Misc divider like LPI2C set to divided by 32.
kCLOCK_MiscDivBy33 Misc divider like LPI2C set to divided by 33.
kCLOCK_MiscDivBy34 Misc divider like LPI2C set to divided by 34.
kCLOCK_MiscDivBy35 Misc divider like LPI2C set to divided by 35.
kCLOCK_MiscDivBy36 Misc divider like LPI2C set to divided by 36.
kCLOCK_MiscDivBy37 Misc divider like LPI2C set to divided by 37.
kCLOCK_MiscDivBy38 Misc divider like LPI2C set to divided by 38.
kCLOCK_MiscDivBy39 Misc divider like LPI2C set to divided by 39.
kCLOCK_MiscDivBy40 Misc divider like LPI2C set to divided by 40.
kCLOCK_MiscDivBy41 Misc divider like LPI2C set to divided by 41.
kCLOCK_MiscDivBy42 Misc divider like LPI2C set to divided by 42.
kCLOCK_MiscDivBy43 Misc divider like LPI2C set to divided by 43.
kCLOCK_MiscDivBy44 Misc divider like LPI2C set to divided by 44.
kCLOCK_MiscDivBy45 Misc divider like LPI2C set to divided by 45.
kCLOCK_MiscDivBy46 Misc divider like LPI2C set to divided by 46.
kCLOCK_MiscDivBy47 Misc divider like LPI2C set to divided by 47.
kCLOCK_MiscDivBy48 Misc divider like LPI2C set to divided by 48.
kCLOCK_MiscDivBy49 Misc divider like LPI2C set to divided by 49.
kCLOCK_MiscDivBy50 Misc divider like LPI2C set to divided by 50.
kCLOCK_MiscDivBy51 Misc divider like LPI2C set to divided by 51.
kCLOCK_MiscDivBy52 Misc divider like LPI2C set to divided by 52.
kCLOCK_MiscDivBy53 Misc divider like LPI2C set to divided by 53.
kCLOCK_MiscDivBy54 Misc divider like LPI2C set to divided by 54.
kCLOCK_MiscDivBy55 Misc divider like LPI2C set to divided by 55.
kCLOCK_MiscDivBy56 Misc divider like LPI2C set to divided by 56.
kCLOCK_MiscDivBy57 Misc divider like LPI2C set to divided by 57.
kCLOCK_MiscDivBy58 Misc divider like LPI2C set to divided by 58.
kCLOCK_MiscDivBy59 Misc divider like LPI2C set to divided by 59.
kCLOCK_MiscDivBy60 Misc divider like LPI2C set to divided by 60.
kCLOCK_MiscDivBy61 Misc divider like LPI2C set to divided by 61.
kCLOCK_MiscDivBy62 Misc divider like LPI2C set to divided by 62.

kCLOCK_MiscDivBy63 Misc divider like LPI2C set to divided by 63.
kCLOCK_MiscDivBy64 Misc divider like LPI2C set to divided by 64.

4.4.8 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_Flexspi2Div flexspi2 div name
kCLOCK_LpspiDiv lpspi div name
kCLOCK_LcdifDiv lcdif 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_Flexio2Div flexio2 pre div name
kCLOCK_Sai3PreDiv sai3 pre div name
kCLOCK_Sai3Div sai3 div name
kCLOCK_Flexio2PreDiv sai3 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_Flexio1PreDiv flexio1 pre div name
kCLOCK_Flexio1Div flexio1 div name
kCLOCK_Lpi2cDiv lpi2c div name
kCLOCK_LcdifPreDiv lcdif pre div name
kCLOCK_CsiDiv csi div name
kCLOCK_NonePreDiv None Pre div.

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_PllArm PLL ARM.
kCLOCK_PllSys PLL SYS.
kCLOCK_PllUsb1 PLL USB1.
kCLOCK_PllAudio PLL Audio.
kCLOCK_PllVideo PLL Video.
kCLOCK_PllEnet PLL Enet0.
kCLOCK_PllEnet2 PLL Enet1.
kCLOCK_PllEnet25M PLL Enet2.
kCLOCK_PllUsb2 PLL USB2.

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_OutputPllUsb1 Selects USB1 PLL clock(Divided by 2) output.
kCLOCK_OutputPllSys Selects SYS PLL clock(Divided by 2) output.
kCLOCK_OutputPllVideo Selects Video PLL clock(Divided by 2) output.
kCLOCK_OutputSemcClk Selects semc clock root output.
kCLOCK_OutputLcdifPixClk Selects Lcdif pix 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_OutputCkilSyncClk Selects Ckil clock root output.
kCLOCK_OutputPll4MainClk Selects PLL4 main clock output.
kCLOCK_DisableClockOutput1 Disables CLKO1.

4.4.15 enum clock_output2_selection_t

Enumerator

kCLOCK_OutputUsdhc1Clk Selects USDHC1 clock root output.
kCLOCK_OutputLpi2cClk Selects LPI2C clock root output.
kCLOCK_OutputCsiClk Selects CSI clock root output.
kCLOCK_OutputOscClk Selects OSC 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_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 CLKO2.

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_Flexspi2ClkRoot FLEXSPI2 clock root.
kCLOCK_CsiClkRoot CSI 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_LcdifClkRoot LCD clock root.
kCLOCK_SpdifClkRoot SPDIF clock root.
kCLOCK_Flexio1ClkRoot FLEXIO1 clock root.
kCLOCK_Flexio2ClkRoot FLEXIO2 clock root.

4.5 Function Documentation

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

Parameters

mux	Which mux node to set, see clock_mux_t.
value	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

mux	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_PerClk, kCLOCK_Lpi2cDiv, kCLOCK_CanDiv, kCLOCK_UartDiv, kCLOCK_Sai1Div, kCLOCK_Sai2Div, kCLOCK_Sai3Div can use the divider kCLOCK_MiscDivByxxx.

Parameters

divider	Which divider node to set.
value	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

divider	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

name	Which clock to enable, see clock_ip_name_t.
value	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

name	Which clock to enable, see clock_ip_name_t.

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

Parameters

name	Which clock to disable, see clock_ip_name_t.

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

Parameters

mode	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

name	Clock names defined in clock_name_t

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

clockRoot	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

bypassXtalOsc	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

osc	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

freq	The XTAL input clock frequency in Hz.

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

Parameters

freq	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 prepheral, upper layer should first call the CLOCK_-EnableUsbhs0PhyPllClock to enable the PHY clock to use USB HS.

Parameters

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

Return values

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

4.5.24 bool CLOCK_EnableUsbhs1Clock (clock_usb_src_t *src*, uint32_t *freq*)

This function only enables the access to USB HS prepheral, upper layer should first call the CLOCK_-EnableUsbhs0PhyPllClock to enable the PHY clock to use USB HS.

Parameters

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

Return values

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

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(240000000);
*
```

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, 4))
  IOMUXC driver version 2.0.3.

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, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_00_FLEXPWM4_PWMA00** 0x401F8014U, 0x1U, 0x401F8494U, 0x0U, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_00_LPSPI2_SCK** 0x401F8014U, 0x2U, 0x401F8500U, 0x1U, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_00_XBAR1_XBAR_IN02** 0x401F8014U, 0x3U, 0x401F860CU, 0x0U, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_00_FLEXIO1_FLEXIO00** 0x401F8014U, 0x4U, 0, 0, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_00_GPIO4_IO00** 0x401F8014U, 0x5U, 0, 0, 0x401F8204U
- #define **IOMUXC_GPIO_EMC_01_SEMC_DATA01** 0x401F8018U, 0x0U, 0, 0, 0x401F8208U
- #define **IOMUXC_GPIO_EMC_01_FLEXPWM4_PWMB00** 0x401F8018U, 0x1U, 0, 0, 0x401F8208U
- #define **IOMUXC_GPIO_EMC_01_LPSPI2_PCS0** 0x401F8018U, 0x2U, 0x401F84FCU, 0x1U, 0x401F8208U
- #define **IOMUXC_GPIO_EMC_01_XBAR1_IN03** 0x401F8018U, 0x3U, 0x401F8610U, 0x0U, 0x401F8208U
- #define **IOMUXC_GPIO_EMC_01_FLEXIO1_FLEXIO01** 0x401F8018U, 0x4U, 0, 0, 0x401F8208U
- #define **IOMUXC_GPIO_EMC_01_GPIO4_IO01** 0x401F8018U, 0x5U, 0, 0, 0x401F8208U
- #define **IOMUXC_GPIO_EMC_02_SEMC_DATA02** 0x401F801CU, 0x0U, 0, 0, 0x401F820CU
- #define **IOMUXC_GPIO_EMC_02_FLEXPWM4_PWMA01** 0x401F801CU, 0x1U, 0x401F8498U, 0x0U, 0x401F820CU
- #define **IOMUXC_GPIO_EMC_02_LPSPI2_SDO** 0x401F801CU, 0x2U, 0x401F8508U, 0x1U, 0x401F820CU

- #define **IOMUXC_GPIO_EMC_02_XBAR1_INOUT04** 0x401F801CU, 0x3U, 0x401F8614U, 0x0U, 0x401F820CU
- #define **IOMUXC_GPIO_EMC_02_FLEXIO1_FLEXIO02** 0x401F801CU, 0x4U, 0, 0, 0x401-F820CU
- #define **IOMUXC_GPIO_EMC_02_GPIO4_IO02** 0x401F801CU, 0x5U, 0, 0, 0x401F820CU
- #define **IOMUXC_GPIO_EMC_03_SEMC_DATA03** 0x401F8020U, 0x0U, 0, 0, 0x401F8210U
- #define **IOMUXC_GPIO_EMC_03_FLEXPWM4_PWMB01** 0x401F8020U, 0x1U, 0, 0, 0x401-F8210U
- #define **IOMUXC_GPIO_EMC_03_LPSPI2_SDI** 0x401F8020U, 0x2U, 0x401F8504U, 0x1U, 0x401F8210U
- #define **IOMUXC_GPIO_EMC_03_XBAR1_INOUT05** 0x401F8020U, 0x3U, 0x401F8618U, 0x0U, 0x401F8210U
- #define **IOMUXC_GPIO_EMC_03_FLEXIO1_FLEXIO03** 0x401F8020U, 0x4U, 0, 0, 0x401-F8210U
- #define **IOMUXC_GPIO_EMC_03_GPIO4_IO03** 0x401F8020U, 0x5U, 0, 0, 0x401F8210U
- #define **IOMUXC_GPIO_EMC_04_SEMC_DATA04** 0x401F8024U, 0x0U, 0, 0, 0x401F8214U
- #define **IOMUXC_GPIO_EMC_04_FLEXPWM4_PWMA02** 0x401F8024U, 0x1U, 0x401-F849CU, 0x0U, 0x401F8214U
- #define **IOMUXC_GPIO_EMC_04_SAI2_TX_DATA** 0x401F8024U, 0x2U, 0, 0, 0x401F8214U
- #define **IOMUXC_GPIO_EMC_04_XBAR1_INOUT06** 0x401F8024U, 0x3U, 0x401F861CU, 0x0U, 0x401F8214U
- #define **IOMUXC_GPIO_EMC_04_FLEXIO1_FLEXIO04** 0x401F8024U, 0x4U, 0, 0, 0x401-F8214U
- #define **IOMUXC_GPIO_EMC_04_GPIO4_IO04** 0x401F8024U, 0x5U, 0, 0, 0x401F8214U
- #define **IOMUXC_GPIO_EMC_05_SEMC_DATA05** 0x401F8028U, 0x0U, 0, 0, 0x401F8218U
- #define **IOMUXC_GPIO_EMC_05_FLEXPWM4_PWMB02** 0x401F8028U, 0x1U, 0, 0, 0x401-F8218U
- #define **IOMUXC_GPIO_EMC_05_SAI2_TX_SYNC** 0x401F8028U, 0x2U, 0x401F85C4U, 0x0U, 0x401F8218U
- #define **IOMUXC_GPIO_EMC_05_XBAR1_INOUT07** 0x401F8028U, 0x3U, 0x401F8620U, 0x0U, 0x401F8218U
- #define **IOMUXC_GPIO_EMC_05_FLEXIO1_FLEXIO05** 0x401F8028U, 0x4U, 0, 0, 0x401-F8218U
- #define **IOMUXC_GPIO_EMC_05_GPIO4_IO05** 0x401F8028U, 0x5U, 0, 0, 0x401F8218U
- #define **IOMUXC_GPIO_EMC_06_SEMC_DATA06** 0x401F802CU, 0x0U, 0, 0, 0x401F821CU
- #define **IOMUXC_GPIO_EMC_06_FLEXPWM2_PWMA00** 0x401F802CU, 0x1U, 0x401-F8478U, 0x0U, 0x401F821CU
- #define **IOMUXC_GPIO_EMC_06_SAI2_TX_BCLK** 0x401F802CU, 0x2U, 0x401F85C0U, 0x0U, 0x401F821CU
- #define **IOMUXC_GPIO_EMC_06_XBAR1_INOUT08** 0x401F802CU, 0x3U, 0x401F8624U, 0x0U, 0x401F821CU
- #define **IOMUXC_GPIO_EMC_06_FLEXIO1_FLEXIO06** 0x401F802CU, 0x4U, 0, 0, 0x401-F821CU
- #define **IOMUXC_GPIO_EMC_06_GPIO4_IO06** 0x401F802CU, 0x5U, 0, 0, 0x401F821CU
- #define **IOMUXC_GPIO_EMC_07_SEMC_DATA07** 0x401F8030U, 0x0U, 0, 0, 0x401F8220U
- #define **IOMUXC_GPIO_EMC_07_FLEXPWM2_PWMB00** 0x401F8030U, 0x1U, 0x401-F8488U, 0x0U, 0x401F8220U
- #define **IOMUXC_GPIO_EMC_07_SAI2_MCLK** 0x401F8030U, 0x2U, 0x401F85B0U, 0x0U, 0x401F8220U
- #define **IOMUXC_GPIO_EMC_07_XBAR1_INOUT09** 0x401F8030U, 0x3U, 0x401F8628U, 0x0U, 0x401F8220U

- #define **IOMUXC_GPIO_EMC_07_FLEXIO1_FLEXIO07** 0x401F8030U, 0x4U, 0, 0, 0x401-F8220U
- #define **IOMUXC_GPIO_EMC_07_GPIO4_IO07** 0x401F8030U, 0x5U, 0, 0, 0x401F8220U
- #define **IOMUXC_GPIO_EMC_08_SEMC_DM00** 0x401F8034U, 0x0U, 0, 0, 0x401F8224U
- #define **IOMUXC_GPIO_EMC_08_FLEXPWM2_PWMA01** 0x401F8034U, 0x1U, 0x401-F847CU, 0x0U, 0x401F8224U
- #define **IOMUXC_GPIO_EMC_08_SAI2_RX_DATA** 0x401F8034U, 0x2U, 0x401F85B8U, 0x0U, 0x401F8224U
- #define **IOMUXC_GPIO_EMC_08_XBAR1_INOUT17** 0x401F8034U, 0x3U, 0x401F862CU, 0x0U, 0x401F8224U
- #define **IOMUXC_GPIO_EMC_08_FLEXIO1_FLEXIO08** 0x401F8034U, 0x4U, 0, 0, 0x401-F8224U
- #define **IOMUXC_GPIO_EMC_08_GPIO4_IO08** 0x401F8034U, 0x5U, 0, 0, 0x401F8224U
- #define **IOMUXC_GPIO_EMC_09_SEMC_ADDR00** 0x401F8038U, 0x0U, 0, 0, 0x401F8228U
- #define **IOMUXC_GPIO_EMC_09_FLEXPWM2_PWMB01** 0x401F8038U, 0x1U, 0x401F848-CU, 0x0U, 0x401F8228U
- #define **IOMUXC_GPIO_EMC_09_SAI2_RX_SYNC** 0x401F8038U, 0x2U, 0x401F85BCU, 0x0U, 0x401F8228U
- #define **IOMUXC_GPIO_EMC_09_FLEXCAN2_TX** 0x401F8038U, 0x3U, 0, 0, 0x401F8228U
- #define **IOMUXC_GPIO_EMC_09_FLEXIO1_FLEXIO09** 0x401F8038U, 0x4U, 0, 0, 0x401-F8228U
- #define **IOMUXC_GPIO_EMC_09_GPIO4_IO09** 0x401F8038U, 0x5U, 0, 0, 0x401F8228U
- #define **IOMUXC_GPIO_EMC_09_FLEXSPI2_B_SS1_B** 0x401F8038U, 0x8U, 0, 0, 0x401-F8228U
- #define **IOMUXC_GPIO_EMC_10_SEMC_ADDR01** 0x401F803CU, 0x0U, 0, 0, 0x401F822CU
- #define **IOMUXC_GPIO_EMC_10_FLEXPWM2_PWMA02** 0x401F803CU, 0x1U, 0x401-F8480U, 0x0U, 0x401F822CU
- #define **IOMUXC_GPIO_EMC_10_SAI2_RX_BCLK** 0x401F803CU, 0x2U, 0x401F85B4U, 0x0U, 0x401F822CU
- #define **IOMUXC_GPIO_EMC_10_FLEXCAN2_RX** 0x401F803CU, 0x3U, 0x401F8450U, 0x0U, 0x401F822CU
- #define **IOMUXC_GPIO_EMC_10_FLEXIO1_FLEXIO10** 0x401F803CU, 0x4U, 0, 0, 0x401-F822CU
- #define **IOMUXC_GPIO_EMC_10_GPIO4_IO10** 0x401F803CU, 0x5U, 0, 0, 0x401F822CU
- #define **IOMUXC_GPIO_EMC_10_FLEXSPI2_B_SS0_B** 0x401F803CU, 0x8U, 0, 0, 0x401-F822CU
- #define **IOMUXC_GPIO_EMC_11_SEMC_ADDR02** 0x401F8040U, 0x0U, 0, 0, 0x401F8230U
- #define **IOMUXC_GPIO_EMC_11_FLEXPWM2_PWMB02** 0x401F8040U, 0x1U, 0x401-F8490U, 0x0U, 0x401F8230U
- #define **IOMUXC_GPIO_EMC_11_LPI2C4_SDA** 0x401F8040U, 0x2U, 0x401F84E8U, 0x0U, 0x401F8230U
- #define **IOMUXC_GPIO_EMC_11_USDHC2_RESET_B** 0x401F8040U, 0x3U, 0, 0, 0x401-F8230U
- #define **IOMUXC_GPIO_EMC_11_FLEXIO1_FLEXIO11** 0x401F8040U, 0x4U, 0, 0, 0x401-F8230U
- #define **IOMUXC_GPIO_EMC_11_GPIO4_IO11** 0x401F8040U, 0x5U, 0, 0, 0x401F8230U
- #define **IOMUXC_GPIO_EMC_11_FLEXSPI2_B_DQS** 0x401F8040U, 0x8U, 0, 0, 0x401-F8230U
- #define **IOMUXC_GPIO_EMC_12_SEMC_ADDR03** 0x401F8044U, 0x0U, 0, 0, 0x401F8234U
- #define **IOMUXC_GPIO_EMC_12_XBAR1_IN24** 0x401F8044U, 0x1U, 0x401F8640U, 0x0U, 0x401F8234U

- #define **IOMUXC_GPIO_EMC_12_LPI2C4_SCL** 0x401F8044U, 0x2U, 0x401F84E4U, 0x0U, 0x401F8234U
- #define **IOMUXC_GPIO_EMC_12_USDHC1_WP** 0x401F8044U, 0x3U, 0x401F85D8U, 0x0U, 0x401F8234U
- #define **IOMUXC_GPIO_EMC_12_FLEXPWM1_PWMA03** 0x401F8044U, 0x4U, 0x401-F8454U, 0x1U, 0x401F8234U
- #define **IOMUXC_GPIO_EMC_12_GPIO4_IO12** 0x401F8044U, 0x5U, 0, 0, 0x401F8234U
- #define **IOMUXC_GPIO_EMC_12_FLEXSPI2_B_SCLK** 0x401F8044U, 0x8U, 0x401F8754U, 0x0U, 0x401F8234U
- #define **IOMUXC_GPIO_EMC_13_SEMC_ADDR04** 0x401F8048U, 0x0U, 0, 0, 0x401F8238U
- #define **IOMUXC_GPIO_EMC_13_XBAR1_IN25** 0x401F8048U, 0x1U, 0x401F8650U, 0x1U, 0x401F8238U
- #define **IOMUXC_GPIO_EMC_13_LPUART3_TX** 0x401F8048U, 0x2U, 0x401F853CU, 0x1-U, 0x401F8238U
- #define **IOMUXC_GPIO_EMC_13_MQS_RIGHT** 0x401F8048U, 0x3U, 0, 0, 0x401F8238U
- #define **IOMUXC_GPIO_EMC_13_FLEXPWM1_PWMB03** 0x401F8048U, 0x4U, 0x401-F8464U, 0x1U, 0x401F8238U
- #define **IOMUXC_GPIO_EMC_13_GPIO4_IO13** 0x401F8048U, 0x5U, 0, 0, 0x401F8238U
- #define **IOMUXC_GPIO_EMC_13_FLEXSPI2_B_DATA00** 0x401F8048U, 0x8U, 0x401-F8740U, 0x0U, 0x401F8238U
- #define **IOMUXC_GPIO_EMC_14_SEMC_ADDR05** 0x401F804CU, 0x0U, 0, 0, 0x401F823CU
- #define **IOMUXC_GPIO_EMC_14_XBAR1_INOUT19** 0x401F804CU, 0x1U, 0x401F8654U, 0x0U, 0x401F823CU
- #define **IOMUXC_GPIO_EMC_14_LPUART3_RX** 0x401F804CU, 0x2U, 0x401F8538U, 0x1-U, 0x401F823CU
- #define **IOMUXC_GPIO_EMC_14_MQS_LEFT** 0x401F804CU, 0x3U, 0, 0, 0x401F823CU
- #define **IOMUXC_GPIO_EMC_14_LPSPI2_PCS1** 0x401F804CU, 0x4U, 0, 0, 0x401F823CU
- #define **IOMUXC_GPIO_EMC_14_GPIO4_IO14** 0x401F804CU, 0x5U, 0, 0, 0x401F823CU
- #define **IOMUXC_GPIO_EMC_14_FLEXSPI2_B_DATA01** 0x401F804CU, 0x8U, 0x401-F8744U, 0x0U, 0x401F823CU
- #define **IOMUXC_GPIO_EMC_15_SEMC_ADDR06** 0x401F8050U, 0x0U, 0, 0, 0x401F8240U
- #define **IOMUXC_GPIO_EMC_15_XBAR1_IN20** 0x401F8050U, 0x1U, 0x401F8634U, 0x0U, 0x401F8240U
- #define **IOMUXC_GPIO_EMC_15_LPUART3_CTS_B** 0x401F8050U, 0x2U, 0x401F8534U, 0x0U, 0x401F8240U
- #define **IOMUXC_GPIO_EMC_15_SPDIF_OUT** 0x401F8050U, 0x3U, 0, 0, 0x401F8240U
- #define **IOMUXC_GPIO_EMC_15_QTIMER3_TIMER0** 0x401F8050U, 0x4U, 0x401F857CU, 0x0U, 0x401F8240U
- #define **IOMUXC_GPIO_EMC_15_GPIO4_IO15** 0x401F8050U, 0x5U, 0, 0, 0x401F8240U
- #define **IOMUXC_GPIO_EMC_15_FLEXSPI2_B_DATA02** 0x401F8050U, 0x8U, 0x401-F8748U, 0x0U, 0x401F8240U
- #define **IOMUXC_GPIO_EMC_16_SEMC_ADDR07** 0x401F8054U, 0x0U, 0, 0, 0x401F8244U
- #define **IOMUXC_GPIO_EMC_16_XBAR1_IN21** 0x401F8054U, 0x1U, 0x401F8658U, 0x0U, 0x401F8244U
- #define **IOMUXC_GPIO_EMC_16_LPUART3_RTS_B** 0x401F8054U, 0x2U, 0, 0, 0x401-F8244U
- #define **IOMUXC_GPIO_EMC_16_SPDIF_IN** 0x401F8054U, 0x3U, 0x401F85C8U, 0x1U, 0x401F8244U
- #define **IOMUXC_GPIO_EMC_16_QTIMER3_TIMER1** 0x401F8054U, 0x4U, 0x401F8580U, 0x1U, 0x401F8244U
- #define **IOMUXC_GPIO_EMC_16_GPIO4_IO16** 0x401F8054U, 0x5U, 0, 0, 0x401F8244U

- #define **IOMUXC_GPIO_EMC_16_FLEXSPI2_B_DATA03** 0x401F8054U, 0x8U, 0x401F874-CU, 0x0U, 0x401F8244U
- #define **IOMUXC_GPIO_EMC_17_SEMC_ADDR08** 0x401F8058U, 0x0U, 0, 0, 0x401F8248U
- #define **IOMUXC_GPIO_EMC_17_FLEXPWM4_PWMA03** 0x401F8058U, 0x1U, 0x401F84-A0U, 0x0U, 0x401F8248U
- #define **IOMUXC_GPIO_EMC_17_LPUART4_CTS_B** 0x401F8058U, 0x2U, 0, 0, 0x401-F8248U
- #define **IOMUXC_GPIO_EMC_17_FLEXCAN1_TX** 0x401F8058U, 0x3U, 0, 0, 0x401F8248U
- #define **IOMUXC_GPIO_EMC_17_QTIMER3_TIMER2** 0x401F8058U, 0x4U, 0x401F8584U, 0x0U, 0x401F8248U
- #define **IOMUXC_GPIO_EMC_17_GPIO4_IO17** 0x401F8058U, 0x5U, 0, 0, 0x401F8248U
- #define **IOMUXC_GPIO_EMC_18_SEMC_ADDR09** 0x401F805CU, 0x0U, 0, 0, 0x401F824CU
- #define **IOMUXC_GPIO_EMC_18_FLEXPWM4_PWMB03** 0x401F805CU, 0x1U, 0, 0, 0x401F824CU
- #define **IOMUXC_GPIO_EMC_18_LPUART4_RTS_B** 0x401F805CU, 0x2U, 0, 0, 0x401F824-CU
- #define **IOMUXC_GPIO_EMC_18_FLEXCAN1_RX** 0x401F805CU, 0x3U, 0x401F844CU, 0x1U, 0x401F824CU
- #define **IOMUXC_GPIO_EMC_18_QTIMER3_TIMER3** 0x401F805CU, 0x4U, 0x401F8588U, 0x0U, 0x401F824CU
- #define **IOMUXC_GPIO_EMC_18_GPIO4_IO18** 0x401F805CU, 0x5U, 0, 0, 0x401F824CU
- #define **IOMUXC_GPIO_EMC_18_SNVS_VIO_5_CTL** 0x401F805CU, 0x6U, 0, 0, 0x401-F824CU
- #define **IOMUXC_GPIO_EMC_19_SEMC_ADDR11** 0x401F8060U, 0x0U, 0, 0, 0x401F8250U
- #define **IOMUXC_GPIO_EMC_19_FLEXPWM2_PWMA03** 0x401F8060U, 0x1U, 0x401-F8474U, 0x1U, 0x401F8250U
- #define **IOMUXC_GPIO_EMC_19_LPUART4_TX** 0x401F8060U, 0x2U, 0x401F8544U, 0x1U, 0x401F8250U
- #define **IOMUXC_GPIO_EMC_19_ENET_RDATA01** 0x401F8060U, 0x3U, 0x401F8438U, 0x0U, 0x401F8250U
- #define **IOMUXC_GPIO_EMC_19_QTIMER2_TIMER0** 0x401F8060U, 0x4U, 0x401F856CU, 0x0U, 0x401F8250U
- #define **IOMUXC_GPIO_EMC_19_GPIO4_IO19** 0x401F8060U, 0x5U, 0, 0, 0x401F8250U
- #define **IOMUXC_GPIO_EMC_19_SNVS_VIO_5** 0x401F8060U, 0x6U, 0, 0, 0x401F8250U
- #define **IOMUXC_GPIO_EMC_20_SEMC_ADDR12** 0x401F8064U, 0x0U, 0, 0, 0x401F8254U
- #define **IOMUXC_GPIO_EMC_20_FLEXPWM2_PWMB03** 0x401F8064U, 0x1U, 0x401-F8484U, 0x1U, 0x401F8254U
- #define **IOMUXC_GPIO_EMC_20_LPUART4_RX** 0x401F8064U, 0x2U, 0x401F8540U, 0x1U, 0x401F8254U
- #define **IOMUXC_GPIO_EMC_20_ENET_RDATA00** 0x401F8064U, 0x3U, 0x401F8434U, 0x0U, 0x401F8254U
- #define **IOMUXC_GPIO_EMC_20_QTIMER2_TIMER1** 0x401F8064U, 0x4U, 0x401F8570U, 0x0U, 0x401F8254U
- #define **IOMUXC_GPIO_EMC_20_GPIO4_IO20** 0x401F8064U, 0x5U, 0, 0, 0x401F8254U
- #define **IOMUXC_GPIO_EMC_21_SEMC_BA0** 0x401F8068U, 0x0U, 0, 0, 0x401F8258U
- #define **IOMUXC_GPIO_EMC_21_FLEXPWM3_PWMA03** 0x401F8068U, 0x1U, 0, 0, 0x401-F8258U
- #define **IOMUXC_GPIO_EMC_21_LPI2C3_SDA** 0x401F8068U, 0x2U, 0x401F84E0U, 0x0U, 0x401F8258U
- #define **IOMUXC_GPIO_EMC_21_ENET_TDATA01** 0x401F8068U, 0x3U, 0, 0, 0x401F8258-U

- #define **IOMUXC_GPIO_EMC_21_QTIMER2_TIMER2** 0x401F8068U, 0x4U, 0x401F8574U, 0x0U, 0x401F8258U
- #define **IOMUXC_GPIO_EMC_21_GPIO4_IO21** 0x401F8068U, 0x5U, 0, 0, 0x401F8258U
- #define **IOMUXC_GPIO_EMC_22_SEMC_BA1** 0x401F806CU, 0x0U, 0, 0, 0x401F825CU
- #define **IOMUXC_GPIO_EMC_22_FLEXPWM3_PWMB03** 0x401F806CU, 0x1U, 0, 0, 0x401F825CU
- #define **IOMUXC_GPIO_EMC_22_LPI2C3_SCL** 0x401F806CU, 0x2U, 0x401F84DCU, 0x0U, 0x401F825CU
- #define **IOMUXC_GPIO_EMC_22_ENET_TDATA00** 0x401F806CU, 0x3U, 0, 0, 0x401F825-CU
- #define **IOMUXC_GPIO_EMC_22_QTIMER2_TIMER3** 0x401F806CU, 0x4U, 0x401F8578U, 0x0U, 0x401F825CU
- #define **IOMUXC_GPIO_EMC_22_GPIO4_IO22** 0x401F806CU, 0x5U, 0, 0, 0x401F825CU
- #define **IOMUXC_GPIO_EMC_22_FLEXSPI2_A_SS1_B** 0x401F806CU, 0x8U, 0, 0, 0x401-F825CU
- #define **IOMUXC_GPIO_EMC_23_SEMC_ADDR10** 0x401F8070U, 0x0U, 0, 0, 0x401F8260U
- #define **IOMUXC_GPIO_EMC_23_FLEXPWM1_PWMA00** 0x401F8070U, 0x1U, 0x401-F8458U, 0x0U, 0x401F8260U
- #define **IOMUXC_GPIO_EMC_23_LPUART5_TX** 0x401F8070U, 0x2U, 0x401F854CU, 0x0-U, 0x401F8260U
- #define **IOMUXC_GPIO_EMC_23_ENET_RX_EN** 0x401F8070U, 0x3U, 0x401F843CU, 0x0-U, 0x401F8260U
- #define **IOMUXC_GPIO_EMC_23_GPT1_CAPTURE2** 0x401F8070U, 0x4U, 0x401F875CU, 0x0U, 0x401F8260U
- #define **IOMUXC_GPIO_EMC_23_GPIO4_IO23** 0x401F8070U, 0x5U, 0, 0, 0x401F8260U
- #define **IOMUXC_GPIO_EMC_23_FLEXSPI2_A_DQS** 0x401F8070U, 0x8U, 0x401F872CU, 0x1U, 0x401F8260U
- #define **IOMUXC_GPIO_EMC_24_SEMC_CAS** 0x401F8074U, 0x0U, 0, 0, 0x401F8264U
- #define **IOMUXC_GPIO_EMC_24_FLEXPWM1_PWMB00** 0x401F8074U, 0x1U, 0x401-F8468U, 0x0U, 0x401F8264U
- #define **IOMUXC_GPIO_EMC_24_LPUART5_RX** 0x401F8074U, 0x2U, 0x401F8548U, 0x0U, 0x401F8264U
- #define **IOMUXC_GPIO_EMC_24_ENET_TX_EN** 0x401F8074U, 0x3U, 0, 0, 0x401F8264U
- #define **IOMUXC_GPIO_EMC_24_GPT1_CAPTURE1** 0x401F8074U, 0x4U, 0x401F8758U, 0x0U, 0x401F8264U
- #define **IOMUXC_GPIO_EMC_24_GPIO4_IO24** 0x401F8074U, 0x5U, 0, 0, 0x401F8264U
- #define **IOMUXC_GPIO_EMC_24_FLEXSPI2_A_SS0_B** 0x401F8074U, 0x8U, 0, 0, 0x401-F8264U
- #define **IOMUXC_GPIO_EMC_25_SEMC_RAS** 0x401F8078U, 0x0U, 0, 0, 0x401F8268U
- #define **IOMUXC_GPIO_EMC_25_FLEXPWM1_PWMA01** 0x401F8078U, 0x1U, 0x401-F845CU, 0x0U, 0x401F8268U
- #define **IOMUXC_GPIO_EMC_25_LPUART6_TX** 0x401F8078U, 0x2U, 0x401F8554U, 0x0U, 0x401F8268U
- #define **IOMUXC_GPIO_EMC_25_ENET_TX_CLK** 0x401F8078U, 0x3U, 0x401F8448U, 0x0-U, 0x401F8268U
- #define **IOMUXC_GPIO_EMC_25_ENET_REF_CLK** 0x401F8078U, 0x4U, 0x401F842CU, 0x0U, 0x401F8268U
- #define **IOMUXC_GPIO_EMC_25_GPIO4_IO25** 0x401F8078U, 0x5U, 0, 0, 0x401F8268U
- #define **IOMUXC_GPIO_EMC_25_FLEXSPI2_A_SCLK** 0x401F8078U, 0x8U, 0x401F8750U, 0x1U, 0x401F8268U
- #define **IOMUXC_GPIO_EMC_26_SEMC_CLK** 0x401F807CU, 0x0U, 0, 0, 0x401F826CU

- #define **IOMUXC_GPIO_EMC_26_FLEXPWM1_PWMB01** 0x401F807CU, 0x1U, 0x401F846CU, 0x0U, 0x401F826CU
- #define **IOMUXC_GPIO_EMC_26_LPUART6_RX** 0x401F807CU, 0x2U, 0x401F8550U, 0x0U, 0x401F826CU
- #define **IOMUXC_GPIO_EMC_26_ENET_RX_ER** 0x401F807CU, 0x3U, 0x401F8440U, 0x0U, 0x401F826CU
- #define **IOMUXC_GPIO_EMC_26_FLEXIO1_FLEXIO12** 0x401F807CU, 0x4U, 0, 0, 0x401F826CU
- #define **IOMUXC_GPIO_EMC_26_GPIO4_IO26** 0x401F807CU, 0x5U, 0, 0, 0x401F826CU
- #define **IOMUXC_GPIO_EMC_26_FLEXSPI2_A_DATA00** 0x401F807CU, 0x8U, 0x401F8730U, 0x1U, 0x401F826CU
- #define **IOMUXC_GPIO_EMC_27_SEMC_CKE** 0x401F8080U, 0x0U, 0, 0, 0x401F8270U
- #define **IOMUXC_GPIO_EMC_27_FLEXPWM1_PWMA02** 0x401F8080U, 0x1U, 0x401F8460U, 0x0U, 0x401F8270U
- #define **IOMUXC_GPIO_EMC_27_LPUART5_RTS_B** 0x401F8080U, 0x2U, 0, 0, 0x401F8270U
- #define **IOMUXC_GPIO_EMC_27_LPSPI1_SCK** 0x401F8080U, 0x3U, 0x401F84F0U, 0x0U, 0x401F8270U
- #define **IOMUXC_GPIO_EMC_27_FLEXIO1_FLEXIO13** 0x401F8080U, 0x4U, 0, 0, 0x401F8270U
- #define **IOMUXC_GPIO_EMC_27_GPIO4_IO27** 0x401F8080U, 0x5U, 0, 0, 0x401F8270U
- #define **IOMUXC_GPIO_EMC_27_FLEXSPI2_A_DATA01** 0x401F8080U, 0x8U, 0x401F8734U, 0x1U, 0x401F8270U
- #define **IOMUXC_GPIO_EMC_28_SEMC_WE** 0x401F8084U, 0x0U, 0, 0, 0x401F8274U
- #define **IOMUXC_GPIO_EMC_28_FLEXPWM1_PWMB02** 0x401F8084U, 0x1U, 0x401F8470U, 0x0U, 0x401F8274U
- #define **IOMUXC_GPIO_EMC_28_LPUART5_CTS_B** 0x401F8084U, 0x2U, 0, 0, 0x401F8274U
- #define **IOMUXC_GPIO_EMC_28_LPSPI1_SDO** 0x401F8084U, 0x3U, 0x401F84F8U, 0x0U, 0x401F8274U
- #define **IOMUXC_GPIO_EMC_28_FLEXIO1_FLEXIO14** 0x401F8084U, 0x4U, 0, 0, 0x401F8274U
- #define **IOMUXC_GPIO_EMC_28_GPIO4_IO28** 0x401F8084U, 0x5U, 0, 0, 0x401F8274U
- #define **IOMUXC_GPIO_EMC_28_FLEXSPI2_A_DATA02** 0x401F8084U, 0x8U, 0x401F8738U, 0x1U, 0x401F8274U
- #define **IOMUXC_GPIO_EMC_29_SEMC_CS0** 0x401F8088U, 0x0U, 0, 0, 0x401F8278U
- #define **IOMUXC_GPIO_EMC_29_FLEXPWM3_PWMA00** 0x401F8088U, 0x1U, 0, 0, 0x401F8278U
- #define **IOMUXC_GPIO_EMC_29_LPUART6_RTS_B** 0x401F8088U, 0x2U, 0, 0, 0x401F8278U
- #define **IOMUXC_GPIO_EMC_29_LPSPI1_SDI** 0x401F8088U, 0x3U, 0x401F84F4U, 0x0U, 0x401F8278U
- #define **IOMUXC_GPIO_EMC_29_FLEXIO1_FLEXIO15** 0x401F8088U, 0x4U, 0, 0, 0x401F8278U
- #define **IOMUXC_GPIO_EMC_29_GPIO4_IO29** 0x401F8088U, 0x5U, 0, 0, 0x401F8278U
- #define **IOMUXC_GPIO_EMC_29_FLEXSPI2_A_DATA03** 0x401F8088U, 0x8U, 0x401F873CU, 0x1U, 0x401F8278U
- #define **IOMUXC_GPIO_EMC_30_SEMC_DATA08** 0x401F808CU, 0x0U, 0, 0, 0x401F827CU
- #define **IOMUXC_GPIO_EMC_30_FLEXPWM3_PWMB00** 0x401F808CU, 0x1U, 0, 0, 0x401F827CU
- #define **IOMUXC_GPIO_EMC_30_LPUART6_CTS_B** 0x401F808CU, 0x2U, 0, 0, 0x401F827-

CU
- #define **IOMUXC_GPIO_EMC_30_LPSPI1_PCS0** 0x401F808CU, 0x3U, 0x401F84ECU, 0x1U, 0x401F827CU
- #define **IOMUXC_GPIO_EMC_30_CSI_DATA23** 0x401F808CU, 0x4U, 0, 0, 0x401F827CU
- #define **IOMUXC_GPIO_EMC_30_GPIO4_IO30** 0x401F808CU, 0x5U, 0, 0, 0x401F827CU
- #define **IOMUXC_GPIO_EMC_30_ENET2_TDATA00** 0x401F808CU, 0x8U, 0, 0, 0x401F827CU
- #define **IOMUXC_GPIO_EMC_31_SEMC_DATA09** 0x401F8090U, 0x0U, 0, 0, 0x401F8280U
- #define **IOMUXC_GPIO_EMC_31_FLEXPWM3_PWMA01** 0x401F8090U, 0x1U, 0, 0, 0x401F8280U
- #define **IOMUXC_GPIO_EMC_31_LPUART7_TX** 0x401F8090U, 0x2U, 0x401F855CU, 0x1U, 0x401F8280U
- #define **IOMUXC_GPIO_EMC_31_LPSPI1_PCS1** 0x401F8090U, 0x3U, 0, 0, 0x401F8280U
- #define **IOMUXC_GPIO_EMC_31_CSI_DATA22** 0x401F8090U, 0x4U, 0, 0, 0x401F8280U
- #define **IOMUXC_GPIO_EMC_31_GPIO4_IO31** 0x401F8090U, 0x5U, 0, 0, 0x401F8280U
- #define **IOMUXC_GPIO_EMC_31_ENET2_TDATA01** 0x401F8090U, 0x8U, 0, 0, 0x401F8280U
- #define **IOMUXC_GPIO_EMC_32_SEMC_DATA10** 0x401F8094U, 0x0U, 0, 0, 0x401F8284U
- #define **IOMUXC_GPIO_EMC_32_FLEXPWM3_PWMB01** 0x401F8094U, 0x1U, 0, 0, 0x401F8284U
- #define **IOMUXC_GPIO_EMC_32_LPUART7_RX** 0x401F8094U, 0x2U, 0x401F8558U, 0x1U, 0x401F8284U
- #define **IOMUXC_GPIO_EMC_32_CCM_PMIC_RDY** 0x401F8094U, 0x3U, 0x401F83FCU, 0x4U, 0x401F8284U
- #define **IOMUXC_GPIO_EMC_32_CSI_DATA21** 0x401F8094U, 0x4U, 0, 0, 0x401F8284U
- #define **IOMUXC_GPIO_EMC_32_GPIO3_IO18** 0x401F8094U, 0x5U, 0, 0, 0x401F8284U
- #define **IOMUXC_GPIO_EMC_32_ENET2_TX_EN** 0x401F8094U, 0x8U, 0, 0, 0x401F8284U
- #define **IOMUXC_GPIO_EMC_33_SEMC_DATA11** 0x401F8098U, 0x0U, 0, 0, 0x401F8288U
- #define **IOMUXC_GPIO_EMC_33_FLEXPWM3_PWMA02** 0x401F8098U, 0x1U, 0, 0, 0x401F8288U
- #define **IOMUXC_GPIO_EMC_33_USDHC1_RESET_B** 0x401F8098U, 0x2U, 0, 0, 0x401F8288U
- #define **IOMUXC_GPIO_EMC_33_SAI3_RX_DATA** 0x401F8098U, 0x3U, 0x401F8778U, 0x0U, 0x401F8288U
- #define **IOMUXC_GPIO_EMC_33_CSI_DATA20** 0x401F8098U, 0x4U, 0, 0, 0x401F8288U
- #define **IOMUXC_GPIO_EMC_33_GPIO3_IO19** 0x401F8098U, 0x5U, 0, 0, 0x401F8288U
- #define **IOMUXC_GPIO_EMC_33_ENET2_TX_CLK** 0x401F8098U, 0x8U, 0x401F8728U, 0x0U, 0x401F8288U
- #define **IOMUXC_GPIO_EMC_33_ENET2_REF_CLK2** 0x401F8098U, 0x9U, 0x401F870CU, 0x0U, 0x401F8288U
- #define **IOMUXC_GPIO_EMC_34_SEMC_DATA12** 0x401F809CU, 0x0U, 0, 0, 0x401F828CU
- #define **IOMUXC_GPIO_EMC_34_FLEXPWM3_PWMB02** 0x401F809CU, 0x1U, 0, 0, 0x401F828CU
- #define **IOMUXC_GPIO_EMC_34_USDHC1_VSELECT** 0x401F809CU, 0x2U, 0, 0, 0x401F828CU
- #define **IOMUXC_GPIO_EMC_34_SAI3_RX_SYNC** 0x401F809CU, 0x3U, 0x401F877CU, 0x0U, 0x401F828CU
- #define **IOMUXC_GPIO_EMC_34_CSI_DATA19** 0x401F809CU, 0x4U, 0, 0, 0x401F828CU
- #define **IOMUXC_GPIO_EMC_34_GPIO3_IO20** 0x401F809CU, 0x5U, 0, 0, 0x401F828CU
- #define **IOMUXC_GPIO_EMC_34_ENET2_RX_ER** 0x401F809CU, 0x8U, 0x401F8720U, 0x0U, 0x401F828CU
- #define **IOMUXC_GPIO_EMC_35_SEMC_DATA13** 0x401F80A0U, 0x0U, 0, 0, 0x401F8290U

- #define **IOMUXC_GPIO_EMC_35_XBAR1_INOUT18** 0x401F80A0U, 0x1U, 0x401F8630U, 0x0U, 0x401F8290U
- #define **IOMUXC_GPIO_EMC_35_GPT1_COMPARE1** 0x401F80A0U, 0x2U, 0, 0, 0x401-F8290U
- #define **IOMUXC_GPIO_EMC_35_SAI3_RX_BCLK** 0x401F80A0U, 0x3U, 0x401F8774U, 0x0U, 0x401F8290U
- #define **IOMUXC_GPIO_EMC_35_CSI_DATA18** 0x401F80A0U, 0x4U, 0, 0, 0x401F8290U
- #define **IOMUXC_GPIO_EMC_35_GPIO3_IO21** 0x401F80A0U, 0x5U, 0, 0, 0x401F8290U
- #define **IOMUXC_GPIO_EMC_35_USDHC1_CD_B** 0x401F80A0U, 0x6U, 0x401F85D4U, 0x0U, 0x401F8290U
- #define **IOMUXC_GPIO_EMC_35_ENET2_RDATA00** 0x401F80A0U, 0x8U, 0x401F8714U, 0x0U, 0x401F8290U
- #define **IOMUXC_GPIO_EMC_36_SEMC_DATA14** 0x401F80A4U, 0x0U, 0, 0, 0x401F8294U
- #define **IOMUXC_GPIO_EMC_36_XBAR1_IN22** 0x401F80A4U, 0x1U, 0x401F8638U, 0x0U, 0x401F8294U
- #define **IOMUXC_GPIO_EMC_36_GPT1_COMPARE2** 0x401F80A4U, 0x2U, 0, 0, 0x401-F8294U
- #define **IOMUXC_GPIO_EMC_36_SAI3_TX_DATA** 0x401F80A4U, 0x3U, 0, 0, 0x401F8294U
- #define **IOMUXC_GPIO_EMC_36_CSI_DATA17** 0x401F80A4U, 0x4U, 0, 0, 0x401F8294U
- #define **IOMUXC_GPIO_EMC_36_GPIO3_IO22** 0x401F80A4U, 0x5U, 0, 0, 0x401F8294U
- #define **IOMUXC_GPIO_EMC_36_USDHC1_WP** 0x401F80A4U, 0x6U, 0x401F85D8U, 0x1U, 0x401F8294U
- #define **IOMUXC_GPIO_EMC_36_ENET2_RDATA01** 0x401F80A4U, 0x8U, 0x401F8718U, 0x0U, 0x401F8294U
- #define **IOMUXC_GPIO_EMC_36_FLEXCAN3_TX** 0x401F80A4U, 0x9U, 0, 0, 0x401F8294U
- #define **IOMUXC_GPIO_EMC_37_SEMC_DATA15** 0x401F80A8U, 0x0U, 0, 0, 0x401F8298U
- #define **IOMUXC_GPIO_EMC_37_XBAR1_IN23** 0x401F80A8U, 0x1U, 0x401F863CU, 0x0U, 0x401F8298U
- #define **IOMUXC_GPIO_EMC_37_GPT1_COMPARE3** 0x401F80A8U, 0x2U, 0, 0, 0x401-F8298U
- #define **IOMUXC_GPIO_EMC_37_SAI3_MCLK** 0x401F80A8U, 0x3U, 0x401F8770U, 0x0U, 0x401F8298U
- #define **IOMUXC_GPIO_EMC_37_CSI_DATA16** 0x401F80A8U, 0x4U, 0, 0, 0x401F8298U
- #define **IOMUXC_GPIO_EMC_37_GPIO3_IO23** 0x401F80A8U, 0x5U, 0, 0, 0x401F8298U
- #define **IOMUXC_GPIO_EMC_37_USDHC2_WP** 0x401F80A8U, 0x6U, 0x401F8608U, 0x0U, 0x401F8298U
- #define **IOMUXC_GPIO_EMC_37_ENET2_RX_EN** 0x401F80A8U, 0x8U, 0x401F871CU, 0x0U, 0x401F8298U
- #define **IOMUXC_GPIO_EMC_37_FLEXCAN3_RX** 0x401F80A8U, 0x9U, 0x401F878CU, 0x0U, 0x401F8298U
- #define **IOMUXC_GPIO_EMC_38_SEMC_DM01** 0x401F80ACU, 0x0U, 0, 0, 0x401F829CU
- #define **IOMUXC_GPIO_EMC_38_FLEXPWM1_PWMA03** 0x401F80ACU, 0x1U, 0x401-F8454U, 0x2U, 0x401F829CU
- #define **IOMUXC_GPIO_EMC_38_LPUART8_TX** 0x401F80ACU, 0x2U, 0x401F8564U, 0x2-U, 0x401F829CU
- #define **IOMUXC_GPIO_EMC_38_SAI3_TX_BCLK** 0x401F80ACU, 0x3U, 0x401F8780U, 0x0U, 0x401F829CU
- #define **IOMUXC_GPIO_EMC_38_CSI_FIELD** 0x401F80ACU, 0x4U, 0, 0, 0x401F829CU
- #define **IOMUXC_GPIO_EMC_38_GPIO3_IO24** 0x401F80ACU, 0x5U, 0, 0, 0x401F829CU
- #define **IOMUXC_GPIO_EMC_38_USDHC2_VSELECT** 0x401F80ACU, 0x6U, 0, 0, 0x401-F829CU

- #define **IOMUXC_GPIO_EMC_38_ENET2_MDC** 0x401F80ACU, 0x8U, 0, 0, 0x401F829CU
- #define **IOMUXC_GPIO_EMC_39_SEMC_DQS** 0x401F80B0U, 0x0U, 0, 0, 0x401F82A0U
- #define **IOMUXC_GPIO_EMC_39_FLEXPWM1_PWMB03** 0x401F80B0U, 0x1U, 0x401F8464U, 0x2U, 0x401F82A0U
- #define **IOMUXC_GPIO_EMC_39_LPUART8_RX** 0x401F80B0U, 0x2U, 0x401F8560U, 0x2U, 0x401F82A0U
- #define **IOMUXC_GPIO_EMC_39_SAI3_TX_SYNC** 0x401F80B0U, 0x3U, 0x401F8784U, 0x0U, 0x401F82A0U
- #define **IOMUXC_GPIO_EMC_39_WDOG1_WDOG_B** 0x401F80B0U, 0x4U, 0, 0, 0x401F82A0U
- #define **IOMUXC_GPIO_EMC_39_GPIO3_IO25** 0x401F80B0U, 0x5U, 0, 0, 0x401F82A0U
- #define **IOMUXC_GPIO_EMC_39_USDHC2_CD_B** 0x401F80B0U, 0x6U, 0x401F85E0U, 0x1U, 0x401F82A0U
- #define **IOMUXC_GPIO_EMC_39_ENET2_MDIO** 0x401F80B0U, 0x8U, 0x401F8710U, 0x0U, 0x401F82A0U
- #define **IOMUXC_GPIO_EMC_39_SEMC_DQS4** 0x401F80B0U, 0x9U, 0x401F8788U, 0x1U, 0x401F82A0U
- #define **IOMUXC_GPIO_EMC_40_SEMC_RDY** 0x401F80B4U, 0x0U, 0, 0, 0x401F82A4U
- #define **IOMUXC_GPIO_EMC_40_GPT2_CAPTURE2** 0x401F80B4U, 0x1U, 0x401F8768U, 0x0U, 0x401F82A4U
- #define **IOMUXC_GPIO_EMC_40_LPSPI1_PCS2** 0x401F80B4U, 0x2U, 0, 0, 0x401F82A4U
- #define **IOMUXC_GPIO_EMC_40_USB_OTG2_OC** 0x401F80B4U, 0x3U, 0x401F85CCU, 0x1U, 0x401F82A4U
- #define **IOMUXC_GPIO_EMC_40_ENET_MDC** 0x401F80B4U, 0x4U, 0, 0, 0x401F82A4U
- #define **IOMUXC_GPIO_EMC_40_GPIO3_IO26** 0x401F80B4U, 0x5U, 0, 0, 0x401F82A4U
- #define **IOMUXC_GPIO_EMC_40_USDHC2_RESET_B** 0x401F80B4U, 0x6U, 0, 0, 0x401F82A4U
- #define **IOMUXC_GPIO_EMC_40_SEMC_CLK5** 0x401F80B4U, 0x9U, 0, 0, 0x401F82A4U
- #define **IOMUXC_GPIO_EMC_41_SEMC_CSX00** 0x401F80B8U, 0x0U, 0, 0, 0x401F82A8U
- #define **IOMUXC_GPIO_EMC_41_GPT2_CAPTURE1** 0x401F80B8U, 0x1U, 0x401F8764U, 0x0U, 0x401F82A8U
- #define **IOMUXC_GPIO_EMC_41_LPSPI1_PCS3** 0x401F80B8U, 0x2U, 0, 0, 0x401F82A8U
- #define **IOMUXC_GPIO_EMC_41_USB_OTG2_PWR** 0x401F80B8U, 0x3U, 0, 0, 0x401F82A8U
- #define **IOMUXC_GPIO_EMC_41_ENET_MDIO** 0x401F80B8U, 0x4U, 0x401F8430U, 0x1U, 0x401F82A8U
- #define **IOMUXC_GPIO_EMC_41_GPIO3_IO27** 0x401F80B8U, 0x5U, 0, 0, 0x401F82A8U
- #define **IOMUXC_GPIO_EMC_41_USDHC1_VSELECT** 0x401F80B8U, 0x6U, 0, 0, 0x401F82A8U
- #define **IOMUXC_GPIO_AD_B0_00_FLEXPWM2_PWMA03** 0x401F80BCU, 0x0U, 0x401F8474U, 0x2U, 0x401F82ACU
- #define **IOMUXC_GPIO_AD_B0_00_XBAR1_INOUT14** 0x401F80BCU, 0x1U, 0x401F8644U, 0x0U, 0x401F82ACU
- #define **IOMUXC_GPIO_AD_B0_00_REF_CLK_32K** 0x401F80BCU, 0x2U, 0, 0, 0x401F82ACU
- #define **IOMUXC_GPIO_AD_B0_00_USB_OTG2_ID** 0x401F80BCU, 0x3U, 0x401F83F8U, 0x0U, 0x401F82ACU
- #define **IOMUXC_GPIO_AD_B0_00_LPI2C1_SCLS** 0x401F80BCU, 0x4U, 0, 0, 0x401F82ACU
- #define **IOMUXC_GPIO_AD_B0_00_GPIO1_IO00** 0x401F80BCU, 0x5U, 0, 0, 0x401F82ACU
- #define **IOMUXC_GPIO_AD_B0_00_USDHC1_RESET_B** 0x401F80BCU, 0x6U, 0, 0, 0x401-

F82ACU
- #define **IOMUXC_GPIO_AD_B0_00_LPSPI3_SCK** 0x401F80BCU, 0x7U, 0x401F8510U, 0x0U, 0x401F82ACU
- #define **IOMUXC_GPIO_AD_B0_01_FLEXPWM2_PWMB03** 0x401F80C0U, 0x0U, 0x401F8484U, 0x2U, 0x401F82B0U
- #define **IOMUXC_GPIO_AD_B0_01_XBAR1_INOUT15** 0x401F80C0U, 0x1U, 0x401F8648U, 0x0U, 0x401F82B0U
- #define **IOMUXC_GPIO_AD_B0_01_REF_CLK_24M** 0x401F80C0U, 0x2U, 0, 0, 0x401F82B0U
- #define **IOMUXC_GPIO_AD_B0_01_USB_OTG1_ID** 0x401F80C0U, 0x3U, 0x401F83F4U, 0x0U, 0x401F82B0U
- #define **IOMUXC_GPIO_AD_B0_01_LPI2C1_SDAS** 0x401F80C0U, 0x4U, 0, 0, 0x401F82B0U
- #define **IOMUXC_GPIO_AD_B0_01_GPIO1_IO01** 0x401F80C0U, 0x5U, 0, 0, 0x401F82B0U
- #define **IOMUXC_GPIO_AD_B0_01_EWM_OUT_B** 0x401F80C0U, 0x6U, 0, 0, 0x401F82B0U
- #define **IOMUXC_GPIO_AD_B0_01_LPSPI3_SDO** 0x401F80C0U, 0x7U, 0x401F8518U, 0x0U, 0x401F82B0U
- #define **IOMUXC_GPIO_AD_B0_02_FLEXCAN2_TX** 0x401F80C4U, 0x0U, 0, 0, 0x401F82B4U
- #define **IOMUXC_GPIO_AD_B0_02_XBAR1_INOUT16** 0x401F80C4U, 0x1U, 0x401F864CU, 0x0U, 0x401F82B4U
- #define **IOMUXC_GPIO_AD_B0_02_LPUART6_TX** 0x401F80C4U, 0x2U, 0x401F8554U, 0x1U, 0x401F82B4U
- #define **IOMUXC_GPIO_AD_B0_02_USB_OTG1_PWR** 0x401F80C4U, 0x3U, 0, 0, 0x401F82B4U
- #define **IOMUXC_GPIO_AD_B0_02_FLEXPWM1_PWMX00** 0x401F80C4U, 0x4U, 0, 0, 0x401F82B4U
- #define **IOMUXC_GPIO_AD_B0_02_GPIO1_IO02** 0x401F80C4U, 0x5U, 0, 0, 0x401F82B4U
- #define **IOMUXC_GPIO_AD_B0_02_LPI2C1_HREQ** 0x401F80C4U, 0x6U, 0, 0, 0x401F82B4U
- #define **IOMUXC_GPIO_AD_B0_02_LPSPI3_SDI** 0x401F80C4U, 0x7U, 0x401F8514U, 0x0U, 0x401F82B4U
- #define **IOMUXC_GPIO_AD_B0_03_FLEXCAN2_RX** 0x401F80C8U, 0x0U, 0x401F8450U, 0x1U, 0x401F82B8U
- #define **IOMUXC_GPIO_AD_B0_03_XBAR1_INOUT17** 0x401F80C8U, 0x1U, 0x401F862CU, 0x1U, 0x401F82B8U
- #define **IOMUXC_GPIO_AD_B0_03_LPUART6_RX** 0x401F80C8U, 0x2U, 0x401F8550U, 0x1U, 0x401F82B8U
- #define **IOMUXC_GPIO_AD_B0_03_USB_OTG1_OC** 0x401F80C8U, 0x3U, 0x401F85D0U, 0x0U, 0x401F82B8U
- #define **IOMUXC_GPIO_AD_B0_03_FLEXPWM1_PWMX01** 0x401F80C8U, 0x4U, 0, 0, 0x401F82B8U
- #define **IOMUXC_GPIO_AD_B0_03_GPIO1_IO03** 0x401F80C8U, 0x5U, 0, 0, 0x401F82B8U
- #define **IOMUXC_GPIO_AD_B0_03_REF_CLK_24M** 0x401F80C8U, 0x6U, 0, 0, 0x401F82B8U
- #define **IOMUXC_GPIO_AD_B0_03_LPSPI3_PCS0** 0x401F80C8U, 0x7U, 0x401F850CU, 0x0U, 0x401F82B8U
- #define **IOMUXC_GPIO_AD_B0_04_SRC_BOOT_MODE00** 0x401F80CCU, 0x0U, 0, 0, 0x401F82BCU
- #define **IOMUXC_GPIO_AD_B0_04_MQS_RIGHT** 0x401F80CCU, 0x1U, 0, 0, 0x401F82BCU
- #define **IOMUXC_GPIO_AD_B0_04_ENET_TX_DATA03** 0x401F80CCU, 0x2U, 0, 0, 0x401-

F82BCU
- #define **IOMUXC_GPIO_AD_B0_04_SAI2_TX_SYNC** 0x401F80CCU, 0x3U, 0x401F85C4U, 0x1U, 0x401F82BCU
- #define **IOMUXC_GPIO_AD_B0_04_CSI_DATA09** 0x401F80CCU, 0x4U, 0x401F841CU, 0x1U, 0x401F82BCU
- #define **IOMUXC_GPIO_AD_B0_04_GPIO1_IO04** 0x401F80CCU, 0x5U, 0, 0, 0x401F82BCU
- #define **IOMUXC_GPIO_AD_B0_04_PIT_TRIGGER00** 0x401F80CCU, 0x6U, 0, 0, 0x401F82BCU
- #define **IOMUXC_GPIO_AD_B0_04_LPSPI3_PCS1** 0x401F80CCU, 0x7U, 0, 0, 0x401F82BCU
- #define **IOMUXC_GPIO_AD_B0_05_SRC_BOOT_MODE01** 0x401F80D0U, 0x0U, 0, 0, 0x401F82C0U
- #define **IOMUXC_GPIO_AD_B0_05_MQS_LEFT** 0x401F80D0U, 0x1U, 0, 0, 0x401F82C0U
- #define **IOMUXC_GPIO_AD_B0_05_ENET_TX_DATA02** 0x401F80D0U, 0x2U, 0, 0, 0x401F82C0U
- #define **IOMUXC_GPIO_AD_B0_05_SAI2_TX_BCLK** 0x401F80D0U, 0x3U, 0x401F85C0U, 0x1U, 0x401F82C0U
- #define **IOMUXC_GPIO_AD_B0_05_CSI_DATA08** 0x401F80D0U, 0x4U, 0x401F8418U, 0x1U, 0x401F82C0U
- #define **IOMUXC_GPIO_AD_B0_05_GPIO1_IO05** 0x401F80D0U, 0x5U, 0, 0, 0x401F82C0U
- #define **IOMUXC_GPIO_AD_B0_05_XBAR1_INOUT17** 0x401F80D0U, 0x6U, 0x401F862CU, 0x2U, 0x401F82C0U
- #define **IOMUXC_GPIO_AD_B0_05_LPSPI3_PCS2** 0x401F80D0U, 0x7U, 0, 0, 0x401F82C0U
- #define **IOMUXC_GPIO_AD_B0_06_JTAG_TMS** 0x401F80D4U, 0x0U, 0, 0, 0x401F82C4U
- #define **IOMUXC_GPIO_AD_B0_06_GPT2_COMPARE1** 0x401F80D4U, 0x1U, 0, 0, 0x401F82C4U
- #define **IOMUXC_GPIO_AD_B0_06_ENET_RX_CLK** 0x401F80D4U, 0x2U, 0, 0, 0x401F82C4U
- #define **IOMUXC_GPIO_AD_B0_06_SAI2_RX_BCLK** 0x401F80D4U, 0x3U, 0x401F85B4U, 0x1U, 0x401F82C4U
- #define **IOMUXC_GPIO_AD_B0_06_CSI_DATA07** 0x401F80D4U, 0x4U, 0x401F8414U, 0x1U, 0x401F82C4U
- #define **IOMUXC_GPIO_AD_B0_06_GPIO1_IO06** 0x401F80D4U, 0x5U, 0, 0, 0x401F82C4U
- #define **IOMUXC_GPIO_AD_B0_06_XBAR1_INOUT18** 0x401F80D4U, 0x6U, 0x401F8630U, 0x1U, 0x401F82C4U
- #define **IOMUXC_GPIO_AD_B0_06_LPSPI3_PCS3** 0x401F80D4U, 0x7U, 0, 0, 0x401F82C4U
- #define **IOMUXC_GPIO_AD_B0_07_JTAG_TCK** 0x401F80D8U, 0x0U, 0, 0, 0x401F82C8U
- #define **IOMUXC_GPIO_AD_B0_07_GPT2_COMPARE2** 0x401F80D8U, 0x1U, 0, 0, 0x401F82C8U
- #define **IOMUXC_GPIO_AD_B0_07_ENET_TX_ER** 0x401F80D8U, 0x2U, 0, 0, 0x401F82C8U
- #define **IOMUXC_GPIO_AD_B0_07_SAI2_RX_SYNC** 0x401F80D8U, 0x3U, 0x401F85BCU, 0x1U, 0x401F82C8U
- #define **IOMUXC_GPIO_AD_B0_07_CSI_DATA06** 0x401F80D8U, 0x4U, 0x401F8410U, 0x1U, 0x401F82C8U
- #define **IOMUXC_GPIO_AD_B0_07_GPIO1_IO07** 0x401F80D8U, 0x5U, 0, 0, 0x401F82C8U
- #define **IOMUXC_GPIO_AD_B0_07_XBAR1_INOUT19** 0x401F80D8U, 0x6U, 0x401F8654U, 0x1U, 0x401F82C8U
- #define **IOMUXC_GPIO_AD_B0_07_ENET_1588_EVENT3_OUT** 0x401F80D8U, 0x7U, 0, 0, 0x401F82C8U
- #define **IOMUXC_GPIO_AD_B0_08_JTAG_MOD** 0x401F80DCU, 0x0U, 0, 0, 0x401F82CCU

- #define **IOMUXC_GPIO_AD_B0_08_GPT2_COMPARE3** 0x401F80DCU, 0x1U, 0, 0, 0x401-F82CCU
- #define **IOMUXC_GPIO_AD_B0_08_ENET_RX_DATA03** 0x401F80DCU, 0x2U, 0, 0, 0x401-F82CCU
- #define **IOMUXC_GPIO_AD_B0_08_SAI2_RX_DATA** 0x401F80DCU, 0x3U, 0x401F85B8U, 0x1U, 0x401F82CCU
- #define **IOMUXC_GPIO_AD_B0_08_CSI_DATA05** 0x401F80DCU, 0x4U, 0x401F840CU, 0x1U, 0x401F82CCU
- #define **IOMUXC_GPIO_AD_B0_08_GPIO1_IO08** 0x401F80DCU, 0x5U, 0, 0, 0x401F82CCU
- #define **IOMUXC_GPIO_AD_B0_08_XBAR1_IN20** 0x401F80DCU, 0x6U, 0x401F8634U, 0x1-U, 0x401F82CCU
- #define **IOMUXC_GPIO_AD_B0_08_ENET_1588_EVENT3_IN** 0x401F80DCU, 0x7U, 0, 0, 0x401F82CCU
- #define **IOMUXC_GPIO_AD_B0_09_JTAG_TDI** 0x401F80E0U, 0x0U, 0, 0, 0x401F82D0U
- #define **IOMUXC_GPIO_AD_B0_09_FLEXPWM2_PWMA03** 0x401F80E0U, 0x1U, 0x401-F8474U, 0x3U, 0x401F82D0U
- #define **IOMUXC_GPIO_AD_B0_09_ENET_RX_DATA02** 0x401F80E0U, 0x2U, 0, 0, 0x401-F82D0U
- #define **IOMUXC_GPIO_AD_B0_09_SAI2_TX_DATA** 0x401F80E0U, 0x3U, 0, 0, 0x401F82-D0U
- #define **IOMUXC_GPIO_AD_B0_09_CSI_DATA04** 0x401F80E0U, 0x4U, 0x401F8408U, 0x1-U, 0x401F82D0U
- #define **IOMUXC_GPIO_AD_B0_09_GPIO1_IO09** 0x401F80E0U, 0x5U, 0, 0, 0x401F82D0U
- #define **IOMUXC_GPIO_AD_B0_09_XBAR1_IN21** 0x401F80E0U, 0x6U, 0x401F8658U, 0x1-U, 0x401F82D0U
- #define **IOMUXC_GPIO_AD_B0_09_GPT2_CLK** 0x401F80E0U, 0x7U, 0x401F876CU, 0x0U, 0x401F82D0U
- #define **IOMUXC_GPIO_AD_B0_09_SEMC_DQS4** 0x401F80E0U, 0x9U, 0x401F8788U, 0x2-U, 0x401F82D0U
- #define **IOMUXC_GPIO_AD_B0_10_JTAG_TDO** 0x401F80E4U, 0x0U, 0, 0, 0x401F82D4U
- #define **IOMUXC_GPIO_AD_B0_10_FLEXPWM1_PWMA03** 0x401F80E4U, 0x1U, 0x401-F8454U, 0x3U, 0x401F82D4U
- #define **IOMUXC_GPIO_AD_B0_10_ENET_CRS** 0x401F80E4U, 0x2U, 0, 0, 0x401F82D4U
- #define **IOMUXC_GPIO_AD_B0_10_SAI2_MCLK** 0x401F80E4U, 0x3U, 0x401F85B0U, 0x1-U, 0x401F82D4U
- #define **IOMUXC_GPIO_AD_B0_10_CSI_DATA03** 0x401F80E4U, 0x4U, 0x401F8404U, 0x1-U, 0x401F82D4U
- #define **IOMUXC_GPIO_AD_B0_10_GPIO1_IO10** 0x401F80E4U, 0x5U, 0, 0, 0x401F82D4U
- #define **IOMUXC_GPIO_AD_B0_10_XBAR1_IN22** 0x401F80E4U, 0x6U, 0x401F8638U, 0x1-U, 0x401F82D4U
- #define **IOMUXC_GPIO_AD_B0_10_ENET_1588_EVENT0_OUT** 0x401F80E4U, 0x7U, 0, 0, 0x401F82D4U
- #define **IOMUXC_GPIO_AD_B0_10_FLEXCAN3_TX** 0x401F80E4U, 0x8U, 0, 0, 0x401F82-D4U
- #define **IOMUXC_GPIO_AD_B0_10_ARM_TRACE_SWO** 0x401F80E4U, 0x9U, 0, 0, 0x401-F82D4U
- #define **IOMUXC_GPIO_AD_B0_11_JTAG_TRSTB** 0x401F80E8U, 0x0U, 0, 0, 0x401F82D8U
- #define **IOMUXC_GPIO_AD_B0_11_FLEXPWM1_PWMB03** 0x401F80E8U, 0x1U, 0x401-F8464U, 0x3U, 0x401F82D8U
- #define **IOMUXC_GPIO_AD_B0_11_ENET_COL** 0x401F80E8U, 0x2U, 0, 0, 0x401F82D8U
- #define **IOMUXC_GPIO_AD_B0_11_WDOG1_WDOG_B** 0x401F80E8U, 0x3U, 0, 0, 0x401-

F82D8U
- #define **IOMUXC_GPIO_AD_B0_11_CSI_DATA02** 0x401F80E8U, 0x4U, 0x401F8400U, 0x1U, 0x401F82D8U
- #define **IOMUXC_GPIO_AD_B0_11_GPIO1_IO11** 0x401F80E8U, 0x5U, 0, 0, 0x401F82D8U
- #define **IOMUXC_GPIO_AD_B0_11_XBAR1_IN23** 0x401F80E8U, 0x6U, 0x401F863CU, 0x1U, 0x401F82D8U
- #define **IOMUXC_GPIO_AD_B0_11_ENET_1588_EVENT0_IN** 0x401F80E8U, 0x7U, 0x401F8444U, 0x1U, 0x401F82D8U
- #define **IOMUXC_GPIO_AD_B0_11_FLEXCAN3_RX** 0x401F80E8U, 0x8U, 0x401F878CU, 0x2U, 0x401F82D8U
- #define **IOMUXC_GPIO_AD_B0_11_SEMC_CLK6** 0x401F80E8U, 0x9U, 0, 0, 0x401F82D8U
- #define **IOMUXC_GPIO_AD_B0_12_LPI2C4_SCL** 0x401F80ECU, 0x0U, 0x401F84E4U, 0x1U, 0x401F82DCU
- #define **IOMUXC_GPIO_AD_B0_12_CCM_PMIC_READY** 0x401F80ECU, 0x1U, 0x401F83FCU, 0x1U, 0x401F82DCU
- #define **IOMUXC_GPIO_AD_B0_12_LPUART1_TX** 0x401F80ECU, 0x2U, 0, 0, 0x401F82DCU
- #define **IOMUXC_GPIO_AD_B0_12_WDOG2_WDOG_B** 0x401F80ECU, 0x3U, 0, 0, 0x401F82DCU
- #define **IOMUXC_GPIO_AD_B0_12_FLEXPWM1_PWMX02** 0x401F80ECU, 0x4U, 0, 0, 0x401F82DCU
- #define **IOMUXC_GPIO_AD_B0_12_GPIO1_IO12** 0x401F80ECU, 0x5U, 0, 0, 0x401F82DCU
- #define **IOMUXC_GPIO_AD_B0_12_ENET_1588_EVENT1_OUT** 0x401F80ECU, 0x6U, 0, 0, 0x401F82DCU
- #define **IOMUXC_GPIO_AD_B0_12_NMI_GLUE_NMI** 0x401F80ECU, 0x7U, 0x401F8568U, 0x0U, 0x401F82DCU
- #define **IOMUXC_GPIO_AD_B0_13_LPI2C4_SDA** 0x401F80F0U, 0x0U, 0x401F84E8U, 0x1U, 0x401F82E0U
- #define **IOMUXC_GPIO_AD_B0_13_GPT1_CLK** 0x401F80F0U, 0x1U, 0x401F8760U, 0x0U, 0x401F82E0U
- #define **IOMUXC_GPIO_AD_B0_13_LPUART1_RX** 0x401F80F0U, 0x2U, 0, 0, 0x401F82E0U
- #define **IOMUXC_GPIO_AD_B0_13_EWM_OUT_B** 0x401F80F0U, 0x3U, 0, 0, 0x401F82E0U
- #define **IOMUXC_GPIO_AD_B0_13_FLEXPWM1_PWMX03** 0x401F80F0U, 0x4U, 0, 0, 0x401F82E0U
- #define **IOMUXC_GPIO_AD_B0_13_GPIO1_IO13** 0x401F80F0U, 0x5U, 0, 0, 0x401F82E0U
- #define **IOMUXC_GPIO_AD_B0_13_ENET_1588_EVENT1_IN** 0x401F80F0U, 0x6U, 0, 0, 0x401F82E0U
- #define **IOMUXC_GPIO_AD_B0_13_REF_CLK_24M** 0x401F80F0U, 0x7U, 0, 0, 0x401F82E0U
- #define **IOMUXC_GPIO_AD_B0_14_USB_OTG2_OC** 0x401F80F4U, 0x0U, 0x401F85CCU, 0x0U, 0x401F82E4U
- #define **IOMUXC_GPIO_AD_B0_14_XBAR1_IN24** 0x401F80F4U, 0x1U, 0x401F8640U, 0x1U, 0x401F82E4U
- #define **IOMUXC_GPIO_AD_B0_14_LPUART1_CTS_B** 0x401F80F4U, 0x2U, 0, 0, 0x401F82E4U
- #define **IOMUXC_GPIO_AD_B0_14_ENET_1588_EVENT0_OUT** 0x401F80F4U, 0x3U, 0, 0, 0x401F82E4U
- #define **IOMUXC_GPIO_AD_B0_14_CSI_VSYNC** 0x401F80F4U, 0x4U, 0x401F8428U, 0x0U, 0x401F82E4U
- #define **IOMUXC_GPIO_AD_B0_14_GPIO1_IO14** 0x401F80F4U, 0x5U, 0, 0, 0x401F82E4U
- #define **IOMUXC_GPIO_AD_B0_14_FLEXCAN2_TX** 0x401F80F4U, 0x6U, 0, 0, 0x401F82-

E4U
- #define **IOMUXC_GPIO_AD_B0_14_FLEXCAN3_TX** 0x401F80F4U, 0x8U, 0, 0, 0x401F82-E4U
- #define **IOMUXC_GPIO_AD_B0_15_USB_OTG2_PWR** 0x401F80F8U, 0x0U, 0, 0, 0x401F82-E8U
- #define **IOMUXC_GPIO_AD_B0_15_XBAR1_IN25** 0x401F80F8U, 0x1U, 0x401F8650U, 0x0-U, 0x401F82E8U
- #define **IOMUXC_GPIO_AD_B0_15_LPUART1_RTS_B** 0x401F80F8U, 0x2U, 0, 0, 0x401-F82E8U
- #define **IOMUXC_GPIO_AD_B0_15_ENET_1588_EVENT0_IN** 0x401F80F8U, 0x3U, 0x401-F8444U, 0x0U, 0x401F82E8U
- #define **IOMUXC_GPIO_AD_B0_15_CSI_HSYNC** 0x401F80F8U, 0x4U, 0x401F8420U, 0x0U, 0x401F82E8U
- #define **IOMUXC_GPIO_AD_B0_15_GPIO1_IO15** 0x401F80F8U, 0x5U, 0, 0, 0x401F82E8U
- #define **IOMUXC_GPIO_AD_B0_15_FLEXCAN2_RX** 0x401F80F8U, 0x6U, 0x401F8450U, 0x2U, 0x401F82E8U
- #define **IOMUXC_GPIO_AD_B0_15_WDOG1_WDOG_RST_B_DEB** 0x401F80F8U, 0x7U, 0, 0, 0x401F82E8U
- #define **IOMUXC_GPIO_AD_B0_15_FLEXCAN3_RX** 0x401F80F8U, 0x8U, 0x401F878CU, 0x1U, 0x401F82E8U
- #define **IOMUXC_GPIO_AD_B1_00_USB_OTG2_ID** 0x401F80FCU, 0x0U, 0x401F83F8U, 0x1U, 0x401F82ECU
- #define **IOMUXC_GPIO_AD_B1_00_QTIMER3_TIMER0** 0x401F80FCU, 0x1U, 0x401F857-CU, 0x1U, 0x401F82ECU
- #define **IOMUXC_GPIO_AD_B1_00_LPUART2_CTS_B** 0x401F80FCU, 0x2U, 0, 0, 0x401-F82ECU
- #define **IOMUXC_GPIO_AD_B1_00_LPI2C1_SCL** 0x401F80FCU, 0x3U, 0x401F84CCU, 0x1-U, 0x401F82ECU
- #define **IOMUXC_GPIO_AD_B1_00_WDOG1_B** 0x401F80FCU, 0x4U, 0, 0, 0x401F82ECU
- #define **IOMUXC_GPIO_AD_B1_00_GPIO1_IO16** 0x401F80FCU, 0x5U, 0, 0, 0x401F82ECU
- #define **IOMUXC_GPIO_AD_B1_00_USDHC1_WP** 0x401F80FCU, 0x6U, 0x401F85D8U, 0x2U, 0x401F82ECU
- #define **IOMUXC_GPIO_AD_B1_00_KPP_ROW07** 0x401F80FCU, 0x7U, 0, 0, 0x401F82ECU
- #define **IOMUXC_GPIO_AD_B1_00_ENET2_1588_EVENT0_OUT** 0x401F80FCU, 0x8U, 0, 0, 0x401F82ECU
- #define **IOMUXC_GPIO_AD_B1_00_FLEXIO3_FLEXIO00** 0x401F80FCU, 0x9U, 0, 0, 0x401F82ECU
- #define **IOMUXC_GPIO_AD_B1_01_USB_OTG1_PWR** 0x401F8100U, 0x0U, 0, 0, 0x401F82-F0U
- #define **IOMUXC_GPIO_AD_B1_01_QTIMER3_TIMER1** 0x401F8100U, 0x1U, 0x401F8580-U, 0x0U, 0x401F82F0U
- #define **IOMUXC_GPIO_AD_B1_01_LPUART2_RTS_B** 0x401F8100U, 0x2U, 0, 0, 0x401F82-F0U
- #define **IOMUXC_GPIO_AD_B1_01_LPI2C1_SDA** 0x401F8100U, 0x3U, 0x401F84D0U, 0x1-U, 0x401F82F0U
- #define **IOMUXC_GPIO_AD_B1_01_CCM_PMIC_READY** 0x401F8100U, 0x4U, 0x401F83-FCU, 0x2U, 0x401F82F0U
- #define **IOMUXC_GPIO_AD_B1_01_GPIO1_IO17** 0x401F8100U, 0x5U, 0, 0, 0x401F82F0U
- #define **IOMUXC_GPIO_AD_B1_01_USDHC1_VSELECT** 0x401F8100U, 0x6U, 0, 0, 0x401-F82F0U

- #define **IOMUXC_GPIO_AD_B1_01_KPP_COL07** 0x401F8100U, 0x7U, 0, 0, 0x401F82F0U
- #define **IOMUXC_GPIO_AD_B1_01_ENET2_1588_EVENT0_IN** 0x401F8100U, 0x8U, 0x401F8724U, 0x0U, 0x401F82F0U
- #define **IOMUXC_GPIO_AD_B1_01_FLEXIO3_FLEXIO01** 0x401F8100U, 0x9U, 0, 0, 0x401-F82F0U
- #define **IOMUXC_GPIO_AD_B1_02_USB_OTG1_ID** 0x401F8104U, 0x0U, 0x401F83F4U, 0x1U, 0x401F82F4U
- #define **IOMUXC_GPIO_AD_B1_02_QTIMER3_TIMER2** 0x401F8104U, 0x1U, 0x401F8584-U, 0x1U, 0x401F82F4U
- #define **IOMUXC_GPIO_AD_B1_02_LPUART2_TX** 0x401F8104U, 0x2U, 0x401F8530U, 0x1-U, 0x401F82F4U
- #define **IOMUXC_GPIO_AD_B1_02_SPDIF_OUT** 0x401F8104U, 0x3U, 0, 0, 0x401F82F4U
- #define **IOMUXC_GPIO_AD_B1_02_ENET_1588_EVENT2_OUT** 0x401F8104U, 0x4U, 0, 0, 0x401F82F4U
- #define **IOMUXC_GPIO_AD_B1_02_GPIO1_IO18** 0x401F8104U, 0x5U, 0, 0, 0x401F82F4U
- #define **IOMUXC_GPIO_AD_B1_02_USDHC1_CD_B** 0x401F8104U, 0x6U, 0x401F85D4U, 0x1U, 0x401F82F4U
- #define **IOMUXC_GPIO_AD_B1_02_KPP_ROW06** 0x401F8104U, 0x7U, 0, 0, 0x401F82F4U
- #define **IOMUXC_GPIO_AD_B1_02_GPT2_CLK** 0x401F8104U, 0x8U, 0x401F876CU, 0x1U, 0x401F82F4U
- #define **IOMUXC_GPIO_AD_B1_02_FLEXIO3_FLEXIO02** 0x401F8104U, 0x9U, 0, 0, 0x401-F82F4U
- #define **IOMUXC_GPIO_AD_B1_03_USB_OTG1_OC** 0x401F8108U, 0x0U, 0x401F85D0U, 0x1U, 0x401F82F8U
- #define **IOMUXC_GPIO_AD_B1_03_QTIMER3_TIMER3** 0x401F8108U, 0x1U, 0x401F8588-U, 0x1U, 0x401F82F8U
- #define **IOMUXC_GPIO_AD_B1_03_LPUART2_RX** 0x401F8108U, 0x2U, 0x401F852CU, 0x1U, 0x401F82F8U
- #define **IOMUXC_GPIO_AD_B1_03_SPDIF_IN** 0x401F8108U, 0x3U, 0x401F85C8U, 0x0U, 0x401F82F8U
- #define **IOMUXC_GPIO_AD_B1_03_ENET_1588_EVENT2_IN** 0x401F8108U, 0x4U, 0, 0, 0x401F82F8U
- #define **IOMUXC_GPIO_AD_B1_03_GPIO1_IO19** 0x401F8108U, 0x5U, 0, 0, 0x401F82F8U
- #define **IOMUXC_GPIO_AD_B1_03_USDHC2_CD_B** 0x401F8108U, 0x6U, 0x401F85E0U, 0x0U, 0x401F82F8U
- #define **IOMUXC_GPIO_AD_B1_03_KPP_COL06** 0x401F8108U, 0x7U, 0, 0, 0x401F82F8U
- #define **IOMUXC_GPIO_AD_B1_03_GPT2_CAPTURE1** 0x401F8108U, 0x8U, 0x401F8764U, 0x1U, 0x401F82F8U
- #define **IOMUXC_GPIO_AD_B1_03_FLEXIO3_FLEXIO03** 0x401F8108U, 0x9U, 0, 0, 0x401-F82F8U
- #define **IOMUXC_GPIO_AD_B1_04_FLEXSPIB_DATA03** 0x401F810CU, 0x0U, 0x401F84-C4U, 0x1U, 0x401F82FCU
- #define **IOMUXC_GPIO_AD_B1_04_ENET_MDC** 0x401F810CU, 0x1U, 0, 0, 0x401F82FCU
- #define **IOMUXC_GPIO_AD_B1_04_LPUART3_CTS_B** 0x401F810CU, 0x2U, 0x401F8534U, 0x1U, 0x401F82FCU
- #define **IOMUXC_GPIO_AD_B1_04_SPDIF_SR_CLK** 0x401F810CU, 0x3U, 0, 0, 0x401F82F-CU
- #define **IOMUXC_GPIO_AD_B1_04_CSI_PIXCLK** 0x401F810CU, 0x4U, 0x401F8424U, 0x0-U, 0x401F82FCU
- #define **IOMUXC_GPIO_AD_B1_04_GPIO1_IO20** 0x401F810CU, 0x5U, 0, 0, 0x401F82FCU
- #define **IOMUXC_GPIO_AD_B1_04_USDHC2_DATA0** 0x401F810CU, 0x6U, 0x401F85E8U,

0x1U, 0x401F82FCU
- #define **IOMUXC_GPIO_AD_B1_04_KPP_ROW05** 0x401F810CU, 0x7U, 0, 0, 0x401F82FCU
- #define **IOMUXC_GPIO_AD_B1_04_GPT2_CAPTURE2** 0x401F810CU, 0x8U, 0x401F8768-U, 0x1U, 0x401F82FCU
- #define **IOMUXC_GPIO_AD_B1_04_FLEXIO3_FLEXIO04** 0x401F810CU, 0x9U, 0, 0, 0x401F82FCU
- #define **IOMUXC_GPIO_AD_B1_05_FLEXSPIB_DATA02** 0x401F8110U, 0x0U, 0x401F84-C0U, 0x1U, 0x401F8300U
- #define **IOMUXC_GPIO_AD_B1_05_ENET_MDIO** 0x401F8110U, 0x1U, 0x401F8430U, 0x0-U, 0x401F8300U
- #define **IOMUXC_GPIO_AD_B1_05_LPUART3_RTS_B** 0x401F8110U, 0x2U, 0, 0, 0x401-F8300U
- #define **IOMUXC_GPIO_AD_B1_05_SPDIF_OUT** 0x401F8110U, 0x3U, 0, 0, 0x401F8300U
- #define **IOMUXC_GPIO_AD_B1_05_CSI_MCLK** 0x401F8110U, 0x4U, 0, 0, 0x401F8300U
- #define **IOMUXC_GPIO_AD_B1_05_GPIO1_IO21** 0x401F8110U, 0x5U, 0, 0, 0x401F8300U
- #define **IOMUXC_GPIO_AD_B1_05_USDHC2_DATA1** 0x401F8110U, 0x6U, 0x401F85ECU, 0x1U, 0x401F8300U
- #define **IOMUXC_GPIO_AD_B1_05_KPP_COL05** 0x401F8110U, 0x7U, 0, 0, 0x401F8300U
- #define **IOMUXC_GPIO_AD_B1_05_GPT2_COMPARE1** 0x401F8110U, 0x8U, 0, 0, 0x401-F8300U
- #define **IOMUXC_GPIO_AD_B1_05_FLEXIO3_FLEXIO05** 0x401F8110U, 0x9U, 0, 0, 0x401-F8300U
- #define **IOMUXC_GPIO_AD_B1_06_FLEXSPIB_DATA01** 0x401F8114U, 0x0U, 0x401F84B-CU, 0x1U, 0x401F8304U
- #define **IOMUXC_GPIO_AD_B1_06_LPI2C3_SDA** 0x401F8114U, 0x1U, 0x401F84E0U, 0x2-U, 0x401F8304U
- #define **IOMUXC_GPIO_AD_B1_06_LPUART3_TX** 0x401F8114U, 0x2U, 0x401F853CU, 0x0U, 0x401F8304U
- #define **IOMUXC_GPIO_AD_B1_06_SPDIF_LOCK** 0x401F8114U, 0x3U, 0, 0, 0x401F8304U
- #define **IOMUXC_GPIO_AD_B1_06_CSI_VSYNC** 0x401F8114U, 0x4U, 0x401F8428U, 0x1U, 0x401F8304U
- #define **IOMUXC_GPIO_AD_B1_06_GPIO1_IO22** 0x401F8114U, 0x5U, 0, 0, 0x401F8304U
- #define **IOMUXC_GPIO_AD_B1_06_USDHC2_DATA2** 0x401F8114U, 0x6U, 0x401F85F0U, 0x1U, 0x401F8304U
- #define **IOMUXC_GPIO_AD_B1_06_KPP_ROW04** 0x401F8114U, 0x7U, 0, 0, 0x401F8304U
- #define **IOMUXC_GPIO_AD_B1_06_GPT2_COMPARE2** 0x401F8114U, 0x8U, 0, 0, 0x401-F8304U
- #define **IOMUXC_GPIO_AD_B1_06_FLEXIO3_FLEXIO06** 0x401F8114U, 0x9U, 0, 0, 0x401-F8304U
- #define **IOMUXC_GPIO_AD_B1_07_FLEXSPIB_DATA00** 0x401F8118U, 0x0U, 0x401F84-B8U, 0x1U, 0x401F8308U
- #define **IOMUXC_GPIO_AD_B1_07_LPI2C3_SCL** 0x401F8118U, 0x1U, 0x401F84DCU, 0x2-U, 0x401F8308U
- #define **IOMUXC_GPIO_AD_B1_07_LPUART3_RX** 0x401F8118U, 0x2U, 0x401F8538U, 0x0U, 0x401F8308U
- #define **IOMUXC_GPIO_AD_B1_07_SPDIF_EXT_CLK** 0x401F8118U, 0x3U, 0, 0, 0x401-F8308U
- #define **IOMUXC_GPIO_AD_B1_07_CSI_HSYNC** 0x401F8118U, 0x4U, 0x401F8420U, 0x1U, 0x401F8308U
- #define **IOMUXC_GPIO_AD_B1_07_GPIO1_IO23** 0x401F8118U, 0x5U, 0, 0, 0x401F8308U
- #define **IOMUXC_GPIO_AD_B1_07_USDHC2_DATA3** 0x401F8118U, 0x6U, 0x401F85F4U,

0x1U, 0x401F8308U
- #define **IOMUXC_GPIO_AD_B1_07_KPP_COL04** 0x401F8118U, 0x7U, 0, 0, 0x401F8308U
- #define **IOMUXC_GPIO_AD_B1_07_GPT2_COMPARE3** 0x401F8118U, 0x8U, 0, 0, 0x401-F8308U
- #define **IOMUXC_GPIO_AD_B1_07_FLEXIO3_FLEXIO07** 0x401F8118U, 0x9U, 0, 0, 0x401-F8308U
- #define **IOMUXC_GPIO_AD_B1_08_FLEXSPIA_SS1_B** 0x401F811CU, 0x0U, 0, 0, 0x401-F830CU
- #define **IOMUXC_GPIO_AD_B1_08_FLEXPWM4_PWMA00** 0x401F811CU, 0x1U, 0x401-F8494U, 0x1U, 0x401F830CU
- #define **IOMUXC_GPIO_AD_B1_08_FLEXCAN1_TX** 0x401F811CU, 0x2U, 0, 0, 0x401F830-CU
- #define **IOMUXC_GPIO_AD_B1_08_CCM_PMIC_READY** 0x401F811CU, 0x3U, 0x401F83-FCU, 0x3U, 0x401F830CU
- #define **IOMUXC_GPIO_AD_B1_08_CSI_DATA09** 0x401F811CU, 0x4U, 0x401F841CU, 0x0-U, 0x401F830CU
- #define **IOMUXC_GPIO_AD_B1_08_GPIO1_IO24** 0x401F811CU, 0x5U, 0, 0, 0x401F830CU
- #define **IOMUXC_GPIO_AD_B1_08_USDHC2_CMD** 0x401F811CU, 0x6U, 0x401F85E4U, 0x1U, 0x401F830CU
- #define **IOMUXC_GPIO_AD_B1_08_KPP_ROW03** 0x401F811CU, 0x7U, 0, 0, 0x401F830CU
- #define **IOMUXC_GPIO_AD_B1_08_FLEXIO3_FLEXIO08** 0x401F811CU, 0x9U, 0, 0, 0x401F830CU
- #define **IOMUXC_GPIO_AD_B1_09_FLEXSPIA_DQS** 0x401F8120U, 0x0U, 0x401F84A4U, 0x1U, 0x401F8310U
- #define **IOMUXC_GPIO_AD_B1_09_FLEXPWM4_PWMA01** 0x401F8120U, 0x1U, 0x401-F8498U, 0x1U, 0x401F8310U
- #define **IOMUXC_GPIO_AD_B1_09_FLEXCAN1_RX** 0x401F8120U, 0x2U, 0x401F844CU, 0x2U, 0x401F8310U
- #define **IOMUXC_GPIO_AD_B1_09_SAI1_MCLK** 0x401F8120U, 0x3U, 0x401F858CU, 0x1-U, 0x401F8310U
- #define **IOMUXC_GPIO_AD_B1_09_CSI_DATA08** 0x401F8120U, 0x4U, 0x401F8418U, 0x0-U, 0x401F8310U
- #define **IOMUXC_GPIO_AD_B1_09_GPIO1_IO25** 0x401F8120U, 0x5U, 0, 0, 0x401F8310U
- #define **IOMUXC_GPIO_AD_B1_09_USDHC2_CLK** 0x401F8120U, 0x6U, 0x401F85DCU, 0x1U, 0x401F8310U
- #define **IOMUXC_GPIO_AD_B1_09_KPP_COL03** 0x401F8120U, 0x7U, 0, 0, 0x401F8310U
- #define **IOMUXC_GPIO_AD_B1_09_FLEXIO3_FLEXIO09** 0x401F8120U, 0x9U, 0, 0, 0x401-F8310U
- #define **IOMUXC_GPIO_AD_B1_10_FLEXSPIA_DATA03** 0x401F8124U, 0x0U, 0x401F84-B4U, 0x1U, 0x401F8314U
- #define **IOMUXC_GPIO_AD_B1_10_WDOG1_B** 0x401F8124U, 0x1U, 0, 0, 0x401F8314U
- #define **IOMUXC_GPIO_AD_B1_10_LPUART8_TX** 0x401F8124U, 0x2U, 0x401F8564U, 0x1-U, 0x401F8314U
- #define **IOMUXC_GPIO_AD_B1_10_SAI1_RX_SYNC** 0x401F8124U, 0x3U, 0x401F85A4U, 0x1U, 0x401F8314U
- #define **IOMUXC_GPIO_AD_B1_10_CSI_DATA07** 0x401F8124U, 0x4U, 0x401F8414U, 0x0-U, 0x401F8314U
- #define **IOMUXC_GPIO_AD_B1_10_GPIO1_IO26** 0x401F8124U, 0x5U, 0, 0, 0x401F8314U
- #define **IOMUXC_GPIO_AD_B1_10_USDHC2_WP** 0x401F8124U, 0x6U, 0x401F8608U, 0x1-U, 0x401F8314U
- #define **IOMUXC_GPIO_AD_B1_10_KPP_ROW02** 0x401F8124U, 0x7U, 0, 0, 0x401F8314U

- #define **IOMUXC_GPIO_AD_B1_10_ENET2_1588_EVENT1_OUT** 0x401F8124U, 0x8U, 0, 0, 0x401F8314U
- #define **IOMUXC_GPIO_AD_B1_10_FLEXIO3_FLEXIO10** 0x401F8124U, 0x9U, 0, 0, 0x401F8314U
- #define **IOMUXC_GPIO_AD_B1_11_FLEXSPIA_DATA02** 0x401F8128U, 0x0U, 0x401F84B0U, 0x1U, 0x401F8318U
- #define **IOMUXC_GPIO_AD_B1_11_EWM_OUT_B** 0x401F8128U, 0x1U, 0, 0, 0x401F8318U
- #define **IOMUXC_GPIO_AD_B1_11_LPUART8_RX** 0x401F8128U, 0x2U, 0x401F8560U, 0x1U, 0x401F8318U
- #define **IOMUXC_GPIO_AD_B1_11_SAI1_RX_BCLK** 0x401F8128U, 0x3U, 0x401F8590U, 0x1U, 0x401F8318U
- #define **IOMUXC_GPIO_AD_B1_11_CSI_DATA06** 0x401F8128U, 0x4U, 0x401F8410U, 0x0U, 0x401F8318U
- #define **IOMUXC_GPIO_AD_B1_11_GPIO1_IO27** 0x401F8128U, 0x5U, 0, 0, 0x401F8318U
- #define **IOMUXC_GPIO_AD_B1_11_USDHC2_RESET_B** 0x401F8128U, 0x6U, 0, 0, 0x401F8318U
- #define **IOMUXC_GPIO_AD_B1_11_KPP_COL02** 0x401F8128U, 0x7U, 0, 0, 0x401F8318U
- #define **IOMUXC_GPIO_AD_B1_11_ENET2_1588_EVENT1_IN** 0x401F8128U, 0x8U, 0, 0, 0x401F8318U
- #define **IOMUXC_GPIO_AD_B1_11_FLEXIO3_FLEXIO11** 0x401F8128U, 0x9U, 0, 0, 0x401F8318U
- #define **IOMUXC_GPIO_AD_B1_12_FLEXSPIA_DATA01** 0x401F812CU, 0x0U, 0x401F84ACU, 0x1U, 0x401F831CU
- #define **IOMUXC_GPIO_AD_B1_12_ACMP_OUT00** 0x401F812CU, 0x1U, 0, 0, 0x401F831CU
- #define **IOMUXC_GPIO_AD_B1_12_LPSPI3_PCS0** 0x401F812CU, 0x2U, 0x401F850CU, 0x1U, 0x401F831CU
- #define **IOMUXC_GPIO_AD_B1_12_SAI1_RX_DATA00** 0x401F812CU, 0x3U, 0x401F8594U, 0x1U, 0x401F831CU
- #define **IOMUXC_GPIO_AD_B1_12_CSI_DATA05** 0x401F812CU, 0x4U, 0x401F840CU, 0x0U, 0x401F831CU
- #define **IOMUXC_GPIO_AD_B1_12_GPIO1_IO28** 0x401F812CU, 0x5U, 0, 0, 0x401F831CU
- #define **IOMUXC_GPIO_AD_B1_12_USDHC2_DATA4** 0x401F812CU, 0x6U, 0x401F85F8U, 0x1U, 0x401F831CU
- #define **IOMUXC_GPIO_AD_B1_12_KPP_ROW01** 0x401F812CU, 0x7U, 0, 0, 0x401F831CU
- #define **IOMUXC_GPIO_AD_B1_12_ENET2_1588_EVENT2_OUT** 0x401F812CU, 0x8U, 0, 0, 0x401F831CU
- #define **IOMUXC_GPIO_AD_B1_12_FLEXIO3_FLEXIO12** 0x401F812CU, 0x9U, 0, 0, 0x401F831CU
- #define **IOMUXC_GPIO_AD_B1_13_FLEXSPIA_DATA00** 0x401F8130U, 0x0U, 0x401F84A8U, 0x1U, 0x401F8320U
- #define **IOMUXC_GPIO_AD_B1_13_ACMP_OUT01** 0x401F8130U, 0x1U, 0, 0, 0x401F8320U
- #define **IOMUXC_GPIO_AD_B1_13_LPSPI3_SDI** 0x401F8130U, 0x2U, 0x401F8514U, 0x1U, 0x401F8320U
- #define **IOMUXC_GPIO_AD_B1_13_SAI1_TX_DATA00** 0x401F8130U, 0x3U, 0, 0, 0x401F8320U
- #define **IOMUXC_GPIO_AD_B1_13_CSI_DATA04** 0x401F8130U, 0x4U, 0x401F8408U, 0x0U, 0x401F8320U
- #define **IOMUXC_GPIO_AD_B1_13_GPIO1_IO29** 0x401F8130U, 0x5U, 0, 0, 0x401F8320U
- #define **IOMUXC_GPIO_AD_B1_13_USDHC2_DATA5** 0x401F8130U, 0x6U, 0x401F85FCU,

0x1U, 0x401F8320U
- #define **IOMUXC_GPIO_AD_B1_13_KPP_COL01** 0x401F8130U, 0x7U, 0, 0, 0x401F8320U
- #define **IOMUXC_GPIO_AD_B1_13_ENET2_1588_EVENT2_IN** 0x401F8130U, 0x8U, 0, 0, 0x401F8320U
- #define **IOMUXC_GPIO_AD_B1_13_FLEXIO3_FLEXIO13** 0x401F8130U, 0x9U, 0, 0, 0x401-F8320U
- #define **IOMUXC_GPIO_AD_B1_14_FLEXSPIA_SCLK** 0x401F8134U, 0x0U, 0x401F84C8U, 0x1U, 0x401F8324U
- #define **IOMUXC_GPIO_AD_B1_14_ACMP_OUT02** 0x401F8134U, 0x1U, 0, 0, 0x401F8324U
- #define **IOMUXC_GPIO_AD_B1_14_LPSPI3_SDO** 0x401F8134U, 0x2U, 0x401F8518U, 0x1-U, 0x401F8324U
- #define **IOMUXC_GPIO_AD_B1_14_SAI1_TX_BCLK** 0x401F8134U, 0x3U, 0x401F85A8U, 0x1U, 0x401F8324U
- #define **IOMUXC_GPIO_AD_B1_14_CSI_DATA03** 0x401F8134U, 0x4U, 0x401F8404U, 0x0-U, 0x401F8324U
- #define **IOMUXC_GPIO_AD_B1_14_GPIO1_IO30** 0x401F8134U, 0x5U, 0, 0, 0x401F8324U
- #define **IOMUXC_GPIO_AD_B1_14_USDHC2_DATA6** 0x401F8134U, 0x6U, 0x401F8600U, 0x1U, 0x401F8324U
- #define **IOMUXC_GPIO_AD_B1_14_KPP_ROW00** 0x401F8134U, 0x7U, 0, 0, 0x401F8324U
- #define **IOMUXC_GPIO_AD_B1_14_ENET2_1588_EVENT3_OUT** 0x401F8134U, 0x8U, 0, 0, 0x401F8324U
- #define **IOMUXC_GPIO_AD_B1_14_FLEXIO3_FLEXIO14** 0x401F8134U, 0x9U, 0, 0, 0x401-F8324U
- #define **IOMUXC_GPIO_AD_B1_15_FLEXSPIA_SS0_B** 0x401F8138U, 0x0U, 0, 0, 0x401-F8328U
- #define **IOMUXC_GPIO_AD_B1_15_ACMP_OUT03** 0x401F8138U, 0x1U, 0, 0, 0x401F8328U
- #define **IOMUXC_GPIO_AD_B1_15_LPSPI3_SCK** 0x401F8138U, 0x2U, 0x401F8510U, 0x1-U, 0x401F8328U
- #define **IOMUXC_GPIO_AD_B1_15_SAI1_TX_SYNC** 0x401F8138U, 0x3U, 0x401F85ACU, 0x1U, 0x401F8328U
- #define **IOMUXC_GPIO_AD_B1_15_CSI_DATA02** 0x401F8138U, 0x4U, 0x401F8400U, 0x0-U, 0x401F8328U
- #define **IOMUXC_GPIO_AD_B1_15_GPIO1_IO31** 0x401F8138U, 0x5U, 0, 0, 0x401F8328U
- #define **IOMUXC_GPIO_AD_B1_15_USDHC2_DATA7** 0x401F8138U, 0x6U, 0x401F8604U, 0x1U, 0x401F8328U
- #define **IOMUXC_GPIO_AD_B1_15_KPP_COL00** 0x401F8138U, 0x7U, 0, 0, 0x401F8328U
- #define **IOMUXC_GPIO_AD_B1_15_ENET2_1588_EVENT3_IN** 0x401F8138U, 0x8U, 0, 0, 0x401F8328U
- #define **IOMUXC_GPIO_AD_B1_15_FLEXIO3_FLEXIO15** 0x401F8138U, 0x9U, 0, 0, 0x401-F8328U
- #define **IOMUXC_GPIO_B0_00_LCD_CLK** 0x401F813CU, 0x0U, 0, 0, 0x401F832CU
- #define **IOMUXC_GPIO_B0_00_QTIMER1_TIMER0** 0x401F813CU, 0x1U, 0, 0, 0x401F832-CU
- #define **IOMUXC_GPIO_B0_00_MQS_RIGHT** 0x401F813CU, 0x2U, 0, 0, 0x401F832CU
- #define **IOMUXC_GPIO_B0_00_LPSPI4_PCS0** 0x401F813CU, 0x3U, 0x401F851CU, 0x0U, 0x401F832CU
- #define **IOMUXC_GPIO_B0_00_FLEXIO2_FLEXIO00** 0x401F813CU, 0x4U, 0, 0, 0x401-F832CU
- #define **IOMUXC_GPIO_B0_00_GPIO2_IO00** 0x401F813CU, 0x5U, 0, 0, 0x401F832CU
- #define **IOMUXC_GPIO_B0_00_SEMC_CSX01** 0x401F813CU, 0x6U, 0, 0, 0x401F832CU
- #define **IOMUXC_GPIO_B0_00_ENET2_MDC** 0x401F813CU, 0x8U, 0, 0, 0x401F832CU

- #define **IOMUXC_GPIO_B0_01_LCD_ENABLE** 0x401F8140U, 0x0U, 0, 0, 0x401F8330U
- #define **IOMUXC_GPIO_B0_01_QTIMER1_TIMER1** 0x401F8140U, 0x1U, 0, 0, 0x401F8330-U
- #define **IOMUXC_GPIO_B0_01_MQS_LEFT** 0x401F8140U, 0x2U, 0, 0, 0x401F8330U
- #define **IOMUXC_GPIO_B0_01_LPSPI4_SDI** 0x401F8140U, 0x3U, 0x401F8524U, 0x0U, 0x401F8330U
- #define **IOMUXC_GPIO_B0_01_FLEXIO2_FLEXIO01** 0x401F8140U, 0x4U, 0, 0, 0x401-F8330U
- #define **IOMUXC_GPIO_B0_01_GPIO2_IO01** 0x401F8140U, 0x5U, 0, 0, 0x401F8330U
- #define **IOMUXC_GPIO_B0_01_SEMC_CSX02** 0x401F8140U, 0x6U, 0, 0, 0x401F8330U
- #define **IOMUXC_GPIO_B0_01_ENET2_MDIO** 0x401F8140U, 0x8U, 0x401F8710U, 0x1U, 0x401F8330U
- #define **IOMUXC_GPIO_B0_02_LCD_HSYNC** 0x401F8144U, 0x0U, 0, 0, 0x401F8334U
- #define **IOMUXC_GPIO_B0_02_QTIMER1_TIMER2** 0x401F8144U, 0x1U, 0, 0, 0x401F8334-U
- #define **IOMUXC_GPIO_B0_02_FLEXCAN1_TX** 0x401F8144U, 0x2U, 0, 0, 0x401F8334U
- #define **IOMUXC_GPIO_B0_02_LPSPI4_SDO** 0x401F8144U, 0x3U, 0x401F8528U, 0x0U, 0x401F8334U
- #define **IOMUXC_GPIO_B0_02_FLEXIO2_FLEXIO02** 0x401F8144U, 0x4U, 0, 0, 0x401-F8334U
- #define **IOMUXC_GPIO_B0_02_GPIO2_IO02** 0x401F8144U, 0x5U, 0, 0, 0x401F8334U
- #define **IOMUXC_GPIO_B0_02_SEMC_CSX03** 0x401F8144U, 0x6U, 0, 0, 0x401F8334U
- #define **IOMUXC_GPIO_B0_02_ENET2_1588_EVENT0_OUT** 0x401F8144U, 0x8U, 0, 0, 0x401F8334U
- #define **IOMUXC_GPIO_B0_03_LCD_VSYNC** 0x401F8148U, 0x0U, 0, 0, 0x401F8338U
- #define **IOMUXC_GPIO_B0_03_QTIMER2_TIMER0** 0x401F8148U, 0x1U, 0x401F856CU, 0x1U, 0x401F8338U
- #define **IOMUXC_GPIO_B0_03_FLEXCAN1_RX** 0x401F8148U, 0x2U, 0x401F844CU, 0x3U, 0x401F8338U
- #define **IOMUXC_GPIO_B0_03_LPSPI4_SCK** 0x401F8148U, 0x3U, 0x401F8520U, 0x0U, 0x401F8338U
- #define **IOMUXC_GPIO_B0_03_FLEXIO2_FLEXIO03** 0x401F8148U, 0x4U, 0, 0, 0x401-F8338U
- #define **IOMUXC_GPIO_B0_03_GPIO2_IO03** 0x401F8148U, 0x5U, 0, 0, 0x401F8338U
- #define **IOMUXC_GPIO_B0_03_WDOG2_RESET_B_DEB** 0x401F8148U, 0x6U, 0, 0, 0x401-F8338U
- #define **IOMUXC_GPIO_B0_03_ENET2_1588_EVENT0_IN** 0x401F8148U, 0x8U, 0x401-F8724U, 0x1U, 0x401F8338U
- #define **IOMUXC_GPIO_B0_04_LCD_DATA00** 0x401F814CU, 0x0U, 0, 0, 0x401F833CU
- #define **IOMUXC_GPIO_B0_04_QTIMER2_TIMER1** 0x401F814CU, 0x1U, 0x401F8570U, 0x1U, 0x401F833CU
- #define **IOMUXC_GPIO_B0_04_LPI2C2_SCL** 0x401F814CU, 0x2U, 0x401F84D4U, 0x1U, 0x401F833CU
- #define **IOMUXC_GPIO_B0_04_ARM_TRACE0** 0x401F814CU, 0x3U, 0, 0, 0x401F833CU
- #define **IOMUXC_GPIO_B0_04_FLEXIO2_FLEXIO04** 0x401F814CU, 0x4U, 0, 0, 0x401-F833CU
- #define **IOMUXC_GPIO_B0_04_GPIO2_IO04** 0x401F814CU, 0x5U, 0, 0, 0x401F833CU
- #define **IOMUXC_GPIO_B0_04_SRC_BOOT_CFG00** 0x401F814CU, 0x6U, 0, 0, 0x401F833-CU
- #define **IOMUXC_GPIO_B0_04_ENET2_TDATA03** 0x401F814CU, 0x8U, 0, 0, 0x401F833CU
- #define **IOMUXC_GPIO_B0_05_LCD_DATA01** 0x401F8150U, 0x0U, 0, 0, 0x401F8340U

- #define **IOMUXC_GPIO_B0_05_QTIMER2_TIMER2** 0x401F8150U, 0x1U, 0x401F8574U, 0x1U, 0x401F8340U
- #define **IOMUXC_GPIO_B0_05_LPI2C2_SDA** 0x401F8150U, 0x2U, 0x401F84D8U, 0x1U, 0x401F8340U
- #define **IOMUXC_GPIO_B0_05_ARM_TRACE1** 0x401F8150U, 0x3U, 0, 0, 0x401F8340U
- #define **IOMUXC_GPIO_B0_05_FLEXIO2_FLEXIO05** 0x401F8150U, 0x4U, 0, 0, 0x401F8340U
- #define **IOMUXC_GPIO_B0_05_GPIO2_IO05** 0x401F8150U, 0x5U, 0, 0, 0x401F8340U
- #define **IOMUXC_GPIO_B0_05_SRC_BOOT_CFG01** 0x401F8150U, 0x6U, 0, 0, 0x401F8340U
- #define **IOMUXC_GPIO_B0_05_ENET2_TDATA02** 0x401F8150U, 0x8U, 0, 0, 0x401F8340U
- #define **IOMUXC_GPIO_B0_06_LCD_DATA02** 0x401F8154U, 0x0U, 0, 0, 0x401F8344U
- #define **IOMUXC_GPIO_B0_06_QTIMER3_TIMER0** 0x401F8154U, 0x1U, 0x401F857CU, 0x2U, 0x401F8344U
- #define **IOMUXC_GPIO_B0_06_FLEXPWM2_PWMA00** 0x401F8154U, 0x2U, 0x401F8478U, 0x1U, 0x401F8344U
- #define **IOMUXC_GPIO_B0_06_ARM_TRACE2** 0x401F8154U, 0x3U, 0, 0, 0x401F8344U
- #define **IOMUXC_GPIO_B0_06_FLEXIO2_FLEXIO06** 0x401F8154U, 0x4U, 0, 0, 0x401F8344U
- #define **IOMUXC_GPIO_B0_06_GPIO2_IO06** 0x401F8154U, 0x5U, 0, 0, 0x401F8344U
- #define **IOMUXC_GPIO_B0_06_SRC_BOOT_CFG02** 0x401F8154U, 0x6U, 0, 0, 0x401F8344U
- #define **IOMUXC_GPIO_B0_06_ENET2_RX_CLK** 0x401F8154U, 0x8U, 0, 0, 0x401F8344U
- #define **IOMUXC_GPIO_B0_07_LCD_DATA03** 0x401F8158U, 0x0U, 0, 0, 0x401F8348U
- #define **IOMUXC_GPIO_B0_07_QTIMER3_TIMER1** 0x401F8158U, 0x1U, 0x401F8580U, 0x2U, 0x401F8348U
- #define **IOMUXC_GPIO_B0_07_FLEXPWM2_PWMB00** 0x401F8158U, 0x2U, 0x401F8488U, 0x1U, 0x401F8348U
- #define **IOMUXC_GPIO_B0_07_ARM_TRACE3** 0x401F8158U, 0x3U, 0, 0, 0x401F8348U
- #define **IOMUXC_GPIO_B0_07_FLEXIO2_FLEXIO07** 0x401F8158U, 0x4U, 0, 0, 0x401F8348U
- #define **IOMUXC_GPIO_B0_07_GPIO2_IO07** 0x401F8158U, 0x5U, 0, 0, 0x401F8348U
- #define **IOMUXC_GPIO_B0_07_SRC_BOOT_CFG03** 0x401F8158U, 0x6U, 0, 0, 0x401F8348U
- #define **IOMUXC_GPIO_B0_07_ENET2_TX_ER** 0x401F8158U, 0x8U, 0, 0, 0x401F8348U
- #define **IOMUXC_GPIO_B0_08_LCD_DATA04** 0x401F815CU, 0x0U, 0, 0, 0x401F834CU
- #define **IOMUXC_GPIO_B0_08_QTIMER3_TIMER2** 0x401F815CU, 0x1U, 0x401F8584U, 0x2U, 0x401F834CU
- #define **IOMUXC_GPIO_B0_08_FLEXPWM2_PWMA01** 0x401F815CU, 0x2U, 0x401F847CU, 0x1U, 0x401F834CU
- #define **IOMUXC_GPIO_B0_08_LPUART3_TX** 0x401F815CU, 0x3U, 0x401F853CU, 0x2U, 0x401F834CU
- #define **IOMUXC_GPIO_B0_08_FLEXIO2_FLEXIO08** 0x401F815CU, 0x4U, 0, 0, 0x401F834CU
- #define **IOMUXC_GPIO_B0_08_GPIO2_IO08** 0x401F815CU, 0x5U, 0, 0, 0x401F834CU
- #define **IOMUXC_GPIO_B0_08_SRC_BOOT_CFG04** 0x401F815CU, 0x6U, 0, 0, 0x401F834CU
- #define **IOMUXC_GPIO_B0_08_ENET2_RDATA03** 0x401F815CU, 0x8U, 0, 0, 0x401F834CU
- #define **IOMUXC_GPIO_B0_09_LCD_DATA05** 0x401F8160U, 0x0U, 0, 0, 0x401F8350U
- #define **IOMUXC_GPIO_B0_09_QTIMER4_TIMER0** 0x401F8160U, 0x1U, 0, 0, 0x401F8350U

- #define **IOMUXC_GPIO_B0_09_FLEXPWM2_PWMB01** 0x401F8160U, 0x2U, 0x401F848C-U, 0x1U, 0x401F8350U
- #define **IOMUXC_GPIO_B0_09_LPUART3_RX** 0x401F8160U, 0x3U, 0x401F8538U, 0x2U, 0x401F8350U
- #define **IOMUXC_GPIO_B0_09_FLEXIO2_FLEXIO09** 0x401F8160U, 0x4U, 0, 0, 0x401-F8350U
- #define **IOMUXC_GPIO_B0_09_GPIO2_IO09** 0x401F8160U, 0x5U, 0, 0, 0x401F8350U
- #define **IOMUXC_GPIO_B0_09_SRC_BOOT_CFG05** 0x401F8160U, 0x6U, 0, 0, 0x401F8350-U
- #define **IOMUXC_GPIO_B0_09_ENET2_RDATA02** 0x401F8160U, 0x8U, 0, 0, 0x401F8350U
- #define **IOMUXC_GPIO_B0_10_LCD_DATA06** 0x401F8164U, 0x0U, 0, 0, 0x401F8354U
- #define **IOMUXC_GPIO_B0_10_QTIMER4_TIMER1** 0x401F8164U, 0x1U, 0, 0, 0x401F8354-U
- #define **IOMUXC_GPIO_B0_10_FLEXPWM2_PWMA02** 0x401F8164U, 0x2U, 0x401F8480-U, 0x1U, 0x401F8354U
- #define **IOMUXC_GPIO_B0_10_SAI1_TX_DATA03** 0x401F8164U, 0x3U, 0x401F8598U, 0x1-U, 0x401F8354U
- #define **IOMUXC_GPIO_B0_10_FLEXIO2_FLEXIO10** 0x401F8164U, 0x4U, 0, 0, 0x401-F8354U
- #define **IOMUXC_GPIO_B0_10_GPIO2_IO10** 0x401F8164U, 0x5U, 0, 0, 0x401F8354U
- #define **IOMUXC_GPIO_B0_10_SRC_BOOT_CFG06** 0x401F8164U, 0x6U, 0, 0, 0x401F8354-U
- #define **IOMUXC_GPIO_B0_10_ENET2_CRS** 0x401F8164U, 0x8U, 0, 0, 0x401F8354U
- #define **IOMUXC_GPIO_B0_11_LCD_DATA07** 0x401F8168U, 0x0U, 0, 0, 0x401F8358U
- #define **IOMUXC_GPIO_B0_11_QTIMER4_TIMER2** 0x401F8168U, 0x1U, 0, 0, 0x401F8358-U
- #define **IOMUXC_GPIO_B0_11_FLEXPWM2_PWMB02** 0x401F8168U, 0x2U, 0x401F8490U, 0x1U, 0x401F8358U
- #define **IOMUXC_GPIO_B0_11_SAI1_TX_DATA02** 0x401F8168U, 0x3U, 0x401F859CU, 0x1U, 0x401F8358U
- #define **IOMUXC_GPIO_B0_11_FLEXIO2_FLEXIO11** 0x401F8168U, 0x4U, 0, 0, 0x401-F8358U
- #define **IOMUXC_GPIO_B0_11_GPIO2_IO11** 0x401F8168U, 0x5U, 0, 0, 0x401F8358U
- #define **IOMUXC_GPIO_B0_11_SRC_BOOT_CFG07** 0x401F8168U, 0x6U, 0, 0, 0x401F8358-U
- #define **IOMUXC_GPIO_B0_11_ENET2_COL** 0x401F8168U, 0x8U, 0, 0, 0x401F8358U
- #define **IOMUXC_GPIO_B0_12_LCD_DATA08** 0x401F816CU, 0x0U, 0, 0, 0x401F835CU
- #define **IOMUXC_GPIO_B0_12_XBAR1_INOUT10** 0x401F816CU, 0x1U, 0, 0, 0x401F835CU
- #define **IOMUXC_GPIO_B0_12_ARM_TRACE_CLK** 0x401F816CU, 0x2U, 0, 0, 0x401F835-CU
- #define **IOMUXC_GPIO_B0_12_SAI1_TX_DATA01** 0x401F816CU, 0x3U, 0x401F85A0U, 0x1U, 0x401F835CU
- #define **IOMUXC_GPIO_B0_12_FLEXIO2_FLEXIO12** 0x401F816CU, 0x4U, 0, 0, 0x401-F835CU
- #define **IOMUXC_GPIO_B0_12_GPIO2_IO12** 0x401F816CU, 0x5U, 0, 0, 0x401F835CU
- #define **IOMUXC_GPIO_B0_12_SRC_BOOT_CFG08** 0x401F816CU, 0x6U, 0, 0, 0x401F835-CU
- #define **IOMUXC_GPIO_B0_12_ENET2_TDATA00** 0x401F816CU, 0x8U, 0, 0, 0x401F835CU
- #define **IOMUXC_GPIO_B0_13_LCD_DATA09** 0x401F8170U, 0x0U, 0, 0, 0x401F8360U
- #define **IOMUXC_GPIO_B0_13_XBAR1_INOUT11** 0x401F8170U, 0x1U, 0, 0, 0x401F8360U
- #define **IOMUXC_GPIO_B0_13_ARM_TRACE_SWO** 0x401F8170U, 0x2U, 0, 0, 0x401-

F8360U
- #define **IOMUXC_GPIO_B0_13_SAI1_MCLK** 0x401F8170U, 0x3U, 0x401F858CU, 0x2U, 0x401F8360U
- #define **IOMUXC_GPIO_B0_13_FLEXIO2_FLEXIO13** 0x401F8170U, 0x4U, 0, 0, 0x401-F8360U
- #define **IOMUXC_GPIO_B0_13_GPIO2_IO13** 0x401F8170U, 0x5U, 0, 0, 0x401F8360U
- #define **IOMUXC_GPIO_B0_13_SRC_BOOT_CFG09** 0x401F8170U, 0x6U, 0, 0, 0x401F8360-U
- #define **IOMUXC_GPIO_B0_13_ENET2_TDATA01** 0x401F8170U, 0x8U, 0, 0, 0x401F8360U
- #define **IOMUXC_GPIO_B0_14_LCD_DATA10** 0x401F8174U, 0x0U, 0, 0, 0x401F8364U
- #define **IOMUXC_GPIO_B0_14_XBAR1_INOUT12** 0x401F8174U, 0x1U, 0, 0, 0x401F8364U
- #define **IOMUXC_GPIO_B0_14_ARM_TXEV** 0x401F8174U, 0x2U, 0, 0, 0x401F8364U
- #define **IOMUXC_GPIO_B0_14_SAI1_RX_SYNC** 0x401F8174U, 0x3U, 0x401F85A4U, 0x2U, 0x401F8364U
- #define **IOMUXC_GPIO_B0_14_FLEXIO2_FLEXIO14** 0x401F8174U, 0x4U, 0, 0, 0x401-F8364U
- #define **IOMUXC_GPIO_B0_14_GPIO2_IO14** 0x401F8174U, 0x5U, 0, 0, 0x401F8364U
- #define **IOMUXC_GPIO_B0_14_SRC_BOOT_CFG10** 0x401F8174U, 0x6U, 0, 0, 0x401F8364-U
- #define **IOMUXC_GPIO_B0_14_ENET2_TX_EN** 0x401F8174U, 0x8U, 0, 0, 0x401F8364U
- #define **IOMUXC_GPIO_B0_15_LCD_DATA11** 0x401F8178U, 0x0U, 0, 0, 0x401F8368U
- #define **IOMUXC_GPIO_B0_15_XBAR1_INOUT13** 0x401F8178U, 0x1U, 0, 0, 0x401F8368U
- #define **IOMUXC_GPIO_B0_15_ARM_RXEV** 0x401F8178U, 0x2U, 0, 0, 0x401F8368U
- #define **IOMUXC_GPIO_B0_15_SAI1_RX_BCLK** 0x401F8178U, 0x3U, 0x401F8590U, 0x2U, 0x401F8368U
- #define **IOMUXC_GPIO_B0_15_FLEXIO2_FLEXIO15** 0x401F8178U, 0x4U, 0, 0, 0x401-F8368U
- #define **IOMUXC_GPIO_B0_15_GPIO2_IO15** 0x401F8178U, 0x5U, 0, 0, 0x401F8368U
- #define **IOMUXC_GPIO_B0_15_SRC_BOOT_CFG11** 0x401F8178U, 0x6U, 0, 0, 0x401F8368-U
- #define **IOMUXC_GPIO_B0_15_ENET2_TX_CLK** 0x401F8178U, 0x8U, 0x401F8728U, 0x2U, 0x401F8368U
- #define **IOMUXC_GPIO_B0_15_ENET2_REF_CLK2** 0x401F8178U, 0x9U, 0x401F870CU, 0x2U, 0x401F8368U
- #define **IOMUXC_GPIO_B1_00_LCD_DATA12** 0x401F817CU, 0x0U, 0, 0, 0x401F836CU
- #define **IOMUXC_GPIO_B1_00_XBAR1_INOUT14** 0x401F817CU, 0x1U, 0x401F8644U, 0x1-U, 0x401F836CU
- #define **IOMUXC_GPIO_B1_00_LPUART4_TX** 0x401F817CU, 0x2U, 0x401F8544U, 0x2U, 0x401F836CU
- #define **IOMUXC_GPIO_B1_00_SAI1_RX_DATA00** 0x401F817CU, 0x3U, 0x401F8594U, 0x2U, 0x401F836CU
- #define **IOMUXC_GPIO_B1_00_FLEXIO2_FLEXIO16** 0x401F817CU, 0x4U, 0, 0, 0x401-F836CU
- #define **IOMUXC_GPIO_B1_00_GPIO2_IO16** 0x401F817CU, 0x5U, 0, 0, 0x401F836CU
- #define **IOMUXC_GPIO_B1_00_FLEXPWM1_PWMA03** 0x401F817CU, 0x6U, 0x401F8454-U, 0x4U, 0x401F836CU
- #define **IOMUXC_GPIO_B1_00_ENET2_RX_ER** 0x401F817CU, 0x8U, 0x401F8720U, 0x2U, 0x401F836CU
- #define **IOMUXC_GPIO_B1_00_FLEXIO3_FLEXIO16** 0x401F817CU, 0x9U, 0, 0, 0x401-F836CU
- #define **IOMUXC_GPIO_B1_01_LCD_DATA13** 0x401F8180U, 0x0U, 0, 0, 0x401F8370U

- #define **IOMUXC_GPIO_B1_01_XBAR1_INOUT15** 0x401F8180U, 0x1U, 0x401F8648U, 0x1U, 0x401F8370U
- #define **IOMUXC_GPIO_B1_01_LPUART4_RX** 0x401F8180U, 0x2U, 0x401F8540U, 0x2U, 0x401F8370U
- #define **IOMUXC_GPIO_B1_01_SAI1_TX_DATA00** 0x401F8180U, 0x3U, 0, 0, 0x401F8370U
- #define **IOMUXC_GPIO_B1_01_FLEXIO2_FLEXIO17** 0x401F8180U, 0x4U, 0, 0, 0x401F8370U
- #define **IOMUXC_GPIO_B1_01_GPIO2_IO17** 0x401F8180U, 0x5U, 0, 0, 0x401F8370U
- #define **IOMUXC_GPIO_B1_01_FLEXPWM1_PWMB03** 0x401F8180U, 0x6U, 0x401F8464U, 0x4U, 0x401F8370U
- #define **IOMUXC_GPIO_B1_01_ENET2_RDATA00** 0x401F8180U, 0x8U, 0x401F8714U, 0x2U, 0x401F8370U
- #define **IOMUXC_GPIO_B1_01_FLEXIO3_FLEXIO17** 0x401F8180U, 0x9U, 0, 0, 0x401F8370U
- #define **IOMUXC_GPIO_B1_02_LCD_DATA14** 0x401F8184U, 0x0U, 0, 0, 0x401F8374U
- #define **IOMUXC_GPIO_B1_02_XBAR1_INOUT16** 0x401F8184U, 0x1U, 0x401F864CU, 0x1U, 0x401F8374U
- #define **IOMUXC_GPIO_B1_02_LPSPI4_PCS2** 0x401F8184U, 0x2U, 0, 0, 0x401F8374U
- #define **IOMUXC_GPIO_B1_02_SAI1_TX_BCLK** 0x401F8184U, 0x3U, 0x401F85A8U, 0x2U, 0x401F8374U
- #define **IOMUXC_GPIO_B1_02_FLEXIO2_FLEXIO18** 0x401F8184U, 0x4U, 0, 0, 0x401F8374U
- #define **IOMUXC_GPIO_B1_02_GPIO2_IO18** 0x401F8184U, 0x5U, 0, 0, 0x401F8374U
- #define **IOMUXC_GPIO_B1_02_FLEXPWM2_PWMA03** 0x401F8184U, 0x6U, 0x401F8474U, 0x4U, 0x401F8374U
- #define **IOMUXC_GPIO_B1_02_ENET2_RDATA01** 0x401F8184U, 0x8U, 0x401F8718U, 0x2U, 0x401F8374U
- #define **IOMUXC_GPIO_B1_02_FLEXIO3_FLEXIO18** 0x401F8184U, 0x9U, 0, 0, 0x401F8374U
- #define **IOMUXC_GPIO_B1_03_LCD_DATA15** 0x401F8188U, 0x0U, 0, 0, 0x401F8378U
- #define **IOMUXC_GPIO_B1_03_XBAR1_INOUT17** 0x401F8188U, 0x1U, 0x401F862CU, 0x3U, 0x401F8378U
- #define **IOMUXC_GPIO_B1_03_LPSPI4_PCS1** 0x401F8188U, 0x2U, 0, 0, 0x401F8378U
- #define **IOMUXC_GPIO_B1_03_SAI1_TX_SYNC** 0x401F8188U, 0x3U, 0x401F85ACU, 0x2U, 0x401F8378U
- #define **IOMUXC_GPIO_B1_03_FLEXIO2_FLEXIO19** 0x401F8188U, 0x4U, 0, 0, 0x401F8378U
- #define **IOMUXC_GPIO_B1_03_GPIO2_IO19** 0x401F8188U, 0x5U, 0, 0, 0x401F8378U
- #define **IOMUXC_GPIO_B1_03_FLEXPWM2_PWMB03** 0x401F8188U, 0x6U, 0x401F8484U, 0x3U, 0x401F8378U
- #define **IOMUXC_GPIO_B1_03_ENET2_RX_EN** 0x401F8188U, 0x8U, 0x401F871CU, 0x2U, 0x401F8378U
- #define **IOMUXC_GPIO_B1_03_FLEXIO3_FLEXIO19** 0x401F8188U, 0x9U, 0, 0, 0x401F8378U
- #define **IOMUXC_GPIO_B1_04_LCD_DATA16** 0x401F818CU, 0x0U, 0, 0, 0x401F837CU
- #define **IOMUXC_GPIO_B1_04_LPSPI4_PCS0** 0x401F818CU, 0x1U, 0x401F851CU, 0x1U, 0x401F837CU
- #define **IOMUXC_GPIO_B1_04_CSI_DATA15** 0x401F818CU, 0x2U, 0, 0, 0x401F837CU
- #define **IOMUXC_GPIO_B1_04_ENET_RX_DATA00** 0x401F818CU, 0x3U, 0x401F8434U, 0x1U, 0x401F837CU
- #define **IOMUXC_GPIO_B1_04_FLEXIO2_FLEXIO20** 0x401F818CU, 0x4U, 0, 0, 0x401-

F837CU
- #define **IOMUXC_GPIO_B1_04_GPIO2_IO20** 0x401F818CU, 0x5U, 0, 0, 0x401F837CU
- #define **IOMUXC_GPIO_B1_04_GPT1_CLK** 0x401F818CU, 0x8U, 0x401F8760U, 0x1U, 0x401F837CU
- #define **IOMUXC_GPIO_B1_04_FLEXIO3_FLEXIO20** 0x401F818CU, 0x9U, 0, 0, 0x401-F837CU
- #define **IOMUXC_GPIO_B1_05_LCD_DATA17** 0x401F8190U, 0x0U, 0, 0, 0x401F8380U
- #define **IOMUXC_GPIO_B1_05_LPSPI4_SDI** 0x401F8190U, 0x1U, 0x401F8524U, 0x1U, 0x401F8380U
- #define **IOMUXC_GPIO_B1_05_CSI_DATA14** 0x401F8190U, 0x2U, 0, 0, 0x401F8380U
- #define **IOMUXC_GPIO_B1_05_ENET_RX_DATA01** 0x401F8190U, 0x3U, 0x401F8438U, 0x1U, 0x401F8380U
- #define **IOMUXC_GPIO_B1_05_FLEXIO2_FLEXIO21** 0x401F8190U, 0x4U, 0, 0, 0x401-F8380U
- #define **IOMUXC_GPIO_B1_05_GPIO2_IO21** 0x401F8190U, 0x5U, 0, 0, 0x401F8380U
- #define **IOMUXC_GPIO_B1_05_GPT1_CAPTURE1** 0x401F8190U, 0x8U, 0x401F8758U, 0x1-U, 0x401F8380U
- #define **IOMUXC_GPIO_B1_05_FLEXIO3_FLEXIO21** 0x401F8190U, 0x9U, 0, 0, 0x401-F8380U
- #define **IOMUXC_GPIO_B1_06_LCD_DATA18** 0x401F8194U, 0x0U, 0, 0, 0x401F8384U
- #define **IOMUXC_GPIO_B1_06_LPSPI4_SDO** 0x401F8194U, 0x1U, 0x401F8528U, 0x1U, 0x401F8384U
- #define **IOMUXC_GPIO_B1_06_CSI_DATA13** 0x401F8194U, 0x2U, 0, 0, 0x401F8384U
- #define **IOMUXC_GPIO_B1_06_ENET_RX_EN** 0x401F8194U, 0x3U, 0x401F843CU, 0x1U, 0x401F8384U
- #define **IOMUXC_GPIO_B1_06_FLEXIO2_FLEXIO22** 0x401F8194U, 0x4U, 0, 0, 0x401-F8384U
- #define **IOMUXC_GPIO_B1_06_GPIO2_IO22** 0x401F8194U, 0x5U, 0, 0, 0x401F8384U
- #define **IOMUXC_GPIO_B1_06_GPT1_CAPTURE2** 0x401F8194U, 0x8U, 0x401F875CU, 0x1U, 0x401F8384U
- #define **IOMUXC_GPIO_B1_06_FLEXIO3_FLEXIO22** 0x401F8194U, 0x9U, 0, 0, 0x401-F8384U
- #define **IOMUXC_GPIO_B1_07_LCD_DATA19** 0x401F8198U, 0x0U, 0, 0, 0x401F8388U
- #define **IOMUXC_GPIO_B1_07_LPSPI4_SCK** 0x401F8198U, 0x1U, 0x401F8520U, 0x1U, 0x401F8388U
- #define **IOMUXC_GPIO_B1_07_CSI_DATA12** 0x401F8198U, 0x2U, 0, 0, 0x401F8388U
- #define **IOMUXC_GPIO_B1_07_ENET_TX_DATA00** 0x401F8198U, 0x3U, 0, 0, 0x401F8388-U
- #define **IOMUXC_GPIO_B1_07_FLEXIO2_FLEXIO23** 0x401F8198U, 0x4U, 0, 0, 0x401-F8388U
- #define **IOMUXC_GPIO_B1_07_GPIO2_IO23** 0x401F8198U, 0x5U, 0, 0, 0x401F8388U
- #define **IOMUXC_GPIO_B1_07_GPT1_COMPARE1** 0x401F8198U, 0x8U, 0, 0, 0x401F8388U
- #define **IOMUXC_GPIO_B1_07_FLEXIO3_FLEXIO23** 0x401F8198U, 0x9U, 0, 0, 0x401-F8388U
- #define **IOMUXC_GPIO_B1_08_LCD_DATA20** 0x401F819CU, 0x0U, 0, 0, 0x401F838CU
- #define **IOMUXC_GPIO_B1_08_QTIMER1_TIMER3** 0x401F819CU, 0x1U, 0, 0, 0x401F838-CU
- #define **IOMUXC_GPIO_B1_08_CSI_DATA11** 0x401F819CU, 0x2U, 0, 0, 0x401F838CU
- #define **IOMUXC_GPIO_B1_08_ENET_TX_DATA01** 0x401F819CU, 0x3U, 0, 0, 0x401F838-CU
- #define **IOMUXC_GPIO_B1_08_FLEXIO2_FLEXIO24** 0x401F819CU, 0x4U, 0, 0, 0x401-

F838CU
- #define **IOMUXC_GPIO_B1_08_GPIO2_IO24** 0x401F819CU, 0x5U, 0, 0, 0x401F838CU
- #define **IOMUXC_GPIO_B1_08_FLEXCAN2_TX** 0x401F819CU, 0x6U, 0, 0, 0x401F838CU
- #define **IOMUXC_GPIO_B1_08_GPT1_COMPARE2** 0x401F819CU, 0x8U, 0, 0, 0x401F838-CU
- #define **IOMUXC_GPIO_B1_08_FLEXIO3_FLEXIO24** 0x401F819CU, 0x9U, 0, 0, 0x401-F838CU
- #define **IOMUXC_GPIO_B1_09_LCD_DATA21** 0x401F81A0U, 0x0U, 0, 0, 0x401F8390U
- #define **IOMUXC_GPIO_B1_09_QTIMER2_TIMER3** 0x401F81A0U, 0x1U, 0x401F8578U, 0x1U, 0x401F8390U
- #define **IOMUXC_GPIO_B1_09_CSI_DATA10** 0x401F81A0U, 0x2U, 0, 0, 0x401F8390U
- #define **IOMUXC_GPIO_B1_09_ENET_TX_EN** 0x401F81A0U, 0x3U, 0, 0, 0x401F8390U
- #define **IOMUXC_GPIO_B1_09_FLEXIO2_FLEXIO25** 0x401F81A0U, 0x4U, 0, 0, 0x401-F8390U
- #define **IOMUXC_GPIO_B1_09_GPIO2_IO25** 0x401F81A0U, 0x5U, 0, 0, 0x401F8390U
- #define **IOMUXC_GPIO_B1_09_FLEXCAN2_RX** 0x401F81A0U, 0x6U, 0x401F8450U, 0x3U, 0x401F8390U
- #define **IOMUXC_GPIO_B1_09_GPT1_COMPARE3** 0x401F81A0U, 0x8U, 0, 0, 0x401F8390-U
- #define **IOMUXC_GPIO_B1_09_FLEXIO3_FLEXIO25** 0x401F81A0U, 0x9U, 0, 0, 0x401-F8390U
- #define **IOMUXC_GPIO_B1_10_LCD_DATA22** 0x401F81A4U, 0x0U, 0, 0, 0x401F8394U
- #define **IOMUXC_GPIO_B1_10_QTIMER3_TIMER3** 0x401F81A4U, 0x1U, 0x401F8588U, 0x2U, 0x401F8394U
- #define **IOMUXC_GPIO_B1_10_CSI_DATA00** 0x401F81A4U, 0x2U, 0, 0, 0x401F8394U
- #define **IOMUXC_GPIO_B1_10_ENET_TX_CLK** 0x401F81A4U, 0x3U, 0x401F8448U, 0x1U, 0x401F8394U
- #define **IOMUXC_GPIO_B1_10_FLEXIO2_FLEXIO26** 0x401F81A4U, 0x4U, 0, 0, 0x401-F8394U
- #define **IOMUXC_GPIO_B1_10_GPIO2_IO26** 0x401F81A4U, 0x5U, 0, 0, 0x401F8394U
- #define **IOMUXC_GPIO_B1_10_ENET_REF_CLK** 0x401F81A4U, 0x6U, 0x401F842CU, 0x1-U, 0x401F8394U
- #define **IOMUXC_GPIO_B1_10_FLEXIO3_FLEXIO26** 0x401F81A4U, 0x9U, 0, 0, 0x401-F8394U
- #define **IOMUXC_GPIO_B1_11_LCD_DATA23** 0x401F81A8U, 0x0U, 0, 0, 0x401F8398U
- #define **IOMUXC_GPIO_B1_11_QTIMER4_TIMER3** 0x401F81A8U, 0x1U, 0, 0, 0x401-F8398U
- #define **IOMUXC_GPIO_B1_11_CSI_DATA01** 0x401F81A8U, 0x2U, 0, 0, 0x401F8398U
- #define **IOMUXC_GPIO_B1_11_ENET_RX_ER** 0x401F81A8U, 0x3U, 0x401F8440U, 0x1U, 0x401F8398U
- #define **IOMUXC_GPIO_B1_11_FLEXIO2_FLEXIO27** 0x401F81A8U, 0x4U, 0, 0, 0x401-F8398U
- #define **IOMUXC_GPIO_B1_11_GPIO2_IO27** 0x401F81A8U, 0x5U, 0, 0, 0x401F8398U
- #define **IOMUXC_GPIO_B1_11_LPSPI4_PCS3** 0x401F81A8U, 0x6U, 0, 0, 0x401F8398U
- #define **IOMUXC_GPIO_B1_11_FLEXIO3_FLEXIO27** 0x401F81A8U, 0x9U, 0, 0, 0x401-F8398U
- #define **IOMUXC_GPIO_B1_12_LPUART5_TX** 0x401F81ACU, 0x1U, 0x401F854CU, 0x1U, 0x401F839CU
- #define **IOMUXC_GPIO_B1_12_CSI_PIXCLK** 0x401F81ACU, 0x2U, 0x401F8424U, 0x1U, 0x401F839CU
- #define **IOMUXC_GPIO_B1_12_ENET_1588_EVENT0_IN** 0x401F81ACU, 0x3U, 0x401-

F8444U, 0x2U, 0x401F839CU
- #define **IOMUXC_GPIO_B1_12_FLEXIO2_FLEXIO28** 0x401F81ACU, 0x4U, 0, 0, 0x401-F839CU
- #define **IOMUXC_GPIO_B1_12_GPIO2_IO28** 0x401F81ACU, 0x5U, 0, 0, 0x401F839CU
- #define **IOMUXC_GPIO_B1_12_USDHC1_CD_B** 0x401F81ACU, 0x6U, 0x401F85D4U, 0x2U, 0x401F839CU
- #define **IOMUXC_GPIO_B1_12_FLEXIO3_FLEXIO28** 0x401F81ACU, 0x9U, 0, 0, 0x401-F839CU
- #define **IOMUXC_GPIO_B1_13_WDOG1_B** 0x401F81B0U, 0x0U, 0, 0, 0x401F83A0U
- #define **IOMUXC_GPIO_B1_13_LPUART5_RX** 0x401F81B0U, 0x1U, 0x401F8548U, 0x1U, 0x401F83A0U
- #define **IOMUXC_GPIO_B1_13_CSI_VSYNC** 0x401F81B0U, 0x2U, 0x401F8428U, 0x2U, 0x401F83A0U
- #define **IOMUXC_GPIO_B1_13_ENET_1588_EVENT0_OUT** 0x401F81B0U, 0x3U, 0, 0, 0x401F83A0U
- #define **IOMUXC_GPIO_B1_13_FLEXIO2_FLEXIO29** 0x401F81B0U, 0x4U, 0, 0, 0x401F83-A0U
- #define **IOMUXC_GPIO_B1_13_GPIO2_IO29** 0x401F81B0U, 0x5U, 0, 0, 0x401F83A0U
- #define **IOMUXC_GPIO_B1_13_USDHC1_WP** 0x401F81B0U, 0x6U, 0x401F85D8U, 0x3U, 0x401F83A0U
- #define **IOMUXC_GPIO_B1_13_SEMC_DQS4** 0x401F81B0U, 0x8U, 0x401F8788U, 0x3U, 0x401F83A0U
- #define **IOMUXC_GPIO_B1_13_FLEXIO3_FLEXIO29** 0x401F81B0U, 0x9U, 0, 0, 0x401F83-A0U
- #define **IOMUXC_GPIO_B1_14_ENET_MDC** 0x401F81B4U, 0x0U, 0, 0, 0x401F83A4U
- #define **IOMUXC_GPIO_B1_14_FLEXPWM4_PWMA02** 0x401F81B4U, 0x1U, 0x401F849C-U, 0x1U, 0x401F83A4U
- #define **IOMUXC_GPIO_B1_14_CSI_HSYNC** 0x401F81B4U, 0x2U, 0x401F8420U, 0x2U, 0x401F83A4U
- #define **IOMUXC_GPIO_B1_14_XBAR1_IN02** 0x401F81B4U, 0x3U, 0x401F860CU, 0x1U, 0x401F83A4U
- #define **IOMUXC_GPIO_B1_14_FLEXIO2_FLEXIO30** 0x401F81B4U, 0x4U, 0, 0, 0x401F83-A4U
- #define **IOMUXC_GPIO_B1_14_GPIO2_IO30** 0x401F81B4U, 0x5U, 0, 0, 0x401F83A4U
- #define **IOMUXC_GPIO_B1_14_USDHC1_VSELECT** 0x401F81B4U, 0x6U, 0, 0, 0x401F83-A4U
- #define **IOMUXC_GPIO_B1_14_ENET2_TDATA00** 0x401F81B4U, 0x8U, 0, 0, 0x401F83A4U
- #define **IOMUXC_GPIO_B1_14_FLEXIO3_FLEXIO30** 0x401F81B4U, 0x9U, 0, 0, 0x401F83-A4U
- #define **IOMUXC_GPIO_B1_15_ENET_MDIO** 0x401F81B8U, 0x0U, 0x401F8430U, 0x2U, 0x401F83A8U
- #define **IOMUXC_GPIO_B1_15_FLEXPWM4_PWMA03** 0x401F81B8U, 0x1U, 0x401F84A0-U, 0x1U, 0x401F83A8U
- #define **IOMUXC_GPIO_B1_15_CSI_MCLK** 0x401F81B8U, 0x2U, 0, 0, 0x401F83A8U
- #define **IOMUXC_GPIO_B1_15_XBAR1_IN03** 0x401F81B8U, 0x3U, 0x401F8610U, 0x1U, 0x401F83A8U
- #define **IOMUXC_GPIO_B1_15_FLEXIO2_FLEXIO31** 0x401F81B8U, 0x4U, 0, 0, 0x401F83-A8U
- #define **IOMUXC_GPIO_B1_15_GPIO2_IO31** 0x401F81B8U, 0x5U, 0, 0, 0x401F83A8U
- #define **IOMUXC_GPIO_B1_15_USDHC1_RESET_B** 0x401F81B8U, 0x6U, 0, 0, 0x401F83-A8U

- #define **IOMUXC_GPIO_B1_15_ENET2_TDATA01** 0x401F81B8U, 0x8U, 0, 0, 0x401F83A8U
- #define **IOMUXC_GPIO_B1_15_FLEXIO3_FLEXIO31** 0x401F81B8U, 0x9U, 0, 0, 0x401F83-A8U
- #define **IOMUXC_GPIO_SD_B0_00_USDHC1_CMD** 0x401F81BCU, 0x0U, 0, 0, 0x401F83A-CU
- #define **IOMUXC_GPIO_SD_B0_00_FLEXPWM1_PWMA00** 0x401F81BCU, 0x1U, 0x401-F8458U, 0x1U, 0x401F83ACU
- #define **IOMUXC_GPIO_SD_B0_00_LPI2C3_SCL** 0x401F81BCU, 0x2U, 0x401F84DCU, 0x1-U, 0x401F83ACU
- #define **IOMUXC_GPIO_SD_B0_00_XBAR1_INOUT04** 0x401F81BCU, 0x3U, 0x401F8614U, 0x1U, 0x401F83ACU
- #define **IOMUXC_GPIO_SD_B0_00_LPSPI1_SCK** 0x401F81BCU, 0x4U, 0x401F84F0U, 0x1-U, 0x401F83ACU
- #define **IOMUXC_GPIO_SD_B0_00_GPIO3_IO12** 0x401F81BCU, 0x5U, 0, 0, 0x401F83ACU
- #define **IOMUXC_GPIO_SD_B0_00_FLEXSPIA_SS1_B** 0x401F81BCU, 0x6U, 0, 0, 0x401-F83ACU
- #define **IOMUXC_GPIO_SD_B0_00_ENET2_TX_EN** 0x401F81BCU, 0x8U, 0, 0, 0x401F83A-CU
- #define **IOMUXC_GPIO_SD_B0_00_SEMC_DQS4** 0x401F81BCU, 0x9U, 0x401F8788U, 0x0-U, 0x401F83ACU
- #define **IOMUXC_GPIO_SD_B0_01_USDHC1_CLK** 0x401F81C0U, 0x0U, 0, 0, 0x401F83B0U
- #define **IOMUXC_GPIO_SD_B0_01_FLEXPWM1_PWMB00** 0x401F81C0U, 0x1U, 0x401-F8468U, 0x1U, 0x401F83B0U
- #define **IOMUXC_GPIO_SD_B0_01_LPI2C3_SDA** 0x401F81C0U, 0x2U, 0x401F84E0U, 0x1-U, 0x401F83B0U
- #define **IOMUXC_GPIO_SD_B0_01_XBAR1_INOUT05** 0x401F81C0U, 0x3U, 0x401F8618U, 0x1U, 0x401F83B0U
- #define **IOMUXC_GPIO_SD_B0_01_LPSPI1_PCS0** 0x401F81C0U, 0x4U, 0x401F84ECU, 0x0-U, 0x401F83B0U
- #define **IOMUXC_GPIO_SD_B0_01_GPIO3_IO13** 0x401F81C0U, 0x5U, 0, 0, 0x401F83B0U
- #define **IOMUXC_GPIO_SD_B0_01_FLEXSPIB_SS1_B** 0x401F81C0U, 0x6U, 0, 0, 0x401F83-B0U
- #define **IOMUXC_GPIO_SD_B0_01_ENET2_TX_CLK** 0x401F81C0U, 0x8U, 0x401F8728U, 0x1U, 0x401F83B0U
- #define **IOMUXC_GPIO_SD_B0_01_ENET2_REF_CLK2** 0x401F81C0U, 0x9U, 0x401F870C-U, 0x1U, 0x401F83B0U
- #define **IOMUXC_GPIO_SD_B0_02_USDHC1_DATA0** 0x401F81C4U, 0x0U, 0, 0, 0x401F83-B4U
- #define **IOMUXC_GPIO_SD_B0_02_FLEXPWM1_PWMA01** 0x401F81C4U, 0x1U, 0x401-F845CU, 0x1U, 0x401F83B4U
- #define **IOMUXC_GPIO_SD_B0_02_LPUART8_CTS_B** 0x401F81C4U, 0x2U, 0, 0, 0x401F83-B4U
- #define **IOMUXC_GPIO_SD_B0_02_XBAR1_INOUT06** 0x401F81C4U, 0x3U, 0x401F861CU, 0x1U, 0x401F83B4U
- #define **IOMUXC_GPIO_SD_B0_02_LPSPI1_SDO** 0x401F81C4U, 0x4U, 0x401F84F8U, 0x1-U, 0x401F83B4U
- #define **IOMUXC_GPIO_SD_B0_02_GPIO3_IO14** 0x401F81C4U, 0x5U, 0, 0, 0x401F83B4U
- #define **IOMUXC_GPIO_SD_B0_02_ENET2_RX_ER** 0x401F81C4U, 0x8U, 0x401F8720U, 0x1U, 0x401F83B4U
- #define **IOMUXC_GPIO_SD_B0_02_SEMC_CLK5** 0x401F81C4U, 0x9U, 0, 0, 0x401F83B4U

- #define **IOMUXC_GPIO_SD_B0_03_USDHC1_DATA1** 0x401F81C8U, 0x0U, 0, 0, 0x401F83B8U
- #define **IOMUXC_GPIO_SD_B0_03_FLEXPWM1_PWMB01** 0x401F81C8U, 0x1U, 0x401F846CU, 0x1U, 0x401F83B8U
- #define **IOMUXC_GPIO_SD_B0_03_LPUART8_RTS_B** 0x401F81C8U, 0x2U, 0, 0, 0x401F83B8U
- #define **IOMUXC_GPIO_SD_B0_03_XBAR1_INOUT07** 0x401F81C8U, 0x3U, 0x401F8620U, 0x1U, 0x401F83B8U
- #define **IOMUXC_GPIO_SD_B0_03_LPSPI1_SDI** 0x401F81C8U, 0x4U, 0x401F84F4U, 0x1U, 0x401F83B8U
- #define **IOMUXC_GPIO_SD_B0_03_GPIO3_IO15** 0x401F81C8U, 0x5U, 0, 0, 0x401F83B8U
- #define **IOMUXC_GPIO_SD_B0_03_ENET2_RDATA00** 0x401F81C8U, 0x8U, 0x401F8714U, 0x1U, 0x401F83B8U
- #define **IOMUXC_GPIO_SD_B0_03_SEMC_CLK6** 0x401F81C8U, 0x9U, 0, 0, 0x401F83B8U
- #define **IOMUXC_GPIO_SD_B0_04_USDHC1_DATA2** 0x401F81CCU, 0x0U, 0, 0, 0x401F83BCU
- #define **IOMUXC_GPIO_SD_B0_04_FLEXPWM1_PWMA02** 0x401F81CCU, 0x1U, 0x401F8460U, 0x1U, 0x401F83BCU
- #define **IOMUXC_GPIO_SD_B0_04_LPUART8_TX** 0x401F81CCU, 0x2U, 0x401F8564U, 0x0U, 0x401F83BCU
- #define **IOMUXC_GPIO_SD_B0_04_XBAR1_INOUT08** 0x401F81CCU, 0x3U, 0x401F8624U, 0x1U, 0x401F83BCU
- #define **IOMUXC_GPIO_SD_B0_04_FLEXSPIB_SS0_B** 0x401F81CCU, 0x4U, 0, 0, 0x401F83BCU
- #define **IOMUXC_GPIO_SD_B0_04_GPIO3_IO16** 0x401F81CCU, 0x5U, 0, 0, 0x401F83BCU
- #define **IOMUXC_GPIO_SD_B0_04_CCM_CLKO1** 0x401F81CCU, 0x6U, 0, 0, 0x401F83BCU
- #define **IOMUXC_GPIO_SD_B0_04_ENET2_RDATA01** 0x401F81CCU, 0x8U, 0x401F8718U, 0x1U, 0x401F83BCU
- #define **IOMUXC_GPIO_SD_B0_05_USDHC1_DATA3** 0x401F81D0U, 0x0U, 0, 0, 0x401F83C0U
- #define **IOMUXC_GPIO_SD_B0_05_FLEXPWM1_PWMB02** 0x401F81D0U, 0x1U, 0x401F8470U, 0x1U, 0x401F83C0U
- #define **IOMUXC_GPIO_SD_B0_05_LPUART8_RX** 0x401F81D0U, 0x2U, 0x401F8560U, 0x0U, 0x401F83C0U
- #define **IOMUXC_GPIO_SD_B0_05_XBAR1_INOUT09** 0x401F81D0U, 0x3U, 0x401F8628U, 0x1U, 0x401F83C0U
- #define **IOMUXC_GPIO_SD_B0_05_FLEXSPIB_DQS** 0x401F81D0U, 0x4U, 0, 0, 0x401F83C0U
- #define **IOMUXC_GPIO_SD_B0_05_GPIO3_IO17** 0x401F81D0U, 0x5U, 0, 0, 0x401F83C0U
- #define **IOMUXC_GPIO_SD_B0_05_CCM_CLKO2** 0x401F81D0U, 0x6U, 0, 0, 0x401F83C0U
- #define **IOMUXC_GPIO_SD_B0_05_ENET2_RX_EN** 0x401F81D0U, 0x8U, 0x401F871CU, 0x1U, 0x401F83C0U
- #define **IOMUXC_GPIO_SD_B1_00_USDHC2_DATA3** 0x401F81D4U, 0x0U, 0x401F85F4U, 0x0U, 0x401F83C4U
- #define **IOMUXC_GPIO_SD_B1_00_FLEXSPIB_DATA03** 0x401F81D4U, 0x1U, 0x401F84C4U, 0x0U, 0x401F83C4U
- #define **IOMUXC_GPIO_SD_B1_00_FLEXPWM1_PWMA03** 0x401F81D4U, 0x2U, 0x401F8454U, 0x0U, 0x401F83C4U
- #define **IOMUXC_GPIO_SD_B1_00_SAI1_TX_DATA03** 0x401F81D4U, 0x3U, 0x401F8598U, 0x0U, 0x401F83C4U

- #define **IOMUXC_GPIO_SD_B1_00_LPUART4_TX** 0x401F81D4U, 0x4U, 0x401F8544U, 0x0U, 0x401F83C4U
- #define **IOMUXC_GPIO_SD_B1_00_GPIO3_IO00** 0x401F81D4U, 0x5U, 0, 0, 0x401F83C4U
- #define **IOMUXC_GPIO_SD_B1_00_SAI3_RX_DATA** 0x401F81D4U, 0x8U, 0x401F8778U, 0x1U, 0x401F83C4U
- #define **IOMUXC_GPIO_SD_B1_01_USDHC2_DATA2** 0x401F81D8U, 0x0U, 0x401F85F0U, 0x0U, 0x401F83C8U
- #define **IOMUXC_GPIO_SD_B1_01_FLEXSPIB_DATA02** 0x401F81D8U, 0x1U, 0x401F84-C0U, 0x0U, 0x401F83C8U
- #define **IOMUXC_GPIO_SD_B1_01_FLEXPWM1_PWMB03** 0x401F81D8U, 0x2U, 0x401-F8464U, 0x0U, 0x401F83C8U
- #define **IOMUXC_GPIO_SD_B1_01_SAI1_TX_DATA02** 0x401F81D8U, 0x3U, 0x401F859C-U, 0x0U, 0x401F83C8U
- #define **IOMUXC_GPIO_SD_B1_01_LPUART4_RX** 0x401F81D8U, 0x4U, 0x401F8540U, 0x0U, 0x401F83C8U
- #define **IOMUXC_GPIO_SD_B1_01_GPIO3_IO01** 0x401F81D8U, 0x5U, 0, 0, 0x401F83C8U
- #define **IOMUXC_GPIO_SD_B1_01_SAI3_TX_DATA** 0x401F81D8U, 0x8U, 0, 0, 0x401F83-C8U
- #define **IOMUXC_GPIO_SD_B1_02_USDHC2_DATA1** 0x401F81DCU, 0x0U, 0x401F85ECU, 0x0U, 0x401F83CCU
- #define **IOMUXC_GPIO_SD_B1_02_FLEXSPIB_DATA01** 0x401F81DCU, 0x1U, 0x401F84B-CU, 0x0U, 0x401F83CCU
- #define **IOMUXC_GPIO_SD_B1_02_FLEXPWM2_PWMA03** 0x401F81DCU, 0x2U, 0x401-F8474U, 0x0U, 0x401F83CCU
- #define **IOMUXC_GPIO_SD_B1_02_SAI1_TX_DATA01** 0x401F81DCU, 0x3U, 0x401F85A0-U, 0x0U, 0x401F83CCU
- #define **IOMUXC_GPIO_SD_B1_02_FLEXCAN1_TX** 0x401F81DCU, 0x4U, 0, 0, 0x401F83-CCU
- #define **IOMUXC_GPIO_SD_B1_02_GPIO3_IO02** 0x401F81DCU, 0x5U, 0, 0, 0x401F83CCU
- #define **IOMUXC_GPIO_SD_B1_02_CCM_WAIT** 0x401F81DCU, 0x6U, 0, 0, 0x401F83CCU
- #define **IOMUXC_GPIO_SD_B1_02_SAI3_TX_SYNC** 0x401F81DCU, 0x8U, 0x401F8784U, 0x1U, 0x401F83CCU
- #define **IOMUXC_GPIO_SD_B1_03_USDHC2_DATA0** 0x401F81E0U, 0x0U, 0x401F85E8U, 0x0U, 0x401F83D0U
- #define **IOMUXC_GPIO_SD_B1_03_FLEXSPIB_DATA00** 0x401F81E0U, 0x1U, 0x401F84-B8U, 0x0U, 0x401F83D0U
- #define **IOMUXC_GPIO_SD_B1_03_FLEXPWM2_PWMB03** 0x401F81E0U, 0x2U, 0x401-F8484U, 0x0U, 0x401F83D0U
- #define **IOMUXC_GPIO_SD_B1_03_SAI1_MCLK** 0x401F81E0U, 0x3U, 0x401F858CU, 0x0-U, 0x401F83D0U
- #define **IOMUXC_GPIO_SD_B1_03_FLEXCAN1_RX** 0x401F81E0U, 0x4U, 0x401F844CU, 0x0U, 0x401F83D0U
- #define **IOMUXC_GPIO_SD_B1_03_GPIO3_IO03** 0x401F81E0U, 0x5U, 0, 0, 0x401F83D0U
- #define **IOMUXC_GPIO_SD_B1_03_CCM_PMIC_READY** 0x401F81E0U, 0x6U, 0x401F83-FCU, 0x0U, 0x401F83D0U
- #define **IOMUXC_GPIO_SD_B1_03_SAI3_TX_BCLK** 0x401F81E0U, 0x8U, 0x401F8780U, 0x1U, 0x401F83D0U
- #define **IOMUXC_GPIO_SD_B1_04_USDHC2_CLK** 0x401F81E4U, 0x0U, 0x401F85DCU, 0x0U, 0x401F83D4U
- #define **IOMUXC_GPIO_SD_B1_04_FLEXSPIB_SCLK** 0x401F81E4U, 0x1U, 0, 0, 0x401F83-

D4U
- #define **IOMUXC_GPIO_SD_B1_04_LPI2C1_SCL** 0x401F81E4U, 0x2U, 0x401F84CCU, 0x0U, 0x401F83D4U
- #define **IOMUXC_GPIO_SD_B1_04_SAI1_RX_SYNC** 0x401F81E4U, 0x3U, 0x401F85A4U, 0x0U, 0x401F83D4U
- #define **IOMUXC_GPIO_SD_B1_04_FLEXSPIA_SS1_B** 0x401F81E4U, 0x4U, 0, 0, 0x401F83D4U
- #define **IOMUXC_GPIO_SD_B1_04_GPIO3_IO04** 0x401F81E4U, 0x5U, 0, 0, 0x401F83D4U
- #define **IOMUXC_GPIO_SD_B1_04_CCM_STOP** 0x401F81E4U, 0x6U, 0, 0, 0x401F83D4U
- #define **IOMUXC_GPIO_SD_B1_04_SAI3_MCLK** 0x401F81E4U, 0x8U, 0x401F8770U, 0x1U, 0x401F83D4U
- #define **IOMUXC_GPIO_SD_B1_05_USDHC2_CMD** 0x401F81E8U, 0x0U, 0x401F85E4U, 0x0U, 0x401F83D8U
- #define **IOMUXC_GPIO_SD_B1_05_FLEXSPIA_DQS** 0x401F81E8U, 0x1U, 0x401F84A4U, 0x0U, 0x401F83D8U
- #define **IOMUXC_GPIO_SD_B1_05_LPI2C1_SDA** 0x401F81E8U, 0x2U, 0x401F84D0U, 0x0U, 0x401F83D8U
- #define **IOMUXC_GPIO_SD_B1_05_SAI1_RX_BCLK** 0x401F81E8U, 0x3U, 0x401F8590U, 0x0U, 0x401F83D8U
- #define **IOMUXC_GPIO_SD_B1_05_FLEXSPIB_SS0_B** 0x401F81E8U, 0x4U, 0, 0, 0x401F83D8U
- #define **IOMUXC_GPIO_SD_B1_05_GPIO3_IO05** 0x401F81E8U, 0x5U, 0, 0, 0x401F83D8U
- #define **IOMUXC_GPIO_SD_B1_05_SAI3_RX_SYNC** 0x401F81E8U, 0x8U, 0x401F877CU, 0x1U, 0x401F83D8U
- #define **IOMUXC_GPIO_SD_B1_06_USDHC2_RESET_B** 0x401F81ECU, 0x0U, 0, 0, 0x401F83DCU
- #define **IOMUXC_GPIO_SD_B1_06_FLEXSPIA_SS0_B** 0x401F81ECU, 0x1U, 0, 0, 0x401F83DCU
- #define **IOMUXC_GPIO_SD_B1_06_LPUART7_CTS_B** 0x401F81ECU, 0x2U, 0, 0, 0x401F83DCU
- #define **IOMUXC_GPIO_SD_B1_06_SAI1_RX_DATA00** 0x401F81ECU, 0x3U, 0x401F8594U, 0x0U, 0x401F83DCU
- #define **IOMUXC_GPIO_SD_B1_06_LPSPI2_PCS0** 0x401F81ECU, 0x4U, 0x401F84FCU, 0x0U, 0x401F83DCU
- #define **IOMUXC_GPIO_SD_B1_06_GPIO3_IO06** 0x401F81ECU, 0x5U, 0, 0, 0x401F83DCU
- #define **IOMUXC_GPIO_SD_B1_06_SAI3_RX_BCLK** 0x401F81ECU, 0x8U, 0x401F8774U, 0x1U, 0x401F83DCU
- #define **IOMUXC_GPIO_SD_B1_07_SEMC_CSX01** 0x401F81F0U, 0x0U, 0, 0, 0x401F83E0U
- #define **IOMUXC_GPIO_SD_B1_07_FLEXSPIA_SCLK** 0x401F81F0U, 0x1U, 0x401F84C8U, 0x0U, 0x401F83E0U
- #define **IOMUXC_GPIO_SD_B1_07_LPUART7_RTS_B** 0x401F81F0U, 0x2U, 0, 0, 0x401F83E0U
- #define **IOMUXC_GPIO_SD_B1_07_SAI1_TX_DATA00** 0x401F81F0U, 0x3U, 0, 0, 0x401F83E0U
- #define **IOMUXC_GPIO_SD_B1_07_LPSPI2_SCK** 0x401F81F0U, 0x4U, 0x401F8500U, 0x0U, 0x401F83E0U
- #define **IOMUXC_GPIO_SD_B1_07_GPIO3_IO07** 0x401F81F0U, 0x5U, 0, 0, 0x401F83E0U
- #define **IOMUXC_GPIO_SD_B1_08_USDHC2_DATA4** 0x401F81F4U, 0x0U, 0x401F85F8U, 0x0U, 0x401F83E4U
- #define **IOMUXC_GPIO_SD_B1_08_FLEXSPIA_DATA00** 0x401F81F4U, 0x1U, 0x401F84-

A8U, 0x0U, 0x401F83E4U
- #define **IOMUXC_GPIO_SD_B1_08_LPUART7_TX** 0x401F81F4U, 0x2U, 0x401F855CU, 0x0U, 0x401F83E4U
- #define **IOMUXC_GPIO_SD_B1_08_SAI1_TX_BCLK** 0x401F81F4U, 0x3U, 0x401F85A8U, 0x0U, 0x401F83E4U
- #define **IOMUXC_GPIO_SD_B1_08_LPSPI2_SD0** 0x401F81F4U, 0x4U, 0x401F8508U, 0x0U, 0x401F83E4U
- #define **IOMUXC_GPIO_SD_B1_08_GPIO3_IO08** 0x401F81F4U, 0x5U, 0, 0, 0x401F83E4U
- #define **IOMUXC_GPIO_SD_B1_08_SEMC_CSX02** 0x401F81F4U, 0x6U, 0, 0, 0x401F83E4U
- #define **IOMUXC_GPIO_SD_B1_09_USDHC2_DATA5** 0x401F81F8U, 0x0U, 0x401F85FCU, 0x0U, 0x401F83E8U
- #define **IOMUXC_GPIO_SD_B1_09_FLEXSPIA_DATA01** 0x401F81F8U, 0x1U, 0x401F84ACU, 0x0U, 0x401F83E8U
- #define **IOMUXC_GPIO_SD_B1_09_LPUART7_RX** 0x401F81F8U, 0x2U, 0x401F8558U, 0x0U, 0x401F83E8U
- #define **IOMUXC_GPIO_SD_B1_09_SAI1_TX_SYNC** 0x401F81F8U, 0x3U, 0x401F85ACU, 0x0U, 0x401F83E8U
- #define **IOMUXC_GPIO_SD_B1_09_LPSPI2_SDI** 0x401F81F8U, 0x4U, 0x401F8504U, 0x0U, 0x401F83E8U
- #define **IOMUXC_GPIO_SD_B1_09_GPIO3_IO09** 0x401F81F8U, 0x5U, 0, 0, 0x401F83E8U
- #define **IOMUXC_GPIO_SD_B1_10_USDHC2_DATA6** 0x401F81FCU, 0x0U, 0x401F8600U, 0x0U, 0x401F83ECU
- #define **IOMUXC_GPIO_SD_B1_10_FLEXSPIA_DATA02** 0x401F81FCU, 0x1U, 0x401F84B0U, 0x0U, 0x401F83ECU
- #define **IOMUXC_GPIO_SD_B1_10_LPUART2_RX** 0x401F81FCU, 0x2U, 0x401F852CU, 0x0U, 0x401F83ECU
- #define **IOMUXC_GPIO_SD_B1_10_LPI2C2_SDA** 0x401F81FCU, 0x3U, 0x401F84D8U, 0x0U, 0x401F83ECU
- #define **IOMUXC_GPIO_SD_B1_10_LPSPI2_PCS2** 0x401F81FCU, 0x4U, 0, 0, 0x401F83ECU
- #define **IOMUXC_GPIO_SD_B1_10_GPIO3_IO10** 0x401F81FCU, 0x5U, 0, 0, 0x401F83ECU
- #define **IOMUXC_GPIO_SD_B1_11_USDHC2_DATA7** 0x401F8200U, 0x0U, 0x401F8604U, 0x0U, 0x401F83F0U
- #define **IOMUXC_GPIO_SD_B1_11_FLEXSPIA_DATA03** 0x401F8200U, 0x1U, 0x401F84B4U, 0x0U, 0x401F83F0U
- #define **IOMUXC_GPIO_SD_B1_11_LPUART2_TX** 0x401F8200U, 0x2U, 0x401F8530U, 0x0U, 0x401F83F0U
- #define **IOMUXC_GPIO_SD_B1_11_LPI2C2_SCL** 0x401F8200U, 0x3U, 0x401F84D4U, 0x0U, 0x401F83F0U
- #define **IOMUXC_GPIO_SD_B1_11_LPSPI2_PCS3** 0x401F8200U, 0x4U, 0, 0, 0x401F83F0U
- #define **IOMUXC_GPIO_SD_B1_11_GPIO3_IO11** 0x401F8200U, 0x5U, 0, 0, 0x401F83F0U
- #define **IOMUXC_SNVS_WAKEUP_GPIO5_IO00** 0x400A8000U, 0x5U, 0, 0, 0x400A8018U
- #define **IOMUXC_SNVS_WAKEUP_NMI** 0x400A8000U, 0x7U, 0x401F8568U, 0x1U, 0x400A8018U
- #define **IOMUXC_SNVS_PMIC_ON_REQ_SNVS_PMIC_ON_REQ** 0x400A8004U, 0x0U, 0, 0, 0x400A801CU
- #define **IOMUXC_SNVS_PMIC_ON_REQ_GPIO5_IO01** 0x400A8004U, 0x5U, 0, 0, 0x400A801CU
- #define **IOMUXC_SNVS_PMIC_STBY_REQ_CCM_PMIC_STBY_REQ** 0x400A8008U, 0x0U, 0, 0, 0x400A8020U
- #define **IOMUXC_SNVS_PMIC_STBY_REQ_GPIO5_IO02** 0x400A8008U, 0x5U, 0, 0, 0x400A8020U

- #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, 4))

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

muxRegister	The pin mux register.
muxMode	The pin mux mode.
inputRegister	The select input register.
inputDaisy	The input daisy.
configRegister	The config register.
inputOnfield	Software input on field.

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_SCLS:

```
* IOMUXC_SetPinConfig(IOMUXC_PTA3_LPI2C0_SCLS,IOMUXC_SW_PAD_CTL_PAD_PUS_MASK|
      IOMUXC_SW_PAD_CTL_PAD_PUS(2U))
*
```

Parameters

muxRegister	The pin mux register.
muxMode	The pin mux mode.
inputRegister	The select input register.
inputDaisy	The input daisy.
configRegister	The config register.
configValue	The pin config value.

6.3.3 static void IOMUXC_EnableMode (IOMUXC_GPR_Type ∗ *base,* uint32_t *mode,* bool *enable*) [inline], [static]

Parameters

base	The IOMUXC GPR base address.
mode	The mode for setting. the mode is the logical OR of "iomuxc_gpr_mode"
enable	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

base	The IOMUXC GPR base address.
mclk	The SAI MCLK.
clkSrc	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

base	The IOMUXC GPR base address.
enable	Enter or exit MQS software reset.

6.3.6 static void IOMUXC_MQSEnable (IOMUXC_GPR_Type ∗ *base,* bool *enable*) `[inline], [static]`

Parameters

base	The IOMUXC GPR base address.
enable	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

base	The IOMUXC GPR base address.
rate	The MQS PWM oversampling rate, refer to "iomuxc_mqs_pwm_oversample_rate_t".
divider	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_GetADCConversionValue (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

base	ADC_ETC peripheral base address.
config	Pointer to "adc_etc_config_t" structure.

7.5.2 void ADC_ETC_Deinit (ADC_ETC_Type * *base*)

Parameters

base	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

config	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

base	ADC_ETC peripheral base address.
triggerGroup	Trigger group index.
config	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

base	ADC_ETC peripheral base address.
triggerGroup	Trigger group index. Available number is 0∼7.
chainGroup	Trigger chain group index. Available number is 0∼7.
config	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

base	ADC_ETC peripheral base address.

sourceIndex	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

base	ADC_ETC peripheral base address.
sourceIndex	trigger source index.
mask	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

base	ADC_ETC peripheral base address.
triggerGroup	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

base	ADC_ETC peripheral base address.
triggerGroup	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

base	ADC_ETC peripheral base address.

Returns

Mask of external XBAR tirgger'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

base	ADC_ETC peripheral base address.
mask	Mask of external XBAR tirgger'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

base	ADC_ETC peripheral base address.
enable	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 tigger. TSC trigger sources can only work in hardware trigger mode.

Parameters

base	ADC_ETC peripheral base address.
triggerGroup	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

base	ADC_ETC peripheral base address.
triggerGroup	Trigger group index. Available number is 0∼7.
chainGroup	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_SetMasterPriviledgeLevel (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

base	AIPSTZ peripheral base pointer
master	Masters for AIPSTZ.
privilegeConfig	Configuration is ORed from aipstz_master_privilege_level_t.

8.3.2 void AIPSTZ_SetPeripheralAccessControl (AIPSTZ_Type ∗ *base,* aipstz_peripheral_t *peripheral,* uint32_t *accessControl*)

Parameters

base	AIPSTZ peripheral base pointer
peripheral	Peripheral for AIPSTZ.

accessControl	Configuration is ORed from aipstz_peripheral_access_control_t.

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 conjuction 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

base	AOI peripheral address.

9.7.2 void AOI_Deinit (AOI_Type ∗ *base*)

This function shutdowns AOI module.

Parameters

base	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

base	AOI peripheral address.
event	Index of the event which will be set of type aoi_event_t.
config	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

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

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 IOMUXC_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

base	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

base	BEE peripheral address.

10.9.3 static void BEE_Enable (BEE_Type ∗ *base*) `[inline]`, `[static]`

This function enables decryption using BEE.

Parameters

base	BEE peripheral address.

10.9.4 static void BEE_Disable (BEE_Type * *base*) [inline], [static]

This function disables decryption using BEE.

Parameters

base	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

config	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 accorging to given configuration structure.

Parameters

base	BEE peripheral address.

config	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 loaded and BEE will use key from OTPMK or SW_GP2.

Parameters

base	BEE peripheral address.
region	Selection of the BEE region to be configured.
key	AES key (in little-endian format).
keySize	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

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

10.9.9 uint32_t BEE_GetStatusFlags (BEE_Type * *base*)

This function returns status of BEE peripheral.

Parameters

base	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

base	BEE peripheral base address.
mask	The status flags to clear. This is a logical OR of members of the enumeration bee_status_flags_t

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 processer 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 + l2 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

address	The start address of the memory to be invalidated.
size_byte	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

address	The start address of the memory to be invalidated.
size_byte	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

address	The start address of the memory to be cleaned.
size_byte	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

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

address	The physical address.
size_byte	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

address	The physical address.

size_byte	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

address	The physical address.
size_byte	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

address	The physical address.
size_byte	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 MCUXpresso 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

base	CMP peripheral base address.
config	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

base	CMP peripheral base address.

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

Parameters

base	CMP peripheral base address.
enable	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

config	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

base	CMP peripheral base address.
positive-Channel	Positive side input channel number. Available range is 0-7.
negative-Channel	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

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

12.6.7 static void CMP_EnableWindowMode (CMP_Type ∗ *base,* bool *enable*) `[inline], [static]`

Parameters

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

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

Parameters

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

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

Parameters

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

12.6.10 void CMP_EnableInterrupts (CMP_Type * *base,* uint32_t *mask*)

Parameters

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

12.6.11 void CMP_DisableInterrupts (CMP_Type * *base,* uint32_t *mask*)

Parameters

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

12.6.12 uint32_t CMP_GetStatusFlags (CMP_Type * *base*)

Parameters

base	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

base	CMP peripheral base address.
mask	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_USART = 57,
  kStatusGroup_DMIC = 58,
  kStatusGroup_SDIF = 59,

kStatusGroup_POWER_MANAGER = 159 }
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, 1))
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, 1))

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 UART 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.

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

size	The length required to malloc.
alignbytes	The alignment size.

Return values

The	allocated memory.

13.5.2 void SDK_Free (void ∗ *ptr*)

Parameters

ptr	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

delayTime_us	Delay time in unit of microsecond.
coreClock_Hz	Core clock frequency with Hz.

Chapter 14
CSI: CMOS Sensor Interface

14.1 Overview

The MCUXpresso SDK provides a driver for the CMOS Sensor Interface (CSI)

The CSI enables the chip to connect directly to external CMOS image sensors. The CSI driver provides functional APIs and transactional APIs for the CSI module. The functional APIs implement the basic functions, so the user can construct them for a special use case. The transactional APIs provide a queue mechanism in order for the user to submit an empty frame buffer and get a fully-filled frame buffer easily.

14.2 Frame Buffer Queue

The CSI transactional functions maintain a frame buffer queue. The queue size is defined by the macro CSI_DRIVER_QUEUE_SIZE. The queue size is 4 by default, but the user can override it by redefining the macro value in the project setting.

To use transactional APIs, first call CSI_TransferCreateHandle to create a handle to save the CSI driver state. This function initializes the frame buffer queue to empty status.

After the handle is created, the function CSI_TransferSubmitEmptyBuffer can be used to submit the empty frame buffer to the queue. If the queue does not have room to save the new empty frame buffers, this function returns with an error. It is not necessary to check the queue rooms before submitting an empty frame buffer. After this step, the application can call CSI_TransferStart to start the transfer. There must be at least two empty buffers in the queue, otherwise this function returns an error. The incoming frames are saved to the empty buffers one by one, and a callback is provided when every frame completed. To get the fully-filled frame buffer, call the function CSI_TransferGetFullBuffer. This function returns an error if the frame buffer queue does not have full buffers. Therefore, it is not necessary to check the full buffer number in the queue before this function.

To stop the transfer, call the function CSI_TransferStop at anytime. If the queue has some full frame buffers, the application can still read them out after this stop function.

Once the transfer is started by calling CSI_TransferStart, the CSI device starts to receive frames and save into buffer. The CSI devices does not stop until CSI_TransferStop is called. If application does not submit empty buffer to CSI driver, the CSI driver always writes to the last submited empty buffer, this buffer will never be sent into full buffer queue until new empty buffer submited. In other words, one frame buffer is reserved by CSI driver, if application submits N empty buffers, it could get (N-1) full buffers.

14.3 Fragment Mode

The frame buffer queue mechanism needs large memory, it is not suitable for some special case, for example, no SDRAM used. Fragment mode is designed for this purpose, it needs two types of buffers:

1. DMA buffer. It could be as small as (camera frame width x 2 x 2) bytes, CSI DMA writes the input data to this buffer.

2. Frame buffer. The input data is copied to this buffer at last. What is more, user could define a window (in other words, region of interest), only image in this window will be copied to the frame buffer. If input data is YUV422 format, user can only save Y component optionally.

Limitations:

1. Fragment mode could not be used together with frame buffer queue mode.
2. In fragment mode, user should pay attention to the system payload. When the payload is high, the image capture might be broken.

14.4 Typical use case

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

Data Structures

- struct csi_config_t
  Configuration to initialize the CSI module. More...
- struct csi_handle_t
  CSI handle structure. More...

Macros

- #define CSI_DRIVER_QUEUE_SIZE 4U
  Size of the frame buffer queue used in CSI transactional function.
- #define CSI_DRIVER_FRAG_MODE 0U
  Enable fragment capture function or not.

Typedefs

- typedef void(∗ csi_transfer_callback_t)(CSI_Type ∗base, csi_handle_t ∗handle, status_t status, void ∗userData)
  CSI transfer callback function.

Enumerations

- enum {
  kStatus_CSI_NoEmptyBuffer = MAKE_STATUS(kStatusGroup_CSI, 0),
  kStatus_CSI_NoFullBuffer = MAKE_STATUS(kStatusGroup_CSI, 1),
  kStatus_CSI_QueueFull = MAKE_STATUS(kStatusGroup_CSI, 2),
  kStatus_CSI_FrameDone = MAKE_STATUS(kStatusGroup_CSI, 3) }
  Error codes for the CSI driver.
- enum csi_work_mode_t {
  kCSI_GatedClockMode = CSI_CR1_GCLK_MODE(1U),
  kCSI_NonGatedClockMode = 0U,
  kCSI_CCIR656ProgressiveMode = CSI_CR1_CCIR_EN(1U) }
  CSI work mode.

- enum csi_data_bus_t {
  kCSI_DataBus8Bit,
  kCSI_DataBus16Bit,
  kCSI_DataBus24Bit }
  CSI data bus witdh.
- enum _csi_polarity_flags {
  kCSI_HsyncActiveLow = 0U,
  kCSI_HsyncActiveHigh = CSI_CR1_HSYNC_POL_MASK,
  kCSI_DataLatchOnRisingEdge = CSI_CR1_REDGE_MASK,
  kCSI_DataLatchOnFallingEdge = 0U,
  kCSI_VsyncActiveHigh = 0U,
  kCSI_VsyncActiveLow = CSI_CR1_SOF_POL_MASK }
  CSI signal polarity.
- enum csi_fifo_t {
  kCSI_RxFifo = (1U << 0U),
  kCSI_StatFifo = (1U << 1U),
  kCSI_AllFifo = 0x01 | 0x02 }
  The CSI FIFO, used for FIFO operation.
- enum _csi_interrupt_enable {
  kCSI_EndOfFrameInterruptEnable = CSI_CR1_EOF_INT_EN_MASK,
  kCSI_ChangeOfFieldInterruptEnable = CSI_CR1_COF_INT_EN_MASK,
  kCSI_StatFifoOverrunInterruptEnable = CSI_CR1_SF_OR_INTEN_MASK,
  kCSI_RxFifoOverrunInterruptEnable = CSI_CR1_RF_OR_INTEN_MASK,
  kCSI_StatFifoDmaDoneInterruptEnable = CSI_CR1_SFF_DMA_DONE_INTEN_MASK,
  kCSI_StatFifoFullInterruptEnable = CSI_CR1_STATFF_INTEN_MASK,
  kCSI_RxBuffer1DmaDoneInterruptEnable = CSI_CR1_FB2_DMA_DONE_INTEN_MASK,
  kCSI_RxBuffer0DmaDoneInterruptEnable = CSI_CR1_FB1_DMA_DONE_INTEN_MASK,
  kCSI_RxFifoFullInterruptEnable = CSI_CR1_RXFF_INTEN_MASK,
  kCSI_StartOfFrameInterruptEnable = CSI_CR1_SOF_INTEN_MASK,
  kCSI_EccErrorInterruptEnable = CSI_CR3_ECC_INT_EN_MASK,
  kCSI_AhbResErrorInterruptEnable = CSI_CR3_HRESP_ERR_EN_MASK,
  kCSI_BaseAddrChangeErrorInterruptEnable = CSI_CR18_BASEADDR_CHANGE_ERROR_IE-
  _MASK << 6U,
  kCSI_Field0DoneInterruptEnable = CSI_CR18_FIELD0_DONE_IE_MASK << 6U,
  kCSI_Field1DoneInterruptEnable = CSI_CR18_DMA_FIELD1_DONE_IE_MASK << 6U }
  CSI feature interrupt source.
- enum _csi_flags {

kCSI_RxFifoDataReadyFlag = CSI_SR_DRDY_MASK,
kCSI_EccErrorFlag = CSI_SR_ECC_INT_MASK,
kCSI_AhbResErrorFlag = CSI_SR_HRESP_ERR_INT_MASK,
kCSI_ChangeOfFieldFlag = CSI_SR_COF_INT_MASK,
kCSI_Field0PresentFlag = CSI_SR_F1_INT_MASK,
kCSI_Field1PresentFlag = CSI_SR_F2_INT_MASK,
kCSI_StartOfFrameFlag = CSI_SR_SOF_INT_MASK,
kCSI_EndOfFrameFlag = CSI_SR_EOF_INT_MASK,
kCSI_RxFifoFullFlag = CSI_SR_RxFF_INT_MASK,
kCSI_RxBuffer1DmaDoneFlag = CSI_SR_DMA_TSF_DONE_FB2_MASK,
kCSI_RxBuffer0DmaDoneFlag = CSI_SR_DMA_TSF_DONE_FB1_MASK,
kCSI_StatFifoFullFlag = CSI_SR_STATFF_INT_MASK,
kCSI_StatFifoDmaDoneFlag = CSI_SR_DMA_TSF_DONE_SFF_MASK,
kCSI_StatFifoOverrunFlag = CSI_SR_SF_OR_INT_MASK,
kCSI_RxFifoOverrunFlag = CSI_SR_RF_OR_INT_MASK,
kCSI_Field0DoneFlag = CSI_SR_DMA_FIELD0_DONE_MASK,
kCSI_Field1DoneFlag = CSI_SR_DMA_FIELD1_DONE_MASK,
kCSI_BaseAddrChangeErrorFlag = CSI_SR_BASEADDR_CHHANGE_ERROR_MASK }

CSI status flags.

Driver version

- #define **FSL_CSI_DRIVER_VERSION** (MAKE_VERSION(2, 1, 5))

Initialization and deinitialization

- status_t CSI_Init (CSI_Type *base, const csi_config_t *config)
  Initialize the CSI.
- void CSI_Deinit (CSI_Type *base)
  De-initialize the CSI.
- void CSI_Reset (CSI_Type *base)
  Reset the CSI.
- void CSI_GetDefaultConfig (csi_config_t *config)
  Get the default configuration for to initialize the CSI.

Module operation

- void CSI_ClearFifo (CSI_Type *base, csi_fifo_t fifo)
  Clear the CSI FIFO.
- void CSI_ReflashFifoDma (CSI_Type *base, csi_fifo_t fifo)
  Reflash the CSI FIFO DMA.
- void CSI_EnableFifoDmaRequest (CSI_Type *base, csi_fifo_t fifo, bool enable)
  Enable or disable the CSI FIFO DMA request.
- static void CSI_Start (CSI_Type *base)
  Start to receive data.
- static void CSI_Stop (CSI_Type *base)
  Stop to receiving data.
- void CSI_SetRxBufferAddr (CSI_Type *base, uint8_t index, uint32_t addr)
  Set the RX frame buffer address.

Interrupts

- void CSI_EnableInterrupts (CSI_Type *base, uint32_t mask)
  Enables CSI interrupt requests.
- void CSI_DisableInterrupts (CSI_Type *base, uint32_t mask)
  Disable CSI interrupt requests.

Status

- static uint32_t CSI_GetStatusFlags (CSI_Type *base)
  Gets the CSI status flags.
- static void CSI_ClearStatusFlags (CSI_Type *base, uint32_t statusMask)
  Clears the CSI status flag.

Transactional

- status_t CSI_TransferCreateHandle (CSI_Type *base, csi_handle_t *handle, csi_transfer_callback_t callback, void *userData)
  Initializes the CSI handle.
- status_t CSI_TransferStart (CSI_Type *base, csi_handle_t *handle)
  Start the transfer using transactional functions.
- status_t CSI_TransferStop (CSI_Type *base, csi_handle_t *handle)
  Stop the transfer using transactional functions.
- status_t CSI_TransferSubmitEmptyBuffer (CSI_Type *base, csi_handle_t *handle, uint32_t frameBuffer)
  Submit empty frame buffer to queue.
- status_t CSI_TransferGetFullBuffer (CSI_Type *base, csi_handle_t *handle, uint32_t *frameBuffer)
  Get one full frame buffer from queue.
- void CSI_TransferHandleIRQ (CSI_Type *base, csi_handle_t *handle)
  CSI IRQ handle function.

14.5 Data Structure Documentation

14.5.1 struct csi_config_t

Data Fields

- uint16_t width
  Pixels of the input frame.
- uint16_t height
  Lines of the input frame.
- uint32_t polarityFlags
  Timing signal polarity flags, OR'ed value of _csi_polarity_flags.
- uint8_t bytesPerPixel
  Bytes per pixel, valid values are:
- uint16_t linePitch_Bytes
  Frame buffer line pitch, must be 8-byte aligned.
- csi_work_mode_t workMode
  CSI work mode.

- csi_data_bus_t dataBus
  Data bus width.
- bool useExtVsync
  In CCIR656 progressive mode, set true to use external VSYNC signal, set false to use internal VSYNC signal decoded from SOF.

Field Documentation

(1) uint16_t csi_config_t::width

(2) uint16_t csi_config_t::height

(3) uint32_t csi_config_t::polarityFlags

(4) uint8_t csi_config_t::bytesPerPixel

- 2: Used for RGB565, YUV422, and so on.
- 4: Used for XRGB8888, XYUV444, and so on.

(5) uint16_t csi_config_t::linePitch_Bytes

(6) csi_work_mode_t csi_config_t::workMode

(7) csi_data_bus_t csi_config_t::dataBus

(8) bool csi_config_t::useExtVsync

14.5.2 struct _csi_handle

Please see the user guide for the details of the CSI driver queue mechanism.

Data Fields

- uint32_t frameBufferQueue [CSI_DRIVER_ACTUAL_QUEUE_SIZE]
  Frame buffer queue.
- volatile uint8_t queueWriteIdx
  Pointer to save incoming item.
- volatile uint8_t queueReadIdx
  Pointer to read out the item.
- void *volatile emptyBuffer
  Pointer to maintain the empty frame buffers.
- volatile uint8_t emptyBufferCnt
  Empty frame buffers count.
- volatile uint8_t activeBufferNum
  How many frame buffers are in progres currently.
- volatile bool transferStarted
  User has called CSI_TransferStart to start frame receiving.
- csi_transfer_callback_t callback
  Callback function.

- void ∗ userData
  CSI callback function parameter.

Field Documentation

(1) uint32_t csi_handle_t::frameBufferQueue[CSI_DRIVER_ACTUAL_QUEUE_SIZE]

(2) volatile uint8_t csi_handle_t::queueWriteIdx

(3) volatile uint8_t csi_handle_t::queueReadIdx

(4) void∗ volatile csi_handle_t::emptyBuffer

(5) volatile uint8_t csi_handle_t::emptyBufferCnt

(6) volatile uint8_t csi_handle_t::activeBufferNum

(7) volatile bool csi_handle_t::transferStarted

(8) csi_transfer_callback_t csi_handle_t::callback

(9) void∗ csi_handle_t::userData

14.6 Macro Definition Documentation

14.6.1 #define CSI_DRIVER_QUEUE_SIZE 4U

14.6.2 #define CSI_DRIVER_FRAG_MODE 0U

14.7 Typedef Documentation

14.7.1 typedef void(∗ csi_transfer_callback_t)(CSI_Type ∗base, csi_handle_t ∗handle, status_t status, void ∗userData)

When a new frame is received and saved to the frame buffer queue, the callback is called and the pass the status kStatus_CSI_FrameDone to upper layer.

14.8 Enumeration Type Documentation

14.8.1 anonymous enum

Enumerator

kStatus_CSI_NoEmptyBuffer No empty frame buffer in queue to load to CSI.
kStatus_CSI_NoFullBuffer No full frame buffer in queue to read out.
kStatus_CSI_QueueFull Queue is full, no room to save new empty buffer.
kStatus_CSI_FrameDone New frame received and saved to queue.

14.8.2 enum csi_work_mode_t

The CCIR656 interlace mode is not supported currently.

Enumerator

kCSI_GatedClockMode HSYNC, VSYNC, and PIXCLK signals are used.
kCSI_NonGatedClockMode VSYNC, and PIXCLK signals are used.
kCSI_CCIR656ProgressiveMode CCIR656 progressive mode.

14.8.3 enum csi_data_bus_t

Enumerator

kCSI_DataBus8Bit 8-bit data bus.
kCSI_DataBus16Bit 16-bit data bus.
kCSI_DataBus24Bit 24-bit data bus.

14.8.4 enum _csi_polarity_flags

Enumerator

kCSI_HsyncActiveLow HSYNC is active low.
kCSI_HsyncActiveHigh HSYNC is active high.
kCSI_DataLatchOnRisingEdge Pixel data latched at rising edge of pixel clock.
kCSI_DataLatchOnFallingEdge Pixel data latched at falling edge of pixel clock.
kCSI_VsyncActiveHigh VSYNC is active high.
kCSI_VsyncActiveLow VSYNC is active low.

14.8.5 enum csi_fifo_t

Enumerator

kCSI_RxFifo RXFIFO.
kCSI_StatFifo STAT FIFO.
kCSI_AllFifo Both RXFIFO and STAT FIFO.

14.8.6 enum _csi_interrupt_enable

Enumerator

kCSI_EndOfFrameInterruptEnable End of frame interrupt enable.

kCSI_ChangeOfFieldInterruptEnable Change of field interrupt enable.
kCSI_StatFifoOverrunInterruptEnable STAT FIFO overrun interrupt enable.
kCSI_RxFifoOverrunInterruptEnable RXFIFO overrun interrupt enable.
kCSI_StatFifoDmaDoneInterruptEnable STAT FIFO DMA done interrupt enable.
kCSI_StatFifoFullInterruptEnable STAT FIFO full interrupt enable.
kCSI_RxBuffer1DmaDoneInterruptEnable RX frame buffer 1 DMA transfer done.
kCSI_RxBuffer0DmaDoneInterruptEnable RX frame buffer 0 DMA transfer done.
kCSI_RxFifoFullInterruptEnable RXFIFO full interrupt enable.
kCSI_StartOfFrameInterruptEnable Start of frame (SOF) interrupt enable.
kCSI_EccErrorInterruptEnable ECC error detection interrupt enable.
kCSI_AhbResErrorInterruptEnable AHB response Error interrupt enable.
kCSI_BaseAddrChangeErrorInterruptEnable The DMA output buffer base address changes before DMA completed.
kCSI_Field0DoneInterruptEnable Field 0 done interrupt enable.
kCSI_Field1DoneInterruptEnable Field 1 done interrupt enable.

14.8.7 enum _csi_flags

The following status register flags can be cleared:

- kCSI_EccErrorFlag
- kCSI_AhbResErrorFlag
- kCSI_ChangeOfFieldFlag
- kCSI_StartOfFrameFlag
- kCSI_EndOfFrameFlag
- kCSI_RxBuffer1DmaDoneFlag
- kCSI_RxBuffer0DmaDoneFlag
- kCSI_StatFifoDmaDoneFlag
- kCSI_StatFifoOverrunFlag
- kCSI_RxFifoOverrunFlag
- kCSI_Field0DoneFlag
- kCSI_Field1DoneFlag
- kCSI_BaseAddrChangeErrorFlag

Enumerator

kCSI_RxFifoDataReadyFlag RXFIFO data ready.
kCSI_EccErrorFlag ECC error detected.
kCSI_AhbResErrorFlag Hresponse (AHB bus response) Error.
kCSI_ChangeOfFieldFlag Change of field.
kCSI_Field0PresentFlag Field 0 present in CCIR mode.
kCSI_Field1PresentFlag Field 1 present in CCIR mode.
kCSI_StartOfFrameFlag Start of frame (SOF) detected.
kCSI_EndOfFrameFlag End of frame (EOF) detected.

kCSI_RxFifoFullFlag RXFIFO full (Number of data reaches trigger level).
kCSI_RxBuffer1DmaDoneFlag RX frame buffer 1 DMA transfer done.
kCSI_RxBuffer0DmaDoneFlag RX frame buffer 0 DMA transfer done.
kCSI_StatFifoFullFlag STAT FIFO full (Reach trigger level).
kCSI_StatFifoDmaDoneFlag STAT FIFO DMA transfer done.
kCSI_StatFifoOverrunFlag STAT FIFO overrun.
kCSI_RxFifoOverrunFlag RXFIFO overrun.
kCSI_Field0DoneFlag Field 0 transfer done.
kCSI_Field1DoneFlag Field 1 transfer done.
kCSI_BaseAddrChangeErrorFlag The DMA output buffer base address changes before DMA completed.

14.9 Function Documentation

14.9.1 status_t CSI_Init (CSI_Type ∗ *base,* const csi_config_t ∗ *config*)

This function enables the CSI peripheral clock, and resets the CSI registers.

Parameters

base	CSI peripheral base address.
config	Pointer to the configuration structure.

Return values

kStatus_Success	Initialize successfully.
kStatus_InvalidArgument	Initialize failed because of invalid argument.

14.9.2 void CSI_Deinit (CSI_Type ∗ *base*)

This function disables the CSI peripheral clock.

Parameters

base	CSI peripheral base address.

14.9.3 void CSI_Reset (CSI_Type ∗ *base*)

This function resets the CSI peripheral registers to default status.

Parameters

base	CSI peripheral base address.

14.9.4 void CSI_GetDefaultConfig (csi_config_t * *config*)

The default configuration value is:

```
config->width = 320U;
config->height = 240U;
config->polarityFlags = kCSI_HsyncActiveHigh |
      kCSI_DataLatchOnRisingEdge;
config->bytesPerPixel = 2U;
config->linePitch_Bytes = 320U * 2U;
config->workMode = kCSI_GatedClockMode;
config->dataBus = kCSI_DataBus8Bit;
config->useExtVsync = true;
```

Parameters

config	Pointer to the CSI configuration.

14.9.5 void CSI_ClearFifo (CSI_Type * *base*, csi_fifo_t *fifo*)

This function clears the CSI FIFO.

Parameters

base	CSI peripheral base address.
fifo	The FIFO to clear.

14.9.6 void CSI_ReflashFifoDma (CSI_Type * *base*, csi_fifo_t *fifo*)

This function reflashes the CSI FIFO DMA.

For RXFIFO, there are two frame buffers. When the CSI module started, it saves the frames to frame buffer 0 then frame buffer 1, the two buffers will be written by turns. After reflash DMA using this function, the CSI is reset to save frame to buffer 0.

Parameters

base	CSI peripheral base address.
fifo	The FIFO DMA to reflash.

14.9.7 void CSI_EnableFifoDmaRequest (CSI_Type * *base,* csi_fifo_t *fifo,* bool *enable*)

Parameters

base	CSI peripheral base address.
fifo	The FIFO DMA reques to enable or disable.
enable	True to enable, false to disable.

14.9.8 static void CSI_Start (CSI_Type * *base*) `[inline]`, `[static]`

Parameters

base	CSI peripheral base address.

14.9.9 static void CSI_Stop (CSI_Type * *base*) `[inline]`, `[static]`

Parameters

base	CSI peripheral base address.

14.9.10 void CSI_SetRxBufferAddr (CSI_Type * *base,* uint8_t *index,* uint32_t *addr*)

Parameters

base	CSI peripheral base address.
index	Buffer index.
addr	Frame buffer address to set.

14.9.11 void CSI_EnableInterrupts (CSI_Type * *base*, uint32_t *mask*)

Parameters

base	CSI peripheral base address.
mask	The interrupts to enable, pass in as OR'ed value of _csi_interrupt_enable.

14.9.12 void CSI_DisableInterrupts (CSI_Type * *base*, uint32_t *mask*)

Parameters

base	CSI peripheral base address.
mask	The interrupts to disable, pass in as OR'ed value of _csi_interrupt_enable.

14.9.13 static uint32_t CSI_GetStatusFlags (CSI_Type * *base*) [inline], [static]

Parameters

base	CSI peripheral base address.

Returns

status flag, it is OR'ed value of _csi_flags.

14.9.14 static void CSI_ClearStatusFlags (CSI_Type * *base*, uint32_t *statusMask*) [inline], [static]

The flags to clear are passed in as OR'ed value of _csi_flags. The following flags are cleared automatically by hardware:

- kCSI_RxFifoFullFlag,

- kCSI_StatFifoFullFlag,
- kCSI_Field0PresentFlag,
- kCSI_Field1PresentFlag,
- kCSI_RxFifoDataReadyFlag,

Parameters

base	CSI peripheral base address.
statusMask	The status flags mask, OR'ed value of _csi_flags.

14.9.15 status_t CSI_TransferCreateHandle (CSI_Type * *base*, csi_handle_t * *handle*, csi_transfer_callback_t *callback*, void * *userData*)

This function initializes CSI handle, it should be called before any other CSI transactional functions.

Parameters

base	CSI peripheral base address.
handle	Pointer to the handle structure.
callback	Callback function for CSI transfer.
userData	Callback function parameter.

Return values

kStatus_Success	Handle created successfully.

14.9.16 status_t CSI_TransferStart (CSI_Type * *base*, csi_handle_t * *handle*)

When the empty frame buffers have been submit to CSI driver using function CSI_TransferSubmitEmpty-Buffer, user could call this function to start the transfer. The incoming frame will be saved to the empty frame buffer, and user could be optionally notified through callback function.

Parameters

base	CSI peripheral base address.
handle	Pointer to the handle structure.

Return values

kStatus_Success	Started successfully.
kStatus_CSI_NoEmpty-Buffer	Could not start because no empty frame buffer in queue.

14.9.17 status_t CSI_TransferStop (CSI_Type * *base*, csi_handle_t * *handle*)

The driver does not clean the full frame buffers in queue. In other words, after calling this function, user still could get the full frame buffers in queue using function CSI_TransferGetFullBuffer.

Parameters

base	CSI peripheral base address.
handle	Pointer to the handle structure.

Return values

kStatus_Success	Stoped successfully.

14.9.18 status_t CSI_TransferSubmitEmptyBuffer (CSI_Type * *base*, csi_handle_t * *handle*, uint32_t *frameBuffer*)

This function could be called before CSI_TransferStart or after CSI_TransferStart. If there is no room in queue to store the empty frame buffer, this function returns error.

Parameters

base	CSI peripheral base address.
handle	Pointer to the handle structure.
frameBuffer	Empty frame buffer to submit.

Return values

kStatus_Success	Started successfully.

kStatus_CSI_QueueFull	Could not submit because there is no room in queue.

14.9.19 status_t CSI_TransferGetFullBuffer (CSI_Type * *base*, csi_handle_t * *handle*, uint32_t * *frameBuffer*)

After the transfer started using function CSI_TransferStart, the incoming frames will be saved to the empty frame buffers in queue. This function gets the full-filled frame buffer from the queue. If there is no full frame buffer in queue, this function returns error.

Parameters

base	CSI peripheral base address.
handle	Pointer to the handle structure.
frameBuffer	Full frame buffer.

Return values

kStatus_Success	Started successfully.
kStatus_CSI_NoFull-Buffer	There is no full frame buffer in queue.

14.9.20 void CSI_TransferHandleIRQ (CSI_Type * *base*, csi_handle_t * *handle*)

This function handles the CSI IRQ request to work with CSI driver transactional APIs.

Parameters

base	CSI peripheral base address.
handle	CSI handle pointer.

Chapter 15
DCDC: DCDC Converter

15.1 Overview

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

15.2 Function groups

15.2.1 Initialization and deinitialization

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

15.2.2 Status

Provides functions to get the DCDC status.

15.2.3 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.

15.3 Application guideline

15.3.1 Continous conduction mode

15.3.2 Discontinous 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(discontinous conduction mode).
- void DCDC_BootIntoCCM (DCDC_Type *base)
  Boot DCDC into CCM(continous conduction mode).

15.4 Data Structure Documentation

15.4.1 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::powerDownLowVlotageDetection

(4) bool dcdc_detection_config_t::powerDownOverCurrentDetection

(5) bool dcdc_detection_config_t::powerDownPeakCurrentDetection

(6) bool dcdc_detection_config_t::powerDownZeroCrossDetection

(7) dcdc_over_current_threshold_t dcdc_detection_config_t::OverCurrentThreshold

(8) dcdc_peak_current_threshold_t dcdc_detection_config_t::PeakCurrentThreshold

15.4.2 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 dcdc_loop_control_config_t::enableRCScaleCircuit

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

(6) uint32_t dcdc_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.

15.4.3 struct dcdc_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.
- dcdc_count_charging_time_period_t countChargingTimePeriod
  The period of counting the charging times in power save mode.
- dcdc_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 dcdc_low_power_config_t::enableOverloadDetection

(2) bool dcdc_low_power_config_t::enableAdjustHystereticValue

(3) dcdc_count_charging_time_period_t dcdc_low_power_config_t::countChargingTimePeriod

(4) dcdc_count_charging_time_threshold_t dcdc_low_power_config_t::countChargingTime-Threshold

15.4.4 struct dcdc_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.

15.4.5 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

15.5 Macro Definition Documentation

15.5.1 #define FSL_DCDC_DRIVER_VERSION (MAKE_VERSION(2, 3, 0))

Version 2.3.0.

15.6 Enumeration Type Documentation

15.6.1 enum _dcdc_status_flags_t

Enumerator

kDCDC_LockedOKStatus Indicate DCDC status. 1'b1: DCDC already settled 1'b0: DCDC is settling.

15.6.2 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.

15.6.3 enum dcdc_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.

15.6.4 enum dcdc_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.

15.6.5 enum dcdc_count_charging_time_period_t

Enumerator

kDCDC_CountChargingTimePeriod8Cycle Eight 32k cycle.
kDCDC_CountChargingTimePeriod16Cycle Sixteen 32k cycle.

15.6.6 enum dcdc_count_charging_time_threshold_t

Enumerator

kDCDC_CountChargingTimeThreshold32 0x0: 32.
kDCDC_CountChargingTimeThreshold64 0x1: 64.
kDCDC_CountChargingTimeThreshold16 0x2: 16.
kDCDC_CountChargingTimeThreshold8 0x3: 8.

15.6.7 enum dcdc_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.

15.7 Function Documentation

15.7.1 void DCDC_Init (DCDC_Type * *base*)

Parameters

base	DCDC peripheral base address.

15.7.2 void DCDC_Deinit (DCDC_Type * *base*)

Parameters

base	DCDC peripheral base address.

15.7.3 uint32_t DCDC_GetstatusFlags (DCDC_Type * *base*)

Parameters

base	peripheral base address.

Returns

Mask of asserted status flags. See to "_dcdc_status_flags_t".

15.7.4 static void DCDC_EnableOutputRangeComparator (DCDC_Type * *base,* bool *enable*) `[inline], [static]`

The output range comparator is disabled by default.

Parameters

base	DCDC peripheral base address.
enable	Enable the feature or not.

15.7.5 void DCDC_SetClockSource (DCDC_Type * *base,* dcdc_clock_source_t *clockSource*)

Parameters

base	DCDC peripheral base address.
clockSource	Clock source for DCDC. See to "dcdc_clock_source_t".

15.7.6 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->powerDownLowVlotageDetection = false;
*   config->powerDownOverCurrentDetection = true;
*   config->powerDownPeakCurrentDetection = true;
*   config->powerDownZeroCrossDetection = true;
*   config->OverCurrentThreshold = kDCDC_OverCurrentThresholdAlt0;
*   config->PeakCurrentThreshold = kDCDC_PeakCurrentThresholdAlt0;
*
```

Parameters

config	Pointer to configuration structure. See to "dcdc_detection_config_t"

15.7.7 void DCDC_SetDetectionConfig (DCDC_Type * *base,* const dcdc_detection_config_t * *config*)

Parameters

base	DCDC peripheral base address.
config	Pointer to configuration structure. See to "dcdc_detection_config_t"

15.7.8 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

config	Pointer to configuration structure. See to "dcdc_low_power_config_t"

15.7.9 void DCDC_SetLowPowerConfig (DCDC_Type * *base,* const dcdc_low_power_config_t * *config*)

Parameters

base	DCDC peripheral base address.
config	Pointer to configuration structure. See to "dcdc_low_power_config_t".

15.7.10 void DCDC_ResetCurrentAlertSignal (DCDC_Type * *base,* bool *enable*)

Alert signal is generate by peak current detection.

Parameters

base	DCDC peripheral base address.
enable	Switcher to reset signal. True means reset signal. False means don't reset signal.

15.7.11 static void DCDC_SetBandgapVoltageTrimValue (DCDC_Type * *base,* uint32_t *trimValue*) `[inline], [static]`

Parameters

base	DCDC peripheral base address.
trimValue	The bangap trim value. Available range is 0U-31U.

15.7.12 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

config	Pointer to configuration structure. See to "dcdc_loop_control_config_t"

15.7.13 void DCDC_SetLoopControlConfig (DCDC_Type * *base,* const dcdc_loop_control_config_t * *config*)

Parameters

base	DCDC peripheral base address.
config	Pointer to configuration structure. See to "dcdc_loop_control_config_t".

15.7.14 void DCDC_SetMinPowerConfig (DCDC_Type * *base,* const dcdc_min_power_config_t * *config*)

Parameters

base	DCDC peripheral base address.
config	Pointer to configuration structure. See to "dcdc_min_power_config_t".

15.7.15 static void DCDC_SetLPComparatorBiasValue (DCDC_Type * *base,* dcdc_comparator_current_bias_t *biasVaule*) `[inline]`, `[static]`

Parameters

base	DCDC peripheral base address.
biasVaule	The current bias of low power comparator. Refer to "dcdc_comparator_current_bias_t".

15.7.16 static void DCDC_LockTargetVoltage (DCDC_Type * *base*) `[inline]`, `[static]`

Parameters

base	DCDC peripheral base address.

15.7.17 void DCDC_AdjustTargetVoltage (DCDC_Type * *base*, uint32_t *VDDRun*, uint32_t *VDDStandby*)

Deprecated Do not use this function. It has been superceded 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

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

15.7.18 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

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

15.7.19 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

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

15.7.20 void DCDC_SetInternalRegulatorConfig (DCDC_Type * *base,* const dcdc_internal_regulator_config_t * *config*)

Parameters

base	DCDC peripheral base address.
config	Pointer to configuration structure. See to "dcdc_internal_regulator_config_t".

15.7.21 static void DCDC_EnableImproveTransition (DCDC_Type * *base,* bool *enable*) `[inline],[static]`

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

Parameters

base	DCDC peripheral base address.
enable	Enable the feature or not.

15.7.22 void DCDC_BootIntoDCM (DCDC_Type * *base*)

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

Parameters

base	DCDC peripheral base address.

15.7.23 void DCDC_BootIntoCCM (DCDC_Type * *base*)

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

Parameters

base	DCDC peripheral base address.

Chapter 16
DCP: Data Co-Processor

16.1 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.

16.2 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.

16.3 Comments about API usage in RTOS

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

16.4 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 it's operation with data (such as message, plaintext, ciphertext, or keys) all data should remain valid until the DCP operation completes.

16.5 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.

16.6 DCP Driver Examples

16.6.1 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.

16.7 Data Structure Documentation

16.7.1 struct dcp_work_packet_t

16.7.2 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

16.7.3 struct dcp_context_t

16.7.4 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

16.8 Macro Definition Documentation

16.8.1 #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

16.9 Enumeration Type Documentation

16.9.1 enum _dcp_status

Enumerator

kStatus_DCP_Again Non-blocking function shall be called again.

16.9.2 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.

16.9.3 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.

16.9.4 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.

16.9.5 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.

16.9.6 enum dcp_swap_t

16.10 Function Documentation

16.10.1 void DCP_Init (DCP_Type ∗ *base,* const dcp_config_t ∗ *config*)

Enable DCP clock and configure DCP.

Parameters

base	DCP base address
config	Pointer to configuration structure.

16.10.2 void DCP_Deinit (DCP_Type ∗ *base*)

Reset DCP and Disable DCP clock.

Parameters

base	DCP base address

16.10.3 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	*config*	Pointer to configuration structure.

16.10.4 status_t DCP_WaitForChannelComplete (DCP_Type * *base,* dcp_handle_t * *handle*)

Polls the specified DCP channel until current it completes activity.

Parameters

base	DCP peripheral base address.
handle	Specifies DCP channel.

Returns

kStatus_Success When data processing completes without error.
kStatus_Fail When error occurs.

16.11 DCP AES blocking driver

16.11.1 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.

16.11.2 Function Documentation

16.11.2.1 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

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

Returns

status from set key operation

16.11.2.2 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

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

Returns

Status from encrypt operation

16.11.2.3 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

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

Returns

Status from decrypt operation

16.11.2.4 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

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

Returns

Status from encrypt operation

16.11.2.5 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

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

Returns

Status from decrypt operation

16.12 DCP AES non-blocking driver

16.12.1 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.

16.12.2 Function Documentation

16.12.2.1 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

	base	DCP peripheral base address
	handle	Handle used for this request.
out	*dcpPacket*	Memory for the DCP work packet.
	plaintext	Input plain text to encrypt.
out	*ciphertext*	Output cipher text
	size	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.

16.12.2.2 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

	base	DCP peripheral base address
	handle	Handle used for this request.
out	*dcpPacket*	Memory for the DCP work packet.
	ciphertext	Input cipher text to decrypt
out	*plaintext*	Output plain text
	size	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.

16.12.2.3 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

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

Returns

kStatus_Success The work packet has been scheduled at DCP channel.
kStatus_DCP_Again The DCP channel is busy processing previous request.

16.12.2.4 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

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

Returns

kStatus_Success The work packet has been scheduled at DCP channel.
kStatus_DCP_Again The DCP channel is busy processing previous request.

16.13 DCP HASH driver

16.13.1 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.

16.13.2 Data Structure Documentation

16.13.2.1 struct dcp_hash_ctx_t

16.13.3 Macro Definition Documentation

16.13.3.1 #define DCP_SHA_BLOCK_SIZE 128U

internal buffer block size

16.13.3.2 #define DCP_HASH_CTX_SIZE 64

16.13.4 Enumeration Type Documentation

16.13.4.1 enum dcp_hash_algo_t

Enumerator

kDCP_Sha1 SHA_1.
kDCP_Sha256 SHA_256.
kDCP_Crc32 CRC_32.

16.13.5 Function Documentation

16.13.5.1 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

	base	DCP peripheral base address
	handle	Specifies the DCP channel used for hashing.
`out`	*ctx*	Output hash context
	algo	Underlaying algorithm to use for hash computation.

Returns

Status of initialization

16.13.5.2 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

	base	DCP peripheral base address
in,out	*ctx*	HASH context
	input	Input data
	inputSize	Size of input data in bytes

Returns

Status of the hash update operation

16.13.5.3 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

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

Returns

Status of the hash finish operation

16.13.5.4 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

	base	DCP peripheral base address
	handle	Handle used for the request.
	algo	Underlaying algorithm to use for hash computation.
	input	Input data
	inputSize	Size of input data in bytes
`out`	*output*	Output hash data
`out`	*outputSize*	Output parameter storing the size of the output hash in bytes

Returns

Status of the one call hash operation.

Chapter 17
DMAMUX: Direct Memory Access Multiplexer Driver

17.1 Overview

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

17.2 Typical use case

17.2.1 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.

17.3 Macro Definition Documentation

17.3.1 #define FSL_DMAMUX_DRIVER_VERSION (MAKE_VERSION(2, 0, 5))

17.4 Function Documentation

17.4.1 void DMAMUX_Init (DMAMUX_Type * *base*)

This function ungates the DMAMUX clock.

Parameters

base	DMAMUX peripheral base address.

17.4.2 void DMAMUX_Deinit (DMAMUX_Type ∗ *base*)

This function gates the DMAMUX clock.

Parameters

base	DMAMUX peripheral base address.

17.4.3 static void DMAMUX_EnableChannel (DMAMUX_Type ∗ *base,* uint32_t *channel*) [inline], [static]

This function enables the DMAMUX channel.

Parameters

base	DMAMUX peripheral base address.
channel	DMAMUX channel number.

17.4.4 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

base	DMAMUX peripheral base address.

channel	DMAMUX channel number.

17.4.5 static void DMAMUX_SetSource (DMAMUX_Type * *base,* uint32_t *channel,* uint32_t *source*) [inline], [static]

Parameters

base	DMAMUX peripheral base address.
channel	DMAMUX channel number.
source	Channel source, which is used to trigger the DMA transfer.

17.4.6 static void DMAMUX_EnablePeriodTrigger (DMAMUX_Type * *base,* uint32_t *channel*) [inline], [static]

This function enables the DMAMUX period trigger feature.

Parameters

base	DMAMUX peripheral base address.
channel	DMAMUX channel number.

17.4.7 static void DMAMUX_DisablePeriodTrigger (DMAMUX_Type * *base,* uint32_t *channel*) [inline], [static]

This function disables the DMAMUX period trigger.

Parameters

base	DMAMUX peripheral base address.
channel	DMAMUX channel number.

17.4.8 static void DMAMUX_EnableAlwaysOn (DMAMUX_Type * *base,* uint32_t *channel,* bool *enable*) [inline], [static]

This function enables the DMAMUX channel always ON feature.

Parameters

base	DMAMUX peripheral base address.
channel	DMAMUX channel number.
enable	Switcher of the always ON feature. "true" means enabled, "false" means disabled.

Chapter 18
eDMA: Enhanced Direct Memory Access (eDMA) Controller Driver

18.1 Overview

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

18.2 Typical use case

18.2.1 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 type, 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 type, 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 type)
  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_GetUnusedTCDNumber (edma_handle_t *handle)
  Get unused TCD slot number.
- static uint32_t EDMA_GetNextTCDAddress (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.

18.3 Data Structure Documentation

18.3.1 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.

18.3.2 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

18.3.3 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.

18.3.4 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

18.3.5 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

18.3.6 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

18.4 Macro Definition Documentation

18.4.1 #define FSL_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 4, 3))

Version 2.4.3.

18.5 Typedef Documentation

18.5.1 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

handle	EDMA handle pointer, users shall not touch the values inside.
userData	The callback user parameter pointer. Users can use this parameter to involve things users need to change in EDMA callback function.
transferDone	If the current loaded transfer done. In normal mode it means if all transfer done. In scatter gather mode, this parameter shows is the current transfer block in EDMA register is done. As the load of core is different, it will be different if the new tcd loaded into EDMA registers while this callback called. If true, it always means new tcd still not loaded into registers, while false means new tcd already loaded into registers.
tcds	How many tcds are done from the last callback. This parameter only used in scatter gather mode. It tells user how many tcds are finished between the last callback and this.

18.6 Enumeration Type Documentation

18.6.1 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.

18.6.2 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.

18.6.3 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.

18.6.4 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.

18.6.5 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

18.6.6 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.

18.6.7 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.

18.6.8 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.

18.6.9 anonymous enum

Enumerator

kStatus_EDMA_QueueFull TCD queue is full.
kStatus_EDMA_Busy Channel is busy and can't handle the transfer request.

18.7 Function Documentation

18.7.1 void EDMA_Init (DMA_Type * *base,* const edma_config_t * *config*)

This function ungates the eDMA clock and configures the eDMA peripheral according to the configuration structure.

Parameters

base	eDMA peripheral base address.
config	A pointer to the configuration structure, see "edma_config_t".

Note

This function enables the minor loop map feature.

18.7.2 void EDMA_Deinit (DMA_Type * *base*)

This function gates the eDMA clock.

Parameters

base	eDMA peripheral base address.

18.7.3 void EDMA_InstallTCD (DMA_Type * *base,* uint32_t *channel,* edma_tcd_t * *tcd*)

Parameters

base	EDMA peripheral base address.
channel	EDMA channel number.
tcd	Point to TCD structure.

18.7.4 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

config	A pointer to the eDMA configuration structure.

18.7.5 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

base	EDMA peripheral base address.
enable	true is enable, false is disable.

18.7.6 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

base	EDMA peripheral base address.
enable	true is enable, false is disable.

18.7.7 void EDMA_ResetChannel (DMA_Type * *base,* uint32_t *channel*)

This function sets TCD registers for this channel to default values.

Parameters

base	eDMA peripheral base address.
channel	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.

18.7.8 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

base	eDMA peripheral base address.
channel	eDMA channel number.
config	Pointer to eDMA transfer configuration structure.
nextTcd	Point to TCD structure. It can be NULL if users do not want to enable scatter/gather feature.

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.

18.7.9 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

base	eDMA peripheral base address.
channel	eDMA channel number.
config	A pointer to the minor offset configuration structure.

18.7.10 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

base	eDMA peripheral base address.
channel	eDMA channel number
config	A pointer to the channel preemption configuration structure.

18.7.11 void EDMA_SetChannelLink (DMA_Type * *base,* uint32_t *channel,* edma_channel_link_type_t *type,* 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

base	eDMA peripheral base address.
channel	eDMA channel number.
type	A channel link type, which can be one of the following: • kEDMA_LinkNone • kEDMA_MinorLink • kEDMA_MajorLink

linkedChannel	The linked channel number.

Note

Users should ensure that DONE flag is cleared before calling this interface, or the configuration is invalid.

18.7.12 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

base	eDMA peripheral base address.
channel	eDMA channel number.
bandWidth	A bandwidth setting, which can be one of the following: • kEDMABandwidthStallNone • kEDMABandwidthStall4Cycle • kEDMABandwidthStall8Cycle

18.7.13 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

base	eDMA peripheral base address.
channel	eDMA channel number.

srcModulo	A source modulo value.
destModulo	A destination modulo value.

18.7.14 static void EDMA_EnableAsyncRequest (DMA_Type * *base,* uint32_t *channel,* bool *enable*) [inline], [static]

Parameters

base	eDMA peripheral base address.
channel	eDMA channel number.
enable	The command to enable (true) or disable (false).

18.7.15 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

base	eDMA peripheral base address.
channel	eDMA channel number.
enable	The command to enable (true) or disable (false).

18.7.16 void EDMA_EnableChannelInterrupts (DMA_Type * *base,* uint32_t *channel,* uint32_t *mask*)

Parameters

base	eDMA peripheral base address.
channel	eDMA channel number.
mask	The mask of interrupt source to be set. Users need to use the defined edma_interrupt_enable_t type.

18.7.17 void EDMA_DisableChannelInterrupts (DMA_Type * *base,* uint32_t *channel,* uint32_t *mask*)

Parameters

base	eDMA peripheral base address.
channel	eDMA channel number.
mask	The mask of the interrupt source to be set. Use the defined edma_interrupt_enable_t type.

18.7.18 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

base	eDMA peripheral base address.
channel	edma channel number.
sourceOffset	source address offset will be applied to source address after major loop done.
destOffset	destination address offset will be applied to source address after major loop done.

18.7.19 void EDMA_TcdReset (edma_tcd_t * *tcd*)

This function sets all fields for this TCD structure to default value.

Parameters

tcd	Pointer to the TCD structure.

Note

This function enables the auto stop request feature.

18.7.20 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 STCD 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

tcd	Pointer to the TCD structure.
config	Pointer to eDMA transfer configuration structure.
nextTcd	Pointer to the next TCD structure. It can be NULL if users do not want to enable scatter/gather feature.

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.

18.7.21 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

tcd	A point to the TCD structure.
config	A pointer to the minor offset configuration structure.

18.7.22 void EDMA_TcdSetChannelLink (edma_tcd_t * *tcd,* edma_channel_link_type_t *type,* 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

tcd	Point to the TCD structure.
type	Channel link type, it can be one of: • kEDMA_LinkNone • kEDMA_MinorLink • kEDMA_MajorLink
linkedChannel	The linked channel number.

18.7.23 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

tcd	A pointer to the TCD structure.
bandWidth	A bandwidth setting, which can be one of the following: • kEDMABandwidthStallNone • kEDMABandwidthStall4Cycle • kEDMABandwidthStall8Cycle

18.7.24 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

tcd	A pointer to the TCD structure.

srcModulo	A source modulo value.
destModulo	A destination modulo value.

18.7.25 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

tcd	A pointer to the TCD structure.
enable	The command to enable (true) or disable (false).

18.7.26 void EDMA_TcdEnableInterrupts (edma_tcd_t * *tcd,* uint32_t *mask*)

Parameters

tcd	Point to the TCD structure.
mask	The mask of interrupt source to be set. Users need to use the defined edma_interrupt-_enable_t type.

18.7.27 void EDMA_TcdDisableInterrupts (edma_tcd_t * *tcd,* uint32_t *mask*)

Parameters

tcd	Point to the TCD structure.
mask	The mask of interrupt source to be set. Users need to use the defined edma_interrupt-_enable_t type.

18.7.28 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

tcd	A point to the TCD structure.
sourceOffset	source address offset wiil be applied to source address after major loop done.
destOffset	destination address offset will be applied to source address after major loop done.

18.7.29 static void EDMA_EnableChannelRequest (DMA_Type ∗ *base,* uint32_t *channel*) [inline], [static]

This function enables the hardware channel request.

Parameters

base	eDMA peripheral base address.
channel	eDMA channel number.

18.7.30 static void EDMA_DisableChannelRequest (DMA_Type ∗ *base,* uint32_t *channel*) [inline], [static]

This function disables the hardware channel request.

Parameters

base	eDMA peripheral base address.
channel	eDMA channel number.

18.7.31 static void EDMA_TriggerChannelStart (DMA_Type ∗ *base,* uint32_t *channel*) [inline], [static]

This function starts a minor loop transfer.

Parameters

base	eDMA peripheral base address.
channel	eDMA channel number.

18.7.32 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

base	eDMA peripheral base address.
channel	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)

18.7.33 static uint32_t EDMA_GetErrorStatusFlags (DMA_Type ∗ *base*) [inline], [static]

Parameters

base	eDMA peripheral base address.

Returns

The mask of error status flags. Users need to use the _edma_error_status_flags type to decode the return variables.

18.7.34 uint32_t EDMA_GetChannelStatusFlags (DMA_Type ∗ *base,* uint32_t *channel*)

Parameters

base	eDMA peripheral base address.
channel	eDMA channel number.

Returns

The mask of channel status flags. Users need to use the _edma_channel_status_flags type to decode the return variables.

18.7.35 void EDMA_ClearChannelStatusFlags (DMA_Type * *base,* uint32_t *channel,* uint32_t *mask*)

Parameters

base	eDMA peripheral base address.
channel	eDMA channel number.
mask	The mask of channel status to be cleared. Users need to use the defined _edma_-channel_status_flags type.

18.7.36 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

handle	eDMA handle pointer. The eDMA handle stores callback function and parameters.
base	eDMA peripheral base address.
channel	eDMA channel number.

18.7.37 void EDMA_InstallTCDMemory (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_SubmitTransfer.

Parameters

handle	eDMA handle pointer.
tcdPool	A memory pool to store TCDs. It must be 32 bytes aligned.
tcdSize	The number of TCD slots.

18.7.38 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

handle	eDMA handle pointer.
callback	eDMA callback function pointer.
userData	A parameter for the callback function.

18.7.39 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

config	The user configuration structure of type edma_transfer_t.
srcAddr	eDMA transfer source address.
srcWidth	eDMA transfer source address width(bytes).
srcOffset	source address offset.
destAddr	eDMA transfer destination address.
destWidth	eDMA transfer destination address width(bytes).
destOffset	destination address offset.
bytesEach-Request	eDMA transfer bytes per channel request.
transferBytes	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).

18.7.40 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 *type*)

This function prepares the transfer configuration structure according to the user input.

Parameters

config	The user configuration structure of type edma_transfer_t.
srcAddr	eDMA transfer source address.
srcWidth	eDMA transfer source address width(bytes).
destAddr	eDMA transfer destination address.
destWidth	eDMA transfer destination address width(bytes).
bytesEach-Request	eDMA transfer bytes per channel request.
transferBytes	eDMA transfer bytes to be transferred.
type	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).

18.7.41 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

handle	eDMA handle pointer.
config	Pointer to eDMA transfer configuration structure.

Return values

kStatus_EDMA_Success	It means submit transfer request succeed.
kStatus_EDMA_Queue-Full	It means TCD queue is full. Submit transfer request is not allowed.
kStatus_EDMA_Busy	It means the given channel is busy, need to submit request later.

18.7.42 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

handle	eDMA handle pointer.

18.7.43 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

handle	eDMA handle pointer.

18.7.44 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

handle	DMA handle pointer.

18.7.45 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

handle	DMA handle pointer.

Returns

The unused tcd slot number.

18.7.46 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

handle	DMA handle pointer.

Returns

The next TCD address.

18.7.47 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

handle	eDMA handle pointer.

Chapter 19
eLCDIF: Enhanced LCD Interface

19.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Enhanced LCD Interface(eLCDIF)

The Enhanced LCD Interface supports MPU mode, VSYNC mode, RGB mode (or DOTCLK mode), and DVI mode. The current eLCDIF driver only supports RGB mode.

19.2 Typical use case

19.2.1 Frame buffer update

The function ELCDIF_SetNextBufferAddr sets the next frame to show to eLCDIF, the eLCDIF loads the new frame and sets the interrupt kELCDIF_CurFrameDone. If no new frame is set, the old one is displayed.

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

19.2.2 Alpha surface

The alpha surface can be enabled to add an extra overlay on the normal display buffer. In this example, the alpha surface is enabled, and the alpha value is updated after every frame loaded to eLCDIF.

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

Data Structures

- struct elcdif_pixel_format_reg_t
  The register value when using different pixel format. More...
- struct elcdif_rgb_mode_config_t
  eLCDIF configure structure for RGB mode (DOTCLK mode). More...
- struct elcdif_as_buffer_config_t
  eLCDIF alpha surface buffer configuration. More...
- struct elcdif_as_blend_config_t
  eLCDIF alpha surface blending configuration. More...

Enumerations

- enum _elcdif_polarity_flags {
  kELCDIF_VsyncActiveLow = 0U,
  kELCDIF_VsyncActiveHigh = LCDIF_VDCTRL0_VSYNC_POL_MASK,
  kELCDIF_HsyncActiveLow = 0U,
  kELCDIF_HsyncActiveHigh = LCDIF_VDCTRL0_HSYNC_POL_MASK,
  kELCDIF_DataEnableActiveLow = 0U,
  kELCDIF_DataEnableActiveHigh = LCDIF_VDCTRL0_ENABLE_POL_MASK,
  kELCDIF_DriveDataOnFallingClkEdge = 0U,
  kELCDIF_DriveDataOnRisingClkEdge = LCDIF_VDCTRL0_DOTCLK_POL_MASK }
  eLCDIF signal polarity flags
- enum _elcdif_interrupt_enable {
  kELCDIF_BusMasterErrorInterruptEnable = LCDIF_CTRL1_BM_ERROR_IRQ_EN_MASK,
  kELCDIF_TxFifoOverflowInterruptEnable = LCDIF_CTRL1_OVERFLOW_IRQ_EN_MASK,
  kELCDIF_TxFifoUnderflowInterruptEnable = LCDIF_CTRL1_UNDERFLOW_IRQ_EN_MASK,
  kELCDIF_CurFrameDoneInterruptEnable,
  kELCDIF_VsyncEdgeInterruptEnable }
  The eLCDIF interrupts to enable.
- enum _elcdif_interrupt_flags {
  kELCDIF_BusMasterError = LCDIF_CTRL1_BM_ERROR_IRQ_MASK,
  kELCDIF_TxFifoOverflow = LCDIF_CTRL1_OVERFLOW_IRQ_MASK,
  kELCDIF_TxFifoUnderflow = LCDIF_CTRL1_UNDERFLOW_IRQ_MASK,
  kELCDIF_CurFrameDone,
  kELCDIF_VsyncEdge = LCDIF_CTRL1_VSYNC_EDGE_IRQ_MASK }
  The eLCDIF interrupt status flags.
- enum _elcdif_status_flags {
  kELCDIF_LFifoFull = LCDIF_STAT_LFIFO_FULL_MASK,
  kELCDIF_LFifoEmpty = LCDIF_STAT_LFIFO_EMPTY_MASK,
  kELCDIF_TxFifoFull = LCDIF_STAT_TXFIFO_FULL_MASK,
  kELCDIF_TxFifoEmpty = LCDIF_STAT_TXFIFO_EMPTY_MASK }
  eLCDIF status flags
- enum elcdif_pixel_format_t {
  kELCDIF_PixelFormatRAW8 = 0,
  kELCDIF_PixelFormatRGB565 = 1,
  kELCDIF_PixelFormatRGB666 = 2,
  kELCDIF_PixelFormatXRGB8888 = 3,
  kELCDIF_PixelFormatRGB888 = 4 }
  The pixel format.
- enum elcdif_lcd_data_bus_t {
  kELCDIF_DataBus8Bit = LCDIF_CTRL_LCD_DATABUS_WIDTH(1),
  kELCDIF_DataBus16Bit = LCDIF_CTRL_LCD_DATABUS_WIDTH(0),
  kELCDIF_DataBus18Bit = LCDIF_CTRL_LCD_DATABUS_WIDTH(2),
  kELCDIF_DataBus24Bit = LCDIF_CTRL_LCD_DATABUS_WIDTH(3) }
  The LCD data bus type.
- enum elcdif_as_pixel_format_t {

kELCDIF_AsPixelFormatARGB8888 = 0x0,
kELCDIF_AsPixelFormatRGB888 = 0x4,
kELCDIF_AsPixelFormatARGB1555 = 0x8,
kELCDIF_AsPixelFormatARGB4444 = 0x9,
kELCDIF_AsPixelFormatRGB555 = 0xC,
kELCDIF_AsPixelFormatRGB444 = 0xD,
kELCDIF_AsPixelFormatRGB565 = 0xE }

eLCDIF alpha surface pixel format.

- enum elcdif_alpha_mode_t {
  kELCDIF_AlphaEmbedded,
  kELCDIF_AlphaOverride,
  kELCDIF_AlphaMultiply,
  kELCDIF_AlphaRop }

  eLCDIF alpha mode during blending.
- enum elcdif_rop_mode_t {
  kELCDIF_RopMaskAs = 0x0,
  kELCDIF_RopMaskNotAs = 0x1,
  kELCDIF_RopMaskAsNot = 0x2,
  kELCDIF_RopMergeAs = 0x3,
  kELCDIF_RopMergeNotAs = 0x4,
  kELCDIF_RopMergeAsNot = 0x5,
  kELCDIF_RopNotCopyAs = 0x6,
  kELCDIF_RopNot = 0x7,
  kELCDIF_RopNotMaskAs = 0x8,
  kELCDIF_RopNotMergeAs = 0x9,
  kELCDIF_RopXorAs = 0xA,
  kELCDIF_RopNotXorAs = 0xB }

  eLCDIF ROP mode during blending.
- enum elcdif_lut_t {
  kELCDIF_Lut0 = 0,
  kELCDIF_Lut1 }

  eLCDIF LUT

Driver version

- #define FSL_ELCDIF_DRIVER_VERSION (MAKE_VERSION(2, 0, 4))

  eLCDIF driver version

eLCDIF initialization and de-initialization

- void ELCDIF_RgbModeInit (LCDIF_Type *base, const elcdif_rgb_mode_config_t *config)

  Initializes the eLCDIF to work in RGB mode (DOTCLK mode).
- void ELCDIF_RgbModeGetDefaultConfig (elcdif_rgb_mode_config_t *config)

  Gets the eLCDIF default configuration structure for RGB (DOTCLK) mode.
- void ELCDIF_Deinit (LCDIF_Type *base)

  Deinitializes the eLCDIF peripheral.

Module operation

- void ELCDIF_RgbModeSetPixelFormat (LCDIF_Type *base, elcdif_pixel_format_t pixelFormat)
  Set the pixel format in RGB (DOTCLK) mode.
- static void ELCDIF_RgbModeStart (LCDIF_Type *base)
  Start to display in RGB (DOTCLK) mode.
- void ELCDIF_RgbModeStop (LCDIF_Type *base)
  Stop display in RGB (DOTCLK) mode and wait until finished.
- static void ELCDIF_SetNextBufferAddr (LCDIF_Type *base, uint32_t bufferAddr)
  Set the next frame buffer address to display.
- void ELCDIF_Reset (LCDIF_Type *base)
  Reset the eLCDIF peripheral.

Status

- static uint32_t ELCDIF_GetCrcValue (LCDIF_Type *base)
  Get the CRC value of the frame sent out.
- static uint32_t ELCDIF_GetBusMasterErrorAddr (LCDIF_Type *base)
  Get the bus master error virtual address.
- static uint32_t ELCDIF_GetStatus (LCDIF_Type *base)
  Get the eLCDIF status.
- static uint32_t ELCDIF_GetLFifoCount (LCDIF_Type *base)
  Get current count in Latency buffer (LFIFO).

Interrupts

- static void ELCDIF_EnableInterrupts (LCDIF_Type *base, uint32_t mask)
  Enables eLCDIF interrupt requests.
- static void ELCDIF_DisableInterrupts (LCDIF_Type *base, uint32_t mask)
  Disables eLCDIF interrupt requests.
- static uint32_t ELCDIF_GetInterruptStatus (LCDIF_Type *base)
  Get eLCDIF interrupt peding status.
- static void ELCDIF_ClearInterruptStatus (LCDIF_Type *base, uint32_t mask)
  Clear eLCDIF interrupt peding status.

LUT

The Lookup Table (LUT) is used to expand the 8 bits pixel to 24 bits pixel before output to external displayer.

There are two 256x24 bits LUT memory in LCDIF, the LSB of frame buffer address determins which memory to use.

- static void ELCDIF_EnableLut (LCDIF_Type *base, bool enable)
  Enable or disable the LUT.
- status_t ELCDIF_UpdateLut (LCDIF_Type *base, elcdif_lut_t lut, uint16_t startIndex, const uint32_t *lutData, uint16_t count)
  Load the LUT value.

19.3 Data Structure Documentation

19.3.1 struct elcdif_pixel_format_reg_t

These register bits control the pixel format:

- CTRL[DATA_FORMAT_24_BIT]
- CTRL[DATA_FORMAT_18_BIT]
- CTRL[DATA_FORMAT_16_BIT]
- CTRL[WORD_LENGTH]
- CTRL1[BYTE_PACKING_FORMAT]

Data Fields

- uint32_t regCtrl
  Value of register CTRL.
- uint32_t regCtrl1
  Value of register CTRL1.

Field Documentation

(1) uint32_t elcdif_pixel_format_reg_t::regCtrl

(2) uint32_t elcdif_pixel_format_reg_t::regCtrl1

19.3.2 struct elcdif_rgb_mode_config_t

Data Fields

- uint16_t panelWidth
  Display panel width, pixels per line.
- uint16_t panelHeight
  Display panel height, how many lines per panel.
- uint8_t hsw
  HSYNC pulse width.
- uint8_t hfp
  Horizontal front porch.
- uint8_t hbp
  Horizontal back porch.
- uint8_t vsw
  VSYNC pulse width.
- uint8_t vfp
  Vrtical front porch.
- uint8_t vbp
  Vertical back porch.
- uint32_t polarityFlags
  OR'ed value of _elcdif_polarity_flags, used to contol the signal polarity.
- uint32_t bufferAddr
  Frame buffer address.
- elcdif_pixel_format_t pixelFormat

Pixel format.
- elcdif_lcd_data_bus_t dataBus
  LCD data bus.

Field Documentation

(1) uint16_t elcdif_rgb_mode_config_t::panelWidth

(2) uint16_t elcdif_rgb_mode_config_t::panelHeight

(3) uint8_t elcdif_rgb_mode_config_t::hsw

(4) uint8_t elcdif_rgb_mode_config_t::hfp

(5) uint8_t elcdif_rgb_mode_config_t::hbp

(6) uint8_t elcdif_rgb_mode_config_t::vsw

(7) uint8_t elcdif_rgb_mode_config_t::vfp

(8) uint8_t elcdif_rgb_mode_config_t::vbp

(9) uint32_t elcdif_rgb_mode_config_t::polarityFlags

(10) uint32_t elcdif_rgb_mode_config_t::bufferAddr

(11) elcdif_pixel_format_t elcdif_rgb_mode_config_t::pixelFormat

(12) elcdif_lcd_data_bus_t elcdif_rgb_mode_config_t::dataBus

19.3.3 struct elcdif_as_buffer_config_t

Data Fields

- uint32_t bufferAddr
  Buffer address.
- elcdif_as_pixel_format_t pixelFormat
  Pixel format.

Field Documentation

(1) uint32_t elcdif_as_buffer_config_t::bufferAddr

(2) elcdif_as_pixel_format_t elcdif_as_buffer_config_t::pixelFormat

19.3.4 struct elcdif_as_blend_config_t

Data Fields

- uint8_t alpha
  User defined alpha value, only used when alphaMode is kELCDIF_AlphaOverride or kELCDIF_AlphaRop.
- bool invertAlpha
  Set true to invert the alpha.
- elcdif_alpha_mode_t alphaMode
  Alpha mode.
- elcdif_rop_mode_t ropMode
  ROP mode, only valid when alphaMode is kELCDIF_AlphaRop.

Field Documentation

(1) uint8_t elcdif_as_blend_config_t::alpha

(2) bool elcdif_as_blend_config_t::invertAlpha

(3) elcdif_alpha_mode_t elcdif_as_blend_config_t::alphaMode

(4) elcdif_rop_mode_t elcdif_as_blend_config_t::ropMode

19.4 Enumeration Type Documentation

19.4.1 enum _elcdif_polarity_flags

Enumerator

kELCDIF_VsyncActiveLow VSYNC active low.
kELCDIF_VsyncActiveHigh VSYNC active high.
kELCDIF_HsyncActiveLow HSYNC active low.
kELCDIF_HsyncActiveHigh HSYNC active high.
kELCDIF_DataEnableActiveLow Data enable line active low.
kELCDIF_DataEnableActiveHigh Data enable line active high.
kELCDIF_DriveDataOnFallingClkEdge Drive data on falling clock edge, capture data on rising clock edge.
kELCDIF_DriveDataOnRisingClkEdge Drive data on falling clock edge, capture data on rising clock edge.

19.4.2 enum _elcdif_interrupt_enable

Enumerator

kELCDIF_BusMasterErrorInterruptEnable Bus master error interrupt.
kELCDIF_TxFifoOverflowInterruptEnable TXFIFO overflow interrupt.

kELCDIF_TxFifoUnderflowInterruptEnable TXFIFO underflow interrupt.
kELCDIF_CurFrameDoneInterruptEnable Interrupt when hardware enters vertical blanking state.

kELCDIF_VsyncEdgeInterruptEnable Interrupt when hardware encounters VSYNC edge.

19.4.3 enum _elcdif_interrupt_flags

Enumerator

kELCDIF_BusMasterError Bus master error interrupt.
kELCDIF_TxFifoOverflow TXFIFO overflow interrupt.
kELCDIF_TxFifoUnderflow TXFIFO underflow interrupt.
kELCDIF_CurFrameDone Interrupt when hardware enters vertical blanking state.
kELCDIF_VsyncEdge Interrupt when hardware encounters VSYNC edge.

19.4.4 enum _elcdif_status_flags

Enumerator

kELCDIF_LFifoFull LFIFO full.
kELCDIF_LFifoEmpty LFIFO empty.
kELCDIF_TxFifoFull TXFIFO full.
kELCDIF_TxFifoEmpty TXFIFO empty.

19.4.5 enum elcdif_pixel_format_t

This enumerator should be defined together with the array s_pixelFormatReg. To support new pixel format, enhance this enumerator and s_pixelFormatReg.

Enumerator

kELCDIF_PixelFormatRAW8 RAW 8 bit, four data use 32 bits.
kELCDIF_PixelFormatRGB565 RGB565, two pixel use 32 bits.
kELCDIF_PixelFormatRGB666 RGB666 unpacked, one pixel uses 32 bits, high byte unused, upper 2 bits of other bytes unused.
kELCDIF_PixelFormatXRGB8888 XRGB8888 unpacked, one pixel uses 32 bits, high byte unused.

kELCDIF_PixelFormatRGB888 RGB888 packed, one pixel uses 24 bits.

19.4.6 enum elcdif_lcd_data_bus_t

Enumerator

kELCDIF_DataBus8Bit 8-bit data bus.
kELCDIF_DataBus16Bit 16-bit data bus, support RGB565.
kELCDIF_DataBus18Bit 18-bit data bus, support RGB666.
kELCDIF_DataBus24Bit 24-bit data bus, support RGB888.

19.4.7 enum elcdif_as_pixel_format_t

Enumerator

kELCDIF_AsPixelFormatARGB8888 32-bit pixels with alpha.
kELCDIF_AsPixelFormatRGB888 32-bit pixels without alpha (unpacked 24-bit format)
kELCDIF_AsPixelFormatARGB1555 16-bit pixels with alpha.
kELCDIF_AsPixelFormatARGB4444 16-bit pixels with alpha.
kELCDIF_AsPixelFormatRGB555 16-bit pixels without alpha.
kELCDIF_AsPixelFormatRGB444 16-bit pixels without alpha.
kELCDIF_AsPixelFormatRGB565 16-bit pixels without alpha.

19.4.8 enum elcdif_alpha_mode_t

Enumerator

kELCDIF_AlphaEmbedded The alpha surface pixel alpha value will be used for blend.
kELCDIF_AlphaOverride The user defined alpha value will be used for blend directly.
kELCDIF_AlphaMultiply The alpha surface pixel alpha value scaled the user defined alpha value will be used for blend, for example, pixel alpha set set to 200, user defined alpha set to 100, then the reault alpha is 200 $*$ 100 / 255.
kELCDIF_AlphaRop Raster operation.

19.4.9 enum elcdif_rop_mode_t

Explanation:

- AS: Alpha surface
- PS: Process surface
- nAS: Alpha surface NOT value
- nPS: Process surface NOT value

Enumerator

kELCDIF_RopMaskAs AS AND PS.
kELCDIF_RopMaskNotAs nAS AND PS.
kELCDIF_RopMaskAsNot AS AND nPS.
kELCDIF_RopMergeAs AS OR PS.
kELCDIF_RopMergeNotAs nAS OR PS.
kELCDIF_RopMergeAsNot AS OR nPS.
kELCDIF_RopNotCopyAs nAS.
kELCDIF_RopNot nPS.
kELCDIF_RopNotMaskAs AS NAND PS.
kELCDIF_RopNotMergeAs AS NOR PS.
kELCDIF_RopXorAs AS XOR PS.
kELCDIF_RopNotXorAs AS XNOR PS.

19.4.10 enum elcdif_lut_t

The Lookup Table (LUT) is used to expand the 8 bits pixel to 24 bits pixel before output to external displayer.

There are two 256x24 bits LUT memory in LCDIF, the LSB of frame buffer address determins which memory to use.

Enumerator

kELCDIF_Lut0 LUT 0.
kELCDIF_Lut1 LUT 1.

19.5 Function Documentation

19.5.1 void ELCDIF_RgbModeInit (LCDIF_Type ∗ *base,* const elcdif_rgb_mode_config_t ∗ *config*)

This function ungates the eLCDIF clock and configures the eLCDIF peripheral according to the configuration structure.

Parameters

base	eLCDIF peripheral base address.

config	Pointer to the configuration structure.

19.5.2 void ELCDIF_RgbModeGetDefaultConfig (elcdif_rgb_mode_config_t * *config*)

This function sets the configuration structure to default values. The default configuration is set to the following values.

```
config->panelWidth = 480U;
config->panelHeight = 272U;
config->hsw = 41;
config->hfp = 4;
config->hbp = 8;
config->vsw = 10;
config->vfp = 4;
config->vbp = 2;
config->polarityFlags = kELCDIF_VsyncActiveLow |
                        kELCDIF_HsyncActiveLow |
                        kELCDIF_DataEnableActiveLow |
                        kELCDIF_DriveDataOnFallingClkEdge;
config->bufferAddr = 0U;
config->pixelFormat = kELCDIF_PixelFormatRGB888;
config->dataBus = kELCDIF_DataBus24Bit;
```

Parameters

config	Pointer to the eLCDIF configuration structure.

19.5.3 void ELCDIF_Deinit (LCDIF_Type * *base*)

Parameters

base	eLCDIF peripheral base address.

19.5.4 void ELCDIF_RgbModeSetPixelFormat (LCDIF_Type * *base*, elcdif_pixel_format_t *pixelFormat*)

Parameters

base	eLCDIF peripheral base address.
pixelFormat	The pixel format.

19.5.5 static void ELCDIF_RgbModeStart (LCDIF_Type * *base*) [inline], [static]

Parameters

base	eLCDIF peripheral base address.

19.5.6 void ELCDIF_RgbModeStop (LCDIF_Type * *base*)

Parameters

base	eLCDIF peripheral base address.

19.5.7 static void ELCDIF_SetNextBufferAddr (LCDIF_Type * *base*, uint32_t *bufferAddr*) [inline], [static]

Parameters

base	eLCDIF peripheral base address.
bufferAddr	The frame buffer address to set.

19.5.8 void ELCDIF_Reset (LCDIF_Type * *base*)

Parameters

base	eLCDIF peripheral base address.

19.5.9 static uint32_t ELCDIF_GetCrcValue (LCDIF_Type * *base*) [inline], [static]

When a frame is sent complete (the interrupt kELCDIF_CurFrameDone assert), this function can be used to get the CRC value of the frame sent.

Parameters

base	eLCDIF peripheral base address.

Returns

The CRC value.

Note

The CRC value is dependent on the LCD_DATABUS_WIDTH.

19.5.10 static uint32_t ELCDIF_GetBusMasterErrorAddr (LCDIF_Type * *base*) [inline], [static]

When bus master error occurs (the interrupt kELCDIF_BusMasterError assert), this function can get the virtual address at which the AXI master received an error response from the slave.

Parameters

base	eLCDIF peripheral base address.

Returns

The error virtual address.

19.5.11 static uint32_t ELCDIF_GetStatus (LCDIF_Type * *base*) [inline], [static]

The status flags are returned as a mask value, application could check the corresponding bit. Example:

```
uint32_t statusFlags;
statusFlags = ELCDIF_GetStatus(LCDIF);

if (kELCDIF_LFifoFull & statusFlags)
{
}

if (kELCDIF_TxFifoEmpty & statusFlags)
{
}
```

Parameters

base	eLCDIF peripheral base address.

Returns

The mask value of status flags, it is OR'ed value of _elcdif_status_flags.

19.5.12 static uint32_t ELCDIF_GetLFifoCount (LCDIF_Type * *base*) [inline], [static]

Parameters

base	eLCDIF peripheral base address.

Returns

The LFIFO current count

19.5.13 static void ELCDIF_EnableInterrupts (LCDIF_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	eLCDIF peripheral base address.
mask	interrupt source, OR'ed value of _elcdif_interrupt_enable.

19.5.14 static void ELCDIF_DisableInterrupts (LCDIF_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	eLCDIF peripheral base address.

mask	interrupt source, OR'ed value of _elcdif_interrupt_enable.

19.5.15 static uint32_t ELCDIF_GetInterruptStatus (LCDIF_Type * *base*) [inline], [static]

Parameters

base	eLCDIF peripheral base address.

Returns

Interrupt pending status, OR'ed value of _elcdif_interrupt_flags.

19.5.16 static void ELCDIF_ClearInterruptStatus (LCDIF_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	eLCDIF peripheral base address.
mask	of the flags to clear, OR'ed value of _elcdif_interrupt_flags.

19.5.17 static void ELCDIF_EnableLut (LCDIF_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	eLCDIF peripheral base address.
enable	True to enable, false to disable.

19.5.18 status_t ELCDIF_UpdateLut (LCDIF_Type * *base,* elcdif_lut_t *lut,* uint16_t *startIndex,* const uint32_t * *lutData,* uint16_t *count*)

This function loads the LUT value to the specific LUT memory, user can specify the start entry index.

Parameters

base	eLCDIF peripheral base address.
lut	Which LUT to load.
startIndex	The start index of the LUT entry to update.
lutData	The LUT data to load.
count	Count of `lutData`.

Return values

kStatus_Success	Initialization success.
kStatus_InvalidArgument	Wrong argument.

Chapter 20
ENC: Quadrature Encoder/Decoder

20.1 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.

20.2 Function groups

20.2.1 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.

20.2.2 Status

This function group get/clear the ENC status.

20.2.3 Interrupts

This function group enable/disable the ENC interrupts.

20.2.4 Value Operation

This function group get the counter/hold value of positions.

20.3 Typical use case

20.3.1 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_PositionCompareInerruptEnable = (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)

Get the current position counter's value.
- uint32_t ENC_GetHoldPositionValue (ENC_Type *base)
  Get the hold position counter's value.
- static uint16_t ENC_GetPositionDifferenceValue (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.

20.4 Data Structure Documentation

20.4.1 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.

20.4.2 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.

20.5 Enumeration Type Documentation

20.5.1 enum _enc_interrupt_enable

Enumerator

kENC_HOMETransitionInterruptEnable HOME interrupt enable.
kENC_INDEXPulseInterruptEnable INDEX pulse interrupt enable.
kENC_WatchdogTimeoutInterruptEnable Watchdog timeout interrupt enable.
kENC_PositionCompareInerruptEnable Position compare interrupt enable.
kENC_PositionRollOverInterruptEnable Roll-over interrupt enable.
kENC_PositionRollUnderInterruptEnable Roll-under interrupt enable.

20.5.2 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.

20.5.3 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.

20.5.4 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.

20.5.5 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.

20.5.6 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.

20.5.7 enum enc_position_match_mode_t

Enumerator

kENC_POSMATCHOnPositionCounterEqualToComapreValue 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.

20.5.8 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.

20.5.9 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.

20.6 Function Documentation

20.6.1 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

base	ENC peripheral base address.
config	Pointer to configuration structure. See to "enc_config_t".

20.6.2 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

base	ENC peripheral base address.

20.6.3 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                  = 0xFFFFFFFFU;
*   config->revolutionCountCondition              =
      kENC_RevolutionCountOnINDEXPulse;
*   config->enableModuloCountMode                 = false;
*   config->positionModulusValue                  = 0U;
*   config->positionInitialValue                  = 0U;
*   config->prescalerValue                        = kENC_ClockDiv1;
*   config->enablePeriodMeasurementFunction       = true;
*
```

Parameters

config	Pointer to a variable of configuration structure. See to "enc_config_t".

20.6.4 void ENC_DoSoftwareLoadInitialPositionValue (ENC_Type * *base*)

This function is to transfer the initial position value (UINIT and LINIT) contents to position counter (UPOS and LPOS), so that to provide the consistent operation the position counter registers.

Parameters

base	ENC peripheral base address.

20.6.5 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

base	ENC peripheral base address.
config	Pointer to configuration structure. See to "enc_self_test_config_t". Pass "NULL" to disable.

20.6.6 void ENC_EnableWatchdog (ENC_Type * *base,* bool *enable*)

Parameters

base	ENC peripheral base address
enable	Enables or disables the watchdog

20.6.7 void ENC_SetInitialPositionValue (ENC_Type * *base,* uint32_t *value*)

Parameters

base	ENC peripheral base address
value	Positive initial value

20.6.8 uint32_t ENC_GetStatusFlags (ENC_Type * *base*)

Parameters

base	ENC peripheral base address.

Returns

Mask value of status flags. For available mask, see to "_enc_status_flags".

20.6.9 void ENC_ClearStatusFlags (ENC_Type * *base,* uint32_t *mask*)

Parameters

base	ENC peripheral base address.
mask	Mask value of status flags to be cleared. For available mask, see to "_enc_status_-flags".

20.6.10 static uint16_t ENC_GetSignalStatusFlags (ENC_Type * *base*) `[inline], [static]`

Parameters

base	ENC peripheral base address.

Returns

Mask value of signals' real-time status. For available mask, see to "_enc_signal_status_flags"

20.6.11 void ENC_EnableInterrupts (ENC_Type * *base,* uint32_t *mask*)

Parameters

base	ENC peripheral base address.
mask	Mask value of interrupts to be enabled. For available mask, see to "_enc_interrupt_-enable".

20.6.12 void ENC_DisableInterrupts (ENC_Type * *base,* uint32_t *mask*)

Parameters

base	ENC peripheral base address.
mask	Mask value of interrupts to be disabled. For available mask, see to "_enc_interrupt_-enable".

20.6.13 uint32_t ENC_GetEnabledInterrupts (ENC_Type * *base*)

Parameters

base	ENC peripheral base address.

Returns

Mask value of enabled interrupts.

20.6.14 uint32_t ENC_GetPositionValue (ENC_Type * *base*)

Parameters

base	ENC peripheral base address.

Returns

Current position counter's value.

20.6.15 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

base	ENC peripheral base address.

Returns

Hold position counter's value.

20.6.16 static uint16_t ENC_GetPositionDifferenceValue (ENC_Type * *base*) [inline], [static]

Parameters

base	ENC peripheral base address.

Returns

The position difference counter's value.

20.6.17 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

base	ENC peripheral base address.

Returns

Hold position difference counter's value.

20.6.18 static uint16_t ENC_GetRevolutionValue (ENC_Type * *base*) [inline], [static]

Parameters

base	ENC peripheral base address.

Returns

The position revolution counter's value.

20.6.19 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

base	ENC peripheral base address.

Returns

Hold position revolution counter's value.

Chapter 21
ENET: Ethernet MAC Driver

21.1 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}

21.2 Operations of Ethernet MAC Driver

21.2.1 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.

21.2.2 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.

21.2.3 Other Baisc 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.

21.2.4 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.

21.2.5 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.

21.3 Typical use case

21.3.1 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, 3))
  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_LENVLIOLATE_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_SOFTOWENER1_MASK 0x4000U
  Software owner one mask.
- #define ENET_BUFFDESCRIPTOR_TX_WRAP_MASK 0x2000U
  Wrap buffer descriptor mask.
- #define ENET_BUFFDESCRIPTOR_TX_SOFTOWENER2_MASK 0x1000U
  Software owner two mask.
- #define ENET_BUFFDESCRIPTOR_TX_LAST_MASK 0x0800U
  Last BD of the frame mask.
- #define ENET_BUFFDESCRIPTOR_TX_TRANMITCRC_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_Tx-BufferInterrupt)
  Enet Tx interrupt flag.
- #define ENET_RX_INTERRUPT ((uint32_t)kENET_RxFrameInterrupt | (uint32_t)kENET_Rx-BufferInterrupt)
  Enet Rx interrupt flag.
- #define ENET_TS_INTERRUPT ((uint32_t)kENET_TsTimerInterrupt | (uint32_t)kENET_Ts-AvailInterrupt)
  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 *eErrorStatic, 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 isEnable, 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.

21.4 Data Structure Documentation

21.4.1 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

21.4.2 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

21.4.3 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

21.4.4 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

21.4.5 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

21.4.6 struct enet_frame_info_t

Data Fields

- void * context
  User specified data.

21.4.7 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

21.4.8 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

21.4.9 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]

21.4.10 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 if 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 decrese 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_rx_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 coalsecence 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

21.4.11 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

21.4.12 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

21.4.13 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

21.5 Macro Definition Documentation

21.5.1 #define FSL_ENET_DRIVER_VERSION (MAKE_VERSION(2, 5, 3))

21.5.2 #define ENET_BUFFDESCRIPTOR_RX_EMPTY_MASK 0x8000U

21.5.3 #define ENET_BUFFDESCRIPTOR_RX_SOFTOWNER1_MASK 0x4000U

21.5.4 #define ENET_BUFFDESCRIPTOR_RX_WRAP_MASK 0x2000U

21.5.5 #define ENET_BUFFDESCRIPTOR_RX_SOFTOWNER2_Mask 0x1000U

21.5.6 #define ENET_BUFFDESCRIPTOR_RX_LAST_MASK 0x0800U

21.5.7 #define ENET_BUFFDESCRIPTOR_RX_MISS_MASK 0x0100U

21.5.8 #define ENET_BUFFDESCRIPTOR_RX_BROADCAST_MASK 0x0080U

21.5.9 #define ENET_BUFFDESCRIPTOR_RX_MULTICAST_MASK 0x0040U

21.5.10 #define ENET_BUFFDESCRIPTOR_RX_LENVLIOLATE_MASK 0x0020U

21.5.11 #define ENET_BUFFDESCRIPTOR_RX_NOOCTET_MASK 0x0010U

21.5.12 #define ENET_BUFFDESCRIPTOR_RX_CRC_MASK 0x0004U

21.5.13 #define ENET_BUFFDESCRIPTOR_RX_OVERRUN_MASK 0x0002U

21.5.14 #define ENET_BUFFDESCRIPTOR_RX_TRUNC_MASK 0x0001U

21.5.15 #define ENET_BUFFDESCRIPTOR_TX_READY_MASK 0x8000U

21.5.16 #define ENET_BUFFDESCRIPTOR_TX_SOFTOWENER1_MASK 0x4000U

21.5.17 #define ENET_BUFFDESCRIPTOR_TX_WRAP_MASK 0x2000U

21.5.18 #define ENET_BUFFDESCRIPTOR_TX_SOFTOWENER2_MASK 0x1000U

21.5.19 #define ENET_BUFFDESCRIPTOR_TX_LAST_MASK 0x0800U

21.5.20 #define ENET_BUFFDESCRIPTOR_TX_TRANMITCRC_MASK 0x0400U

21.5.21 #define ENET_BUFFDESCRIPTOR_RX_ERR_MASK

Value:

```
(ENET_BUFFDESCRIPTOR_RX_TRUNC_MASK |
      ENET_BUFFDESCRIPTOR_RX_OVERRUN_MASK | \
     ENET_BUFFDESCRIPTOR_RX_LENVLIOLATE_MASK |
      ENET_BUFFDESCRIPTOR_RX_NOOCTET_MASK |
      ENET_BUFFDESCRIPTOR_RX_CRC_MASK)
```

21.5.22 #define ENET_FRAME_MAX_FRAMELEN 1518U

21.5.23 #define ENET_FRAME_VLAN_TAGLEN 4U

21.5.24 #define ENET_FRAME_CRC_LEN 4U

21.5.25 #define ENET_FIFO_MIN_RX_FULL 5U

21.5.26 #define ENET_RX_MIN_BUFFERSIZE 256U

21.5.27 #define ENET_PHY_MAXADDRESS (ENET_MMFR_PA_MASK >> ENET_MMFR_PA_SHIFT)

21.5.28 #define ENET_TX_INTERRUPT ((uint32_t)kENET_TxFrameInterrupt | (uint32_t)kENET_TxBufferInterrupt)

21.5.29 #define ENET_RX_INTERRUPT ((uint32_t)kENET_RxFrameInterrupt | (uint32_t)kENET_RxBufferInterrupt)

21.5.30 #define ENET_TS_INTERRUPT ((uint32_t)kENET_TsTimerInterrupt | (uint32_t)kENET_TsAvailInterrupt)

21.5.31 #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)
```

21.6 Typedef Documentation

21.6.1 typedef void*(* enet_rx_alloc_callback_t)(ENET_Type *base, void *userData, uint8_t ringId)

21.6.2 typedef void(* enet_rx_free_callback_t)(ENET_Type *base, void *buffer, void *userData, uint8_t ringId)

21.6.3 typedef void(* enet_callback_t)(ENET_Type *base, enet_handle_t *handle,enet_event_t event, enet_frame_info_t *frameInfo, void *userData)

21.6.4 typedef void(* enet_isr_t)(ENET_Type *base, enet_handle_t *handle)

21.7 Enumeration Type Documentation

21.7.1 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.

21.7.2 enum enet_mii_mode_t

Enumerator

kENET_MiiMode MII mode for data interface.
kENET_RmiiMode RMII mode for data interface.

21.7.3 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.

21.7.4 enum enet_mii_duplex_t

Enumerator

kENET_MiiHalfDuplex Half duplex mode.
kENET_MiiFullDuplex Full duplex mode.

21.7.5 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.

21.7.6 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.

21.7.7 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.

21.7.8 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).

21.7.9 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.

21.7.10 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.

21.7.11 enum enet_tx_accelerator_t

Enumerator

kENET_TxAccelIsShift16Enabled Transmit FIFO shift-16.
kENET_TxAccelIpCheckEnabled Insert IP header checksum.
kENET_TxAccelProtoCheckEnabled Insert protocol checksum.

21.7.12 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.

21.8 Function Documentation

21.8.1 uint32_t ENET_GetInstance (ENET_Type ∗ *base*)

Parameters

base	ENET peripheral base address.

Returns

ENET instance.

21.8.2 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

config	The ENET mac controller configuration structure pointer.

21.8.3 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

base	ENET peripheral base address.
handle	ENET handler pointer.
config	ENET mac configuration structure pointer. The "enet_config_t" type mac configuration return from ENET_GetDefaultConfig can be used directly. It is also possible to verify the Mac configuration using other methods.
bufferConfig	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.
macAddr	ENET mac address of Ethernet device. This MAC address should be provided.
srcClock_Hz	The internal module clock source for MII clock.

Return values

kStatus_Success	Succeed to initialize the ethernet driver.
kStatus_ENET_Init-MemoryFail	Init fails since buffer memory is not enough.

21.8.4 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

base	ENET peripheral base address.
handle	ENET handler pointer.
config	ENET mac configuration structure pointer. The "enet_config_t" type mac configuration return from ENET_GetDefaultConfig can be used directly. It is also possible to verify the Mac configuration using other methods.
bufferConfig	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.
macAddr	ENET mac address of Ethernet device. This MAC address should be provided.
srcClock_Hz	The internal module clock source for MII clock.

Return values

kStatus_Success	Succeed to initialize the ethernet driver.
kStatus_ENET_Init-MemoryFail	Init fails since buffer memory is not enough.

21.8.5 void ENET_Down (ENET_Type ∗ *base*)

This function disables the ENET module.

Parameters

base	ENET peripheral base address.

21.8.6 void ENET_Deinit (ENET_Type ∗ *base*)

This function gates the module clock, clears ENET interrupts, and disables the ENET module.

Parameters

base	ENET peripheral base address.

21.8.7 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

base	ENET peripheral base address.

21.8.8 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

base	ENET peripheral base address.
speed	The speed of the RMII mode.
duplex	The duplex of the RMII mode.

21.8.9 void ENET_SetSMI (ENET_Type * *base*, uint32_t *srcClock_Hz*, bool *isPreambleDisabled*)

Parameters

base	ENET peripheral base address.
srcClock_Hz	This is the ENET module clock frequency. See clock distribution.
isPreamble-Disabled	The preamble disable flag. • true Enables the preamble. • false Disables the preamble.

21.8.10 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

base	ENET peripheral base address.

Returns

The SMI setup status true or false.

21.8.11 static uint32_t ENET_ReadSMIData (ENET_Type ∗ *base*) [inline], [static]

Parameters

base	ENET peripheral base address.

Returns

The data read from PHY

21.8.12 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

base	ENET peripheral base address.
phyAddr	The PHY address.
phyReg	The PHY register. Range from 0 ∼ 31.
operation	The read operation.

21.8.13 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

base	ENET peripheral base address.
phyAddr	The PHY address.
phyReg	The PHY register. Range from 0 ∼ 31.
operation	The write operation.
data	The data written to PHY.

21.8.14 void ENET_StartExtC45SMIWriteReg (ENET_Type ∗ *base,* uint32_t *phyAddr,* uint32_t *phyReg*)

Parameters

base	ENET peripheral base address.
phyAddr	The PHY address.
phyReg	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.

21.8.15 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 precedure 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

base	ENET peripheral base address.
phyAddr	The PHY address.
phyReg	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.
data	The data written to PHY.

21.8.16 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 precedure 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

base	ENET peripheral base address.
phyAddr	The PHY address.
phyReg	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.

21.8.17 void ENET_SetMacAddr (ENET_Type * *base,* uint8_t * *macAddr*)

Parameters

base	ENET peripheral base address.
macAddr	The six-byte Mac address pointer. The pointer is allocated by application and input into the API.

21.8.18 void ENET_GetMacAddr (ENET_Type * *base*, uint8_t * *macAddr*)

Parameters

base	ENET peripheral base address.
macAddr	The six-byte Mac address pointer. The pointer is allocated by application and input into the API.

21.8.19 void ENET_AddMulticastGroup (ENET_Type * *base*, uint8_t * *address*)

Parameters

base	ENET peripheral base address.
address	The six-byte multicast group address which is provided by application.

21.8.20 void ENET_LeaveMulticastGroup (ENET_Type * *base*, uint8_t * *address*)

Parameters

base	ENET peripheral base address.
address	The six-byte multicast group address which is provided by application.

21.8.21 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

base	ENET peripheral base address.

21.8.22 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

base	ENET peripheral base address.
enable	True enable sleep mode, false disable sleep mode.

21.8.23 static void ENET_GetAccelFunction (ENET_Type * *base*, uint32_t * *txAccelOption*, uint32_t * *rxAccelOption*) [inline], [static]

Parameters

base	ENET peripheral base address.
txAccelOption	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.
rxAccelOption	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.

21.8.24 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

base	ENET peripheral base address.
mask	ENET interrupts to enable. This is a logical OR of the enumeration enet_interrupt_-enable_t.

21.8.25 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

base	ENET peripheral base address.
mask	ENET interrupts to disable. This is a logical OR of the enumeration enet_interrupt_-enable_t.

21.8.26 static uint32_t ENET_GetInterruptStatus (ENET_Type * *base*) [inline], [static]

Parameters

base	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.

21.8.27 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

base	ENET peripheral base address.
mask	ENET interrupt source to be cleared. This is the logical OR of members of the enumeration enet_interrupt_enable_t.

21.8.28 void ENET_SetRxISRHandler (ENET_Type * *base*, enet_isr_t *ISRHandler*)

Parameters

base	ENET peripheral base address.
ISRHandler	The handler to install.

21.8.29 void ENET_SetTxISRHandler (ENET_Type * *base*, enet_isr_t *ISRHandler*)

Parameters

base	ENET peripheral base address.
ISRHandler	The handler to install.

21.8.30 void ENET_SetErrISRHandler (ENET_Type * *base*, enet_isr_t *ISRHandler*)

Parameters

base	ENET peripheral base address.
ISRHandler	The handler to install.

21.8.31 void ENET_SetCallback (enet_handle_t * *handle*, enet_callback_t *callback*, void * *userData*)

Deprecated Do not use this function. It has been superceded 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

handle	ENET handler pointer. Should be provided by application.
callback	The ENET callback function.
userData	The callback function parameter.

21.8.32 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

handle	The ENET handler structure pointer. This is the same handler pointer used in the ENET_Init.
eErrorStatic	The error statistics structure pointer.
ringId	The ring index, range from 0 ~ (FSL_FEATURE_ENET_INSTANCE_QUEUEn(x) - 1).

21.8.33 void ENET_GetStatistics (ENET_Type * *base*, enet_transfer_stats_t * *statistics*)

Parameters

base	ENET peripheral base address.
statistics	The statistics structure pointer.

21.8.34 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

handle	The ENET handler structure. This is the same handler pointer used in the ENET_Init.
length	The length of the valid frame received.
ringId	The ring index or ring number.

Return values

kStatus_ENET_RxFrame-Empty	No frame received. Should not call ENET_ReadFrame to read frame.
kStatus_ENET_RxFrame-Error	Data error happens. ENET_ReadFrame should be called with NULL data and NULL length to update the receive buffers.
kStatus_Success	Receive a frame Successfully then the ENET_ReadFrame should be called with the right data buffer and the captured data length input.

21.8.35 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

base	ENET peripheral base address.
handle	The ENET handler structure. This is the same handler pointer used in the ENET_Init.
data	The data buffer provided by user to store the frame which memory size should be at least "length".
length	The size of the data buffer which is still the length of the received frame.
ringId	The ring index or ring number.
ts	The timestamp address to store received timestamp.

Returns

The execute status, successful or failure.

21.8.36 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 A-PI 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

base	ENET peripheral base address.
handle	The ENET handler pointer. This is the same handler pointer used in the ENET_Init.
data	The data buffer provided by user to send.
length	The length of the data to send.
ringId	The ring index or ring number.
tsFlag	Timestamp enable flag.
context	Used by user to handle some events after transmit over.

Return values

kStatus_Success	Send frame succeed.
kStatus_ENET_TxFrame-Busy	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.

21.8.37 status_t ENET_SetTxReclaim (enet_handle_t ∗ *handle*, bool *isEnable*, 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

handle	The ENET handler pointer. This is the same handler pointer used in the ENET_Init.
isEnable	Enable or disable flag.
ringId	The ring index or ring number.

Return values

kStatus_Success	Succeed to enable/disable Tx reclaim.
kStatus_Fail	Fail to enable/disable Tx reclaim.

21.8.38 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 interupt IRQ handler after the complete of a frame transmission.

Parameters

base	ENET peripheral base address.
handle	The ENET handler pointer. This is the same handler pointer used in the ENET_Init.
ringId	The ring index or ring number.

21.8.39 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

base	ENET peripheral base address.
handle	The ENET handler structure. This is the same handler pointer used in the ENET_Init.
buffer	The data buffer pointer to store the frame.
length	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.

ringId	The ring index, range from 0 ∼ (FSL_FEATURE_ENET_INSTANCE_QUEUEn(x) - 1).
isLastBuff	The flag represents whether this buffer is the last buffer to store frame.
ts	The 1588 timestamp value, vaild in last buffer.

Return values

kStatus_Success	Get receive buffer succeed.
kStatus_ENET_RxFrameFail	Get receive buffer fails, it's owned by application, should wait app to release this buffer.

21.8.40 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

base	ENET peripheral base address.
handle	The ENET handler structure. This is the same handler pointer used in the ENET_Init.
buffer	The buffer address to store frame, using it to find the correspond BD and release it.
ringId	The ring index, range from 0 ∼ (FSL_FEATURE_ENET_INSTANCE_QUEUEn(x) - 1).

21.8.41 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

base	ENET peripheral base address.
handle	The ENET handler pointer. This is the same handler pointer used in the ENET_Init.
rxFrame	The received frame information structure provided by user.
ringId	The ring index or ring number.

Return values

kStatus_Success	Succeed to get one frame and allocate new memory for Rx buffer.
kStatus_ENET_RxFrame-Empty	There's no Rx frame in the BD.
kStatus_ENET_RxFrame-Error	There's issue in this receiving.
kStatus_ENET_RxFrame-Drop	There's no new buffer memory for BD, drop this frame.

21.8.42 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

base	ENET peripheral base address.
handle	The ENET handler pointer. This is the same handler pointer used in the ENET_Init.
txFrame	The Tx frame structure.
ringId	The ring index or ring number.

Return values

kStatus_Success	Succeed to send one frame.
kStatus_ENET_TxFrame-Busy	The BD is not ready for Tx or the reclaim operation still not finishs.
kStatus_ENET_TxFrame-OverLen	The Tx frame length is over max ethernet frame length.

21.8.43 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

base	ENET peripheral base address.
handle	The ENET handler pointer. This is the same handler pointer used in the ENET_Init.
data	The data buffer provided by user to send.
length	The length of the data to send.

ringId	The ring index or ring number.
tsFlag	Timestamp enable flag.
context	Used by user to handle some events after transmit over.

Return values

kStatus_Success	Send frame succeed.
kStatus_ENET_TxFrameBusy	Transmit buffer descriptor is busy under transmission. The transmit busy happens when the data send rate is over the MAC capacity. The waiting mechanism is recommended to be added after each call return with kStatus_ENET_TxFrameBusy.

21.8.44 void ENET_TransmitIRQHandler (ENET_Type * *base,* enet_handle_t * *handle*)

Parameters

base	ENET peripheral base address.
handle	The ENET handler pointer.

21.8.45 void ENET_ReceiveIRQHandler (ENET_Type * *base,* enet_handle_t * *handle*)

Parameters

base	ENET peripheral base address.
handle	The ENET handler pointer.

21.8.46 void ENET_ErrorIRQHandler (ENET_Type * *base,* enet_handle_t * *handle*)

Parameters

base	ENET peripheral base address.
handle	The ENET handler pointer.

21.8.47 void ENET_Ptp1588IRQHandler (ENET_Type * *base*)

This is used for the 1588 timer interrupt.

Parameters

base	ENET peripheral base address.

21.8.48 void ENET_CommonFrame0IRQHandler (ENET_Type * *base*)

This is used for the combined tx/rx/error interrupt for single/mutli-ring (frame 0).

Parameters

base	ENET peripheral base address.

21.9 Variable Documentation

21.9.1 const clock_ip_name_t s_enetClock[]

21.10 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 methord 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.

21.10.1 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 successfuly 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 22
EWM: External Watchdog Monitor Driver

22.1 Overview

The MCUXpresso SDK provides a peripheral driver for the External Watchdog (EWM) Driver module of MCUXpresso SDK devices.

22.2 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.

22.3 Data Structure Documentation

22.3.1 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.

22.4 Macro Definition Documentation

22.4.1 #define FSL_EWM_DRIVER_VERSION (MAKE_VERSION(2, 0, 3))

22.5 Enumeration Type Documentation

22.5.1 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].

22.5.2 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.

22.5.3 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.

22.6 Function Documentation

22.6.1 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

base	EWM peripheral base address
config	The configuration of the EWM

22.6.2 void EWM_Deinit (EWM_Type ∗ *base*)

This function is used to shut down the EWM.

Parameters

base	EWM peripheral base address

22.6.3 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

config	Pointer to the EWM configuration structure.

See Also

ewm_config_t

22.6.4 static void EWM_EnableInterrupts (EWM_Type * *base*, uint32_t *mask*) [inline], [static]

This function enables the EWM interrupt.

Parameters

base	EWM peripheral base address
mask	The interrupts to enable The parameter can be combination of the following source if defined • kEWM_InterruptEnable

22.6.5 static void EWM_DisableInterrupts (EWM_Type * *base*, uint32_t *mask*) [inline], [static]

This function enables the EWM interrupt.

Parameters

base	EWM peripheral base address
mask	The interrupts to disable The parameter can be combination of the following source if defined • kEWM_InterruptEnable

22.6.6 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

base	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.

22.6.7 void EWM_Refresh (EWM_Type * *base*)

This function resets the EWM counter to zero.

Parameters

base	EWM peripheral base address

Chapter 23
FlexCAN: Flex Controller Area Network Driver

23.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Flex Controller Area Network (FlexCAN) module of MCUXpresso SDK devices.

Modules

- FlexCAN Driver
- FlexCAN eDMA Driver

23.2 FlexCAN Driver

23.2.1 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.

23.2.2 Typical use case

23.2.2.1 Message Buffer Send Operation

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

23.2.2.2 Message Buffer Receive Operation

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

23.2.2.3 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_fd_frame_t
  CAN FD 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 DLC_LENGTH_DECODE(dlc) (((dlc) <= 8U) ? (dlc) : (((dlc) <= 12U) ? (((dlc)-6U) ∗ 4U) : (((dlc)-11U) ∗ 16U)))
  FlexCAN frame length helper macro.
- #define FLEXCAN_ID_STD(id) (((uint32_t)(((uint32_t)(id)) << CAN_ID_STD_SHIFT)) & CAN_ID_STD_MASK)
  FlexCAN Frame ID 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_mb_size_t {
  kFLEXCAN_8BperMB = 0x0U,
  kFLEXCAN_16BperMB = 0x1U,
  kFLEXCAN_32BperMB = 0x2U,

kFLEXCAN_64BperMB = 0x3U }

FlexCAN Message Buffer Payload size.

- enum _flexcan_fd_frame_length {
  kFLEXCAN_0BperFrame = 0x0U,
  kFLEXCAN_1BperFrame,
  kFLEXCAN_2BperFrame,
  kFLEXCAN_3BperFrame,
  kFLEXCAN_4BperFrame,
  kFLEXCAN_5BperFrame,
  kFLEXCAN_6BperFrame,
  kFLEXCAN_7BperFrame,
  kFLEXCAN_8BperFrame,
  kFLEXCAN_12BperFrame,
  kFLEXCAN_16BperFrame,
  kFLEXCAN_20BperFrame,
  kFLEXCAN_24Bperrame,
  kFLEXCAN_32BperFrame,
  kFLEXCAN_48BperFrame,
  kFLEXCAN_64BperFrame }

  FlexCAN CAN FD frame supporting data length (available DLC values).
- 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,
  kFLEXCAN_FDErrorInterruptEnable = CAN_CTRL2_ERRMSK_FAST_MASK }

  FlexCAN interrupt enable enumerations.
- enum _flexcan_flags {
  kFLEXCAN_ErrorOverrunFlag = CAN_ESR1_ERROVR_MASK,
  kFLEXCAN_FDErrorIntFlag = CAN_ESR1_ERRINT_FAST_MASK,
  kFLEXCAN_BusoffDoneIntFlag = CAN_ESR1_BOFFDONEINT_MASK,
  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_FDStuffingError = CAN_ESR1_STFERR_FAST_MASK,
  kFLEXCAN_FDFormError = CAN_ESR1_FRMERR_FAST_MASK,
  kFLEXCAN_FDCrcError = CAN_ESR1_CRCERR_FAST_MASK,
  kFLEXCAN_FDBit0Error = CAN_ESR1_BIT0ERR_FAST_MASK,
  kFLEXCAN_FDBit1Error = (int)CAN_ESR1_BIT1ERR_FAST_MASK,
  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, 2))
  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.
- bool FLEXCAN_FDCalculateImprovedTimingValues (CAN_Type *base, uint32_t bitRate, uint32_t bitRateFD, uint32_t sourceClock_Hz, flexcan_timing_config_t *pTimingConfig)
  Calculates the improved timing values by specific bit rates for CANFD.
- void FLEXCAN_FDInit (CAN_Type *base, const flexcan_config_t *pConfig, uint32_t sourceClock_Hz, flexcan_mb_size_t dataSize, bool brs)

Initializes a FlexCAN instance.
- 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_SetFDTimingConfig (CAN_Type *base, const flexcan_timing_config_t *pConfig)
  Sets the FlexCAN CANFD data phase 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_SetFDTxMbConfig (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_SetFDRxMbConfig (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.

DMA Control

- void FLEXCAN_EnableRxFifoDMA (CAN_Type *base, bool enable)
  Enables or disables the FlexCAN Rx FIFO DMA request.
- static uint32_t FLEXCAN_GetRxFifoHeadAddr (CAN_Type *base)
  Gets the Rx FIFO Head address.

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_WriteFDTxMb (CAN_Type *base, uint8_t mbIdx, const flexcan_fd_frame_t *pTxFrame)
  Writes a FlexCAN FD Message to the Transmit Message Buffer.
- status_t FLEXCAN_ReadFDRxMb (CAN_Type *base, uint8_t mbIdx, flexcan_fd_frame_t *pRxFrame)
  Reads a FlexCAN FD 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_TransferFDSendBlocking (CAN_Type *base, uint8_t mbIdx, flexcan_fd_frame_t *pTxFrame)
  Performs a polling send transaction on the CAN bus.
- status_t FLEXCAN_TransferFDReceiveBlocking (CAN_Type *base, uint8_t mbIdx, flexcan_fd_frame_t *pRxFrame)
  Performs a polling receive transaction on the CAN bus.
- status_t FLEXCAN_TransferFDSendNonBlocking (CAN_Type *base, flexcan_handle_t *handle, flexcan_mb_transfer_t *pMbXfer)

Sends a message using IRQ.

- status_t FLEXCAN_TransferFDReceiveNonBlocking (CAN_Type *base, flexcan_handle_t *handle, flexcan_mb_transfer_t *pMbXfer)
  Receives a message using IRQ.
- void FLEXCAN_TransferFDAbortSend (CAN_Type *base, flexcan_handle_t *handle, uint8_t mbIdx)
  Aborts the interrupt driven message send process.
- void FLEXCAN_TransferFDAbortReceive (CAN_Type *base, flexcan_handle_t *handle, uint8_t mbIdx)
  Aborts the interrupt driven message receive process.
- 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.

23.2.3 Data Structure Documentation

23.2.3.1 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

23.2.3.2 struct flexcan_fd_frame_t

The CAN FD message supporting up to sixty four bytes can be used for a data frame, depending on the length selected for the message buffers. The length should be a enumeration member, see _flexcan_fd_-frame_length.

Field Documentation

(1) uint32_t flexcan_fd_frame_t::timestamp

(2) uint32_t flexcan_fd_frame_t::length

user can use DLC_LENGTH_DECODE(length) macro to get the number of valid data bytes.

(3) uint32_t flexcan_fd_frame_t::type

(4) uint32_t flexcan_fd_frame_t::format

(5) uint32_t flexcan_fd_frame_t::srr

(6) uint32_t flexcan_fd_frame_t::__pad0__

(7) uint32_t flexcan_fd_frame_t::esi

(8) uint32_t flexcan_fd_frame_t::brs

(9) uint32_t flexcan_fd_frame_t::edl

(10) uint32_t flexcan_fd_frame_t::id

(11) uint32_t flexcan_fd_frame_t::dataWord[16]

(12) uint8_t flexcan_fd_frame_t::dataByte3

(13) uint8_t flexcan_fd_frame_t::dataByte2

(14) uint8_t flexcan_fd_frame_t::dataByte1

(15) uint8_t flexcan_fd_frame_t::dataByte0

(16) uint8_t flexcan_fd_frame_t::dataByte7

(17) uint8_t flexcan_fd_frame_t::dataByte6

(18) uint8_t flexcan_fd_frame_t::dataByte5

(19) uint8_t flexcan_fd_frame_t::dataByte4

23.2.3.3 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.
- uint16_t fpreDivider
  CAN FD data phase bit rate prescaler.
- uint8_t frJumpwidth
  CAN FD data phase Re-sync Jump Width.
- uint8_t fphaseSeg1
  CAN FD data phase Phase Segment 1.
- uint8_t fphaseSeg2
  CAN FD data phase Phase Segment 2.
- uint8_t fpropSeg
  CAN FD data phase Propagation Segment.

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

(6) uint16_t flexcan_timing_config_t::fpreDivider

(7) uint8_t flexcan_timing_config_t::frJumpwidth

(8) uint8_t flexcan_timing_config_t::fphaseSeg1

(9) uint8_t flexcan_timing_config_t::fphaseSeg2

(10) uint8_t flexcan_timing_config_t::fpropSeg

23.2.3.4 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.
- bool enableDoze

  Enable or Disable Doze Mode.
- uint32_t baudRate

  FlexCAN bit rate in bps, for classical CAN or CANFD nominal phase.
- uint32_t baudRateFD

  FlexCAN FD bit rate in bps, for CANFD data phase.
- uint32_t bitRate

  FlexCAN bit rate in bps, for classical CAN or CANFD nominal phase.
- uint32_t bitRateFD

  FlexCAN FD bit rate in bps, for CANFD data phase.

Field Documentation

(1) uint32_t flexcan_config_t::baudRate

(2) uint32_t flexcan_config_t::baudRateFD

(3) uint32_t flexcan_config_t::bitRate

(4) uint32_t flexcan_config_t::bitRateFD

(5) flexcan_clock_source_t flexcan_config_t::clkSrc

(6) flexcan_wake_up_source_t flexcan_config_t::wakeupSrc

(7) uint8_t flexcan_config_t::maxMbNum

(8) bool flexcan_config_t::enableLoopBack

(9) bool flexcan_config_t::enableTimerSync

(10) bool flexcan_config_t::enableSelfWakeup

(11) bool flexcan_config_t::enableIndividMask

(12) bool flexcan_config_t::disableSelfReception

(13) bool flexcan_config_t::enableListenOnlyMode

(14) bool flexcan_config_t::enableSupervisorMode

(15) bool flexcan_config_t::enableDoze

23.2.3.5 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

23.2.3.6 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

23.2.3.7 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

23.2.3.8 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

23.2.3.9 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_fd_frame_t *volatile mbFDFrameBuf [CAN_WORD1_COUNT]
  The buffer for received CAN FD data from Message Buffers.
- flexcan_frame_t *volatile rxFifoFrameBuf
  The buffer for received CAN data from Legacy Rx FIFO.
- 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_fd_frame_t∗ volatile flexcan_handle_t::mbFDFrameBuf[CAN_WORD1_COUNT]**

(5) **flexcan_frame_t∗ volatile flexcan_handle_t::rxFifoFrameBuf**

(6) **volatile uint8_t flexcan_handle_t::mbState[CAN_WORD1_COUNT]**

(7) **volatile uint8_t flexcan_handle_t::rxFifoState**

(8) **volatile uint32_t flexcan_handle_t::timestamp[CAN_WORD1_COUNT]**

23.2.4 Macro Definition Documentation

23.2.4.1 #define FSL_FLEXCAN_DRIVER_VERSION (MAKE_VERSION(2, 8, 2))

23.2.4.2 #define DLC_LENGTH_DECODE(*dlc*) (((dlc) <= 8U) ? (dlc) : (((dlc) <= 12U) ? (((dlc)-6U) ∗ 4U) : (((dlc)-11U) ∗ 16U)))

23.2.4.3 #define FLEXCAN_ID_STD(*id*) (((uint32_t)(((uint32_t)(id)) << CAN_ID_STD_SHIFT)) & CAN_ID_STD_MASK)

Standard Frame ID helper macro.

23.2.4.4 #define FLEXCAN_ID_EXT(*id*)

Value:

```
(((uint32_t)(((uint32_t)(id)) << CAN_ID_EXT_SHIFT)) & \
     (CAN_ID_EXT_MASK | CAN_ID_STD_MASK))
```

23.2.4.5 #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.

23.2.4.6 #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))
```

23.2.4.7 #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.

23.2.4.8 #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))
```

23.2.4.9 #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))
```

23.2.4.10 #define FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_HIGH(*id*) (((uint32_t)(id)&0x7F8) << 21)

23.2.4.11 #define FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_HIGH(*id*) (((uint32_t)(id)&0x7F8) << 13)

23.2.4.12 #define FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_LOW(*id*) (((uint32_t)(id)&0x7F8) << 5)

23.2.4.13 #define FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_LOW(*id*) (((uint32_t)(id)&0x7F8) >> 3)

23.2.4.14 #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))
```

23.2.4.15 #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))
```

23.2.4.16 #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))
```

23.2.4.17 #define FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_HIGH(*id*) ((FLEXCAN_ID_EXT(id) & 0x1FE00000) << 3)

23.2.4.18 #define FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_HIGH(*id*)

Value:

```
((FLEXCAN_ID_EXT(id) & 0x1FE00000) >>            \
     5)
```

23.2.4.19 #define FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_LOW(*id*)

Value:

```
((FLEXCAN_ID_EXT(id) & 0x1FE00000) >>           \
     13)
```

23.2.4.20 #define FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_LOW(*id*) ((FLEXCAN_ID_EXT(id) & 0x1FE00000) >> 21)

23.2.4.21 #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.

23.2.4.22 #define FLEXCAN_RX_FIFO_STD_FILTER_TYPE_B_HIGH(*id, rtr, ide*)

Value:

```
FLEXCAN_RX_FIFO_STD_MASK_TYPE_B_HIGH(                    \
        id, rtr, ide)
```

23.2.4.23 #define FLEXCAN_RX_FIFO_STD_FILTER_TYPE_B_LOW(*id, rtr, ide*)

Value:

```
FLEXCAN_RX_FIFO_STD_MASK_TYPE_B_LOW(                     \
        id, rtr, ide)
```

23.2.4.24 #define FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_HIGH(*id*)

Value:

```
FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_HIGH(           \
        id)
```

23.2.4.25 #define FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_MID_HIGH(*id*)

Value:

```
FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_HIGH(           \
        id)
```

23.2.4.26 #define FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_MID_LOW(*id*)

Value:

```
FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_MID_LOW(           \
        id)
```

23.2.4.27 #define FLEXCAN_RX_FIFO_STD_FILTER_TYPE_C_LOW(*id*)

Value:

```
FLEXCAN_RX_FIFO_STD_MASK_TYPE_C_LOW(           \
        id)
```

23.2.4.28 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_A(*id, rtr, ide*) FLEXCAN_RX_FIFO_EXT_MASK_TYPE_A(id, rtr, ide)

23.2.4.29 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_B_HIGH(*id, rtr, ide*)

Value:

```
FLEXCAN_RX_FIFO_EXT_MASK_TYPE_B_HIGH(                    \
        id, rtr, ide)
```

23.2.4.30 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_B_LOW(*id, rtr, ide*)

Value:

```
FLEXCAN_RX_FIFO_EXT_MASK_TYPE_B_LOW(                    \
        id, rtr, ide)
```

23.2.4.31 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_HIGH(*id*)

Value:

```
FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_HIGH(          \
        id)
```

23.2.4.32 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_MID_HIGH(*id*)

Value:

```
FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_HIGH(          \
        id)
```

23.2.4.33 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_MID_LOW(*id*)

Value:

```
FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_MID_LOW(          \
        id)
```

23.2.4.34 #define FLEXCAN_RX_FIFO_EXT_FILTER_TYPE_C_LOW(*id*) FLEXCAN_RX_FIFO_EXT_MASK_TYPE_C_LOW(id)

23.2.4.35 #define FLEXCAN_ERROR_AND_STATUS_INIT_FLAG

Value:

```
((uint32_t)kFLEXCAN_ErrorOverrunFlag | (uint32_t)
      kFLEXCAN_FDErrorIntFlag | (uint32_t)
      kFLEXCAN_BusoffDoneIntFlag | \
     (uint32_t)kFLEXCAN_TxWarningIntFlag | (uint32_t)
      kFLEXCAN_RxWarningIntFlag | (uint32_t)
      kFLEXCAN_BusOffIntFlag |   \
     (uint32_t)kFLEXCAN_ErrorIntFlag | FLEXCAN_MEMORY_ERROR_INIT_FLAG)
```

23.2.4.36 #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.

23.2.5 Enumeration Type Documentation

23.2.5.1 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.

23.2.5.2 enum flexcan_frame_format_t

Enumerator

kFLEXCAN_FrameFormatStandard Standard frame format attribute.
kFLEXCAN_FrameFormatExtend Extend frame format attribute.

23.2.5.3 enum flexcan_frame_type_t

Enumerator

kFLEXCAN_FrameTypeData Data frame type attribute.
kFLEXCAN_FrameTypeRemote Remote frame type attribute.

23.2.5.4 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.

23.2.5.5 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.

23.2.5.6 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.

23.2.5.7 enum flexcan_mb_size_t

Enumerator

kFLEXCAN_8BperMB Selects 8 bytes per Message Buffer.
kFLEXCAN_16BperMB Selects 16 bytes per Message Buffer.
kFLEXCAN_32BperMB Selects 32 bytes per Message Buffer.
kFLEXCAN_64BperMB Selects 64 bytes per Message Buffer.

23.2.5.8 enum _flexcan_fd_frame_length

For Tx, when the Data size corresponding to DLC value stored in the MB selected for transmission is larger than the MB Payload size, FlexCAN adds the necessary number of bytes with constant 0xCC pattern to complete the expected DLC. For Rx, when the Data size corresponding to DLC value received from the CAN bus is larger than the MB Payload size, the high order bytes that do not fit the Payload size will lose.

Enumerator

kFLEXCAN_0BperFrame Frame contains 0 valid data bytes.
kFLEXCAN_1BperFrame Frame contains 1 valid data bytes.
kFLEXCAN_2BperFrame Frame contains 2 valid data bytes.
kFLEXCAN_3BperFrame Frame contains 3 valid data bytes.
kFLEXCAN_4BperFrame Frame contains 4 valid data bytes.
kFLEXCAN_5BperFrame Frame contains 5 valid data bytes.
kFLEXCAN_6BperFrame Frame contains 6 valid data bytes.
kFLEXCAN_7BperFrame Frame contains 7 valid data bytes.
kFLEXCAN_8BperFrame Frame contains 8 valid data bytes.
kFLEXCAN_12BperFrame Frame contains 12 valid data bytes.
kFLEXCAN_16BperFrame Frame contains 16 valid data bytes.
kFLEXCAN_20BperFrame Frame contains 20 valid data bytes.
kFLEXCAN_24Bperrame Frame contains 24 valid data bytes.
kFLEXCAN_32BperFrame Frame contains 32 valid data bytes.
kFLEXCAN_48BperFrame Frame contains 48 valid data bytes.
kFLEXCAN_64BperFrame Frame contains 64 valid data bytes.

23.2.5.9 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.

23.2.5.10 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 22.
kFLEXCAN_FDErrorInterruptEnable CAN FD Error interrupt, use bit 31.

23.2.5.11 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_ErrorOverrunFlag Error Overrun Status.
kFLEXCAN_FDErrorIntFlag CAN FD Error Interrupt Flag.
kFLEXCAN_BusoffDoneIntFlag Bus Off process completed Interrupt Flag.
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.

23.2.5.12 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 ditermine which error is generated.

Enumerator

kFLEXCAN_FDStuffingError Stuffing Error.
kFLEXCAN_FDFormError Form Error.
kFLEXCAN_FDCrcError Cyclic Redundancy Check Error.
kFLEXCAN_FDBit0Error Unable to send dominant bit.
kFLEXCAN_FDBit1Error Unable to send recessive bit.
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.

23.2.5.13 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 $\sim$ 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.

23.2.6 Function Documentation

23.2.6.1 void FLEXCAN_EnterFreezeMode (CAN_Type * *base*)

This function makes the FlexCAN work under Freeze Mode.

Parameters

base	FlexCAN peripheral base address.

23.2.6.2 void FLEXCAN_ExitFreezeMode (CAN_Type ∗ *base*)

This function makes the FlexCAN leave Freeze Mode.

Parameters

base	FlexCAN peripheral base address.

23.2.6.3 uint32_t FLEXCAN_GetInstance (CAN_Type ∗ *base*)

Parameters

base	FlexCAN peripheral base address.

Returns

FlexCAN instance.

23.2.6.4 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

base	FlexCAN peripheral base address.
bitRate	The classical CAN speed in bps defined by user, should be less than or equal to 1-Mbps.

sourceClock_Hz	The Source clock frequency in Hz.
pTimingConfig	Pointer to the FlexCAN timing configuration structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration.

23.2.6.5 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, 40000000UL);
*
```

Parameters

base	FlexCAN peripheral base address.
pConfig	Pointer to the user-defined configuration structure.
sourceClock_Hz	FlexCAN Protocol Engine clock source frequency in Hz.

23.2.6.6 bool FLEXCAN_FDCalculateImprovedTimingValues (CAN_Type * *base*, uint32_t *bitRate*, uint32_t *bitRateFD*, uint32_t *sourceClock_Hz*, flexcan_timing_config_t * *pTimingConfig*)

This function use to calculates the CANFD timing values according to the given nominal phase bit rate and data phase bit rate. The Calculated timing values will be set in CBT/ENCBT and FDCBT/EDCBT registers. The calculation is based on the recommendation of the CiA 1301 v1.0.0 document.

Parameters

base	FlexCAN peripheral base address.
bitRate	The CANFD bus control speed in bps defined by user.
bitRateFD	The CAN FD data phase speed in bps defined by user. Equal to bitRate means disable bit rate switching.
sourceClock_-Hz	The Source clock frequency in Hz.
pTimingConfig	Pointer to the FlexCAN timing configuration structure.

Returns

TRUE if timing configuration found, FALSE if failed to find configuration

23.2.6.7 void FLEXCAN_FDInit (CAN_Type * *base*, const flexcan_config_t * *pConfig*, uint32_t *sourceClock_Hz*, flexcan_mb_size_t *dataSize*, bool *brs*)

This function initializes the FlexCAN module with user-defined settings. This example shows how to set up the flexcan_config_t parameters and how to call the FLEXCAN_FDInit function by passing in these parameters.

```
*   flexcan_config_t flexcanConfig;
*   flexcanConfig.clkSrc               = kFLEXCAN_ClkSrc0;
*   flexcanConfig.bitRate              = 1000000U;
*   flexcanConfig.bitRateFD            = 2000000U;
*   flexcanConfig.maxMbNum             = 16;
*   flexcanConfig.enableLoopBack       = false;
*   flexcanConfig.enableSelfWakeup     = false;
*   flexcanConfig.enableIndividMask    = false;
*   flexcanConfig.disableSelfReception = false;
*   flexcanConfig.enableListenOnlyMode = false;
*   flexcanConfig.enableDoze           = false;
*   flexcanConfig.timingConfig         = timingConfig;
*   FLEXCAN_FDInit(CAN0, &flexcanConfig, 80000000UL,
      kFLEXCAN_16BperMB, true);
*
```

Parameters

base	FlexCAN peripheral base address.
pConfig	Pointer to the user-defined configuration structure.

sourceClock_-Hz	FlexCAN Protocol Engine clock source frequency in Hz.
dataSize	FlexCAN Message Buffer payload size. The actual transmitted or received CAN FD frame data size needs to be less than or equal to this value.
brs	True if bit rate switch is enabled in FD mode.

23.2.6.8 void FLEXCAN_Deinit (CAN_Type ∗ *base*)

This function disables the FlexCAN module clock and sets all register values to the reset value.

Parameters

base	FlexCAN peripheral base address.

23.2.6.9 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; flexcan-Config->bitRateFD = 2000000U; flexcanConfig->maxMbNum = 16; flexcanConfig->enableLoopBack = false; flexcanConfig->enableSelfWakeup = false; flexcanConfig->enableIndividMask = false; flexcan-Config->disableSelfReception = false; flexcanConfig->enableListenOnlyMode = false; flexcanConfig-->enableDoze = false; flexcanConfig->enableMemoryErrorControl = true; flexcanConfig->enableNon-CorrectableErrorEnterFreeze = true; flexcanConfig.timingConfig = timingConfig;

Parameters

pConfig	Pointer to the FlexCAN configuration structure.

23.2.6.10 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 characteristicsthe, then call FLEXCAN_Init() and fill the bit rate field.

Note

Calling FLEXCAN_SetTimingConfig() overrides the bit rate set in FLEXCAN_Init().

Parameters

base	FlexCAN peripheral base address.
pConfig	Pointer to the timing configuration structure.

23.2.6.11 void FLEXCAN_SetFDTimingConfig (CAN_Type * *base*, const flexcan_timing_config_t * *pConfig*)

This function gives user settings to CANFD data phase timing characteristic. The function is for an experienced user. For less experienced users, call the FLEXCAN_GetDefaultConfig() and get the default timing characteristicsthe, then call FLEXCAN_FDInit() and fill the data phase bit rate field.

Note

Calling FLEXCAN_SetFDTimingConfig() overrides the bit rate set in FLEXCAN_FDInit().

Parameters

base	FlexCAN peripheral base address.
pConfig	Pointer to the timing configuration structure.

23.2.6.12 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

base	FlexCAN peripheral base address.
mask	Rx Message Buffer Global Mask value.

23.2.6.13 void FLEXCAN_SetRxFifoGlobalMask (CAN_Type * *base*, uint32_t *mask*)

This function sets the global mask for FlexCAN FIFO in a matching process.

Parameters

base	FlexCAN peripheral base address.
mask	Rx Fifo Global Mask value.

23.2.6.14 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

base	FlexCAN peripheral base address.
maskIdx	The Index of individual Mask.
mask	Rx Individual Mask value.

23.2.6.15 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

base	FlexCAN peripheral base address.
mbIdx	The Message Buffer index.
enable	Enable/disable Tx Message Buffer. • true: Enable Tx Message Buffer. • false: Disable Tx Message Buffer.

23.2.6.16 void FLEXCAN_SetFDTxMbConfig (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

base	FlexCAN peripheral base address.
mbIdx	The Message Buffer index.
enable	Enable/disable Tx Message Buffer. • true: Enable Tx Message Buffer. • false: Disable Tx Message Buffer.

23.2.6.17 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

base	FlexCAN peripheral base address.
mbIdx	The Message Buffer index.
pRxMbConfig	Pointer to the FlexCAN Message Buffer configuration structure.
enable	Enable/disable Rx Message Buffer. • true: Enable Rx Message Buffer. • false: Disable Rx Message Buffer.

23.2.6.18 void FLEXCAN_SetFDRxMbConfig (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

base	FlexCAN peripheral base address.
mbIdx	The Message Buffer index.
pRxMbConfig	Pointer to the FlexCAN Message Buffer configuration structure.
enable	Enable/disable Rx Message Buffer. • true: Enable Rx Message Buffer. • false: Disable Rx Message Buffer.

23.2.6.19 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

base	FlexCAN peripheral base address.
pRxFifoConfig	Pointer to the FlexCAN Legacy Rx FIFO configuration structure. Can be NULL when enable parameter is false.
enable	Enable/disable Legacy Rx FIFO. • true: Enable Legacy Rx FIFO. • false: Disable Legacy Rx FIFO.

23.2.6.20 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

base	FlexCAN peripheral base address.

Returns

FlexCAN status flags which are ORed by the enumerators in the _flexcan_flags.

23.2.6.21 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

base	FlexCAN peripheral base address.
mask	The status flags to be cleared, it is logical OR value of _flexcan_flags.

23.2.6.22 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

base	FlexCAN peripheral base address.
txErrBuf	Buffer to store Tx Error Counter value.
rxErrBuf	Buffer to store Rx Error Counter value.

23.2.6.23 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

base	FlexCAN peripheral base address.
mask	The ORed FlexCAN Message Buffer mask.

Returns

The status of given Message Buffers.

23.2.6.24 static void FLEXCAN_ClearMbStatusFlags (CAN_Type * *base*, uint64_t *mask*) [inline], [static]

This function clears the interrupt flags of a given Message Buffers.

Parameters

base	FlexCAN peripheral base address.
mask	The ORed FlexCAN Message Buffer mask.

23.2.6.25 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

base	FlexCAN peripheral base address.
mask	The interrupts to enable. Logical OR of _flexcan_interrupt_enable.

23.2.6.26 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

base	FlexCAN peripheral base address.
mask	The interrupts to disable. Logical OR of _flexcan_interrupt_enable.

23.2.6.27 static void FLEXCAN_EnableMbInterrupts (CAN_Type * *base*, uint64_t *mask*) [inline], [static]

This function enables the interrupts of given Message Buffers.

Parameters

base	FlexCAN peripheral base address.
mask	The ORed FlexCAN Message Buffer mask.

23.2.6.28 static void FLEXCAN_DisableMbInterrupts (CAN_Type * *base,* uint64_t *mask*) [inline], [static]

This function disables the interrupts of given Message Buffers.

Parameters

base	FlexCAN peripheral base address.
mask	The ORed FlexCAN Message Buffer mask.

23.2.6.29 void FLEXCAN_EnableRxFifoDMA (CAN_Type * *base,* bool *enable*)

This function enables or disables the DMA feature of FlexCAN build-in Rx FIFO.

Parameters

base	FlexCAN peripheral base address.
enable	true to enable, false to disable.

23.2.6.30 static uint32_t FLEXCAN_GetRxFifoHeadAddr (CAN_Type * *base*) [inline], [static]

This function returns the FlexCAN Rx FIFO Head address, which is mainly used for the DMA/eDMA use case.

Parameters

base	FlexCAN peripheral base address.

Returns

FlexCAN Rx FIFO Head address.

23.2.6.31 static void FLEXCAN_Enable (CAN_Type * *base,* bool *enable*) [inline], [static]

This function enables or disables the FlexCAN module.

Parameters

base	FlexCAN base pointer.

enable	true to enable, false to disable.

23.2.6.32 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

base	FlexCAN peripheral base address.
mbIdx	The FlexCAN Message Buffer index.
pTxFrame	Pointer to CAN message frame to be sent.

Return values

kStatus_Success	- Write Tx Message Buffer Successfully.
kStatus_Fail	- Tx Message Buffer is currently in use.

23.2.6.33 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

base	FlexCAN peripheral base address.
mbIdx	The FlexCAN Message Buffer index.
pRxFrame	Pointer to CAN message frame structure for reception.

Return values

kStatus_Success	- Rx Message Buffer is full and has been read successfully.
kStatus_FLEXCAN_RxOverflow	- Rx Message Buffer is already overflowed and has been read successfully.
kStatus_Fail	- Rx Message Buffer is empty.

23.2.6.34 status_t FLEXCAN_WriteFDTxMb (CAN_Type * *base,* uint8_t *mbIdx,* const flexcan_fd_frame_t * *pTxFrame*)

This function writes a CAN FD Message to the specified Transmit Message Buffer and changes the Message Buffer state to start CAN FD Message transmit. After that the function returns immediately.

Parameters

base	FlexCAN peripheral base address.
mbIdx	The FlexCAN FD Message Buffer index.
pTxFrame	Pointer to CAN FD message frame to be sent.

Return values

kStatus_Success	- Write Tx Message Buffer Successfully.
kStatus_Fail	- Tx Message Buffer is currently in use.

23.2.6.35 status_t FLEXCAN_ReadFDRxMb (CAN_Type * *base*, uint8_t *mbIdx*, flexcan_fd_frame_t * *pRxFrame*)

This function reads a CAN FD message from a specified Receive Message Buffer. The function fills a receive CAN FD message frame structure with just received data and activates the Message Buffer again. The function returns immediately.

Parameters

base	FlexCAN peripheral base address.
mbIdx	The FlexCAN FD Message Buffer index.
pRxFrame	Pointer to CAN FD message frame structure for reception.

Return values

kStatus_Success	- Rx Message Buffer is full and has been read successfully.
kStatus_FLEXCAN_RxOverflow	- Rx Message Buffer is already overflowed and has been read successfully.
kStatus_Fail	- Rx Message Buffer is empty.

23.2.6.36 status_t FLEXCAN_ReadRxFifo (CAN_Type * *base*, flexcan_frame_t * *pRxFrame*)

This function reads a CAN message from the FlexCAN Legacy Rx FIFO.

Parameters

base	FlexCAN peripheral base address.
pRxFrame	Pointer to CAN message frame structure for reception.

Return values

kStatus_Success	- Read Message from Rx FIFO successfully.
kStatus_Fail	- Rx FIFO is not enabled.

23.2.6.37 status_t FLEXCAN_TransferFDSendBlocking (CAN_Type * *base,* uint8_t *mbIdx,* flexcan_fd_frame_t * *pTxFrame*)

Note

A transfer handle does not need to be created before calling this API.

Parameters

base	FlexCAN peripheral base pointer.
mbIdx	The FlexCAN FD Message Buffer index.
pTxFrame	Pointer to CAN FD message frame to be sent.

Return values

kStatus_Success	- Write Tx Message Buffer Successfully.
kStatus_Fail	- Tx Message Buffer is currently in use.

23.2.6.38 status_t FLEXCAN_TransferFDReceiveBlocking (CAN_Type * *base,* uint8_t *mbIdx,* flexcan_fd_frame_t * *pRxFrame*)

Note

A transfer handle does not need to be created before calling this API.

Parameters

base	FlexCAN peripheral base pointer.
mbIdx	The FlexCAN FD Message Buffer index.
pRxFrame	Pointer to CAN FD message frame structure for reception.

Return values

kStatus_Success	- Rx Message Buffer is full and has been read successfully.
kStatus_FLEXCAN_RxOverflow	- Rx Message Buffer is already overflowed and has been read successfully.
kStatus_Fail	- Rx Message Buffer is empty.

23.2.6.39 status_t FLEXCAN_TransferFDSendNonBlocking (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

base	FlexCAN peripheral base address.
handle	FlexCAN handle pointer.
pMbXfer	FlexCAN FD Message Buffer transfer structure. See the flexcan_mb_transfer_t.

Return values

kStatus_Success	Start Tx Message Buffer sending process successfully.
kStatus_Fail	Write Tx Message Buffer failed.
kStatus_FLEXCAN_TxBusy	Tx Message Buffer is in use.

23.2.6.40 status_t FLEXCAN_TransferFDReceiveNonBlocking (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

base	FlexCAN peripheral base address.
handle	FlexCAN handle pointer.
pMbXfer	FlexCAN FD Message Buffer transfer structure. See the flexcan_mb_transfer_t.

Return values

kStatus_Success	- Start Rx Message Buffer receiving process successfully.
kStatus_FLEXCAN_RxBusy	- Rx Message Buffer is in use.

23.2.6.41 void FLEXCAN_TransferFDAbortSend (CAN_Type * *base*, flexcan_handle_t * *handle*, uint8_t *mbIdx*)

This function aborts the interrupt driven message send process.

Parameters

base	FlexCAN peripheral base address.
handle	FlexCAN handle pointer.
mbIdx	The FlexCAN FD Message Buffer index.

23.2.6.42 void FLEXCAN_TransferFDAbortReceive (CAN_Type * *base*, flexcan_handle_t * *handle*, uint8_t *mbIdx*)

This function aborts the interrupt driven message receive process.

Parameters

base	FlexCAN peripheral base address.
handle	FlexCAN handle pointer.
mbIdx	The FlexCAN FD Message Buffer index.

23.2.6.43 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

base	FlexCAN peripheral base pointer.
mbIdx	The FlexCAN Message Buffer index.
pTxFrame	Pointer to CAN message frame to be sent.

Return values

kStatus_Success	- Write Tx Message Buffer Successfully.
kStatus_Fail	- Tx Message Buffer is currently in use.

23.2.6.44 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

base	FlexCAN peripheral base pointer.
mbIdx	The FlexCAN Message Buffer index.
pRxFrame	Pointer to CAN message frame structure for reception.

Return values

kStatus_Success	- Rx Message Buffer is full and has been read successfully.
kStatus_FLEXCAN_RxOverflow	- Rx Message Buffer is already overflowed and has been read successfully.
kStatus_Fail	- Rx Message Buffer is empty.

23.2.6.45 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

base	FlexCAN peripheral base pointer.
pRxFrame	Pointer to CAN message frame structure for reception.

Return values

kStatus_Success	- Read Message from Rx FIFO successfully.
kStatus_Fail	- Rx FIFO is not enabled.

23.2.6.46 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

base	FlexCAN peripheral base address.
handle	FlexCAN handle pointer.
callback	The callback function.
userData	The parameter of the callback function.

23.2.6.47 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

base	FlexCAN peripheral base address.
handle	FlexCAN handle pointer.
pMbXfer	FlexCAN Message Buffer transfer structure. See the flexcan_mb_transfer_t.

Return values

kStatus_Success	Start Tx Message Buffer sending process successfully.
kStatus_Fail	Write Tx Message Buffer failed.
kStatus_FLEXCAN_Tx-Busy	Tx Message Buffer is in use.

23.2.6.48 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

base	FlexCAN peripheral base address.
handle	FlexCAN handle pointer.
pMbXfer	FlexCAN Message Buffer transfer structure. See the flexcan_mb_transfer_t.

Return values

kStatus_Success	- Start Rx Message Buffer receiving process successfully.
kStatus_FLEXCAN_Rx-Busy	- Rx Message Buffer is in use.

23.2.6.49 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

base	FlexCAN peripheral base address.
handle	FlexCAN handle pointer.
pFifoXfer	FlexCAN Rx FIFO transfer structure. See the flexcan_fifo_transfer_t.

Return values

kStatus_Success	- Start Rx FIFO receiving process successfully.
kStatus_FLEXCAN_RxFifoBusy	- Rx FIFO is currently in use.

23.2.6.50 uint32_t FLEXCAN_GetTimeStamp (flexcan_handle_t * *handle,* uint8_t *mbIdx*)

Then function can only be used when calling non-blocking Data transfer (TX/RX) API, After TX/RX data transfer done (User can get the status by handler's callback function), we can get the detail index of Mailbox's timestamp by handle, Detail non-blocking data transfer API (TX/RX) contain. -FLEXCAN_TransferSendNonBlocking -FLEXCAN_TransferFDSendNonBlocking -FLEXCAN_TransferReceiveNonBlocking -FLEXCAN_TransferFDReceiveNonBlocking -FLEXCAN_TransferReceiveFifoNonBlocking

Parameters

handle	FlexCAN handle pointer.
mbIdx	The FlexCAN Message Buffer index.

Return values

the	index of mailbox 's timestamp stored in the handle.

23.2.6.51 void FLEXCAN_TransferAbortSend (CAN_Type * *base,* flexcan_handle_t * *handle,* uint8_t *mbIdx*)

This function aborts the interrupt driven message send process.

Parameters

base	FlexCAN peripheral base address.
handle	FlexCAN handle pointer.
mbIdx	The FlexCAN Message Buffer index.

23.2.6.52 void FLEXCAN_TransferAbortReceive (CAN_Type * *base,* flexcan_handle_t * *handle,* uint8_t *mbIdx*)

This function aborts the interrupt driven message receive process.

Parameters

base	FlexCAN peripheral base address.
handle	FlexCAN handle pointer.
mbIdx	The FlexCAN Message Buffer index.

23.2.6.53 void FLEXCAN_TransferAbortReceiveFifo (CAN_Type * *base,* flexcan_handle_t * *handle*)

This function aborts the interrupt driven message receive from Rx FIFO process.

Parameters

base	FlexCAN peripheral base address.
handle	FlexCAN handle pointer.

23.2.6.54 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

base	FlexCAN peripheral base address.
handle	FlexCAN handle pointer.

23.3 FlexCAN eDMA Driver

23.3.1 Overview

Data Structures

- struct flexcan_edma_handle_t
  FlexCAN eDMA handle. More...

Typedefs

- typedef void(∗ flexcan_edma_transfer_callback_t)(CAN_Type ∗base, flexcan_edma_handle_t ∗handle, status_t status, void ∗userData)
  FlexCAN transfer callback function.

Driver version

- #define FSL_FLEXCAN_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 8, 1))
  FlexCAN EDMA driver version.

eDMA transactional

- void FLEXCAN_TransferCreateHandleEDMA (CAN_Type ∗base, flexcan_edma_handle_t ∗handle, flexcan_edma_transfer_callback_t callback, void ∗userData, edma_handle_t ∗rxFifoEdmaHandle)
  Initializes the FlexCAN handle, which is used in transactional functions.
- void FLEXCAN_PrepareTransfConfiguration (CAN_Type ∗base, flexcan_fifo_transfer_t ∗pFifoXfer, edma_transfer_config_t ∗pEdmaConfig)
  Prepares the eDMA transfer configuration for FLEXCAN Legacy RX FIFO.
- status_t FLEXCAN_StartTransferDatafromRxFIFO (CAN_Type ∗base, flexcan_edma_handle_t ∗handle, edma_transfer_config_t ∗pEdmaConfig)
  Start Transfer Data from the FLEXCAN Legacy Rx FIFO using eDMA.
- status_t FLEXCAN_TransferReceiveFifoEDMA (CAN_Type ∗base, flexcan_edma_handle_t ∗handle, flexcan_fifo_transfer_t ∗pFifoXfer)
  Receives the CAN Message from the Legacy Rx FIFO using eDMA.
- void FLEXCAN_TransferAbortReceiveFifoEDMA (CAN_Type ∗base, flexcan_edma_handle_t ∗handle)
  Aborts the receive Legacy/Enhanced Rx FIFO process which used eDMA.

23.3.2 Data Structure Documentation

23.3.2.1 struct _flexcan_edma_handle

Data Fields

- flexcan_edma_transfer_callback_t callback
  Callback function.
- void ∗ userData
  FlexCAN callback function parameter.
- edma_handle_t ∗ rxFifoEdmaHandle
  The EDMA handler for Rx FIFO.
- volatile uint8_t rxFifoState
  Rx FIFO transfer state.

Field Documentation

(1) flexcan_edma_transfer_callback_t flexcan_edma_handle_t::callback

(2) void∗ flexcan_edma_handle_t::userData

(3) edma_handle_t∗ flexcan_edma_handle_t::rxFifoEdmaHandle

(4) volatile uint8_t flexcan_edma_handle_t::rxFifoState

23.3.3 Macro Definition Documentation

23.3.3.1 #define FSL_FLEXCAN_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 8, 1))

23.3.4 Typedef Documentation

23.3.4.1 typedef void(∗ flexcan_edma_transfer_callback_t)(CAN_Type ∗base, flexcan_edma_handle_t ∗handle, status_t status, void ∗userData)

23.3.5 Function Documentation

23.3.5.1 void FLEXCAN_TransferCreateHandleEDMA (CAN_Type ∗ *base,* flexcan_edma_handle_t ∗ *handle,* flexcan_edma_transfer_callback_t *callback,* void ∗ *userData,* edma_handle_t ∗ *rxFifoEdmaHandle*)

Parameters

base	FlexCAN peripheral base address.

handle	Pointer to flexcan_edma_handle_t structure.
callback	The callback function.
userData	The parameter of the callback function.
rxFifoEdma-Handle	User-requested DMA handle for Rx FIFO DMA transfer.

23.3.5.2 void FLEXCAN_PrepareTransfConfiguration (CAN_Type * *base*, flexcan_fifo_transfer_t * *pFifoXfer*, edma_transfer_config_t * *pEdmaConfig*)

This function prepares the eDMA transfer configuration structure according to FLEXCAN Legacy RX FIFO.

Parameters

base	FlexCAN peripheral base address.
pFifoXfer	FlexCAN Rx FIFO EDMA transfer structure, see flexcan_fifo_transfer_t.
pEdmaConfig	The user configuration structure of type edma_transfer_t.

23.3.5.3 status_t FLEXCAN_StartTransferDatafromRxFIFO (CAN_Type * *base*, flexcan_edma_handle_t * *handle*, edma_transfer_config_t * *pEdmaConfig*)

This function to Update edma transfer confiugration and Start eDMA transfer

Parameters

base	FlexCAN peripheral base address.
handle	Pointer to flexcan_edma_handle_t structure.
pEdmaConfig	The user configuration structure of type edma_transfer_t.

Return values

kStatus_Success	if succeed, others failed.
kStatus_FLEXCAN_Rx-FifoBusy	Previous transfer ongoing.

23.3.5.4 status_t FLEXCAN_TransferReceiveFifoEDMA (CAN_Type * *base,* flexcan_edma_handle_t * *handle,* flexcan_fifo_transfer_t * *pFifoXfer*)

This function receives the CAN Message using eDMA. This is a non-blocking function, which returns right away. After the CAN Message is received, the receive callback function is called.

Parameters

base	FlexCAN peripheral base address.
handle	Pointer to flexcan_edma_handle_t structure.
pFifoXfer	FlexCAN Rx FIFO EDMA transfer structure, see flexcan_fifo_transfer_t.

Return values

kStatus_Success	if succeed, others failed.
kStatus_FLEXCAN_RxFifoBusy	Previous transfer ongoing.

23.3.5.5 void FLEXCAN_TransferAbortReceiveFifoEDMA (CAN_Type * *base*, flexcan_edma_handle_t * *handle*)

This function aborts the receive Legacy/Enhanced Rx FIFO process which used eDMA.

Parameters

base	FlexCAN peripheral base address.
handle	Pointer to flexcan_edma_handle_t structure.

Chapter 24
FlexIO: FlexIO Driver

24.1 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

24.2 FlexIO Driver

24.2.1 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_ShifterTimerPolarityOnNegitive = 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.

24.2.2 Data Structure Documentation

24.2.2.1 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

24.2.2.2 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

24.2.2.3 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

24.2.3 Macro Definition Documentation

24.2.3.1 #define FSL_FLEXIO_DRIVER_VERSION (MAKE_VERSION(2, 0, 4))

24.2.3.2 #define FLEXIO_TIMER_TRIGGER_SEL_PININPUT(*x*) ((uint32_t)(x) << 1U)

24.2.4 Typedef Documentation

24.2.4.1 typedef void(∗ flexio_isr_t)(void ∗base, void ∗handle)

24.2.5 Enumeration Type Documentation

24.2.5.1 enum flexio_timer_trigger_polarity_t

Enumerator

kFLEXIO_TimerTriggerPolarityActiveHigh Active high.
kFLEXIO_TimerTriggerPolarityActiveLow Active low.

24.2.5.2 enum flexio_timer_trigger_source_t

Enumerator

kFLEXIO_TimerTriggerSourceExternal External trigger selected.
kFLEXIO_TimerTriggerSourceInternal Internal trigger selected.

24.2.5.3 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.

24.2.5.4 enum flexio_pin_polarity_t

Enumerator

kFLEXIO_PinActiveHigh Active high.
kFLEXIO_PinActiveLow Active low.

24.2.5.5 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.

24.2.5.6 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.

24.2.5.7 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.

24.2.5.8 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.

24.2.5.9 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.

24.2.5.10 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.

24.2.5.11 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.

24.2.5.12 enum flexio_timer_start_bit_condition_t

Enumerator

kFLEXIO_TimerStartBitDisabled Start bit disabled.
kFLEXIO_TimerStartBitEnabled Start bit enabled.

24.2.5.13 enum flexio_shifter_timer_polarity_t

Enumerator

kFLEXIO_ShifterTimerPolarityOnPositive Shift on positive edge of shift clock.
kFLEXIO_ShifterTimerPolarityOnNegitive Shift on negative edge of shift clock.

24.2.5.14 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.

24.2.5.15 enum flexio_shifter_input_source_t

Enumerator

kFLEXIO_ShifterInputFromPin Shifter input from pin.
kFLEXIO_ShifterInputFromNextShifterOutput Shifter input from Shifter N+1.

24.2.5.16 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.

24.2.5.17 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.

24.2.5.18 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.

24.2.6 Function Documentation

24.2.6.1 void FLEXIO_GetDefaultConfig (flexio_config_t * *userConfig*)

The configuration can used directly to call the FLEXIO_Configure().

Example:

```
flexio_config_t config;
FLEXIO_GetDefaultConfig(&config);
```

Parameters

userConfig	pointer to flexio_config_t structure

24.2.6.2 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

base	FlexIO peripheral base address
userConfig	pointer to flexio_config_t structure

24.2.6.3 void FLEXIO_Deinit (FLEXIO_Type * *base*)

Call this API to stop the FlexIO clock.

Note

After calling this API, call the FLEXO_Init to use the FlexIO module.

Parameters

base	FlexIO peripheral base address

24.2.6.4 uint32_t FLEXIO_GetInstance (FLEXIO_Type ∗ *base*)

Parameters

base	FLEXIO peripheral base address.

24.2.6.5 void FLEXIO_Reset (FLEXIO_Type ∗ *base*)

Parameters

base	FlexIO peripheral base address

24.2.6.6 static void FLEXIO_Enable (FLEXIO_Type ∗ *base,* bool *enable*) `[inline], [static]`

Parameters

base	FlexIO peripheral base address
enable	true to enable, false to disable.

24.2.6.7 static uint32_t FLEXIO_ReadPinInput (FLEXIO_Type ∗ *base*) `[inline], [static]`

Parameters

base	FlexIO peripheral base address

Returns

FlexIO pin input data

24.2.6.8 static uint8_t FLEXIO_GetShifterState (FLEXIO_Type ∗ *base*) `[inline], [static]`

Parameters

base	FlexIO peripheral base address

Returns

current State pointer

24.2.6.9 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

base	FlexIO peripheral base address
index	Shifter index
shifterConfig	Pointer to flexio_shifter_config_t structure

24.2.6.10 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

base	FlexIO peripheral base address
index	Timer index
timerConfig	Pointer to the flexio_timer_config_t structure

24.2.6.11 static void FLEXIO_EnableShifterStatusInterrupts (FLEXIO_Type * *base*, uint32_t *mask*) [inline], [static]

The interrupt generates when the corresponding SSF is set.

Parameters

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

Note

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

24.2.6.12 static void FLEXIO_DisableShifterStatusInterrupts (FLEXIO_Type * *base*, uint32_t *mask*) [inline], [static]

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

Parameters

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

Note

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

24.2.6.13 static void FLEXIO_EnableShifterErrorInterrupts (FLEXIO_Type * *base*, uint32_t *mask*) [inline], [static]

The interrupt generates when the corresponding SEF is set.

Parameters

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

Note

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

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

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

Parameters

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

Note

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

24.2.6.15 static void FLEXIO_EnableTimerStatusInterrupts (FLEXIO_Type * *base,* uint32_t *mask*) [inline], [static]

The interrupt generates when the corresponding SSF is set.

Parameters

base	FlexIO peripheral base address
mask	The timer status mask which can be calculated by (1 << timer index)

Note

For multiple timer status interrupt enable, for example, two timer status enable, can calculate the mask by using ((1 << timer index0) | (1 << timer index1))

24.2.6.16 static void FLEXIO_DisableTimerStatusInterrupts (FLEXIO_Type * *base,* uint32_t *mask*) [inline], [static]

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

Parameters

base	FlexIO peripheral base address
mask	The timer status mask which can be calculated by (1 << timer index)

Note

For multiple timer status interrupt enable, for example, two timer status enable, can calculate the mask by using ((1 << timer index0) | (1 << timer index1))

24.2.6.17 static uint32_t FLEXIO_GetShifterStatusFlags (FLEXIO_Type * *base*) [inline], [static]

Parameters

base	FlexIO peripheral base address

Returns

Shifter status flags

24.2.6.18 static void FLEXIO_ClearShifterStatusFlags (FLEXIO_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

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

Note

For clearing multiple shifter status flags, for example, two shifter status flags, can calculate the mask by using ((1 << shifter index0) | (1 << shifter index1))

24.2.6.19 static uint32_t FLEXIO_GetShifterErrorFlags (FLEXIO_Type * *base*) [inline], [static]

Parameters

base	FlexIO peripheral base address

Returns

Shifter error flags

24.2.6.20 static void FLEXIO_ClearShifterErrorFlags (FLEXIO_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

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

Note

For clearing multiple shifter error flags, for example, two shifter error flags, can calculate the mask by using ((1 << shifter index0) | (1 << shifter index1))

24.2.6.21 static uint32_t FLEXIO_GetTimerStatusFlags (FLEXIO_Type * *base*) [inline], [static]

Parameters

base	FlexIO peripheral base address

Returns

Timer status flags

24.2.6.22 static void FLEXIO_ClearTimerStatusFlags (FLEXIO_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	FlexIO peripheral base address
mask	The timer status mask which can be calculated by (1 << timer index)

Note

For clearing multiple timer status flags, for example, two timer status flags, can calculate the mask by using ((1 << timer index0) | (1 << timer index1))

24.2.6.23 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 << shifter index0) | (1 << shifter index1))

Parameters

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

enable	True to enable, false to disable.

24.2.6.24 uint32_t FLEXIO_GetShifterBufferAddress (FLEXIO_Type * *base*, flexio_shifter_buffer_type_t *type*, uint8_t *index*)

Parameters

base	FlexIO peripheral base address
type	Shifter type of flexio_shifter_buffer_type_t
index	Shifter index

Returns

Corresponding shifter buffer index

24.2.6.25 status_t FLEXIO_RegisterHandleIRQ (void * *base*, void * *handle*, flexio_isr_t *isr*)

Parameters

base	Pointer to the FlexIO simulated peripheral type.
handle	Pointer to the handler for FlexIO simulated peripheral.
isr	FlexIO simulated peripheral interrupt handler.

Return values

kStatus_Success	Successfully create the handle.
kStatus_OutOfRange	The FlexIO type/handle/ISR table out of range.

24.2.6.26 status_t FLEXIO_UnregisterHandleIRQ (void * *base*)

Parameters

base	Pointer to the FlexIO simulated peripheral type.

Return values

kStatus_Success	Successfully create the handle.
kStatus_OutOfRange	The FlexIO type/handle/ISR table out of range.

24.2.7 Variable Documentation

24.2.7.1 FLEXIO_Type∗ const s_flexioBases[]

24.2.7.2 const clock_ip_name_t s_flexioClocks[]

24.3 FlexIO Camera Driver

24.3.1 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_TransferCreateHandleEDMA() 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.

24.3.2 Typical use case

24.3.2.1 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.

24.3.3 Data Structure Documentation

24.3.3.1 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

24.3.3.2 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

24.3.3.3 struct flexio_camera_transfer_t

Data Fields

- uint32_t dataAddress
  Transfer buffer.
- uint32_t dataNum
  Transfer num.

24.3.4 Macro Definition Documentation

24.3.4.1 #define FSL_FLEXIO_CAMERA_DRIVER_VERSION (MAKE_VERSION(2, 1, 3))

24.3.4.2 #define FLEXIO_CAMERA_PARALLEL_DATA_WIDTH (8U)

24.3.5 Enumeration Type Documentation

24.3.5.1 anonymous enum

Enumerator

kStatus_FLEXIO_CAMERA_RxBusy Receiver is busy.
kStatus_FLEXIO_CAMERA_RxIdle Camera receiver is idle.

24.3.5.2 enum _flexio_camera_status_flags

Enumerator

kFLEXIO_CAMERA_RxDataRegFullFlag Receive buffer full flag.
kFLEXIO_CAMERA_RxErrorFlag Receive buffer error flag.

24.3.6 Function Documentation

24.3.6.1 void FLEXIO_CAMERA_Init (FLEXIO_CAMERA_Type * *base*, const flexio_camera_config_t * *config*)

Parameters

base	Pointer to FLEXIO_CAMERA_Type structure
config	Pointer to flexio_camera_config_t structure

24.3.6.2 void FLEXIO_CAMERA_Deinit (FLEXIO_CAMERA_Type * *base*)

Note

After calling this API, call FLEXO_CAMERA_Init to use the FlexIO Camera module.

Parameters

base	Pointer to FLEXIO_CAMERA_Type structure

24.3.6.3 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

config	Pointer to the flexio_camera_config_t structure

24.3.6.4 static void FLEXIO_CAMERA_Enable (FLEXIO_CAMERA_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	Pointer to the FLEXIO_CAMERA_Type
enable	True to enable, false does not have any effect.

24.3.6.5 uint32_t FLEXIO_CAMERA_GetStatusFlags (FLEXIO_CAMERA_Type ∗ *base*)

Parameters

base	Pointer to FLEXIO_CAMERA_Type structure

Returns

FlexIO shifter status flags
- FLEXIO_SHIFTSTAT_SSF_MASK
- 0

24.3.6.6 void FLEXIO_CAMERA_ClearStatusFlags (FLEXIO_CAMERA_Type ∗ *base*, uint32_t *mask*)

Parameters

base	Pointer to the device.
mask	status flag The parameter can be any combination of the following values: • kFLEXIO_CAMERA_RxDataRegFullFlag • kFLEXIO_CAMERA_RxErrorFlag

24.3.6.7 void FLEXIO_CAMERA_EnableInterrupt (FLEXIO_CAMERA_Type ∗ *base*)

Parameters

base	Pointer to the device.

24.3.6.8 void FLEXIO_CAMERA_DisableInterrupt (FLEXIO_CAMERA_Type ∗ *base*)

Parameters

base	Pointer to the device.

24.3.6.9 static void FLEXIO_CAMERA_EnableRxDMA (FLEXIO_CAMERA_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	Pointer to FLEXIO_CAMERA_Type structure
enable	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.

24.3.6.10 static uint32_t FLEXIO_CAMERA_GetRxBufferAddress (FLEXIO_CAMERA_Type * *base*) [inline], [static]

Parameters

base	Pointer to the device.

Returns

data Pointer to the buffer that keeps the data with count of base->shifterCount .

24.3.7 FlexIO eDMA Camera Driver

24.3.7.1 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.

24.3.7.2 Data Structure Documentation

24.3.7.2.1 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

24.3.7.3 Macro Definition Documentation

24.3.7.3.1 #define FSL_FLEXIO_CAMERA_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 1, 3))

24.3.7.4 Typedef Documentation

24.3.7.4.1 typedef void(* flexio_camera_edma_transfer_callback_t)(FLEXIO_CAMERA_Type *base, flexio_camera_edma_handle_t *handle, status_t status, void *userData)

24.3.7.5 Function Documentation

24.3.7.5.1 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

base	Pointer to the FLEXIO_CAMERA_Type.

handle	Pointer to flexio_camera_edma_handle_t structure.
callback	The callback function.
userData	The parameter of the callback function.
rxEdmaHandle	User requested DMA handle for RX DMA transfer.

Return values

kStatus_Success	Successfully create the handle.
kStatus_OutOfRange	The FlexIO Camera eDMA type/handle table out of range.

24.3.7.5.2 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

base	Pointer to the FLEXIO_CAMERA_Type.
handle	Pointer to the flexio_camera_edma_handle_t structure.
xfer	Camera eDMA transfer structure, see flexio_camera_transfer_t.

Return values

kStatus_Success	if succeeded, others failed.
kStatus_CAMERA_Rx-Busy	Previous transfer on going.

24.3.7.5.3 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

base	Pointer to the FLEXIO_CAMERA_Type.

handle	Pointer to the flexio_camera_edma_handle_t structure.

24.3.7.5.4 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

base	Pointer to the FLEXIO_CAMERA_Type.
handle	Pointer to the flexio_camera_edma_handle_t structure.
count	Number of bytes sent so far by the non-blocking transaction.

Return values

kStatus_Success	Succeed get the transfer count.
kStatus_InvalidArgument	The count parameter is invalid.

24.4 FlexIO I2C Master Driver

24.4.1 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.

24.4.2 Typical use case

24.4.2.1 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.

24.4.3 Data Structure Documentation

24.4.3.1 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

24.4.3.2 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

24.4.3.3 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

24.4.3.4 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

24.4.4 Macro Definition Documentation

24.4.4.1 #define I2C_RETRY_TIMES 0U /∗ Define to zero means keep waiting until the flag is assert/deassert. ∗/

24.4.5 Typedef Documentation

24.4.5.1 typedef void(∗ flexio_i2c_master_transfer_callback_t)(FLEXIO_I2C_Type ∗base, flexio_i2c_master_handle_t ∗handle, status_t status, void ∗userData)

24.4.6 Enumeration Type Documentation

24.4.6.1 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.

24.4.6.2 enum _flexio_i2c_master_interrupt

Enumerator

kFLEXIO_I2C_TxEmptyInterruptEnable Tx buffer empty interrupt enable.
kFLEXIO_I2C_RxFullInterruptEnable Rx buffer full interrupt enable.

24.4.6.3 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.

24.4.6.4 enum flexio_i2c_direction_t

Enumerator

kFLEXIO_I2C_Write Master send to slave.
kFLEXIO_I2C_Read Master receive from slave.

24.4.7 Function Documentation

24.4.7.1 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

base	Pointer to FLEXIO_I2C_Type structure..

Return values

kStatus_Success	
kStatus_FLEXIO_I2C_-Busy	

24.4.7.2 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

base	Pointer to FLEXIO_I2C_Type structure.
masterConfig	Pointer to flexio_i2c_master_config_t structure.
srcClock_Hz	FlexIO source clock in Hz.

Return values

kStatus_Success	Initialization successful
kStatus_InvalidArgument	The source clock exceed upper range limitation

24.4.7.3 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

base	pointer to FLEXIO_I2C_Type structure.

24.4.7.4 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

masterConfig	Pointer to flexio_i2c_master_config_t structure.

24.4.7.5 static void FLEXIO_I2C_MasterEnable (FLEXIO_I2C_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	Pointer to FLEXIO_I2C_Type structure.
enable	Pass true to enable module, false does not have any effect.

24.4.7.6 uint32_t FLEXIO_I2C_MasterGetStatusFlags (FLEXIO_I2C_Type * *base*)

Parameters

base	Pointer to FLEXIO_I2C_Type structure

Returns

Status flag, use status flag to AND _flexio_i2c_master_status_flags can get the related status.

24.4.7.7 void FLEXIO_I2C_MasterClearStatusFlags (FLEXIO_I2C_Type * *base*, uint32_t *mask*)

Parameters

base	Pointer to FLEXIO_I2C_Type structure.
mask	Status flag. The parameter can be any combination of the following values: • kFLEXIO_I2C_RxFullFlag • kFLEXIO_I2C_ReceiveNakFlag

24.4.7.8 void FLEXIO_I2C_MasterEnableInterrupts (FLEXIO_I2C_Type * *base*, uint32_t *mask*)

Parameters

base	Pointer to FLEXIO_I2C_Type structure.
mask	Interrupt source. Currently only one interrupt request source: • kFLEXIO_I2C_TransferCompleteInterruptEnable

24.4.7.9 void FLEXIO_I2C_MasterDisableInterrupts (FLEXIO_I2C_Type * *base*, uint32_t *mask*)

Parameters

base	Pointer to FLEXIO_I2C_Type structure.
mask	Interrupt source.

24.4.7.10 void FLEXIO_I2C_MasterSetBaudRate (FLEXIO_I2C_Type * *base*, uint32_t *baudRate_Bps*, uint32_t *srcClock_Hz*)

Parameters

base	Pointer to FLEXIO_I2C_Type structure
baudRate_Bps	the baud rate value in HZ

srcClock_Hz	source clock in HZ

24.4.7.11 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

base	Pointer to FLEXIO_I2C_Type structure.
address	7-bit address.
direction	transfer direction. This parameter is one of the values in flexio_i2c_direction_t: • kFLEXIO_I2C_Write: Transmit • kFLEXIO_I2C_Read: Receive

24.4.7.12 void FLEXIO_I2C_MasterStop (FLEXIO_I2C_Type * *base*)

Parameters

base	Pointer to FLEXIO_I2C_Type structure.

24.4.7.13 void FLEXIO_I2C_MasterRepeatedStart (FLEXIO_I2C_Type * *base*)

Parameters

base	Pointer to FLEXIO_I2C_Type structure.

24.4.7.14 void FLEXIO_I2C_MasterAbortStop (FLEXIO_I2C_Type * *base*)

Parameters

base	Pointer to FLEXIO_I2C_Type structure.

24.4.7.15 void FLEXIO_I2C_MasterEnableAck (FLEXIO_I2C_Type * *base*, bool *enable*)

Parameters

base	Pointer to FLEXIO_I2C_Type structure.
enable	True to configure send ACK, false configure to send NAK.

24.4.7.16 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

base	Pointer to FLEXIO_I2C_Type structure.
count	Number of bytes need to be transferred from a start signal to a re-start/stop signal

Return values

kStatus_Success	Successfully configured the count.
kStatus_InvalidArgument	Input argument is invalid.

24.4.7.17 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

base	Pointer to FLEXIO_I2C_Type structure.
data	a byte of data.

24.4.7.18 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

base	Pointer to FLEXIO_I2C_Type structure.

Returns

data byte read.

24.4.7.19 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

base	Pointer to FLEXIO_I2C_Type structure.
txBuff	The data bytes to send.
txSize	The number of data bytes to send.

Return values

kStatus_Success	Successfully write data.
kStatus_FLEXIO_I2C_-Nak	Receive NAK during writing data.
kStatus_FLEXIO_I2C_-Timeout	Timeout polling status flags.

24.4.7.20 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

base	Pointer to FLEXIO_I2C_Type structure.
rxBuff	The buffer to store the received bytes.
rxSize	The number of data bytes to be received.

Return values

kStatus_Success	Successfully read data.
kStatus_FLEXIO_I2C_-Timeout	Timeout polling status flags.

24.4.7.21 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

base	pointer to FLEXIO_I2C_Type structure.
xfer	pointer to flexio_i2c_master_transfer_t structure.

Returns

status of status_t.

24.4.7.22 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

base	Pointer to FLEXIO_I2C_Type structure.
handle	Pointer to flexio_i2c_master_handle_t structure to store the transfer state.
callback	Pointer to user callback function.
userData	User param passed to the callback function.

Return values

kStatus_Success	Successfully create the handle.
kStatus_OutOfRange	The FlexIO type/handle/isr table out of range.

24.4.7.23 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

base	Pointer to FLEXIO_I2C_Type structure
handle	Pointer to flexio_i2c_master_handle_t structure which stores the transfer state
xfer	pointer to flexio_i2c_master_transfer_t structure

Return values

kStatus_Success	Successfully start a transfer.
kStatus_FLEXIO_I2C_Busy	FlexIO I2C is not idle, is running another transfer.

24.4.7.24 status_t FLEXIO_I2C_MasterTransferGetCount (FLEXIO_I2C_Type * *base*, flexio_i2c_master_handle_t * *handle*, size_t * *count*)

Parameters

base	Pointer to FLEXIO_I2C_Type structure.
handle	Pointer to flexio_i2c_master_handle_t structure which stores the transfer state.
count	Number of bytes transferred so far by the non-blocking transaction.

Return values

kStatus_InvalidArgument	count is Invalid.
kStatus_NoTransferIn-Progress	There is not a non-blocking transaction currently in progress.
kStatus_Success	Successfully return the count.

24.4.7.25 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

base	Pointer to FLEXIO_I2C_Type structure
handle	Pointer to flexio_i2c_master_handle_t structure which stores the transfer state

24.4.7.26 void FLEXIO_I2C_MasterTransferHandleIRQ (void ∗ *i2cType*, void ∗ *i2cHandle*)

Parameters

i2cType	Pointer to FLEXIO_I2C_Type structure
i2cHandle	Pointer to flexio_i2c_master_transfer_t structure

24.5 FlexIO I2S Driver

24.5.1 Overview

The MCUXpresso SDK provides a peripheral driver for I2S function using Flexible I/O module of MCUXpresso 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.

24.5.2 Typical use case

24.5.2.1 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)
    {
    }

    // ...
}
```

24.5.2.2 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.

24.5.3 Data Structure Documentation

24.5.3.1 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.

24.5.3.2 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.

24.5.3.3 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.

24.5.3.4 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

24.5.3.5 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.

24.5.4 Macro Definition Documentation

24.5.4.1 #define FSL_FLEXIO_I2S_DRIVER_VERSION (MAKE_VERSION(2, 2, 0))

24.5.4.2 #define I2S_RETRY_TIMES 0U /∗ Define to zero means keep waiting until the flag is assert/deassert. ∗/

24.5.4.3 #define FLEXIO_I2S_XFER_QUEUE_SIZE (4U)

24.5.5 Enumeration Type Documentation

24.5.5.1 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 Tx 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.

24.5.5.2 enum flexio_i2s_master_slave_t

Enumerator

kFLEXIO_I2S_Master Master mode.
kFLEXIO_I2S_Slave Slave mode.

24.5.5.3 anonymous enum

Enumerator

kFLEXIO_I2S_TxDataRegEmptyInterruptEnable Transmit buffer empty interrupt enable.
kFLEXIO_I2S_RxDataRegFullInterruptEnable Receive buffer full interrupt enable.

24.5.5.4 anonymous enum

Enumerator

kFLEXIO_I2S_TxDataRegEmptyFlag Transmit buffer empty flag.
kFLEXIO_I2S_RxDataRegFullFlag Receive buffer full flag.

24.5.5.5 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.

24.5.5.6 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.

24.5.6 Function Documentation

24.5.6.1 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

base	FlexIO I2S base pointer
config	FlexIO I2S configure structure.

24.5.6.2 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

config	pointer to master configuration structure

24.5.6.3 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 FLEXO_-I2S_Init to use the FlexIO I2S module.

Parameters

base	FlexIO I2S base pointer

24.5.6.4 static void FLEXIO_I2S_Enable (FLEXIO_I2S_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	Pointer to FLEXIO_I2S_Type
enable	True to enable, false dose not have any effect.

24.5.6.5 uint32_t FLEXIO_I2S_GetStatusFlags (FLEXIO_I2S_Type * *base*)

Parameters

base	Pointer to FLEXIO_I2S_Type structure

Returns

Status flag, which are ORed by the enumerators in the _flexio_i2s_status_flags.

24.5.6.6 void FLEXIO_I2S_EnableInterrupts (FLEXIO_I2S_Type * *base,* uint32_t *mask*)

This function enables the FlexIO UART interrupt.

Parameters

base	Pointer to FLEXIO_I2S_Type structure
mask	interrupt source

24.5.6.7 void FLEXIO_I2S_DisableInterrupts (FLEXIO_I2S_Type * *base*, uint32_t *mask*)

This function enables the FlexIO UART interrupt.

Parameters

base	pointer to FLEXIO_I2S_Type structure
mask	interrupt source

24.5.6.8 static void FLEXIO_I2S_TxEnableDMA (FLEXIO_I2S_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	FlexIO I2S base pointer
enable	True means enable DMA, false means disable DMA.

24.5.6.9 static void FLEXIO_I2S_RxEnableDMA (FLEXIO_I2S_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	FlexIO I2S base pointer
enable	True means enable DMA, false means disable DMA.

24.5.6.10 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

base	Pointer to FLEXIO_I2S_Type structure

Returns

FlexIO i2s send data register address.

24.5.6.11 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

base	Pointer to FLEXIO_I2S_Type structure

Returns

FlexIO i2s receive data register address.

24.5.6.12 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

base	Pointer to FLEXIO_I2S_Type structure
format	Pointer to FlexIO I2S audio data format structure.
srcClock_Hz	I2S master clock source frequency in Hz.

24.5.6.13 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

base	Pointer to FLEXIO_I2S_Type structure
format	Pointer to FlexIO I2S audio data format structure.

24.5.6.14 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

base	FlexIO I2S base pointer.
bitWidth	How many bits in a audio word, usually 8/16/24/32 bits.
txData	Pointer to the data to be written.
size	Bytes to be written.

Return values

kStatus_Success	Successfully write data.
kStatus_FLEXIO_I2C_-Timeout	Timeout polling status flags.

24.5.6.15 static void FLEXIO_I2S_WriteData (FLEXIO_I2S_Type ∗ *base*, uint8_t *bitWidth*, uint32_t *data*) `[inline], [static]`

Parameters

base	FlexIO I2S base pointer.
bitWidth	How many bits in a audio word, usually 8/16/24/32 bits.
data	Data to be written.

24.5.6.16 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

base	FlexIO I2S base pointer
bitWidth	How many bits in a audio word, usually 8/16/24/32 bits.
rxData	Pointer to the data to be read.
size	Bytes to be read.

Return values

kStatus_Success	Successfully read data.
kStatus_FLEXIO_I2C_-Timeout	Timeout polling status flags.

24.5.6.17 static uint32_t FLEXIO_I2S_ReadData (FLEXIO_I2S_Type ∗ *base*) [inline], [static]

Parameters

base	FlexIO I2S base pointer

Returns

Data read from data register.

24.5.6.18 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

base	Pointer to FLEXIO_I2S_Type structure
handle	Pointer to flexio_i2s_handle_t structure to store the transfer state.
callback	FlexIO I2S callback function, which is called while finished a block.
userData	User parameter for the FlexIO I2S callback.

24.5.6.19 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

base	Pointer to FLEXIO_I2S_Type structure.
handle	FlexIO I2S handle pointer.
format	Pointer to audio data format structure.
srcClock_Hz	FlexIO I2S bit clock source frequency in Hz. This parameter should be 0 while in slave mode.

24.5.6.20 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

base	Pointer to FLEXIO_I2S_Type structure.
handle	Pointer to flexio_i2s_handle_t structure to store the transfer state.
callback	FlexIO I2S callback function, which is called while finished a block.
userData	User parameter for the FlexIO I2S callback.

24.5.6.21 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

base	Pointer to FLEXIO_I2S_Type structure.
handle	Pointer to flexio_i2s_handle_t structure which stores the transfer state
xfer	Pointer to flexio_i2s_transfer_t structure

Return values

kStatus_Success	Successfully start the data transmission.
kStatus_FLEXIO_I2S_TxBusy	Previous transmission still not finished, data not all written to TX register yet.
kStatus_InvalidArgument	The input parameter is invalid.

24.5.6.22 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

base	Pointer to FLEXIO_I2S_Type structure.
handle	Pointer to flexio_i2s_handle_t structure which stores the transfer state
xfer	Pointer to flexio_i2s_transfer_t structure

Return values

kStatus_Success	Successfully start the data receive.

kStatus_FLEXIO_I2S_-RxBusy	Previous receive still not finished.
kStatus_InvalidArgument	The input parameter is invalid.

24.5.6.23 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

base	Pointer to FLEXIO_I2S_Type structure.
handle	Pointer to flexio_i2s_handle_t structure which stores the transfer state

24.5.6.24 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

base	Pointer to FLEXIO_I2S_Type structure.
handle	Pointer to flexio_i2s_handle_t structure which stores the transfer state

24.5.6.25 status_t FLEXIO_I2S_TransferGetSendCount (FLEXIO_I2S_Type * *base*, flexio_i2s_handle_t * *handle*, size_t * *count*)

Parameters

base	Pointer to FLEXIO_I2S_Type structure.
handle	Pointer to flexio_i2s_handle_t structure which stores the transfer state
count	Bytes sent.

Return values

kStatus_Success	Succeed get the transfer count.
kStatus_NoTransferIn-Progress	There is not a non-blocking transaction currently in progress.

24.5.6.26 status_t FLEXIO_I2S_TransferGetReceiveCount (FLEXIO_I2S_Type ∗ *base*, flexio_i2s_handle_t ∗ *handle*, size_t ∗ *count*)

Parameters

base	Pointer to FLEXIO_I2S_Type structure.
handle	Pointer to flexio_i2s_handle_t structure which stores the transfer state
count	Bytes recieved.

Returns

count Bytes received.

Return values

kStatus_Success	Succeed get the transfer count.
kStatus_NoTransferIn-Progress	There is not a non-blocking transaction currently in progress.

24.5.6.27 void FLEXIO_I2S_TransferTxHandleIRQ (void ∗ *i2sBase*, void ∗ *i2sHandle*)

Parameters

i2sBase	Pointer to FLEXIO_I2S_Type structure.

i2sHandle	Pointer to flexio_i2s_handle_t structure

24.5.6.28 void FLEXIO_I2S_TransferRxHandleIRQ (void * *i2sBase,* void * *i2sHandle*)

Parameters

i2sBase	Pointer to FLEXIO_I2S_Type structure.
i2sHandle	Pointer to flexio_i2s_handle_t structure.

24.5.7 FlexIO eDMA I2S Driver

24.5.7.1 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.

24.5.7.2 Data Structure Documentation

24.5.7.2.1 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

24.5.7.3 Macro Definition Documentation

24.5.7.3.1 #define FSL_FLEXIO_I2S_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 1, 7))

24.5.7.4 Function Documentation

24.5.7.4.1 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

base	FlexIO I2S peripheral base address.
handle	FlexIO I2S eDMA handle pointer.
callback	FlexIO I2S eDMA callback function called while finished a block.
userData	User parameter for callback.
dmaHandle	eDMA handle for FlexIO I2S. This handle is a static value allocated by users.

24.5.7.4.2 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

base	FlexIO I2S peripheral base address.
handle	FlexIO I2S eDMA handle pointer.
callback	FlexIO I2S eDMA callback function called while finished a block.
userData	User parameter for callback.
dmaHandle	eDMA handle for FlexIO I2S. This handle is a static value allocated by users.

24.5.7.4.3 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

base	FlexIO I2S peripheral base address.
handle	FlexIO I2S eDMA handle pointer
format	Pointer to FlexIO I2S audio data format structure.
srcClock_Hz	FlexIO I2S clock source frequency in Hz, it should be 0 while in slave mode.

24.5.7.4.4 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

base	FlexIO I2S peripheral base address.
handle	FlexIO I2S DMA handle pointer.
xfer	Pointer to DMA transfer structure.

Return values

kStatus_Success	Start a FlexIO I2S eDMA send successfully.
kStatus_InvalidArgument	The input arguments is invalid.
kStatus_TxBusy	FlexIO I2S is busy sending data.

24.5.7.4.5 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

base	FlexIO I2S peripheral base address.
handle	FlexIO I2S DMA handle pointer.
xfer	Pointer to DMA transfer structure.

Return values

kStatus_Success	Start a FlexIO I2S eDMA receive successfully.
kStatus_InvalidArgument	The input arguments is invalid.
kStatus_RxBusy	FlexIO I2S is busy receiving data.

24.5.7.4.6 void FLEXIO_I2S_TransferAbortSendEDMA (FLEXIO_I2S_Type * *base*, flexio_i2s_edma_handle_t * *handle*)

Parameters

base	FlexIO I2S peripheral base address.
handle	FlexIO I2S DMA handle pointer.

24.5.7.4.7 void FLEXIO_I2S_TransferAbortReceiveEDMA (FLEXIO_I2S_Type * *base*, flexio_i2s_edma_handle_t * *handle*)

Parameters

base	FlexIO I2S peripheral base address.
handle	FlexIO I2S DMA handle pointer.

24.5.7.4.8 status_t FLEXIO_I2S_TransferGetSendCountEDMA (FLEXIO_I2S_Type * *base*, flexio_i2s_edma_handle_t * *handle*, size_t * *count*)

Parameters

base	FlexIO I2S peripheral base address.

handle	FlexIO I2S DMA handle pointer.
count	Bytes sent.

Return values

kStatus_Success	Succeed get the transfer count.
kStatus_NoTransferIn-Progress	There is not a non-blocking transaction currently in progress.

24.5.7.4.9 status_t FLEXIO_I2S_TransferGetReceiveCountEDMA (FLEXIO_I2S_Type ∗ *base,* flexio_i2s_edma_handle_t ∗ *handle,* size_t ∗ *count*)

Parameters

base	FlexIO I2S peripheral base address.
handle	FlexIO I2S DMA handle pointer.
count	Bytes received.

Return values

kStatus_Success	Succeed get the transfer count.
kStatus_NoTransferIn-Progress	There is not a non-blocking transaction currently in progress.

24.6 FlexIO MCU Interface LCD Driver

24.6.1 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.

24.6.2 Typical use case

24.6.2.1 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);
```

24.6.2.2 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.

24.6.3 Data Structure Documentation

24.6.3.1 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

24.6.3.2 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

24.6.3.3 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

24.6.3.4 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

24.6.4 Macro Definition Documentation

24.6.4.1 #define FSL_FLEXIO_MCULCD_DRIVER_VERSION (MAKE_VERSION(2, 0, 6))

24.6.4.2 #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.

24.6.5 Typedef Documentation

24.6.5.1 typedef void(∗ flexio_mculcd_pin_func_t)(bool set)

24.6.5.2 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.

24.6.6 Enumeration Type Documentation

24.6.6.1 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.

24.6.6.2 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.

24.6.6.3 enum flexio_mculcd_bus_t

Enumerator

kFLEXIO_MCULCD_8080 Using Intel 8080 bus.
kFLEXIO_MCULCD_6800 Using Motorola 6800 bus.

24.6.6.4 enum _flexio_mculcd_interrupt_enable

Enumerator

kFLEXIO_MCULCD_TxEmptyInterruptEnable Transmit buffer empty interrupt enable.
kFLEXIO_MCULCD_RxFullInterruptEnable Receive buffer full interrupt enable.

24.6.6.5 enum _flexio_mculcd_status_flags

Enumerator

kFLEXIO_MCULCD_TxEmptyFlag Transmit buffer empty flag.
kFLEXIO_MCULCD_RxFullFlag Receive buffer full flag.

24.6.6.6 enum _flexio_mculcd_dma_enable

Enumerator

kFLEXIO_MCULCD_TxDmaEnable Tx DMA request source.
kFLEXIO_MCULCD_RxDmaEnable Rx DMA request source.

24.6.6.7 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.

24.6.7 Function Documentation

24.6.7.1 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_MCULCD_GetDefaultConfig.

Parameters

base	Pointer to the FLEXIO_MCULCD_Type structure.
config	Pointer to the flexio_mculcd_config_t structure.
srcClock_Hz	FlexIO source clock in Hz.

Return values

kStatus_Success	Initialization success.
kStatus_InvalidArgument	Initialization failed because of invalid argument.

24.6.7.2 void FLEXIO_MCULCD_Deinit (FLEXIO_MCULCD_Type * *base*)

Parameters

base	Pointer to the FLEXIO_MCULCD_Type.

24.6.7.3 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

config	Pointer to the flexio_mculcd_config_t structure.

24.6.7.4 uint32_t FLEXIO_MCULCD_GetStatusFlags (FLEXIO_MCULCD_Type * *base*)

Parameters

base	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.

24.6.7.5 void FLEXIO_MCULCD_ClearStatusFlags (FLEXIO_MCULCD_Type * *base*, uint32_t *mask*)

Parameters

base	Pointer to the FLEXIO_MCULCD_Type structure.
mask	Status to clear, it is the OR'ed value of _flexio_mculcd_status_flags.

Note

Don't use this function with DMA APIs.

24.6.7.6 void FLEXIO_MCULCD_EnableInterrupts (FLEXIO_MCULCD_Type * *base*, uint32_t *mask*)

This function enables the FlexIO MCULCD interrupt.

Parameters

base	Pointer to the FLEXIO_MCULCD_Type structure.
mask	Interrupts to enable, it is the OR'ed value of _flexio_mculcd_interrupt_enable.

24.6.7.7 void FLEXIO_MCULCD_DisableInterrupts (FLEXIO_MCULCD_Type * *base*, uint32_t *mask*)

This function disables the FlexIO MCULCD interrupt.

Parameters

base	Pointer to the FLEXIO_MCULCD_Type structure.
mask	Interrupts to disable, it is the OR'ed value of _flexio_mculcd_interrupt_enable.

24.6.7.8 static void FLEXIO_MCULCD_EnableTxDMA (FLEXIO_MCULCD_Type * *base*, bool *enable*) `[inline], [static]`

Parameters

base	Pointer to the FLEXIO_MCULCD_Type structure.

enable	True means enable DMA, false means disable DMA.

24.6.7.9 static void FLEXIO_MCULCD_EnableRxDMA (FLEXIO_MCULCD_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	Pointer to the FLEXIO_MCULCD_Type structure.
enable	True means enable DMA, false means disable DMA.

24.6.7.10 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

base	Pointer to the FLEXIO_MCULCD_Type structure.

Returns

FlexIO MCULCD transmit data register address.

24.6.7.11 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

base	Pointer to the FLEXIO_MCULCD_Type structure.

Returns

FlexIO MCULCD receive data register address.

24.6.7.12 status_t FLEXIO_MCULCD_SetBaudRate (FLEXIO_MCULCD_Type * *base*, uint32_t *baudRate_Bps*, uint32_t *srcClock_Hz*)

Parameters

base	Pointer to the FLEXIO_MCULCD_Type structure.
baudRate_Bps	Desired baud rate.
srcClock_Hz	FLEXIO clock frequency in Hz.

Return values

kStatus_Success	Set successfully.
kStatus_InvalidArgument	Could not set the baud rate.

24.6.7.13 void FLEXIO_MCULCD_SetSingleBeatWriteConfig (FLEXIO_MCULCD_Type * *base*)

At the begining 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

base	Pointer to the FLEXIO_MCULCD_Type.

Note

This is an internal used function, upper layer should not use.

24.6.7.14 void FLEXIO_MCULCD_ClearSingleBeatWriteConfig (FLEXIO_MCULCD_Type * *base*)

Clear the write configuration set by FLEXIO_MCULCD_SetSingleBeatWriteConfig.

Parameters

base	Pointer to the FLEXIO_MCULCD_Type.

Note

This is an internal used function, upper layer should not use.

24.6.7.15 void FLEXIO_MCULCD_SetSingleBeatReadConfig (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-_ClearSingleBeatReadConfig.

Parameters

base	Pointer to the FLEXIO_MCULCD_Type.

Note

This is an internal used function, upper layer should not use.

24.6.7.16 void FLEXIO_MCULCD_ClearSingleBeatReadConfig (FLEXIO_MCULCD_-Type * *base*)

Clear the read configuration set by FLEXIO_MCULCD_SetSingleBeatReadConfig.

Parameters

base	Pointer to the FLEXIO_MCULCD_Type.

Note

This is an internal used function, upper layer should not use.

24.6.7.17 void FLEXIO_MCULCD_SetMultiBeatsWriteConfig (FLEXIO_MCULCD_Type * *base*)

At the begining 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_MCULC-D_ClearMultBeatsWriteConfig.

Parameters

base	Pointer to the FLEXIO_MCULCD_Type.

Note

This is an internal used function, upper layer should not use.

24.6.7.18 void FLEXIO_MCULCD_ClearMultiBeatsWriteConfig (FLEXIO_MCULCD_Type * *base*)

Clear the write configuration set by FLEXIO_MCULCD_SetMultBeatsWriteConfig.

Parameters

base	Pointer to the FLEXIO_MCULCD_Type.

Note

This is an internal used function, upper layer should not use.

24.6.7.19 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

base	Pointer to the FLEXIO_MCULCD_Type.

Note

This is an internal used function, upper layer should not use.

24.6.7.20 void FLEXIO_MCULCD_ClearMultiBeatsReadConfig (FLEXIO_MCULCD_-Type * *base*)

Clear the read configuration set by FLEXIO_MCULCD_SetMultBeatsReadConfig.

Parameters

base	Pointer to the FLEXIO_MCULCD_Type.

Note

This is an internal used function, upper layer should not use.

24.6.7.21 static void FLEXIO_MCULCD_Enable (FLEXIO_MCULCD_Type * *base,* bool *enable*) `[inline], [static]`

Parameters

base	Pointer to the FLEXIO_MCULCD_Type.
enable	True to enable, false does not have any effect.

24.6.7.22 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

base	Pointer to the FLEXIO_MCULCD_Type structure.

Returns

The data read out.

Note

Don't use this function with DMA APIs.

24.6.7.23 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

base	Pointer to the FLEXIO_MCULCD_Type structure.
data	The data to write.

Note

Don't use this function with DMA APIs.

24.6.7.24 static void FLEXIO_MCULCD_StartTransfer (FLEXIO_MCULCD_Type * *base*) [inline], [static]

Parameters

base	Pointer to the FLEXIO_MCULCD_Type structure.

24.6.7.25 static void FLEXIO_MCULCD_StopTransfer (FLEXIO_MCULCD_Type * *base*) [inline], [static]

Parameters

base	Pointer to the FLEXIO_MCULCD_Type structure.

24.6.7.26 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.

24.6.7.27 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

base	Pointer to the FLEXIO_MCULCD_Type structure.
command	The command to send.

24.6.7.28 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

base	Pointer to the FLEXIO_MCULCD_Type structure.
data	The data array to send.
size	How many bytes to write.

24.6.7.29 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

base	Pointer to the FLEXIO_MCULCD_Type structure.
data	The array to save the data.
size	How many bytes to read.

24.6.7.30 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

base	Pointer to the FLEXIO_MCULCD_Type structure.
sameValue	The same value to send.
size	How many bytes to send.

24.6.7.31 void FLEXIO_MCULCD_TransferBlocking (FLEXIO_MCULCD_Type * *base*, flexio_mculcd_transfer_t * *xfer*)

Note

The API does not return until the transfer finished.

Parameters

base	pointer to FLEXIO_MCULCD_Type structure.
xfer	pointer to flexio_mculcd_transfer_t structure.

24.6.7.32 status_t FLEXIO_MCULCD_TransferCreateHandle (FLEXIO_MCULCD_Type * *base*, flexio_mculcd_handle_t * *handle*, flexio_mculcd_transfer_callback_t *callback*, void * *userData*)

Parameters

base	Pointer to the FLEXIO_MCULCD_Type structure.
handle	Pointer to the flexio_mculcd_handle_t structure to store the transfer state.
callback	The callback function.
userData	The parameter of the callback function.

Return values

kStatus_Success	Successfully create the handle.
kStatus_OutOfRange	The FlexIO type/handle/ISR table out of range.

24.6.7.33 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

base	Pointer to the FLEXIO_MCULCD_Type structure.
handle	Pointer to the flexio_mculcd_handle_t structure to store the transfer state.
xfer	FlexIO MCULCD transfer structure. See flexio_mculcd_transfer_t.

Return values

kStatus_Success	Successfully start a transfer.
kStatus_InvalidArgument	Input argument is invalid.
kStatus_FLEXIO_MCUL-CD_Busy	MCULCD is busy with another transfer.

24.6.7.34 void FLEXIO_MCULCD_TransferAbort (FLEXIO_MCULCD_Type ∗ *base*, flexio_mculcd_handle_t ∗ *handle*)

Parameters

base	Pointer to the FLEXIO_MCULCD_Type structure.
handle	Pointer to the flexio_mculcd_handle_t structure to store the transfer state.

24.6.7.35 status_t FLEXIO_MCULCD_TransferGetCount (FLEXIO_MCULCD_Type ∗ *base*, flexio_mculcd_handle_t ∗ *handle*, size_t ∗ *count*)

Parameters

base	Pointer to the FLEXIO_MCULCD_Type structure.
handle	Pointer to the flexio_mculcd_handle_t structure to store the transfer state.
count	How many bytes transferred so far by the non-blocking transaction.

Return values

kStatus_Success	Get the transferred count Successfully.
kStatus_NoTransferIn-Progress	No transfer in process.

24.6.7.36 void FLEXIO_MCULCD_TransferHandleIRQ (void ∗ *base*, void ∗ *handle*)

Parameters

base	Pointer to the FLEXIO_MCULCD_Type structure.
handle	Pointer to the flexio_mculcd_handle_t structure to store the transfer state.

24.6.8 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.

24.6.8.1 Overview

Note

eDMA transactional functions use multiple beats method for better performance, in contrast, the blocking functions and interupt 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 requst source.
    // txEdmaHandle should use the first FlexIO TX shifters as DMA requst 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 FLEXO 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.

24.6.8.2 Data Structure Documentation

24.6.8.2.1 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 transfered.
- 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

24.6.8.3 Macro Definition Documentation

24.6.8.3.1 #define FSL_FLEXIO_MCULCD_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 0, 4))

24.6.8.4 Typedef Documentation

24.6.8.4.1 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.

24.6.8.5 Function Documentation

24.6.8.5.1 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 FLEXO MCULCD master eDMA handle which can be used for other FLEXO MCULCD transactional APIs. For a specified FLEXO MCULCD instance, call this API once to get the initialized handle.

Parameters

base	Pointer to FLEXIO_MCULCD_Type structure.
handle	Pointer to flexio_mculcd_edma_handle_t structure to store the transfer state.
callback	MCULCD transfer complete callback, NULL means no callback.
userData	callback function parameter.
txDmaHandle	User requested eDMA handle for FlexIO MCULCD eDMA TX, the DMA request source of this handle should be the first of TX shifters.
rxDmaHandle	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

kStatus_Success	Successfully create the handle.

24.6.8.5.2 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

base	pointer to FLEXIO_MCULCD_Type structure.
handle	pointer to flexio_mculcd_edma_handle_t structure to store the transfer state.
xfer	Pointer to FlexIO MCULCD transfer structure.

Return values

kStatus_Success	Successfully start a transfer.
kStatus_InvalidArgument	Input argument is invalid.
kStatus_FLEXIO_MCULCD_Busy	FlexIO MCULCD is not idle, it is running another transfer.

24.6.8.5.3 void FLEXIO_MCULCD_TransferAbortEDMA (FLEXIO_MCULCD_Type ∗ *base,* flexio_mculcd_edma_handle_t ∗ *handle*)

Parameters

base	pointer to FLEXIO_MCULCD_Type structure.
handle	FlexIO MCULCD eDMA handle pointer.

24.6.8.5.4 status_t FLEXIO_MCULCD_TransferGetCountEDMA (FLEXIO_MCULCD_Type * *base,* flexio_mculcd_edma_handle_t * *handle,* size_t * *count*)

Parameters

base	pointer to FLEXIO_MCULCD_Type structure.
handle	FlexIO MCULCD eDMA handle pointer.
count	Number of count transferred so far by the eDMA transaction.

Return values

kStatus_Success	Get the transferred count Successfully.
kStatus_NoTransferIn-Progress	No transfer in process.

24.7 FlexIO SPI Driver

24.7.1 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/operati 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.

24.7.2 Typical use case

24.7.2.1 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)
    {
    }

        // ...
}
```

24.7.2.2 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 (0xFFFFU)
  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.

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 }
  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 = 0x1U,
  kFLEXIO_SPI_8bitLsb = 0x2U,
  kFLEXIO_SPI_16bitMsb = 0x9U,
  kFLEXIO_SPI_16bitLsb = 0xaU }
  Define FlexIO SPI transfer flags.

Driver version

- #define FSL_FLEXIO_SPI_DRIVER_VERSION (MAKE_VERSION(2, 2, 1))
  FlexIO SPI driver version 2.2.1.

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, uint16_t data)
  Writes one byte of data, which is sent using the MSB method.
- static uint16_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.

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.

24.7.3 Data Structure Documentation

24.7.3.1 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

(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]

24.7.3.2 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

24.7.3.3 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

24.7.3.4 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

24.7.3.5 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

24.7.4 Macro Definition Documentation

24.7.4.1 #define FSL_FLEXIO_SPI_DRIVER_VERSION (MAKE_VERSION(2, 2, 1))

24.7.4.2 #define FLEXIO_SPI_DUMMYDATA (0xFFFFU)

24.7.4.3 #define SPI_RETRY_TIMES 0U /* Define to zero means keep waiting until the flag is assert/deassert. */

24.7.5 Typedef Documentation

24.7.5.1 typedef flexio_spi_master_handle_t flexio_spi_slave_handle_t

24.7.6 Enumeration Type Documentation

24.7.6.1 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.

24.7.6.2 enum flexio_spi_clock_phase_t

Enumerator

kFLEXIO_SPI_ClockPhaseFirstEdge First edge on SPSCK occurs at the middle of the first cycle of a data transfer.
kFLEXIO_SPI_ClockPhaseSecondEdge First edge on SPSCK occurs at the start of the first cycle of a data transfer.

24.7.6.3 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.

24.7.6.4 enum flexio_spi_data_bitcount_mode_t

Enumerator

kFLEXIO_SPI_8BitMode 8-bit data transmission mode.
kFLEXIO_SPI_16BitMode 16-bit data transmission mode.

24.7.6.5 enum _flexio_spi_interrupt_enable

Enumerator

kFLEXIO_SPI_TxEmptyInterruptEnable Transmit buffer empty interrupt enable.
kFLEXIO_SPI_RxFullInterruptEnable Receive buffer full interrupt enable.

24.7.6.6 enum _flexio_spi_status_flags

Enumerator

kFLEXIO_SPI_TxBufferEmptyFlag Transmit buffer empty flag.
kFLEXIO_SPI_RxBufferFullFlag Receive buffer full flag.

24.7.6.7 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.

24.7.6.8 enum _flexio_spi_transfer_flags

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.

24.7.7 Function Documentation

24.7.7.1 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 S-PI 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

base	Pointer to the FLEXIO_SPI_Type structure.
masterConfig	Pointer to the flexio_spi_master_config_t structure.
srcClock_Hz	FlexIO source clock in Hz.

24.7.7.2 void FLEXIO_SPI_MasterDeinit (FLEXIO_SPI_Type ∗ *base*)

Parameters

base	Pointer to the FLEXIO_SPI_Type.

24.7.7.3 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

masterConfig	Pointer to the flexio_spi_master_config_t structure.

24.7.7.4 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

base	Pointer to the FLEXIO_SPI_Type structure.
slaveConfig	Pointer to the flexio_spi_slave_config_t structure.

24.7.7.5 void FLEXIO_SPI_SlaveDeinit (FLEXIO_SPI_Type * *base*)

Parameters

base	Pointer to the FLEXIO_SPI_Type.

24.7.7.6 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

slaveConfig	Pointer to the flexio_spi_slave_config_t structure.

24.7.7.7 uint32_t FLEXIO_SPI_GetStatusFlags (FLEXIO_SPI_Type * *base*)

Parameters

base	Pointer to the FLEXIO_SPI_Type structure.

Returns

status flag; Use the status flag to AND the following flag mask and get the status.
- kFLEXIO_SPI_TxEmptyFlag
- kFLEXIO_SPI_RxEmptyFlag

24.7.7.8 void FLEXIO_SPI_ClearStatusFlags (FLEXIO_SPI_Type * *base*, uint32_t *mask*)

Parameters

base	Pointer to the FLEXIO_SPI_Type structure.
mask	status flag The parameter can be any combination of the following values: • kFLEXIO_SPI_TxEmptyFlag • kFLEXIO_SPI_RxEmptyFlag

24.7.7.9 void FLEXIO_SPI_EnableInterrupts (FLEXIO_SPI_Type * *base,* uint32_t *mask*)

This function enables the FlexIO SPI interrupt.

Parameters

base	Pointer to the FLEXIO_SPI_Type structure.
mask	interrupt source. The parameter can be any combination of the following values: • kFLEXIO_SPI_RxFullInterruptEnable • kFLEXIO_SPI_TxEmptyInterruptEnable

24.7.7.10 void FLEXIO_SPI_DisableInterrupts (FLEXIO_SPI_Type * *base*, uint32_t *mask*)

This function disables the FlexIO SPI interrupt.

Parameters

base	Pointer to the FLEXIO_SPI_Type structure.
mask	interrupt source The parameter can be any combination of the following values: • kFLEXIO_SPI_RxFullInterruptEnable • kFLEXIO_SPI_TxEmptyInterruptEnable

24.7.7.11 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

base	Pointer to the FLEXIO_SPI_Type structure.
mask	SPI DMA source.
enable	True means enable DMA, false means disable DMA.

24.7.7.12 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

base	Pointer to the FLEXIO_SPI_Type structure.
direction	Shift direction of MSB first or LSB first.

Returns

FlexIO SPI transmit data register address.

24.7.7.13 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

base	Pointer to the FLEXIO_SPI_Type structure.
direction	Shift direction of MSB first or LSB first.

Returns

FlexIO SPI receive data register address.

24.7.7.14 static void FLEXIO_SPI_Enable (FLEXIO_SPI_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	Pointer to the FLEXIO_SPI_Type.
enable	True to enable, false does not have any effect.

24.7.7.15 void FLEXIO_SPI_MasterSetBaudRate (FLEXIO_SPI_Type * *base*, uint32_t *baudRate_Bps*, uint32_t *srcClockHz*)

Parameters

base	Pointer to the FLEXIO_SPI_Type structure.
baudRate_Bps	Baud Rate needed in Hz.
srcClockHz	SPI source clock frequency in Hz.

24.7.7.16 static void FLEXIO_SPI_WriteData (FLEXIO_SPI_Type * *base*, flexio_spi_shift_direction_t *direction*, uint16_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

base	Pointer to the FLEXIO_SPI_Type structure.
direction	Shift direction of MSB first or LSB first.
data	8 bit/16 bit data.

24.7.7.17 static uint16_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

base	Pointer to the FLEXIO_SPI_Type structure.
direction	Shift direction of MSB first or LSB first.

Returns

8 bit/16 bit data received.

24.7.7.18 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

base	Pointer to the FLEXIO_SPI_Type structure.
direction	Shift direction of MSB first or LSB first.
buffer	The data bytes to send.
size	The number of data bytes to send.

Return values

kStatus_Success	Successfully create the handle.
kStatus_FLEXIO_SPI_-Timeout	The transfer timed out and was aborted.

24.7.7.19 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

base	Pointer to the FLEXIO_SPI_Type structure.
direction	Shift direction of MSB first or LSB first.
buffer	The buffer to store the received bytes.
size	The number of data bytes to be received.
direction	Shift direction of MSB first or LSB first.

Return values

kStatus_Success	Successfully create the handle.
kStatus_FLEXIO_SPI_-Timeout	The transfer timed out and was aborted.

24.7.7.20 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

base	pointer to FLEXIO_SPI_Type structure
xfer	FlexIO SPI transfer structure, see flexio_spi_transfer_t.

Return values

kStatus_Success	Successfully create the handle.
kStatus_FLEXIO_SPI_-Timeout	The transfer timed out and was aborted.

24.7.7.21 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

base	Pointer to the FLEXIO_SPI_Type structure.
handle	Pointer to the flexio_spi_master_handle_t structure to store the transfer state.
callback	The callback function.
userData	The parameter of the callback function.

Return values

kStatus_Success	Successfully create the handle.
kStatus_OutOfRange	The FlexIO type/handle/ISR table out of range.

24.7.7.22 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

base	Pointer to the FLEXIO_SPI_Type structure.
handle	Pointer to the flexio_spi_master_handle_t structure to store the transfer state.
xfer	FlexIO SPI transfer structure. See flexio_spi_transfer_t.

Return values

kStatus_Success	Successfully start a transfer.
kStatus_InvalidArgument	Input argument is invalid.
kStatus_FLEXIO_SPI_-Busy	SPI is not idle, is running another transfer.

24.7.7.23 void FLEXIO_SPI_MasterTransferAbort (FLEXIO_SPI_Type ∗ *base*, flexio_spi_master_handle_t ∗ *handle*)

Parameters

base	Pointer to the FLEXIO_SPI_Type structure.
handle	Pointer to the flexio_spi_master_handle_t structure to store the transfer state.

24.7.7.24 status_t FLEXIO_SPI_MasterTransferGetCount (FLEXIO_SPI_Type ∗ *base*, flexio_spi_master_handle_t ∗ *handle*, size_t ∗ *count*)

Parameters

base	Pointer to the FLEXIO_SPI_Type structure.
handle	Pointer to the flexio_spi_master_handle_t structure to store the transfer state.
count	Number of bytes transferred so far by the non-blocking transaction.

Return values

kStatus_InvalidArgument	count is Invalid.
kStatus_Success	Successfully return the count.

24.7.7.25 void FLEXIO_SPI_MasterTransferHandleIRQ (void ∗ *spiType*, void ∗ *spiHandle*)

Parameters

spiType	Pointer to the FLEXIO_SPI_Type structure.
spiHandle	Pointer to the flexio_spi_master_handle_t structure to store the transfer state.

24.7.7.26 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

base	Pointer to the FLEXIO_SPI_Type structure.
handle	Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.
callback	The callback function.
userData	The parameter of the callback function.

Return values

kStatus_Success	Successfully create the handle.
kStatus_OutOfRange	The FlexIO type/handle/ISR table out of range.

24.7.7.27 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

handle	Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.
base	Pointer to the FLEXIO_SPI_Type structure.
xfer	FlexIO SPI transfer structure. See flexio_spi_transfer_t.

Return values

kStatus_Success	Successfully start a transfer.
kStatus_InvalidArgument	Input argument is invalid.
kStatus_FLEXIO_SPI_-Busy	SPI is not idle; it is running another transfer.

24.7.7.28 static void FLEXIO_SPI_SlaveTransferAbort (FLEXIO_SPI_Type ∗ *base*, flexio_spi_slave_handle_t ∗ *handle*) [inline], [static]

Parameters

base	Pointer to the FLEXIO_SPI_Type structure.
handle	Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.

24.7.7.29 static status_t FLEXIO_SPI_SlaveTransferGetCount (FLEXIO_SPI_Type ∗ *base*, flexio_spi_slave_handle_t ∗ *handle*, size_t ∗ *count*) [inline], [static]

Parameters

base	Pointer to the FLEXIO_SPI_Type structure.
handle	Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.
count	Number of bytes transferred so far by the non-blocking transaction.

Return values

kStatus_InvalidArgument	count is Invalid.
kStatus_Success	Successfully return the count.

24.7.7.30 void FLEXIO_SPI_SlaveTransferHandleIRQ (void ∗ *spiType*, void ∗ *spiHandle*)

Parameters

spiType	Pointer to the FLEXIO_SPI_Type structure.
spiHandle	Pointer to the flexio_spi_slave_handle_t structure to store the transfer state.

24.7.8 FlexIO eDMA SPI Driver

24.7.8.1 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, 2, 1))
  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.

24.7.8.2 Data Structure Documentation

24.7.8.2.1 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

24.7.8.3 Macro Definition Documentation

24.7.8.3.1 #define FSL_FLEXIO_SPI_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 2, 1))

24.7.8.4 Typedef Documentation

24.7.8.4.1 typedef flexio_spi_master_edma_handle_t flexio_spi_slave_edma_handle_t

24.7.8.5 Function Documentation

24.7.8.5.1 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

base	Pointer to FLEXIO_SPI_Type structure.
handle	Pointer to flexio_spi_master_edma_handle_t structure to store the transfer state.
callback	SPI callback, NULL means no callback.
userData	callback function parameter.
txHandle	User requested eDMA handle for FlexIO SPI RX eDMA transfer.
rxHandle	User requested eDMA handle for FlexIO SPI TX eDMA transfer.

Return values

kStatus_Success	Successfully create the handle.
kStatus_OutOfRange	The FlexIO SPI eDMA type/handle table out of range.

24.7.8.5.2 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

base	Pointer to FLEXIO_SPI_Type structure.

handle	Pointer to flexio_spi_master_edma_handle_t structure to store the transfer state.
xfer	Pointer to FlexIO SPI transfer structure.

Return values

kStatus_Success	Successfully start a transfer.
kStatus_InvalidArgument	Input argument is invalid.
kStatus_FLEXIO_SPI_-Busy	FlexIO SPI is not idle, is running another transfer.

24.7.8.5.3 void FLEXIO_SPI_MasterTransferAbortEDMA (FLEXIO_SPI_Type ∗ *base*, flexio_spi_master_edma_handle_t ∗ *handle*)

Parameters

base	Pointer to FLEXIO_SPI_Type structure.
handle	FlexIO SPI eDMA handle pointer.

24.7.8.5.4 status_t FLEXIO_SPI_MasterTransferGetCountEDMA (FLEXIO_SPI_Type ∗ *base*, flexio_spi_master_edma_handle_t ∗ *handle*, size_t ∗ *count*)

Parameters

base	Pointer to FLEXIO_SPI_Type structure.
handle	FlexIO SPI eDMA handle pointer.
count	Number of bytes transferred so far by the non-blocking transaction.

24.7.8.5.5 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

base	Pointer to FLEXIO_SPI_Type structure.
handle	Pointer to flexio_spi_slave_edma_handle_t structure to store the transfer state.
callback	SPI callback, NULL means no callback.
userData	callback function parameter.
txHandle	User requested eDMA handle for FlexIO SPI TX eDMA transfer.
rxHandle	User requested eDMA handle for FlexIO SPI RX eDMA transfer.

24.7.8.5.6 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

base	Pointer to FLEXIO_SPI_Type structure.
handle	Pointer to flexio_spi_slave_edma_handle_t structure to store the transfer state.
xfer	Pointer to FlexIO SPI transfer structure.

Return values

kStatus_Success	Successfully start a transfer.
kStatus_InvalidArgument	Input argument is invalid.
kStatus_FLEXIO_SPI_Busy	FlexIO SPI is not idle, is running another transfer.

24.7.8.5.7 static void FLEXIO_SPI_SlaveTransferAbortEDMA (FLEXIO_SPI_Type * *base*, flexio_spi_slave_edma_handle_t * *handle*) `[inline], [static]`

Parameters

base	Pointer to FLEXIO_SPI_Type structure.
handle	Pointer to flexio_spi_slave_edma_handle_t structure to store the transfer state.

24.7.8.5.8 static status_t FLEXIO_SPI_SlaveTransferGetCountEDMA (FLEXIO_SPI_Type * *base*, flexio_spi_slave_edma_handle_t * *handle*, size_t * *count*) [inline], [static]

Parameters

base	Pointer to FLEXIO_SPI_Type structure.
handle	FlexIO SPI eDMA handle pointer.
count	Number of bytes transferred so far by the non-blocking transaction.

24.8 FlexIO UART Driver

24.8.1 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 the 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.

24.8.2 Typical use case

24.8.2.1 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);
}
```

24.8.2.2 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)
    {
    }

    // ...
}
```

24.8.2.3 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)
        {
        }
    }

    // ...
}
```

24.8.2.4 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 */
#if defined(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 */

#if defined(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);
```

```
        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 *user-Config, 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.

24.8.3 Data Structure Documentation

24.8.3.1 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]

24.8.3.2 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

24.8.3.3 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

24.8.3.4 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

24.8.4 Macro Definition Documentation

24.8.4.1 #define FSL_FLEXIO_UART_DRIVER_VERSION (MAKE_VERSION(2, 4, 0))

24.8.4.2 #define UART_RETRY_TIMES 0U /∗ Defining to zero means to keep waiting for the flag until it is assert/deassert. ∗/

24.8.5 Typedef Documentation

24.8.5.1 typedef void(∗ flexio_uart_transfer_callback_t)(FLEXIO_UART_Type ∗base, flexio_uart_handle_t ∗handle, status_t status, void ∗userData)

24.8.6 Enumeration Type Documentation

24.8.6.1 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.

24.8.6.2 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

24.8.6.3 enum _flexio_uart_interrupt_enable

Enumerator

kFLEXIO_UART_TxDataRegEmptyInterruptEnable Transmit buffer empty interrupt enable.
kFLEXIO_UART_RxDataRegFullInterruptEnable Receive buffer full interrupt enable.

24.8.6.4 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.

24.8.7 Function Documentation

24.8.7.1 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

base	Pointer to the FLEXIO_UART_Type structure.
userConfig	Pointer to the flexio_uart_config_t structure.
srcClock_Hz	FlexIO source clock in Hz.

Return values

kStatus_Success	Configuration success.
kStatus_FLEXIO_UART-_BaudrateNotSupport	Baudrate is not supported for current clock source frequency.

24.8.7.2 void FLEXIO_UART_Deinit (FLEXIO_UART_Type * *base*)

Note

After calling this API, call the FLEXO_UART_Init to use the FlexIO UART module.

Parameters

base	Pointer to FLEXIO_UART_Type structure

24.8.7.3 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

userConfig	Pointer to the flexio_uart_config_t structure.

24.8.7.4 uint32_t FLEXIO_UART_GetStatusFlags (FLEXIO_UART_Type * *base*)

Parameters

base	Pointer to the FLEXIO_UART_Type structure.

Returns

FlexIO UART status flags.

24.8.7.5 void FLEXIO_UART_ClearStatusFlags (FLEXIO_UART_Type * *base*, uint32_t *mask*)

Parameters

base	Pointer to the FLEXIO_UART_Type structure.
mask	Status flag. The parameter can be any combination of the following values: • kFLEXIO_UART_TxDataRegEmptyFlag • kFLEXIO_UART_RxEmptyFlag • kFLEXIO_UART_RxOverRunFlag

24.8.7.6 void FLEXIO_UART_EnableInterrupts (FLEXIO_UART_Type * *base*, uint32_t *mask*)

This function enables the FlexIO UART interrupt.

Parameters

base	Pointer to the FLEXIO_UART_Type structure.
mask	Interrupt source.

24.8.7.7 void FLEXIO_UART_DisableInterrupts (FLEXIO_UART_Type * *base*, uint32_t *mask*)

This function disables the FlexIO UART interrupt.

Parameters

base	Pointer to the FLEXIO_UART_Type structure.
mask	Interrupt source.

24.8.7.8 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

base	Pointer to the FLEXIO_UART_Type structure.

Returns

FlexIO UART transmit data register address.

24.8.7.9 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

base	Pointer to the FLEXIO_UART_Type structure.

Returns

FlexIO UART receive data register address.

24.8.7.10 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

base	Pointer to the FLEXIO_UART_Type structure.
enable	True to enable, false to disable.

24.8.7.11 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

base	Pointer to the FLEXIO_UART_Type structure.
enable	True to enable, false to disable.

24.8.7.12 static void FLEXIO_UART_Enable (FLEXIO_UART_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	Pointer to the FLEXIO_UART_Type.
enable	True to enable, false does not have any effect.

24.8.7.13 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

base	Pointer to the FLEXIO_UART_Type structure.

buffer	The data bytes to send.

24.8.7.14 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

base	Pointer to the FLEXIO_UART_Type structure.
buffer	The buffer to store the received bytes.

24.8.7.15 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

base	Pointer to the FLEXIO_UART_Type structure.
txData	The data bytes to send.
txSize	The number of data bytes to send.

Return values

kStatus_FLEXIO_UART-_Timeout	Transmission timed out and was aborted.
kStatus_Success	Successfully wrote all data.

24.8.7.16 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

base	Pointer to the FLEXIO_UART_Type structure.
rxData	The buffer to store the received bytes.
rxSize	The number of data bytes to be received.

Return values

kStatus_FLEXIO_UART-_Timeout	Transmission timed out and was aborted.
kStatus_Success	Successfully received all data.

24.8.7.17 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

base	to FLEXIO_UART_Type structure.
handle	Pointer to the flexio_uart_handle_t structure to store the transfer state.
callback	The callback function.
userData	The parameter of the callback function.

Return values

kStatus_Success	Successfully create the handle.
kStatus_OutOfRange	The FlexIO type/handle/ISR table out of range.

24.8.7.18 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

base	Pointer to the FLEXIO_UART_Type structure.
handle	Pointer to the flexio_uart_handle_t structure to store the transfer state.
ringBuffer	Start address of ring buffer for background receiving. Pass NULL to disable the ring buffer.
ringBufferSize	Size of the ring buffer.

24.8.7.19 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

base	Pointer to the FLEXIO_UART_Type structure.
handle	Pointer to the flexio_uart_handle_t structure to store the transfer state.

24.8.7.20 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

base	Pointer to the FLEXIO_UART_Type structure.
handle	Pointer to the flexio_uart_handle_t structure to store the transfer state.
xfer	FlexIO UART transfer structure. See flexio_uart_transfer_t.

Return values

kStatus_Success	Successfully starts the data transmission.
kStatus_UART_TxBusy	Previous transmission still not finished, data not written to the TX register.

24.8.7.21 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

base	Pointer to the FLEXIO_UART_Type structure.
handle	Pointer to the flexio_uart_handle_t structure to store the transfer state.

24.8.7.22 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

base	Pointer to the FLEXIO_UART_Type structure.
handle	Pointer to the flexio_uart_handle_t structure to store the transfer state.
count	Number of bytes sent so far by the non-blocking transaction.

Return values

kStatus_NoTransferInProgress	transfer has finished or no transfer in progress.
kStatus_Success	Successfully return the count.

24.8.7.23 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_-UART_RxIdle. For example, if the upper layer needs 10 bytes but there are only 5 bytes in the ring buffer, the 5 bytes are copied to xfer->data. This function returns with the parameter `receivedBytes` set to 5. For the last 5 bytes, newly arrived data is saved from the xfer->data[5]. When 5 bytes are received, the UART driver notifies upper layer. If the RX ring buffer is not enabled, this function enables the RX and RX interrupt to receive data to xfer->data. When all data is received, the upper layer is notified.

Parameters

base	Pointer to the FLEXIO_UART_Type structure.
handle	Pointer to the flexio_uart_handle_t structure to store the transfer state.
xfer	UART transfer structure. See flexio_uart_transfer_t.
receivedBytes	Bytes received from the ring buffer directly.

Return values

kStatus_Success	Successfully queue the transfer into the transmit queue.
kStatus_FLEXIO_UART-_RxBusy	Previous receive request is not finished.

24.8.7.24 void FLEXIO_UART_TransferAbortReceive (FLEXIO_UART_Type * *base*, flexio_uart_handle_t * *handle*)

This function aborts the receive data which was using IRQ.

Parameters

base	Pointer to the FLEXIO_UART_Type structure.
handle	Pointer to the flexio_uart_handle_t structure to store the transfer state.

24.8.7.25 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

base	Pointer to the FLEXIO_UART_Type structure.
handle	Pointer to the flexio_uart_handle_t structure to store the transfer state.
count	Number of bytes received so far by the non-blocking transaction.

Return values

kStatus_NoTransferIn-Progress	transfer has finished or no transfer in progress.
kStatus_Success	Successfully return the count.

24.8.7.26 void FLEXIO_UART_TransferHandleIRQ (void ∗ *uartType,* void ∗ *uartHandle*)

This function processes the FlexIO UART transmit and receives the IRQ request.

Parameters

uartType	Pointer to the FLEXIO_UART_Type structure.
uartHandle	Pointer to the flexio_uart_handle_t structure to store the transfer state.

24.8.8 FlexIO eDMA UART Driver

24.8.8.1 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.

24.8.8.2 Data Structure Documentation

24.8.8.2.1 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

24.8.8.3 Macro Definition Documentation

24.8.8.3.1 #define FSL_FLEXIO_UART_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 4, 1))

24.8.8.4 Typedef Documentation

24.8.8.4.1 typedef void(∗ flexio_uart_edma_transfer_callback_t)(FLEXIO_UART_Type ∗base, flexio_uart_edma_handle_t ∗handle, status_t status, void ∗userData)

24.8.8.5 Function Documentation

24.8.8.5.1 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

base	Pointer to FLEXIO_UART_Type.
handle	Pointer to flexio_uart_edma_handle_t structure.
callback	The callback function.
userData	The parameter of the callback function.
rxEdmaHandle	User requested DMA handle for RX DMA transfer.
txEdmaHandle	User requested DMA handle for TX DMA transfer.

Return values

kStatus_Success	Successfully create the handle.
kStatus_OutOfRange	The FlexIO SPI eDMA type/handle table out of range.

24.8.8.5.2 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

base	Pointer to FLEXIO_UART_Type
handle	UART handle pointer.
xfer	UART eDMA transfer structure, see flexio_uart_transfer_t.

Return values

kStatus_Success	if succeed, others failed.
kStatus_FLEXIO_UART-_TxBusy	Previous transfer on going.

24.8.8.5.3 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

base	Pointer to FLEXIO_UART_Type
handle	Pointer to flexio_uart_edma_handle_t structure
xfer	UART eDMA transfer structure, see flexio_uart_transfer_t.

Return values

kStatus_Success	if succeed, others failed.
kStatus_UART_RxBusy	Previous transfer on going.

24.8.8.5.4 void FLEXIO_UART_TransferAbortSendEDMA (FLEXIO_UART_Type * *base*, flexio_uart_edma_handle_t * *handle*)

This function aborts sent data which using eDMA.

Parameters

base	Pointer to FLEXIO_UART_Type
handle	Pointer to flexio_uart_edma_handle_t structure

24.8.8.5.5 void FLEXIO_UART_TransferAbortReceiveEDMA (FLEXIO_UART_Type * *base*, flexio_uart_edma_handle_t * *handle*)

This function aborts the receive data which using eDMA.

Parameters

base	Pointer to FLEXIO_UART_Type
handle	Pointer to flexio_uart_edma_handle_t structure

24.8.8.5.6 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

base	Pointer to FLEXIO_UART_Type
handle	Pointer to flexio_uart_edma_handle_t structure
count	Number of bytes sent so far by the non-blocking transaction.

Return values

kStatus_NoTransferInProgress	transfer has finished or no transfer in progress.
kStatus_Success	Successfully return the count.

24.8.8.5.7 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

base	Pointer to FLEXIO_UART_Type
handle	Pointer to flexio_uart_edma_handle_t structure
count	Number of bytes received so far by the non-blocking transaction.

Return values

kStatus_NoTransferInProgress	transfer has finished or no transfer in progress.

kStatus_Success	Successfully return the count.

Chapter 25
FLEXRAM: on-chip RAM manager

25.1 Overview

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

The FLEXRAM module intergrates 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_OCRAMAccessError = 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, 1U, 0U))
  Driver version 2.1.0.

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.

25.2 Macro Definition Documentation

25.2.1 #define FSL_FLEXRAM_DRIVER_VERSION (MAKE_VERSION(2U, 1U, 0U))

25.2.2 #define FLEXRAM_ECC_ERROR_DETAILED_INFO 0U /∗ Define to zero means get raw ECC error information, which needs parse it by user. ∗/

25.3 Enumeration Type Documentation

25.3.1 anonymous enum

Enumerator

kFLEXRAM_Read read
kFLEXRAM_Write write

25.3.2 anonymous enum

Enumerator

kFLEXRAM_OCRAMAccessError OCRAM accesses unallocated address.
kFLEXRAM_DTCMAccessError DTCM accesses unallocated address.
kFLEXRAM_ITCMAccessError ITCM accesses unallocated address.
kFLEXRAM_InterruptStatusAll all the interrupt status mask

25.3.3 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 better.

Enumerator

kFLEXRAM_TCMAccessFastMode fast access mode
kFLEXRAM_TCMAccessWaitMode wait access mode

25.3.4 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.

25.4 Function Documentation

25.4.1 void FLEXRAM_Init (FLEXRAM_Type ∗ *base*)

Parameters

base	FLEXRAM base address.

25.4.2 static uint32_t FLEXRAM_GetInterruptStatus (FLEXRAM_Type * *base*) [inline], [static]

Parameters

base	FLEXRAM base address.

25.4.3 static void FLEXRAM_ClearInterruptStatus (FLEXRAM_Type * *base,* uint32_t *status*) [inline], [static]

Parameters

base	FLEXRAM base address.
status	Status to be cleared.

25.4.4 static void FLEXRAM_EnableInterruptStatus (FLEXRAM_Type * *base,* uint32_t *status*) [inline], [static]

Parameters

base	FLEXRAM base address.
status	Status to be enabled.

25.4.5 static void FLEXRAM_DisableInterruptStatus (FLEXRAM_Type * *base,* uint32_t *status*) [inline], [static]

Parameters

base	FLEXRAM base address.
status	Status to be disabled.

25.4.6 static void FLEXRAM_EnableInterruptSignal (FLEXRAM_Type * *base*, uint32_t *status*) [inline], [static]

Parameters

base	FLEXRAM base address.
status	Status interrupt to be enabled.

25.4.7 static void FLEXRAM_DisableInterruptSignal (FLEXRAM_Type * *base*, uint32_t *status*) [inline], [static]

Parameters

base	FLEXRAM base address.
status	Status interrupt to be disabled.

25.4.8 static void FLEXRAM_SetTCMReadAccessMode (FLEXRAM_Type * *base*, flexram_tcm_access_mode_t *mode*) [inline], [static]

Parameters

base	FLEXRAM base address.
mode	Access mode.

25.4.9 static void FLEXRAM_SetTCMWriteAccessMode (FLEXRAM_Type * *base*, flexram_tcm_access_mode_t *mode*) [inline], [static]

Parameters

base	FLEXRAM base address.
mode	Access mode.

25.4.10 static void FLEXRAM_EnableForceRamClockOn (FLEXRAM_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	FLEXRAM base address.
enable	Enable or disable clock force on.

Chapter 26
FLEXSPI: Flexible Serial Peripheral Interface Driver

26.1 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, 5))

  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.

26.2 Data Structure Documentation

26.2.1 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

26.2.2 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

26.2.3 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

26.2.4 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

26.3 Macro Definition Documentation

26.3.1 #define FSL_FLEXSPI_DRIVER_VERSION (MAKE_VERSION(2, 3, 5))

26.3.2 #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))
```

26.4 Typedef Documentation

26.4.1 typedef void(∗ flexspi_transfer_callback_t)(FLEXSPI_Type ∗base, flexspi_handle_t ∗handle, status_t status, void ∗userData)

26.5 Enumeration Type Documentation

26.5.1 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.

26.5.2 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.

26.5.3 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].

26.5.4 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.

26.5.5 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.

26.5.6 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.

26.5.7 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.

26.5.8 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_RWDS_SDR used in DDR sequence.
kFLEXSPI_IpCmdErrorDdrDummyInSdrSequence Instruction DUMMY_DDR/DUMMY_RWDS_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.

26.5.9 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_RWDS_SDR used in DDR sequence.
kFLEXSPI_AhbCmdErrorDdrDummyInSdrSequence Instruction DUMMY_DDR/DUMMY_RWDS_DDR used in SDR sequence.
kFLEXSPI_AhbCmdSequenceExecutionTimeout Sequence execution timeout.

26.5.10 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.

26.5.11 enum flexspi_arb_command_source_t

26.5.12 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.

26.6 Function Documentation

26.6.1 uint32_t FLEXSPI_GetInstance (FLEXSPI_Type ∗ *base*)

Parameters

base	FLEXSPI base pointer.

26.6.2 status_t FLEXSPI_CheckAndClearError (FLEXSPI_Type ∗ *base,* uint32_t *status*)

Parameters

base	FLEXSPI base pointer.
status	interrupt status.

26.6.3 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

base	FLEXSPI peripheral base address.
config	FLEXSPI configure structure.

26.6.4 void FLEXSPI_GetDefaultConfig (flexspi_config_t ∗ *config*)

Parameters

config	FLEXSPI configuration structure.

26.6.5 void FLEXSPI_Deinit (FLEXSPI_Type * *base*)

Clears the FLEXSPI state and FLEXSPI module registers.

Parameters

base	FLEXSPI peripheral base address.

26.6.6 void FLEXSPI_UpdateDllValue (FLEXSPI_Type * *base*, flexspi_device_config_t * *config*, flexspi_port_t *port*)

Parameters

base	FLEXSPI peripheral base address.
config	Flash configuration parameters.
port	FLEXSPI Operation port.

26.6.7 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

base	FLEXSPI peripheral base address.
config	Flash configuration parameters.
port	FLEXSPI Operation port.

26.6.8 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

base	FLEXSPI peripheral base address.

26.6.9 static void FLEXSPI_Enable (FLEXSPI_Type ∗ *base,* bool *enable*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.
enable	True means enable FLEXSPI, false means disable.

26.6.10 static void FLEXSPI_EnableInterrupts (FLEXSPI_Type ∗ *base,* uint32_t *mask*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.
mask	FLEXSPI interrupt source.

26.6.11 static void FLEXSPI_DisableInterrupts (FLEXSPI_Type ∗ *base,* uint32_t *mask*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.
mask	FLEXSPI interrupt source.

26.6.12 static void FLEXSPI_EnableTxDMA (FLEXSPI_Type ∗ *base,* bool *enable*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.
enable	Enable flag for transmit DMA request. Pass true for enable, false for disable.

26.6.13 static void FLEXSPI_EnableRxDMA (FLEXSPI_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.
enable	Enable flag for receive DMA request. Pass true for enable, false for disable.

26.6.14 static uint32_t FLEXSPI_GetTxFifoAddress (FLEXSPI_Type * *base*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.

Return values

The	tx fifo address.

26.6.15 static uint32_t FLEXSPI_GetRxFifoAddress (FLEXSPI_Type * *base*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.

Return values

The	rx fifo address.

26.6.16 static void FLEXSPI_ResetFifos (FLEXSPI_Type * *base,* bool *txFifo,* bool *rxFifo*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.
txFifo	Pass true to reset TX FIFO.
rxFifo	Pass true to reset RX FIFO.

26.6.17 static void FLEXSPI_GetFifoCounts (FLEXSPI_Type * *base,* size_t * *txCount,* size_t * *rxCount*) [inline], [static]

Parameters

	base	FLEXSPI peripheral base address.
out	*txCount*	Pointer through which the current number of bytes in the transmit FIFO is returned. Pass NULL if this value is not required.
out	*rxCount*	Pointer through which the current number of bytes in the receive FIFO is returned. Pass NULL if this value is not required.

26.6.18 static uint32_t FLEXSPI_GetInterruptStatusFlags (FLEXSPI_Type * *base*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.

Return values

interrupt	status flag, use status flag to AND flexspi_flags_t could get the related status.

26.6.19 static void FLEXSPI_ClearInterruptStatusFlags (FLEXSPI_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.
mask	FLEXSPI interrupt source.

26.6.20 static flexspi_arb_command_source_t FLEXSPI_GetArbitrator-CommandSource (FLEXSPI_Type * *base*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.

Return values

trigger	source of current command sequence.

26.6.21 static flexspi_ip_error_code_t FLEXSPI_GetIPCommandErrorCode (FLEXSPI_Type * *base,* uint8_t * *index*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.
index	Pointer to a uint8_t type variable to receive the sequence index when error detected.

Return values

error	code when IP command error detected.

26.6.22 static flexspi_ahb_error_code_t FLEXSPI_GetAHBCommandErrorCode (FLEXSPI_Type * *base,* uint8_t * *index*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.
index	Pointer to a uint8_t type variable to receive the sequence index when error detected.

Return values

error	code when AHB command error detected.

26.6.23 static bool FLEXSPI_GetBusIdleStatus (FLEXSPI_Type * *base*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.

Return values

true	Bus is idle.
false	Bus is busy.

26.6.24 void FLEXSPI_UpdateRxSampleClock (FLEXSPI_Type * *base*, flexspi_read_sample_clock_t *clockSource*)

Parameters

base	FLEXSPI peripheral base address.
clockSource	clockSource of type flexspi_read_sample_clock_t

26.6.25 static void FLEXSPI_EnableIPParallelMode (FLEXSPI_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.
enable	True means enable parallel mode, false means disable parallel mode.

26.6.26 static void FLEXSPI_EnableAHBParallelMode (FLEXSPI_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	FLEXSPI peripheral base address.
enable	True means enable parallel mode, false means disable parallel mode.

26.6.27 void FLEXSPI_UpdateLUT (FLEXSPI_Type ∗ *base,* uint32_t *index,* const uint32_t ∗ *cmd,* uint32_t *count*)

Parameters

base	FLEXSPI peripheral base address.
index	From which index start to update. It could be any index of the LUT table, which also allows user to update command content inside a command. Each command consists of up to 8 instructions and occupy 4∗32-bit memory.
cmd	Command sequence array.
count	Number of sequences.

26.6.28 static void FLEXSPI_WriteData (FLEXSPI_Type ∗ *base,* uint32_t *data,* uint8_t *fifoIndex*) `[inline],[static]`

Parameters

base	FLEXSPI peripheral base address
data	The data bytes to send
fifoIndex	Destination fifo index.

26.6.29 static uint32_t FLEXSPI_ReadData (FLEXSPI_Type ∗ *base,* uint8_t *fifoIndex*) `[inline],[static]`

Parameters

base	FLEXSPI peripheral base address
fifoIndex	Source fifo index.

Returns

The data in the FIFO.

26.6.30 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

base	FLEXSPI peripheral base address
buffer	The data bytes to send
size	The number of data bytes to send

Return values

kStatus_Success	write success without error
kStatus_FLEXSPI_-SequenceExecution-Timeout	sequence execution timeout
kStatus_FLEXSPI_Ip-CommandSequenceError	IP command sequence error detected
kStatus_FLEXSPI_Ip-CommandGrantTimeout	IP command grant timeout detected

26.6.31 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

base	FLEXSPI peripheral base address
buffer	The data bytes to send
size	The number of data bytes to receive

Return values

kStatus_Success	read success without error
kStatus_FLEXSPI_-SequenceExecution-Timeout	sequence execution timeout
kStatus_FLEXSPI_Ip-CommandSequenceError	IP command sequencen error detected
kStatus_FLEXSPI_Ip-CommandGrantTimeout	IP command grant timeout detected

26.6.32 status_t FLEXSPI_TransferBlocking (FLEXSPI_Type * *base*, flexspi_transfer_t * *xfer*)

Parameters

base	FLEXSPI peripheral base address
xfer	pointer to the transfer structure.

Return values

kStatus_Success	command transfer success without error
kStatus_FLEXSPI_-SequenceExecution-Timeout	sequence execution timeout
kStatus_FLEXSPI_Ip-CommandSequenceError	IP command sequence error detected
kStatus_FLEXSPI_Ip-CommandGrantTimeout	IP command grant timeout detected

26.6.33 void FLEXSPI_TransferCreateHandle (FLEXSPI_Type * *base*, flexspi_handle_t * *handle*, flexspi_transfer_callback_t *callback*, void * *userData*)

Parameters

base	FLEXSPI peripheral base address.
handle	pointer to flexspi_handle_t structure to store the transfer state.
callback	pointer to user callback function.
userData	user parameter passed to the callback function.

26.6.34 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

base	FLEXSPI peripheral base address.
handle	pointer to flexspi_handle_t structure which stores the transfer state.
xfer	pointer to flexspi_transfer_t structure.

Return values

kStatus_Success	Successfully start the data transmission.
kStatus_FLEXSPI_Busy	Previous transmission still not finished.

26.6.35 status_t FLEXSPI_TransferGetCount (FLEXSPI_Type * *base*, flexspi_handle_t * *handle*, size_t * *count*)

Parameters

base	FLEXSPI peripheral base address.
handle	pointer to flexspi_handle_t structure which stores the transfer state.
count	Number of bytes transferred so far by the non-blocking transaction.

Return values

kStatus_InvalidArgument	count is Invalid.
kStatus_Success	Successfully return the count.

26.6.36 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

base	FLEXSPI peripheral base address.
handle	pointer to flexspi_handle_t structure which stores the transfer state

26.6.37 void FLEXSPI_TransferHandleIRQ (FLEXSPI_Type * *base,* flexspi_handle_t * *handle*)

Parameters

base	FLEXSPI peripheral base address.
handle	pointer to flexspi_handle_t structure.

Chapter 27
GPC: General Power Controller Driver

27.1 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.

27.2 Macro Definition Documentation

27.2.1 #define FSL_GPC_DRIVER_VERSION (MAKE_VERSION(2, 1, 1))

27.3 Function Documentation

27.3.1 void GPC_EnableIRQ (GPC_Type ∗ *base,* uint32_t *irqId*)

Parameters

base	GPC peripheral base address.
irqId	ID number of IRQ to be enabled, available range is 32-159. 0-31 is available in some platforms.

27.3.2 void GPC_DisableIRQ (GPC_Type ∗ *base,* uint32_t *irqId*)

Parameters

base	GPC peripheral base address.
irqId	ID number of IRQ to be disabled, available range is 32-159. 0-31 is available in some platforms.

27.3.3 bool GPC_GetIRQStatusFlag (GPC_Type ∗ *base,* uint32_t *irqId*)

Parameters

base	GPC peripheral base address.
irqId	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.

27.3.4 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

base	GPC peripheral base address.
enable	Enable the request or not.

27.3.5 static void GPC_RequestMEGAPowerOn (GPC_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	GPC peripheral base address.
enable	Enable the power on sequence, or the power down sequence.

Chapter 28
GPT: General Purpose Timer

28.1 Overview

The MCUXpresso SDK provides a driver for the General Purpose Timer (GPT) of MCUXpresso SDK devices.

28.2 Function groups

The gpt driver supports the generation of PWM signals, input capture, and setting up the timer match conditions.

28.2.1 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.

28.3 Typical use case

28.3.1 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, 3))

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.

28.4 Data Structure Documentation

28.4.1 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

28.5 Enumeration Type Documentation

28.5.1 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.

28.5.2 enum gpt_input_capture_channel_t

Enumerator

kGPT_InputCapture_Channel1 GPT Input Capture Channel1.
kGPT_InputCapture_Channel2 GPT Input Capture Channel2.

28.5.3 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.

28.5.4 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.

28.5.5 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.

28.5.6 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.

28.5.7 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.

28.6 Function Documentation

28.6.1 void GPT_Init (GPT_Type ∗ *base,* const gpt_config_t ∗ *initConfig*)

Parameters

base	GPT peripheral base address.
initConfig	GPT mode setting configuration.

28.6.2 void GPT_Deinit (GPT_Type ∗ *base*)

Parameters

base	GPT peripheral base address.

28.6.3 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

config	Pointer to the user configuration structure.

28.6.4 static void GPT_SoftwareReset (GPT_Type * *base*) [inline], [static]

Parameters

base	GPT peripheral base address.

28.6.5 static void GPT_SetClockSource (GPT_Type * *base*, gpt_clock_source_t *gptClkSource*) [inline], [static]

Parameters

base	GPT peripheral base address.
gptClkSource	Clock source (see gpt_clock_source_t typedef enumeration).

28.6.6 static gpt_clock_source_t GPT_GetClockSource (GPT_Type * *base*) [inline], [static]

Parameters

base	GPT peripheral base address.

Returns

clock source (see gpt_clock_source_t typedef enumeration).

28.6.7 static void GPT_SetClockDivider (GPT_Type * *base*, uint32_t *divider*) [inline], [static]

Parameters

base	GPT peripheral base address.
divider	Divider of GPT (1-4096).

28.6.8 static uint32_t GPT_GetClockDivider (GPT_Type * *base*) [inline], [static]

Parameters

base	GPT peripheral base address.

Returns

clock divider in GPT module (1-4096).

28.6.9 static void GPT_SetOscClockDivider (GPT_Type * *base,* uint32_t *divider*) [inline], [static]

Parameters

base	GPT peripheral base address.
divider	OSC Divider(1-16).

28.6.10 static uint32_t GPT_GetOscClockDivider (GPT_Type * *base*) [inline], [static]

Parameters

base	GPT peripheral base address.

Returns

OSC clock divider in GPT module (1-16).

28.6.11 static void GPT_StartTimer (GPT_Type * *base*) [inline], [static]

Parameters

base	GPT peripheral base address.

28.6.12 static void GPT_StopTimer (GPT_Type * *base*) [inline], [static]

Parameters

base	GPT peripheral base address.

28.6.13 static uint32_t GPT_GetCurrentTimerCount (GPT_Type * *base*) [inline], [static]

Parameters

base	GPT peripheral base address.

Returns

Current GPT counter value.

28.6.14 static void GPT_SetInputOperationMode (GPT_Type * *base*, gpt_input_capture_channel_t *channel*, gpt_input_operation_mode_t *mode*) [inline], [static]

Parameters

base	GPT peripheral base address.
channel	GPT capture channel (see gpt_input_capture_channel_t typedef enumeration).
mode	GPT input capture operation mode (see gpt_input_operation_mode_t typedef enumeration).

28.6.15 static gpt_input_operation_mode_t GPT_GetInputOperationMode (GPT_Type * *base*, gpt_input_capture_channel_t *channel*) [inline], [static]

Parameters

base	GPT peripheral base address.
channel	GPT capture channel (see gpt_input_capture_channel_t typedef enumeration).

Returns

GPT input capture operation mode (see gpt_input_operation_mode_t typedef enumeration).

28.6.16 static uint32_t GPT_GetInputCaptureValue (GPT_Type * *base*, gpt_input_capture_channel_t *channel*) [inline], [static]

Parameters

base	GPT peripheral base address.
channel	GPT capture channel (see gpt_input_capture_channel_t typedef enumeration).

Returns

GPT input capture value.

28.6.17 static void GPT_SetOutputOperationMode (GPT_Type * *base*, gpt_output_compare_channel_t *channel*, gpt_output_operation_mode_t *mode*) [inline], [static]

Parameters

base	GPT peripheral base address.
channel	GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).
mode	GPT output operation mode (see gpt_output_operation_mode_t typedef enumeration).

28.6.18 static gpt_output_operation_mode_t GPT_GetOutputOperationMode (GPT_Type * *base*, gpt_output_compare_channel_t *channel*) [inline], [static]

Parameters

base	GPT peripheral base address.
channel	GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).

Returns

GPT output operation mode (see gpt_output_operation_mode_t typedef enumeration).

28.6.19 static void GPT_SetOutputCompareValue (GPT_Type * *base*, gpt_output_compare_channel_t *channel*, uint32_t *value*) [inline], [static]

Parameters

base	GPT peripheral base address.
channel	GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).
value	GPT output compare value.

28.6.20 static uint32_t GPT_GetOutputCompareValue (GPT_Type * *base*, gpt_output_compare_channel_t *channel*) [inline], [static]

Parameters

base	GPT peripheral base address.
channel	GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).

Returns

GPT output compare value.

28.6.21 static void GPT_ForceOutput (GPT_Type * *base*, gpt_output_compare_-channel_t *channel*) [inline], [static]

Parameters

base	GPT peripheral base address.
channel	GPT output compare channel (see gpt_output_compare_channel_t typedef enumeration).

28.6.22 static void GPT_EnableInterrupts (GPT_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	GPT peripheral base address.
mask	The interrupts to enable. This is a logical OR of members of the enumeration gpt_-interrupt_enable_t

28.6.23 static void GPT_DisableInterrupts (GPT_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	GPT peripheral base address
mask	The interrupts to disable. This is a logical OR of members of the enumeration gpt_-interrupt_enable_t

28.6.24 static uint32_t GPT_GetEnabledInterrupts (GPT_Type * *base*) [inline], [static]

Parameters

base	GPT peripheral base address

Returns

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

28.6.25 static uint32_t GPT_GetStatusFlags (GPT_Type * *base*, gpt_status_flag_t *flags*) [inline], [static]

Parameters

base	GPT peripheral base address.
flags	GPT status flag mask (see gpt_status_flag_t for bit definition).

Returns

GPT status, each bit represents one status flag.

28.6.26 static void GPT_ClearStatusFlags (GPT_Type * *base*, gpt_status_flag_t *flags*) [inline], [static]

Parameters

base	GPT peripheral base address.
flags	GPT status flag mask (see gpt_status_flag_t for bit definition).

Chapter 29
GPIO: General-Purpose Input/Output Driver

29.1 Overview

The MCUXpresso SDK provides a peripheral driver for the General-Purpose Input/Output (GPIO) module of MCUXpresso SDK devices.

29.2 Typical use case

29.2.1 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, 5))
  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.

29.3 Data Structure Documentation

29.3.1 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

29.4 Macro Definition Documentation

29.4.1 #define FSL_GPIO_DRIVER_VERSION (MAKE_VERSION(2, 0, 5))

29.5 Enumeration Type Documentation

29.5.1 enum gpio_pin_direction_t

Enumerator

kGPIO_DigitalInput Set current pin as digital input.
kGPIO_DigitalOutput Set current pin as digital output.

29.5.2 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.

29.6 Function Documentation

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

Parameters

base	GPIO base pointer.
pin	Specifies the pin number
Config	pointer to a gpio_pin_config_t structure that contains the configuration information.

29.6.2 void GPIO_PinWrite (GPIO_Type ∗ *base,* uint32_t *pin,* uint8_t *output*)

Parameters

base	GPIO base pointer.
pin	GPIO port pin number.
output	GPIOpin output logic level. • 0: corresponding pin output low-logic level. • 1: corresponding pin output high-logic level.

29.6.3 static void GPIO_WritePinOutput (GPIO_Type ∗ *base,* uint32_t *pin,* uint8_t *output*) `[inline], [static]`

Deprecated Do not use this function. It has been superceded by GPIO_PinWrite.

29.6.4 static void GPIO_PortSet (GPIO_Type ∗ *base,* uint32_t *mask*) `[inline], [static]`

Parameters

base	GPIO peripheral base pointer (GPIO1, GPIO2, GPIO3, and so on.)
mask	GPIO pin number macro

29.6.5 static void GPIO_SetPinsOutput (GPIO_Type ∗ *base,* uint32_t *mask*) `[inline], [static]`

Deprecated Do not use this function. It has been superceded by GPIO_PortSet.

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

Parameters

base	GPIO peripheral base pointer (GPIO1, GPIO2, GPIO3, and so on.)
mask	GPIO pin number macro

29.6.7 static void GPIO_ClearPinsOutput (GPIO_Type * *base*, uint32_t *mask*) [inline], [static]

Deprecated Do not use this function. It has been superceded by GPIO_PortClear.

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

Parameters

base	GPIO peripheral base pointer (GPIO1, GPIO2, GPIO3, and so on.)
mask	GPIO pin number macro

29.6.9 static uint32_t GPIO_PinRead (GPIO_Type * *base*, uint32_t *pin*) [inline], [static]

Parameters

base	GPIO base pointer.
pin	GPIO port pin number.

Return values

GPIO	port input value.

29.6.10 static uint32_t GPIO_ReadPinInput (GPIO_Type * *base*, uint32_t *pin*) [inline], [static]

Deprecated Do not use this function. It has been superceded by GPIO_PinRead.

29.6.11 static uint8_t GPIO_PinReadPadStatus (GPIO_Type * *base,* uint32_t *pin*) [inline], [static]

Parameters

base	GPIO base pointer.
pin	GPIO port pin number.

Return values

GPIO	pin pad status value.

29.6.12 static uint8_t GPIO_ReadPadStatus (GPIO_Type * *base*, uint32_t *pin*) [inline], [static]

Deprecated Do not use this function. It has been superceded by GPIO_PinReadPadStatus.

29.6.13 void GPIO_PinSetInterruptConfig (GPIO_Type * *base*, uint32_t *pin*, gpio_interrupt_mode_t *pinInterruptMode*)

Parameters

base	GPIO base pointer.
pin	GPIO port pin number.
pinInterrupt-Mode	pointer to a gpio_interrupt_mode_t structure that contains the interrupt mode information.

29.6.14 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 superceded by GPIO_PinSetInterruptConfig.

29.6.15 static void GPIO_PortEnableInterrupts (GPIO_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	GPIO base pointer.
mask	GPIO pin number macro.

29.6.16 static void GPIO_EnableInterrupts (GPIO_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	GPIO base pointer.
mask	GPIO pin number macro.

29.6.17 static void GPIO_PortDisableInterrupts (GPIO_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	GPIO base pointer.
mask	GPIO pin number macro.

29.6.18 static void GPIO_DisableInterrupts (GPIO_Type * *base,* uint32_t *mask*) [inline], [static]

Deprecated Do not use this function. It has been superceded by GPIO_PortDisableInterrupts.

29.6.19 static uint32_t GPIO_PortGetInterruptFlags (GPIO_Type * *base*) [inline], [static]

Parameters

base	GPIO base pointer.

Return values

current	pin interrupt status flag.

29.6.20 static uint32_t GPIO_GetPinsInterruptFlags (GPIO_Type * *base*) [inline], [static]

Parameters

base	GPIO base pointer.

Return values

current	pin interrupt status flag.

29.6.21 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

base	GPIO base pointer.
mask	GPIO pin number macro.

29.6.22 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

base	GPIO base pointer.
mask	GPIO pin number macro.

Chapter 30
KPP: KeyPad Port Driver

30.1 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.

30.2 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.

30.3 Data Structure Documentation

30.3.1 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".

30.4 Macro Definition Documentation

30.4.1 #define FSL_KPP_DRIVER_VERSION (MAKE_VERSION(2, 0, 0))

30.5 Enumeration Type Documentation

30.5.1 enum kpp_interrupt_enable_t

This enumeration uses one-bot 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.

30.5.2 enum kpp_sync_operation_t

Enumerator

kKPP_ClearKeyDepressSyncChain Keypad depress interrupt status.
kKPP_SetKeyReleasesSyncChain Keypad release interrupt status.

30.6 Function Documentation

30.6.1 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

base	KPP peripheral base address.
configure	The KPP configuration structure pointer.

30.6.2 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

base	KPP peripheral base address.

30.6.3 static void KPP_EnableInterrupts (KPP_Type ∗ *base,* uint16_t *mask*) [inline], [static]

Parameters

base	KPP peripheral base address.
mask	KPP interrupts to enable. This is a logical OR of the enumeration :: kpp_interrupt_-enable_t.

30.6.4 static void KPP_DisableInterrupts (KPP_Type ∗ *base,* uint16_t *mask*) [inline], [static]

Parameters

base	KPP peripheral base address.
mask	KPP interrupts to disable. This is a logical OR of the enumeration :: kpp_interrupt_-enable_t.

30.6.5 static uint16_t KPP_GetStatusFlag (KPP_Type ∗ *base*) [inline], [static]

Parameters

base	KPP peripheral base address.

Returns

The status of the KPP. Application can use the enum type in the "kpp_interrupt_enable_t" to get the right status of the related event.

30.6.6 static void KPP_ClearStatusFlag (KPP_Type ∗ *base,* uint16_t *mask*) [inline], [static]

Parameters

base	KPP peripheral base address.

mask	KPP mask to be cleared. This is a logical OR of the enumeration :: kpp_interrupt_-enable_t.

30.6.7 static void KPP_SetSynchronizeChain (KPP_Type ∗ *base,* uint16_t *mask*) [inline], [static]

Parameters

base	KPP peripheral base address.
mask	KPP mask to be cleared. This is a logical OR of the enumeration :: kpp_sync_-operation_t.

30.6.8 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

base	KPP peripheral base address.
data	KPP key press scanning data. The data buffer should be prepared with length at least equal to KPP_KEYPAD_COLUMNNUM_MAX ∗ KPP_KEYPAD_ROWNUM_M-AX. the data pointer is recommended to be a array like uint8_t data[KPP_KEYPAD-_COLUMNNUM_MAX]. for example the data[2] = 4, that means in column 1 row 2 has a key press event.
clockSrc_Hz	Source clock.

Chapter 31
LPI2C: Low Power Inter-Integrated Circuit Driver

31.1 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.

31.2 Macro Definition Documentation

31.2.1 #define FSL_LPI2C_DRIVER_VERSION (MAKE_VERSION(2, 3, 1))

31.2.2 #define I2C_RETRY_TIMES 0U /∗ Define to zero means keep waiting until the flag is assert/deassert. ∗/

31.3 Enumeration Type Documentation

31.3.1 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.

31.4 LPI2C Master Driver

31.4.1 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.

31.4.2 Data Structure Documentation

31.4.2.1 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

31.4.2.2 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

31.4.2.3 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

31.4.2.4 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

31.4.3 Typedef Documentation

31.4.3.1 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

base	The LPI2C peripheral base address.
completion-Status	Either kStatus_Success or an error code describing how the transfer completed.

userData	Arbitrary pointer-sized value passed from the application.

31.4.4 Enumeration Type Documentation

31.4.4.1 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.

31.4.4.2 enum lpi2c_direction_t

Enumerator

kLPI2C_Write Master transmit.
kLPI2C_Read Master receive.

31.4.4.3 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)

31.4.4.4 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.

31.4.4.5 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.

31.4.4.6 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.

31.4.4.7 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.

31.4.5 Function Documentation

31.4.5.1 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	*masterConfig*	User provided configuration structure for default values. Refer to lpi2c_master_config_t.

31.4.5.2 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

base	The LPI2C peripheral base address.
masterConfig	User provided peripheral configuration. Use LPI2C_MasterGetDefaultConfig() to get a set of defaults that you can override.
sourceClock_Hz	Frequency in Hertz of the LPI2C functional clock. Used to calculate the baud rate divisors, filter widths, and timeout periods.

31.4.5.3 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

base	The LPI2C peripheral base address.

31.4.5.4 void LPI2C_MasterConfigureDataMatch (LPI2C_Type * *base*, const lpi2c_data_match_config_t * *matchConfig*)

Parameters

base	The LPI2C peripheral base address.
matchConfig	Settings for the data match feature.

31.4.5.5 static void LPI2C_MasterReset (LPI2C_Type * *base*) [inline], [static]

Restores the LPI2C master peripheral to reset conditions.

Parameters

base	The LPI2C peripheral base address.

31.4.5.6 static void LPI2C_MasterEnable (LPI2C_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	The LPI2C peripheral base address.
enable	Pass true to enable or false to disable the specified LPI2C as master.

31.4.5.7 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

base	The LPI2C peripheral base address.

Returns

State of the status flags:
- 1: related status flag is set.
- 0: related status flag is not set.

See Also

_lpi2c_master_flags

31.4.5.8 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

base	The LPI2C peripheral base address.
statusMask	A bitmask of status flags that are to be cleared. The mask is composed of _lpi2c_-master_flags enumerators OR'd together. You may pass the result of a previous call to LPI2C_MasterGetStatusFlags().

See Also

_lpi2c_master_flags.

31.4.5.9 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

base	The LPI2C peripheral base address.
interruptMask	Bit mask of interrupts to enable. See _lpi2c_master_flags for the set of constants that should be OR'd together to form the bit mask.

31.4.5.10 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

base	The LPI2C peripheral base address.
interruptMask	Bit mask of interrupts to disable. See _lpi2c_master_flags for the set of constants that should be OR'd together to form the bit mask.

31.4.5.11 static uint32_t LPI2C_MasterGetEnabledInterrupts (LPI2C_Type * *base*) [inline], [static]

Parameters

base	The LPI2C peripheral base address.

Returns

A bitmask composed of _lpi2c_master_flags enumerators OR'd together to indicate the set of enabled interrupts.

31.4.5.12 static void LPI2C_MasterEnableDMA (LPI2C_Type ∗ *base,* bool *enableTx,* bool *enableRx*) [inline], [static]

Parameters

base	The LPI2C peripheral base address.
enableTx	Enable flag for transmit DMA request. Pass true for enable, false for disable.
enableRx	Enable flag for receive DMA request. Pass true for enable, false for disable.

31.4.5.13 static uint32_t LPI2C_MasterGetTxFifoAddress (LPI2C_Type ∗ *base*) [inline], [static]

Parameters

base	The LPI2C peripheral base address.

Returns

The LPI2C Master Transmit Data Register address.

31.4.5.14 static uint32_t LPI2C_MasterGetRxFifoAddress (LPI2C_Type ∗ *base*) [inline], [static]

Parameters

base	The LPI2C peripheral base address.

Returns

The LPI2C Master Receive Data Register address.

31.4.5.15 static void LPI2C_MasterSetWatermarks (LPI2C_Type * *base*, size_t *txWords*, size_t *rxWords*) [inline], [static]

Parameters

base	The LPI2C peripheral base address.
txWords	Transmit FIFO watermark value in words. The kLPI2C_MasterTxReadyFlag flag is set whenever the number of words in the transmit FIFO is equal or less than *txWords*. Writing a value equal or greater than the FIFO size is truncated.
rxWords	Receive FIFO watermark value in words. The kLPI2C_MasterRxReadyFlag flag is set whenever the number of words in the receive FIFO is greater than *rxWords*. Writing a value equal or greater than the FIFO size is truncated.

31.4.5.16 static void LPI2C_MasterGetFifoCounts (LPI2C_Type * *base*, size_t * *rxCount*, size_t * *txCount*) [inline], [static]

Parameters

	base	The LPI2C peripheral base address.
out	*txCount*	Pointer through which the current number of words in the transmit FIFO is returned. Pass NULL if this value is not required.
out	*rxCount*	Pointer through which the current number of words in the receive FIFO is returned. Pass NULL if this value is not required.

31.4.5.17 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

base	The LPI2C peripheral base address.
sourceClock_-Hz	LPI2C functional clock frequency in Hertz.
baudRate_Hz	Requested bus frequency in Hertz.

31.4.5.18 static bool LPI2C_MasterGetBusIdleState (LPI2C_Type ∗ *base*) [inline], [static]

Requires the master mode to be enabled.

Parameters

base	The LPI2C peripheral base address.

Return values

true	Bus is busy.
false	Bus is idle.

31.4.5.19 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

base	The LPI2C peripheral base address.
address	7-bit slave device address, in bits [6:0].
dir	Master transfer direction, either kLPI2C_Read or kLPI2C_Write. This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.

Return values

kStatus_Success	START signal and address were successfully enqueued in the transmit FIFO.
kStatus_LPI2C_Busy	Another master is currently utilizing the bus.

31.4.5.20 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

base	The LPI2C peripheral base address.
address	7-bit slave device address, in bits [6:0].
dir	Master transfer direction, either kLPI2C_Read or kLPI2C_Write. This parameter is used to set the R/w bit (bit 0) in the transmitted slave address.

Return values

kStatus_Success	Repeated START signal and address were successfully enqueued in the transmit FIFO.
kStatus_LPI2C_Busy	Another master is currently utilizing the bus.

31.4.5.21 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

base	The LPI2C peripheral base address.
txBuff	The pointer to the data to be transferred.
txSize	The length in bytes of the data to be transferred.

Return values

kStatus_Success	Data was sent successfully.
kStatus_LPI2C_Busy	Another master is currently utilizing the bus.
kStatus_LPI2C_Nak	The slave device sent a NAK in response to a byte.
kStatus_LPI2C_FifoError	FIFO under run or over run.
kStatus_LPI2C_-ArbitrationLost	Arbitration lost error.
kStatus_LPI2C_PinLow-Timeout	SCL or SDA were held low longer than the timeout.

31.4.5.22 status_t LPI2C_MasterReceive (LPI2C_Type * *base*, void * *rxBuff*, size_t *rxSize*)

Parameters

base	The LPI2C peripheral base address.
rxBuff	The pointer to the data to be transferred.
rxSize	The length in bytes of the data to be transferred.

Return values

kStatus_Success	Data was received successfully.
kStatus_LPI2C_Busy	Another master is currently utilizing the bus.
kStatus_LPI2C_Nak	The slave device sent a NAK in response to a byte.
kStatus_LPI2C_FifoError	FIFO under run or overrun.
kStatus_LPI2C_-ArbitrationLost	Arbitration lost error.
kStatus_LPI2C_PinLow-Timeout	SCL or SDA were held low longer than the timeout.

31.4.5.23 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

base	The LPI2C peripheral base address.

Return values

kStatus_Success	The STOP signal was successfully sent on the bus and the transaction terminated.
kStatus_LPI2C_Busy	Another master is currently utilizing the bus.
kStatus_LPI2C_Nak	The slave device sent a NAK in response to a byte.
kStatus_LPI2C_FifoError	FIFO under run or overrun.
kStatus_LPI2C_-ArbitrationLost	Arbitration lost error.
kStatus_LPI2C_PinLow-Timeout	SCL or SDA were held low longer than the timeout.

31.4.5.24 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

base	The LPI2C peripheral base address.
transfer	Pointer to the transfer structure.

Return values

kStatus_Success	Data was received successfully.
kStatus_LPI2C_Busy	Another master is currently utilizing the bus.
kStatus_LPI2C_Nak	The slave device sent a NAK in response to a byte.
kStatus_LPI2C_FifoError	FIFO under run or overrun.
kStatus_LPI2C_-ArbitrationLost	Arbitration lost error.
kStatus_LPI2C_PinLow-Timeout	SCL or SDA were held low longer than the timeout.

31.4.5.25 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

	base	The LPI2C peripheral base address.
`out`	*handle*	Pointer to the LPI2C master driver handle.
	callback	User provided pointer to the asynchronous callback function.
	userData	User provided pointer to the application callback data.

31.4.5.26 status_t LPI2C_MasterTransferNonBlocking (LPI2C_Type * *base*, lpi2c_master_handle_t * *handle*, lpi2c_master_transfer_t * *transfer*)

Parameters

base	The LPI2C peripheral base address.
handle	Pointer to the LPI2C master driver handle.
transfer	The pointer to the transfer descriptor.

Return values

kStatus_Success	The transaction was started successfully.
kStatus_LPI2C_Busy	Either another master is currently utilizing the bus, or a non-blocking transaction is already in progress.

31.4.5.27 status_t LPI2C_MasterTransferGetCount (LPI2C_Type * *base*, lpi2c_master_handle_t * *handle*, size_t * *count*)

Parameters

	base	The LPI2C peripheral base address.
	handle	Pointer to the LPI2C master driver handle.
`out`	*count*	Number of bytes transferred so far by the non-blocking transaction.

Return values

kStatus_Success	
kStatus_NoTransferInProgress	There is not a non-blocking transaction currently in progress.

31.4.5.28 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

base	The LPI2C peripheral base address.
handle	Pointer to the LPI2C master driver handle.

Return values

kStatus_Success	A transaction was successfully aborted.
kStatus_LPI2C_Idle	There is not a non-blocking transaction currently in progress.

31.4.5.29 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

base	The LPI2C peripheral base address.
lpi2cMaster-Handle	Pointer to the LPI2C master driver handle.

31.5 LPI2C Slave Driver

31.5.1 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 enable-Rx, 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.

31.5.2 Data Structure Documentation

31.5.2.1 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

31.5.2.2 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

31.5.2.3 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

31.5.3 Typedef Documentation

31.5.3.1 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

base	Base address for the LPI2C instance on which the event occurred.
transfer	Pointer to transfer descriptor containing values passed to and/or from the callback.
userData	Arbitrary pointer-sized value passed from the application.

31.5.4 Enumeration Type Documentation

31.5.4.1 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.

31.5.4.2 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.

31.5.4.3 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.

31.5.5 Function Documentation

31.5.5.1 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	*slaveConfig*	User provided configuration structure that is set to default values. Refer to lpi2c_slave_config_t.

31.5.5.2 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

base	The LPI2C peripheral base address.
slaveConfig	User provided peripheral configuration. Use LPI2C_SlaveGetDefaultConfig() to get a set of defaults that you can override.
sourceClock_Hz	Frequency in Hertz of the LPI2C functional clock. Used to calculate the filter widths, data valid delay, and clock hold time.

31.5.5.3 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

base	The LPI2C peripheral base address.

31.5.5.4 static void LPI2C_SlaveReset (LPI2C_Type * *base*) [inline], [static]

Parameters

base	The LPI2C peripheral base address.

31.5.5.5 static void LPI2C_SlaveEnable (LPI2C_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	The LPI2C peripheral base address.
enable	Pass true to enable or false to disable the specified LPI2C as slave.

31.5.5.6 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

base	The LPI2C peripheral base address.

Returns

State of the status flags:
- 1: related status flag is set.
- 0: related status flag is not set.

See Also

_lpi2c_slave_flags

31.5.5.7 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

base	The LPI2C peripheral base address.
statusMask	A bitmask of status flags that are to be cleared. The mask is composed of _lpi2c_slave_flags enumerators OR'd together. You may pass the result of a previous call to LPI2C_SlaveGetStatusFlags().

See Also

_lpi2c_slave_flags.

31.5.5.8 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

base	The LPI2C peripheral base address.
interruptMask	Bit mask of interrupts to enable. See _lpi2c_slave_flags for the set of constants that should be OR'd together to form the bit mask.

31.5.5.9 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

base	The LPI2C peripheral base address.
interruptMask	Bit mask of interrupts to disable. See _lpi2c_slave_flags for the set of constants that should be OR'd together to form the bit mask.

31.5.5.10 static uint32_t LPI2C_SlaveGetEnabledInterrupts (LPI2C_Type * *base*) [inline], [static]

Parameters

base	The LPI2C peripheral base address.

Returns

A bitmask composed of _lpi2c_slave_flags enumerators OR'd together to indicate the set of enabled interrupts.

31.5.5.11 static void LPI2C_SlaveEnableDMA (LPI2C_Type * *base*, bool *enableAddressValid*, bool *enableRx*, bool *enableTx*) [inline], [static]

Parameters

base	The LPI2C peripheral base address.
enableAddressValid	Enable flag for the address valid DMA request. Pass true for enable, false for disable. The address valid DMA request is shared with the receive data DMA request.
enableRx	Enable flag for the receive data DMA request. Pass true for enable, false for disable.
enableTx	Enable flag for the transmit data DMA request. Pass true for enable, false for disable.

31.5.5.12 static bool LPI2C_SlaveGetBusIdleState (LPI2C_Type * *base*) [inline], [static]

Requires the slave mode to be enabled.

Parameters

base	The LPI2C peripheral base address.

Return values

true	Bus is busy.
false	Bus is idle.

31.5.5.13 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

base	The LPI2C peripheral base address.
ackOrNack	Pass true for an ACK or false for a NAK.

31.5.5.14 static uint32_t LPI2C_SlaveGetReceivedAddress (LPI2C_Type * *base*) [inline], [static]

This function should only be called if the kLPI2C_SlaveAddressValidFlag is asserted.

Parameters

base	The LPI2C peripheral base address.

Returns

The 8-bit address matched by the LPI2C slave. Bit 0 contains the R/w direction bit, and the 7-bit slave address is in the upper 7 bits.

31.5.5.15 status_t LPI2C_SlaveSend (LPI2C_Type * *base*, void * *txBuff*, size_t *txSize*, size_t * *actualTxSize*)

Parameters

	base	The LPI2C peripheral base address.
	txBuff	The pointer to the data to be transferred.
	txSize	The length in bytes of the data to be transferred.
out	*actualTxSize*	

Returns

Error or success status returned by API.

31.5.5.16 status_t LPI2C_SlaveReceive (LPI2C_Type * *base*, void * *rxBuff*, size_t *rxSize*, size_t * *actualRxSize*)

Parameters

	base	The LPI2C peripheral base address.
	rxBuff	The pointer to the data to be transferred.
	rxSize	The length in bytes of the data to be transferred.
out	*actualRxSize*	

Returns

Error or success status returned by API.

31.5.5.17 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

	base	The LPI2C peripheral base address.
out	*handle*	Pointer to the LPI2C slave driver handle.
	callback	User provided pointer to the asynchronous callback function.
	userData	User provided pointer to the application callback data.

31.5.5.18 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

base	The LPI2C peripheral base address.
handle	Pointer to lpi2c_slave_handle_t structure which stores the transfer state.
eventMask	Bit mask formed by OR'ing together lpi2c_slave_transfer_event_t enumerators to specify which events to send to the callback. Other accepted values are 0 to get a default set of only the transmit and receive events, and kLPI2C_SlaveAllEvents to enable all events.

Return values

kStatus_Success	Slave transfers were successfully started.
kStatus_LPI2C_Busy	Slave transfers have already been started on this handle.

31.5.5.19 status_t LPI2C_SlaveTransferGetCount (LPI2C_Type * *base*, lpi2c_slave_handle_t * *handle*, size_t * *count*)

Parameters

	base	The LPI2C peripheral base address.
	handle	Pointer to i2c_slave_handle_t structure.
`out`	*count*	Pointer to a value to hold the number of bytes transferred. May be NULL if the count is not required.

Return values

kStatus_Success	
kStatus_NoTransferInProgress	

31.5.5.20 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

base	The LPI2C peripheral base address.
handle	Pointer to lpi2c_slave_handle_t structure which stores the transfer state.

Return values

kStatus_Success	
kStatus_LPI2C_Idle	

31.5.5.21 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

base	The LPI2C peripheral base address.
handle	Pointer to lpi2c_slave_handle_t structure which stores the transfer state.

31.6 LPI2C Master DMA Driver

31.6.1 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.

31.6.2 Data Structure Documentation

31.6.2.1 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.

31.6.3 Typedef Documentation

31.6.3.1 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

base	The LPI2C peripheral base address.
handle	Handle associated with the completed transfer.
completion-Status	Either kStatus_Success or an error code describing how the transfer completed.
userData	Arbitrary pointer-sized value passed from the application.

31.6.4 Function Documentation

31.6.4.1 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_MasterTransferAbort-EDMA() API shall be called.

For devices where the LPI2C send and receive DMA requests are OR'd together, the *txDmaHandle* parameter is ignored and may be set to NULL.

Parameters

	base	The LPI2C peripheral base address.
`out`	*handle*	Pointer to the LPI2C master driver handle.
	rxDmaHandle	Handle for the eDMA receive channel. Created by the user prior to calling this function.
	txDmaHandle	Handle for the eDMA transmit channel. Created by the user prior to calling this function.
	callback	User provided pointer to the asynchronous callback function.
	userData	User provided pointer to the application callback data.

31.6.4.2 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

base	The LPI2C peripheral base address.
handle	Pointer to the LPI2C master driver handle.
transfer	The pointer to the transfer descriptor.

Return values

kStatus_Success	The transaction was started successfully.
kStatus_LPI2C_Busy	Either another master is currently utilizing the bus, or another DMA transaction is already in progress.

31.6.4.3 status_t LPI2C_MasterTransferGetCountEDMA (LPI2C_Type * *base*, lpi2c_master_edma_handle_t * *handle*, size_t * *count*)

Parameters

	base	The LPI2C peripheral base address.
	handle	Pointer to the LPI2C master driver handle.
`out`	*count*	Number of bytes transferred so far by the non-blocking transaction.

Return values

kStatus_Success	
kStatus_NoTransferInProgress	There is not a DMA transaction currently in progress.

31.6.4.4 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

base	The LPI2C peripheral base address.
handle	Pointer to the LPI2C master driver handle.

Return values

kStatus_Success	A transaction was successfully aborted.
kStatus_LPI2C_Idle	There is not a DMA transaction currently in progress.

31.7 LPI2C FreeRTOS Driver

31.7.1 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.

31.7.2 Macro Definition Documentation

31.7.2.1 #define FSL_LPI2C_FREERTOS_DRIVER_VERSION (MAKE_VERSION(2, 3, 0))

31.7.3 Function Documentation

31.7.3.1 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

handle	The RTOS LPI2C handle, the pointer to an allocated space for RTOS context.
base	The pointer base address of the LPI2C instance to initialize.
masterConfig	Configuration structure to set-up LPI2C in master mode.
srcClock_Hz	Frequency of input clock of the LPI2C module.

Returns

status of the operation.

31.7.3.2 status_t LPI2C_RTOS_Deinit (lpi2c_rtos_handle_t * *handle*)

This function deinitializes the LPI2C module and related RTOS context.

Parameters

handle	The RTOS LPI2C handle.

31.7.3.3 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

handle	The RTOS LPI2C handle.
transfer	Structure specifying the transfer parameters.

Returns

status of the operation.

31.8 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 methord 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.

31.8.1 LPI2C CMSIS Driver

31.8.1.1 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;
```

31.8.1.2 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;
```

31.8.1.3 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 32
LPSPI: Low Power Serial Peripheral Interface

32.1 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

32.2 LPSPI Peripheral driver

32.2.1 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.

32.2.2 Function groups

32.2.2.1 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.

32.2.2.2 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.

32.2.2.3 LPSPI Transfer Operation

This function group controls the transfer, master send/receive data, and slave send/receive data.

32.2.2.4 LPSPI Status Operation

This function group gets/clears the LPSPI status.

32.2.2.5 LPSPI Block Transfer Operation

This function group transfers a block of data, gets the transfer status, and aborts the transfer.

32.2.3 Typical use case

32.2.3.1 Master Operation

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

32.2.3.2 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_SetPCSContinous (LPSPI_Type ∗base, bool IsContinous)
  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.

32.2.4 Data Structure Documentation

32.2.4.1 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

32.2.4.2 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

32.2.4.3 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.

32.2.4.4 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::txBuffIfNull

(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

32.2.4.5 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

32.2.5 Macro Definition Documentation

32.2.5.1 #define FSL_LPSPI_DRIVER_VERSION (MAKE_VERSION(2, 2, 1))

32.2.5.2 #define LPSPI_DUMMY_DATA (0x00U)

Dummy data used for tx if there is not txData.

32.2.5.3 #define SPI_RETRY_TIMES 0U /∗ Define to zero means keep waiting until the flag is assert/deassert. ∗/

32.2.5.4 #define LPSPI_MASTER_PCS_SHIFT (4U)

32.2.5.5 #define LPSPI_MASTER_PCS_MASK (0xF0U)

32.2.5.6 #define LPSPI_SLAVE_PCS_SHIFT (4U)

32.2.5.7 #define LPSPI_SLAVE_PCS_MASK (0xF0U)

32.2.6 Typedef Documentation

32.2.6.1 typedef void(∗ lpspi_master_transfer_callback_t)(LPSPI_Type ∗base, lpspi_master_handle_t ∗handle, status_t status, void ∗userData)

Parameters

base	LPSPI peripheral address.
handle	Pointer to the handle for the LPSPI master.
status	Success or error code describing whether the transfer is completed.
userData	Arbitrary pointer-dataSized value passed from the application.

32.2.6.2 typedef void(∗ lpspi_slave_transfer_callback_t)(LPSPI_Type ∗base, lpspi_slave_handle_t ∗handle, status_t status, void ∗userData)

Parameters

base	LPSPI peripheral address.
handle	Pointer to the handle for the LPSPI slave.
status	Success or error code describing whether the transfer is completed.
userData	Arbitrary pointer-dataSized value passed from the application.

32.2.7 Enumeration Type Documentation

32.2.7.1 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.

32.2.7.2 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 w1c status flags.

32.2.7.3 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.

32.2.7.4 enum _lpspi_dma_enable

Enumerator

kLPSPI_TxDmaEnable Transmit data DMA enable.
kLPSPI_RxDmaEnable Receive data DMA enable.

32.2.7.5 enum lpspi_master_slave_mode_t

Enumerator

kLPSPI_Master LPSPI peripheral operates in master mode.
kLPSPI_Slave LPSPI peripheral operates in slave mode.

32.2.7.6 enum lpspi_which_pcs_t

Enumerator

kLPSPI_Pcs0 PCS[0].
kLPSPI_Pcs1 PCS[1].
kLPSPI_Pcs2 PCS[2].
kLPSPI_Pcs3 PCS[3].

32.2.7.7 enum lpspi_pcs_polarity_config_t

Enumerator

kLPSPI_PcsActiveHigh PCS Active High (idles low)
kLPSPI_PcsActiveLow PCS Active Low (idles high)

32.2.7.8 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).

32.2.7.9 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)

32.2.7.10 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.

32.2.7.11 enum lpspi_shift_direction_t

Enumerator

kLPSPI_MsbFirst Data transfers start with most significant bit.
kLPSPI_LsbFirst Data transfers start with least significant bit.

32.2.7.12 enum lpspi_host_request_select_t

Enumerator

kLPSPI_HostReqExtPin Host Request is an ext pin.
kLPSPI_HostReqInternalTrigger Host Request is an internal trigger.

32.2.7.13 enum lpspi_match_config_t

Enumerator

kLPSI_MatchDisabled LPSPI Match Disabled.
kLPSI_1stWordEqualsM0orM1 LPSPI Match Enabled.
kLPSI_AnyWordEqualsM0orM1 LPSPI Match Enabled.

kLPSI_1stWordEqualsM0and2ndWordEqualsM1 LPSPI Match Enabled.
kLPSI_AnyWordEqualsM0andNxtWordEqualsM1 LPSPI Match Enabled.
kLPSI_1stWordAndM1EqualsM0andM1 LPSPI Match Enabled.
kLPSI_AnyWordAndM1EqualsM0andM1 LPSPI Match Enabled.

32.2.7.14 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.

32.2.7.15 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.

32.2.7.16 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]

32.2.7.17 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.

32.2.7.18 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_MasterByteSwapyou 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.

32.2.7.19 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.

32.2.7.20 enum _lpspi_transfer_state

Enumerator

kLPSPI_Idle Nothing in the transmitter/receiver.

kLPSPI_Busy Transfer queue is not finished.
kLPSPI_Error Transfer error.

32.2.8 Function Documentation

32.2.8.1 void LPSPI_MasterInit (LPSPI_Type ∗ *base*, const lpspi_master_config_t ∗ *masterConfig*, uint32_t *srcClock_Hz*)

Parameters

base	LPSPI peripheral address.
masterConfig	Pointer to structure lpspi_master_config_t.
srcClock_Hz	Module source input clock in Hertz

32.2.8.2 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

masterConfig	pointer to lpspi_master_config_t structure

32.2.8.3 void LPSPI_SlaveInit (LPSPI_Type ∗ *base*, const lpspi_slave_config_t ∗ *slaveConfig*)

Parameters

base	LPSPI peripheral address.
slaveConfig	Pointer to a structure lpspi_slave_config_t.

32.2.8.4 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

slaveConfig	pointer to lpspi_slave_config_t structure.

32.2.8.5 void LPSPI_Deinit (LPSPI_Type * *base*)

Call this API to disable the LPSPI clock.

Parameters

base	LPSPI peripheral address.

32.2.8.6 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

base	LPSPI peripheral address.

32.2.8.7 uint32_t LPSPI_GetInstance (LPSPI_Type * *base*)

Parameters

base	LPSPI peripheral base address.

Returns

LPSPI instance.

32.2.8.8 static void LPSPI_Enable (LPSPI_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	LPSPI peripheral address.
enable	Pass true to enable module, false to disable module.

32.2.8.9 static uint32_t LPSPI_GetStatusFlags (LPSPI_Type * *base*) [inline], [static]

Parameters

base	LPSPI peripheral address.

Returns

The LPSPI status(in SR register).

32.2.8.10 static uint8_t LPSPI_GetTxFifoSize (LPSPI_Type * *base*) [inline], [static]

Parameters

base	LPSPI peripheral address.

Returns

The LPSPI Tx FIFO size.

32.2.8.11 static uint8_t LPSPI_GetRxFifoSize (LPSPI_Type * *base*) [inline], [static]

Parameters

base	LPSPI peripheral address.

Returns

The LPSPI Rx FIFO size.

32.2.8.12 static uint32_t LPSPI_GetTxFifoCount (LPSPI_Type * *base*) [inline], [static]

Parameters

base	LPSPI peripheral address.

Returns

The number of words in the transmit FIFO.

32.2.8.13 static uint32_t LPSPI_GetRxFifoCount (LPSPI_Type * *base*) [inline], [static]

Parameters

base	LPSPI peripheral address.

Returns

The number of words in the receive FIFO.

32.2.8.14 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

base	LPSPI peripheral address.
statusFlags	The status flag used from type _lpspi_flags.

< The status flags are cleared by writing 1 (w1c).

32.2.8.15 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

base	LPSPI peripheral address.
mask	The interrupt mask; Use the enum _lpspi_interrupt_enable.

32.2.8.16 static void LPSPI_DisableInterrupts (LPSPI_Type * *base*, uint32_t *mask*) [inline], [static]

```
* LPSPI_DisableInterrupts(base, kLPSPI_TxInterruptEnable |
    kLPSPI_RxInterruptEnable );
*
```

Parameters

base	LPSPI peripheral address.
mask	The interrupt mask; Use the enum _lpspi_interrupt_enable.

32.2.8.17 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

base	LPSPI peripheral address.
mask	The interrupt mask; Use the enum _lpspi_dma_enable.

32.2.8.18 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.

```
* SPI_DisableDMA(base, kLPSPI_TxDmaEnable |
    kLPSPI_RxDmaEnable);
*
```

Parameters

base	LPSPI peripheral address.
mask	The interrupt mask; Use the enum _lpspi_dma_enable.

32.2.8.19 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

base	LPSPI peripheral address.

Returns

The LPSPI Transmit Data Register address.

32.2.8.20 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

base	LPSPI peripheral address.

Returns

The LPSPI Receive Data Register address.

32.2.8.21 bool LPSPI_CheckTransferArgument (LPSPI_Type * *base*, lpspi_transfer_t * *transfer*, bool *isEdma*)

Parameters

base	LPSPI peripheral address.
transfer	the transfer struct to be used.
isEdma	True to check for EDMA transfer, false to check interrupt non-blocking transfer

Returns

Return true for right and false for wrong.

32.2.8.22 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 (LPSPIx_CR_MEN = 0).

Parameters

base	LPSPI peripheral address.
mode	Mode setting (master or slave) of type lpspi_master_slave_mode_t.

32.2.8.23 static void LPSPI_SelectTransferPCS (LPSPI_Type * *base,* lpspi_which_pcs_t *select*) [inline], [static]

Parameters

base	LPSPI peripheral address.
select	LPSPI Peripheral Chip Select (PCS) configuration.

32.2.8.24 static void LPSPI_SetPCSContinous (LPSPI_Type * *base,* bool *IsContinous*) [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

base	LPSPI peripheral address.
IsContinous	True to set the transfer PCS to continuous mode, false to set to uncontinuous mode.

32.2.8.25 static bool LPSPI_IsMaster (LPSPI_Type ∗ *base*) [inline], [static]

Parameters

base	LPSPI peripheral address.

Returns

Returns true if the module is in master mode or false if the module is in slave mode.

32.2.8.26 static void LPSPI_FlushFifo (LPSPI_Type ∗ *base,* bool *flushTxFifo,* bool *flushRxFifo*) [inline], [static]

Parameters

base	LPSPI peripheral address.
flushTxFifo	Flushes (true) the Tx FIFO, else do not flush (false) the Tx FIFO.
flushRxFifo	Flushes (true) the Rx FIFO, else do not flush (false) the Rx FIFO.

32.2.8.27 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

base	LPSPI peripheral address.

txWater	The TX FIFO watermark value. Writing a value equal or greater than the FIFO size is truncated.
rxWater	The RX FIFO watermark value. Writing a value equal or greater than the FIFO size is truncated.

32.2.8.28 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

base	LPSPI peripheral address.
mask	The PCS polarity mask; Use the enum _lpspi_pcs_polarity.

32.2.8.29 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

base	LPSPI peripheral address.
frameSize	The frame size in number of bits.

32.2.8.30 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

base	LPSPI peripheral address.
baudRate_Bps	The desired baud rate in bits per second.
srcClock_Hz	Module source input clock in Hertz.
tcrPrescale-Value	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.

32.2.8.31 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

base	LPSPI peripheral address.
scaler	The 8-bit delay value 0x00 to 0xFF (255).
whichDelay	The desired delay to configure, must be of type lpspi_delay_type_t.

32.2.8.32 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

base	LPSPI peripheral address.
delayTimeIn-NanoSec	The desired delay value in nano-seconds.
whichDelay	The desired delay to configuration, which must be of type lpspi_delay_type_t.
srcClock_Hz	Module source input clock in Hertz.

Returns

actual Calculated delay value in nano-seconds.

32.2.8.33 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

base	LPSPI peripheral address.
data	The data word to be sent.

32.2.8.34 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

base	LPSPI peripheral address.

Returns

The data read from the data buffer.

32.2.8.35 void LPSPI_SetDummyData (LPSPI_Type * *base,* uint8_t *dummyData*)

Parameters

base	LPSPI peripheral address.
dummyData	Data to be transferred when tx buffer is NULL. Note: This API has no effect when LPSPI in slave interrupt mode, because driver will set the TXMSK bit to 1 if txData is NULL, no data is loaded from transmit FIFO and output pin is tristated.

32.2.8.36 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

base	LPSPI peripheral address.
handle	LPSPI handle pointer to lpspi_master_handle_t.
callback	DSPI callback.
userData	callback function parameter.

32.2.8.37 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

base	LPSPI peripheral address.
transfer	pointer to lpspi_transfer_t structure.

Returns

status of status_t.

32.2.8.38 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

base	LPSPI peripheral address.
handle	pointer to lpspi_master_handle_t structure which stores the transfer state.
transfer	pointer to lpspi_transfer_t structure.

Returns

status of status_t.

32.2.8.39 status_t LPSPI_MasterTransferGetCount (LPSPI_Type * *base*, lpspi_master_handle_t * *handle*, size_t * *count*)

This function gets the master transfer remaining bytes.

Parameters

base	LPSPI peripheral address.
handle	pointer to lpspi_master_handle_t structure which stores the transfer state.
count	Number of bytes transferred so far by the non-blocking transaction.

Returns

status of status_t.

32.2.8.40 void LPSPI_MasterTransferAbort (LPSPI_Type * *base,* lpspi_master_handle_t * *handle*)

This function aborts a transfer which uses an interrupt method.

Parameters

base	LPSPI peripheral address.
handle	pointer to lpspi_master_handle_t structure which stores the transfer state.

32.2.8.41 void LPSPI_MasterTransferHandleIRQ (LPSPI_Type * *base,* lpspi_master_handle_t * *handle*)

This function processes the LPSPI transmit and receive IRQ.

Parameters

base	LPSPI peripheral address.
handle	pointer to lpspi_master_handle_t structure which stores the transfer state.

32.2.8.42 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

base	LPSPI peripheral address.
handle	LPSPI handle pointer to lpspi_slave_handle_t.
callback	DSPI callback.
userData	callback function parameter.

32.2.8.43 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

base	LPSPI peripheral address.
handle	pointer to lpspi_slave_handle_t structure which stores the transfer state.
transfer	pointer to lpspi_transfer_t structure.

Returns

status of status_t.

32.2.8.44 status_t LPSPI_SlaveTransferGetCount (LPSPI_Type * *base*, lpspi_slave_handle_t * *handle*, size_t * *count*)

This function gets the slave transfer remaining bytes.

Parameters

base	LPSPI peripheral address.
handle	pointer to lpspi_slave_handle_t structure which stores the transfer state.
count	Number of bytes transferred so far by the non-blocking transaction.

Returns

status of status_t.

32.2.8.45 void LPSPI_SlaveTransferAbort (LPSPI_Type * *base,* lpspi_slave_handle_t * *handle*)

This function aborts a transfer which uses an interrupt method.

Parameters

base	LPSPI peripheral address.
handle	pointer to lpspi_slave_handle_t structure which stores the transfer state.

32.2.8.46 void LPSPI_SlaveTransferHandleIRQ (LPSPI_Type * *base*, lpspi_slave_handle_t * *handle*)

This function processes the LPSPI transmit and receives an IRQ.

Parameters

base	LPSPI peripheral address.
handle	pointer to lpspi_slave_handle_t structure which stores the transfer state.

32.2.9 Variable Documentation

32.2.9.1 volatile uint8_t g_lpspiDummyData[]

32.3 LPSPI eDMA Driver

32.3.1 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.

32.3.2 Data Structure Documentation

32.3.2.1 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

32.3.2.2 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

32.3.3 Macro Definition Documentation

32.3.3.1 #define FSL_LPSPI_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 1, 0))

32.3.4 Typedef Documentation

32.3.4.1 typedef void(∗ lpspi_master_edma_transfer_callback_t)(LPSPI_Type ∗base, lpspi_master_edma_handle_t ∗handle, status_t status, void ∗userData)

Parameters

base	LPSPI peripheral base address.
handle	Pointer to the handle for the LPSPI master.
status	Success or error code describing whether the transfer completed.
userData	Arbitrary pointer-dataSized value passed from the application.

32.3.4.2 typedef void(∗ lpspi_slave_edma_transfer_callback_t)(LPSPI_Type ∗base, lpspi_slave_edma_handle_t ∗handle, status_t status, void ∗userData)

Parameters

base	LPSPI peripheral base address.
handle	Pointer to the handle for the LPSPI slave.
status	Success or error code describing whether the transfer completed.
userData	Arbitrary pointer-dataSized value passed from the application.

32.3.5 Function Documentation

32.3.5.1 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 Rx 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 edmaIntermediaryTo-TxRegHandle. (2) For a shared DMA request source, enable and set the Rx/Rx DMAMUX source for edmaRxRegToRxDataHandle.

Parameters

base	LPSPI peripheral base address.
handle	LPSPI handle pointer to lpspi_master_edma_handle_t.
callback	LPSPI callback.
userData	callback function parameter.
edmaRxRegTo-RxDataHandle	edmaRxRegToRxDataHandle pointer to edma_handle_t.
edmaTxData-ToTxReg-Handle	edmaTxDataToTxRegHandle pointer to edma_handle_t.

32.3.5.2 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

base	LPSPI peripheral base address.
handle	pointer to lpspi_master_edma_handle_t structure which stores the transfer state.
transfer	pointer to lpspi_transfer_t structure.

Returns

status of status_t.

32.3.5.3 void LPSPI_MasterTransferAbortEDMA (LPSPI_Type * *base*, lpspi_master_edma_handle_t * *handle*)

This function aborts a transfer which is using eDMA.

Parameters

base	LPSPI peripheral base address.
handle	pointer to lpspi_master_edma_handle_t structure which stores the transfer state.

32.3.5.4 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

base	LPSPI peripheral base address.
handle	pointer to lpspi_master_edma_handle_t structure which stores the transfer state.
count	Number of bytes transferred so far by the EDMA transaction.

Returns

status of status_t.

32.3.5.5 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

base	LPSPI peripheral base address.
handle	LPSPI handle pointer to lpspi_slave_edma_handle_t.
callback	LPSPI callback.
userData	callback function parameter.
edmaRxRegToRxDataHandle	edmaRxRegToRxDataHandle pointer to edma_handle_t.
edmaTxDataToTxRegHandle	edmaTxDataToTxRegHandle pointer to edma_handle_t.

32.3.5.6 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

base	LPSPI peripheral base address.
handle	pointer to lpspi_slave_edma_handle_t structure which stores the transfer state.
transfer	pointer to lpspi_transfer_t structure.

Returns

status of status_t.

32.3.5.7 void LPSPI_SlaveTransferAbortEDMA (LPSPI_Type * *base,* lpspi_slave_edma_handle_t * *handle*)

This function aborts a transfer which is using eDMA.

Parameters

base	LPSPI peripheral base address.
handle	pointer to lpspi_slave_edma_handle_t structure which stores the transfer state.

32.3.5.8 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

base	LPSPI peripheral base address.
handle	pointer to lpspi_slave_edma_handle_t structure which stores the transfer state.
count	Number of bytes transferred so far by the eDMA transaction.

Returns

status of status_t.

32.4 LPSPI FreeRTOS Driver

32.4.1 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.

32.4.2 Macro Definition Documentation

32.4.2.1 #define FSL_LPSPI_FREERTOS_DRIVER_VERSION (MAKE_VERSION(2, 0, 5))

32.4.3 Function Documentation

32.4.3.1 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

handle	The RTOS LPSPI handle, the pointer to an allocated space for RTOS context.
base	The pointer base address of the LPSPI instance to initialize.
masterConfig	Configuration structure to set-up LPSPI in master mode.
srcClock_Hz	Frequency of input clock of the LPSPI module.

Returns

status of the operation.

32.4.3.2 status_t LPSPI_RTOS_Deinit (lpspi_rtos_handle_t * *handle*)

This function deinitializes the LPSPI module and related RTOS context.

Parameters

handle	The RTOS LPSPI handle.

32.4.3.3 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

handle	The RTOS LPSPI handle.
transfer	Structure specifying the transfer parameters.

Returns

status of the operation.

32.5 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 methord please refer to http://www.keil.com/pack/doc/cmsis/Driver/html/index.html.

32.5.1 Function groups

32.5.1.1 LPSPI CMSIS GetVersion Operation

This function group will return the DSPI CMSIS Driver version to user.

32.5.1.2 LPSPI CMSIS GetCapabilities Operation

This function group will return the capabilities of this driver.

32.5.1.3 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 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.

32.5.1.4 LPSPI Transfer Operation

This function group controls the transfer, master send/receive data, and slave send/receive data.

32.5.1.5 LPSPI Status Operation

This function group gets the LPSPI transfer status.

32.5.1.6 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.

32.5.2 Typical use case

32.5.2.1 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 uninitialize */
Driver_SPI0.Uninitialize();
```

32.5.2.2 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 uninitialize */
Driver_SPI2.Uninitialize();
```

Chapter 33

LPUART: Low Power Universal Asynchronous Receiver/-Transmitter Driver

33.1 Overview

Modules

- LPUART CMSIS Driver
- LPUART Driver
- LPUART FreeRTOS Driver
- LPUART eDMA Driver

33.2 LPUART Driver

33.2.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Low Power UART (LPUART) module of MCUXpresso SDK devices.

33.2.2 Typical use case

33.2.2.1 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, 2))
  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.

33.2.3 Data Structure Documentation

33.2.3.1 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

33.2.3.2 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

33.2.3.3 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

33.2.4 Macro Definition Documentation

33.2.4.1 #define FSL_LPUART_DRIVER_VERSION (MAKE_VERSION(2, 5, 2))

33.2.4.2 #define UART_RETRY_TIMES 0U /∗ Defining to zero means to keep waiting for the flag until it is assert/deassert. ∗/

33.2.5 Typedef Documentation

33.2.5.1 typedef void(∗ lpuart_transfer_callback_t)(LPUART_Type ∗base, lpuart_handle_t ∗handle, status_t status, void ∗userData)

33.2.6 Enumeration Type Documentation

33.2.6.1 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.

33.2.6.2 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.

33.2.6.3 enum lpuart_data_bits_t

Enumerator

kLPUART_EightDataBits Eight data bit.
kLPUART_SevenDataBits Seven data bit.

33.2.6.4 enum lpuart_stop_bit_count_t

Enumerator

kLPUART_OneStopBit One stop bit.
kLPUART_TwoStopBit Two stop bits.

33.2.6.5 enum lpuart_transmit_cts_source_t

Enumerator

kLPUART_CtsSourcePin CTS resource is the LPUART_CTS pin.
kLPUART_CtsSourceMatchResult CTS resource is the match result.

33.2.6.6 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.

33.2.6.7 enum lpuart_idle_type_select_t

Enumerator

kLPUART_IdleTypeStartBit Start counting after a valid start bit.
kLPUART_IdleTypeStopBit Start counting after a stop bit.

33.2.6.8 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.

33.2.6.9 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

33.2.6.10 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

33.2.7 Function Documentation

33.2.7.1 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

base	LPUART peripheral base address.

33.2.7.2 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_GetDefaultConfig() function to configure the configuration structure and get the default configuration. The example below shows how to use this API to configure the LPUART.

```
*  lpuart_config_t lpuartConfig;
*  lpuartConfig.baudRate_Bps = 115200U;
*  lpuartConfig.parityMode = kLPUART_ParityDisabled;
*  lpuartConfig.dataBitsCount = kLPUART_EightDataBits;
*  lpuartConfig.isMsb = false;
*  lpuartConfig.stopBitCount = kLPUART_OneStopBit;
*  lpuartConfig.txFifoWatermark = 0;
*  lpuartConfig.rxFifoWatermark = 1;
*  LPUART_Init(LPUART1, &lpuartConfig, 20000000U);
*
```

Parameters

base	LPUART peripheral base address.
config	Pointer to a user-defined configuration structure.
srcClock_Hz	LPUART clock source frequency in HZ.

Return values

kStatus_LPUART_BaudrateNotSupport	Baudrate is not support in current clock source.
kStatus_Success	LPUART initialize succeed

33.2.7.3 void LPUART_Deinit (LPUART_Type * *base*)

This function waits for transmit to complete, disables TX and RX, and disables the LPUART clock.

Parameters

base	LPUART peripheral base address.

33.2.7.4 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

config	Pointer to a configuration structure.

33.2.7.5 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, 20000000U);
*
```

Parameters

base	LPUART peripheral base address.
baudRate_Bps	LPUART baudrate to be set.
srcClock_Hz	LPUART clock source frequency in HZ.

Return values

kStatus_LPUART_-BaudrateNotSupport	Baudrate is not supported in the current clock source.
kStatus_Success	Set baudrate succeeded.

33.2.7.6 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

base	LPUART peripheral base address.
enable	true to enable, flase to disable.

33.2.7.7 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 receices with MSB being 1 is considered as an address frame, otherwise it is considered as data frame. Once the address frame matches one of slave's own addresses, this slave is addressed. This address frame and its following data frames are stored in the receive buffer, otherwise the frames will be discarded. To un-address a slave, just send an address frame with unmatched address.

Note

Any LPUART instance joined in the multi-slave system can work as slave. The position of the address mark is the same as the parity bit when parity is enabled for 8 bit and 9 bit data formats.

Parameters

base	LPUART peripheral base address.
address1	LPUART slave address1.
address2	LPUART slave address2.

33.2.7.8 static void LPUART_EnableMatchAddress (LPUART_Type * *base,* bool *match1,* bool *match2*) [inline], [static]

Parameters

base	LPUART peripheral base address.
match1	true to enable match address1, false to disable.
match2	true to enable match address2, false to disable.

33.2.7.9 static void LPUART_SetRxFifoWatermark (LPUART_Type * *base,* uint8_t *water*) [inline], [static]

Parameters

base	LPUART peripheral base address.
water	Rx FIFO watermark.

33.2.7.10 static void LPUART_SetTxFifoWatermark (LPUART_Type * *base*, uint8_t *water*) [inline], [static]

Parameters

base	LPUART peripheral base address.
water	Tx FIFO watermark.

33.2.7.11 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

base	LPUART peripheral base address.

Returns

LPUART status flags which are ORed by the enumerators in the _lpuart_flags.

33.2.7.12 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 cleared or set by hardware are: kLPUART_TxDataRegEmptyFlag, kLPUART_TransmissionCompleteFlag, kLPUART_RxDataRegFullFlag, kLPUART_RxActiveFlag, kLPUART_NoiseErrorInRxDataRegFlag, kLPUART_ParityErrorInRxDataRegFlag, kLPUART_TxFifoEmptyFlag,kLPUART_RxFifoEmptyFlag Note: This API should be called when the Tx/Rx is idle, otherwise it takes no effects.

Parameters

base	LPUART peripheral base address.
mask	the status flags to be cleared. The user can use the enumerators in the _lpuart_status-_flag_t to do the OR operation and get the mask.

Returns

0 succeed, others failed.

Return values

kStatus_LPUART_Flag-CannotClearManually	The flag can't be cleared by this function but it is cleared automatically by hardware.
kStatus_Success	Status in the mask are cleared.

33.2.7.13 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

base	LPUART peripheral base address.
mask	The interrupts to enable. Logical OR of the enumeration _uart_interrupt_enable.

33.2.7.14 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

base	LPUART peripheral base address.
mask	The interrupts to disable. Logical OR of _lpuart_interrupt_enable.

33.2.7.15 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

base	LPUART peripheral base address.

Returns

LPUART interrupt flags which are logical OR of the enumerators in _lpuart_interrupt_enable.

33.2.7.16 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

base	LPUART peripheral base address.

Returns

LPUART data register addresses which are used both by the transmitter and receiver.

33.2.7.17 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

base	LPUART peripheral base address.
enable	True to enable, false to disable.

33.2.7.18 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

base	LPUART peripheral base address.
enable	True to enable, false to disable.

33.2.7.19 uint32_t LPUART_GetInstance (LPUART_Type * *base*)

Parameters

base	LPUART peripheral base address.

Returns

LPUART instance.

33.2.7.20 static void LPUART_EnableTx (LPUART_Type * *base,* bool *enable*) [inline], [static]

This function enables or disables the LPUART transmitter.

Parameters

base	LPUART peripheral base address.
enable	True to enable, false to disable.

33.2.7.21 static void LPUART_EnableRx (LPUART_Type * *base,* bool *enable*) [inline], [static]

This function enables or disables the LPUART receiver.

Parameters

base	LPUART peripheral base address.
enable	True to enable, false to disable.

33.2.7.22 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

base	LPUART peripheral base address.
data	Data write to the TX register.

33.2.7.23 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

base	LPUART peripheral base address.

Returns

Data read from data register.

33.2.7.24 static uint8_t LPUART_GetRxFifoCount (LPUART_Type * *base*) [inline], [static]

Parameters

base	LPUART peripheral base address.

Returns

rx FIFO data count.

33.2.7.25 static uint8_t LPUART_GetTxFifoCount (LPUART_Type ∗ *base*) [inline], [static]

Parameters

base	LPUART peripheral base address.

Returns

tx FIFO data count.

33.2.7.26 void LPUART_SendAddress (LPUART_Type ∗ *base,* uint8_t *address*)

Parameters

base	LPUART peripheral base address.
address	LPUART slave address.

33.2.7.27 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 dat to be sent out to the bus.

Parameters

base	LPUART peripheral base address.
data	Start address of the data to write.
length	Size of the data to write.

Return values

kStatus_LPUART_Timeout	Transmission timed out and was aborted.
kStatus_Success	Successfully wrote all data.

33.2.7.28 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

base	LPUART peripheral base address.
data	Start address of the buffer to store the received data.
length	Size of the buffer.

Return values

kStatus_LPUART_RxHardwareOverrun	Receiver overrun happened while receiving data.
kStatus_LPUART_NoiseError	Noise error happened while receiving data.
kStatus_LPUART_FramingError	Framing error happened while receiving data.
kStatus_LPUART_ParityError	Parity error happened while receiving data.
kStatus_LPUART_Timeout	Transmission timed out and was aborted.
kStatus_Success	Successfully received all data.

33.2.7.29 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

base	LPUART peripheral base address.
handle	LPUART handle pointer.
callback	Callback function.
userData	User data.

33.2.7.30 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 TX, check the kLPUART_TransmissionCompleteFlag to ensure that the transmit is finished.

Parameters

base	LPUART peripheral base address.
handle	LPUART handle pointer.
xfer	LPUART transfer structure, see lpuart_transfer_t.

Return values

kStatus_Success	Successfully start the data transmission.
kStatus_LPUART_TxBusy	Previous transmission still not finished, data not all written to the TX register.
kStatus_InvalidArgument	Invalid argument.

33.2.7.31 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

base	LPUART peripheral base address.
handle	LPUART handle pointer.
ringBuffer	Start address of ring buffer for background receiving. Pass NULL to disable the ring buffer.
ringBufferSize	size of the ring buffer.

33.2.7.32 void LPUART_TransferStopRingBuffer (LPUART_Type * *base,* lpuart_handle_t * *handle*)

This function aborts the background transfer and uninstalls the ring buffer.

Parameters

base	LPUART peripheral base address.
handle	LPUART handle pointer.

33.2.7.33 size_t LPUART_TransferGetRxRingBufferLength (LPUART_Type * *base,* lpuart_handle_t * *handle*)

Parameters

base	LPUART peripheral base address.
handle	LPUART handle pointer.

Returns

Length of received data in RX ring buffer.

33.2.7.34 void LPUART_TransferAbortSend (LPUART_Type * *base,* lpuart_handle_t * *handle*)

This function aborts the interrupt driven data sending. The user can get the remainBtyes to find out how many bytes are not sent out.

Parameters

base	LPUART peripheral base address.
handle	LPUART handle pointer.

33.2.7.35 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

base	LPUART peripheral base address.
handle	LPUART handle pointer.
count	Send bytes count.

Return values

kStatus_NoTransferInProgress	No send in progress.
kStatus_InvalidArgument	Parameter is invalid.
kStatus_Success	Get successfully through the parameter `count`;

33.2.7.36 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

base	LPUART peripheral base address.
handle	LPUART handle pointer.
xfer	LPUART transfer structure, see uart_transfer_t.
receivedBytes	Bytes received from the ring buffer directly.

Return values

kStatus_Success	Successfully queue the transfer into the transmit queue.
kStatus_LPUART_RxBusy	Previous receive request is not finished.
kStatus_InvalidArgument	Invalid argument.

33.2.7.37 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

base	LPUART peripheral base address.
handle	LPUART handle pointer.

33.2.7.38 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

base	LPUART peripheral base address.
handle	LPUART handle pointer.
count	Receive bytes count.

Return values

kStatus_NoTransferInProgress	No receive in progress.
kStatus_InvalidArgument	Parameter is invalid.
kStatus_Success	Get successfully through the parameter `count`;

33.2.7.39 void LPUART_TransferHandleIRQ (LPUART_Type * *base*, void * *irqHandle*)

This function handles the LPUART transmit and receive IRQ request.

Parameters

base	LPUART peripheral base address.
irqHandle	LPUART handle pointer.

33.2.7.40 void LPUART_TransferHandleErrorIRQ (LPUART_Type * *base*, void * *irqHandle*)

This function handles the LPUART error IRQ request.

Parameters

base	LPUART peripheral base address.
irqHandle	LPUART handle pointer.

33.3 LPUART eDMA Driver

33.3.1 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.

33.3.2 Data Structure Documentation

33.3.2.1 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

33.3.3 Macro Definition Documentation

33.3.3.1 #define FSL_LPUART_EDMA_DRIVER_VERSION (MAKE_VERSION(2, 5, 2))

33.3.4 Typedef Documentation

33.3.4.1 typedef void(∗ lpuart_edma_transfer_callback_t)(LPUART_Type ∗base, lpuart_edma_handle_t ∗handle, status_t status, void ∗userData)

33.3.5 Function Documentation

33.3.5.1 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

base	LPUART peripheral base address.
handle	Pointer to lpuart_edma_handle_t structure.
callback	Callback function.
userData	User data.
txEdmaHandle	User requested DMA handle for TX DMA transfer.
rxEdmaHandle	User requested DMA handle for RX DMA transfer.

33.3.5.2 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

base	LPUART peripheral base address.
handle	LPUART handle pointer.
xfer	LPUART eDMA transfer structure. See lpuart_transfer_t.

Return values

kStatus_Success	if succeed, others failed.
kStatus_LPUART_TxBusy	Previous transfer on going.
kStatus_InvalidArgument	Invalid argument.

33.3.5.3 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

base	LPUART peripheral base address.
handle	Pointer to lpuart_edma_handle_t structure.
xfer	LPUART eDMA transfer structure, see lpuart_transfer_t.

Return values

kStatus_Success	if succeed, others fail.
kStatus_LPUART_Rx-Busy	Previous transfer ongoing.
kStatus_InvalidArgument	Invalid argument.

33.3.5.4 void LPUART_TransferAbortSendEDMA (LPUART_Type * *base*, lpuart_edma_handle_t * *handle*)

This function aborts the sent data using eDMA.

Parameters

base	LPUART peripheral base address.
handle	Pointer to lpuart_edma_handle_t structure.

33.3.5.5 void LPUART_TransferAbortReceiveEDMA (LPUART_Type * *base*, lpuart_edma_handle_t * *handle*)

This function aborts the received data using eDMA.

Parameters

base	LPUART peripheral base address.
handle	Pointer to lpuart_edma_handle_t structure.

33.3.5.6 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

base	LPUART peripheral base address.
handle	LPUART handle pointer.
count	Send bytes count.

Return values

kStatus_NoTransferIn-Progress	No send in progress.
kStatus_InvalidArgument	Parameter is invalid.
kStatus_Success	Get successfully through the parameter `count`;

33.3.5.7 status_t LPUART_TransferGetReceiveCountEDMA (LPUART_Type * *base*, lpuart_edma_handle_t * *handle*, uint32_t * *count*)

This function gets the number of received bytes.

Parameters

base	LPUART peripheral base address.
handle	LPUART handle pointer.
count	Receive bytes count.

Return values

kStatus_NoTransferInProgress	No receive in progress.
kStatus_InvalidArgument	Parameter is invalid.
kStatus_Success	Get successfully through the parameter `count`;

33.3.5.8 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

base	LPUART peripheral base address.
lpuartEdmaHandle	LPUART handle pointer.

33.4 LPUART FreeRTOS Driver

33.4.1 Overview

Data Structures

- struct lpuart_rtos_config_t
  LPUART RTOS configuration structure. More...

Driver version

- #define FSL_LPUART_FREERTOS_DRIVER_VERSION (MAKE_VERSION(2, 5, 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.

33.4.2 Data Structure Documentation

33.4.2.1 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.
- 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.

33.4.3 Macro Definition Documentation

33.4.3.1 #define FSL_LPUART_FREERTOS_DRIVER_VERSION (MAKE_VERSION(2, 5, 0))

33.4.4 Function Documentation

33.4.4.1 int LPUART_RTOS_Init (lpuart_rtos_handle_t * *handle*, lpuart_handle_t * *t_handle*, const lpuart_rtos_config_t * *cfg*)

Parameters

handle	The RTOS LPUART handle, the pointer to an allocated space for RTOS context.
t_handle	The pointer to an allocated space to store the transactional layer internal state.
cfg	The pointer to the parameters required to configure the LPUART after initialization.

Returns

0 succeed, others failed

33.4.4.2 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

handle	The RTOS LPUART handle.

33.4.4.3 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

handle	The RTOS LPUART handle.
buffer	The pointer to buffer to send.
length	The number of bytes to send.

33.4.4.4 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

handle	The RTOS LPUART handle.
buffer	The pointer to buffer where to write received data.
length	The number of bytes to receive.
received	The pointer to a variable of size_t where the number of received data is filled.

33.5 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 methord 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.

33.5.1 Function groups

33.5.1.1 LPUART CMSIS GetVersion Operation

This function group will return the LPUART CMSIS Driver version to user.

33.5.1.2 LPUART CMSIS GetCapabilities Operation

This function group will return the capabilities of this driver.

33.5.1.3 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.

33.5.1.4 LPUART CMSIS Transfer Operation

This function group controls the transfer, send/receive data.

33.5.1.5 LPUART CMSIS Status Operation

This function group gets the LPUART transfer status.

33.5.1.6 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 34
OCOTP: On Chip One-Time Programmable controller.

34.1 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.

34.2 OCOTP function group

The OCOTP driver support operaing API to allow read and write the fuse map.

34.2.1 Initialization and de-initialization

The funciton 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.

34.2.2 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.

34.3 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 addess.
- status_t OCOTP_ReadFuseShadowRegisterExt (OCOTP_Type ∗base, uint32_t address, uint32_t ∗data, uint8_t fuseWords)
  Read the fuse shadow register from the fuse addess.
- status_t OCOTP_WriteFuseShadowRegister (OCOTP_Type ∗base, uint32_t address, uint32_t data)
  Write the fuse shadow register with the fuse addess 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.

34.4 Data Structure Documentation

34.4.1 struct ocotp_timing_t

Note that, these value are used for calcalating the read/write timings. And the values should statisfy below rules:

Tsp_rd=(WAIT+1)/ipg_clk_freq should be >= 150ns; Tsp_pgm=(RELAX+1)/ipg_clk_freq should be >= 100ns; 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 ns < Tpgm < 11000 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
  Storbe program time value to fill in the TIMING register.
- uint32_t strobe_read
  Storbe 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

34.5 Macro Definition Documentation

34.5.1 #define FSL_OCOTP_DRIVER_VERSION (MAKE_VERSION(2, 1, 3))

34.6 Enumeration Type Documentation

34.6.1 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.

34.7 Function Documentation

34.7.1 void OCOTP_Init (OCOTP_Type ∗ *base,* uint32_t *srcClock_Hz*)

Parameters

base	OCOTP peripheral base address.
srcClock_Hz	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.

34.7.2 void OCOTP_Deinit (OCOTP_Type ∗ *base*)

Return values

kStatus_Success	upon successful execution, error status otherwise.

34.7.3 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

base	OCOTP peripheral base address.

Return values

true	for bit set and false for cleared.

34.7.4 static bool OCOTP_CheckErrorStatus (OCOTP_Type ∗ *base*) [inline], [static]

Parameters

base	OCOTP peripheral base address.

Return values

true	for bit set and false for cleared.

34.7.5 static void OCOTP_ClearErrorStatus (OCOTP_Type * *base*) [inline], [static]

Parameters

base	OCOTP peripheral base address.

34.7.6 status_t OCOTP_ReloadShadowRegister (OCOTP_Type * *base*)

This function will help reload the shadow register without reseting the OCOTP module. Please make sure the OCOTP has been initialized before calling this API.

Parameters

base	OCOTP peripheral base addess.

Return values

kStatus_Success	Reload success.
kStatus_OCOTP_Reload-Error	Reload failed.

34.7.7 uint32_t OCOTP_ReadFuseShadowRegister (OCOTP_Type * *base*, uint32_t *address*)

Deprecated Use OCOTP_ReadFuseShadowRegisterExt instead of this function.

Parameters

base	OCOTP peripheral base address.

address	the fuse address to be read from.

Returns

The read out data.

34.7.8 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

base	OCOTP peripheral base address.
address	the fuse address to be read from.
data	Data array to save the readout fuse value.
fuseWords	How many words to read.

Return values

kStatus_Success	Read success.
kStatus_Fail	Error occurs during read.

34.7.9 status_t OCOTP_WriteFuseShadowRegister (OCOTP_Type * *base,* uint32_t *address,* uint32_t *data*)

Please make sure the wrtie address is not locked while calling this API.

Parameters

base	OCOTP peripheral base address.
address	the fuse address to be written.
data	the value will be writen to fuse address.

Return values

write	status, kStatus_Success for success and kStatus_Fail for failed.

34.7.10 status_t OCOTP_WriteFuseShadowRegisterWithLock (OCOTP_Type * *base,* uint32_t *address,* uint32_t *data,* bool *lock*)

Please make sure the wrtie address is not locked while calling this API.

Some OCOTP controller supports ECC mode and redundancy mode (see reference mananual 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

base	OCOTP peripheral base address.
address	The fuse address to be written.
data	The value will be writen to fuse address.
lock	Lock or unlock write fuse shadow register operation.

Return values

kStatus_Success	Program and reload success.
kStatus_OCOTP_Locked	The eFuse word is locked and cannot be programmed.
kStatus_OCOTP_-ProgramFail	eFuse word programming failed.
kStatus_OCOTP_Reload-Error	eFuse word programming success, but error happens during reload the values.
kStatus_OCOTP_Access-Error	Cannot access eFuse word.

34.7.11 static uint32_t OCOTP_GetVersion (OCOTP_Type * *base*) [inline], [static]

Parameters

base	OCOTP peripheral base address.

Return values

return	the version value.

Chapter 35
PIT: Periodic Interrupt Timer

35.1 Overview

The MCUXpresso SDK provides a driver for the Periodic Interrupt Timer (PIT) of MCUXpresso SDK devices.

35.2 Function groups

The PIT driver supports operating the module as a time counter.

35.2.1 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.

35.2.2 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.

35.2.3 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.

35.2.4 Status

Provides functions to get and clear the PIT status.

35.2.5 Interrupt

Provides functions to enable/disable PIT interrupts and get current enabled interrupts.

35.3 Typical use case

35.3.1 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.

35.4 Data Structure Documentation

35.4.1 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

35.5 Enumeration Type Documentation

35.5.1 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.

35.5.2 enum pit_interrupt_enable_t

Enumerator

kPIT_TimerInterruptEnable Timer interrupt enable.

35.5.3 enum pit_status_flags_t

Enumerator

kPIT_TimerFlag Timer flag.

35.6 Function Documentation

35.6.1 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

base	PIT peripheral base address
config	Pointer to the user's PIT config structure

35.6.2 void PIT_Deinit (PIT_Type * *base*)

Parameters

base	PIT peripheral base address

35.6.3 static void PIT_GetDefaultConfig (pit_config_t * *config*) [inline], [static]

The default values are as follows.

```
*     config->enableRunInDebug = false;
*
```

Parameters

config	Pointer to the configuration structure.

35.6.4 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

base	PIT peripheral base address

channel	Timer channel number which is chained with the previous timer
enable	Enable or disable chain. true: Current timer is chained with the previous timer. false: Timer doesn't chain with other timers.

35.6.5 static void PIT_EnableInterrupts (PIT_Type * *base*, pit_chnl_t *channel*, uint32_t *mask*) [inline], [static]

Parameters

base	PIT peripheral base address
channel	Timer channel number
mask	The interrupts to enable. This is a logical OR of members of the enumeration pit_interrupt_enable_t

35.6.6 static void PIT_DisableInterrupts (PIT_Type * *base*, pit_chnl_t *channel*, uint32_t *mask*) [inline], [static]

Parameters

base	PIT peripheral base address
channel	Timer channel number
mask	The interrupts to disable. This is a logical OR of members of the enumeration pit_interrupt_enable_t

35.6.7 static uint32_t PIT_GetEnabledInterrupts (PIT_Type * *base*, pit_chnl_t *channel*) [inline], [static]

Parameters

base	PIT peripheral base address
channel	Timer channel number

Returns

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

35.6.8 static uint32_t PIT_GetStatusFlags (PIT_Type * *base,* pit_chnl_t *channel*) [inline], [static]

Parameters

base	PIT peripheral base address
channel	Timer channel number

Returns

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

35.6.9 static void PIT_ClearStatusFlags (PIT_Type * *base*, pit_chnl_t *channel*, uint32_t *mask*) [inline], [static]

Parameters

base	PIT peripheral base address
channel	Timer channel number
mask	The status flags to clear. This is a logical OR of members of the enumeration pit_status_flags_t

35.6.10 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

base	PIT peripheral base address
channel	Timer channel number

count	Timer period in units of ticks

35.6.11 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

base	PIT peripheral base address
channel	Timer channel number

Returns

Current timer counting value in ticks

35.6.12 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

base	PIT peripheral base address
channel	Timer channel number.

35.6.13 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

base	PIT peripheral base address
channel	Timer channel number.

35.6.14 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

base	PIT peripheral base address

Returns

Current lifetime timer value

Chapter 36
PMU: Power Management Unit

36.1 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_2P5nableBrownout (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.

36.2 Macro Definition Documentation

36.2.1 #define FSL_PMU_DRIVER_VERSION (MAKE_VERSION(2, 1, 1))

Version 2.1.1.

36.3 Enumeration Type Documentation

36.3.1 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.

36.3.2 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.

36.3.3 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.

36.3.4 enum pmu_core_reg_voltage_ramp_rate_t

Enumerator

kPMU_CoreRegVoltageRampRateFast Fast.
kPMU_CoreRegVoltageRampRateMediumFast Medium Fast.
kPMU_CoreRegVoltageRampRateMediumSlow Medium Slow.
kPMU_CoreRegVoltageRampRateSlow Slow.

36.3.5 enum pmu_power_bandgap_t

Enumerator

kPMU_NormalPowerBandgap Normal power bandgap.
kPMU_LowPowerBandgap Low power bandgap.

36.4 Function Documentation

36.4.1 uint32_t PMU_GetStatusFlags (PMU_Type ∗ *base*)

Parameters

base	PMU peripheral base address.

Returns

PMU status flags.It indicate if regulator output of 1P1,3P0 and 2P5 is ok and brownout output of 1P1,3P0 and 2P5 is detected.

36.4.2 static void PMU_1P1SetWeakReferenceSource (PMU_Type * *base*, pmu_1p1_weak_reference_source_t *option*) [inline], [static]

Parameters

base	PMU peripheral base address.
option	The option for reference voltage source, see to pmu_1p1_weak_reference_source_t.

36.4.3 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

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.4 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

base	PMU peripheral base address.
value	Setting value for the output.

36.4.5 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

base	PMU peripheral base address.
value	Setting value for the brownout offset. The available range is in 3-bit.

36.4.6 static void PMU_1P1EnablePullDown (PMU_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.7 static void PMU_1P1EnableCurrentLimit (PMU_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.8 static void PMU_1P1EnableBrownout (PMU_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.9 static void PMU_1P1EnableOutput (PMU_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.10 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

base	PMU peripheral base address.
value	Setting value for the output.

36.4.11 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

base	PMU peripheral base address.
option	User-defined input voltage source for LDO_3P0.

36.4.12 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

base	PMU peripheral base address.
value	Setting value for the brownout offset. The available range is in 3-bit.

36.4.13 static void PMU_3P0EnableCurrentLimit (PMU_Type ∗ *base,* bool *enable*) [inline], [static]

Parameters

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.14 static void PMU_3P0EnableBrownout (PMU_Type ∗ *base,* bool *enable*) [inline], [static]

Parameters

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.15 static void PMU_3P0EnableOutput (PMU_Type ∗ *base,* bool *enable*) [inline], [static]

Parameters

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.16 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

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.17 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

base	PMU peripheral base address.
value	Setting value for the output.

36.4.18 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

base	PMU peripheral base address.
value	Setting value for the brownout offset. The available range is in 3-bit.

36.4.19 static void PMU_2P5EnablePullDown (PMU_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.20 static void PMU_2P1EnablePullDown (PMU_Type * *base*, bool *enable*) [inline], [static]

Deprecated Do not use this function. It has been superceded by PMU_2P5EnablePullDown.

36.4.21 static void PMU_2P5EnableCurrentLimit (PMU_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.22 static void PMU_2P5nableBrownout (PMU_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.23 static void PMU_2P5EnableOutput (PMU_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.24 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

base	PMU peripheral base address.
enable	Enable the feature or not.

36.4.25 static void PMU_CoreSetRegulatorVoltageRampRate (PMU_Type * *base,* pmu_core_reg_voltage_ramp_rate_t *option*) [inline], [static]

Parameters

base	PMU peripheral base address.
option	User-defined option for voltage ramp rate, see to pmu_core_reg_voltage_ramp_rate_t.

36.4.26 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

base	PMU peripheral base address.
value	Setting value for target voltage. 5-bit available

36.4.27 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

base	PMU peripheral base address.
value	Setting value for target voltage. 5-bit available

Chapter 37
PWM: Pulse Width Modulator

37.1 Overview

The MCUXpresso SDK provides a driver for the Pulse Width Modulator (PWM) of MCUXpresso SDK devices.

37.2 PWM: Pulse Width Modulator

37.2.1 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.

37.2.2 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.

37.2.3 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.

37.2.4 Fault operation

The function PWM_SetupFault() sets up the properties for each fault.

37.2.5 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.

37.2.6 Status

Provide functions to get and clear the PWM status.

37.2.7 Interrupt

Provide functions to enable/disable PWM interrupts and get current enabled interrupts.

37.3 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/pwmThe 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_RO-OT>/boards/<BOARD>/driver_examples/pwm

37.4 Typical use case

37.4.1 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/<B-OARD>/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)
  Ungates 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.

37.5 Data Structure Documentation

37.5.1 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)

37.5.2 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 indepedent 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.

37.5.3 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.

37.5.4 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.

37.5.5 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

37.6 Enumeration Type Documentation

37.6.1 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.

37.6.2 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.

37.6.3 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.

37.6.4 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.

37.6.5 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.

37.6.6 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.

37.6.7 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.

37.6.8 enum pwm_load_frequency_t

Enumerator

kPWM_LoadEveryOportunity 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.

37.6.9 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.

37.6.10 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.

37.6.11 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.

37.6.12 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_EXTA signal is used by the deadtime logic.

37.6.13 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.

37.6.14 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.

37.6.15 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.

37.6.16 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.

37.6.17 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.

37.6.18 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.

37.6.19 enum pwm_dma_source_select_t

Enumerator

kPWM_DMARequestDisable Read DMA requests disabled.
kPWM_DMAWatermarksEnable Exceeding a FIFO watermark sets the DMA read request.
kPWM_DMALocalSync A local sync (VAL1 matches counter) sets the read DMA request.
kPWM_DMALocalReload A local reload (STS[RF] being set) sets the read DMA request.

37.6.20 enum pwm_watermark_control_t

Enumerator

kPWM_FIFOWatermarksOR Selected FIFO watermarks are OR'ed together.
kPWM_FIFOWatermarksAND Selected FIFO watermarks are AND'ed together.

37.6.21 enum pwm_mode_t

Enumerator

kPWM_SignedCenterAligned Signed center-aligned.
kPWM_CenterAligned Unsigned cente-aligned.
kPWM_SignedEdgeAligned Signed edge-aligned.
kPWM_EdgeAligned Unsigned edge-aligned.

37.6.22 enum pwm_level_select_t

Enumerator

kPWM_HighTrue High level represents "on" or "active" state.
kPWM_LowTrue Low level represents "on" or "active" state.

37.6.23 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.

37.6.24 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.

37.6.25 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.

37.6.26 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.

37.7 Function Documentation

37.7.1 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

base	PWM peripheral base address
subModule	PWM submodule to configure
config	Pointer to user's PWM config structure.

Returns

kStatus_Success means success; else failed.

37.7.2 void PWM_Deinit (PWM_Type * *base*, pwm_submodule_t *subModule*)

Parameters

base	PWM peripheral base address
subModule	PWM submodule to deinitialize

37.7.3 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_LoadEveryOportunity;
*   config->reloadLogic = kPWM_ReloadImmediate;
*   config->pairOperation = kPWM_Independent;
*
```

Parameters

config	Pointer to user's PWM config structure.

37.7.4 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

base	PWM peripheral base address
subModule	PWM submodule to configure

chnlParams	Array of PWM channel parameters to configure the channel(s)
numOfChnls	Number of channels to configure, this should be the size of the array passed in. Array size should not be more than 2 as each submodule has 2 pins to output PWM
mode	PWM operation mode, options available in enumeration pwm_mode_t
pwmFreq_Hz	PWM signal frequency in Hz
srcClock_Hz	PWM main counter clock in Hz.

Returns

Returns kStatusFail if there was error setting up the signal; kStatusSuccess otherwise

37.7.5 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 dutycyle to the new value that is passed in. If the dead time insertion logic is enabled then the pulse period is reduced by the dead time period specified by the user.

Parameters

base	PWM peripheral base address
subModule	PWM submodule to configure
pwmSignal	Signal (PWM A or PWM B) to update
currPwmMode	The current PWM mode set during PWM setup
dutyCycle-Percent	New PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)... 100=active signal (100% duty cycle)

37.7.6 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 dutycyle to the new value that is passed in. If the dead time insertion logic is enabled then the pulse period is reduced by the dead time period specified by the user.

Parameters

base	PWM peripheral base address
subModule	PWM submodule to configure
pwmSignal	Signal (PWM A or PWM B) to update
currPwmMode	The current PWM mode set during PWM setup
dutyCycle	New PWM pulse width, value should be between 0 to 65535 0=inactive signal(0% duty cycle)... 65535=active signal (100% duty cycle)

37.7.7 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

base	PWM peripheral base address
subModule	PWM submodule to configure
pwmChannel	Channel in the submodule to setup
inputCaptureParams	Parameters passed in to set up the input pin

37.7.8 void PWM_SetupFaultInputFilter (PWM_Type * *base,* const pwm_fault_input_filter_param_t * *faultInputFilterParams*)

Parameters

base	PWM peripheral base address
faultInputFilterParams	Parameters passed in to set up the fault input filter.

37.7.9 void PWM_SetupFaults (PWM_Type * *base,* pwm_fault_input_t *faultNum,* const pwm_fault_param_t * *faultParams*)

PWM has 4 fault inputs.

Parameters

base	PWM peripheral base address
faultNum	PWM fault to configure.
faultParams	Pointer to the PWM fault config structure

37.7.10 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

config	Pointer to user's PWM fault config structure.

37.7.11 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

base	PWM peripheral base address
subModule	PWM submodule to configure
pwmChannel	Channel to configure
mode	Signal to output when a FORCE_OUT is triggered

37.7.12 void PWM_EnableInterrupts (PWM_Type * *base*, pwm_submodule_t *subModule*, uint32_t *mask*)

Parameters

base	PWM peripheral base address
subModule	PWM submodule to configure
mask	The interrupts to enable. This is a logical OR of members of the enumeration pwm_-interrupt_enable_t

37.7.13 void PWM_DisableInterrupts (PWM_Type * *base*, pwm_submodule_t *subModule*, uint32_t *mask*)

Parameters

base	PWM peripheral base address
subModule	PWM submodule to configure
mask	The interrupts to enable. This is a logical OR of members of the enumeration pwm_-interrupt_enable_t

37.7.14 uint32_t PWM_GetEnabledInterrupts (PWM_Type * *base*, pwm_submodule_t *subModule*)

Parameters

base	PWM peripheral base address
subModule	PWM submodule to configure

Returns

The enabled interrupts. This is the logical OR of members of the enumeration pwm_interrupt_-enable_t

37.7.15 static void PWM_DMAFIFOWatermarkControl (PWM_Type * *base*, pwm_submodule_t *subModule*, pwm_watermark_control_t *pwm_watermark_control*) [inline], [static]

Parameters

base	PWM peripheral base address
subModule	PWM submodule to configure
pwm_watermark_control	PWM FIFO watermark and control

37.7.16 static void PWM_DMACaptureSourceSelect (PWM_Type * *base*, pwm_submodule_t *subModule*, pwm_dma_source_select_t *pwm_dma_source_select*) [inline], [static]

Parameters

base	PWM peripheral base address
subModule	PWM submodule to configure
pwm_dma_source_select	PWM capture DMA enable source select

37.7.17 static void PWM_EnableDMACapture (PWM_Type * *base*, pwm_submodule_t *subModule*, uint16_t *mask*, bool *activate*) [inline], [static]

Parameters

base	PWM peripheral base address
subModule	PWM submodule to configure
mask	The DMA to enable or disable. This is a logical OR of members of the enumeration pwm_dma_enable_t
activate	true: Enable DMA read request; false: Disable DMA read request

37.7.18 static void PWM_EnableDMAWrite (PWM_Type * *base*, pwm_submodule_t *subModule*, bool *activate*) [inline], [static]

Parameters

base	PWM peripheral base address
subModule	PWM submodule to configure
activate	true: Enable DMA write request; false: Disable DMA write request

37.7.19 uint32_t PWM_GetStatusFlags (PWM_Type * *base*, pwm_submodule_t *subModule*)

Parameters

base	PWM peripheral base address
subModule	PWM submodule to configure

Returns

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

37.7.20 void PWM_ClearStatusFlags (PWM_Type * *base*, pwm_submodule_t *subModule*, uint32_t *mask*)

Parameters

base	PWM peripheral base address
subModule	PWM submodule to configure
mask	The status flags to clear. This is a logical OR of members of the enumeration pwm_status_flags_t

37.7.21 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

base	PWM peripheral base address
subModulesToStart	PWM submodules to start. This is a logical OR of members of the enumeration pwm_module_control_t

37.7.22 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

base	PWM peripheral base address
subModulesToStop	PWM submodules to stop. This is a logical OR of members of the enumeration pwm_module_control_t

37.7.23 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

base	PWM peripheral base address
subModule	PWM submodule to configure
valueRegister	Value register that will activate the trigger
activate	true: Enable the trigger; false: Disable the trigger

37.7.24 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

base	PWM peripheral base address
subModule	PWM submodule to configure
valueRegister-Mask	Value register mask that will activate one or more (VAL0-5) trigger enumeration _-pwm_value_register_mask

37.7.25 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

base	PWM peripheral base address
subModule	PWM submodule to configure
valueRegister-Mask	Value register mask that will Deactivate one or more (VAL0-5) trigger enumeration _pwm_value_register_mask

37.7.26 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

base	PWM peripheral base address
subModule	PWM submodule to configure
pwmChannel	Channel to configure
value	true: Supply a logic 1, false: Supply a logic 0.

37.7.27 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 choosen during config. Else the values are loaded at the next PWM reload point. This function can issue the load command to multiple submodules at the same time.

Parameters

base	PWM peripheral base address
subModulesToUpdate	PWM submodules to update with buffered values. This is a logical OR of members of the enumeration pwm_module_control_t
value	true: Set LDOK bit for the submodule list; false: Clear LDOK bit

37.7.28 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

base	PWM peripheral base address
subModule	PWM submodule to configure
pwmChannel	Channel to configure
faultState	PWM output fault status

37.7.29 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

base	PWM peripheral base address
subModule	PWM submodule to configure
pwmChannel	PWM channel to configure
pwm_fault_-channels	PWM fault channel to configure
value	Fault disable mapping mask value enumeration pwm_fault_disable_t

Chapter 38
PXP: Pixel Pipeline

38.1 Overview

The MCUXpresso SDK provides a driver for the Pixel Pipeline (PXP)

The PXP is used to process graphics buffers or composite video and graphics data before sending to an LCD display or TV encoder. The PXP driver only provides functional APIs. It does not maintain software level state, so that the APIs could be involved directly to any upper layer graphics framework easily.

To use the PXP driver, call PXP_Init first to enable and initialize the peripheral. Generally, call the PXP driver APIs the configure input buffer, output buffer, and other setting such as flip, rotate, then call PXP_Start, thus the PXP starts the processing. When finished, the flag kPXP_CompleteFlag asserts. PXP also supports operation queuing, it means that a new operation could be submited to PXP while the current PXP operation is running. When current operation finished, the new operation configurations are loaded to PXP register and new processing starts.

38.2 Typical use case

38.2.1 PXP normal operation

This example shows how to perform vertical flip to process surface and save to output buffer. The input and output buffer pixel format are RGB888.

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

38.2.2 PXP operation queue

This example shows how to perform vertical flip to process surface using operation queue. The input and output buffer pixel format are RGB888.

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

Data Structures

- struct pxp_output_buffer_config_t
  PXP output buffer configuration. More...
- struct pxp_ps_buffer_config_t
  PXP process surface buffer configuration. More...
- struct pxp_as_buffer_config_t
  PXP alphs surface buffer configuration. More...
- struct pxp_as_blend_config_t
  PXP alpha surface blending configuration. More...
- struct pxp_csc2_config_t

PXP CSC2 configuration. More...
- struct pxp_dither_final_lut_data_t
  PXP dither final LUT data. More...
- struct pxp_dither_config_t
  PXP dither configuration. More...
- struct pxp_porter_duff_config_t
  PXP Porter Duff configuration. More...
- struct pxp_pic_copy_config_t
  PXP Porter Duff blend mode. More...

Enumerations

- enum _pxp_interrupt_enable {
  kPXP_CommandLoadInterruptEnable = PXP_CTRL_NEXT_IRQ_ENABLE_MASK,
  kPXP_CompleteInterruptEnable = PXP_CTRL_IRQ_ENABLE_MASK }
  PXP interrupts to enable.
- enum _pxp_flags {
  kPXP_CommandLoadFlag = PXP_STAT_NEXT_IRQ_MASK,
  kPXP_CompleteFlag = PXP_STAT_IRQ0_MASK,
  kPXP_Axi0ReadErrorFlag = PXP_STAT_AXI_READ_ERROR_0_MASK,
  kPXP_Axi0WriteErrorFlag = PXP_STAT_AXI_WRITE_ERROR_0_MASK }
  PXP status flags.
- enum pxp_flip_mode_t {
  kPXP_FlipDisable = 0U,
  kPXP_FlipHorizontal = 0x01U,
  kPXP_FlipVertical = 0x02U,
  kPXP_FlipBoth = 0x03U }
  PXP output flip mode.
- enum pxp_rotate_position_t {
  kPXP_RotateOutputBuffer = 0U,
  kPXP_RotateProcessSurface }
  PXP rotate mode.
- enum pxp_rotate_degree_t {
  kPXP_Rotate0 = 0U,
  kPXP_Rotate90,
  kPXP_Rotate180,
  kPXP_Rotate270 }
  PXP rotate degree.
- enum pxp_interlaced_output_mode_t {
  kPXP_OutputProgressive = 0U,
  kPXP_OutputField0,
  kPXP_OutputField1,
  kPXP_OutputInterlaced }
  PXP interlaced output mode.
- enum pxp_output_pixel_format_t {

kPXP_OutputPixelFormatARGB8888 = 0x0,
kPXP_OutputPixelFormatRGB888 = 0x4,
kPXP_OutputPixelFormatRGB888P = 0x5,
kPXP_OutputPixelFormatARGB1555 = 0x8,
kPXP_OutputPixelFormatARGB4444 = 0x9,
kPXP_OutputPixelFormatRGB555 = 0xC,
kPXP_OutputPixelFormatRGB444 = 0xD,
kPXP_OutputPixelFormatRGB565 = 0xE,
kPXP_OutputPixelFormatYUV1P444 = 0x10,
kPXP_OutputPixelFormatUYVY1P422 = 0x12,
kPXP_OutputPixelFormatVYUY1P422 = 0x13,
kPXP_OutputPixelFormatY8 = 0x14,
kPXP_OutputPixelFormatY4 = 0x15,
kPXP_OutputPixelFormatYUV2P422 = 0x18,
kPXP_OutputPixelFormatYUV2P420 = 0x19,
kPXP_OutputPixelFormatYVU2P422 = 0x1A,
kPXP_OutputPixelFormatYVU2P420 = 0x1B }

PXP output buffer format.

- enum pxp_ps_pixel_format_t {
  kPXP_PsPixelFormatRGB888 = 0x4,
  kPXP_PsPixelFormatRGB555 = 0xC,
  kPXP_PsPixelFormatRGB444 = 0xD,
  kPXP_PsPixelFormatRGB565 = 0xE,
  kPXP_PsPixelFormatYUV1P444 = 0x10,
  kPXP_PsPixelFormatUYVY1P422 = 0x12,
  kPXP_PsPixelFormatVYUY1P422 = 0x13,
  kPXP_PsPixelFormatY8 = 0x14,
  kPXP_PsPixelFormatY4 = 0x15,
  kPXP_PsPixelFormatYUV2P422 = 0x18,
  kPXP_PsPixelFormatYUV2P420 = 0x19,
  kPXP_PsPixelFormatYVU2P422 = 0x1A,
  kPXP_PsPixelFormatYVU2P420 = 0x1B,
  kPXP_PsPixelFormatYVU422 = 0x1E,
  kPXP_PsPixelFormatYVU420 = 0x1F }

  PXP process surface buffer pixel format.

- enum pxp_ps_yuv_format_t {
  kPXP_PsYUVFormatYUV = 0U,
  kPXP_PsYUVFormatYCbCr }

  PXP process surface buffer YUV format.

- enum pxp_as_pixel_format_t {

kPXP_AsPixelFormatARGB8888 = 0x0,
kPXP_AsPixelFormatRGB888 = 0x4,
kPXP_AsPixelFormatARGB1555 = 0x8,
kPXP_AsPixelFormatARGB4444 = 0x9,
kPXP_AsPixelFormatRGB555 = 0xC,
kPXP_AsPixelFormatRGB444 = 0xD,
kPXP_AsPixelFormatRGB565 = 0xE }

PXP alpha surface buffer pixel format.

- enum pxp_alpha_mode_t {
  kPXP_AlphaEmbedded,
  kPXP_AlphaOverride,
  kPXP_AlphaMultiply,
  kPXP_AlphaRop }

  PXP alpha mode during blending.
- enum pxp_rop_mode_t {
  kPXP_RopMaskAs = 0x0,
  kPXP_RopMaskNotAs = 0x1,
  kPXP_RopMaskAsNot = 0x2,
  kPXP_RopMergeAs = 0x3,
  kPXP_RopMergeNotAs = 0x4,
  kPXP_RopMergeAsNot = 0x5,
  kPXP_RopNotCopyAs = 0x6,
  kPXP_RopNot = 0x7,
  kPXP_RopNotMaskAs = 0x8,
  kPXP_RopNotMergeAs = 0x9,
  kPXP_RopXorAs = 0xA,
  kPXP_RopNotXorAs = 0xB }

  PXP ROP mode during blending.
- enum pxp_block_size_t {
  kPXP_BlockSize8 = 0U,
  kPXP_BlockSize16 }

  PXP process block size.
- enum pxp_csc1_mode_t {
  kPXP_Csc1YUV2RGB = 0U,
  kPXP_Csc1YCbCr2RGB }

  PXP CSC1 mode.
- enum pxp_csc2_mode_t {
  kPXP_Csc2YUV2RGB = 0U,
  kPXP_Csc2YCbCr2RGB,
  kPXP_Csc2RGB2YUV,
  kPXP_Csc2RGB2YCbCr }

  PXP CSC2 mode.
- enum pxp_ram_t {
  kPXP_RamDither0Lut = 0U,
  kPXP_RamDither1Lut = 3U,
  kPXP_RamDither2Lut = 4U }

PXP internal memory.

- enum _pxp_dither_mode {
  kPXP_DitherPassThrough = 0U,
  kPXP_DitherOrdered = 3U,
  kPXP_DitherQuantOnly = 4U }
  PXP dither mode.
- enum _pxp_dither_lut_mode {
  kPXP_DitherLutOff = 0U,
  kPXP_DitherLutPreDither,
  kPXP_DitherLutPostDither }
  PXP dither LUT mode.
- enum _pxp_dither_matrix_size {
  kPXP_DitherMatrix8 = 1,
  kPXP_DitherMatrix16 }
  PXP dither matrix size.
- enum {
  kPXP_PorterDuffFactorOne = 0U,
  kPXP_PorterDuffFactorZero,
  kPXP_PorterDuffFactorStraight,
  kPXP_PorterDuffFactorInversed }
  Porter Duff factor mode.
- enum {
  kPXP_PorterDuffGlobalAlpha = 0U,
  kPXP_PorterDuffLocalAlpha,
  kPXP_PorterDuffScaledAlpha }
  Porter Duff global alpha mode.
- enum {
  kPXP_PorterDuffAlphaStraight = 0U,
  kPXP_PorterDuffAlphaInversed }
  Porter Duff alpha mode.
- enum {
  kPXP_PorterDuffColorStraight = 0,
  kPXP_PorterDuffColorInversed = 1,
  kPXP_PorterDuffColorNoAlpha = 0,
  kPXP_PorterDuffColorWithAlpha = 1 }
  Porter Duff color mode.
- enum pxp_porter_duff_blend_mode_t {

kPXP_PorterDuffSrc = 0,
kPXP_PorterDuffAtop,
kPXP_PorterDuffOver,
kPXP_PorterDuffIn,
kPXP_PorterDuffOut,
kPXP_PorterDuffDst,
kPXP_PorterDuffDstAtop,
kPXP_PorterDuffDstOver,
kPXP_PorterDuffDstIn,
kPXP_PorterDuffDstOut,
kPXP_PorterDuffXor,
kPXP_PorterDuffClear }
PXP Porter Duff blend mode.

Driver version

- #define **FSL_PXP_DRIVER_VERSION** (MAKE_VERSION(2, 2, 2))

Initialization and deinitialization

- void PXP_Init (PXP_Type ∗base)
  Initialize the PXP.
- void PXP_Deinit (PXP_Type ∗base)
  De-initialize the PXP.
- void PXP_Reset (PXP_Type ∗base)
  Reset the PXP.

Global operations

- static void PXP_Start (PXP_Type ∗base)
  Start process.
- static void PXP_EnableLcdHandShake (PXP_Type ∗base, bool enable)
  Enable or disable LCD hand shake.
- static void PXP_EnableContinousRun (PXP_Type ∗base, bool enable)
  Enable or disable continous run.
- static void PXP_SetProcessBlockSize (PXP_Type ∗base, pxp_block_size_t size)
  Set the PXP processing block size.

Status

- static uint32_t PXP_GetStatusFlags (PXP_Type ∗base)
  Gets PXP status flags.
- static void PXP_ClearStatusFlags (PXP_Type ∗base, uint32_t statusMask)
  Clears status flags with the provided mask.
- static uint8_t PXP_GetAxiErrorId (PXP_Type ∗base, uint8_t axiIndex)
  Gets the AXI ID of the failing bus operation.

Interrupts

- static void PXP_EnableInterrupts (PXP_Type ∗base, uint32_t mask)

Enables PXP interrupts according to the provided mask.
- static void PXP_DisableInterrupts (PXP_Type *base, uint32_t mask)
  Disables PXP interrupts according to the provided mask.

Alpha surface

- void PXP_SetAlphaSurfaceBufferConfig (PXP_Type *base, const pxp_as_buffer_config_t *config)
  Set the alpha surface input buffer configuration.
- void PXP_SetAlphaSurfaceBlendConfig (PXP_Type *base, const pxp_as_blend_config_t *config)
  Set the alpha surface blending configuration.
- void PXP_SetAlphaSurfaceOverlayColorKey (PXP_Type *base, uint32_t colorKeyLow, uint32_t colorKeyHigh)
  Set the alpha surface overlay color key.
- static void PXP_EnableAlphaSurfaceOverlayColorKey (PXP_Type *base, bool enable)
  Enable or disable the alpha surface color key.
- void PXP_SetAlphaSurfacePosition (PXP_Type *base, uint16_t upperLeftX, uint16_t upperLeftY, uint16_t lowerRightX, uint16_t lowerRightY)
  Set the alpha surface position in output buffer.

Process surface

- static void PXP_SetProcessSurfaceBackGroundColor (PXP_Type *base, uint32_t backGroundColor)
  Set the back ground color of PS.
- void PXP_SetProcessSurfaceBufferConfig (PXP_Type *base, const pxp_ps_buffer_config_t *config)
  Set the process surface input buffer configuration.
- void PXP_SetProcessSurfaceScaler (PXP_Type *base, uint16_t inputWidth, uint16_t inputHeight, uint16_t outputWidth, uint16_t outputHeight)
  Set the process surface scaler configuration.
- void PXP_SetProcessSurfacePosition (PXP_Type *base, uint16_t upperLeftX, uint16_t upperLeftY, uint16_t lowerRightX, uint16_t lowerRightY)
  Set the process surface position in output buffer.
- void PXP_SetProcessSurfaceColorKey (PXP_Type *base, uint32_t colorKeyLow, uint32_t colorKeyHigh)
  Set the process surface color key.
- static void PXP_SetProcessSurfaceYUVFormat (PXP_Type *base, pxp_ps_yuv_format_t format)
  Set the process surface input pixel format YUV or YCbCr.

Output buffer

- void PXP_SetOutputBufferConfig (PXP_Type *base, const pxp_output_buffer_config_t *config)
  Set the PXP outpt buffer configuration.
- static void PXP_SetOverwrittenAlphaValue (PXP_Type *base, uint8_t alpha)
  Set the global overwritten alpha value.
- static void PXP_EnableOverWrittenAlpha (PXP_Type *base, bool enable)
  Enable or disable the global overwritten alpha value.
- static void PXP_SetRotateConfig (PXP_Type *base, pxp_rotate_position_t position, pxp_rotate_degree_t degree, pxp_flip_mode_t flipMode)
  Set the rotation configuration.

Command queue

- void PXP_SetNextCommand (PXP_Type *base, void *commandAddr)
  Set the next command.
- static bool PXP_IsNextCommandPending (PXP_Type *base)
  Check whether the next command is pending.
- static void PXP_CancelNextCommand (PXP_Type *base)
  Cancel command set by PXP_SetNextCommand.

Color space conversion

- void PXP_SetCsc1Mode (PXP_Type *base, pxp_csc1_mode_t mode)
  Set the CSC1 mode.
- static void PXP_EnableCsc1 (PXP_Type *base, bool enable)
  Enable or disable the CSC1.

Porter Duff

- void PXP_SetPorterDuffConfig (PXP_Type *base, const pxp_porter_duff_config_t *config)
  Set the Porter Duff configuration.
- status_t PXP_GetPorterDuffConfig (pxp_porter_duff_blend_mode_t mode, pxp_porter_duff_-config_t *config)
  Get the Porter Duff configuration by blend mode.

Buffer copy

- status_t PXP_StartPictureCopy (PXP_Type *base, const pxp_pic_copy_config_t *config)
  Copy picture from one buffer to another buffer.
- status_t PXP_StartMemCopy (PXP_Type *base, uint32_t srcAddr, uint32_t destAddr, uint32_t size)
  Copy continous memory.

38.3 Data Structure Documentation

38.3.1 struct pxp_output_buffer_config_t

Data Fields

- pxp_output_pixel_format_t pixelFormat
  Output buffer pixel format.
- pxp_interlaced_output_mode_t interlacedMode
  Interlaced output mode.
- uint32_t buffer0Addr
  Output buffer 0 address.
- uint32_t buffer1Addr
  Output buffer 1 address, used for UV data in YUV 2-plane mode, or field 1 in output interlaced mode.
- uint16_t pitchBytes
  Number of bytes between two vertically adjacent pixels.
- uint16_t width
  Pixels per line.
- uint16_t height
  How many lines in output buffer.

Field Documentation

(1) pxp_output_pixel_format_t pxp_output_buffer_config_t::pixelFormat

(2) pxp_interlaced_output_mode_t pxp_output_buffer_config_t::interlacedMode

(3) uint32_t pxp_output_buffer_config_t::buffer0Addr

(4) uint32_t pxp_output_buffer_config_t::buffer1Addr

(5) uint16_t pxp_output_buffer_config_t::pitchBytes

(6) uint16_t pxp_output_buffer_config_t::width

(7) uint16_t pxp_output_buffer_config_t::height

38.3.2 struct pxp_ps_buffer_config_t

Data Fields

- pxp_ps_pixel_format_t pixelFormat
  PS buffer pixel format.
- bool swapByte
  For each 16 bit word, set true to swap the two bytes.
- uint32_t bufferAddr
  Input buffer address for the first panel.
- uint32_t bufferAddrU
  Input buffer address for the second panel.
- uint32_t bufferAddrV
  Input buffer address for the third panel.
- uint16_t pitchBytes
  Number of bytes between two vertically adjacent pixels.

Field Documentation

(1) pxp_ps_pixel_format_t pxp_ps_buffer_config_t::pixelFormat

(2) bool pxp_ps_buffer_config_t::swapByte

(3) uint32_t pxp_ps_buffer_config_t::bufferAddr

(4) uint32_t pxp_ps_buffer_config_t::bufferAddrU

(5) uint32_t pxp_ps_buffer_config_t::bufferAddrV

(6) uint16_t pxp_ps_buffer_config_t::pitchBytes

38.3.3 struct pxp_as_buffer_config_t

Data Fields

- pxp_as_pixel_format_t pixelFormat
  AS buffer pixel format.
- uint32_t bufferAddr
  Input buffer address.
- uint16_t pitchBytes
  Number of bytes between two vertically adjacent pixels.

Field Documentation

(1) pxp_as_pixel_format_t pxp_as_buffer_config_t::pixelFormat

(2) uint32_t pxp_as_buffer_config_t::bufferAddr

(3) uint16_t pxp_as_buffer_config_t::pitchBytes

38.3.4 struct pxp_as_blend_config_t

Data Fields

- uint8_t alpha
  User defined alpha value, only used when alphaMode is kPXP_AlphaOverride or kPXP_AlphaRop.
- bool invertAlpha
  Set true to invert the alpha.
- pxp_alpha_mode_t alphaMode
  Alpha mode.
- pxp_rop_mode_t ropMode
  ROP mode, only valid when alphaMode is kPXP_AlphaRop.

Field Documentation

(1) uint8_t pxp_as_blend_config_t::alpha

(2) bool pxp_as_blend_config_t::invertAlpha

(3) pxp_alpha_mode_t pxp_as_blend_config_t::alphaMode

(4) pxp_rop_mode_t pxp_as_blend_config_t::ropMode

38.3.5 struct pxp_csc2_config_t

Converting from YUV/YCbCr color spaces to the RGB color space uses the following equation structure:

R = A1(Y+D1) + A2(U+D2) + A3(V+D3) G = B1(Y+D1) + B2(U+D2) + B3(V+D3) B = C1(Y+D1) + C2(U+D2) + C3(V+D3)

Converting from the RGB color space to YUV/YCbCr color spaces uses the following equation structure:

Y = A1∗R + A2∗G + A3∗B + D1 U = B1∗R + B2∗G + B3∗B + D2 V = C1∗R + C2∗G + C3∗B + D3

Data Fields

- pxp_csc2_mode_t mode
  Convertion mode.
- float A1
  A1.
- float A2
  A2.
- float A3
  A3.
- float B1
  B1.
- float B2
  B2.
- float B3
  B3.
- float C1
  C1.
- float C2
  C2.
- float C3
  C3.
- int16_t D1
  D1.
- int16_t D2
  D2.
- int16_t D3
  D3.

Field Documentation

(1) pxp_csc2_mode_t pxp_csc2_config_t::mode

(2) float pxp_csc2_config_t::A1

(3) float pxp_csc2_config_t::A2

(4) float pxp_csc2_config_t::A3

(5) float pxp_csc2_config_t::B1

(6) float pxp_csc2_config_t::B2

(7) float pxp_csc2_config_t::B3

(8) float pxp_csc2_config_t::C1

(9) float pxp_csc2_config_t::C2

(10) float pxp_csc2_config_t::C3

(11) int16_t pxp_csc2_config_t::D1

(12) int16_t pxp_csc2_config_t::D2

(13) int16_t pxp_csc2_config_t::D3

38.3.6 struct pxp_dither_final_lut_data_t

Data Fields

- uint32_t data_3_0
  Data 3 to data 0.
- uint32_t data_7_4
  Data 7 to data 4.
- uint32_t data_11_8
  Data 11 to data 8.
- uint32_t data_15_12
  Data 15 to data 12.

Field Documentation

(1) uint32_t pxp_dither_final_lut_data_t::data_3_0

Data 0 is the least significant byte.

(2) uint32_t pxp_dither_final_lut_data_t::data_7_4

Data 4 is the least significant byte.

(3) uint32_t pxp_dither_final_lut_data_t::data_11_8

Data 8 is the least significant byte.

(4) uint32_t pxp_dither_final_lut_data_t::data_15_12

Data 12 is the least significant byte.

38.3.7 struct pxp_dither_config_t

Data Fields

- uint32_t enableDither0: 1
  Enable dither engine 0 or not, set 1 to enable, 0 to disable.
- uint32_t enableDither1: 1

Enable dither engine 1 or not, set 1 to enable, 0 to disable.

- uint32_t enableDither2: 1

  Enable dither engine 2 or not, set 1 to enable, 0 to disable.
- uint32_t ditherMode0: 3

  Dither mode for dither engine 0.
- uint32_t ditherMode1: 3

  Dither mode for dither engine 1.
- uint32_t ditherMode2: 3

  Dither mode for dither engine 2.
- uint32_t quantBitNum: 3

  Number of bits quantize down to, the valid value is 1∼7.
- uint32_t lutMode: 2

  How to use the memory LUT, see _pxp_dither_lut_mode.
- uint32_t idxMatrixSize0: 2

  Size of index matrix used for dither for dither engine 0, see _pxp_dither_matrix_size.
- uint32_t idxMatrixSize1: 2

  Size of index matrix used for dither for dither engine 1, see _pxp_dither_matrix_size.
- uint32_t idxMatrixSize2: 2

  Size of index matrix used for dither for dither engine 2, see _pxp_dither_matrix_size.
- uint32_t enableFinalLut: 1

  Enable the final LUT, set 1 to enable, 0 to disable.

Field Documentation

(1) uint32_t pxp_dither_config_t::enableDither0

(2) uint32_t pxp_dither_config_t::enableDither1

(3) uint32_t pxp_dither_config_t::enableDither2

(4) uint32_t pxp_dither_config_t::ditherMode0

See _pxp_dither_mode.

(5) uint32_t pxp_dither_config_t::ditherMode1

See _pxp_dither_mode.

(6) uint32_t pxp_dither_config_t::ditherMode2

See _pxp_dither_mode.

(7) uint32_t pxp_dither_config_t::quantBitNum

(8) uint32_t pxp_dither_config_t::lutMode

This must be set to kPXP_DitherLutOff if any dither engine uses kPXP_DitherOrdered mode.

(9) uint32_t pxp_dither_config_t::idxMatrixSize0

(10) uint32_t pxp_dither_config_t::idxMatrixSize1

(11) uint32_t pxp_dither_config_t::idxMatrixSize2

(12) uint32_t pxp_dither_config_t::enableFinalLut

38.3.8 struct pxp_porter_duff_config_t

Data Fields

- uint32_t enable: 1
  Enable or disable Porter Duff.
- uint32_t srcFactorMode: 2
  Source layer (or AS, s1) factor mode, see pxp_porter_duff_factor_mode.
- uint32_t dstGlobalAlphaMode: 2
  Destination layer (or PS, s0) global alpha mode, see pxp_porter_duff_global_alpha_mode.
- uint32_t dstAlphaMode: 1
  Destination layer (or PS, s0) alpha mode, see pxp_porter_duff_alpha_mode.
- uint32_t dstColorMode: 1
  Destination layer (or PS, s0) color mode, see pxp_porter_duff_color_mode.
- uint32_t dstFactorMode: 2
  Destination layer (or PS, s0) factor mode, see pxp_porter_duff_factor_mode.
- uint32_t srcGlobalAlphaMode: 2
  Source layer (or AS, s1) global alpha mode, see pxp_porter_duff_global_alpha_mode.
- uint32_t srcAlphaMode: 1
  Source layer (or AS, s1) alpha mode, see pxp_porter_duff_alpha_mode.
- uint32_t srcColorMode: 1
  Source layer (or AS, s1) color mode, see pxp_porter_duff_color_mode.
- uint32_t dstGlobalAlpha: 8
  Destination layer (or PS, s0) global alpha value, 0∼255.
- uint32_t srcGlobalAlpha: 8
  Source layer (or AS, s1) global alpha value, 0∼255.

Field Documentation

(1) uint32_t pxp_porter_duff_config_t::enable

(2) uint32_t pxp_porter_duff_config_t::srcFactorMode

(3) uint32_t pxp_porter_duff_config_t::dstGlobalAlphaMode

(4) uint32_t pxp_porter_duff_config_t::dstAlphaMode

(5) uint32_t pxp_porter_duff_config_t::dstColorMode

(6) uint32_t pxp_porter_duff_config_t::dstFactorMode

(7) uint32_t pxp_porter_duff_config_t::srcGlobalAlphaMode

(8) uint32_t pxp_porter_duff_config_t::srcAlphaMode

(9) uint32_t pxp_porter_duff_config_t::srcColorMode

(10) uint32_t pxp_porter_duff_config_t::dstGlobalAlpha

(11) uint32_t pxp_porter_duff_config_t::srcGlobalAlpha

38.3.9 struct pxp_pic_copy_config_t

Note: don't change the enum item value

Data Fields

- uint32_t srcPicBaseAddr
  Source picture base address.
- uint16_t srcPitchBytes
  Pitch of the source buffer.
- uint16_t srcOffsetX
  Copy position in source picture.
- uint16_t srcOffsetY
  Copy position in source picture.
- uint32_t destPicBaseAddr
  Destination picture base address.
- uint16_t destPitchBytes
  Pitch of the destination buffer.
- uint16_t destOffsetX
  Copy position in destination picture.
- uint16_t destOffsetY
  Copy position in destination picture.
- uint16_t width
  Pixel number each line to copy.
- uint16_t height
  Lines to copy.
- pxp_as_pixel_format_t pixelFormat
  Buffer pixel format.

Field Documentation

(1) uint32_t pxp_pic_copy_config_t::srcPicBaseAddr

(2) uint16_t pxp_pic_copy_config_t::srcPitchBytes

(3) uint16_t pxp_pic_copy_config_t::srcOffsetX

(4) uint16_t pxp_pic_copy_config_t::srcOffsetY

(5) uint32_t pxp_pic_copy_config_t::destPicBaseAddr

(6) uint16_t pxp_pic_copy_config_t::destPitchBytes

(7) uint16_t pxp_pic_copy_config_t::destOffsetX

(8) uint16_t pxp_pic_copy_config_t::destOffsetY

(9) uint16_t pxp_pic_copy_config_t::width

(10) uint16_t pxp_pic_copy_config_t::height

(11) pxp_as_pixel_format_t pxp_pic_copy_config_t::pixelFormat

38.4 Enumeration Type Documentation

38.4.1 enum _pxp_interrupt_enable

Enumerator

kPXP_CommandLoadInterruptEnable Interrupt to show that the command set by PXP_SetNextCommand has been loaded.

kPXP_CompleteInterruptEnable PXP process completed.

38.4.2 enum _pxp_flags

Note

These enumerations are meant to be OR'd together to form a bit mask.

Enumerator

kPXP_CommandLoadFlag The command set by PXP_SetNextCommand has been loaded, could set new command.

kPXP_CompleteFlag PXP process completed.

kPXP_Axi0ReadErrorFlag PXP encountered an AXI read error and processing has been terminated.

kPXP_Axi0WriteErrorFlag PXP encountered an AXI write error and processing has been terminated.

38.4.3 enum pxp_flip_mode_t

Enumerator

kPXP_FlipDisable Flip disable.

kPXP_FlipHorizontal Horizontal flip.

kPXP_FlipVertical Vertical flip.

kPXP_FlipBoth Flip both directions.

38.4.4 enum pxp_rotate_position_t

Enumerator

kPXP_RotateOutputBuffer Rotate the output buffer.
kPXP_RotateProcessSurface Rotate the process surface.

38.4.5 enum pxp_rotate_degree_t

Enumerator

kPXP_Rotate0 Clock wise rotate 0 deg.
kPXP_Rotate90 Clock wise rotate 90 deg.
kPXP_Rotate180 Clock wise rotate 180 deg.
kPXP_Rotate270 Clock wise rotate 270 deg.

38.4.6 enum pxp_interlaced_output_mode_t

Enumerator

kPXP_OutputProgressive All data written in progressive format to output buffer 0.
kPXP_OutputField0 Only write field 0 data to output buffer 0.
kPXP_OutputField1 Only write field 1 data to output buffer 0.
kPXP_OutputInterlaced Field 0 write to buffer 0, field 1 write to buffer 1.

38.4.7 enum pxp_output_pixel_format_t

Enumerator

kPXP_OutputPixelFormatARGB8888 32-bit pixels with alpha.
kPXP_OutputPixelFormatRGB888 32-bit pixels without alpha (unpacked 24-bit format)
kPXP_OutputPixelFormatRGB888P 24-bit pixels without alpha (packed 24-bit format)
kPXP_OutputPixelFormatARGB1555 16-bit pixels with alpha.
kPXP_OutputPixelFormatARGB4444 16-bit pixels with alpha.
kPXP_OutputPixelFormatRGB555 16-bit pixels without alpha.
kPXP_OutputPixelFormatRGB444 16-bit pixels without alpha.
kPXP_OutputPixelFormatRGB565 16-bit pixels without alpha.
kPXP_OutputPixelFormatYUV1P444 32-bit pixels (1-plane XYUV unpacked).
kPXP_OutputPixelFormatUYVY1P422 16-bit pixels (1-plane U0,Y0,V0,Y1 interleaved bytes)
kPXP_OutputPixelFormatVYUY1P422 16-bit pixels (1-plane V0,Y0,U0,Y1 interleaved bytes)
kPXP_OutputPixelFormatY8 8-bit monochrome pixels (1-plane Y luma output)
kPXP_OutputPixelFormatY4 4-bit monochrome pixels (1-plane Y luma, 4 bit truncation)

kPXP_OutputPixelFormatYUV2P422 16-bit pixels (2-plane UV interleaved bytes)
kPXP_OutputPixelFormatYUV2P420 16-bit pixels (2-plane UV)
kPXP_OutputPixelFormatYVU2P422 16-bit pixels (2-plane VU interleaved bytes)
kPXP_OutputPixelFormatYVU2P420 16-bit pixels (2-plane VU)

38.4.8 enum pxp_ps_pixel_format_t

Enumerator

kPXP_PsPixelFormatRGB888 32-bit pixels without alpha (unpacked 24-bit format)
kPXP_PsPixelFormatRGB555 16-bit pixels without alpha.
kPXP_PsPixelFormatRGB444 16-bit pixels without alpha.
kPXP_PsPixelFormatRGB565 16-bit pixels without alpha.
kPXP_PsPixelFormatYUV1P444 32-bit pixels (1-plane XYUV unpacked).
kPXP_PsPixelFormatUYVY1P422 16-bit pixels (1-plane U0,Y0,V0,Y1 interleaved bytes)
kPXP_PsPixelFormatVYUY1P422 16-bit pixels (1-plane V0,Y0,U0,Y1 interleaved bytes)
kPXP_PsPixelFormatY8 8-bit monochrome pixels (1-plane Y luma output)
kPXP_PsPixelFormatY4 4-bit monochrome pixels (1-plane Y luma, 4 bit truncation)
kPXP_PsPixelFormatYUV2P422 16-bit pixels (2-plane UV interleaved bytes)
kPXP_PsPixelFormatYUV2P420 16-bit pixels (2-plane UV)
kPXP_PsPixelFormatYVU2P422 16-bit pixels (2-plane VU interleaved bytes)
kPXP_PsPixelFormatYVU2P420 16-bit pixels (2-plane VU)
kPXP_PsPixelFormatYVU422 16-bit pixels (3-plane)
kPXP_PsPixelFormatYVU420 16-bit pixels (3-plane)

38.4.9 enum pxp_ps_yuv_format_t

Enumerator

kPXP_PsYUVFormatYUV YUV format.
kPXP_PsYUVFormatYCbCr YCbCr format.

38.4.10 enum pxp_as_pixel_format_t

Enumerator

kPXP_AsPixelFormatARGB8888 32-bit pixels with alpha.
kPXP_AsPixelFormatRGB888 32-bit pixels without alpha (unpacked 24-bit format)
kPXP_AsPixelFormatARGB1555 16-bit pixels with alpha.
kPXP_AsPixelFormatARGB4444 16-bit pixels with alpha.
kPXP_AsPixelFormatRGB555 16-bit pixels without alpha.

kPXP_AsPixelFormatRGB444 16-bit pixels without alpha.
kPXP_AsPixelFormatRGB565 16-bit pixels without alpha.

38.4.11 enum pxp_alpha_mode_t

Enumerator

kPXP_AlphaEmbedded The alpha surface pixel alpha value will be used for blend.
kPXP_AlphaOverride The user defined alpha value will be used for blend directly.
kPXP_AlphaMultiply The alpha surface pixel alpha value scaled the user defined alpha value will be used for blend, for example, pixel alpha set set to 200, user defined alpha set to 100, then the reault alpha is 200 ∗ 100 / 255.
kPXP_AlphaRop Raster operation.

38.4.12 enum pxp_rop_mode_t

Explanation:

- AS: Alpha surface
- PS: Process surface
- nAS: Alpha surface NOT value
- nPS: Process surface NOT value

Enumerator

kPXP_RopMaskAs AS AND PS.
kPXP_RopMaskNotAs nAS AND PS.
kPXP_RopMaskAsNot AS AND nPS.
kPXP_RopMergeAs AS OR PS.
kPXP_RopMergeNotAs nAS OR PS.
kPXP_RopMergeAsNot AS OR nPS.
kPXP_RopNotCopyAs nAS.
kPXP_RopNot nPS.
kPXP_RopNotMaskAs AS NAND PS.
kPXP_RopNotMergeAs AS NOR PS.
kPXP_RopXorAs AS XOR PS.
kPXP_RopNotXorAs AS XNOR PS.

38.4.13 enum pxp_block_size_t

Enumerator

kPXP_BlockSize8 Process 8x8 pixel blocks.

kPXP_BlockSize16 Process 16x16 pixel blocks.

38.4.14 enum pxp_csc1_mode_t

Enumerator

kPXP_Csc1YUV2RGB YUV to RGB.
kPXP_Csc1YCbCr2RGB YCbCr to RGB.

38.4.15 enum pxp_csc2_mode_t

Enumerator

kPXP_Csc2YUV2RGB YUV to RGB.
kPXP_Csc2YCbCr2RGB YCbCr to RGB.
kPXP_Csc2RGB2YUV RGB to YUV.
kPXP_Csc2RGB2YCbCr RGB to YCbCr.

38.4.16 enum pxp_ram_t

Enumerator

kPXP_RamDither0Lut Dither 0 LUT memory.
kPXP_RamDither1Lut Dither 1 LUT memory.
kPXP_RamDither2Lut Dither 2 LUT memory.

38.4.17 enum _pxp_dither_mode

Enumerator

kPXP_DitherPassThrough Pass through, no dither.
kPXP_DitherOrdered Ordered dither.
kPXP_DitherQuantOnly No dithering, only quantization.

38.4.18 enum _pxp_dither_lut_mode

Enumerator

kPXP_DitherLutOff The LUT memory is not used for LUT, could be used as ordered dither index matrix.

kPXP_DitherLutPreDither Use LUT at the pre-dither stage, The pre-dither LUT could only be used in Floyd mode or Atkinson mode, which are not supported by current PXP module.
kPXP_DitherLutPostDither Use LUT at the post-dither stage.

38.4.19 enum _pxp_dither_matrix_size

Enumerator

kPXP_DitherMatrix8 The dither index matrix is 8x8.
kPXP_DitherMatrix16 The dither index matrix is 16x16.

38.4.20 anonymous enum

Enumerator

kPXP_PorterDuffFactorOne Use 1.
kPXP_PorterDuffFactorZero Use 0.
kPXP_PorterDuffFactorStraight Use straight alpha.
kPXP_PorterDuffFactorInversed Use inversed alpha.

38.4.21 anonymous enum

Enumerator

kPXP_PorterDuffGlobalAlpha Use global alpha.
kPXP_PorterDuffLocalAlpha Use local alpha in each pixel.
kPXP_PorterDuffScaledAlpha Use global alpha ∗ local alpha.

38.4.22 anonymous enum

Enumerator

kPXP_PorterDuffAlphaStraight Use straight alpha, s0_alpha' = s0_alpha.
kPXP_PorterDuffAlphaInversed Use inversed alpha, s0_alpha' = 0xFF - s0_alpha.

38.4.23 anonymous enum

Enumerator

kPXP_PorterDuffColorStraight **Deprecated** Use kPXP_PorterDuffColorNoAlpha.
kPXP_PorterDuffColorInversed **Deprecated** Use kPXP_PorterDuffColorWithAlpha.
kPXP_PorterDuffColorNoAlpha s0_pixel' = s0_pixel.

kPXP_PorterDuffColorWithAlpha s0_pixel' = s0_pixel ∗ s0_alpha".

38.4.24 enum pxp_porter_duff_blend_mode_t

Note: don't change the enum item value

Enumerator

kPXP_PorterDuffSrc Source Only.
kPXP_PorterDuffAtop Source Atop.
kPXP_PorterDuffOver Source Over.
kPXP_PorterDuffIn Source In.
kPXP_PorterDuffOut Source Out.
kPXP_PorterDuffDst Destination Only.
kPXP_PorterDuffDstAtop Destination Atop.
kPXP_PorterDuffDstOver Destination Over.
kPXP_PorterDuffDstIn Destination In.
kPXP_PorterDuffDstOut Destination Out.
kPXP_PorterDuffXor XOR.
kPXP_PorterDuffClear Clear.

38.5 Function Documentation

38.5.1 void PXP_Init (PXP_Type ∗ *base*)

This function enables the PXP peripheral clock, and resets the PXP registers to default status.

Parameters

base	PXP peripheral base address.

38.5.2 void PXP_Deinit (PXP_Type ∗ *base*)

This function disables the PXP peripheral clock.

Parameters

base	PXP peripheral base address.

38.5.3 void PXP_Reset (PXP_Type * *base*)

This function resets the PXP peripheral registers to default status.

Parameters

base	PXP peripheral base address.

38.5.4 static void PXP_Start (PXP_Type * *base*) [inline], [static]

Start PXP process using current configuration.

Parameters

base	PXP peripheral base address.

38.5.5 static void PXP_EnableLcdHandShake (PXP_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	PXP peripheral base address.
enable	True to enable, false to disable.

38.5.6 static void PXP_EnableContinousRun (PXP_Type * *base*, bool *enable*) [inline], [static]

If continous run not enabled, PXP_Start starts the PXP process. When completed, PXP enters idle mode and flag kPXP_CompleteFlag asserts.

If continous run enabled, the PXP will repeat based on the current configuration register settings.

Parameters

base	PXP peripheral base address.
enable	True to enable, false to disable.

38.5.7 static void PXP_SetProcessBlockSize (PXP_Type * *base*, pxp_block_size_t *size*) [inline], [static]

This function chooses the pixel block size that PXP using during process. Larger block size means better performace, but be careful that when PXP is rotating, the output must be divisible by the block size selected.

Parameters

base	PXP peripheral base address.
size	The pixel block size.

38.5.8 static uint32_t PXP_GetStatusFlags (PXP_Type * *base*) [inline], [static]

This function gets all PXP status flags. The flags are returned as the logical OR value of the enumerators _pxp_flags. To check a specific status, compare the return value with enumerators in _pxp_flags. For example, to check whether the PXP has completed process, use like this:

```
if (kPXP_CompleteFlag & PXP_GetStatusFlags(PXP))
{
    ...
}
```

Parameters

base	PXP peripheral base address.

Returns

PXP status flags which are OR'ed by the enumerators in the _pxp_flags.

38.5.9 static void PXP_ClearStatusFlags (PXP_Type * *base*, uint32_t *statusMask*) [inline], [static]

This function clears PXP status flags with a provided mask.

Parameters

base	PXP peripheral base address.
statusMask	The status flags to be cleared; it is logical OR value of _pxp_flags.

38.5.10 static uint8_t PXP_GetAxiErrorId (PXP_Type * *base*, uint8_t *axiIndex*) [inline], [static]

Parameters

base	PXP peripheral base address.
axiIndex	Whitch AXI to get • 0: AXI0 • 1: AXI1

Returns

The AXI ID of the failing bus operation.

38.5.11 static void PXP_EnableInterrupts (PXP_Type * *base*, uint32_t *mask*) [inline], [static]

This function enables the PXP interrupts according to the provided mask. The mask is a logical OR of enumeration members. See _pxp_interrupt_enable. For example, to enable PXP process complete interrupt and command loaded interrupt, do the following.

```
PXP_EnableInterrupts(PXP, kPXP_CommandLoadInterruptEnable
       | kPXP_CompleteInterruptEnable);
```

Parameters

base	PXP peripheral base address.
mask	The interrupts to enable. Logical OR of _pxp_interrupt_enable.

38.5.12 static void PXP_DisableInterrupts (PXP_Type * *base*, uint32_t *mask*) [inline], [static]

This function disables the PXP interrupts according to the provided mask. The mask is a logical OR of enumeration members. See _pxp_interrupt_enable.

Parameters

base	PXP peripheral base address.
mask	The interrupts to disable. Logical OR of _pxp_interrupt_enable.

38.5.13 void PXP_SetAlphaSurfaceBufferConfig (PXP_Type * *base*, const pxp_as_buffer_config_t * *config*)

Parameters

base	PXP peripheral base address.
config	Pointer to the configuration.

38.5.14 void PXP_SetAlphaSurfaceBlendConfig (PXP_Type * *base*, const pxp_as_blend_config_t * *config*)

Parameters

base	PXP peripheral base address.
config	Pointer to the configuration structure.

38.5.15 void PXP_SetAlphaSurfaceOverlayColorKey (PXP_Type * *base*, uint32_t *colorKeyLow*, uint32_t *colorKeyHigh*)

If a pixel in the current overlay image with a color that falls in the range from the `colorKeyLow` to `colorKeyHigh` range, it will use the process surface pixel value for that location. If no PS image is present or if the PS image also matches its colorkey range, the PS background color is used.

Parameters

base	PXP peripheral base address.
colorKeyLow	Color key low range.

colorKeyHigh	Color key high range.

Note

Colorkey operations are higher priority than alpha or ROP operations

38.5.16 static void PXP_EnableAlphaSurfaceOverlayColorKey (PXP_Type ∗ *base,* bool *enable*) [inline], [static]

Parameters

base	PXP peripheral base address.
enable	True to enable, false to disable.

38.5.17 void PXP_SetAlphaSurfacePosition (PXP_Type ∗ *base,* uint16_t *upperLeftX,* uint16_t *upperLeftY,* uint16_t *lowerRightX,* uint16_t *lowerRightY*)

Parameters

base	PXP peripheral base address.
upperLeftX	X of the upper left corner.
upperLeftY	Y of the upper left corner.
lowerRightX	X of the lower right corner.
lowerRightY	Y of the lower right corner.

38.5.18 static void PXP_SetProcessSurfaceBackGroundColor (PXP_Type ∗ *base,* uint32_t *backGroundColor*) [inline], [static]

Parameters

base	PXP peripheral base address.
backGround-Color	Pixel value of the background color.

38.5.19 void PXP_SetProcessSurfaceBufferConfig (PXP_Type * *base,* const pxp_ps_buffer_config_t * *config*)

Parameters

base	PXP peripheral base address.
config	Pointer to the configuration.

38.5.20 void PXP_SetProcessSurfaceScaler (PXP_Type * *base,* uint16_t *inputWidth,* uint16_t *inputHeight,* uint16_t *outputWidth,* uint16_t *outputHeight*)

The valid down scale fact is 1/(2^12) ∼ 16.

Parameters

base	PXP peripheral base address.
inputWidth	Input image width.
inputHeight	Input image height.
outputWidth	Output image width.
outputHeight	Output image height.

38.5.21 void PXP_SetProcessSurfacePosition (PXP_Type * *base,* uint16_t *upperLeftX,* uint16_t *upperLeftY,* uint16_t *lowerRightX,* uint16_t *lowerRightY*)

Parameters

base	PXP peripheral base address.
upperLeftX	X of the upper left corner.
upperLeftY	Y of the upper left corner.
lowerRightX	X of the lower right corner.
lowerRightY	Y of the lower right corner.

38.5.22 void PXP_SetProcessSurfaceColorKey (PXP_Type * *base,* uint32_t *colorKeyLow,* uint32_t *colorKeyHigh*)

If the PS image matches colorkey range, the PS background color is output. Set `colorKeyLow` to 0xFFFFFFFF and `colorKeyHigh` to 0 will disable the colorkeying.

Parameters

base	PXP peripheral base address.
colorKeyLow	Color key low range.
colorKeyHigh	Color key high range.

38.5.23 static void PXP_SetProcessSurfaceYUVFormat (PXP_Type ∗ *base,* pxp_ps_yuv_format_t *format*) [inline], [static]

If process surface input pixel format is YUV and CSC1 is not enabled, in other words, the process surface output pixel format is also YUV, then this function should be called to set whether input pixel format is YUV or YCbCr.

Parameters

base	PXP peripheral base address.
format	The YUV format.

38.5.24 void PXP_SetOutputBufferConfig (PXP_Type ∗ *base,* const pxp_output_buffer_config_t ∗ *config*)

Parameters

base	PXP peripheral base address.
config	Pointer to the configuration.

38.5.25 static void PXP_SetOverwrittenAlphaValue (PXP_Type ∗ *base,* uint8_t *alpha*) [inline], [static]

If global overwritten alpha is enabled, the alpha component in output buffer pixels will be overwritten, otherwise the computed alpha value is used.

Parameters

base	PXP peripheral base address.
alpha	The alpha value.

38.5.26 static void PXP_EnableOverWrittenAlpha (PXP_Type * *base,* bool *enable*) [inline], [static]

If global overwritten alpha is enabled, the alpha component in output buffer pixels will be overwritten, otherwise the computed alpha value is used.

Parameters

base	PXP peripheral base address.
enable	True to enable, false to disable.

38.5.27 static void PXP_SetRotateConfig (PXP_Type * *base*, pxp_rotate_position_t *position*, pxp_rotate_degree_t *degree*, pxp_flip_mode_t *flipMode*) [inline], [static]

The PXP could rotate the process surface or the output buffer. There are two PXP versions:

- Version 1: Only has one rotate sub module, the output buffer and process surface share the same rotate sub module, which means the process surface and output buffer could not be rotate at the same time. When pass in kPXP_RotateOutputBuffer, the process surface could not use the rotate, Also when pass in kPXP_RotateProcessSurface, output buffer could not use the rotate.
- Version 2: Has two seperate rotate sub modules, the output buffer and process surface could configure the rotation independently.

Upper layer could use the macro PXP_SHARE_ROTATE to check which version is. PXP_SHARE_ROTATE=1 means version 1.

Parameters

base	PXP peripheral base address.
position	Rotate process surface or output buffer.
degree	Rotate degree.
flipMode	Flip mode.

Note

This function is different depends on the macro PXP_SHARE_ROTATE.

38.5.28 void PXP_SetNextCommand (PXP_Type * *base*, void * *commandAddr*)

The PXP supports a primitive ability to queue up one operation while the current operation is running. Workflow:

1. Prepare the PXP register values except STAT, CSCCOEFn, NEXT in the memory in the order they appear in the register map.
2. Call this function sets the new operation to PXP.
3. There are two methods to check whether the PXP has loaded the new operation. The first method is using PXP_IsNextCommandPending. If there is new operation not loaded by the PXP, this function

returns true. The second method is checking the flag kPXP_CommandLoadFlag, if command loaded, this flag asserts. User could enable interrupt kPXP_CommandLoadInterruptEnable to get the loaded signal in interrupt way.

4. When command loaded by PXP, a new command could be set using this function.

```
uint32_t pxp_command1[48];
uint32_t pxp_command2[48];

pxp_command1[0] = ...;
pxp_command1[1] = ...;
...
pxp_command2[0] = ...;
pxp_command2[1] = ...;
...

while (PXP_IsNextCommandPending(PXP))
{
}

PXP_SetNextCommand(PXP, pxp_command1);

while (PXP_IsNextCommandPending(PXP))
{
}

PXP_SetNextCommand(PXP, pxp_command2);
```

Parameters

base	PXP peripheral base address.
commandAddr	Address of the new command.

38.5.29 static bool PXP_IsNextCommandPending (PXP_Type * *base*) [inline], [static]

Parameters

base	UART peripheral base address.

Returns

True is pending, false is not.

38.5.30 static void PXP_CancelNextCommand (PXP_Type * *base*) [inline], [static]

Parameters

base	UART peripheral base address.

38.5.31 void PXP_SetCsc1Mode (PXP_Type * *base*, pxp_csc1_mode_t *mode*)

The CSC1 module receives scaled YUV/YCbCr444 pixels from the scale engine and converts the pixels to the RGB888 color space. It could only be used by process surface.

Parameters

base	PXP peripheral base address.
mode	The conversion mode.

38.5.32 static void PXP_EnableCsc1 (PXP_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	PXP peripheral base address.
enable	True to enable, false to disable.

38.5.33 void PXP_SetPorterDuffConfig (PXP_Type * *base*, const pxp_porter_duff_config_t * *config*)

Parameters

base	PXP peripheral base address.
config	Pointer to the configuration.

38.5.34 status_t PXP_GetPorterDuffConfig (pxp_porter_duff_blend_mode_t *mode*, pxp_porter_duff_config_t * *config*)

The FactorMode are selected based on blend mode, the AlphaMode are set to kPXP_PorterDuffAlpha-Straight, the ColorMode are set to kPXP_PorterDuffColorWithAlpha, the GlobalAlphaMode are set to kPXP_PorterDuffLocalAlpha. These values could be modified after calling this function.

Parameters

mode	The blend mode.
config	Pointer to the configuration.

Return values

kStatus_Success	Successfully get the configuratoin.
kStatus_InvalidArgument	The blend mode not supported.

38.5.35 status_t PXP_StartPictureCopy (PXP_Type * *base,* const pxp_pic_copy_config_t * *config*)

This function copies a rectangle from one buffer to another buffer.

```
                   Source buffer:
srcPicBaseAddr
+-------------------------------------------------------------+
|                                                             |
|  (srcOffsetX, srcOffsetY)                                   |
|           +-------------------+                             |
|           |                   |                             |
|           |                   |                             |
|           |                   | height                      |
|           |                   |                             |
|           |                   |                             |
|           +-------------------+                             |
|                 width                                       |
|                                                             |
|                       srcPicthBytes                         |
+-------------------------------------------------------------+

                  Destination buffer:
destPicBaseAddr
+-------------------------------------------+
|                                           |
|                                           |
|                                           |
|  (destOffsetX, destOffsetY)               |
|       +-------------------+               |
|       |                   |               |
|       |                   |               |
|       |                   | height        |
|       |                   |               |
|       |                   |               |
|       +-------------------+               |
|             width                         |
|                                           |
```

```
|                                          |
|                                          |
|                  destPicthBytes          |
+------------------------------------------+
```

Note

This function resets the old PXP settings, which means the settings like rotate, flip, will be reseted to disabled status.

Parameters

base	PXP peripheral base address.
config	Pointer to the picture copy configuration structure.

Return values

kStatus_Success	Successfully started the copy process.
kStatus_InvalidArgument	Invalid argument.

38.5.36 status_t PXP_StartMemCopy (PXP_Type * *base,* uint32_t *srcAddr,* uint32_t *destAddr,* uint32_t *size*)

Note

The copy size should be 512 byte aligned.
This function resets the old PXP settings, which means the settings like rotate, flip, will be reseted to disabled status.

Parameters

base	PXP peripheral base address.
srcAddr	Source memory address.
destAddr	Destination memory address.
size	How many bytes to copy, should be 512 byte aligned.

Return values

kStatus_Success	Successfully started the copy process.
kStatus_InvalidArgument	Invalid argument.

Chapter 39
QTMR: Quad Timer Driver

39.1 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, 0, 2))
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.
- 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.

39.2 Data Structure Documentation

39.2.1 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.

39.3 Enumeration Type Documentation

39.3.1 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.

39.3.2 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.

39.3.3 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)

39.3.4 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.

39.3.5 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.

39.3.6 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.

39.3.7 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.

39.3.8 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.

39.3.9 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.

39.3.10 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.

39.3.11 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.

39.4 Function Documentation

39.4.1 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

base	Quad Timer peripheral base address
channel	Quad Timer channel number
config	Pointer to user's Quad Timer config structure

39.4.2 void QTMR_Deinit (TMR_Type ∗ *base*, qtmr_channel_selection_t *channel*)

Parameters

base	Quad Timer peripheral base address
channel	Quad Timer channel number

39.4.3 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

config	Pointer to user's Quad Timer config structure.

39.4.4 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

base	Quad Timer peripheral base address
channel	Quad Timer channel number
pwmFreqHz	PWM signal frequency in Hz
dutyCycle-Percent	PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)... 100=active signal (100% duty cycle)
outputPolarity	true: invert polarity of the output signal, false: no inversion
srcClock_Hz	Main counter clock in Hz.

Returns

Returns an error if there was error setting up the signal.

39.4.5 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

base	Quad Timer peripheral base address
channel	Quad Timer channel number
capturePin	Pin through which we receive the input signal to trigger the capture
inputPolarity	true: invert polarity of the input signal, false: no inversion
reloadOn-Capture	true: reload the counter when an input capture occurs, false: no reload
captureMode	Specifies which edge of the input signal triggers a capture

39.4.6 void QTMR_EnableInterrupts (TMR_Type * *base*, qtmr_channel_selection_t *channel*, uint32_t *mask*)

Parameters

base	Quad Timer peripheral base address
channel	Quad Timer channel number
mask	The interrupts to enable. This is a logical OR of members of the enumeration qtmr_-interrupt_enable_t

39.4.7 void QTMR_DisableInterrupts (TMR_Type * *base*, qtmr_channel_selection_t *channel*, uint32_t *mask*)

Parameters

base	Quad Timer peripheral base addres
channel	Quad Timer channel number
mask	The interrupts to enable. This is a logical OR of members of the enumeration qtmr_-interrupt_enable_t

39.4.8 uint32_t QTMR_GetEnabledInterrupts (TMR_Type * *base*, qtmr_channel_selection_t *channel*)

Parameters

base	Quad Timer peripheral base address
channel	Quad Timer channel number

Returns

The enabled interrupts. This is the logical OR of members of the enumeration qtmr_interrupt_-enable_t

39.4.9 uint32_t QTMR_GetStatus (TMR_Type * *base*, qtmr_channel_selection_t *channel*)

Parameters

base	Quad Timer peripheral base address
channel	Quad Timer channel number

Returns

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

39.4.10 void QTMR_ClearStatusFlags (TMR_Type * *base*, qtmr_channel_-selection_t *channel*, uint32_t *mask*)

Parameters

base	Quad Timer peripheral base address
channel	Quad Timer channel number
mask	The status flags to clear. This is a logical OR of members of the enumeration qtmr_-status_flags_t

39.4.11 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

base	Quad Timer peripheral base address
channel	Quad Timer channel number
ticks	Timer period in units of ticks

39.4.12 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

base	Quad Timer peripheral base address
channel	Quad Timer channel number

Returns

Current counter value in ticks

39.4.13 static void QTMR_StartTimer (TMR_Type * *base,* qtmr_channel_selection_t *channel,* qtmr_counting_mode_t *clockSource*) [inline], [static]

Parameters

base	Quad Timer peripheral base address
channel	Quad Timer channel number
clockSource	Quad Timer clock source

39.4.14 static void QTMR_StopTimer (TMR_Type ∗ *base*, qtmr_channel_selection_t *channel*) [inline], [static]

Parameters

base	Quad Timer peripheral base address
channel	Quad Timer channel number

39.4.15 void QTMR_EnableDma (TMR_Type ∗ *base*, qtmr_channel_selection_t *channel*, uint32_t *mask*)

Parameters

base	Quad Timer peripheral base address
channel	Quad Timer channel number
mask	The DMA to enable. This is a logical OR of members of the enumeration qtmr_dma_enable_t

39.4.16 void QTMR_DisableDma (TMR_Type ∗ *base*, qtmr_channel_selection_t *channel*, uint32_t *mask*)

Parameters

base	Quad Timer peripheral base address
channel	Quad Timer channel number

mask	The DMA to enable. This is a logical OR of members of the enumeration qtmr_dma-_enable_t

Chapter 40
RTWDOG: 32-bit Watchdog Timer

40.1 Overview

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

40.2 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 clockFreqInHz)
  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.

40.3 Data Structure Documentation

40.3.1 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.

40.3.2 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.

40.4 Macro Definition Documentation

40.4.1 #define FSL_RTWDOG_DRIVER_VERSION (MAKE_VERSION(2, 1, 2))

40.5 Enumeration Type Documentation

40.5.1 enum rtwdog_clock_source_t

Enumerator

kRTWDOG_ClockSource0 Clock source 0.
kRTWDOG_ClockSource1 Clock source 1.
kRTWDOG_ClockSource2 Clock source 2.
kRTWDOG_ClockSource3 Clock source 3.

40.5.2 enum rtwdog_clock_prescaler_t

Enumerator

kRTWDOG_ClockPrescalerDivide1 Divided by 1.
kRTWDOG_ClockPrescalerDivide256 Divided by 256.

40.5.3 enum rtwdog_test_mode_t

Enumerator

kRTWDOG_TestModeDisabled Test Mode disabled.
kRTWDOG_UserModeEnabled User Mode enabled.
kRTWDOG_LowByteTest Test Mode enabled, only low byte is used.
kRTWDOG_HighByteTest Test Mode enabled, only high byte is used.

40.5.4 enum _rtwdog_interrupt_enable_t

This structure contains the settings for all of the RTWDOG interrupt configurations.

Enumerator

kRTWDOG_InterruptEnable Interrupt is generated before forcing a reset.

40.5.5 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.

40.6 Function Documentation

40.6.1 void RTWDOG_GetDefaultConfig (rtwdog_config_t ∗ *config*)

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

```
*   rtwdogConfig->enableRtwdog = true;
*   rtwdogConfig->clockSource = kRTWDOG_ClockSource1;
*   rtwdogConfig->prescaler = kRTWDOG_ClockPrescalerDivide1;
*   rtwdogConfig->workMode.enableWait = true;
*   rtwdogConfig->workMode.enableStop = false;
*   rtwdogConfig->workMode.enableDebug = false;
*   rtwdogConfig->testMode = kRTWDOG_TestModeDisabled;
*   rtwdogConfig->enableUpdate = true;
*   rtwdogConfig->enableInterrupt = false;
*   rtwdogConfig->enableWindowMode = false;
*   rtwdogConfig->windowValue = 0U;
*   rtwdogConfig->timeoutValue = 0xFFFFU;
*
```

Parameters

config	Pointer to the RTWDOG configuration structure.

See Also

rtwdog_config_t

40.6.2 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

base	RTWDOG peripheral base address.
config	The configuration of the RTWDOG.

40.6.3 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

base	RTWDOG peripheral base address.

40.6.4 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

base	RTWDOG peripheral base address.

40.6.5 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

base	RTWDOG peripheral base address

40.6.6 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

base	RTWDOG peripheral base address.
mask	The interrupts to enable. The parameter can be a combination of the following source if defined: • kRTWDOG_InterruptEnable

40.6.7 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

base	RTWDOG peripheral base address.
mask	The interrupts to disabled. The parameter can be a combination of the following source if defined: • kRTWDOG_InterruptEnable

40.6.8 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

base	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.

40.6.9 static void RTWDOG_EnableWindowMode (RTWDOG_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	RTWDOG peripheral base address.
enable	Enables(true) or disables(false) the feature.

40.6.10 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

base	RTWDOG peripheral base address.
count	Raw count value.
clockFreqInHz	The frequency of the clock source RTWDOG uses.

40.6.11 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

base	RTWDOG peripheral base address.
mask	The status flags to clear. The parameter can be any combination of the following values: • kRTWDOG_InterruptFlag

40.6.12 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

base	RTWDOG peripheral base address
timeoutCount	RTWDOG timeout value, count of RTWDOG clock ticks.

40.6.13 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

base	RTWDOG peripheral base address.
windowValue	RTWDOG window value.

40.6.14 __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

base	RTWDOG peripheral base address

40.6.15 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

base	RTWDOG peripheral base address

40.6.16 static uint16_t RTWDOG_GetCounterValue (RTWDOG_Type * *base*) [inline], [static]

This function gets the RTWDOG counter value.

Parameters

base	RTWDOG peripheral base address.

Returns

Current RTWDOG counter value.

Chapter 41
SAI: Serial Audio Interface

41.1 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.

41.2 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

41.3 Typical use case

41.3.1 SAI Send/receive using an interrupt method

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

41.3.2 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

41.4 SAI Driver

41.4.1 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, 4))

  Version 2.3.4.

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 Rx 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.
- 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 Tx 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 type)
Do software reset or FIFO reset .
- void SAI_RxSoftwareReset (I2S_Type *base, sai_reset_type_t type)
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 uint32_t SAI_TxGetDataRegisterAddress (I2S_Type *base, uint32_t channel)
  Gets the SAI Tx data register address.
- static uint32_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.

41.4.2 Data Structure Documentation

41.4.2.1 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.

41.4.2.2 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

41.4.2.3 struct sai_fifo_t

Data Fields

- bool fifoContinueOneError
  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

41.4.2.4 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

41.4.2.5 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.
- sai_clock_polarity_t frameSyncPolarity
  frame sync polarity

41.4.2.6 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

41.4.2.7 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.

41.4.2.8 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

41.4.2.9 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.

41.4.3 Macro Definition Documentation

41.4.3.1 #define SAI_XFER_QUEUE_SIZE (4U)

41.4.4 Enumeration Type Documentation

41.4.4.1 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.

41.4.4.2 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

41.4.4.3 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.

41.4.4.4 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

41.4.4.5 enum sai_mono_stereo_t

Enumerator

kSAI_Stereo Stereo sound.
kSAI_MonoRight Only Right channel have sound.
kSAI_MonoLeft Only left channel have sound.

41.4.4.6 enum sai_data_order_t

Enumerator

kSAI_DataLSB LSB bit transferred first.
kSAI_DataMSB MSB bit transferred first.

41.4.4.7 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.

41.4.4.8 enum sai_sync_mode_t

Enumerator

kSAI_ModeAsync Asynchronous mode.
kSAI_ModeSync Synchronous mode (with receiver or transmit)

41.4.4.9 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.

41.4.4.10 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.

41.4.4.11 anonymous enum

Enumerator

kSAI_FIFOWarningDMAEnable FIFO warning caused by the DMA request.
kSAI_FIFORequestDMAEnable FIFO request caused by the DMA request.

41.4.4.12 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.

41.4.4.13 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.

41.4.4.14 enum sai_fifo_packing_t

Enumerator

kSAI_FifoPackingDisabled Packing disabled.
kSAI_FifoPacking8bit 8 bit packing enabled
kSAI_FifoPacking16bit 16bit packing enabled

41.4.4.15 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.

41.4.4.16 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.

41.4.4.17 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

41.4.4.18 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

41.4.4.19 enum sai_transceiver_type_t

Enumerator

kSAI_Transmitter sai transmitter
kSAI_Receiver sai receiver

41.4.4.20 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.

41.4.5 Function Documentation

41.4.5.1 void SAI_TxInit (I2S_Type * *base*, const sai_config_t * *config*)

Deprecated Do not use this function. It has been superceded 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

base	SAI base pointer
config	SAI configuration structure.

41.4.5.2 void SAI_RxInit (I2S_Type * *base,* const sai_config_t * *config*)

Deprecated Do not use this function. It has been superceded 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

base	SAI base pointer
config	SAI configuration structure.

41.4.5.3 void SAI_TxGetDefaultConfig (sai_config_t * *config*)

Deprecated Do not use this function. It has been superceded 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

config	pointer to master configuration structure

41.4.5.4 void SAI_RxGetDefaultConfig (sai_config_t * *config*)

Deprecated Do not use this function. It has been superceded by SAI_GetClassicI2SConfig, SAI_GetLeftJustifiedConfig , 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

config	pointer to master configuration structure

41.4.5.5 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

base	SAI base pointer.

41.4.5.6 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

base	SAI base pointer.

41.4.5.7 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

base	SAI base pointer

41.4.5.8 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

base	SAI base pointer

41.4.5.9 void SAI_TxEnable (I2S_Type * *base,* bool *enable*)

Parameters

base	SAI base pointer.
enable	True means enable SAI Tx, false means disable.

41.4.5.10 void SAI_RxEnable (I2S_Type * *base,* bool *enable*)

Parameters

base	SAI base pointer.
enable	True means enable SAI Rx, false means disable.

41.4.5.11 static void SAI_TxSetBitClockDirection (I2S_Type * *base,* sai_master_slave_t *masterSlave*) `[inline], [static]`

Select bit clock direction, master or slave.

Parameters

base	SAI base pointer.

masterSlave	reference sai_master_slave_t.

41.4.5.12 static void SAI_RxSetBitClockDirection (I2S_Type * *base,* sai_master_slave_t *masterSlave*) [inline], [static]

Select bit clock direction, master or slave.

Parameters

base	SAI base pointer.
masterSlave	reference sai_master_slave_t.

41.4.5.13 static void SAI_RxSetFrameSyncDirection (I2S_Type * *base,* sai_master_slave_t *masterSlave*) [inline], [static]

Select frame sync direction, master or slave.

Parameters

base	SAI base pointer.
masterSlave	reference sai_master_slave_t.

41.4.5.14 static void SAI_TxSetFrameSyncDirection (I2S_Type * *base,* sai_master_slave_t *masterSlave*) [inline], [static]

Select frame sync direction, master or slave.

Parameters

base	SAI base pointer.
masterSlave	reference sai_master_slave_t.

41.4.5.15 void SAI_TxSetBitClockRate (I2S_Type * *base,* uint32_t *sourceClockHz,* uint32_t *sampleRate,* uint32_t *bitWidth,* uint32_t *channelNumbers*)

Parameters

base	SAI base pointer.
sourceClockHz	Bit clock source frequency.
sampleRate	Audio data sample rate.
bitWidth	Audio data bitWidth.
channel-Numbers	Audio channel numbers.

41.4.5.16 void SAI_RxSetBitClockRate (I2S_Type * *base*, uint32_t *sourceClockHz*, uint32_t *sampleRate*, uint32_t *bitWidth*, uint32_t *channelNumbers*)

Parameters

base	SAI base pointer.
sourceClockHz	Bit clock source frequency.
sampleRate	Audio data sample rate.
bitWidth	Audio data bitWidth.
channel-Numbers	Audio channel numbers.

41.4.5.17 void SAI_TxSetBitclockConfig (I2S_Type * *base*, sai_master_slave_t *masterSlave*, sai_bit_clock_t * *config*)

Parameters

base	SAI base pointer.
masterSlave	master or slave.
config	bit clock other configurations, can be NULL in slave mode.

41.4.5.18 void SAI_RxSetBitclockConfig (I2S_Type * *base*, sai_master_slave_t *masterSlave*, sai_bit_clock_t * *config*)

Parameters

base	SAI base pointer.
masterSlave	master or slave.
config	bit clock other configurations, can be NULL in slave mode.

41.4.5.19 void SAI_TxSetFifoConfig (I2S_Type * *base*, sai_fifo_t * *config*)

Parameters

base	SAI base pointer.
config	fifo configurations.

41.4.5.20 void SAI_RxSetFifoConfig (I2S_Type * *base*, sai_fifo_t * *config*)

Parameters

base	SAI base pointer.
config	fifo configurations.

41.4.5.21 void SAI_TxSetFrameSyncConfig (I2S_Type * *base*, sai_master_slave_t *masterSlave*, sai_frame_sync_t * *config*)

Parameters

base	SAI base pointer.
masterSlave	master or slave.
config	frame sync configurations, can be NULL in slave mode.

41.4.5.22 void SAI_RxSetFrameSyncConfig (I2S_Type * *base*, sai_master_slave_t *masterSlave*, sai_frame_sync_t * *config*)

Parameters

base	SAI base pointer.
masterSlave	master or slave.
config	frame sync configurations, can be NULL in slave mode.

41.4.5.23 void SAI_TxSetSerialDataConfig (I2S_Type * *base*, sai_serial_data_t * *config*)

Parameters

base	SAI base pointer.
config	serial data configurations.

41.4.5.24 void SAI_RxSetSerialDataConfig (I2S_Type * *base*, sai_serial_data_t * *config*)

Parameters

base	SAI base pointer.
config	serial data configurations.

41.4.5.25 void SAI_TxSetConfig (I2S_Type * *base*, sai_transceiver_t * *config*)

Parameters

base	SAI base pointer.
config	transmitter configurations.

41.4.5.26 void SAI_RxSetConfig (I2S_Type * *base*, sai_transceiver_t * *config*)

Parameters

base	SAI base pointer.

config	receiver configurations.

41.4.5.27 void SAI_GetClassicI2SConfig (sai_transceiver_t * *config*, sai_word_width_t *bitWidth*, sai_mono_stereo_t *mode*, uint32_t *saiChannelMask*)

Parameters

config	transceiver configurations.
bitWidth	audio data bitWidth.
mode	audio data channel.
saiChannel-Mask	mask value of the channel to be enable.

41.4.5.28 void SAI_GetLeftJustifiedConfig (sai_transceiver_t * *config*, sai_word_width_t *bitWidth*, sai_mono_stereo_t *mode*, uint32_t *saiChannelMask*)

Parameters

config	transceiver configurations.
bitWidth	audio data bitWidth.
mode	audio data channel.
saiChannel-Mask	mask value of the channel to be enable.

41.4.5.29 void SAI_GetRightJustifiedConfig (sai_transceiver_t * *config*, sai_word_width_t *bitWidth*, sai_mono_stereo_t *mode*, uint32_t *saiChannelMask*)

Parameters

config	transceiver configurations.
bitWidth	audio data bitWidth.

mode	audio data channel.
saiChannel-Mask	mask value of the channel to be enable.

41.4.5.30 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

config	transceiver configurations.
frameSync-Width	length of frame sync.
bitWidth	audio data word width.
dataWordNum	word number in one frame.
saiChannel-Mask	mask value of the channel to be enable.

41.4.5.31 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

config	transceiver configurations.
frameSyncWidth	length of frame sync.
bitWidth	audio data bitWidth.
mode	audio data channel.
saiChannelMask	mask value of the channel to enable.

41.4.5.32 static uint32_t SAI_TxGetStatusFlag (I2S_Type * *base*) [inline], [static]

Parameters

base	SAI base pointer

Returns

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

41.4.5.33 static void SAI_TxClearStatusFlags (I2S_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	SAI base pointer
mask	State mask. It can be a combination of the following source if defined: • kSAI_WordStartFlag • kSAI_SyncErrorFlag • kSAI_FIFOErrorFlag

41.4.5.34 static uint32_t SAI_RxGetStatusFlag (I2S_Type * *base*) [inline], [static]

Parameters

base	SAI base pointer

Returns

SAI Rx status flag value. Use the Status Mask to get the status value needed.

41.4.5.35 static void SAI_RxClearStatusFlags (I2S_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	SAI base pointer
mask	State mask. It can be a combination of the following sources if defined. • kSAI_WordStartFlag • kSAI_SyncErrorFlag • kSAI_FIFOErrorFlag

41.4.5.36 void SAI_TxSoftwareReset (I2S_Type * *base,* sai_reset_type_t *type*)

FIFO reset means clear all the data in the FIFO, and make the FIFO pointer both to 0. Software reset means clear the Tx internal logic, including the bit clock, frame count etc. But software reset will not clear any configuration registers like TCR1∼TCR5. This function will also clear all the error flags such as FIFO error, sync error etc.

Parameters

base	SAI base pointer
type	Reset type, FIFO reset or software reset

41.4.5.37 void SAI_RxSoftwareReset (I2S_Type * *base,* sai_reset_type_t *type*)

FIFO reset means clear all the data in the FIFO, and make the FIFO pointer both to 0. Software reset means clear the Rx internal logic, including the bit clock, frame count etc. But software reset will not clear any configuration registers like RCR1∼RCR5. This function will also clear all the error flags such as FIFO error, sync error etc.

Parameters

base	SAI base pointer
type	Reset type, FIFO reset or software reset

41.4.5.38 void SAI_TxSetChannelFIFOMask (I2S_Type * *base,* uint8_t *mask*)

Parameters

base	SAI base pointer
mask	Channel enable mask, 0 means all channel FIFO disabled, 1 means channel 0 enabled, 3 means both channel 0 and channel 1 enabled.

41.4.5.39 void SAI_RxSetChannelFIFOMask (I2S_Type * *base,* uint8_t *mask*)

Parameters

base	SAI base pointer
mask	Channel enable mask, 0 means all channel FIFO disabled, 1 means channel 0 enabled, 3 means both channel 0 and channel 1 enabled.

41.4.5.40 void SAI_TxSetDataOrder (I2S_Type * *base,* sai_data_order_t *order*)

Parameters

base	SAI base pointer
order	Data order MSB or LSB

41.4.5.41 void SAI_RxSetDataOrder (I2S_Type * *base,* sai_data_order_t *order*)

Parameters

base	SAI base pointer

order	Data order MSB or LSB

41.4.5.42 void SAI_TxSetBitClockPolarity (I2S_Type * *base*, sai_clock_polarity_t *polarity*)

Parameters

base	SAI base pointer
polarity	

41.4.5.43 void SAI_RxSetBitClockPolarity (I2S_Type * *base*, sai_clock_polarity_t *polarity*)

Parameters

base	SAI base pointer
polarity	

41.4.5.44 void SAI_TxSetFrameSyncPolarity (I2S_Type * *base*, sai_clock_polarity_t *polarity*)

Parameters

base	SAI base pointer
polarity	

41.4.5.45 void SAI_RxSetFrameSyncPolarity (I2S_Type * *base*, sai_clock_polarity_t *polarity*)

Parameters

base	SAI base pointer
polarity	

41.4.5.46 void SAI_TxSetFIFOPacking (I2S_Type * *base*, sai_fifo_packing_t *pack*)

Parameters

base	SAI base pointer.
pack	FIFO pack type. It is element of sai_fifo_packing_t.

41.4.5.47 void SAI_RxSetFIFOPacking (I2S_Type * *base*, sai_fifo_packing_t *pack*)

Parameters

base	SAI base pointer.
pack	FIFO pack type. It is element of sai_fifo_packing_t.

41.4.5.48 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

base	SAI base pointer.
isEnabled	Is FIFO error continue enabled, true means enable, false means disable.

41.4.5.49 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

base	SAI base pointer.
isEnabled	Is FIFO error continue enabled, true means enable, false means disable.

41.4.5.50 static void SAI_TxEnableInterrupts (I2S_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	SAI base pointer
mask	interrupt source The parameter can be a combination of the following sources if defined. • kSAI_WordStartInterruptEnable • kSAI_SyncErrorInterruptEnable • kSAI_FIFOWarningInterruptEnable • kSAI_FIFORequestInterruptEnable • kSAI_FIFOErrorInterruptEnable

41.4.5.51 static void SAI_RxEnableInterrupts (I2S_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	SAI base pointer
mask	interrupt source The parameter can be a combination of the following sources if defined. • kSAI_WordStartInterruptEnable • kSAI_SyncErrorInterruptEnable • kSAI_FIFOWarningInterruptEnable • kSAI_FIFORequestInterruptEnable • kSAI_FIFOErrorInterruptEnable

41.4.5.52 static void SAI_TxDisableInterrupts (I2S_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	SAI base pointer
mask	interrupt source The parameter can be a combination of the following sources if defined. • kSAI_WordStartInterruptEnable • kSAI_SyncErrorInterruptEnable • kSAI_FIFOWarningInterruptEnable • kSAI_FIFORequestInterruptEnable • kSAI_FIFOErrorInterruptEnable

41.4.5.53 static void SAI_RxDisableInterrupts (I2S_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	SAI base pointer
mask	interrupt source The parameter can be a combination of the following sources if defined. • kSAI_WordStartInterruptEnable • kSAI_SyncErrorInterruptEnable • kSAI_FIFOWarningInterruptEnable • kSAI_FIFORequestInterruptEnable • kSAI_FIFOErrorInterruptEnable

41.4.5.54 static void SAI_TxEnableDMA (I2S_Type * *base,* uint32_t *mask,* bool *enable*) [inline], [static]

Parameters

base	SAI base pointer
mask	DMA source The parameter can be combination of the following sources if defined. • kSAI_FIFOWarningDMAEnable • kSAI_FIFORequestDMAEnable
enable	True means enable DMA, false means disable DMA.

41.4.5.55 static void SAI_RxEnableDMA (I2S_Type * *base,* uint32_t *mask,* bool *enable*) [inline], [static]

Parameters

base	SAI base pointer

mask	DMA source The parameter can be a combination of the following sources if defined. • kSAI_FIFOWarningDMAEnable • kSAI_FIFORequestDMAEnable
enable	True means enable DMA, false means disable DMA.

41.4.5.56 static uint32_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

base	SAI base pointer.
channel	Which data channel used.

Returns

data register address.

41.4.5.57 static uint32_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

base	SAI base pointer.
channel	Which data channel used.

Returns

data register address.

41.4.5.58 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 superceded 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

base	SAI base pointer.
format	Pointer to the SAI audio data format structure.
mclkSource-ClockHz	SAI master clock source frequency in Hz.
bclkSource-ClockHz	SAI bit clock source frequency in Hz. If the bit clock source is a master clock, this value should equal the masterClockHz.

41.4.5.59 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 superceded 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

base	SAI base pointer.
format	Pointer to the SAI audio data format structure.
mclkSource-ClockHz	SAI master clock source frequency in Hz.
bclkSource-ClockHz	SAI bit clock source frequency in Hz. If the bit clock source is a master clock, this value should equal the masterClockHz.

41.4.5.60 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

base	SAI base pointer.
channel	Data channel used.
bitWidth	How many bits in an audio word; usually 8/16/24/32 bits.
buffer	Pointer to the data to be written.
size	Bytes to be written.

41.4.5.61 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

base	SAI base pointer.
channel	Data channel used.
channelMask	channel mask.
bitWidth	How many bits in an audio word; usually 8/16/24/32 bits.
buffer	Pointer to the data to be written.
size	Bytes to be written.

41.4.5.62 static void SAI_WriteData (I2S_Type ∗ *base,* uint32_t *channel,* uint32_t *data*) `[inline], [static]`

Parameters

base	SAI base pointer.
channel	Data channel used.
data	Data needs to be written.

41.4.5.63 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

base	SAI base pointer.
channel	Data channel used.
bitWidth	How many bits in an audio word; usually 8/16/24/32 bits.
buffer	Pointer to the data to be read.
size	Bytes to be read.

41.4.5.64 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

base	SAI base pointer.
channel	Data channel used.
channelMask	channel mask.
bitWidth	How many bits in an audio word; usually 8/16/24/32 bits.
buffer	Pointer to the data to be read.
size	Bytes to be read.

41.4.5.65 static uint32_t SAI_ReadData (I2S_Type ∗ *base,* uint32_t *channel*) `[inline], [static]`

Parameters

base	SAI base pointer.
channel	Data channel used.

Returns

Data in SAI FIFO.

41.4.5.66 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

base	SAI base pointer
handle	SAI handle pointer.
callback	Pointer to the user callback function.
userData	User parameter passed to the callback function

41.4.5.67 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

base	SAI base pointer.
handle	SAI handle pointer.
callback	Pointer to the user callback function.
userData	User parameter passed to the callback function.

41.4.5.68 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

base	SAI base pointer.
handle	SAI handle pointer.
config	tranmitter configurations.

41.4.5.69 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

base	SAI base pointer.
handle	SAI handle pointer.
config	receiver configurations.

41.4.5.70 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 superceded 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

base	SAI base pointer.
handle	SAI handle pointer.
format	Pointer to the SAI audio data format structure.
mclkSourceClockHz	SAI master clock source frequency in Hz.
bclkSourceClockHz	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.

41.4.5.71 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 superceded 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

base	SAI base pointer.
handle	SAI handle pointer.
format	Pointer to the SAI audio data format structure.
mclkSourceClockHz	SAI master clock source frequency in Hz.
bclkSourceClockHz	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.

41.4.5.72 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

base	SAI base pointer.
handle	Pointer to the sai_handle_t structure which stores the transfer state.
xfer	Pointer to the sai_transfer_t structure.

Return values

kStatus_Success	Successfully started the data receive.
kStatus_SAI_TxBusy	Previous receive still not finished.
kStatus_InvalidArgument	The input parameter is invalid.

41.4.5.73 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

base	SAI base pointer
handle	Pointer to the sai_handle_t structure which stores the transfer state.
xfer	Pointer to the sai_transfer_t structure.

Return values

kStatus_Success	Successfully started the data receive.
kStatus_SAI_RxBusy	Previous receive still not finished.
kStatus_InvalidArgument	The input parameter is invalid.

41.4.5.74 status_t SAI_TransferGetSendCount (I2S_Type * *base*, sai_handle_t * *handle*, size_t * *count*)

Parameters

base	SAI base pointer.
handle	Pointer to the sai_handle_t structure which stores the transfer state.
count	Bytes count sent.

Return values

kStatus_Success	Succeed get the transfer count.
kStatus_NoTransferIn-Progress	There is not a non-blocking transaction currently in progress.

41.4.5.75 status_t SAI_TransferGetReceiveCount (I2S_Type * *base*, sai_handle_t * *handle*, size_t * *count*)

Parameters

base	SAI base pointer.
handle	Pointer to the sai_handle_t structure which stores the transfer state.
count	Bytes count received.

Return values

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

41.4.5.76 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

base	SAI base pointer.
handle	Pointer to the sai_handle_t structure which stores the transfer state.

41.4.5.77 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

base	SAI base pointer
handle	Pointer to the sai_handle_t structure which stores the transfer state.

41.4.5.78 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.

41.4.5.79 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.

41.4.5.80 void SAI_TransferTxHandleIRQ (I2S_Type * *base,* sai_handle_t * *handle*)

Parameters

base	SAI base pointer.
handle	Pointer to the sai_handle_t structure.

41.4.5.81 void SAI_TransferRxHandleIRQ (I2S_Type * *base,* sai_handle_t * *handle*)

Parameters

base	SAI base pointer.
handle	Pointer to the sai_handle_t structure.

41.5 SAI EDMA Driver

41.5.1 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.

41.5.2 Data Structure Documentation

41.5.2.1 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

41.5.3 Function Documentation

41.5.3.1 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.
base	SAI peripheral base address.
callback	Pointer to user callback function.
userData	User parameter passed to the callback function.
txDmaHandle	eDMA handle pointer, this handle shall be static allocated by users.

41.5.3.2 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.
base	SAI peripheral base address.
callback	Pointer to user callback function.
userData	User parameter passed to the callback function.
rxDmaHandle	eDMA handle pointer, this handle shall be static allocated by users.

41.5.3.3 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 superceded 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.
format	Pointer to SAI audio data format structure.
mclkSourceClockHz	SAI master clock source frequency in Hz.
bclkSourceClockHz	SAI bit clock source frequency in Hz. If bit clock source is master clock, this value should equals to masterClockHz in format.

Return values

kStatus_Success	Audio format set successfully.
kStatus_InvalidArgument	The input argument is invalid.

41.5.3.4 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 superceded 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.
format	Pointer to SAI audio data format structure.
mclkSourceClockHz	SAI master clock source frequency in Hz.
bclkSourceClockHz	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

kStatus_Success	Audio format set successfully.
kStatus_InvalidArgument	The input argument is invalid.

41.5.3.5 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.
saiConfig	sai configurations.

41.5.3.6 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.
saiConfig	sai configurations.

41.5.3.7 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.
xfer	Pointer to the DMA transfer structure.

Return values

kStatus_Success	Start a SAI eDMA send successfully.
kStatus_InvalidArgument	The input argument is invalid.
kStatus_TxBusy	SAI is busy sending data.

41.5.3.8 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_GetReceiveRemaining-Bytes 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

base	SAI base pointer
handle	SAI eDMA handle pointer.
xfer	Pointer to DMA transfer structure.

Return values

kStatus_Success	Start a SAI eDMA receive successfully.
kStatus_InvalidArgument	The input argument is invalid.

kStatus_RxBusy	SAI is busy receiving data.

41.5.3.9 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.
xfer	Pointer to the DMA transfer structure, should be a array with elements counts >=1(loopTransferCount).
loopTransfer-Count	the counts of xfer array.

Return values

kStatus_Success	Start a SAI eDMA send successfully.
kStatus_InvalidArgument	The input argument is invalid.

41.5.3.10 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.
xfer	Pointer to the DMA transfer structure, should be a array with elements counts >=1(loopTransferCount).
loopTransfer-Count	the counts of xfer array.

Return values

kStatus_Success	Start a SAI eDMA receive successfully.
kStatus_InvalidArgument	The input argument is invalid.

41.5.3.11 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.

41.5.3.12 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.

41.5.3.13 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

base	SAI base pointer.
handle	SAI eDMA handle pointer.

41.5.3.14 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

base	SAI base pointer
handle	SAI eDMA handle pointer.

41.5.3.15 status_t SAI_TransferGetSendCountEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*, size_t * *count*)

Parameters

base	SAI base pointer.
handle	SAI eDMA handle pointer.
count	Bytes count sent by SAI.

Return values

kStatus_Success	Succeed get the transfer count.
kStatus_NoTransferInProgress	There is no non-blocking transaction in progress.

41.5.3.16 status_t SAI_TransferGetReceiveCountEDMA (I2S_Type * *base*, sai_edma_handle_t * *handle*, size_t * *count*)

Parameters

base	SAI base pointer
handle	SAI eDMA handle pointer.
count	Bytes count received by SAI.

Return values

kStatus_Success	Succeed get the transfer count.
kStatus_NoTransferIn-Progress	There is no non-blocking transaction in progress.

41.5.3.17 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

base	SAI base pointer
handle	SAI eDMA handle pointer.

Return values

valid	slot count that application submit.

Chapter 42
SEMC: Smart External DRAM Controller Driver

42.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Smart External DRAM Controller block of MCUXpresso SDK devices.

42.2 SEMC: Smart External DRAM Controller Driver

42.2.1 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.

42.2.2 SEMC Interrupt Operation

The interrupt and disable operation for SEMC.

42.2.3 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.

42.3 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_SdramColunm_12bit = 0x0U,
kSEMC_SdramColunm_11bit,
kSEMC_SdramColunm_10bit,
kSEMC_SdramColunm_9bit,
kSEMC_SdramColunm_8bit }
SEMC sdram column address bit number.
- enum sem_sdram_burst_len_t {
kSEMC_Sdram_BurstLen1 = 0,
kSEMC_Sdram_BurstLen2,
kSEMC_Sdram_BurstLen4,
kSEMC_Sdram_BurstLen8 }
SEMC sdram burst length.
- enum semc_nand_column_bit_num_t {
kSEMC_NandColum_16bit = 0x0U,
kSEMC_NandColum_15bit,
kSEMC_NandColum_14bit,
kSEMC_NandColum_13bit,
kSEMC_NandColum_12bit,
kSEMC_NandColum_11bit,
kSEMC_NandColum_10bit,

kSEMC_NandColum_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_NorColum_12bit = 0x0U,
  kSEMC_NorColum_11bit,
  kSEMC_NorColum_10bit,
  kSEMC_NorColum_9bit,
  kSEMC_NorColum_8bit,
  kSEMC_NorColum_7bit,
  kSEMC_NorColum_6bit,
  kSEMC_NorColum_5bit,
  kSEMC_NorColum_4bit,
  kSEMC_NorColum_3bit,
  kSEMC_NorColum_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_IOCR_MUX_A8_SHIFT,
  kSEMC_MUXCSX0 = SEMC_IOCR_MUX_CSX0_SHIFT,
  kSEMC_MUXCSX1 = SEMC_IOCR_MUX_CSX1_SHIFT,
  kSEMC_MUXCSX2 = SEMC_IOCR_MUX_CSX2_SHIFT,
  kSEMC_MUXCSX3 = SEMC_IOCR_MUX_CSX3_SHIFT,
  kSEMC_MUXRDY = SEMC_IOCR_MUX_RDY_SHIFT }
  SEMC IOMUXC.
- enum semc_iomux_nora27_pin {
  kSEMC_MORA27_NONE = 0,
  kSEMC_NORA27_MUXCSX3 = SEMC_IOCR_MUX_CSX3_SHIFT,
  kSEMC_NORA27_MUXRDY = SEMC_IOCR_MUX_RDY_SHIFT }
  SEMC NOR/PSRAM Address bit 27 A27.
- enum smec_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, 0))
  SEMC driver version 2.3.1.

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 type, 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.

42.4 Data Structure Documentation

42.4.1 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 ∗ clock cycle.
- uint32_t tIdleTimeout_Ns
  Idle timeout in unit of prescale time period.
- uint32_t refreshPeriod_nsPerRow
  Refresh timer period like 64ms ∗ 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

42.4.2 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

42.4.3 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

42.4.4 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.
- uint8_t latencyCount
  Latency count for sync mode.
- uint8_t readCycle

Read cycle time for sync 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**

(23) **uint8_t semc_nor_config_t::latencyCount**

(24) **uint8_t semc_nor_config_t::readCycle**

42.4.5 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.
- uint8_t tWriteSetup_Ns
  Write data setup time for sync mode.
- uint8_t tWriteHold_Ns
  Write hold time for sync mode.
- uint8_t latencyCount
  Latency count for sync mode.
- uint8_t readCycle

Read cycle time for sync mode.

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**

(21) **uint8_t semc_sram_config_t::tWriteSetup_Ns**

(22) **uint8_t semc_sram_config_t::tWriteHold_Ns**

(23) **uint8_t semc_sram_config_t::latencyCount**

(24) **uint8_t semc_sram_config_t::readCycle**

42.4.6 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

42.4.7 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 slaveHitSwith: 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

42.4.8 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

42.4.9 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

42.4.10 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

42.4.11 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

42.4.12 struct semc_config_t

busTimeoutCycles: when busTimeoutCycles is zero, the bus timeout cycle is 255∗1024. otherwise the bus timeout cycles is busTimeoutCycles∗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

42.5 Macro Definition Documentation

42.5.1 #define FSL_SEMC_DRIVER_VERSION (MAKE_VERSION(2, 4, 0))

42.6 Enumeration Type Documentation

42.6.1 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 sie.
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.

42.6.2 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.

42.6.3 enum semc_waitready_polarity_t

Enumerator

kSEMC_LowActive Low active.
kSEMC_HighActive High active.

42.6.4 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.

42.6.5 enum semc_sram_cs_t

Enumerator

kSEMC_SRAM_CS0 SEMC SRAM CS0.

42.6.6 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.

42.6.7 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.

42.6.8 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.

42.6.9 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.

42.6.10 enum semc_caslatency_t

Enumerator

kSEMC_LatencyOne Latency 1.
kSEMC_LatencyTwo Latency 2.
kSEMC_LatencyThree Latency 3.

42.6.11 enum semc_sdram_column_bit_num_t

Enumerator

kSEMC_SdramColunm_12bit 12 bit.
kSEMC_SdramColunm_11bit 11 bit.
kSEMC_SdramColunm_10bit 10 bit.
kSEMC_SdramColunm_9bit 9 bit.
kSEMC_SdramColunm_8bit 8 bit.

42.6.12 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
kSEMC_Sdram_BurstLen2 Burst length 2.
kSEMC_Sdram_BurstLen4 Burst length 4.
kSEMC_Sdram_BurstLen8 Burst length 8.

42.6.13 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.

42.6.14 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.

42.6.15 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.

42.6.16 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.

42.6.17 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.

42.6.18 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.

42.6.19 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.

42.6.20 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.

42.6.21 enum smec_port_size_t

Enumerator

kSEMC_PortSize8Bit 8-Bit port size.
kSEMC_PortSize16Bit 16-Bit port size.

42.6.22 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.

42.6.23 enum semc_dqs_mode_t

Enumerator

kSEMC_Loopbackinternal Dummy read strobe loopbacked internally.
kSEMC_Loopbackdqspad Dummy read strobe loopbacked from DQS pad.

42.6.24 enum semc_adv_polarity_t

Enumerator

kSEMC_AdvActiveLow Adv active low.
kSEMC_AdvActiveHigh Adv active high.

42.6.25 enum semc_sync_mode_t

Enumerator

kSEMC_AsyncMode Async mode.
kSEMC_SyncMode Sync mode.

42.6.26 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.

42.6.27 enum semc_rdy_polarity_t

Enumerator

kSEMC_RdyActiveLow Adv active low.
kSEMC_RdyActivehigh Adv active low.

42.6.28 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).

42.6.29 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.

42.6.30 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.

42.6.31 enum semc_ipcmd_nor_dbi_t

Enumerator

kSEMC_NORDBICM_Read NOR read.
kSEMC_NORDBICM_Write NOR write.

42.6.32 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.

42.6.33 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.

42.7 Function Documentation

42.7.1 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

config	The SEMC configuration structure pointer.

42.7.2 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

base	SEMC peripheral base address.
configure	The SEMC configuration structure pointer.

42.7.3 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

base	SEMC peripheral base address.

42.7.4 status_t SEMC_ConfigureSDRAM (SEMC_Type * *base*, semc_sdram_cs_t *cs*, semc_sdram_config_t * *config*, uint32_t *clkSrc_Hz*)

Parameters

base	SEMC peripheral base address.
cs	The chip selection.
config	The sdram configuration.
clkSrc_Hz	The SEMC clock frequency.

42.7.5 status_t SEMC_ConfigureNAND (SEMC_Type * *base*, semc_nand_config_t * *config*, uint32_t *clkSrc_Hz*)

Parameters

base	SEMC peripheral base address.
config	The nand configuration.
clkSrc_Hz	The SEMC clock frequency.

42.7.6 status_t SEMC_ConfigureNOR (SEMC_Type * *base*, semc_nor_config_t * *config*, uint32_t *clkSrc_Hz*)

Parameters

base	SEMC peripheral base address.
config	The nor configuration.
clkSrc_Hz	The SEMC clock frequency.

42.7.7 status_t SEMC_ConfigureSRAMWithChipSelection (SEMC_Type * *base*, semc_sram_cs_t *cs*, semc_sram_config_t * *config*, uint32_t *clkSrc_Hz*)

Parameters

base	SEMC peripheral base address.
cs	The chip selection.
config	The sram configuration.
clkSrc_Hz	The SEMC clock frequency.

42.7.8 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

base	SEMC peripheral base address.
config	The sram configuration.
clkSrc_Hz	The SEMC clock frequency.

42.7.9 status_t SEMC_ConfigureDBI (SEMC_Type * *base*, semc_dbi_config_t * *config*, uint32_t *clkSrc_Hz*)

Parameters

base	SEMC peripheral base address.
config	The dbi configuration.
clkSrc_Hz	The SEMC clock frequency.

42.7.10 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

base	SEMC peripheral base address.
mask	SEMC interrupts to enable. This is a logical OR of the enumeration :: semc_interrupt-_enable_t.

42.7.11 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

base	SEMC peripheral base address.
mask	SEMC interrupts to disable. This is a logical OR of the enumeration :: semc_-interrupt_enable_t.

42.7.12 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

base	SEMC peripheral base address.

Returns

status flag, use status flag in semc_interrupt_enable_t to get the related status.

42.7.13 static void SEMC_ClearStatusFlags (SEMC_Type * *base*, uint32_t *mask*) [inline], [static]

The following status register flags can be cleared SEMC interrupt status.

Parameters

base	SEMC base pointer
mask	The status flag mask, a logical OR of enumeration member semc_interrupt_enable_t.

42.7.14 static bool SEMC_IsInIdle (SEMC_Type * *base*) [inline], [static]

Parameters

base	SEMC peripheral base address.

Returns

True SEMC is in idle, false is not in idle.

42.7.15 status_t SEMC_SendIPCommand (SEMC_Type * *base*, semc_mem_type_t *type*, uint32_t *address*, uint32_t *command*, uint32_t *write*, uint32_t * *read*)

Parameters

base	SEMC peripheral base address.
type	SEMC memory type. refer to "semc_mem_type_t"
address	SEMC device address.
command	SEMC IP command. For NAND device, we should use the SEMC_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".
write	Data for write access.
read	Data pointer for read data out.

42.7.16 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

userCommand	NAND device normal command.
addrMode	NAND address mode. Refer to "semc_ipcmd_nand_addrmode_t".
cmdMode	NAND command mode. Refer to "semc_ipcmd_nand_cmdmode_t".

42.7.17 static bool SEMC_IsNandReady (SEMC_Type * *base*) [inline], [static]

Parameters

base	SEMC peripheral base address.

Returns

True NAND is ready, false NAND is not ready.

42.7.18 status_t SEMC_IPCommandNandWrite (SEMC_Type * *base,* uint32_t *address,* uint8_t * *data,* uint32_t *size_bytes*)

Parameters

base	SEMC peripheral base address.
address	SEMC NAND device address.
data	Data for write access.
size_bytes	Data length.

42.7.19 status_t SEMC_IPCommandNandRead (SEMC_Type * *base,* uint32_t *address,* uint8_t * *data,* uint32_t *size_bytes*)

Parameters

base	SEMC peripheral base address.
address	SEMC NAND device address.
data	Data pointer for data read out.
size_bytes	Data length.

42.7.20 status_t SEMC_IPCommandNorWrite (SEMC_Type ∗ *base*, uint32_t *address*, uint8_t ∗ *data*, uint32_t *size_bytes*)

Parameters

base	SEMC peripheral base address.
address	SEMC NOR device address.
data	Data for write access.
size_bytes	Data length.

42.7.21 status_t SEMC_IPCommandNorRead (SEMC_Type ∗ *base*, uint32_t *address*, uint8_t ∗ *data*, uint32_t *size_bytes*)

Parameters

base	SEMC peripheral base address.
address	SEMC NOR device address.
data	Data pointer for data read out.
size_bytes	Data length.

Chapter 43
SNVS: Secure Non-Volatile Storage

43.1 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

43.2 Secure Non-Volatile Storage High-Power

43.2.1 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 << (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, 1))
  Version 2.3.1.

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 *alarmTime)
  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)

43.2.2 Data Structure Documentation

43.2.2.1 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

43.2.2.2 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.

43.2.3 Macro Definition Documentation

43.2.3.1 #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.

43.2.4 Enumeration Type Documentation

43.2.4.1 enum snvs_hp_interrupts_t

Enumerator

kSNVS_RTC_AlarmInterrupt RTC time alarm.
kSNVS_RTC_PeriodicInterrupt RTC periodic interrupt.

43.2.4.2 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.

43.2.4.3 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.

43.2.4.4 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.

43.2.5 Function Documentation

43.2.5.1 void SNVS_HP_Init (SNVS_Type * *base*)

Note

This API should be called at the beginning of the application using the SNVS driver.

Parameters

base	SNVS peripheral base address

43.2.5.2 void SNVS_HP_Deinit (SNVS_Type * *base*)

Parameters

base	SNVS peripheral base address

43.2.5.3 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

base	SNVS peripheral base address
config	Pointer to the user's SNVS configuration structure.

43.2.5.4 void SNVS_HP_RTC_Deinit (SNVS_Type * *base*)

Parameters

base	SNVS peripheral base address

43.2.5.5 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

config	Pointer to the user's SNVS configuration structure.

43.2.5.6 status_t SNVS_HP_RTC_SetDatetime (SNVS_Type * *base,* const snvs_hp_rtc_datetime_t * *datetime*)

Parameters

base	SNVS peripheral base address
datetime	Pointer to the structure where the date and time details are stored.

Returns

kStatus_Success: Success in setting the time and starting the SNVS RTC kStatus_InvalidArgument: Error because the datetime format is incorrect

43.2.5.7 void SNVS_HP_RTC_GetDatetime (SNVS_Type * *base,* snvs_hp_rtc_datetime_t * *datetime*)

Parameters

base	SNVS peripheral base address
datetime	Pointer to the structure where the date and time details are stored.

43.2.5.8 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

base	SNVS peripheral base address
alarmTime	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

43.2.5.9 void SNVS_HP_RTC_GetAlarm (SNVS_Type * *base*, snvs_hp_rtc_datetime_t * *datetime*)

Parameters

base	SNVS peripheral base address
datetime	Pointer to the structure where the alarm date and time details are stored.

43.2.5.10 void SNVS_HP_RTC_TimeSynchronize (SNVS_Type * *base*)

Parameters

base	SNVS peripheral base address

43.2.5.11 static void SNVS_HP_RTC_EnableInterrupts (SNVS_Type * *base*, uint32_t *mask*) `[inline]`, `[static]`

Parameters

base	SNVS peripheral base address
mask	The interrupts to enable. This is a logical OR of members of the enumeration :: _snvs_hp_interrupts_t

43.2.5.12 static void SNVS_HP_RTC_DisableInterrupts (SNVS_Type * *base*, uint32_t *mask*) `[inline]`, `[static]`

Parameters

base	SNVS peripheral base address
mask	The interrupts to disable. This is a logical OR of members of the enumeration :: _snvs_hp_interrupts_t

43.2.5.13 uint32_t SNVS_HP_RTC_GetEnabledInterrupts (SNVS_Type * *base*)

Parameters

base	SNVS peripheral base address

Returns

The enabled interrupts. This is the logical OR of members of the enumeration :: _snvs_hp_interrupts-_t

43.2.5.14 uint32_t SNVS_HP_RTC_GetStatusFlags (SNVS_Type * *base*)

Parameters

base	SNVS peripheral base address

Returns

The status flags. This is the logical OR of members of the enumeration :: _snvs_hp_status_flags_t

43.2.5.15 static void SNVS_HP_RTC_ClearStatusFlags (SNVS_Type * *base,* uint32_t *mask*) `[inline]`, `[static]`

Parameters

base	SNVS peripheral base address
mask	The status flags to clear. This is a logical OR of members of the enumeration :: _-snvs_hp_status_flags_t

43.2.5.16 static void SNVS_HP_RTC_StartTimer (SNVS_Type * *base*) `[inline]`, `[static]`

Parameters

base	SNVS peripheral base address

43.2.5.17 static void SNVS_HP_RTC_StopTimer (SNVS_Type * *base*) [inline], [static]

Parameters

base	SNVS peripheral base address

43.2.5.18 static void SNVS_HP_EnableMasterKeySelection (SNVS_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	SNVS peripheral base address
enable	Pass true to enable, false to disable.

43.2.5.19 static void SNVS_HP_ProgramZeroizableMasterKey (SNVS_Type * *base*) [inline], [static]

Parameters

base	SNVS peripheral base address

43.2.5.20 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

base	SNVS peripheral base address

43.2.5.21 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

base	SNVS peripheral base address

43.2.5.22 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

base	SNVS peripheral base address

43.2.5.23 static snvs_hp_ssm_state_t SNVS_HP_GetSSMState (SNVS_Type * *base*) [inline], [static]

Parameters

base	SNVS peripheral base address

Returns

Current SSM state

43.2.5.24 static void SNVS_HP_ResetLP (SNVS_Type * *base*) [inline], [static]

Reset the LP section except SRTC and Time alarm.

Parameters

base	SNVS peripheral base address

43.2.5.25 static void SNVS_HP_EnableHighAssuranceCounter (SNVS_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	SNVS peripheral base address
enable	Pass true to enable, false to disable.

43.2.5.26 static void SNVS_HP_StartHighAssuranceCounter (SNVS_Type * *base,* bool *start*) [inline], [static]

Parameters

base	SNVS peripheral base address
start	Pass true to start, false to stop.

43.2.5.27 static void SNVS_HP_SetHighAssuranceCounterInitialValue (SNVS_Type * *base,* uint32_t *value*) [inline], [static]

Parameters

base	SNVS peripheral base address
value	The initial value to set.

43.2.5.28 static void SNVS_HP_LoadHighAssuranceCounter (SNVS_Type * *base*) [inline], [static]

This function loads the HAC initialize value to counter register.

Parameters

base	SNVS peripheral base address

43.2.5.29 static uint32_t SNVS_HP_GetHighAssuranceCounter (SNVS_Type * *base*) [inline], [static]

Parameters

base	SNVS peripheral base address

Returns

HAC currnet value.

43.2.5.30 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

base	SNVS peripheral base address

43.2.5.31 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

base	SNVS peripheral base address

43.2.5.32 static uint32_t SNVS_HP_GetStatusFlags (SNVS_Type * *base*) [inline], [static]

The flags are returned as the OR'ed value f the enumeration :: _snvs_hp_status_flags_t.

Parameters

base	SNVS peripheral base address

Returns

The OR'ed value of status flags.

43.2.5.33 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

base	SNVS peripheral base address
mask	OR'ed value of the flags to clear.

43.2.5.34 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

base	SNVS peripheral base address

Returns

The OR'ed value of security violation status flags.

43.2.5.35 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

base	SNVS peripheral base address
mask	OR'ed value of the flags to clear.

43.3 Secure Non-Volatile Storage Low-Power

43.3.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Secure Non-Volatile Storage Low-Power (S-NVS-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 }
  List of SNVS_LP interrupts.
- enum snvs_lp_srtc_status_flags_t { kSNVS_SRTC_AlarmInterruptFlag = SNVS_LPSR_LPTA_-MASK }
  List of SNVS_LP flags.
- enum snvs_lp_external_tamper_status_t
  List of SNVS_LP external tampers status.
- enum snvs_lp_external_tamper_polarity_t
  SNVS_LP external tamper polarity.
- enum snvs_lp_zmk_program_mode_t {
  kSNVS_ZMKSoftwareProgram,
  kSNVS_ZMKHardwareProgram }
  SNVS_LP Zeroizable Master Key programming mode.
- enum snvs_lp_master_key_mode_t {
  kSNVS_OTPMK = 0,
  kSNVS_ZMK = 2,

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, 3))
  Version 2.4.3.

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 *alarmTime)
  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.

43.3.2 Data Structure Documentation

43.3.2.1 struct snvs_lp_passive_tamper_t

43.3.2.2 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

43.3.2.3 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.

43.3.3 Enumeration Type Documentation

43.3.3.1 enum snvs_lp_srtc_interrupts_t

Enumerator

kSNVS_SRTC_AlarmInterrupt SRTC time alarm.

43.3.3.2 enum snvs_lp_srtc_status_flags_t

Enumerator

kSNVS_SRTC_AlarmInterruptFlag SRTC time alarm flag.

43.3.3.3 enum snvs_lp_zmk_program_mode_t

Enumerator

kSNVS_ZMKSoftwareProgram Software programming mode.
kSNVS_ZMKHardwareProgram Hardware programming mode.

43.3.3.4 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.

43.3.4 Function Documentation

43.3.4.1 void SNVS_LP_Init (SNVS_Type * *base*)

Note

This API should be called at the beginning of the application using the SNVS driver.

Parameters

base	SNVS peripheral base address

43.3.4.2 void SNVS_LP_Deinit (SNVS_Type * *base*)

Parameters

base	SNVS peripheral base address

43.3.4.3 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

base	SNVS peripheral base address
config	Pointer to the user's SNVS configuration structure.

43.3.4.4 void SNVS_LP_SRTC_Deinit (SNVS_Type * *base*)

Parameters

base	SNVS peripheral base address

43.3.4.5 void SNVS_LP_SRTC_GetDefaultConfig (snvs_lp_srtc_config_t * *config*)

The default values are as follows.

```
*    config->srtccalenable = false;
*    config->srtccalvalue = 0U;
*
```

Parameters

config	Pointer to the user's SNVS configuration structure.

43.3.4.6 status_t SNVS_LP_SRTC_SetDatetime (SNVS_Type * *base,* const snvs_lp_srtc_datetime_t * *datetime*)

Parameters

base	SNVS peripheral base address
datetime	Pointer to the structure where the date and time details are stored.

Returns

kStatus_Success: Success in setting the time and starting the SNVS SRTC kStatus_InvalidArgument: Error because the datetime format is incorrect

43.3.4.7 void SNVS_LP_SRTC_GetDatetime (SNVS_Type * *base,* snvs_lp_srtc_datetime_t * *datetime*)

Parameters

base	SNVS peripheral base address
datetime	Pointer to the structure where the date and time details are stored.

43.3.4.8 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

base	SNVS peripheral base address
alarmTime	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

43.3.4.9 void SNVS_LP_SRTC_GetAlarm (SNVS_Type * *base*, snvs_lp_srtc_datetime_t * *datetime*)

Parameters

base	SNVS peripheral base address
datetime	Pointer to the structure where the alarm date and time details are stored.

43.3.4.10 static void SNVS_LP_SRTC_EnableInterrupts (SNVS_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	SNVS peripheral base address
mask	The interrupts to enable. This is a logical OR of members of the enumeration :: _snvs_lp_srtc_interrupts

43.3.4.11 static void SNVS_LP_SRTC_DisableInterrupts (SNVS_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	SNVS peripheral base address
mask	The interrupts to enable. This is a logical OR of members of the enumeration :: _snvs_lp_srtc_interrupts

43.3.4.12 uint32_t SNVS_LP_SRTC_GetEnabledInterrupts (SNVS_Type * *base*)

Parameters

base	SNVS peripheral base address

Returns

The enabled interrupts. This is the logical OR of members of the enumeration :: _snvs_lp_srtc_-interrupts

43.3.4.13 uint32_t SNVS_LP_SRTC_GetStatusFlags (SNVS_Type * *base*)

Parameters

base	SNVS peripheral base address

Returns

The status flags. This is the logical OR of members of the enumeration :: _snvs_lp_srtc_status_flags

43.3.4.14 static void SNVS_LP_SRTC_ClearStatusFlags (SNVS_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	SNVS peripheral base address
mask	The status flags to clear. This is a logical OR of members of the enumeration :: _-snvs_lp_srtc_status_flags

43.3.4.15 static void SNVS_LP_SRTC_StartTimer (SNVS_Type * *base*) [inline], [static]

Parameters

base	SNVS peripheral base address

43.3.4.16 static void SNVS_LP_SRTC_StopTimer (SNVS_Type * *base*) [inline], [static]

Parameters

base	SNVS peripheral base address

43.3.4.17 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

config	Pointer to the user's SNVS configuration structure.

43.3.4.18 static void SNVS_LP_EnableMonotonicCounter (SNVS_Type ∗ *base,* bool *enable*) `[inline],[static]`

Parameters

base	SNVS peripheral base address
enable	Pass true to enable, false to disable.

43.3.4.19 uint64_t SNVS_LP_GetMonotonicCounter (SNVS_Type ∗ *base*)

Parameters

base	SNVS peripheral base address

Returns

Current Monotonic Counter value.

43.3.4.20 static void SNVS_LP_IncreaseMonotonicCounter (SNVS_Type ∗ *base*) `[inline],[static]`

Increase the Monotonic Counter by 1.

Parameters

base	SNVS peripheral base address

43.3.4.21 void SNVS_LP_WriteZeroizableMasterKey (SNVS_Type * *base,* uint32_t *ZMKey[SNVS_ZMK_REG_COUNT]*)

Parameters

base	SNVS peripheral base address
ZMKey	The ZMK write to the SNVS register.

43.3.4.22 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

base	SNVS peripheral base address
valid	Pass true to set valid, false to set invalid.

43.3.4.23 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

base	SNVS peripheral base address

Returns

true if valid, false if invalid.

43.3.4.24 static void SNVS_LP_SetZeroizableMasterKeyProgramMode (SNVS_Type * *base,* snvs_lp_zmk_program_mode_t *mode*) `[inline], [static]`

Parameters

base	SNVS peripheral base address
mode	ZMK programming mode.

43.3.4.25 static void SNVS_LP_EnableZeroizableMasterKeyECC (SNVS_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	SNVS peripheral base address
enable	Pass true to enable, false to disable.

43.3.4.26 static void SNVS_LP_SetMasterKeyMode (SNVS_Type * *base*, snvs_lp_master_key_mode_t *mode*) [inline], [static]

Parameters

base	SNVS peripheral base address
mode	Master Key mode.

Note

When kSNVS_ZMK or kSNVS_CMK used, the SNVS_HP must be configured to enable the master key selection.

Chapter 44
SPDIF: Sony/Philips Digital Interface

44.1 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.

44.2 Typical use case

44.2.1 SPDIF Send/receive using an interrupt method

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

44.2.2 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 falg 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 falg 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_ValidityFlagNoGood = 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)
  Tx interrupt handler.

44.3 Data Structure Documentation

44.3.1 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

44.3.2 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

44.3.3 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.

44.4 Macro Definition Documentation

44.4.1 #define SPDIF_XFER_QUEUE_SIZE (4U)

44.5 Enumeration Type Documentation

44.5.1 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_ValidatyNoGood SPDIF validaty 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.

44.5.2 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.

44.5.3 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.

44.5.4 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.

44.5.5 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.

44.5.6 enum spdif_tx_source_t

Enumerator

kSPDIF_txFromReceiver Tx data directly through SPDIF receiver.
kSPDIF_txNormal Normal operation, data from processor.

44.5.7 enum spdif_validity_config_t

Enumerator

kSPDIF_validityFlagAlwaysSet Outgoing validity flags always set.
kSPDIF_validityFlagAlwaysClear Outgoing validity flags always clear.

44.5.8 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 revceive register full.
kSPDIF_UChannelReceiveRegisterOverrun SPDIF U channel receive register overrun.
kSPDIF_QChannelReceiveRegisterFull SPDIF Q channel receive reigster 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

44.5.9 anonymous enum

Enumerator

kSPDIF_RxDMAEnable Rx FIFO full.
kSPDIF_TxDMAEnable Tx FIFO empty.

44.6 Function Documentation

44.6.1 void SPDIF_Init (SPDIF_Type ∗ *base,* const spdif_config_t ∗ *config*)

Ungates the SPDIF clock, resets the module, and configures SPDIF with a configuration structure. The configuration structure can be custom filled or set with default values by SPDIF_GetDefaultConfig().

Note

This API should be called at the beginning of the application to use the SPDIF driver. Otherwise, accessing the SPDIF module can cause a hard fault because the clock is not enabled.

Parameters

base	SPDIF base pointer

config	SPDIF configuration structure.

44.6.2 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

config	pointer to master configuration structure

44.6.3 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

base	SPDIF base pointer

44.6.4 uint32_t SPDIF_GetInstance (SPDIF_Type * *base*)

Parameters

base	SPDIF base pointer.

44.6.5 static void SPDIF_TxFIFOReset (SPDIF_Type * *base*) [inline], [static]

This function makes Tx FIFO in reset mode.

Parameters

base	SPDIF base pointer

44.6.6 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

base	SPDIF base pointer

44.6.7 void SPDIF_TxEnable (SPDIF_Type * *base,* bool *enable*)

Parameters

base	SPDIF base pointer
enable	True means enable SPDIF Tx, false means disable.

44.6.8 static void SPDIF_RxEnable (SPDIF_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	SPDIF base pointer
enable	True means enable SPDIF Rx, false means disable.

44.6.9 static uint32_t SPDIF_GetStatusFlag (SPDIF_Type * *base*) [inline], [static]

Parameters

base	SPDIF base pointer

Returns

SPDIF status flag value. Use the _spdif_interrupt_enable_t to get the status value needed.

44.6.10 static void SPDIF_ClearStatusFlags (SPDIF_Type ∗ *base,* uint32_t *mask*) [inline], [static]

Parameters

base	SPDIF base pointer
mask	State mask. It can be a combination of the _spdif_interrupt_enable_t member. Notice these members cannot be included, as these flags cannot be cleared by writing 1 to these bits: • kSPDIF_UChannelReceiveRegisterFull • kSPDIF_QChannelReceiveRegisterFull • kSPDIF_TxFIFOEmpty • kSPDIF_RxFIFOFull

44.6.11 static void SPDIF_EnableInterrupts (SPDIF_Type ∗ *base,* uint32_t *mask*) [inline], [static]

Parameters

base	SPDIF base pointer
mask	interrupt source The parameter can be a combination of the following sources if defined. • kSPDIF_WordStartInterruptEnable • kSPDIF_SyncErrorInterruptEnable • kSPDIF_FIFOWarningInterruptEnable • kSPDIF_FIFORequestInterruptEnable • kSPDIF_FIFOErrorInterruptEnable

44.6.12 static void SPDIF_DisableInterrupts (SPDIF_Type ∗ *base,* uint32_t *mask*) [inline], [static]

Parameters

base	SPDIF base pointer
mask	interrupt source The parameter can be a combination of the following sources if defined. • kSPDIF_WordStartInterruptEnable • kSPDIF_SyncErrorInterruptEnable • kSPDIF_FIFOWarningInterruptEnable • kSPDIF_FIFORequestInterruptEnable • kSPDIF_FIFOErrorInterruptEnable

44.6.13 static void SPDIF_EnableDMA (SPDIF_Type ∗ *base,* uint32_t *mask,* bool *enable*) [inline],[static]

Parameters

base	SPDIF base pointer
mask	SPDIF DMA enable mask, The parameter can be a combination of the following sources if defined • kSPDIF_RxDMAEnable • kSPDIF_TxDMAEnable
enable	True means enable DMA, false means disable DMA.

44.6.14 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

base	SPDIF base pointer.

Returns

data register address.

44.6.15 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

base	SPDIF base pointer.

Returns

data register address.

44.6.16 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

base	SPDIF base pointer.

Returns

data register address.

44.6.17 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

base	SPDIF base pointer.

Returns

data register address.

44.6.18 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

base	SPDIF base pointer.
sampleRate_Hz	SPDIF sample rate frequency in Hz.
sourceClock-Freq_Hz	SPDIF tx clock source frequency in Hz.

44.6.19 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

base	SPDIF base pointer.
clockSource-Freq_Hz	SPDIF system clock frequency in hz.

44.6.20 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

base	SPDIF base pointer.
buffer	Pointer to the data to be written.
size	Bytes to be written.

44.6.21 static void SPDIF_WriteLeftData (SPDIF_Type * *base,* uint32_t *data*) `[inline], [static]`

Parameters

base	SPDIF base pointer.
data	Data needs to be written.

44.6.22 static void SPDIF_WriteRightData (SPDIF_Type * *base,* uint32_t *data*) [inline], [static]

Parameters

base	SPDIF base pointer.
data	Data needs to be written.

44.6.23 static void SPDIF_WriteChannelStatusHigh (SPDIF_Type * *base,* uint32_t *data*) [inline], [static]

Parameters

base	SPDIF base pointer.
data	Data needs to be written.

44.6.24 static void SPDIF_WriteChannelStatusLow (SPDIF_Type * *base,* uint32_t *data*) [inline], [static]

Parameters

base	SPDIF base pointer.
data	Data needs to be written.

44.6.25 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

base	SPDIF base pointer.
buffer	Pointer to the data to be read.
size	Bytes to be read.

44.6.26 static uint32_t SPDIF_ReadLeftData (SPDIF_Type * *base*) [inline], [static]

Parameters

base	SPDIF base pointer.

Returns

Data in SPDIF FIFO.

44.6.27 static uint32_t SPDIF_ReadRightData (SPDIF_Type * *base*) [inline], [static]

Parameters

base	SPDIF base pointer.

Returns

Data in SPDIF FIFO.

44.6.28 static uint32_t SPDIF_ReadChannelStatusHigh (SPDIF_Type * *base*) [inline], [static]

Parameters

base	SPDIF base pointer.

Returns

Data in SPDIF FIFO.

44.6.29 static uint32_t SPDIF_ReadChannelStatusLow (SPDIF_Type * *base*) [inline], [static]

Parameters

base	SPDIF base pointer.

Returns

Data in SPDIF FIFO.

44.6.30 static uint32_t SPDIF_ReadQChannel (SPDIF_Type * *base*) [inline], [static]

Parameters

base	SPDIF base pointer.

Returns

Data in SPDIF FIFO.

44.6.31 static uint32_t SPDIF_ReadUChannel (SPDIF_Type * *base*) [inline], [static]

Parameters

base	SPDIF base pointer.

Returns

Data in SPDIF FIFO.

44.6.32 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

base	SPDIF base pointer
handle	SPDIF handle pointer.
callback	Pointer to the user callback function.
userData	User parameter passed to the callback function

44.6.33 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

base	SPDIF base pointer.
handle	SPDIF handle pointer.
callback	Pointer to the user callback function.
userData	User parameter passed to the callback function.

44.6.34 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

base	SPDIF base pointer.
handle	Pointer to the spdif_handle_t structure which stores the transfer state.
xfer	Pointer to the spdif_transfer_t structure.

Return values

kStatus_Success	Successfully started the data receive.
kStatus_SPDIF_TxBusy	Previous receive still not finished.
kStatus_InvalidArgument	The input parameter is invalid.

44.6.35 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

base	SPDIF base pointer
handle	Pointer to the spdif_handle_t structure which stores the transfer state.
xfer	Pointer to the spdif_transfer_t structure.

Return values

kStatus_Success	Successfully started the data receive.
kStatus_SPDIF_RxBusy	Previous receive still not finished.
kStatus_InvalidArgument	The input parameter is invalid.

44.6.36 status_t SPDIF_TransferGetSendCount (SPDIF_Type * *base*, spdif_handle_t * *handle*, size_t * *count*)

Parameters

base	SPDIF base pointer.

handle	Pointer to the spdif_handle_t structure which stores the transfer state.
count	Bytes count sent.

Return values

kStatus_Success	Succeed get the transfer count.
kStatus_NoTransferIn-Progress	There is not a non-blocking transaction currently in progress.

44.6.37 status_t SPDIF_TransferGetReceiveCount (SPDIF_Type * *base,* spdif_handle_t * *handle,* size_t * *count*)

Parameters

base	SPDIF base pointer.
handle	Pointer to the spdif_handle_t structure which stores the transfer state.
count	Bytes count received.

Return values

kStatus_Success	Succeed get the transfer count.
kStatus_NoTransferIn-Progress	There is not a non-blocking transaction currently in progress.

44.6.38 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

base	SPDIF base pointer.
handle	Pointer to the spdif_handle_t structure which stores the transfer state.

44.6.39 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

base	SPDIF base pointer
handle	Pointer to the spdif_handle_t structure which stores the transfer state.

44.6.40 void SPDIF_TransferTxHandleIRQ (SPDIF_Type * *base,* spdif_handle_t * *handle*)

Parameters

base	SPDIF base pointer.
handle	Pointer to the spdif_handle_t structure.

44.6.41 void SPDIF_TransferRxHandleIRQ (SPDIF_Type * *base,* spdif_handle_t * *handle*)

Parameters

base	SPDIF base pointer.
handle	Pointer to the spdif_handle_t structure.

44.7 SPDIF eDMA Driver

44.7.1 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.

44.7.2 Data Structure Documentation

44.7.2.1 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

44.7.2.2 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

44.7.3 Function Documentation

44.7.3.1 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

base	SPDIF base pointer.
handle	SPDIF eDMA handle pointer.
base	SPDIF peripheral base address.
callback	Pointer to user callback function.
userData	User parameter passed to the callback function.
dmaLeftHandle	eDMA handle pointer for left channel, this handle shall be static allocated by users.
dmaRight-Handle	eDMA handle pointer for right channel, this handle shall be static allocated by users.

44.7.3.2 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

base	SPDIF base pointer.
handle	SPDIF eDMA handle pointer.
base	SPDIF peripheral base address.
callback	Pointer to user callback function.
userData	User parameter passed to the callback function.
dmaLeftHandle	eDMA handle pointer for left channel, this handle shall be static allocated by users.
dmaRight-Handle	eDMA handle pointer for right channel, this handle shall be static allocated by users.

44.7.3.3 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

base	SPDIF base pointer.
handle	SPDIF eDMA handle pointer.
xfer	Pointer to the DMA transfer structure.

Return values

kStatus_Success	Start a SPDIF eDMA send successfully.
kStatus_InvalidArgument	The input argument is invalid.
kStatus_TxBusy	SPDIF is busy sending data.

44.7.3.4 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_GetReceiveRemainingBytes to poll the transfer status and check whether the SPDIF transfer is finished.

Parameters

base	SPDIF base pointer
handle	SPDIF eDMA handle pointer.
xfer	Pointer to DMA transfer structure.

Return values

kStatus_Success	Start a SPDIF eDMA receive successfully.
kStatus_InvalidArgument	The input argument is invalid.
kStatus_RxBusy	SPDIF is busy receiving data.

44.7.3.5 void SPDIF_TransferAbortSendEDMA (SPDIF_Type * *base*, spdif_edma_handle_t * *handle*)

Parameters

base	SPDIF base pointer.
handle	SPDIF eDMA handle pointer.

44.7.3.6 void SPDIF_TransferAbortReceiveEDMA (SPDIF_Type * *base*, spdif_edma_handle_t * *handle*)

Parameters

base	SPDIF base pointer
handle	SPDIF eDMA handle pointer.

44.7.3.7 status_t SPDIF_TransferGetSendCountEDMA (SPDIF_Type * *base*, spdif_edma_handle_t * *handle*, size_t * *count*)

Parameters

base	SPDIF base pointer.
handle	SPDIF eDMA handle pointer.
count	Bytes count sent by SPDIF.

Return values

kStatus_Success	Succeed get the transfer count.
kStatus_NoTransferIn-Progress	There is no non-blocking transaction in progress.

44.7.3.8 status_t SPDIF_TransferGetReceiveCountEDMA (SPDIF_Type * *base,* spdif_edma_handle_t * *handle,* size_t * *count*)

Parameters

base	SPDIF base pointer
handle	SPDIF eDMA handle pointer.
count	Bytes count received by SPDIF.

Return values

kStatus_Success	Succeed get the transfer count.
kStatus_NoTransferIn-Progress	There is no non-blocking transaction in progress.

Chapter 45
SRC: System Reset Controller Driver

45.1 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_LockupSysResetFlag,
  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 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.

45.2 Macro Definition Documentation

45.2.1 #define FSL_SRC_DRIVER_VERSION (MAKE_VERSION(2, 0, 1))

45.3 Enumeration Type Documentation

45.3.1 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_LockupSysResetFlag Indicates a reset has been caused by CPU lockup or software setting of SYSRESETREQ bit in Application Interrupt and Reset Control Register of the ARM core.

kSRC_IppResetPinFlag Indicates whether reset was the result of ipp_reset_b pin (Power-up sequence).

45.3.2 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.

45.4 Function Documentation

45.4.1 static void SRC_EnableWDOG3Reset (SRC_Type ∗ *base,* bool *enable*) [inline], [static]

The WDOG3 reset is enabled by default.

Parameters

base	SRC peripheral base address.
enable	Enable the reset or not.

45.4.2 static void SRC_EnableCoreDebugResetAfterPowerGate (SRC_Type ∗ *base,* bool *enable*) [inline], [static]

Parameters

base	SRC peripheral base address.
enable	Enable the reset or not.

45.4.3 static void SRC_DoSoftwareResetARMCore0 (SRC_Type ∗ *base*) [inline], [static]

Parameters

base	SRC peripheral base address.

45.4.4 static bool SRC_GetSoftwareResetARMCore0Done (SRC_Type * *base*) [inline], [static]

Parameters

base	SRC peripheral base address.

Returns

If the reset is done.

45.4.5 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

base	SRC peripheral base address.
enable	Enable the reset or not.

45.4.6 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

base	SRC peripheral base address.

Returns

status of BOOT_CFGx pins of the chip.

45.4.7 static uint32_t SRC_GetBootModeWord2 (SRC_Type * *base*) [inline], [static]

The Boot Mode register contains bits that reflect the status of BOOT_MODEx Pins and fuse values that controls boot of the chip. See to chip-specific document for detail information about value.

Parameters

base	SRC peripheral base address.

Returns

status of BOOT_MODEx Pins and fuse values that controls boot of the chip.

45.4.8 static uint32_t SRC_GetResetStatusFlags (SRC_Type * *base*) [inline], [static]

Parameters

base	SRC peripheral base address.

Returns

Mask value of status flags, see to _src_reset_status_flags.

45.4.9 void SRC_ClearResetStatusFlags (SRC_Type * *base,* uint32_t *flags*)

Parameters

base	SRC peripheral base address.
flags	value of status flags to be cleared, see to _src_reset_status_flags.

45.4.10 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

base	SRC peripheral base address.
index	The index of GPRx register array. Note index 0 reponses the GPR1 register.
value	Setting value for GPRx register.

45.4.11 static uint32_t SRC_GetGeneralPurposeRegister (SRC_Type * *base*, uint32_t *index*) [inline], [static]

Parameters

base	SRC peripheral base address.
index	The index of GPRx register array. Note index 0 reponses the GPR1 register.

Returns

The setting value for GPRx register.

Chapter 46
TEMPMON: Temperature Monitor Module

46.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Temperature Monitor Module (TEMPMON) module of MCUXpresso SDK devices.

46.2 TEMPMON: Temperature Monitor Module

46.2.1 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.

46.3 Data Structure Documentation

46.3.1 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

46.4 Macro Definition Documentation

46.4.1 #define FSL_TEMPMON_DRIVER_VERSION (MAKE_VERSION(2, 1, 1))

46.5 Enumeration Type Documentation

46.5.1 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.

46.6 Function Documentation

46.6.1 void TEMPMON_Init (TEMPMON_Type ∗ *base,* const tempmon_config_t ∗ *config*)

Parameters

base	TEMPMON base pointer
config	Pointer to configuration structure.

46.6.2 void TEMPMON_Deinit (TEMPMON_Type ∗ *base*)

Parameters

base	TEMPMON base pointer

46.6.3 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

config	Pointer to a configuration structure.

46.6.4 static void TEMPMON_StartMeasure (TEMPMON_Type ∗ *base*) `[inline],[static]`

Parameters

base	TEMPMON base pointer.

46.6.5 static void TEMPMON_StopMeasure (TEMPMON_Type * *base*) [inline], [static]

Parameters

base	TEMPMON base pointer

46.6.6 float TEMPMON_GetCurrentTemperature (TEMPMON_Type * *base*)

Parameters

base	TEMPMON base pointer

Returns

current temperature with degrees Celsius.

46.6.7 void TEMPMON_SetTempAlarm (TEMPMON_Type * *base*, int8_t *tempVal*, tempmon_alarm_mode *alarmMode*)

Parameters

base	TEMPMON base pointer
tempVal	The alarm temperature with degrees Celsius
alarmMode	The alarm mode.

Chapter 47
TRNG: True Random Number Generator

47.1 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.

47.2 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.

47.3 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.

47.4 Data Structure Documentation

47.4.1 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

47.4.2 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

47.5 Macro Definition Documentation

47.5.1 #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

47.6 Enumeration Type Documentation

47.6.1 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.

47.6.2 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.

47.6.3 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.

47.7 Function Documentation

47.7.1 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

userConfig	User configuration structure.

Returns

If successful, returns the kStatus_TRNG_Success. Otherwise, it returns an error.

47.7.2 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

base	TRNG base address
userConfig	Pointer to the initialization configuration structure.

Returns

If successful, returns the kStatus_TRNG_Success. Otherwise, it returns an error.

47.7.3 void TRNG_Deinit (TRNG_Type ∗ *base*)

This function shuts down the TRNG.

Parameters

base	TRNG base address.

47.7.4 status_t TRNG_GetRandomData (TRNG_Type * *base,* void * *data,* size_t *dataSize*)

This function gets random data from the TRNG.

Parameters

base	TRNG base address.
data	Pointer address used to store random data.
dataSize	Size of the buffer pointed by the data parameter.

Returns

random data

Chapter 48
TSC: Touch Screen Controller Driver

48.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Touch Screen Controller(TSC) module of MCUXpresso SDK devices.

48.2 Typical use case

48.2.1 4-wire Polling Configuration

Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOARD>/driver_examples/fsl_-tsc

48.2.2 4-wire Interrupt Configuration

Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOARD>/driver_examples/fsl_-tsc

Data Structures

- struct tsc_config_t
  @ Controller configuration. More...

Macros

- #define FSL_TSC_DRIVER_VERSION (MAKE_VERSION(2, 0, 3))
  TSC driver version.

Enumerations

- enum tsc_detection_mode_t {
  kTSC_Detection4WireMode = 0U,
  kTSC_Detection5WireMode = 1U }
  @ Controller detection mode.
- enum tsc_corrdinate_value_selection_t {
  kTSC_XCoordinateValueSelection = 0U,
  kTSC_YCoordinateValueSelection = 1U }
  @ Coordinate value mask.

- enum _tsc_interrupt_signal_mask {
  kTSC_IdleSoftwareSignalEnable = TSC_INT_SIG_EN_IDLE_SW_SIG_EN_MASK,
  kTSC_ValidSignalEnable = TSC_INT_SIG_EN_VALID_SIG_EN_MASK,
  kTSC_DetectSignalEnable,
  kTSC_MeasureSignalEnable = TSC_INT_SIG_EN_MEASURE_SIG_EN_MASK }
  @ Interrupt signal enable/disable mask.
- enum _tsc_interrupt_mask {
  kTSC_IdleSoftwareInterruptEnable,
  kTSC_DetectInterruptEnable,
  kTSC_MeasureInterruptEnable = TSC_INT_EN_MEASURE_INT_EN_MASK }
  @ Interrupt enable/disable mask.
- enum _tsc_interrupt_status_flag_mask {
  kTSC_IdleSoftwareFlag,
  kTSC_ValidSignalFlag,
  kTSC_DetectSignalFlag = TSC_INT_STATUS_DETECT_MASK,
  kTSC_MeasureSignalFlag }
  @ Interrupt Status flag mask.
- enum _tsc_adc_status_flag_mask {
  kTSC_ADCCOCOSignalFlag,
  kTSC_ADCConversionValueFlag = TSC_DEBUG_MODE_ADC_CONV_VALUE_MASK }
  @ ADC status flag mask.
- enum _tsc_status_flag_mask {
  kTSC_IntermediateStateFlag = TSC_DEBUG_MODE2_INTERMEDIATE_MASK,
  kTSC_DetectFiveWireFlag = TSC_DEBUG_MODE2_DETECT_FIVE_WIRE_MASK,
  kTSC_DetectFourWireFlag = TSC_DEBUG_MODE2_DETECT_FOUR_WIRE_MASK,
  kTSC_GlitchThresholdFlag = TSC_DEBUG_MODE2_DE_GLITCH_MASK,
  kTSC_StateMachineFlag }
  @ TSC status flag mask.
- enum tsc_state_machine_t {
  kTSC_IdleState = 0U << TSC_DEBUG_MODE2_STATE_MACHINE_SHIFT,
  kTSC_1stPreChargeState = 1U << TSC_DEBUG_MODE2_STATE_MACHINE_SHIFT,
  kTSC_1stDetectState = 2U << TSC_DEBUG_MODE2_STATE_MACHINE_SHIFT,
  kTSC_XMeasureState = 3U << TSC_DEBUG_MODE2_STATE_MACHINE_SHIFT,
  kTSC_YMeasureState = 4U << TSC_DEBUG_MODE2_STATE_MACHINE_SHIFT,
  kTSC_2ndPreChargeState = 5U << TSC_DEBUG_MODE2_STATE_MACHINE_SHIFT,
  kTSC_2ndDetectState = 6U << TSC_DEBUG_MODE2_STATE_MACHINE_SHIFT }
  TSC state machine.
- enum tsc_glitch_threshold_t {
  kTSC_glitchThresholdALT0 = 0U << TSC_DEBUG_MODE2_DE_GLITCH_SHIFT,
  kTSC_glitchThresholdALT1 = 1U << TSC_DEBUG_MODE2_DE_GLITCH_SHIFT,
  kTSC_glitchThresholdALT2 = 2U << TSC_DEBUG_MODE2_DE_GLITCH_SHIFT,
  kTSC_glitchThresholdALT3 }
  TSC glitch threshold.
- enum tsc_trigger_signal_t {

kTSC_TriggerToChannel0 = 1U << 0U,
kTSC_TriggerToChannel1 = 1U << 1U,
kTSC_TriggerToChannel2 = 1U << 2U,
kTSC_TriggerToChannel3 = 1U << 3U,
kTSC_TriggerToChannel4 = 1U << 4U }
@ Hardware trigger select signal, select which ADC channel to start conversion.

- enum tsc_port_source_t {
  kTSC_WiperPortSource = 0U,
  kTSC_YnlrPortSource = 1U,
  kTSC_YpllPortSource = 2U,
  kTSC_XnurPortSource = 3U,
  kTSC_XpulPortSource = 4U }
  @ TSC controller ports.
- enum tsc_port_mode_t {
  kTSC_PortOffMode = 0U,
  kTSC_Port200k_PullUpMode = 1U << 2U,
  kTSC_PortPullUpMode = 1U << 1U,
  kTSC_PortPullDownMode = 1U << 0U }
  @ TSC port mode.

Functions

- void TSC_Init (TSC_Type *base, const tsc_config_t *config)
  Initialize the TSC module.
- void TSC_Deinit (TSC_Type *base)
  De-initializes the TSC module.
- void TSC_GetDefaultConfig (tsc_config_t *config)
  Gets an available pre-defined settings for the controller's configuration.
- static void TSC_ReturnToIdleStatus (TSC_Type *base)
  Make the TSC module return to idle status after finish the current state operation.
- static void TSC_StartSenseDetection (TSC_Type *base)
  Start sense detection and (if work in auto-measure mode) measure after detect a touch.
- static void TSC_StartMeasure (TSC_Type *base)
  start measure X/Y coordinate value after detect a touch.
- static void TSC_DropMeasure (TSC_Type *base)
  Drop measure X/Y coordinate value after detect a touch and controller return to idle status.
- static void TSC_SoftwareReset (TSC_Type *base)
  This is a synchronization reset, which resets every register except IPS directly access ones.
- uint32_t TSC_GetMeasureValue (TSC_Type *base, tsc_corrdinate_value_selection_t selection)
  Get Y coordinate value or X coordinate value.
- static void TSC_EnableInterruptSignals (TSC_Type *base, uint32_t mask)
  Enable the interrupt signals.
- static void TSC_DisableInterruptSignals (TSC_Type *base, uint32_t mask)
  Disable the interrupt signals.
- static void TSC_EnableInterrupts (TSC_Type *base, uint32_t mask)
  Enable the interrupts.
- static void TSC_DisableInterrupts (TSC_Type *base, uint32_t mask)
  Disable the interrupts.
- static uint32_t TSC_GetInterruptStatusFlags (TSC_Type *base)

Get interrupt status flags.
- static void TSC_ClearInterruptStatusFlags (TSC_Type *base, uint32_t mask)
  Clear interrupt status flags.
- static uint32_t TSC_GetADCStatusFlags (TSC_Type *base)
  Get the status flags of ADC working with TSC.
- static uint32_t TSC_GetStatusFlags (TSC_Type *base)
  Get the status flags of TSC.

48.3 Data Structure Documentation

48.3.1 struct tsc_config_t

Data Fields

- bool enableAutoMeasure
  Enable the auto-measure.
- uint32_t measureDelayTime
  Set delay time(0U~0xFFFFFFU) to even potential distribution ready.It is a preparation for measure stage.
- uint32_t prechargeTime
  Set pre-charge time(1U~0xFFFFFFFFU) to make the upper layer of screen to charge to positive high.
- tsc_detection_mode_t detectionMode
  Select the detection mode.

Field Documentation

(1) bool tsc_config_t::enableAutoMeasure

It indicates after detect touch, whether automatic start measurement

(2) uint32_t tsc_config_t::measureDelayTime

If measure dalay time is too short, maybe it would have an undesired effect on measure value.

(3) uint32_t tsc_config_t::prechargeTime

It is a preparation for detection stage. Pre-charge time must is greater than 0U, otherwise TSC could not work normally. If pre-charge dalay time is too short, maybe it would have an undesired effect on generation of valid signal(kTSC_ValidSignalFlag).

(4) tsc_detection_mode_t tsc_config_t::detectionMode

See "tsc_detection_mode_t".

48.4 Macro Definition Documentation

48.4.1 #define FSL_TSC_DRIVER_VERSION (MAKE_VERSION(2, 0, 3))

Version 2.0.3.

48.5 Enumeration Type Documentation

48.5.1 enum tsc_detection_mode_t

Enumerator

kTSC_Detection4WireMode 4-Wire Detection Mode.
kTSC_Detection5WireMode 5-Wire Detection Mode.

48.5.2 enum tsc_corrdinate_value_selection_t

Enumerator

kTSC_XCoordinateValueSelection X coordinate value is selected.
kTSC_YCoordinateValueSelection Y coordinate value is selected.

48.5.3 enum _tsc_interrupt_signal_mask

Enumerator

kTSC_IdleSoftwareSignalEnable Enable the interrupt signal when the controller has return to idle status. The signal is only valid after using TSC_ReturnToIdleStatus API.
kTSC_ValidSignalEnable Enable the interrupt signal when controller receives a detect signal after measurement.
kTSC_DetectSignalEnable Enable the interrupt signal when controller receives a detect signal.
kTSC_MeasureSignalEnable Enable the interrupt signal after the touch detection which follows measurement.

48.5.4 enum _tsc_interrupt_mask

Enumerator

kTSC_IdleSoftwareInterruptEnable Enable the interrupt when the controller has return to idle status. The interrupt is only valid after using TSC_ReturnToIdleStatus API.
kTSC_DetectInterruptEnable Enable the interrupt when controller receive a detect signal.
kTSC_MeasureInterruptEnable Enable the interrupt after the touch detection which follows measurement.

48.5.5 enum _tsc_interrupt_status_flag_mask

Enumerator

kTSC_IdleSoftwareFlag This flag is set if the controller has return to idle status. The flag is only valid after using TSC_ReturnToIdleStatus API.

kTSC_ValidSignalFlag This flag is set if controller receives a detect signal after measurement.

kTSC_DetectSignalFlag This flag is set if controller receives a detect signal.

kTSC_MeasureSignalFlag This flag is set after the touch detection which follows measurement. Note: Valid signal falg will be cleared along with measure signal flag.

48.5.6 enum _tsc_adc_status_flag_mask

Enumerator

kTSC_ADCCOCOSignalFlag This signal is generated by ADC when a conversion is completed.

kTSC_ADCConversionValueFlag This signal is generated by ADC and indicates the result of an ADC conversion.

48.5.7 enum _tsc_status_flag_mask

Enumerator

kTSC_IntermediateStateFlag This flag is set if TSC is in intermediate state, between two state machine states.

kTSC_DetectFiveWireFlag This flag is set if TSC receives a 5-wire detect signal. It is only valid when the TSC in detect state and DETECT_ENABLE_FIVE_WIRE bit is set.

kTSC_DetectFourWireFlag This flag is set if TSC receives a 4-wire detect signal. It is only valid when the TSC in detect state and DETECT_ENABLE_FOUR_WIRE bit is set.

kTSC_GlitchThresholdFlag This field indicates glitch threshold.The threshold is defined by number of clock cycles. See "tsc_glitch_threshold_t". If value = 00, Normal function: 0x1fff ipg clock cycles, Low power mode: 0x9 low power clock cycles. If value = 01, Normal function: 0xfff ipg clock cycles, Low power mode: :0x7 low power clock cycles. If value = 10, Normal function: 0x7ff ipg clock cycles, Low power mode:0x5 low power clock cycles. If value = 11, Normal function: 0x3 ipg clock cycles, Low power mode:0x3 low power clock cycles.

kTSC_StateMachineFlag This field indicates the state of TSC. See "tsc_state_machine_t"; if value = 000, Controller is in idle state. if value = 001, Controller is in 1st-Pre-charge state. if value = 010, Controller is in 1st-detect state. if value = 011, Controller is in x-measure state. if value = 100, Controller is in y-measure state. if value = 101, Controller is in 2nd-Pre-charge state. if value = 110, Controller is in 2nd-detect state.

48.5.8 enum tsc_state_machine_t

These seven states are TSC complete workflow.

Enumerator

kTSC_IdleState Controller is in idle state.
kTSC_1stPreChargeState Controller is in 1st-Pre-charge state.
kTSC_1stDetectState Controller is in 1st-detect state.
kTSC_XMeasureState Controller is in x-measure state.
kTSC_YMeasureState Controller is in y-measure state.
kTSC_2ndPreChargeState Controller is in 2nd-Pre-charge state.
kTSC_2ndDetectState Controller is in 2nd-detect state.

48.5.9 enum tsc_glitch_threshold_t

Enumerator

kTSC_glitchThresholdALT0 Normal function: 0x1fff ipg clock cycles, Low power mode: 0x9 low power clock cycles.
kTSC_glitchThresholdALT1 Normal function: 0xfff ipg clock cycles, Low power mode: :0x7 low power clock cycles.
kTSC_glitchThresholdALT2 Normal function: 0x7ff ipg clock cycles, Low power mode: :0x5 low power clock cycles.
kTSC_glitchThresholdALT3 Normal function: 0x3 ipg clock cycles, Low power mode: :0x3 low power clock cycles.

48.5.10 enum tsc_trigger_signal_t

Enumerator

kTSC_TriggerToChannel0 Trigger to ADC channel0. ADC_HC0 register will be used to conversion.
kTSC_TriggerToChannel1 Trigger to ADC channel1. ADC_HC1 register will be used to conversion.
kTSC_TriggerToChannel2 Trigger to ADC channel2. ADC_HC2 register will be used to conversion.
kTSC_TriggerToChannel3 Trigger to ADC channel3. ADC_HC3 register will be used to conversion.
kTSC_TriggerToChannel4 Trigger to ADC channel4. ADC_HC4 register will be used to conversion.

48.5.11 enum tsc_port_source_t

Enumerator

kTSC_WiperPortSource TSC controller wiper port.
kTSC_YnlrPortSource TSC controller ynlr port.
kTSC_YpllPortSource TSC controller ypll port.
kTSC_XnurPortSource TSC controller xnur port.
kTSC_XpulPortSource TSC controller xpul port.

48.5.12 enum tsc_port_mode_t

Enumerator

kTSC_PortOffMode Disable pull up/down mode.
kTSC_Port200k_PullUpMode 200k-pull up mode.
kTSC_PortPullUpMode Pull up mode.
kTSC_PortPullDownMode Pull down mode.

48.6 Function Documentation

48.6.1 void TSC_Init (TSC_Type ∗ *base,* const tsc_config_t ∗ *config*)

Parameters

base	TSC peripheral base address.
config	Pointer to "tsc_config_t" structure.

48.6.2 void TSC_Deinit (TSC_Type ∗ *base*)

Parameters

base	TSC peripheral base address.

48.6.3 void TSC_GetDefaultConfig (tsc_config_t ∗ *config*)

This function initializes the converter configuration structure with available settings. The default values of measureDelayTime and prechargeTime is tested on LCD8000-43T screen and work normally. The default values are:

```
*    config->enableAutoMeausre = false;
*    config->measureDelayTime = 0xFFFFU;
*    config->prechargeTime = 0xFFFFU;
*    config->detectionMode = kTSC_4WireDetectionMode;
*
```

Parameters

config	Pointer to "tsc_config_t" structure.

48.6.4 static void TSC_ReturnToIdleStatus (TSC_Type * *base*) [inline], [static]

```
Application could check TSC status to confirm that the controller has return to idle status
```

Parameters

base	TSC peripheral base address.

48.6.5 static void TSC_StartSenseDetection (TSC_Type * *base*) [inline], [static]

Parameters

base	TSC peripheral base address.

48.6.6 static void TSC_StartMeasure (TSC_Type * *base*) [inline], [static]

Parameters

base	TSC peripheral base address.

48.6.7 static void TSC_DropMeasure (TSC_Type * *base*) [inline], [static]

Parameters

base	TSC peripheral base address.

48.6.8 static void TSC_SoftwareReset (TSC_Type * *base*) [inline], [static]

Parameters

base	TSC peripheral base address.

48.6.9 uint32_t TSC_GetMeasureValue (TSC_Type * *base*, tsc_corrdinate_value_selection_t *selection*)

The value is an ADC conversion value.

Parameters

base	TSC peripheral base address.
selection	Select alternative measure value which is Y coordinate value or X coordinate value. See "tsc_corrdinate_value_selection_t".

Returns

If selection is "kTSC_XCoordinateValueSelection", the API returns x-coordinate vlaue. If selection is "kTSC_YCoordinateValueSelection", the API returns y-coordinate vlaue.

48.6.10 static void TSC_EnableInterruptSignals (TSC_Type * *base*, uint32_t *mask*) [inline], [static]

Interrupt signal will be set when corresponding event happens. Specific events point to "_tsc_interrupt_signal_mask" . Specific interrupt signal point to "_tsc_interrupt_status_flag_mask";

Parameters

base	TSC peripheral base address.
mask	Interrupt signals mask. See "_tsc_interrupt_signal_mask".

48.6.11 static void TSC_DisableInterruptSignals (TSC_Type * *base,* uint32_t *mask*) [inline], [static]

Interrupt signal will be set when corresponding event happens. Specific events point to "_tsc_interrupt_-signal_mask". Specific interrupt signal point to "_tsc_interrupt_status_flag_mask";

Parameters

base	TSC peripheral base address.
mask	Interrupt signals mask. See "_tsc_interrupt_signal_mask".

48.6.12 static void TSC_EnableInterrupts (TSC_Type * *base,* uint32_t *mask*) [inline], [static]

Notice: Only interrupts and signals are all enabled, interrupts could work normally.

Parameters

base	TSC peripheral base address.
mask	Interrupts mask. See "_tsc_interrupt_mask".

48.6.13 static void TSC_DisableInterrupts (TSC_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	TSC peripheral base address.
mask	Interrupts mask. See "_tsc_interrupt_mask".

48.6.14 static uint32_t TSC_GetInterruptStatusFlags (TSC_Type * *base*) [inline], [static]

Interrupt status falgs are valid when corresponding interrupt signals are enabled.

Parameters

base	TSC peripheral base address.

Returns

Status flags asserted mask. See "_tsc_interrupt_status_flag_mask".

48.6.15 static void TSC_ClearInterruptStatusFlags (TSC_Type * *base,* uint32_t *mask*) [inline], [static]

Interrupt status falgs are valid when corresponding interrupt signals are enabled.

Parameters

base	TSC peripheral base address.
mask	Status flags mask. See "_tsc_interrupt_status_flag_mask".

48.6.16 static uint32_t TSC_GetADCStatusFlags (TSC_Type * *base*) [inline], [static]

Parameters

base	TSC peripheral base address.

Returns

Status flags asserted mask. See "_tsc_adc_status_flag_mask".

48.6.17 static uint32_t TSC_GetStatusFlags (TSC_Type * *base*) [inline], [static]

Parameters

base	TSC peripheral base address.

Returns

Status flags asserted mask. See "_tsc_status_flag_mask".

Chapter 49
USDHC: Ultra Secured Digital Host Controller Driver

49.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Ultra Secured Digital Host Controller (USDHC) module of MCUXpresso SDK/i.MX devices.

49.2 Typical use case

49.2.1 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 suppport 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_DMADataAddrNotAlign = 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_TransferDMAComplete = 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_MSBSEL_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_DLSL_SHIFT,
  kUSDHC_Data1LineLevelFlag = 1U << (USDHC_PRES_STATE_DLSL_SHIFT + 1U),
  kUSDHC_Data2LineLevelFlag = 1U << (USDHC_PRES_STATE_DLSL_SHIFT + 2U),
  kUSDHC_Data3LineLevelFlag = 1U << (USDHC_PRES_STATE_DLSL_SHIFT + 3U),
  kUSDHC_Data4LineLevelFlag = 1U << (USDHC_PRES_STATE_DLSL_SHIFT + 4U),
  kUSDHC_Data5LineLevelFlag = 1U << (USDHC_PRES_STATE_DLSL_SHIFT + 5U),
  kUSDHC_Data6LineLevelFlag = 1U << (USDHC_PRES_STATE_DLSL_SHIFT + 6U),
  kUSDHC_Data7LineLevelFlag = (int)(1U << (USDHC_PRES_STATE_DLSL_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 | kUS-DHC_ReTuningEventFlag),
  kUSDHC_AllInterruptFlags }

Enum _usdhc_interrupt_status_flag.

- enum {
  kUSDHC_AutoCommand12NotExecutedFlag = USDHC_AUTOCMD12_ERR_STATUS_AC12-NE_MASK,
  kUSDHC_AutoCommand12TimeoutFlag = USDHC_AUTOCMD12_ERR_STATUS_AC12TOE-_MASK,
  kUSDHC_AutoCommand12EndBitErrorFlag = USDHC_AUTOCMD12_ERR_STATUS_AC12-EBE_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_FEVTCTOE_MASK,
kUSDHC_ForceEventCommandCrcError = USDHC_FORCE_EVENT_FEVTCCE_MASK,
kUSDHC_ForceEventCommandEndBitError = USDHC_FORCE_EVENT_FEVTCEBE_MASK,
kUSDHC_ForceEventCommandIndexError = USDHC_FORCE_EVENT_FEVTCIE_MASK,
kUSDHC_ForceEventDataTimeout = USDHC_FORCE_EVENT_FEVTDTOE_MASK,
kUSDHC_ForceEventDataCrcError = USDHC_FORCE_EVENT_FEVTDCE_MASK,
kUSDHC_ForceEventDataEndBitError = USDHC_FORCE_EVENT_FEVTDEBE_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_M-
  ASK }

  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_Adma1DescriptorInterrupFlag = (1U << 2U),
kUSDHC_Adma1DescriptorActivity1Flag = (1U << 4U),
kUSDHC_Adma1DescriptorActivity2Flag = (1U << 5U),
kUSDHC_Adma1DescriptorTypeNop = (kUSDHC_Adma1DescriptorValidFlag),
kUSDHC_Adma1DescriptorTypeTransfer = (kUSDHC_Adma1DescriptorActivity2Flag | kUSDHC_Adma1DescriptorValidFlag),
kUSDHC_Adma1DescriptorTypeLink,
kUSDHC_Adma1DescriptorTypeSetLength = (kUSDHC_Adma1DescriptorActivity1Flag | kUSDHC_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 | kUSDHC_Adma2DescriptorValidFlag),
kUSDHC_Adma2DescriptorTypeTransfer = (kUSDHC_Adma2DescriptorActivity2Flag | kUSDHC_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_TransferDataBootcontinous = 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 UDSHC_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 enbale 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 mannual 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_EnableDDRMode (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.

49.3 Data Structure Documentation

49.3.1 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

49.3.2 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

49.3.3 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

49.3.4 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

49.3.5 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

49.3.6 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

49.3.7 struct usdhc_scatter_gather_data_list_t

Allow application register uncontinuous data buffer for data transfer.

49.3.8 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 enableAutoCommand23
  Enable auto CMD23.
- bool enableIgnoreError
  Enable to ignore error event to read/write all the data.
- usdhc_transfer_direction_t dataDirection
  data direction
- uint8_t dataType
  this is used to distinguish the normal/tuning/boot data.
- size_t blockSize
  Block size.
- usdhc_scatter_gather_data_list_t sgData
  scatter gather data

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

49.3.9 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

49.3.10 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

49.3.11 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

49.3.12 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)

49.3.13 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

49.3.14 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

49.4 Macro Definition Documentation

49.4.1 #define FSL_USDHC_DRIVER_VERSION (MAKE_VERSION(2U, 8U, 1U))

49.4.2 #define USDHC_ADMA1_ADDRESS_ALIGN (4096U)

49.4.3 #define USDHC_ADMA1_LENGTH_ALIGN (4096U)

49.4.4 #define USDHC_ADMA2_ADDRESS_ALIGN (4U)

49.4.5 #define USDHC_ADMA2_LENGTH_ALIGN (4U)

49.4.6 #define USDHC_ADMA1_DESCRIPTOR_ADDRESS_SHIFT (12U)

Address/page field	**Reserved**		6p(*8-*3)*6/8|lightgray**Attribute**			
31 12	11 6	05	04	03	02	0
address or data length	000000	Act2	Act1	0	Int	E

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

49.4.7 #define USDHC_ADMA1_DESCRIPTOR_ADDRESS_MASK (0xFFFFFU)

49.4.8 #define USDHC_ADMA1_DESCRIPTOR_LENGTH_SHIFT (12U)

49.4.9 #define USDHC_ADMA1_DESCRIPTOR_LENGTH_MASK (0xFFFFU)

49.4.10 #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.

49.4.11 #define USDHC_ADMA2_DESCRIPTOR_LENGTH_SHIFT (16U)

Address field	**Length**	**Reserved**		6p(*9-*4)*6/9|lightgray**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

49.4.12 #define USDHC_ADMA2_DESCRIPTOR_LENGTH_MASK (0xFFFFU)

49.4.13 #define USDHC_ADMA2_DESCRIPTOR_MAX_LENGTH_PER_ENTRY (USDHC_ADMA2_DESCRIPTOR_LENGTH_MASK - 3U)

49.5 Typedef Documentation

49.5.1 typedef uint32_t usdhc_adma1_descriptor_t

49.5.2 typedef status_t(∗ usdhc_transfer_function_t)(USDHC_Type ∗base, usdhc_transfer_t ∗content)

49.6 Enumeration Type Documentation

49.6.1 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_DMADataAddrNotAlign 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.

49.6.2 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.

49.6.3 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.

49.6.4 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.

49.6.5 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.

49.6.6 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.

49.6.7 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.

49.6.8 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.

49.6.9 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 sampleing clock.

49.6.10 anonymous enum

ADMA error status flag mask.

Enumerator

kUSDHC_AdmaLenghMismatchFlag Length mismatch error.
kUSDHC_AdmaDescriptorErrorFlag Descriptor error.

49.6.11 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.

49.6.12 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.

49.6.13 enum usdhc_transfer_direction_t

Enumerator

kUSDHC_TransferDirectionReceive USDHC transfer direction receive.
kUSDHC_TransferDirectionSend USDHC transfer direction send.

49.6.14 enum usdhc_data_bus_width_t

Enumerator

kUSDHC_DataBusWidth1Bit 1-bit mode
kUSDHC_DataBusWidth4Bit 4-bit mode
kUSDHC_DataBusWidth8Bit 8-bit mode

49.6.15 enum usdhc_endian_mode_t

Enumerator

kUSDHC_EndianModeBig Big endian mode.
kUSDHC_EndianModeHalfWordBig Half word big endian mode.
kUSDHC_EndianModeLittle Little endian mode.

49.6.16 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.

49.6.17 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.

49.6.18 enum usdhc_boot_mode_t

Enumerator

kUSDHC_BootModeNormal Normal boot.
kUSDHC_BootModeAlternative Alternative boot.

49.6.19 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.

49.6.20 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.

49.6.21 anonymous enum

The mask for the control/status field in ADMA1 descriptor.

Enumerator

kUSDHC_Adma1DescriptorValidFlag Valid flag.
kUSDHC_Adma1DescriptorEndFlag End flag.
kUSDHC_Adma1DescriptorInterrupFlag 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.

49.6.22 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.

49.6.23 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.

49.6.24 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.

49.6.25 anonymous enum

Tansfer data type definition.

Enumerator

kUSDHC_TransferDataNormal Transfer normal read/write data.
kUSDHC_TransferDataTuning Transfer tuning data.
kUSDHC_TransferDataBoot Transfer boot data.
kUSDHC_TransferDataBootcontinous Transfer boot data continuously.

49.7 Function Documentation

49.7.1 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

base	USDHC peripheral base address.
config	USDHC configuration information.

Return values

kStatus_Success	Operate successfully.

49.7.2 void USDHC_Deinit (USDHC_Type * *base*)

Parameters

base	USDHC peripheral base address.

49.7.3 bool USDHC_Reset (USDHC_Type * *base*, uint32_t *mask*, uint32_t *timeout*)

Parameters

base	USDHC peripheral base address.
mask	The reset type mask(_usdhc_reset).
timeout	Timeout for reset.

Return values

true	Reset successfully.
false	Reset failed.

49.7.4 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

base	USDHC peripheral base address.
dmaConfig	ADMA configuration
dataConfig	Data descriptor
flags	ADAM descriptor flag, used to indicate to create multiple or single descriptor, please refer to enum _usdhc_adma_flag.

Return values

kStatus_OutOfRange	ADMA descriptor table length isn't enough to describe data.
kStatus_Success	Operate successfully.

49.7.5 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

base	USDHC peripheral base address.
dmaConfig	ADMA configuration.
dataAddr	Transfer data address, a simple DMA parameter, if ADMA is used, leave it to NULL.
enAutoCmd23	Flag to indicate Auto CMD23 is enable or not, a simple DMA parameter, if ADMA is used, leave it to false.

Return values

kStatus_OutOfRange	ADMA descriptor table length isn't enough to describe data.
kStatus_Success	Operate successfully.

49.7.6 status_t USDHC_SetADMA2Descriptor (uint32_t * *admaTable*, uint32_t *admaTableWords*, const uint32_t * *dataBufferAddr*, uint32_t *dataBytes*, uint32_t *flags*)

Parameters

admaTable	ADMA table address.
admaTable-Words	ADMA table length.
dataBufferAddr	Data buffer address.
dataBytes	Data Data length.
flags	ADAM descriptor flag, used to indicate to create multiple or single descriptor, please refer to enum _usdhc_adma_flag.

Return values

kStatus_OutOfRange	ADMA descriptor table length isn't enough to describe data.
kStatus_Success	Operate successfully.

49.7.7 status_t USDHC_SetADMA1Descriptor (uint32_t * *admaTable,* uint32_t *admaTableWords,* const uint32_t * *dataBufferAddr,* uint32_t *dataBytes,* uint32_t *flags*)

Parameters

admaTable	ADMA table address.
admaTable-Words	ADMA table length.
dataBufferAddr	Data buffer address.
dataBytes	Data length.
flags	ADAM descriptor flag, used to indicate to create multiple or single descriptor, please refer to enum _usdhc_adma_flag.

Return values

kStatus_OutOfRange	ADMA descriptor table length isn't enough to describe data.
kStatus_Success	Operate successfully.

49.7.8 static void USDHC_EnableInternalDMA (USDHC_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	USDHC peripheral base address.
enable	enable or disable flag

49.7.9 static void USDHC_EnableInterruptStatus (USDHC_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	USDHC peripheral base address.
mask	Interrupt status flags mask(_usdhc_interrupt_status_flag).

49.7.10 static void USDHC_DisableInterruptStatus (USDHC_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	USDHC peripheral base address.
mask	The interrupt status flags mask(_usdhc_interrupt_status_flag).

49.7.11 static void USDHC_EnableInterruptSignal (USDHC_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	USDHC peripheral base address.
mask	The interrupt status flags mask(_usdhc_interrupt_status_flag).

49.7.12 static void USDHC_DisableInterruptSignal (USDHC_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	USDHC peripheral base address.
mask	The interrupt status flags mask(_usdhc_interrupt_status_flag).

49.7.13 static uint32_t USDHC_GetEnabledInterruptStatusFlags (USDHC_Type * *base*) [inline], [static]

Parameters

base	USDHC peripheral base address.

Returns

Current interrupt status flags mask(_usdhc_interrupt_status_flag).

49.7.14 static uint32_t USDHC_GetInterruptStatusFlags (USDHC_Type * *base*) [inline], [static]

Parameters

base	USDHC peripheral base address.

Returns

Current interrupt status flags mask(_usdhc_interrupt_status_flag).

49.7.15 static void USDHC_ClearInterruptStatusFlags (USDHC_Type * *base*, uint32_t *mask*) [inline], [static]

write 1 clears

Parameters

base	USDHC peripheral base address.
mask	The interrupt status flags mask(_usdhc_interrupt_status_flag).

49.7.16 static uint32_t USDHC_GetAutoCommand12ErrorStatusFlags (USDHC_Type * *base*) [inline], [static]

Parameters

base	USDHC peripheral base address.

Returns

Auto command 12 error status flags mask(_usdhc_auto_command12_error_status_flag).

49.7.17 static uint32_t USDHC_GetAdmaErrorStatusFlags (USDHC_Type * *base*) [inline], [static]

Parameters

base	USDHC peripheral base address.

Returns

ADMA error status flags mask(_usdhc_adma_error_status_flag).

49.7.18 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

base	USDHC peripheral base address.

Returns

Present USDHC's status flags mask(_usdhc_present_status_flag).

49.7.19 void USDHC_GetCapability (USDHC_Type * *base,* usdhc_capability_t * *capability*)

Parameters

base	USDHC peripheral base address.
capability	Structure to save capability information.

49.7.20 static void USDHC_ForceClockOn (USDHC_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	USDHC peripheral base address.
enable	enable/disable flag

49.7.21 uint32_t USDHC_SetSdClock (USDHC_Type * *base*, uint32_t *srcClock_Hz*, uint32_t *busClock_Hz*)

Parameters

base	USDHC peripheral base address.
srcClock_Hz	USDHC source clock frequency united in Hz.
busClock_Hz	SD bus clock frequency united in Hz.

Returns

The nearest frequency of busClock_Hz configured for SD bus.

49.7.22 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

base	USDHC peripheral base address.
timeout	Timeout to initialize card.

Return values

true	Set card active successfully.
false	Set card active failed.

49.7.23 static void USDHC_AssertHardwareReset (USDHC_Type * *base,* bool *high*) [inline], [static]

Parameters

base	USDHC peripheral base address.
high	1 or 0 level

49.7.24 static void USDHC_SetDataBusWidth (USDHC_Type * *base,* usdhc_data_bus_width_t *width*) [inline], [static]

Parameters

base	USDHC peripheral base address.
width	Data transfer width.

49.7.25 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

base	USDHC peripheral base address.
data	The data about to be sent.

49.7.26 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

base	USDHC peripheral base address.

Returns

The data has been read.

49.7.27 void USDHC_SendCommand (USDHC_Type * *base*, usdhc_command_t * *command*)

Parameters

base	USDHC peripheral base address.
command	configuration

49.7.28 static void USDHC_EnableWakeupEvent (USDHC_Type * *base*, uint32_t *mask*, bool *enable*) [inline], [static]

Parameters

base	USDHC peripheral base address.
mask	Wakeup events mask(_usdhc_wakeup_event).
enable	True to enable, false to disable.

49.7.29 static void USDHC_CardDetectByData3 (USDHC_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	USDHC peripheral base address.
enable	enable/disable flag

49.7.30 static bool USDHC_DetectCardInsert (USDHC_Type * *base*) [inline], [static]

Parameters

base	USDHC peripheral base address.

49.7.31 static void USDHC_EnableSdioControl (USDHC_Type * *base*, uint32_t *mask*, bool *enable*) [inline], [static]

Parameters

base	USDHC peripheral base address.
mask	SDIO card control flags mask(_usdhc_sdio_control_flag).
enable	True to enable, false to disable.

49.7.32 static void USDHC_SetContinueRequest (USDHC_Type * *base*) [inline], [static]

Parameters

base	USDHC peripheral base address.

49.7.33 static void USDHC_RequestStopAtBlockGap (USDHC_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	USDHC peripheral base address.
enable	True to stop at block gap, false to normal transfer.

49.7.34 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

base	USDHC peripheral base address.
config	The MMC boot configuration information.

49.7.35 static void USDHC_EnableMmcBoot (USDHC_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	USDHC peripheral base address.
enable	True to enable, false to disable.

49.7.36 static void USDHC_SetForceEvent (USDHC_Type * *base,* uint32_t *mask*) [inline], [static]

Parameters

base	USDHC peripheral base address.
mask	The force events bit posistion (_usdhc_force_event).

49.7.37 static void UDSHC_SelectVoltage (USDHC_Type * *base,* bool *en18v*) [inline], [static]

Parameters

base	USDHC peripheral base address.
en18v	True means 1.8V, false means 3.0V.

49.7.38 static bool USDHC_RequestTuningForSDR50 (USDHC_Type * *base*) [inline], [static]

When this bit set, application shall perform tuning for SDR50 mode.

Parameters

base	USDHC peripheral base address.

49.7.39 static bool USDHC_RequestReTuning (USDHC_Type * *base*) [inline], [static]

When this bit is set, user should do manual tuning or standard tuning function.

Parameters

base	USDHC peripheral base address.

49.7.40 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

base	USDHC peripheral base address.
enable	enable/disable flag

49.7.41 void USDHC_EnableAutoTuningForCmdAndData (USDHC_Type * *base*)

Parameters

base	USDHC peripheral base address.

49.7.42 void USDHC_EnableManualTuning (USDHC_Type * *base*, bool *enable*)

User should handle the tuning cmd and find the boundary of the delay then calucate a average value which will be configured to the **CLK_TUNE_CTRL_STATUS** This function should be called before function USDHC_AdjustDelayForManualTuning.

Parameters

base	USDHC peripheral base address.
enable	tuning enable flag

49.7.43 static uint32_t USDHC_GetTuningDelayStatus (USDHC_Type * *base*) [inline], [static]

Parameters

base	USDHC peripheral base address.

Return values

CLK	Tuning Control and Status register value.

49.7.44 status_t USDHC_SetTuningDelay (USDHC_Type * *base*, uint32_t *preDelay*, uint32_t *outDelay*, uint32_t *postDelay*)

Parameters

base	USDHC peripheral base address.
preDelay	Set the number of delay cells on the feedback clock between the feedback clock and CLK_PRE.
outDelay	Set the number of delay cells on the feedback clock between CLK_PRE and CLK_-OUT.
postDelay	Set the number of delay cells on the feedback clock between CLK_OUT and CLK_-POST.

Return values

kStatus_Fail	config the delay setting fail
kStatus_Success	config the delay setting success

49.7.45 status_t USDHC_AdjustDelayForManualTuning (USDHC_Type * *base*, uint32_t *delay*)

Deprecated Do not use this function. It has been superceded by USDHC_SetTuingDelay

Parameters

base	USDHC peripheral base address.
delay	setting configuration

Return values

kStatus_Fail	config the delay setting fail
kStatus_Success	config the delay setting success

49.7.46 static void USDHC_SetStandardTuningCounter (USDHC_Type * *base*, uint8_t *counter*) [inline], [static]

Parameters

base	USDHC peripheral base address.
counter	tuning counter

Return values

kStatus_Fail	config the delay setting fail
kStatus_Success	config the delay setting success

49.7.47 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

base	USDHC peripheral base address.
tuningStartTap	start tap
step	tuning step

enable	enable/disable flag

49.7.48 static uint32_t USDHC_GetExecuteStdTuningStatus (USDHC_Type * *base*) [inline], [static]

Parameters

base	USDHC peripheral base address.

49.7.49 static uint32_t USDHC_CheckStdTuningResult (USDHC_Type * *base*) [inline], [static]

Parameters

base	USDHC peripheral base address.

49.7.50 static uint32_t USDHC_CheckTuningError (USDHC_Type * *base*) [inline], [static]

Parameters

base	USDHC peripheral base address.

49.7.51 void USDHC_EnableDDRMode (USDHC_Type * *base,* bool *enable,* uint32_t *nibblePos*)

Parameters

base	USDHC peripheral base address.
enable	enable/disable flag
nibblePos	nibble position

49.7.52 void USDHC_SetDataConfig (USDHC_Type * *base,* usdhc_transfer-_direction_t *dataDirection,* uint32_t *blockCount,* uint32_t *blockSize*)

Parameters

base	USDHC peripheral base address.
dataDirection	Data direction, tx or rx.
blockCount	Data block count.
blockSize	Data block size.

49.7.53 void USDHC_TransferCreateHandle (USDHC_Type * *base*, usdhc_handle_t * *handle*, const usdhc_transfer_callback_t * *callback*, void * *userData*)

Parameters

base	USDHC peripheral base address.
handle	USDHC handle pointer.
callback	Structure pointer to contain all callback functions.
userData	Callback function parameter.

49.7.54 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

base	USDHC peripheral base address.

handle	USDHC handle.
dmaConfig	ADMA configuration.
transfer	Transfer content.

Return values

kStatus_InvalidArgument	Argument is invalid.
kStatus_USDHC_BusyTransferring	Busy transferring.
kStatus_USDHC_PrepareAdmaDescriptorFailed	Prepare ADMA descriptor failed.
kStatus_Success	Operate successfully.

49.7.55 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

base	USDHC peripheral base address.
dmaConfig	adma configuration
transfer	Transfer content.

Return values

kStatus_InvalidArgument	Argument is invalid.

kStatus_USDHC_PrepareAdmaDescriptorFailed	Prepare ADMA descriptor failed.
kStatus_USDHC_SendCommandFailed	Send command failed.
kStatus_USDHC_TransferDataFailed	Transfer data failed.
kStatus_Success	Operate successfully.

49.7.56 void USDHC_TransferHandleIRQ (USDHC_Type * *base*, usdhc_handle_t * *handle*)

This function deals with the IRQs on the given host controller.

Parameters

base	USDHC peripheral base address.
handle	USDHC handle.

Chapter 50
WDOG: Watchdog Timer Driver

50.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Watchdog module (WDOG) of MCUXpresso SDK devices.

50.2 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_SetInterrputTimeoutValue (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.

50.3 Data Structure Documentation

50.3.1 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

50.3.2 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

50.4 Enumeration Type Documentation

50.4.1 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.

50.4.2 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

50.5 Function Documentation

50.5.1 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 = flase;
*   wdogConfig->timeoutValue = 0xFFU;
*   wdogConfig->interruptTimeValue = 0x04u;
*
```

Parameters

config	Pointer to the WDOG configuration structure.

See Also

wdog_config_t

50.5.2 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

base	WDOG peripheral base address
config	The configuration of WDOG

50.5.3 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).

50.5.4 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

base	WDOG peripheral base address

50.5.5 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

base	WDOG peripheral base address

50.5.6 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

base	WDOG peripheral base address

50.5.7 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

base	WDOG peripheral base address

50.5.8 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

base	WDOG peripheral base address
mask	The interrupts to enable The parameter can be combination of the following source if defined. • kWDOG_InterruptEnable

50.5.9 uint16_t WDOG_GetStatusFlags (WDOG_Type * *base*)

This function gets all reset status flags.

```
* uint16_t status;
* status = WDOG_GetStatusFlags (wdog_base);
*
```

Parameters

base	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.

50.5.10 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

base	WDOG peripheral base address
mask	The status flags to clear. The parameter could be any combination of the following values. kWDOG_TimeoutFlag

50.5.11 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

base	WDOG peripheral base address
timeoutCount	WDOG timeout value; count of WDOG clock tick.

50.5.12 static void WDOG_SetInterrputTimeoutValue (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 wirte-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

base	WDOG peripheral base address
timeoutCount	WDOG timeout value; count of WDOG clock tick.

50.5.13 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 wirte-once. This field is write once only. Once software sets this bit it cannot be reset until the next system reset.

Parameters

base	WDOG peripheral base address

50.5.14 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

base	WDOG peripheral base address

Chapter 51
XBARA: Inter-Peripheral Crossbar Switch

51.1 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.

51.2 Function

51.2.1 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.

51.2.2 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.

51.3 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_RequestInterruptEnalbe = 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.

51.4 Data Structure Documentation

51.4.1 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

51.5 Enumeration Type Documentation

51.5.1 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.

51.5.2 enum xbara_request_t

Enumerator

kXBARA_RequestDisable Interrupt and DMA are disabled.
kXBARA_RequestDMAEnable DMA enabled, interrupt disabled.
kXBARA_RequestInterruptEnalbe Interrupt enabled, DMA disabled.

51.5.3 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.

51.6 Function Documentation

51.6.1 void XBARA_Init (XBARA_Type * *base*)

This function un-gates the XBARA clock.

Parameters

base	XBARA peripheral address.

51.6.2 void XBARA_Deinit (XBARA_Type * *base*)

This function disables XBARA clock.

Parameters

base	XBARA peripheral address.

51.6.3 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

base	XBARA peripheral address.
input	XBARA input signal.
output	XBARA output signal.

51.6.4 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

base	XBARA peripheral address.

Returns

the mask of these status flag bits.

51.6.5 void XBARA_ClearStatusFlags (XBARA_Type * *base,* uint32_t *mask*)

Parameters

base	XBARA peripheral address.
mask	the status flags to clear.

51.6.6 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

base	XBARA peripheral address.
output	XBARA output number.
controlConfig	Pointer to structure that keeps configuration of control register.

Chapter 52
XBARB: Inter-Peripheral Crossbar Switch

52.1 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.

52.2 Function groups

52.2.1 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.

52.2.2 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.

52.3 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, xbar_input_signal_t input, xbar_-output_signal_t output)
  Configures a connection between the selected XBARB_IN[∗] input and the XBARB_OUT[∗] output signal.

52.4 Function Documentation

52.4.1 void XBARB_Init (XBARB_Type * *base*)

This function un-gates the XBARB clock.

Parameters

base	XBARB peripheral address.

52.4.2 void XBARB_Deinit (XBARB_Type * *base*)

This function disables XBARB clock.

Parameters

base	XBARB peripheral address.

52.4.3 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

base	XBARB peripheral address.
input	XBARB input signal.
output	XBARB output signal.

Chapter 53
Debug Console

53.1 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 laylout of debug console.

Debug console overview

53.2 Function groups

53.2.1 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);
```

53.2.2 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.

.precision	Description
.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.

length	Description
Do not support	

specifier	Description
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 */
```

53.2.3 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 fucntion 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 MCUXpresso, 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 perihpheral "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.

SDK_DEBUGCONSOLE	SDK_DEBUGCONSOLE_UART	PRINTF	printf
DEBUGCONSOLE_REDIRECT_TO_SDK	defined	Low level peripheral∗	Low level peripheral
DEBUGCONSOLE_REDIRECT_TO_SDK	undefined	Low level peripheral∗	semihost
DEBUGCONSOLE_REDIRECT_TO_TOOLCHAIN	defined	Low level peripheral∗	Low level peripheral
DEBUGCONSOLE_REDIRECT_TO_TOOLCHAIN	undefined	semihost	semihost
DEBUGCONSOLE_DISABLE	defined	No ouput	Low level peripheral
DEBUGCONSOLE_DISABLE	undefined	No ouput	semihost

∗ the **low level peripheral** could be USB CDC, UART, or SWO, and so on.

53.3 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 equivalents 255", 255);
```

Statement prints the decimal floating point and unsigned decimal.

```
PRINTF("Execution timer: %s\n\rTime: %u ticks %2.5f milliseconds\n\rDONE\n\r", "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.

53.4 Macro Definition Documentation

53.4.1 #define DEBUGCONSOLE_REDIRECT_TO_TOOLCHAIN 0U

Select toolchain printf and scanf.

53.4.2 #define DEBUGCONSOLE_REDIRECT_TO_SDK 1U

53.4.3 #define DEBUGCONSOLE_DISABLE 2U

53.4.4 #define SDK_DEBUGCONSOLE DEBUGCONSOLE_REDIRECT_TO_SDK

The macro only support to be redefined in project setting.

53.4.5 #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.

53.5 Function Documentation

53.5.1 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

instance	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 periheral is LPUART1. If the uart_adapter.c is added to the current project, the UART periheral is UART1.
baudRate	The desired baud rate in bits per second.
device	Low level device type for the debug console, can be one of the following. • kSerialPort_Uart, • kSerialPort_UsbCdc
clkSrcFreq	Frequency of peripheral source clock.

Returns

Indicates whether initialization was successful or not.

Return values

kStatus_Success	Execution successfully

53.5.2 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.

53.5.3 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.

53.5.4 status_t DbgConsole_ExitLowpower (void)

This function is used to restore from low power consumption.

Returns

Indicates whether de-initialization was successful or not.

53.5.5 int DbgConsole_Printf (const char * *fmt_s,* ...)

Call this function to write a formatted output to the standard output stream.

Parameters

fmt_s	Format control string.

Returns

Returns the number of characters printed or a negative value if an error occurs.

53.5.6 int DbgConsole_Vprintf (const char * *fmt_s,* va_list *formatStringArg*)

Call this function to write a formatted output to the standard output stream.

Parameters

fmt_s	Format control string.
formatString-Arg	Format arguments.

Returns

Returns the number of characters printed or a negative value if an error occurs.

53.5.7 int DbgConsole_Putchar (int *ch*)

Call this function to write a character to stdout.

Parameters

ch	Character to be written.

Returns

Returns the character written.

53.5.8 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

fmt_s	Format control string.

Returns

Returns the number of fields successfully converted and assigned.

53.5.9 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.

53.5.10 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

fmt_s	Format control string.

Returns

Returns the number of characters printed or a negative value if an error occurs.

53.5.11 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

fmt_s	Format control string.
formatString-Arg	Format arguments.

Returns

Returns the number of characters printed or a negative value if an error occurs.

53.5.12 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.

53.5.13 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	*fmt*	Format string for printf.
in	*ap*	Arguments to printf.
in	*buf*	pointer to the buffer
	cb	print callbck function pointer

Returns

Number of characters to be print

53.5.14 int StrFormatScanf (const char ∗ *line_ptr,* char ∗ *format,* va_list *args_ptr*)

Parameters

in	*line_ptr*	The input line of ASCII data.
in	*format*	Format first points to the format string.
in	*args_ptr*	The list of parameters.

Returns

Number of input items converted and assigned.

Return values

IO_EOF	When line_ptr is empty string "".

53.6 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.

53.6.1 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.

53.6.2 Guide Semihosting for Keil µVision

NOTE: Semihosting is not support by MDK-ARM, use the retargeting functionality of MDK-ARM instead.

53.6.3 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.

53.6.4 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.

53.7 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.

53.7.1 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

53.7.1.1 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.

53.7.2 Guide SWO for Keil µVision

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 OK, 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.

53.7.3 Guide SWO for MCUXpresso IDE

NOTE: MCUX support SWO for LPC-Link2 debug probe only.

53.7.4 Guide SWO for ARMGCC

NOTE: ARMGCC has no library support SWO.

Chapter 54
Notification Framework

54.1 Overview

This section describes the programming interface of the Notifier driver.

54.2 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.

54.3 Data Structure Documentation

54.3.1 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

54.3.2 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

54.3.3 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

54.4 Typedef Documentation

54.4.1 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.

54.4.2 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

targetConfig	target Configuration.
userData	Refers to other specific data passed to user function.

Returns

An error code or kStatus_Success.

54.4.3 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

notify	Notification block.
data	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.

54.5 Enumeration Type Documentation

54.5.1 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.

54.5.2 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.

54.5.3 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.

54.5.4 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.

54.6 Function Documentation

54.6.1 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

notifierHandle	A pointer to the notifier handle.
configs	A pointer to an array with references to all configurations which is handled by the Notifier.
configsNumber	Number of configurations. Size of the configuration array.
callbacks	A pointer to an array of callback configurations. If there are no callbacks to register during Notifier initialization, use NULL value.
callbacks-Number	Number of registered callbacks. Size of the callbacks array.
userFunction	User function.
userData	User data passed to user function.

Returns

An error Code or kStatus_Success.

54.6.2 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_Get-ErrorCallback() 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

notifierHandle	pointer to notifier handle
configIndex	Index of the target configuration.
policy	Transaction policy, kNOTIFIER_PolicyAgreement or kNOTIFIER_PolicyForcible.

Returns

An error code or kStatus_Success.

54.6.3 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

notifierHandle	Pointer to the notifier handle

Returns

Callback Index of the last failed callback or value equal to callbacks count.

Chapter 55
Shell

55.1 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.

55.2 Function groups

55.2.1 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>");
```

55.2.2 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.

55.2.3 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.

55.3 Data Structure Documentation

55.3.1 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

55.4 Macro Definition Documentation

55.4.1 #define SHELL_NON_BLOCKING_MODE SERIAL_MANAGER_NON_BLOCKING_MODE

55.4.2 #define SHELL_AUTO_COMPLETE (1U)

55.4.3 #define SHELL_BUFFER_SIZE (64U)

55.4.4 #define SHELL_MAX_ARGS (8U)

55.4.5 #define SHELL_HISTORY_COUNT (3U)

55.4.6 #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

55.4.7 #define SHELL_USE_COMMON_TASK (0U)

55.4.8 #define SHELL_TASK_PRIORITY (2U)

55.4.9 #define SHELL_TASK_STACK_SIZE (1000U)

55.4.10 #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

name	The name string of the shell handle.

55.4.11 #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

command	The command string of the command. The double quotes do not need. Such as exit for "exit", help for "Help", read for "read".

descriptor	The description of the command is used for showing the command usage when "help" is typing.
callback	The callback of the command is used to handle the command line when the input command is matched.
paramCount	The max parameter count of the current command.

55.4.12 #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

command	The command string of the command. The double quotes do not need. Such as exit for "exit", help for "Help", read for "read".

55.5 Typedef Documentation

55.5.1 typedef shell_status_t(∗ cmd_function_t)(shell_handle_t shellHandle, int32_t argc, char ∗∗argv)

55.6 Enumeration Type Documentation

55.6.1 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.

55.7 Function Documentation

55.7.1 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

shellHandle	Pointer to point to a memory space of size SHELL_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: SHELL_HANDLE_DEFINE(shellHandle); or uint32_t shellHandle[((SHELL_HANDLE_SIZE + sizeof(uint32_t) - 1U) / sizeof(uint32_t))];
serialHandle	The serial manager module handle pointer.
prompt	The string prompt pointer of Shell. Only the global variable can be passed.

Return values

kStatus_SHELL_Success	The shell initialization succeed.
kStatus_SHELL_Error	An error occurred when the shell is initialized.
kStatus_SHELL_OpenWriteHandleFailed	Open the write handle failed.
kStatus_SHELL_OpenReadHandleFailed	Open the read handle failed.

55.7.2 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

shellHandle	The shell module handle pointer.
shellCommand	The command element.

Return values

kStatus_SHELL_Success	Successfully register the command.
kStatus_SHELL_Error	An error occurred.

55.7.3 shell_status_t SHELL_UnregisterCommand (shell_command_t * *shellCommand*)

This function is used to unregister the shell command.

Parameters

shellCommand	The command element.

Return values

kStatus_SHELL_Success	Successfully unregister the command.

55.7.4 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

shellHandle	The shell module handle pointer.
buffer	Start address of the data to write.
length	Length of the data to write.

Return values

kStatus_SHELL_Success	Successfully send data.
kStatus_SHELL_Error	An error occurred.

55.7.5 int SHELL_Printf (shell_handle_t *shellHandle,* const char * *formatString,* ...)

Call this function to write a formatted output to the shell output stream.

Parameters

shellHandle	The shell module handle pointer.
formatString	Format string.

Returns

Returns the number of characters printed or a negative value if an error occurs.

55.7.6 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

shellHandle	The shell module handle pointer.
buffer	Start address of the data to write.
length	Length of the data to write.

Return values

kStatus_SHELL_Success	Successfully send data.
kStatus_SHELL_Error	An error occurred.

55.7.7 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

shellHandle	The shell module handle pointer.

formatString	Format string.

Returns

Returns the number of characters printed or a negative value if an error occurs.

55.7.8 void SHELL_ChangePrompt (shell_handle_t *shellHandle,* char ∗ *prompt*)

Call this function to change shell prompt.

Parameters

shellHandle	The shell module handle pointer.
prompt	The string which will be used for command prompt

Returns

NULL.

55.7.9 void SHELL_PrintPrompt (shell_handle_t *shellHandle*)

Call this function to print shell prompt.

Parameters

shellHandle	The shell module handle pointer.

Returns

NULL.

55.7.10 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

shellHandle	The shell module handle pointer.

55.7.11 static bool SHELL_checkRunningInIsr (void) [inline], [static]

This function is used to check if code running in ISR.

Return values

TRUE	if code runing in ISR.

Chapter 56

Cards: Secure Digital Card/Embedded MultiMedia Card/SD-IO Card

56.1 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:

```
---------------------------
|       Application       |
---------------------------
            |
            v
---------------------------
|       Card driver       |
---------------------------
            |
            v
------------- -------------
|host driver| |OSA adapter|
------------- -------------
            |
            v
----------------------------
|  host controller driver  |
----------------------------
            |
            v
----------------------------
|host controller peripheral|
----------------------------
            |
            v
----------------------------
|          card            |
----------------------------
```

Modules

- MMC Card Driver
- SD Card Driver
- SDIO Card Driver
- SDMMC Common
- SDMMC HOST Driver
- SDMMC OSA

56.2 SDIO Card Driver

56.2.1 Overview

The SDIO card driver provide card initialization/IO direct and extend command interface.

56.2.2 SDIO CARD Operation

error log support

Not supported yet.

User configuable

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.

56.2.3 Data Structure Documentation

56.2.3.1 struct _sdio_card

sdio card descriptor

Define the card structure including the necessary fields to identify and describe the card.

Data Fields

- sdmmchost_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 cccrVersioin
  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 avalible 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
- sdmmc_osa_mutex_t lock
  card access lock

Field Documentation

(1) bool sdio_card_t::noInternalAlign

If disable, sdmmc will not make sure the data buffer address is word align, otherwise all the transfer are align to low level driver

56.2.4 Macro Definition Documentation

56.2.4.1 #define FSL_SDIO_DRIVER_VERSION (MAKE_VERSION(2U, 4U, 0U)) /∗2.4.0∗/

56.2.5 Enumeration Type Documentation

56.2.5.1 enum sdio_io_direction_t

Enumerator

kSDIO_IORead io read
kSDIO_IOWrite io write

56.2.6 Function Documentation

56.2.6.1 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

card	Card descriptor.

Return values

kStatus_SDMMC_GoIdleFailed	
kStatus_SDMMC_HandShakeOperationConditionFailed	
kStatus_SDMMC_SDIO_InvalidCard	
kStatus_SDMMC_SDIO_InvalidVoltage	
kStatus_SDMMC_SendRelativeAddressFailed	
kStatus_SDMMC_SelectCardFailed	
kStatus_SDMMC_SDIO_SwitchHighSpeedFail	
kStatus_SDMMC_SDIO_ReadCISFail	
kStatus_SDMMC_TransferFailed	
kStatus_Success	

56.2.6.2 void SDIO_Deinit (sdio_card_t * *card*)

Please note it is a thread safe function.

Parameters

card	Card descriptor.

56.2.6.3 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

card	Card descriptor.

Return values

kStatus_SDMMC_HostNotReady	host is not ready.
kStatus_SDMMC_GoIdleFailed	Go idle failed.
kStatus_SDMMC_NotSupportYet	Card not support.
kStatus_SDMMC_SendOperationConditionFailed	Send operation condition failed.
kStatus_SDMMC_AllSendCidFailed	Send CID failed.
kStatus_SDMMC_SendRelativeAddressFailed	Send relative address failed.
kStatus_SDMMC_SendCsdFailed	Send CSD failed.
kStatus_SDMMC_SelectCardFailed	Send SELECT_CARD command failed.
kStatus_SDMMC_SendScrFailed	Send SCR failed.
kStatus_SDMMC_SetBusWidthFailed	Set bus width failed.
kStatus_SDMMC_SwitchHighSpeedFailed	Switch high speed failed.

kStatus_SDMMC_SetCardBlockSizeFailed	Set card block size failed.
kStatus_Success	Operate successfully.

56.2.6.4 void SDIO_CardDeinit (sdio_card_t * *card*)

This function deinitializes the specific card.

Please note it is a thread safe function.

Parameters

card	Card descriptor.

56.2.6.5 status_t SDIO_HostInit (sdio_card_t * *card*)

This function deinitializes the specific host.

Parameters

card	Card descriptor.

56.2.6.6 void SDIO_HostDeinit (sdio_card_t * *card*)

This function deinitializes the host.

Parameters

card	Card descriptor.

56.2.6.7 void SDIO_HostDoReset (sdio_card_t * *card*)

This function reset the specific host.

Parameters

card	Card descriptor.

56.2.6.8 void SDIO_SetCardPower (sdio_card_t * *card,* bool *enable*)

The power off operation depend on host or the user define power on function.

Parameters

card	card descriptor.
enable	true is power on, false is power off.

56.2.6.9 status_t SDIO_CardInActive (sdio_card_t * *card*)

Parameters

card	Card descriptor.

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_Success	

56.2.6.10 status_t SDIO_GetCardCapability (sdio_card_t * *card,* sdio_func_num_t *func*)

Parameters

card	Card descriptor.
func	IO number

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_Success	

56.2.6.11 status_t SDIO_SetBlockSize (sdio_card_t * *card,* sdio_func_num_t *func,* uint32_t *blockSize*)

Parameters

card	Card descriptor.
func	io number
blockSize	block size

Return values

kStatus_SDMMC_SetCardBlockSizeFailed	
kStatus_SDMMC_SDIO_InvalidArgument	
kStatus_Success	

56.2.6.12 status_t SDIO_CardReset (sdio_card_t * *card*)

Parameters

card	Card descriptor.

Return values

kStatus_SDMMC_TransferFailed	
kStatus_Success	

56.2.6.13 status_t SDIO_SetDataBusWidth (sdio_card_t * *card,* sdio_bus_width_t *busWidth*)

Parameters

card	Card descriptor.
busWidth	bus width

Return values

kStatus_SDMMC_TransferFailed	
kStatus_Success	

56.2.6.14 status_t SDIO_SwitchToHighSpeed (sdio_card_t * *card*)

Parameters

card	Card descriptor.

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_SDMMC_SDIO-_SwitchHighSpeedFail	
kStatus_Success	

56.2.6.15 status_t SDIO_ReadCIS (sdio_card_t ∗ *card,* sdio_func_num_t *func,* const uint32_t ∗ *tupleList,* uint32_t *tupleNum*)

Parameters

card	Card descriptor.
func	io number
tupleList	code list
tupleNum	code number

Return values

kStatus_SDMMC_SDIO-_ReadCISFail	
kStatus_SDMMC_-TransferFailed	
kStatus_Success	

56.2.6.16 status_t SDIO_PollingCardInsert (sdio_card_t ∗ *card,* uint32_t *status*)

Detect card through GPIO, CD, DATA3.

Parameters

card	card descriptor.
status	detect status, kSD_Inserted or kSD_Removed.

56.2.6.17 bool SDIO_IsCardPresent (sdio_card_t ∗ *card*)

Parameters

card	card descriptor.

56.2.6.18 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

card	Card descriptor.
func	IO numner
regAddr	register address
data	the data pinter to write
raw	flag, indicate read after write or write only

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_Success	

56.2.6.19 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

card	Card descriptor.
func	IO number
regAddr	register address
data	pointer to read

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_Success	

56.2.6.20 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

card	Card descriptor.
direction	io access direction, please reference sdio_io_direction_t.
func	IO number
regAddr	register address
dataIn	data to write
dataOut	data pointer for readback data, support both for read and write, when application want readback the data after write command, dataOut should not be NULL.

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_Success	

56.2.6.21 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

card	Card descriptor.
func	IO number
regAddr	register address
buffer	data buffer to write
count	data count
flags	write flags

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_SDMMC_SDIO-_InvalidArgument	
kStatus_Success	

56.2.6.22 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

card	Card descriptor.
func	IO number
regAddr	register address
buffer	data buffer to read
count	data count
flags	write flags

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_SDMMC_SDIO-_InvalidArgument	
kStatus_Success	

56.2.6.23 status_t SDIO_EnableIOInterrupt (sdio_card_t ∗ *card,* sdio_func_num_t *func,* bool *enable*)

Parameters

card	Card descriptor.
func	IO number
enable	enable/disable flag

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_Success	

56.2.6.24 status_t SDIO_EnableIO (sdio_card_t * *card,* sdio_func_num_t *func,* bool *enable*)

Parameters

card	Card descriptor.
func	IO number
enable	enable/disable flag

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_Success	

56.2.6.25 status_t SDIO_SelectIO (sdio_card_t * *card,* sdio_func_num_t *func*)

Parameters

card	Card descriptor.
func	IO number

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_Success	

56.2.6.26 status_t SDIO_AbortIO (sdio_card_t * *card,* sdio_func_num_t *func*)

Parameters

card	Card descriptor.
func	IO number

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_Success	

56.2.6.27 status_t SDIO_SetDriverStrength (sdio_card_t ∗ *card,* sd_driver_strength_t *driverStrength*)

Parameters

card	Card descriptor.
driverStrength	target driver strength.

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_Success	

56.2.6.28 status_t SDIO_EnableAsyncInterrupt (sdio_card_t ∗ *card,* bool *enable*)

Parameters

card	Card descriptor.
enable	true is enable, false is disable.

Return values

kStatus_SDMMC_-TransferFailed	

kStatus_Success	

56.2.6.29 status_t SDIO_GetPendingInterrupt (sdio_card_t * *card*, uint8_t * *pendingInt*)

Parameters

card	Card descriptor.
pendingInt	pointer store pending interrupt

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_Success	

56.2.6.30 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 trnansfer 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

card	card descriptor.
cmd	command to transfer
argument	argument to transfer
blockSize	used for block mode.
txData	tx buffer pointer or NULL

rxData	rx buffer pointer or NULL
dataSize	transfer data size
response	reponse pointer, if application want read response back, please set it to a NON-NULL pointer.

56.2.6.31 void SDIO_SetIOIRQHandler (sdio_card_t * *card*, sdio_func_num_t *func*, sdio_io_irq_handler_t *handler*)

Parameters

card	card descriptor.
func	function io number.
handler	io IRQ handler.

56.2.6.32 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

card	card descriptor.

Return values

kStatus_SDMMC_-TransferFailed	
kStatus_Success	

56.3 SD Card Driver

56.3.1 Overview

The SDCARD driver provide card initialization/read/write/erase interface.

56.3.2 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
{
    sdmmchost_t *host;
    sd_usr_param_t usrParam;
    bool isHostReady;
    bool noInteralAlign;
    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_USDHC1ClockConfiguration();

   /* 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;

a. 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.
b. pwr-which allow application redefine the card power on/off function.
c. ioStrength-which is used to switch the signal pin configurations include driver strength/speed mode
      dynamiclly for different timing(SDR/HS timing) mode, reference the function defined sdmmc_config.c
d. ioVoltage-which allow application register io voltage switch function instead of using the function host
       driver provided for SDR/HS200/HS400 timing.
e. maxFreq-which allow application set the maximum bus clock that the board support.
```

1. bool noInteralAlign
   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 blockCount)

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.

56.3.3 Data Structure Documentation

56.3.3.1 struct sd_card_t

Define the card structure including the necessary fields to identify and describe the card.

Data Fields

- sdmmchost_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 noInteralAlign
  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

56.3.4 Macro Definition Documentation

56.3.4.1 #define FSL_SD_DRIVER_VERSION (MAKE_VERSION(2U, 4U, 0U)) /∗2.4.0∗/

56.3.5 Enumeration Type Documentation

56.3.5.1 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

56.3.6 Function Documentation

56.3.6.1 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

card	Card descriptor.

Return values

kStatus_SDMMC_HostNotReady	host is not ready.
kStatus_SDMMC_GoIdleFailed	Go idle failed.
kStatus_SDMMC_NotSupportYet	Card not support.
kStatus_SDMMC_HandShakeOperationConditionFailed	Send operation condition failed.
kStatus_SDMMC_AllSendCidFailed	Send CID failed.
kStatus_SDMMC_SendRelativeAddressFailed	Send relative address failed.
kStatus_SDMMC_SendCsdFailed	Send CSD failed.
kStatus_SDMMC_SelectCardFailed	Send SELECT_CARD command failed.
kStatus_SDMMC_SendScrFailed	Send SCR failed.
kStatus_SDMMC_SetDataBusWidthFailed	Set bus width failed.
kStatus_SDMMC_SwitchBusTimingFailed	Switch high speed failed.
kStatus_SDMMC_SetCardBlockSizeFailed	Set card block size failed.

kStatus_Success	Operate successfully.

56.3.6.2 void SD_Deinit (sd_card_t * *card*)

This function deinitializes the specific card and host. Please note it is a thread safe function.

Parameters

card	Card descriptor.

56.3.6.3 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

card	Card descriptor.

Return values

kStatus_SDMMC_HostNotReady	host is not ready.
kStatus_SDMMC_GoIdleFailed	Go idle failed.
kStatus_SDMMC_NotSupportYet	Card not support.
kStatus_SDMMC_HandShakeOperationConditionFailed	Send operation condition failed.

kStatus_SDMMC_AllSendCidFailed	Send CID failed.
kStatus_SDMMC_SendRelativeAddressFailed	Send relative address failed.
kStatus_SDMMC_SendCsdFailed	Send CSD failed.
kStatus_SDMMC_SelectCardFailed	Send SELECT_CARD command failed.
kStatus_SDMMC_SendScrFailed	Send SCR failed.
kStatus_SDMMC_SetDataBusWidthFailed	Set bus width failed.
kStatus_SDMMC_SwitchBusTimingFailed	Switch high speed failed.
kStatus_SDMMC_SetCardBlockSizeFailed	Set card block size failed.
kStatus_Success	Operate successfully.

56.3.6.4 void SD_CardDeinit (sd_card_t * *card*)

This function deinitializes the specific card. Please note it is a thread safe function.

Parameters

card	Card descriptor.

56.3.6.5 status_t SD_HostInit (sd_card_t * *card*)

This function deinitializes the specific host.

Parameters

card	Card descriptor.

56.3.6.6 void SD_HostDeinit (sd_card_t * *card*)

This function deinitializes the host.

Parameters

card	Card descriptor.

56.3.6.7 void SD_HostDoReset (sd_card_t * *card*)

This function reset the specific host.

Parameters

card	Card descriptor.

56.3.6.8 void SD_SetCardPower (sd_card_t * *card,* bool *enable*)

The power off operation depend on host or the user define power on function.

Parameters

card	card descriptor.
enable	true is power on, false is power off.

56.3.6.9 status_t SD_PollingCardInsert (sd_card_t * *card,* uint32_t *status*)

Detect card through GPIO, CD, DATA3.

Parameters

card	card descriptor.
status	detect status, kSD_Inserted or kSD_Removed.

56.3.6.10 bool SD_IsCardPresent (sd_card_t * *card*)

Parameters

card	card descriptor.

56.3.6.11 bool SD_CheckReadOnly (sd_card_t * *card*)

This function checks if the card is write-protected via the CSD register.

Parameters

card	The specific card.

Return values

true	Card is read only.
false	Card isn't read only.

56.3.6.12 status_t SD_SelectCard (sd_card_t * *card*, bool *isSelected*)

Parameters

card	Card descriptor.
isSelected	True to set the card into transfer state, false to disselect.

Return values

kStatus_SDMMC_TransferFailed	Transfer failed.
kStatus_Success	Operate successfully.

56.3.6.13 status_t SD_ReadStatus (sd_card_t * *card*)

Parameters

card	Card descriptor.

Return values

kStatus_SDMMC_TransferFailed	Transfer failed.
kStatus_SDMMC_SendApplicationCommandFailed	send application command failed.

kStatus_Success	Operate successfully.

56.3.6.14 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

card	Card descriptor.
buffer	The buffer to save the data read from card.
startBlock	The start block index.
blockCount	The number of blocks to read.

Return values

kStatus_InvalidArgument	Invalid argument.
kStatus_SDMMC_Card-NotSupport	Card not support.
kStatus_SDMMC_Not-SupportYet	Not support now.
kStatus_SDMMC_Wait-WriteCompleteFailed	Send status failed.
kStatus_SDMMC_-TransferFailed	Transfer failed.
kStatus_SDMMC_Stop-TransmissionFailed	Stop transmission failed.
kStatus_Success	Operate successfully.

56.3.6.15 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

card	Card descriptor.
buffer	The buffer holding the data to be written to the card.
startBlock	The start block index.
blockCount	The number of blocks to write.

Return values

kStatus_InvalidArgument	Invalid argument.
kStatus_SDMMC_NotSupportYet	Not support now.
kStatus_SDMMC_CardNotSupport	Card not support.
kStatus_SDMMC_WaitWriteCompleteFailed	Send status failed.
kStatus_SDMMC_TransferFailed	Transfer failed.
kStatus_SDMMC_StopTransmissionFailed	Stop transmission failed.
kStatus_Success	Operate successfully.

56.3.6.16 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

card	Card descriptor.
startBlock	The start block index.
blockCount	The number of blocks to erase.

Return values

kStatus_InvalidArgument	Invalid argument.
kStatus_SDMMC_WaitWriteCompleteFailed	Send status failed.
kStatus_SDMMC_TransferFailed	Transfer failed.
kStatus_SDMMC_WaitWriteCompleteFailed	Send status failed.
kStatus_Success	Operate successfully.

56.3.6.17 status_t SD_SetDriverStrength (sd_card_t * *card*, sd_driver_strength_t *driverStrength*)

Parameters

card	Card descriptor.
driverStrength	Driver strength

56.3.6.18 status_t SD_SetMaxCurrent (sd_card_t * *card*, sd_max_current_t *maxCurrent*)

Parameters

card	Card descriptor.
maxCurrent	Max current

56.3.6.19 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

card	Card descriptor.
timeoutMs	polling card status timeout value.

Return values

kStatus_Success	Operate successfully.
kStatus_SDMMC_WaitWriteCompleteFailed	CMD13 transfer failed.
kStatus_SDMMC_PollingCardIdleFailed,polling	card DAT0 idle failed.

56.4 MMC Card Driver

56.4.1 Overview

The MMCCARD driver provide card initialization/read/write/erase interface.

56.4.2 MMC CARD Operation

error log support

Not support yet

User configuable

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.

56.4.3 Data Structure Documentation

56.4.3.1 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

56.4.3.2 struct mmc_card_t

Defines the card structure including the necessary fields to identify and describe the card.

Data Fields

- sdmmchost_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 noInteralAlign
  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.

56.4.4 Macro Definition Documentation

56.4.4.1 #define FSL_MMC_DRIVER_VERSION (MAKE_VERSION(2U, 5U, 0U)) /∗2.5.0∗/

56.4.5 Enumeration Type Documentation

56.4.5.1 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

56.4.5.2 enum mmc_sleep_awake_t

Enumerator

kMMC_Sleep MMC card sleep.
kMMC_Awake MMC card awake.

56.4.6 Function Documentation

56.4.6.1 status_t MMC_Init (mmc_card_t * *card*)

Parameters

card	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

kStatus_SDMMC_HostNotReady	Host is not ready.
kStatus_SDMMC_GoIdleFailed	Going idle failed.
kStatus_SDMMC_HandShakeOperationConditionFailed	Sending operation condition failed.
kStatus_SDMMC_AllSendCidFailed	Sending CID failed.
kStatus_SDMMC_SetRelativeAddressFailed	Setging relative address failed.
kStatus_SDMMC_SendCsdFailed	Sending CSD failed.
kStatus_SDMMC_CardNotSupport	Card not support.
kStatus_SDMMC_SelectCardFailed	Sending SELECT_CARD command failed.
kStatus_SDMMC_SendExtendedCsdFailed	Sending EXT_CSD failed.
kStatus_SDMMC_SetDataBusWidthFailed	Setting bus width failed.

kStatus_SDMMC_SwitchBusTimingFailed	Switching high speed failed.
kStatus_SDMMC_SetCardBlockSizeFailed	Setting card block size failed.
kStatus_SDMMC_SetPowerClassFail	Setting card power class failed.
kStatus_Success	Operation succeeded.

56.4.6.2 void MMC_Deinit (mmc_card_t * *card*)

Note

It is a thread safe function.

Parameters

card	Card descriptor.

56.4.6.3 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

card	Card descriptor.

Return values

kStatus_SDMMC_HostNotReady	Host is not ready.

kStatus_SDMMC_GoIdleFailed	Going idle failed.
kStatus_SDMMC_HandShakeOperationConditionFailed	Sending operation condition failed.
kStatus_SDMMC_AllSendCidFailed	Sending CID failed.
kStatus_SDMMC_SetRelativeAddressFailed	Setting relative address failed.
kStatus_SDMMC_SendCsdFailed	Sending CSD failed.
kStatus_SDMMC_CardNotSupport	Card not support.
kStatus_SDMMC_SelectCardFailed	Sending SELECT_CARD command failed.
kStatus_SDMMC_SendExtendedCsdFailed	Sending EXT_CSD failed.
kStatus_SDMMC_SetDataBusWidthFailed	Setting bus width failed.
kStatus_SDMMC_SwitchBusTimingFailed	Switching high speed failed.
kStatus_SDMMC_SetCardBlockSizeFailed	Setting card block size failed.
kStatus_SDMMC_SetPowerClassFail	Setting card power class failed.
kStatus_Success	Operation succeeded.

56.4.6.4 void MMC_CardDeinit (mmc_card_t * *card*)

Note

It is a thread safe function.

Parameters

card	Card descriptor.

56.4.6.5 status_t MMC_HostInit (mmc_card_t * *card*)

This function deinitializes the specific host.

Parameters

card	Card descriptor.

56.4.6.6 void MMC_HostDeinit (mmc_card_t * *card*)

This function deinitializes the host.

Parameters

card	Card descriptor.

56.4.6.7 void MMC_HostDoReset (mmc_card_t * *card*)

This function resets the specific host.

Parameters

card	Card descriptor.

56.4.6.8 void MMC_HostReset (SDMMCHOST_CONFIG * *host*)

Deprecated Do not use this function. It has been superceded by MMC_HostDoReset. This function resets the specific host.

Parameters

host	Host descriptor.

56.4.6.9 void MMC_SetCardPower (mmc_card_t * *card,* bool *enable*)

Parameters

card	Card descriptor.
enable	True is powering on, false is powering off.

56.4.6.10 bool MMC_CheckReadOnly (mmc_card_t * *card*)

Parameters

card	Card descriptor.

Return values

true	Card is read only.
false	Card isn't read only.

56.4.6.11 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

card	Card descriptor.
buffer	The buffer to save data.
startBlock	The start block index.
blockCount	The number of blocks to read.

Return values

kStatus_InvalidArgument	Invalid argument.
kStatus_SDMMC_Card-NotSupport	Card not support.

kStatus_SDMMC_SetBlockCountFailed	Setting block count failed.
kStatus_SDMMC_TransferFailed	Transfer failed.
kStatus_SDMMC_StopTransmissionFailed	Stopping transmission failed.
kStatus_Success	Operation succeeded.

56.4.6.12 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

card	Card descriptor.
buffer	The buffer to save data blocks.
startBlock	Start block number to write.
blockCount	Block count.

Return values

kStatus_InvalidArgument	Invalid argument.
kStatus_SDMMC_NotSupportYet	Not support now.
kStatus_SDMMC_SetBlockCountFailed	Setting block count failed.
kStatus_SDMMC_WaitWriteCompleteFailed	Sending status failed.

kStatus_SDMMC_-TransferFailed	Transfer failed.
kStatus_SDMMC_Stop-TransmissionFailed	Stop transmission failed.
kStatus_Success	Operation succeeded.

56.4.6.13 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

card	Card descriptor.
startGroup	Start group number.
endGroup	End group number.

Return values

kStatus_InvalidArgument	Invalid argument.
kStatus_SDMMC_Wait-WriteCompleteFailed	Send status failed.
kStatus_SDMMC_-TransferFailed	Transfer failed.
kStatus_Success	Operation succeeded.

56.4.6.14 status_t MMC_SelectPartition (mmc_card_t * *card*, mmc_access_partition_t *partitionNumber*)

Note

It is a thread safe function.

Parameters

card	Card descriptor.
partition-Number	The partition number.

Return values

kStatus_SDMMC_-ConfigureExtendedCsd-Failed	Configuring EXT_CSD failed.
kStatus_Success	Operation succeeded.

56.4.6.15 status_t MMC_SetBootConfig (mmc_card_t * *card*, const mmc_boot_config_t * *config*)

Parameters

card	Card descriptor.
config	Boot configuration structure.

Return values

kStatus_SDMMC_Not-SupportYet	Not support now.
kStatus_SDMMC_-ConfigureExtendedCsd-Failed	Configuring EXT_CSD failed.
kStatus_SDMMC_-ConfigureBootFailed	Configuring boot failed.
kStatus_Success	Operation succeeded.

56.4.6.16 status_t MMC_StartBoot (mmc_card_t * *card*, const mmc_boot_config_t * *mmcConfig*, uint8_t * *buffer*, sdmmchost_boot_config_t * *hostConfig*)

Parameters

card	Card descriptor.
mmcConfig	The mmc Boot configuration structure.
buffer	Address to receive data.
hostConfig	Host boot configurations.

Return values

kStatus_Fail	Failed.
kStatus_SDMMC_-TransferFailed	Transfer failed.
kStatus_SDMMC_Go-IdleFailed	Resetting card failed.
kStatus_Success	Operation succeeded.

56.4.6.17 status_t MMC_SetBootConfigWP (mmc_card_t * *card,* uint8_t *wp*)

Parameters

card	Card descriptor.
wp	Write protect value.

56.4.6.18 status_t MMC_ReadBootData (mmc_card_t * *card,* uint8_t * *buffer,* sdmmchost_boot_config_t * *hostConfig*)

Parameters

card	Card descriptor.
buffer	Buffer address.
hostConfig	Host boot configurations.

56.4.6.19 status_t MMC_StopBoot (mmc_card_t * *card,* uint32_t *bootMode*)

Parameters

card	Card descriptor.
bootMode	Boot mode.

56.4.6.20 status_t MMC_SetBootPartitionWP (mmc_card_t * *card,* mmc_boot_partition_wp_t *bootPartitionWP*)

Parameters

card	Card descriptor.
bootPartition-WP	Boot partition write protect value.

56.4.6.21 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

card	Card descriptor.
enable	True is enabling the cache, false is disabling the cache.

56.4.6.22 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

card	Card descriptor.

56.4.6.23 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

card	Card descriptor.
state	The sleep/awake command argument, refer to mmc_sleep_awake_t.

Return values

kStatus_SDMMC_NotSupportYet	Indicates the memory device doesn't support the Sleep/Awake command.
kStatus_SDMMC_TransferFailed	Indicates command transferred fail.
kStatus_SDMMC_PollingCardIdleFailed	Indicates polling DAT0 busy timeout.
kStatus_SDMMC_DeselectCardFailed	Indicates deselect card command failed.
kStatus_SDMMC_SelectCardFailed	Indicates select card command failed.
kStatus_Success	Indicates the card state switched successfully.

56.4.6.24 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

card	Card descriptor.
checkStatus	True is send CMD and read DAT0 status to check card status, false is read DAT0 status only.
timeoutMs	Polling card status timeout value.

Return values

kStatus_SDMMC_CardStatusIdle	Card is idle.
kStatus_SDMMC_CardStatusBusy	Card is busy.
kStatus_SDMMC_TransferFailed	Command tranfer failed.
kStatus_SDMMC_SwitchFailed	Status command reports switch error.

56.5 SDMMC HOST Driver

56.5.1 Overview

The host adapter driver provide adapter for blocking/non_blocking mode.

Modules

- USDHC HOST adapter Driver

56.6 SDMMC OSA

56.6.1 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 semphore 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 timeoutMilliseconds, 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.

56.6.2 Data Structure Documentation

56.6.2.1 struct sdmmc_osa_event_t

56.6.2.2 struct sdmmc_osa_mutex_t

56.6.3 Function Documentation

56.6.3.1 status_t SDMMC_OSAEventCreate (void ∗ *eventHandle*)

Parameters

eventHandle	event handle.

Return values

kStatus_Fail	or kStatus_Success.

56.6.3.2 status_t SDMMC_OSAEventWait (void ∗ *eventHandle,* uint32_t *eventType,* uint32_t *timeoutMilliseconds,* uint32_t ∗ *event*)

Parameters

eventHandle	The event type
eventType	Timeout time in milliseconds.
timeout-Milliseconds	timeout value in ms.
event	event flags.

Return values

kStatus_Fail	or kStatus_Success.

56.6.3.3 status_t SDMMC_OSAEventSet (void ∗ *eventHandle,* uint32_t *eventType*)

Parameters

eventHandle	event handle.
eventType	The event type

Return values

kStatus_Fail	or kStatus_Success.

56.6.3.4 status_t SDMMC_OSAEventGet (void ∗ *eventHandle,* uint32_t *eventType,* uint32_t ∗ *flag*)

Parameters

eventHandle	event handle.
eventType	event type.
flag	pointer to store event value.

Return values

kStatus_Fail	or kStatus_Success.

56.6.3.5 status_t SDMMC_OSAEventClear (void ∗ *eventHandle,* uint32_t *eventType*)

Parameters

eventHandle	event handle.
eventType	The event type

Return values

kStatus_Fail	or kStatus_Success.

56.6.3.6 status_t SDMMC_OSAEventDestroy (void ∗ *eventHandle*)

Parameters

eventHandle	The event handle.

56.6.3.7 status_t SDMMC_OSAMutexCreate (void ∗ *mutexHandle*)

Parameters

mutexHandle	mutex handle.

Return values

kStatus_Fail	or kStatus_Success.

56.6.3.8 status_t SDMMC_OSAMutexLock (void ∗ *mutexHandle,* uint32_t *millisec*)

Parameters

mutexHandle	mutex handle.
millisec	The maximum number of milliseconds to wait for the mutex. If the mutex is locked, Pass the value osaWaitForever_c will wait indefinitely, pass 0 will return KOSA_-StatusTimeout immediately.

Return values

kStatus_Fail	or kStatus_Success.

56.6.3.9 status_t SDMMC_OSAMutexUnlock (void ∗ *mutexHandle*)

Parameters

mutexHandle	mutex handle.

Return values

kStatus_Fail	or kStatus_Success.

56.6.3.10 status_t SDMMC_OSAMutexDestroy (void ∗ *mutexHandle*)

Parameters

mutexHandle	The mutex handle.

56.6.3.11 void SDMMC_OSADelay (uint32_t *milliseconds*)

Parameters

milliseconds	time to delay

56.6.3.12 uint32_t SDMMC_OSADelayUs (uint32_t *microseconds*)

Parameters

microseconds	time to delay

Returns

actual delayed microseconds

56.6.4 USDHC HOST adapter Driver

56.6.4.1 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 aovid 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 ∗ 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, 1U)) /∗2.6.-1∗/
  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_SupportDDRMode = 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 initilization 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 nibblePos)
  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 *hostConfig, 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

56.6.4.2 Data Structure Documentation

56.6.4.2.1 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

56.6.4.3 Macro Definition Documentation

56.6.4.3.1 #define FSL_SDMMC_HOST_ADAPTER_VERSION (MAKE_VERSION(2U, 6U, 1U)) /∗2.6.1∗/

56.6.4.3.2 #define SDMMCHOST_STANDARD_TUNING_START (10U)

standard tuning start point

56.6.4.4 Enumeration Type Documentation

56.6.4.4.1 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.

56.6.4.4.2 anonymous enum

Enumerator

kSDMMCHOST_EndianModeBig Big endian mode.
kSDMMCHOST_EndianModeHalfWordBig Half word big endian mode.
kSDMMCHOST_EndianModeLittle Little endian mode.

56.6.4.4.3 anonymous enum

Enumerator

kSDMMCHOST_StandardTuning standard tuning type
kSDMMCHOST_ManualTuning manual tuning type

56.6.4.4.4 anonymous enum

Enumerator

kSDMMCHOST_NoCacheControl sdmmc host cache control disabled
kSDMMCHOST_CacheControlRWBuffer sdmmc host cache control read/write buffer

56.6.4.5 Function Documentation

56.6.4.5.1 void SDMMCHOST_SetCardBusWidth (sdmmchost_t * *host*, uint32_t *dataBusWidth*)

Parameters

host	host handler
dataBusWidth	data bus width

56.6.4.5.2 static void SDMMCHOST_SendCardActive (sdmmchost_t * *host*) [inline], [static]

Parameters

host	host handler

56.6.4.5.3 static uint32_t SDMMCHOST_SetCardClock (sdmmchost_t * *host*, uint32_t *targetClock*) [inline], [static]

Parameters

host	host handler
targetClock	target clock frequency

Return values

actual	clock frequency can be reach.

56.6.4.5.4 static bool SDMMCHOST_IsCardBusy (sdmmchost_t * *host*) [inline], [static]

Parameters

host	host handler

Return values

true	is busy, false is idle.

56.6.4.5.5 static uint32_t SDMMCHOST_GetSignalLineStatus (sdmmchost_t * *host,* uint32_t *signalLine*) [inline], [static]

Parameters

host	host handler
signalLine	signal line type, reference _sdmmc_signal_line

56.6.4.5.6 static void SDMMCHOST_EnableCardInt (sdmmchost_t * *host,* bool *enable*) [inline], [static]

Parameters

host	host handler
enable	true is enable, false is disable.

56.6.4.5.7 static void SDMMCHOST_EnableDDRMode (sdmmchost_t * *host,* bool *enable,* uint32_t *nibblePos*) [inline], [static]

Parameters

host	host handler
enable	true is enable, false is disable.
nibblePos	nibble position indictation. 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'.

56.6.4.5.8 static void SDMMCHOST_EnableHS400Mode (sdmmchost_t * *host,* bool *enable*) [inline], [static]

Parameters

host	host handler
enable	true is enable, false is disable.

56.6.4.5.9 static void SDMMCHOST_EnableStrobeDll (sdmmchost_t * *host*, bool *enable*) [inline], [static]

Parameters

host	host handler
enable	true is enable, false is disable.

56.6.4.5.10 status_t SDMMCHOST_StartBoot (sdmmchost_t * *host*, sdmmchost_boot_config_t * *hostConfig*, sdmmchost_cmd_t * *cmd*, uint8_t * *buffer*)

Parameters

host	host handler
hostConfig	boot configuration
cmd	boot command
buffer	buffer address

56.6.4.5.11 status_t SDMMCHOST_ReadBootData (sdmmchost_t * *host*, sdmmchost_boot_config_t * *hostConfig*, uint8_t * *buffer*)

Parameters

host	host handler
hostConfig	boot configuration
buffer	buffer address

56.6.4.5.12 static void SDMMCHOST_EnableBoot (sdmmchost_t * *host*, bool *enable*) [inline], [static]

Parameters

host	host handler
enable	true is enable, false is disable

56.6.4.5.13 status_t SDMMCHOST_CardIntInit (sdmmchost_t * *host,* void * *sdioInt*)

Parameters

host	host handler
sdioInt	card interrupt configuration

56.6.4.5.14 static void SDMMCHOST_ForceClockOn (sdmmchost_t * *host,* bool *enable*) [inline], [static]

Parameters

host	host handler
enable	true is enable, false is disable.

56.6.4.5.15 void SDMMCHOST_SwitchToVoltage (sdmmchost_t * *host,* uint32_t *voltage*)

Parameters

host	host handler
voltage	switch to voltage level.

56.6.4.5.16 status_t SDMMCHOST_CardDetectInit (sdmmchost_t * *host,* void * *cd*)

Parameters

host	host handler

cd	card detect configuration

56.6.4.5.17 status_t SDMMCHOST_PollingCardDetectStatus (sdmmchost_t * *host*, uint32_t *waitCardStatus*, uint32_t *timeout*)

Parameters

host	host handler
waitCardStatus	status which user want to wait
timeout	wait time out.

Return values

kStatus_Success	detect card insert
kStatus_Fail	card insert event fail

56.6.4.5.18 uint32_t SDMMCHOST_CardDetectStatus (sdmmchost_t * *host*)

Parameters

host	host handler

Return values

kSD_Inserted,kSD_-Removed	

56.6.4.5.19 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

host	host handler

Return values

kStatus_Success	host init success
kStatus_Fail	event fail

56.6.4.5.20 void SDMMCHOST_Deinit (sdmmchost_t * *host*)

Please note it is a thread safe function.

Parameters

host	host handler

56.6.4.5.21 void SDMMCHOST_SetCardPower (sdmmchost_t * *host,* bool *enable*)

Parameters

host	host handler
enable	true is power on, false is power down.

56.6.4.5.22 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

host	host handler
content	transfer content.

56.6.4.5.23 status_t SDMMCHOST_ExecuteTuning (sdmmchost_t ∗ *host*, uint32_t *tuningCmd*, uint32_t ∗ *revBuf*, uint32_t *blockSize*)

Parameters

host	host handler
tuningCmd	tuning command.
revBuf	receive buffer pointer
blockSize	tuning data block size.

56.6.4.5.24 void SDMMCHOST_Reset (sdmmchost_t ∗ *host*)

Parameters

host	host handler

56.6.4.5.25 void SDMMCHOST_ConvertDataToLittleEndian (sdmmchost_t ∗ *host*, uint32_t ∗ *data*, uint32_t *wordSize*, uint32_t *format*)

Parameters

host	host handler.
data	data buffer address.
wordSize	data buffer size in word.
format	data packet format.

56.7 SDMMC Common

56.7.1 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_FUNCE (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 reigster 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)
  aync 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 FRQEUENCY 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 MULTIPLER filed 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 filed 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_SWTICH_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 aoolication 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_SDMM-

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_BusWdith1Bit = 0U,
  kSDMMC_BusWdith4Bit = 1U,
  kSDMMC_BusWdith8Bit = 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_R1InIdleStateFlag = (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_ApplicationSetBusWdith = 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_FunctionSDR12Deafult = 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_CsdStrucureVersion10 = 0U,
  kMMC_CsdStrucureVersion11 = 1U,
  kMMC_CsdStrucureVersion12 = 2U,
  kMMC_CsdStrucureVersionInExtcsd = 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 mdde 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_ExtCsdPrgCIDCSDInDDRModeSupport = (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.

56.7.2 Data Structure Documentation

56.7.2.1 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

56.7.2.2 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

56.7.2.3 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
  swicth 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

56.7.2.4 struct sdio_card_int_t

Data Fields

- void * userData
  user data
- sdio_int_t cardInterrupt
  card int call back

56.7.2.5 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
  swicth 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

56.7.2.6 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

56.7.2.7 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

56.7.2.8 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
  avaliable 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

56.7.2.9 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

56.7.2.10 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].

56.7.2.11 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].

56.7.2.12 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]

56.7.2.13 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.

56.7.2.14 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]

56.7.2.15 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 extendecCsdVersion
  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]

56.7.2.16 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.

56.7.2.17 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

56.7.3 Macro Definition Documentation

56.7.3.1 #define SDMMC_LOG(*format, ...*)

56.7.3.2 #define READ_MMC_TRANSFER_SPEED_FREQUENCY_UNIT(*CSD*) ((((CSD).transferSpeed) & MMC_TRANSFER_SPEED_FREQUENCY_UNIT_MASK) >> MMC_TRANSFER_SPEED_FREQUENCY_UNIT_SHIFT)

56.7.3.3 #define READ_MMC_TRANSFER_SPEED_MULTIPLIER(*CSD*) ((((CSD).transferSpeed) & MMC_TRANSFER_SPEED_MULTIPLIER_MASK) >> MMC_TRANSFER_SPEED_MULTIPLIER_SHIFT)

56.7.3.4 #define MMC_EXTENDED_CSD_BYTES (512U)

56.7.3.5 #define SD_PRODUCT_NAME_BYTES (5U)

56.7.3.6 #define MMC_PRODUCT_NAME_BYTES (6U)

56.7.3.7 #define MMC_SWITCH_COMMAND_SET_SHIFT (0U)

56.7.3.8 #define MMC_SWITCH_COMMAND_SET_MASK (0x00000007U)

56.7.4 Enumeration Type Documentation

56.7.4.1 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

56.7.4.2 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

56.7.4.3 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

56.7.4.4 anonymous enum

Enumerator

kSDMMC_BusWdith1Bit card bus 1 width
kSDMMC_BusWdith4Bit card bus 4 width
kSDMMC_BusWdith8Bit card bus 8 width

56.7.4.5 anonymous enum

Enumerator

kSDMMC_Support8BitWidth 8 bit data width capability

56.7.4.6 anonymous enum

Enumerator

kSDMMC_DataPacketFormatLSBFirst usual data packet format LSB first, MSB last
kSDMMC_DataPacketFormatMSBFirst Wide width data packet format MSB first, LSB last.

56.7.4.7 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

56.7.4.8 anonymous enum

Enumerator

kSD_Inserted card is inserted
kSD_Removed card is removed

56.7.4.9 anonymous enum

Enumerator

kSD_DAT3PullDown data3 pull down
kSD_DAT3PullUp data3 pull up

56.7.4.10 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

56.7.4.11 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

56.7.4.12 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.

56.7.4.13 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.

56.7.4.14 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.

56.7.4.15 anonymous enum

Enumerator

kSDSPI_DataErrorTokenError Data error.
kSDSPI_DataErrorTokenCardControllerError Card controller error.
kSDSPI_DataErrorTokenCardEccFailed Card ecc error.
kSDSPI_DataErrorTokenOutOfRange Out of range.

56.7.4.16 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.

56.7.4.17 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.

56.7.4.18 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.

56.7.4.19 enum sdspi_command_t

Enumerator

kSDSPI_CommandCrc Command crc protection on/off.

56.7.4.20 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 Connnect/Disconnect pull up on detect pin.
kSD_ApplicationSendScr Send Scr.

56.7.4.21 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.

56.7.4.22 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.

56.7.4.23 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.

56.7.4.24 enum sd_switch_mode_t

Enumerator

kSD_SwitchCheck SD switch mode 0: check function.
kSD_SwitchSet SD switch mode 1: set function.

56.7.4.25 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].

56.7.4.26 anonymous enum

Enumerator

kSD_ScrDataStatusAfterErase Data status after erases [55:55].
kSD_ScrSdSpecification3 Specification version 3.00 or higher [47:47].

56.7.4.27 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.

56.7.4.28 anonymous enum

Enumerator

kSD_GroupTimingMode acess mode group
kSD_GroupCommandSystem command system group
kSD_GroupDriverStrength driver strength group
kSD_GroupCurrentLimit current limit group

56.7.4.29 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.

56.7.4.30 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

56.7.4.31 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

56.7.4.32 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.

56.7.4.33 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.

56.7.4.34 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

56.7.4.35 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

56.7.4.36 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 invail function error
kSDIO_StatusOutofRange cmd argument was out of the allowed range

56.7.4.37 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.

56.7.4.38 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

56.7.4.39 anonymous enum

Enumerator

kSDIO_FBRSupportCSA function support CSA
kSDIO_FBRSupportPowerSelection function support power selection

56.7.4.40 enum sdio_bus_width_t

Enumerator

kSDIO_DataBus1Bit 1 bit bus mode
kSDIO_DataBus4Bit 4 bit bus mode
kSDIO_DataBus8Bit 8 bit bus mode

56.7.4.41 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.

56.7.4.42 enum mmc_classified_voltage_t

Enumerator

kMMC_ClassifiedVoltageHigh High-voltage MMC card.
kMMC_ClassifiedVoltageDual Dual-voltage MMC card.

56.7.4.43 enum mmc_classified_density_t

Enumerator

kMMC_ClassifiedDensityWithin2GB Density byte is less than or equal 2GB.

56.7.4.44 enum mmc_access_mode_t

Enumerator

kMMC_AccessModeByte The card should be accessed as byte.
kMMC_AccessModeSector The card should be accessed as sector.

56.7.4.45 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.

56.7.4.46 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.

56.7.4.47 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.

56.7.4.48 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.

56.7.4.49 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.

56.7.4.50 anonymous enum

Enumerator

kMMC_SupportAlternateBoot support alternative boot mode
kMMC_SupportDDRBoot support DDR boot mode
kMMC_SupportHighSpeedBoot support high speed boot mode

56.7.4.51 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.

56.7.4.52 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.

56.7.4.53 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.

56.7.4.54 enum mmc_boot_timing_mode_t

Enumerator

kMMC_BootModeSDRWithDefaultTiming boot mode single data rate with backward compatiable timings
kMMC_BootModeSDRWithHighSpeedTiming boot mode single data rate with high speed timing
kMMC_BootModeDDRTiming boot mode dual date rate

56.7.4.55 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

56.7.4.56 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

56.7.4.57 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

56.7.4.58 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.

56.7.4.59 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.

56.7.4.60 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.

56.7.4.61 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.

56.7.4.62 enum mmc_extended_csd_flags_t

Enumerator

kMMC_ExtCsdExtPartitionSupport partitioning support[160]
kMMC_ExtCsdEnhancePartitionSupport partitioning support[160]
kMMC_ExtCsdPartitioningSupport partitioning support[160]
kMMC_ExtCsdPrgCIDCSDInDDRModeSupport 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]

56.7.4.63 enum mmc_boot_mode_t

Enumerator

kMMC_BootModeNormal Normal boot.
kMMC_BootModeAlternative Alternative boot.

56.7.5 Function Documentation

56.7.5.1 status_t SDMMC_SelectCard (sdmmchost_t * *host*, uint32_t *relativeAddress*, bool *isSelected*)

Parameters

host	host handler.
relativeAddress	Relative address.
isSelected	True to put card into transfer state.

Return values

kStatus_SDMMC_-TransferFailed	Transfer failed.
kStatus_Success	Operate successfully.

56.7.5.2 status_t SDMMC_SendApplicationCommand (sdmmchost_t * *host,* uint32_t *relativeAddress*)

Parameters

host	host handler.
relativeAddress	Card relative address.

Return values

kStatus_SDMMC_-TransferFailed	Transfer failed.
kStatus_SDMMC_Card-NotSupport	Card doesn't support.
kStatus_Success	Operate successfully.

56.7.5.3 status_t SDMMC_SetBlockCount (sdmmchost_t * *host,* uint32_t *blockCount*)

Parameters

host	host handler.
blockCount	Block count.

Return values

kStatus_SDMMC_-TransferFailed	Transfer failed.
kStatus_Success	Operate successfully.

56.7.5.4 status_t SDMMC_GoIdle (sdmmchost_t * *host*)

Parameters

host	host handler.

Return values

kStatus_SDMMC_-TransferFailed	Transfer failed.
kStatus_Success	Operate successfully.

56.7.5.5 status_t SDMMC_SetBlockSize (sdmmchost_t * *host,* uint32_t *blockSize*)

Parameters

host	host handler.
blockSize	Block size.

Return values

kStatus_SDMMC_-TransferFailed	Transfer failed.
kStatus_Success	Operate successfully.

56.7.5.6 status_t SDMMC_SetCardInactive (sdmmchost_t * *host*)

Parameters

host	host handler.

Return values

kStatus_SDMMC_-TransferFailed	Transfer failed.
kStatus_Success	Operate successfully.

Chapter 57
CODEC Driver

57.1 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

57.2 CODEC Common Driver

57.2.1 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 initilization.
- status_t CODEC_Deinit (codec_handle_t *handle)
  Codec de-initilization.
- 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, 0))
  CLOCK driver version 2.3.0.

57.2.2 Data Structure Documentation

57.2.2.1 struct codec_config_t

Data Fields

- uint32_t codecDevType
  codec type
- void * codecDevConfig
  Codec device specific configuration.

57.2.2.2 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

57.2.2.3 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

57.2.3 Macro Definition Documentation

57.2.3.1 #define FSL_CODEC_DRIVER_VERSION (MAKE_VERSION(2, 3, 0))

57.2.4 Enumeration Type Documentation

57.2.4.1 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.

57.2.4.2 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.

57.2.4.3 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.

57.2.4.4 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

57.2.4.5 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

57.2.4.6 enum codec_module_ctrl_cmd_t

Enumerator

kCODEC_ModuleSwitchI2SInInterface module digital interface siwtch.

57.2.4.7 anonymous enum

Enumerator

kCODEC_ModuleI2SInInterfacePCM Pcm interface.
kCODEC_ModuleI2SInInterfaceDSD DSD interface.

57.2.4.8 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

57.2.4.9 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

kCODEC_RecordChannelDifferentialPositive2 differential positive record channel 2
kCODEC_RecordChannelDifferentialPositive3 differential positive record channel 3
kCODEC_RecordChannelDifferentialNegative1 differential negative record channel 1
kCODEC_RecordChannelDifferentialNegative2 differential negative record channel 2
kCODEC_RecordChannelDifferentialNegative3 differential negative record channel 3

57.2.4.10 anonymous enum

Enumerator

kCODEC_PlaySourcePGA play source PGA, bypass ADC
kCODEC_PlaySourceInput play source Input3
kCODEC_PlaySourceDAC play source DAC
kCODEC_PlaySourceMixerIn play source mixer in
kCODEC_PlaySourceMixerInLeft play source mixer in left
kCODEC_PlaySourceMixerInRight play source mixer in right
kCODEC_PlaySourceAux play source mixer in AUx

57.2.4.11 anonymous enum

Enumerator

kCODEC_PlayChannelHeadphoneLeft play channel headphone left
kCODEC_PlayChannelHeadphoneRight play channel headphone right
kCODEC_PlayChannelSpeakerLeft play channel speaker left
kCODEC_PlayChannelSpeakerRight play channel speaker right
kCODEC_PlayChannelLineOutLeft play channel lineout left
kCODEC_PlayChannelLineOutRight play channel lineout right
kCODEC_PlayChannelLeft0 play channel left0
kCODEC_PlayChannelRight0 play channel right0
kCODEC_PlayChannelLeft1 play channel left1
kCODEC_PlayChannelRight1 play channel right1
kCODEC_PlayChannelLeft2 play channel left2
kCODEC_PlayChannelRight2 play channel right2
kCODEC_PlayChannelLeft3 play channel left3
kCODEC_PlayChannelRight3 play channel right3

57.2.4.12 anonymous enum

Enumerator

kCODEC_VolumeHeadphoneLeft headphone left volume
kCODEC_VolumeHeadphoneRight headphone right volume
kCODEC_VolumeSpeakerLeft speaker left volume
kCODEC_VolumeSpeakerRight 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

57.2.4.13 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

57.2.5 Function Documentation

57.2.5.1 status_t CODEC_Init (codec_handle_t ∗ *handle,* codec_config_t ∗ *config*)

Parameters

handle	codec handle.
config	codec configurations.

Returns

kStatus_Success is success, else de-initial failed.

57.2.5.2 status_t CODEC_Deinit (codec_handle_t ∗ *handle*)

Parameters

handle	codec handle.

Returns

kStatus_Success is success, else de-initial failed.

57.2.5.3 status_t CODEC_SetFormat (codec_handle_t ∗ *handle,* uint32_t *mclk,* uint32_t *sampleRate,* uint32_t *bitWidth*)

Parameters

handle	codec handle.
mclk	master clock frequency in HZ.
sampleRate	sample rate in HZ.
bitWidth	bit width.

Returns

kStatus_Success is success, else configure failed.

57.2.5.4 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

handle	codec handle.
cmd	module control cmd, reference _codec_module_ctrl_cmd.
data	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.

57.2.5.5 status_t CODEC_SetVolume (codec_handle_t * *handle,* uint32_t *channel,* uint32_t *volume*)

Parameters

handle	codec handle.
channel	audio codec volume channel, can be a value or combine value of _codec_volume_-capability or _codec_play_channel.
volume	volume value, support 0 ∼ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

57.2.5.6 status_t CODEC_SetMute (codec_handle_t ∗ *handle,* uint32_t *channel,* bool *mute*)

Parameters

handle	codec handle.
channel	audio codec volume channel, can be a value or combine value of _codec_volume_-capability or _codec_play_channel.
mute	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

57.2.5.7 status_t CODEC_SetPower (codec_handle_t ∗ *handle,* codec_module_t *module,* bool *powerOn*)

Parameters

handle	codec handle.
module	audio codec module.
powerOn	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

57.2.5.8 status_t CODEC_SetRecord (codec_handle_t ∗ *handle,* uint32_t *recordSource*)

Parameters

handle	codec handle.
recordSource	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

57.2.5.9 status_t CODEC_SetRecordChannel (codec_handle_t * *handle,* uint32_t *leftRecordChannel,* uint32_t *rightRecordChannel*)

Parameters

handle	codec handle.
leftRecordChannel	audio codec record channel, reference _codec_record_channel, can be a value combine of member in _codec_record_channel.
rightRecordChannel	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.

57.2.5.10 status_t CODEC_SetPlay (codec_handle_t * *handle,* uint32_t *playSource*)

Parameters

handle	codec handle.
playSource	audio codec play source, can be a value or combine value of _codec_play_source.

Returns

kStatus_Success is success, else configure failed.

57.3 CODEC I2C Driver

57.3.1 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 i2c-SourceClockHz)
  Codec i2c bus initilization.
- status_t CODEC_I2C_Deinit (void ∗handle)
  Codec i2c de-initilization.
- 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.

57.3.2 Data Structure Documentation

57.3.2.1 struct codec_i2c_config_t

Data Fields

- uint32_t codecI2CInstance
  i2c bus instance
- uint32_t codecI2CSourceClock
  i2c bus source clock frequency

57.3.3 Enumeration Type Documentation

57.3.3.1 enum codec_reg_addr_t

Enumerator

kCODEC_RegAddr8Bit 8-bit register address.
kCODEC_RegAddr16Bit 16-bit register address.

57.3.3.2 enum codec_reg_width_t

Enumerator

kCODEC_RegWidth8Bit 8-bit register width.
kCODEC_RegWidth16Bit 16-bit register width.
kCODEC_RegWidth32Bit 32-bit register width.

57.3.4 Function Documentation

57.3.4.1 status_t CODEC_I2C_Init (void ∗ *handle*, uint32_t *i2cInstance*, uint32_t *i2cBaudrate*, uint32_t *i2cSourceClockHz*)

Parameters

handle	i2c master handle.
i2cInstance	instance number of the i2c bus, such as 0 is corresponding to I2C0.

i2cBaudrate	i2c baudrate.
i2cSourceClockHz	i2c source clock frequency.

Returns

kStatus_HAL_I2cSuccess is success, else initial failed.

57.3.4.2 status_t CODEC_I2C_Deinit (void ∗ *handle*)

Parameters

handle	i2c master handle.

Returns

kStatus_HAL_I2cSuccess is success, else deinitial failed.

57.3.4.3 status_t CODEC_I2C_Send (void ∗ *handle,* uint8_t *deviceAddress,* uint32_t *subAddress,* uint8_t *subaddressSize,* uint8_t ∗ *txBuff,* uint8_t *txBuffSize*)

Parameters

handle	i2c master handle.
deviceAddress	codec device address.
subAddress	register address.
subaddressSize	register address width.
txBuff	tx buffer pointer.
txBuffSize	tx buffer size.

Returns

kStatus_HAL_I2cSuccess is success, else send failed.

57.3.4.4 status_t CODEC_I2C_Receive (void ∗ *handle,* uint8_t *deviceAddress,* uint32_t *subAddress,* uint8_t *subaddressSize,* uint8_t ∗ *rxBuff,* uint8_t *rxBuffSize*)

Parameters

handle	i2c master handle.
deviceAddress	codec device address.
subAddress	register address.
subaddressSize	register address width.
rxBuff	rx buffer pointer.
rxBuffSize	rx buffer size.

Returns

kStatus_HAL_I2cSuccess is success, else receive failed.

57.4 CS42888 Driver

57.4.1 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 bitWidth)
  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 adcMode, 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 sample_rate, 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.

57.4.2 Data Structure Documentation

57.4.2.1 struct cs42888_audio_format_t

Data Fields

- uint32_t mclk_HZ
  master clock frequency
- uint32_t sampleRate
  sample rate
- uint32_t bitWidth
  bit width

57.4.2.2 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

57.4.2.3 struct cs42888_handle_t

Data Fields

- cs42888_config_t * config
  cs42888 config pointer
- uint8_t i2cHandle [CS42888_I2C_HANDLER_SIZE]
  i2c handle pointer

57.4.3 Macro Definition Documentation

57.4.3.1 #define FSL_CS42888_DRIVER_VERSION (MAKE_VERSION(2, 1, 3))

57.4.3.2 #define CS42888_ID 0x01U

57.4.3.3 #define CS42888_I2C_ADDR 0x48U

57.4.4 Enumeration Type Documentation

57.4.4.1 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

57.4.4.2 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.

57.4.4.3 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.

57.4.4.4 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

57.4.5 Function Documentation

57.4.5.1 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

handle	CS42888 handle structure.
config	CS42888 configuration structure.

57.4.5.2 status_t CS42888_Deinit (cs42888_handle_t ∗ *handle*)

This function close all modules in CS42888 to save power.

Parameters

handle	CS42888 handle structure pointer.

57.4.5.3 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

handle	CS42888 handle structure.
protocol	Audio data transfer protocol.
bitWidth	bit width

57.4.5.4 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

handle	CS42888 handle structure.
mode	differenht working mode of CS42888.

57.4.5.5 status_t CS42888_SelectFunctionalMode (cs42888_handle_t ∗ *handle,* cs42888_func_mode *adcMode,* cs42888_func_mode *dacMode*)

Parameters

handle	CS42888 handle structure.
adcMode	differenht working mode of CS42888.
dacMode	differenht working mode of CS42888.

57.4.5.6 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

handle	CS42888 handle structure.
channel	AOUT channel, it shall be 1∼8.
volume	Volume value need to be set.

57.4.5.7 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

handle	CS42888 handle structure.
channel	AIN channel, it shall be 1∼4.
volume	Volume value need to be set.

57.4.5.8 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

handle	CS42888 handle structure.
channel	AOUT channel, it shall be 1∼8.

57.4.5.9 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

handle	CS42888 handle structure.
channel	AIN channel, it shall be 1∼4.

57.4.5.10 status_t CS42888_SetMute (cs42888_handle_t ∗ *handle,* uint8_t *channelMask*)

Parameters

handle	CS42888 handle structure.
channelMask	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.

57.4.5.11 status_t CS42888_SetChannelMute (cs42888_handle_t ∗ *handle,* uint8_t *channel,* bool *isMute*)

Parameters

handle	CS42888 handle structure.
channel	reference _cs42888_play_channel.
isMute	true is mute, falase is unmute.

57.4.5.12 status_t CS42888_SetModule (cs42888_handle_t ∗ *handle,* cs42888_module_t *module,* bool *isEnabled*)

Parameters

handle	CS42888 handle structure.
module	Module expected to enable.
isEnabled	Enable or disable moudles.

57.4.5.13 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

handle	CS42888 handle structure pointer.
mclk	Master clock frequency of I2S.
sample_rate	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.
bits	Bit depth of audio file (CS42888 only supports 16bit, 20bit, 24bit and 32 bit in HW).

57.4.5.14 status_t CS42888_WriteReg (cs42888_handle_t * *handle,* uint8_t *reg,* uint8_t *val*)

Parameters

handle	CS42888 handle structure.
reg	The register address in CS42888.
val	Value needs to write into the register.

57.4.5.15 status_t CS42888_ReadReg (cs42888_handle_t * *handle,* uint8_t *reg,* uint8_t * *val*)

Parameters

handle	CS42888 handle structure.
reg	The register address in CS42888.
val	Value written to.

57.4.5.16 status_t CS42888_ModifyReg (cs42888_handle_t ∗ *handle,* uint8_t *reg,* uint8_t *mask,* uint8_t *val*)

Parameters

handle	CS42888 handle structure.
reg	The register address in CS42888.
mask	The mask code for the bits want to write. The bit you want to write should be 0.
val	Value needs to write into the register.

57.4.6 CS42888 Adapter

57.4.6.1 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 initilization.
- status_t HAL_CODEC_CS42888_Deinit (void *handle)
  Codec de-initilization.
- 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 initilization.
- static status_t HAL_CODEC_Deinit (void *handle)
  Codec de-initilization.
- 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.

57.4.6.2 Function Documentation

57.4.6.2.1 status_t HAL_CODEC_CS42888_Init (void ∗ *handle,* void ∗ *config*)

Parameters

handle	codec handle.
config	codec configuration.

Returns

kStatus_Success is success, else initial failed.

57.4.6.2.2 status_t HAL_CODEC_CS42888_Deinit (void ∗ *handle*)

Parameters

handle	codec handle.

Returns

kStatus_Success is success, else de-initial failed.

57.4.6.2.3 status_t HAL_CODEC_CS42888_SetFormat (void ∗ *handle,* uint32_t *mclk,* uint32_t *sampleRate,* uint32_t *bitWidth*)

Parameters

handle	codec handle.
mclk	master clock frequency in HZ.
sampleRate	sample rate in HZ.
bitWidth	bit width.

Returns

kStatus_Success is success, else configure failed.

57.4.6.2.4 status_t HAL_CODEC_CS42888_SetVolume (void ∗ *handle,* uint32_t *playChannel,* uint32_t *volume*)

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
volume	volume value, support 0 ∼ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

57.4.6.2.5 status_t HAL_CODEC_CS42888_SetMute (void ∗ *handle,* uint32_t *playChannel,* bool *isMute*)

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
isMute	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

57.4.6.2.6 status_t HAL_CODEC_CS42888_SetPower (void ∗ *handle,* uint32_t *module,* bool *powerOn*)

Parameters

handle	codec handle.
module	audio codec module.
powerOn	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

57.4.6.2.7 status_t HAL_CODEC_CS42888_SetRecord (void * *handle,* uint32_t *recordSource*)

Parameters

handle	codec handle.
recordSource	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

57.4.6.2.8 status_t HAL_CODEC_CS42888_SetRecordChannel (void * *handle,* uint32_t *leftRecordChannel,* uint32_t *rightRecordChannel*)

Parameters

handle	codec handle.
leftRecordChannel	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
rightRecordChannel	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.

57.4.6.2.9 status_t HAL_CODEC_CS42888_SetPlay (void * *handle,* uint32_t *playSource*)

Parameters

handle	codec handle.
playSource	audio codec play source, can be a value or combine value of _codec_play_source.

Returns

kStatus_Success is success, else configure failed.

57.4.6.2.10 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

handle	codec handle.
cmd	module control cmd, reference _codec_module_ctrl_cmd.
data	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.

57.4.6.2.11 static status_t HAL_CODEC_Init (void * *handle,* void * *config*) `[inline], [static]`

Parameters

handle	codec handle.
config	codec configuration.

Returns

kStatus_Success is success, else initial failed.

57.4.6.2.12 static status_t HAL_CODEC_Deinit (void * *handle*) `[inline], [static]`

Parameters

handle	codec handle.

Returns

kStatus_Success is success, else de-initial failed.

57.4.6.2.13 static status_t HAL_CODEC_SetFormat (void ∗ *handle,* uint32_t *mclk,* uint32_t *sampleRate,* uint32_t *bitWidth*) [inline], [static]

Parameters

handle	codec handle.
mclk	master clock frequency in HZ.
sampleRate	sample rate in HZ.
bitWidth	bit width.

Returns

kStatus_Success is success, else configure failed.

57.4.6.2.14 static status_t HAL_CODEC_SetVolume (void ∗ *handle,* uint32_t *playChannel,* uint32_t *volume*) [inline], [static]

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
volume	volume value, support 0 ∼ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

57.4.6.2.15 static status_t HAL_CODEC_SetMute (void ∗ *handle,* uint32_t *playChannel,* bool *isMute*) [inline], [static]

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
isMute	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

57.4.6.2.16 static status_t HAL_CODEC_SetPower (void * *handle,* uint32_t *module,* bool *powerOn*) [inline], [static]

Parameters

handle	codec handle.
module	audio codec module.
powerOn	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

57.4.6.2.17 static status_t HAL_CODEC_SetRecord (void * *handle,* uint32_t *recordSource*) [inline], [static]

Parameters

handle	codec handle.
recordSource	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

57.4.6.2.18 static status_t HAL_CODEC_SetRecordChannel (void * *handle,* uint32_t *leftRecordChannel,* uint32_t *rightRecordChannel*) [inline], [static]

Parameters

handle	codec handle.
leftRecord-Channel	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
rightRecord-Channel	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.

57.4.6.2.19 static status_t HAL_CODEC_SetPlay (void ∗ *handle,* uint32_t *playSource*) [inline], [static]

Parameters

handle	codec handle.
playSource	audio codec play source, can be a value or combine value of _codec_play_source.

Returns

kStatus_Success is success, else configure failed.

57.4.6.2.20 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

handle	codec handle.
cmd	module control cmd, reference _codec_module_ctrl_cmd.
data	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.

57.5 DA7212 Driver

57.5.1 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 fll 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.

57.5.2 Data Structure Documentation

57.5.2.1 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

57.5.2.2 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 intervet

57.5.2.3 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

57.5.2.4 struct da7212_handle_t

Data Fields

- da7212_config_t * config
  da7212 config pointer
- uint8_t i2cHandle [DA7212_I2C_HANDLER_SIZE]
  i2c handle

57.5.3 Macro Definition Documentation

57.5.3.1 #define FSL_DA7212_DRIVER_VERSION (MAKE_VERSION(2, 2, 2))

57.5.4 Enumeration Type Documentation

57.5.4.1 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.

57.5.4.2 enum _da7212_play_channel

Enumerator

kDA7212_HeadphoneLeft headphone left
kDA7212_HeadphoneRight headphone right
kDA7212_Speaker speaker channel

57.5.4.3 enum da7212_Output_t

Enumerator

kDA7212_Output_HP Output to headphone.
kDA7212_Output_SP Output to speaker.

57.5.4.4 enum _da7212_module

Enumerator

kDA7212_ModuleADC module ADC
kDA7212_ModuleDAC module DAC
kDA7212_ModuleHeadphone module headphone
kDA7212_ModuleSpeaker module speaker

57.5.4.5 enum da7212_dac_source_t

Enumerator

kDA7212_DACSourceADC DAC source from ADC.
kDA7212_DACSourceInputStream DAC source from.

57.5.4.6 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 -6bb.
kDA7212_DACGain0DB DAC volume +0db.
kDA7212_DACGain6DB DAC volume +6db.
kDA7212_DACGain12DB DAC volume +12db.

57.5.4.7 enum da7212_protocol_t

Enumerator

kDA7212_BusI2S I2S Type.
kDA7212_BusLeftJustified Left justified.
kDA7212_BusRightJustified Right Justified.
kDA7212_BusDSPMode DSP mode.

57.5.4.8 enum da7212_sys_clk_source_t

Enumerator

kDA7212_SysClkSourceMCLK da7212 system clock soure from MCLK
kDA7212_SysClkSourcePLL da7212 system clock soure from pLL

57.5.4.9 enum da7212_pll_clk_source_t

Enumerator

kDA7212_PLLClkSourceMCLK DA7212 PLL clock source from MCLK.

57.5.4.10 enum da7212_pll_out_clk_t

Enumerator

kDA7212_PLLOutputClk11289600 output 112896000U
kDA7212_PLLOutputClk12288000 output 12288000U

57.5.4.11 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

57.5.5 Function Documentation

57.5.5.1 status_t DA7212_Init (da7212_handle_t * *handle*, da7212_config_t * *codecConfig*)

Parameters

handle	DA7212 handle pointer.

codecConfig	Codec configure structure. This parameter can be NULL, if NULL, set as default settings. The default setting:
	`* sgtl_init_t codec_config`
	`* codec_config.route = kDA7212_RoutePlayback`
	`* codec_config.bus = kDA7212_BusI2S`
	`* codec_config.isMaster = false`
	`*`

57.5.5.2 status_t DA7212_ConfigAudioFormat (da7212_handle_t ∗ *handle,* uint32_t *masterClock_Hz,* uint32_t *sampleRate_Hz,* uint32_t *dataBits*)

Parameters

handle	DA7212 handle pointer.
masterClock_Hz	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
sampleRate_Hz	Sample rate frequency in Hz.
dataBits	How many bits in a word of a audio frame, DA7212 only supports 16/20/24/32 bits.

57.5.5.3 status_t DA7212_SetPLLConfig (da7212_handle_t ∗ *handle,* da7212_pll_config_t ∗ *config*)

Parameters

handle	DA7212 handler pointer.
config	PLL configuration pointer.

57.5.5.4 void DA7212_ChangeHPVolume (da7212_handle_t ∗ *handle,* da7212_volume_t *volume*)

Parameters

handle	DA7212 handle pointer.
volume	The volume of playback.

57.5.5.5 void DA7212_Mute (da7212_handle_t ∗ *handle,* bool *isMuted*)

Parameters

handle	DA7212 handle pointer.
isMuted	True means mute, false means unmute.

57.5.5.6 void DA7212_ChangeInput (da7212_handle_t ∗ *handle,* da7212_Input_t *DA7212_Input*)

Parameters

handle	DA7212 handle pointer.
DA7212_Input	Input data source.

57.5.5.7 void DA7212_ChangeOutput (da7212_handle_t ∗ *handle,* da7212_Output_t *DA7212_Output*)

Parameters

handle	DA7212 handle pointer.
DA7212_-Output	Output device of DA7212.

57.5.5.8 status_t DA7212_SetChannelVolume (da7212_handle_t ∗ *handle,* uint32_t *channel,* uint32_t *volume*)

Parameters

handle	DA7212 handle pointer.
channel	shoule be a value of _da7212_channel.
volume	volume range 0 - 0x3F mapped to range -57dB - 6dB.

57.5.5.9 status_t DA7212_SetChannelMute (da7212_handle_t ∗ *handle,* uint32_t *channel,* bool *isMute*)

Parameters

handle	DA7212 handle pointer.
channel	shoule be a value of _da7212_channel.
isMute	true is mute, false is unmute.

57.5.5.10 status_t DA7212_SetProtocol (da7212_handle_t ∗ *handle,* da7212_protocol_t *protocol*)

Parameters

handle	DA7212 handle pointer.
protocol	da7212_protocol_t.

57.5.5.11 status_t DA7212_SetMasterModeBits (da7212_handle_t ∗ *handle,* uint32_t *bitWidth*)

Parameters

handle	DA7212 handle pointer.
bitWidth	audio data bitwidth.

57.5.5.12 status_t DA7212_WriteRegister (da7212_handle_t ∗ *handle,* uint8_t *u8Register,* uint8_t *u8RegisterData*)

Parameters

handle	DA7212 handle pointer.
u8Register	DA7212 register address to be written.
u8RegisterData	Data to be written into regsiter

57.5.5.13 status_t DA7212_ReadRegister (da7212_handle_t ∗ *handle,* uint8_t *u8Register,* uint8_t ∗ *pu8RegisterData*)

Parameters

handle	DA7212 handle pointer.
u8Register	DA7212 register address to be read.
pu8Register-Data	Pointer where the read out value to be stored.

57.5.5.14 status_t DA7212_Deinit (da7212_handle_t ∗ *handle*)

Parameters

handle	DA7212 handle pointer.

57.5.6 DA7212 Adapter

57.5.6.1 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 initilization.
- status_t HAL_CODEC_DA7212_Deinit (void *handle)
  Codec de-initilization.
- 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 initilization.
- static status_t HAL_CODEC_Deinit (void *handle)
  Codec de-initilization.
- 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.

57.5.6.2 Function Documentation

57.5.6.2.1 status_t HAL_CODEC_DA7212_Init (void ∗ *handle,* void ∗ *config*)

Parameters

handle	codec handle.
config	codec configuration.

Returns

kStatus_Success is success, else initial failed.

57.5.6.2.2 status_t HAL_CODEC_DA7212_Deinit (void ∗ *handle*)

Parameters

handle	codec handle.

Returns

kStatus_Success is success, else de-initial failed.

57.5.6.2.3 status_t HAL_CODEC_DA7212_SetFormat (void ∗ *handle,* uint32_t *mclk,* uint32_t *sampleRate,* uint32_t *bitWidth*)

Parameters

handle	codec handle.
mclk	master clock frequency in HZ.
sampleRate	sample rate in HZ.
bitWidth	bit width.

Returns

kStatus_Success is success, else configure failed.

57.5.6.2.4 status_t HAL_CODEC_DA7212_SetVolume (void ∗ *handle,* uint32_t *playChannel,* uint32_t *volume*)

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
volume	volume value, support 0 ∼ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

57.5.6.2.5 status_t HAL_CODEC_DA7212_SetMute (void ∗ *handle,* uint32_t *playChannel,* bool *isMute*)

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
isMute	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

57.5.6.2.6 status_t HAL_CODEC_DA7212_SetPower (void ∗ *handle,* uint32_t *module,* bool *powerOn*)

Parameters

handle	codec handle.
module	audio codec module.
powerOn	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

57.5.6.2.7 status_t HAL_CODEC_DA7212_SetRecord (void ∗ *handle,* uint32_t *recordSource*)

Parameters

handle	codec handle.
recordSource	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

57.5.6.2.8 status_t HAL_CODEC_DA7212_SetRecordChannel (void ∗ *handle,* uint32_t *leftRecordChannel,* uint32_t *rightRecordChannel*)

Parameters

handle	codec handle.
leftRecordChannel	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
rightRecordChannel	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.

57.5.6.2.9 status_t HAL_CODEC_DA7212_SetPlay (void ∗ *handle,* uint32_t *playSource*)

Parameters

handle	codec handle.
playSource	audio codec play source, can be a value or combine value of _codec_play_source.

Returns

kStatus_Success is success, else configure failed.

57.5.6.2.10 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

handle	codec handle.
cmd	module control cmd, reference _codec_module_ctrl_cmd.
data	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.

57.5.6.2.11 static status_t HAL_CODEC_Init (void * *handle,* void * *config*) `[inline], [static]`

Parameters

handle	codec handle.
config	codec configuration.

Returns

kStatus_Success is success, else initial failed.

57.5.6.2.12 static status_t HAL_CODEC_Deinit (void * *handle*) `[inline], [static]`

Parameters

handle	codec handle.

Returns

kStatus_Success is success, else de-initial failed.

57.5.6.2.13 static status_t HAL_CODEC_SetFormat (void ∗ *handle,* uint32_t *mclk,* uint32_t *sampleRate,* uint32_t *bitWidth*) [inline], [static]

Parameters

handle	codec handle.
mclk	master clock frequency in HZ.
sampleRate	sample rate in HZ.
bitWidth	bit width.

Returns

kStatus_Success is success, else configure failed.

57.5.6.2.14 static status_t HAL_CODEC_SetVolume (void ∗ *handle,* uint32_t *playChannel,* uint32_t *volume*) [inline], [static]

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
volume	volume value, support 0 ∼ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

57.5.6.2.15 static status_t HAL_CODEC_SetMute (void ∗ *handle,* uint32_t *playChannel,* bool *isMute*) [inline], [static]

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
isMute	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

57.5.6.2.16 static status_t HAL_CODEC_SetPower (void * *handle,* uint32_t *module,* bool *powerOn*) [inline], [static]

Parameters

handle	codec handle.
module	audio codec module.
powerOn	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

57.5.6.2.17 static status_t HAL_CODEC_SetRecord (void * *handle,* uint32_t *recordSource*) [inline], [static]

Parameters

handle	codec handle.
recordSource	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

57.5.6.2.18 static status_t HAL_CODEC_SetRecordChannel (void * *handle,* uint32_t *leftRecordChannel,* uint32_t *rightRecordChannel*) [inline], [static]

Parameters

handle	codec handle.
leftRecord-Channel	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
rightRecord-Channel	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.

57.5.6.2.19 static status_t HAL_CODEC_SetPlay (void ∗ *handle,* uint32_t *playSource*) [inline], [static]

Parameters

handle	codec handle.
playSource	audio codec play source, can be a value or combine value of _codec_play_source.

Returns

kStatus_Success is success, else configure failed.

57.5.6.2.20 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

handle	codec handle.
cmd	module control cmd, reference _codec_module_ctrl_cmd.
data	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.

57.6 SGTL5000 Driver

57.6.1 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 _stgl_play_source
- enum sgtl_sclk_edge_t {
  kSGTL_SclkValidEdgeRising = 0U,
  kSGTL_SclkValidEdgeFailling = 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.

57.6.2 Data Structure Documentation

57.6.2.1 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

57.6.2.2 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.

57.6.2.3 struct sgtl_handle_t

Data Fields

- sgtl_config_t * config
  sgtl config pointer
- uint8_t i2cHandle [SGTL_I2C_HANDLER_SIZE]
  i2c handle

57.6.3 Macro Definition Documentation

57.6.3.1 #define FSL_SGTL5000_DRIVER_VERSION (MAKE_VERSION(2, 1, 1))

57.6.3.2 #define CHIP_ID 0x0000U

57.6.3.3 #define SGTL5000_I2C_ADDR 0x0A

57.6.4 Enumeration Type Documentation

57.6.4.1 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 moudle in SGTL5000.
kSGTL_ModuleLineOut Line-out module in SGTL5000.
kSGTL_ModuleMicin Micphone module in SGTL5000.

57.6.4.2 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 precios 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.

57.6.4.3 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.

57.6.4.4 anonymous enum

Enumerator

kSGTL_HeadphoneLeft headphone left channel
kSGTL_HeadphoneRight headphone right channel
kSGTL_LineoutLeft lineout left channel
kSGTL_LineoutRight lineout right channel

57.6.4.5 anonymous enum

Enumerator

kSGTL_RecordSourceLineIn record source line in
kSGTL_RecordSourceMic record source single end

57.6.4.6 anonymous enum

Enumerator

kSGTL_PlaySourceLineIn play source line in
kSGTL_PlaySourceDAC play source line in

57.6.4.7 enum sgtl_sclk_edge_t

Enumerator

kSGTL_SclkValidEdgeRising SCLK valid edge.
kSGTL_SclkValidEdgeFailling SCLK failling edge.

57.6.5 Function Documentation

57.6.5.1 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

handle	Sgtl5000 handle structure.
config	sgtl5000 configuration structure. If this pointer equals to NULL, it means using the default configuration.

Returns

Initialization status

57.6.5.2 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

handle	Sgtl5000 handle structure.
route	Audio data route in sgtl5000.

57.6.5.3 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

handle	Sgtl5000 handle structure.
protocol	Audio data transfer protocol.

57.6.5.4 void SGTL_SetMasterSlave (sgtl_handle_t * *handle,* bool *master*)

Parameters

handle	Sgtl5000 handle structure.
master	1 represent master, 0 represent slave.

57.6.5.5 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

handle	Sgtl5000 handle structure.
module	Sgtl5000 module, such as DAC, ADC and etc.
volume	Volume value need to be set. The value is the exact value in register.

57.6.5.6 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

handle	Sgtl5000 handle structure.
module	Sgtl5000 module, such as DAC, ADC and etc.

Returns

Module value, the value is exact value in register.

57.6.5.7 status_t SGTL_SetMute (sgtl_handle_t * *handle,* sgtl_module_t *module,* bool *mute*)

Parameters

handle	Sgtl5000 handle structure.
module	Sgtl5000 module, such as DAC, ADC and etc.
mute	True means mute, and false means unmute.

57.6.5.8 status_t SGTL_EnableModule (sgtl_handle_t ∗ *handle,* sgtl_module_t *module*)

Parameters

handle	Sgtl5000 handle structure.
module	Module expected to enable.

57.6.5.9 status_t SGTL_DisableModule (sgtl_handle_t ∗ *handle,* sgtl_module_t *module*)

Parameters

handle	Sgtl5000 handle structure.
module	Module expected to enable.

57.6.5.10 status_t SGTL_Deinit (sgtl_handle_t ∗ *handle*)

Shut down Sgtl5000 modules.

Parameters

handle	Sgtl5000 handle structure pointer.

57.6.5.11 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

handle	Sgtl5000 handle structure pointer.
mclk	Master clock frequency of I2S.
sample_rate	Sample rate of audio file running in sgtl5000. Sgtl5000 now supports 8k, 11.025k, 12k, 16k, 22.05k, 24k, 32k, 44.1k, 48k and 96k sample rate.
bits	Bit depth of audio file (Sgtl5000 only supports 16bit, 20bit, 24bit and 32 bit in HW).

57.6.5.12 status_t SGTL_SetPlay (sgtl_handle_t * *handle,* uint32_t *playSource*)

Parameters

handle	Sgtl5000 handle structure pointer.
playSource	play source value, reference _sgtl_play_source.

Returns

kStatus_Success, else failed.

57.6.5.13 status_t SGTL_SetRecord (sgtl_handle_t * *handle,* uint32_t *recordSource*)

Parameters

handle	Sgtl5000 handle structure pointer.
recordSource	record source value, reference _sgtl_record_source.

Returns

kStatus_Success, else failed.

57.6.5.14 status_t SGTL_WriteReg (sgtl_handle_t * *handle,* uint16_t *reg,* uint16_t *val*)

Parameters

handle	Sgtl5000 handle structure.

reg	The register address in sgtl.
val	Value needs to write into the register.

57.6.5.15 status_t SGTL_ReadReg (sgtl_handle_t ∗ *handle,* uint16_t *reg,* uint16_t ∗ *val*)

Parameters

handle	Sgtl5000 handle structure.
reg	The register address in sgtl.
val	Value written to.

57.6.5.16 status_t SGTL_ModifyReg (sgtl_handle_t ∗ *handle,* uint16_t *reg,* uint16_t *clr_mask,* uint16_t *val*)

Parameters

handle	Sgtl5000 handle structure.
reg	The register address in sgtl.
clr_mask	The mask code for the bits want to write. The bit you want to write should be 0.
val	Value needs to write into the register.

57.6.6 SGTL5000 Adapter

57.6.6.1 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 initilization.
- status_t HAL_CODEC_SGTL5000_Deinit (void *handle)
  Codec de-initilization.
- 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 initilization.
- static status_t HAL_CODEC_Deinit (void *handle)
  Codec de-initilization.
- 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.

57.6.6.2 Function Documentation

57.6.6.2.1 status_t HAL_CODEC_SGTL5000_Init (void ∗ *handle,* void ∗ *config*)

Parameters

handle	codec handle.
config	codec configuration.

Returns

kStatus_Success is success, else initial failed.

57.6.6.2.2 status_t HAL_CODEC_SGTL5000_Deinit (void ∗ *handle*)

Parameters

handle	codec handle.

Returns

kStatus_Success is success, else de-initial failed.

57.6.6.2.3 status_t HAL_CODEC_SGTL5000_SetFormat (void ∗ *handle,* uint32_t *mclk,* uint32_t *sampleRate,* uint32_t *bitWidth*)

Parameters

handle	codec handle.
mclk	master clock frequency in HZ.
sampleRate	sample rate in HZ.
bitWidth	bit width.

Returns

kStatus_Success is success, else configure failed.

57.6.6.2.4 status_t HAL_CODEC_SGTL5000_SetVolume (void ∗ *handle,* uint32_t *playChannel,* uint32_t *volume*)

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
volume	volume value, support 0 ∼ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

57.6.6.2.5 status_t HAL_CODEC_SGTL5000_SetMute (void ∗ *handle,* uint32_t *playChannel,* bool *isMute*)

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
isMute	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

57.6.6.2.6 status_t HAL_CODEC_SGTL5000_SetPower (void ∗ *handle,* uint32_t *module,* bool *powerOn*)

Parameters

handle	codec handle.
module	audio codec module.
powerOn	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

57.6.6.2.7 status_t HAL_CODEC_SGTL5000_SetRecord (void ∗ *handle,* uint32_t *recordSource*)

Parameters

handle	codec handle.
recordSource	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

57.6.6.2.8 status_t HAL_CODEC_SGTL5000_SetRecordChannel (void ∗ *handle,* uint32_t *leftRecordChannel,* uint32_t *rightRecordChannel*)

Parameters

handle	codec handle.
leftRecordChannel	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
rightRecordChannel	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.

57.6.6.2.9 status_t HAL_CODEC_SGTL5000_SetPlay (void ∗ *handle,* uint32_t *playSource*)

Parameters

handle	codec handle.
playSource	audio codec play source, can be a value or combine value of _codec_play_source.

Returns

kStatus_Success is success, else configure failed.

57.6.6.2.10 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

handle	codec handle.
cmd	module control cmd, reference _codec_module_ctrl_cmd.
data	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.

57.6.6.2.11 static status_t HAL_CODEC_Init (void * *handle,* void * *config*) `[inline], [static]`

Parameters

handle	codec handle.
config	codec configuration.

Returns

kStatus_Success is success, else initial failed.

57.6.6.2.12 static status_t HAL_CODEC_Deinit (void * *handle*) `[inline], [static]`

Parameters

handle	codec handle.

Returns

kStatus_Success is success, else de-initial failed.

57.6.6.2.13 static status_t HAL_CODEC_SetFormat (void ∗ *handle,* uint32_t *mclk,* uint32_t *sampleRate,* uint32_t *bitWidth*) [inline], [static]

Parameters

handle	codec handle.
mclk	master clock frequency in HZ.
sampleRate	sample rate in HZ.
bitWidth	bit width.

Returns

kStatus_Success is success, else configure failed.

57.6.6.2.14 static status_t HAL_CODEC_SetVolume (void ∗ *handle,* uint32_t *playChannel,* uint32_t *volume*) [inline], [static]

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
volume	volume value, support 0 ∼ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

57.6.6.2.15 static status_t HAL_CODEC_SetMute (void ∗ *handle,* uint32_t *playChannel,* bool *isMute*) [inline], [static]

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
isMute	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

57.6.6.2.16 static status_t HAL_CODEC_SetPower (void ∗ *handle,* uint32_t *module,* bool *powerOn*) [inline], [static]

Parameters

handle	codec handle.
module	audio codec module.
powerOn	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

57.6.6.2.17 static status_t HAL_CODEC_SetRecord (void ∗ *handle,* uint32_t *recordSource*) [inline], [static]

Parameters

handle	codec handle.
recordSource	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

57.6.6.2.18 static status_t HAL_CODEC_SetRecordChannel (void ∗ *handle,* uint32_t *leftRecordChannel,* uint32_t *rightRecordChannel*) [inline], [static]

Parameters

handle	codec handle.
leftRecord-Channel	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
rightRecord-Channel	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.

57.6.6.2.19 static status_t HAL_CODEC_SetPlay (void ∗ *handle,* uint32_t *playSource*) [inline], [static]

Parameters

handle	codec handle.
playSource	audio codec play source, can be a value or combine value of _codec_play_source.

Returns

kStatus_Success is success, else configure failed.

57.6.6.2.20 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

handle	codec handle.
cmd	module control cmd, reference _codec_module_ctrl_cmd.
data	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.

57.7 WM8960 Driver

57.7.1 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, 0))
  CLOCK driver version 2.2.0.

57.7.2 Data Structure Documentation

57.7.2.1 struct wm8960_audio_format_t

Data Fields

- uint32_t mclk_HZ
  master clock frequency
- uint32_t sampleRate
  sample rate
- uint32_t bitWidth
  bit width

57.7.2.2 struct wm8960_master_sysclk_config_t

Data Fields

- wm8960_sysclk_source_t sysclkSource
  sysclk source
- uint32_t sysclkFreq
  PLL output frequency value.

57.7.2.3 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

57.7.2.4 struct wm8960_handle_t

Data Fields

- const wm8960_config_t ∗ config
  wm8904 config pointer
- uint8_t i2cHandle [WM8960_I2C_HANDLER_SIZE]
  i2c handle

57.7.3 Macro Definition Documentation

57.7.3.1 #define WM8960_LINVOL 0x0U

57.7.3.2 #define WM8960_I2C_ADDR 0x1A

57.7.4 Enumeration Type Documentation

57.7.4.1 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.

57.7.4.2 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

57.7.4.3 enum wm8960_play_source_t

Enumerator

kWM8960_PlaySourcePGA wm8960 play source PGA
kWM8960_PlaySourceInput wm8960 play source Input
kWM8960_PlaySourceDAC wm8960 play source DAC

57.7.4.4 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.

57.7.4.5 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.

57.7.4.6 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.

57.7.4.7 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.

57.7.4.8 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

57.7.4.9 enum wm8960_sysclk_source_t

Enumerator

kWM8960_SysClkSourceMclk sysclk source from external MCLK
kWM8960_SysClkSourceInternalPLL sysclk source from internal PLL

57.7.5 Function Documentation

57.7.5.1 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

handle	WM8960 handle structure.
config	WM8960 configuration structure.

57.7.5.2 status_t WM8960_Deinit (wm8960_handle_t * *handle*)

This function close all modules in WM8960 to save power.

Parameters

handle	WM8960 handle structure pointer.

57.7.5.3 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

handle	WM8960 handle structure.
route	Audio data route in WM8960.

57.7.5.4 status_t WM8960_SetLeftInput (wm8960_handle_t * *handle*, wm8960_input_t *input*)

Parameters

handle	WM8960 handle structure.
input	Audio input source.

57.7.5.5 status_t WM8960_SetRightInput (wm8960_handle_t * *handle*, wm8960_input_t *input*)

Parameters

handle	WM8960 handle structure.
input	Audio input source.

57.7.5.6 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

handle	WM8960 handle structure.
protocol	Audio data transfer protocol.

57.7.5.7 void WM8960_SetMasterSlave (wm8960_handle_t * *handle,* bool *master*)

Parameters

handle	WM8960 handle structure.
master	1 represent master, 0 represent slave.

57.7.5.8 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

handle	WM8960 handle structure.
module	Module to set volume, it can be ADC, DAC, Headphone and so on.
volume	Volume value need to be set.

57.7.5.9 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

handle	WM8960 handle structure.
module	Module to set volume, it can be ADC, DAC, Headphone and so on.

Returns

Volume value of the module.

57.7.5.10 status_t WM8960_SetMute (wm8960_handle_t * *handle*, wm8960_module_t *module*, bool *isEnabled*)

Parameters

handle	WM8960 handle structure.
module	Modules need to be mute.
isEnabled	Mute or unmute, 1 represent mute.

57.7.5.11 status_t WM8960_SetModule (wm8960_handle_t * *handle*, wm8960_module_t *module*, bool *isEnabled*)

Parameters

handle	WM8960 handle structure.
module	Module expected to enable.
isEnabled	Enable or disable moudles.

57.7.5.12 status_t WM8960_SetPlay (wm8960_handle_t * *handle*, uint32_t *playSource*)

Parameters

handle	WM8960 handle structure.
playSource	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..

57.7.5.13 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

handle	WM8960 handle structure pointer.
sysclk	system clock of the codec which can be generated by MCLK or PLL output.
sample_rate	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.
bits	Bit depth of audio file (WM8960 only supports 16bit, 20bit, 24bit and 32 bit in HW).

57.7.5.14 status_t WM8960_SetJackDetect (wm8960_handle_t ∗ *handle,* bool *isEnabled*)

Parameters

handle	WM8960 handle structure.
isEnabled	Enable or disable moudles.

57.7.5.15 status_t WM8960_WriteReg (wm8960_handle_t ∗ *handle,* uint8_t *reg,* uint16_t *val*)

Parameters

handle	WM8960 handle structure.
reg	The register address in WM8960.
val	Value needs to write into the register.

57.7.5.16 status_t WM8960_ReadReg (uint8_t *reg,* uint16_t ∗ *val*)

Parameters

reg	The register address in WM8960.
val	Value written to.

57.7.5.17 status_t WM8960_ModifyReg (wm8960_handle_t ∗ *handle,* uint8_t *reg,* uint16_t *mask,* uint16_t *val*)

Parameters

handle	WM8960 handle structure.
reg	The register address in WM8960.
mask	The mask code for the bits want to write. The bit you want to write should be 0.
val	Value needs to write into the register.

57.7.6 WM8960 Adapter

57.7.6.1 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 initilization.
- status_t HAL_CODEC_WM8960_Deinit (void *handle)
  Codec de-initilization.
- 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 initilization.
- static status_t HAL_CODEC_Deinit (void *handle)
  Codec de-initilization.
- 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.

57.7.6.2 Function Documentation

57.7.6.2.1 status_t HAL_CODEC_WM8960_Init (void ∗ *handle,* void ∗ *config*)

Parameters

handle	codec handle.
config	codec configuration.

Returns

kStatus_Success is success, else initial failed.

57.7.6.2.2 status_t HAL_CODEC_WM8960_Deinit (void ∗ *handle*)

Parameters

handle	codec handle.

Returns

kStatus_Success is success, else de-initial failed.

57.7.6.2.3 status_t HAL_CODEC_WM8960_SetFormat (void ∗ *handle,* uint32_t *mclk,* uint32_t *sampleRate,* uint32_t *bitWidth*)

Parameters

handle	codec handle.
mclk	master clock frequency in HZ.
sampleRate	sample rate in HZ.
bitWidth	bit width.

Returns

kStatus_Success is success, else configure failed.

57.7.6.2.4 status_t HAL_CODEC_WM8960_SetVolume (void ∗ *handle,* uint32_t *playChannel,* uint32_t *volume*)

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
volume	volume value, support 0 ∼ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

57.7.6.2.5 status_t HAL_CODEC_WM8960_SetMute (void ∗ *handle,* uint32_t *playChannel,* bool *isMute*)

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
isMute	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

57.7.6.2.6 status_t HAL_CODEC_WM8960_SetPower (void ∗ *handle,* uint32_t *module,* bool *powerOn*)

Parameters

handle	codec handle.
module	audio codec module.
powerOn	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

57.7.6.2.7 status_t HAL_CODEC_WM8960_SetRecord (void ∗ *handle,* uint32_t *recordSource*)

Parameters

handle	codec handle.
recordSource	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

57.7.6.2.8 status_t HAL_CODEC_WM8960_SetRecordChannel (void ∗ *handle,* uint32_t *leftRecordChannel,* uint32_t *rightRecordChannel*)

Parameters

handle	codec handle.
leftRecordChannel	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
rightRecordChannel	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.

57.7.6.2.9 status_t HAL_CODEC_WM8960_SetPlay (void ∗ *handle,* uint32_t *playSource*)

Parameters

handle	codec handle.
playSource	audio codec play source, can be a value or combine value of _codec_play_source.

Returns

kStatus_Success is success, else configure failed.

57.7.6.2.10 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

handle	codec handle.
cmd	module control cmd, reference _codec_module_ctrl_cmd.
data	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.

57.7.6.2.11 static status_t HAL_CODEC_Init (void * *handle,* void * *config*) `[inline], [static]`

Parameters

handle	codec handle.
config	codec configuration.

Returns

kStatus_Success is success, else initial failed.

57.7.6.2.12 static status_t HAL_CODEC_Deinit (void * *handle*) `[inline], [static]`

Parameters

handle	codec handle.

Returns

kStatus_Success is success, else de-initial failed.

57.7.6.2.13 static status_t HAL_CODEC_SetFormat (void ∗ *handle,* uint32_t *mclk,* uint32_t *sampleRate,* uint32_t *bitWidth*) [inline], [static]

Parameters

handle	codec handle.
mclk	master clock frequency in HZ.
sampleRate	sample rate in HZ.
bitWidth	bit width.

Returns

kStatus_Success is success, else configure failed.

57.7.6.2.14 static status_t HAL_CODEC_SetVolume (void ∗ *handle,* uint32_t *playChannel,* uint32_t *volume*) [inline], [static]

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
volume	volume value, support 0 ∼ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

57.7.6.2.15 static status_t HAL_CODEC_SetMute (void ∗ *handle,* uint32_t *playChannel,* bool *isMute*) [inline], [static]

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
isMute	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

57.7.6.2.16 static status_t HAL_CODEC_SetPower (void * *handle,* uint32_t *module,* bool *powerOn*) [inline], [static]

Parameters

handle	codec handle.
module	audio codec module.
powerOn	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

57.7.6.2.17 static status_t HAL_CODEC_SetRecord (void * *handle,* uint32_t *recordSource*) [inline], [static]

Parameters

handle	codec handle.
recordSource	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

57.7.6.2.18 static status_t HAL_CODEC_SetRecordChannel (void * *handle,* uint32_t *leftRecordChannel,* uint32_t *rightRecordChannel*) [inline], [static]

Parameters

handle	codec handle.
leftRecord-Channel	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
rightRecord-Channel	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.

57.7.6.2.19 static status_t HAL_CODEC_SetPlay (void ∗ *handle,* uint32_t *playSource*) [inline], [static]

Parameters

handle	codec handle.
playSource	audio codec play source, can be a value or combine value of _codec_play_source.

Returns

kStatus_Success is success, else configure failed.

57.7.6.2.20 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

handle	codec handle.
cmd	module control cmd, reference _codec_module_ctrl_cmd.
data	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.

57.8 WM8904 Driver

57.8.1 Overview

The wm8904 driver provides a codec control interface.

Data Structures

- struct wm8904_fll_config_t
  wm8904 fll 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 write 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_fll_config_t *config)
  WM8904 set PLL configuration This function will enable the GPIO1 FLL clock output function, so user can see the generated fll 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_EnableDACTDMMode (wm8904_handle_t *handle, wm8904_timeslot_t timeSlot)
  Enable WM8904 DAC time slot.
- status_t WM8904_EnableADCTDMMode (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, 0))
  WM8904 driver version 2.5.0.

57.8.2 Data Structure Documentation

57.8.2.1 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

57.8.2.2 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.

57.8.2.3 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

57.8.2.4 struct wm8904_handle_t

Data Fields

- wm8904_config_t * config
  wm8904 config pointer
- uint8_t i2cHandle [WM8904_I2C_HANDLER_SIZE]
  i2c handle

57.8.3 Macro Definition Documentation

57.8.3.1 #define FSL_WM8904_DRIVER_VERSION (MAKE_VERSION(2, 5, 0))

57.8.3.2 #define WM8904_I2C_ADDRESS (0x1A)

57.8.3.3 #define WM8904_I2C_BITRATE (400000U)

57.8.4 Enumeration Type Documentation

57.8.4.1 anonymous enum

Enumerator

kStatus_WM8904_Success Success.
kStatus_WM8904_Fail Failure.

57.8.4.2 anonymous enum

Enumerator

kWM8904_LRCPolarityNormal LRC polarity normal.
kWM8904_LRCPolarityInverted LRC polarity inverted.

57.8.4.3 enum wm8904_module_t

Enumerator

kWM8904_ModuleADC moduel ADC
kWM8904_ModuleDAC module DAC
kWM8904_ModulePGA module PGA
kWM8904_ModuleHeadphone module headphone
kWM8904_ModuleLineout module line out

57.8.4.4 anonymous enum

57.8.4.5 enum wm8904_timeslot_t

Enumerator

kWM8904_TimeSlot0 time slot0
kWM8904_TimeSlot1 time slot1

57.8.4.6 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.

57.8.4.7 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.

57.8.4.8 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

57.8.4.9 enum wm8904_bit_width_t

Enumerator

kWM8904_BitWidth16 16 bits
kWM8904_BitWidth20 20 bits
kWM8904_BitWidth24 24 bits
kWM8904_BitWidth32 32 bits

57.8.4.10 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

57.8.4.11 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

57.8.4.12 anonymous enum

Enumerator

kWM8904_PlaySourcePGA play source PGA, bypass ADC
kWM8904_PlaySourceDAC play source Input3

57.8.4.13 enum wm8904_sys_clk_source_t

Enumerator

kWM8904_SysClkSourceMCLK wm8904 system clock soure from MCLK
kWM8904_SysClkSourceFLL wm8904 system clock soure from FLL

57.8.4.14 enum wm8904_fll_clk_source_t

Enumerator

kWM8904_FLLClkSourceMCLK wm8904 FLL clock source from MCLK

57.8.5 Function Documentation

57.8.5.1 status_t WM8904_WriteRegister (wm8904_handle_t * *handle*, uint8_t *reg*, uint16_t *value*)

Parameters

handle	WM8904 handle structure.
reg	register address.
value	value to write.

Returns

kStatus_Success, else failed.

57.8.5.2 status_t WM8904_ReadRegister (wm8904_handle_t * *handle*, uint8_t *reg*, uint16_t * *value*)

Parameters

handle	WM8904 handle structure.
reg	register address.
value	value to read.

Returns

kStatus_Success, else failed.

57.8.5.3 status_t WM8904_ModifyRegister (wm8904_handle_t * *handle,* uint8_t *reg,* uint16_t *mask,* uint16_t *value*)

Parameters

handle	WM8904 handle structure.
reg	register address.
mask	register bits mask.
value	value to write.

Returns

kStatus_Success, else failed.

57.8.5.4 status_t WM8904_Init (wm8904_handle_t * *handle,* wm8904_config_t * *wm8904Config*)

Parameters

handle	WM8904 handle structure.
wm8904Config	WM8904 configuration structure.

57.8.5.5 status_t WM8904_Deinit (wm8904_handle_t * *handle*)

This function resets WM8904.

Parameters

handle	WM8904 handle structure.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.5.6 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

config	default configurations of wm8904.

57.8.5.7 status_t WM8904_SetMasterSlave (wm8904_handle_t * *handle*, bool *master*)

Deprecated DO NOT USE THIS API ANYMORE. IT HAS BEEN SUPERCEDED BY WM8904_Set-MasterClock

Parameters

handle	WM8904 handle structure.
master	true for master, false for slave.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.5.8 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

handle	WM8904 handle structure.
sysclk	system clock source frequency.
sampleRate	sample rate
bitWidth	bit width

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.5.9 status_t WM8904_SetFLLConfig (wm8904_handle_t * *handle,* wm8904_fll_config_t * *config*)

Parameters

handle	wm8904 handler pointer.
config	FLL configuration pointer.

57.8.5.10 status_t WM8904_SetProtocol (wm8904_handle_t * *handle,* wm8904_protocol_t *protocol*)

Parameters

handle	WM8904 handle structure.
protocol	Audio transfer protocol.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.5.11 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

handle	WM8904 handle structure.
sysclk	system clock source frequency.
sampleRate	Sample rate frequency in Hz.
bitWidth	Audio data bit width.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.5.12 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

handle	WM8904 handle structure.
format	audio data format
mclkFreq	mclk frequency

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.5.13 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

handle	WM8904 handle structure.

volumeLeft	left channel volume.
volumeRight	right channel volume.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.5.14 status_t WM8904_SetMute (wm8904_handle_t * *handle,* bool *muteLeft,* bool *muteRight*)

Parameters

handle	WM8904 handle structure.
muteLeft	true to mute left channel, false to unmute.
muteRight	true to mute right channel, false to unmute.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.5.15 status_t WM8904_SelectLRCPolarity (wm8904_handle_t * *handle,* uint32_t *polarity*)

Parameters

handle	WM8904 handle structure.
polarity	LRC clock polarity.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.5.16 status_t WM8904_EnableDACTDMMode (wm8904_handle_t * *handle,* wm8904_timeslot_t *timeSlot*)

Parameters

handle	WM8904 handle structure.
timeSlot	timeslot number.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.5.17 status_t WM8904_EnableADCTDMMode (wm8904_handle_t * *handle,* wm8904_timeslot_t *timeSlot*)

Parameters

handle	WM8904 handle structure.
timeSlot	timeslot number.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.5.18 status_t WM8904_SetModulePower (wm8904_handle_t * *handle,* wm8904_module_t *module,* bool *isEnabled*)

Parameters

handle	WM8904 handle structure.
module	wm8904 module.
isEnabled,true	is power on, false is power down.

Returns

kStatus_WM8904_Success if successful, different code otherwise..

57.8.5.19 status_t WM8904_SetDACVolume (wm8904_handle_t * *handle,* uint8_t *volume*)

Parameters

handle	WM8904 handle structure.
volume	volume to be configured.

Returns

kStatus_WM8904_Success if successful, different code otherwise..

57.8.5.20 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

handle	codec handle structure.
channel	codec channel.
volume	volume value from 0 -63.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.5.21 status_t WM8904_SetRecord (wm8904_handle_t * *handle,* uint32_t *recordSource*)

Parameters

handle	WM8904 handle structure.
recordSource	record source , can be a value of kCODEC_ModuleRecordSourceDifferentialLine, kCODEC_ModuleRecordSourceDifferentialMic, kCODEC_ModuleRecordSourceSingleEndMic, kCODEC_ModuleRecordSourceDigitalMic.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.5.22 status_t WM8904_SetRecordChannel (wm8904_handle_t * *handle,* uint32_t *leftRecordChannel,* uint32_t *rightRecordChannel*)

Parameters

handle	WM8904 handle structure.
leftRecord-Channel	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.
rightRecord-Channel	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..

57.8.5.23 status_t WM8904_SetPlay (wm8904_handle_t ∗ *handle,* uint32_t *playSource*)

Parameters

handle	WM8904 handle structure.
playSource	play source , can be a value of kCODEC_ModuleHeadphoneSourcePGA, kCODEC-_ModuleHeadphoneSourceDAC, kCODEC_ModuleLineoutSourcePGA, kCODEC-_ModuleLineoutSourceDAC.

Returns

kStatus_WM8904_Success if successful, different code otherwise..

57.8.5.24 status_t WM8904_SetChannelMute (wm8904_handle_t ∗ *handle,* uint32_t *channel,* bool *isMute*)

Parameters

handle	codec handle structure.
channel	codec module name.
isMute	true is mute, false unmute.

Returns

kStatus_WM8904_Success if successful, different code otherwise.

57.8.6 WM8904 Adapter

57.8.6.1 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 initilization.
- status_t HAL_CODEC_WM8904_Deinit (void *handle)
  Codec de-initilization.
- 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 initilization.
- static status_t HAL_CODEC_Deinit (void *handle)
  Codec de-initilization.
- 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.

57.8.6.2 Function Documentation

57.8.6.2.1 status_t HAL_CODEC_WM8904_Init (void ∗ *handle,* void ∗ *config*)

Parameters

handle	codec handle.
config	codec configuration.

Returns

kStatus_Success is success, else initial failed.

57.8.6.2.2 status_t HAL_CODEC_WM8904_Deinit (void ∗ *handle*)

Parameters

handle	codec handle.

Returns

kStatus_Success is success, else de-initial failed.

57.8.6.2.3 status_t HAL_CODEC_WM8904_SetFormat (void ∗ *handle,* uint32_t *mclk,* uint32_t *sampleRate,* uint32_t *bitWidth*)

Parameters

handle	codec handle.
mclk	master clock frequency in HZ.
sampleRate	sample rate in HZ.
bitWidth	bit width.

Returns

kStatus_Success is success, else configure failed.

57.8.6.2.4 status_t HAL_CODEC_WM8904_SetVolume (void ∗ *handle,* uint32_t *playChannel,* uint32_t *volume*)

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
volume	volume value, support 0 ∼ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

57.8.6.2.5 status_t HAL_CODEC_WM8904_SetMute (void ∗ *handle,* uint32_t *playChannel,* bool *isMute*)

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
isMute	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

57.8.6.2.6 status_t HAL_CODEC_WM8904_SetPower (void ∗ *handle,* uint32_t *module,* bool *powerOn*)

Parameters

handle	codec handle.
module	audio codec module.
powerOn	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

57.8.6.2.7 status_t HAL_CODEC_WM8904_SetRecord (void ∗ *handle,* uint32_t *recordSource*)

Parameters

handle	codec handle.
recordSource	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

57.8.6.2.8 status_t HAL_CODEC_WM8904_SetRecordChannel (void ∗ *handle,* uint32_t *leftRecordChannel,* uint32_t *rightRecordChannel*)

Parameters

handle	codec handle.
leftRecordChannel	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
rightRecordChannel	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.

57.8.6.2.9 status_t HAL_CODEC_WM8904_SetPlay (void ∗ *handle,* uint32_t *playSource*)

Parameters

handle	codec handle.
playSource	audio codec play source, can be a value or combine value of _codec_play_source.

Returns

kStatus_Success is success, else configure failed.

57.8.6.2.10 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

handle	codec handle.
cmd	module control cmd, reference _codec_module_ctrl_cmd.
data	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.

57.8.6.2.11 static status_t HAL_CODEC_Init (void * *handle,* void * *config*) `[inline], [static]`

Parameters

handle	codec handle.
config	codec configuration.

Returns

kStatus_Success is success, else initial failed.

57.8.6.2.12 static status_t HAL_CODEC_Deinit (void * *handle*) `[inline], [static]`

Parameters

handle	codec handle.

Returns

kStatus_Success is success, else de-initial failed.

57.8.6.2.13 static status_t HAL_CODEC_SetFormat (void ∗ *handle,* uint32_t *mclk,* uint32_t *sampleRate,* uint32_t *bitWidth*) [inline], [static]

Parameters

handle	codec handle.
mclk	master clock frequency in HZ.
sampleRate	sample rate in HZ.
bitWidth	bit width.

Returns

kStatus_Success is success, else configure failed.

57.8.6.2.14 static status_t HAL_CODEC_SetVolume (void ∗ *handle,* uint32_t *playChannel,* uint32_t *volume*) [inline], [static]

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
volume	volume value, support 0 ∼ 100, 0 is mute, 100 is the maximum volume value.

Returns

kStatus_Success is success, else configure failed.

57.8.6.2.15 static status_t HAL_CODEC_SetMute (void ∗ *handle,* uint32_t *playChannel,* bool *isMute*) [inline], [static]

Parameters

handle	codec handle.
playChannel	audio codec play channel, can be a value or combine value of _codec_play_channel.
isMute	true is mute, false is unmute.

Returns

kStatus_Success is success, else configure failed.

57.8.6.2.16 static status_t HAL_CODEC_SetPower (void ∗ *handle,* uint32_t *module,* bool *powerOn*) [inline], [static]

Parameters

handle	codec handle.
module	audio codec module.
powerOn	true is power on, false is power down.

Returns

kStatus_Success is success, else configure failed.

57.8.6.2.17 static status_t HAL_CODEC_SetRecord (void ∗ *handle,* uint32_t *recordSource*) [inline], [static]

Parameters

handle	codec handle.
recordSource	audio codec record source, can be a value or combine value of _codec_record_source.

Returns

kStatus_Success is success, else configure failed.

57.8.6.2.18 static status_t HAL_CODEC_SetRecordChannel (void ∗ *handle,* uint32_t *leftRecordChannel,* uint32_t *rightRecordChannel*) [inline], [static]

Parameters

handle	codec handle.
leftRecord-Channel	audio codec record channel, reference _codec_record_channel, can be a value or combine value of member in _codec_record_channel.
rightRecord-Channel	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.

57.8.6.2.19 static status_t HAL_CODEC_SetPlay (void ∗ *handle,* uint32_t *playSource*) [inline], [static]

Parameters

handle	codec handle.
playSource	audio codec play source, can be a value or combine value of _codec_play_source.

Returns

kStatus_Success is success, else configure failed.

57.8.6.2.20 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

handle	codec handle.
cmd	module control cmd, reference _codec_module_ctrl_cmd.
data	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.

Chapter 58
Serial Manager

58.1 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)
  Macro to determine whether use common task.
- #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)
  callback function

Enumerations

- enum serial_port_type_t {
  kSerialPort_Uart = 1U,
  kSerialPort_UsbCdc,
  kSerialPort_Swo,
  kSerialPort_Virtual,
  kSerialPort_Rpmsg,
  kSerialPort_UartDma,
  kSerialPort_SpiMaster,
  kSerialPort_SpiSlave,
  kSerialPort_None }
  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.
- static bool SerialManager_needPollingIsr (void)
  Check if need polling ISR.

58.2 Data Structure Documentation

58.2.1 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.

58.2.2 struct serial_manager_callback_message_t

Data Fields

- uint8_t * buffer
  Transferred buffer.
- uint32_t length
  Transferred data length.

58.3 Macro Definition Documentation

58.3.1 #define SERIAL_MANAGER_WRITE_TIME_DELAY_DEFAULT_VALUE (1U)

58.3.2 #define SERIAL_MANAGER_READ_TIME_DELAY_DEFAULT_VALUE (1U)

58.3.3 #define SERIAL_MANAGER_USE_COMMON_TASK (0U)

Macro to determine whether use common task.

58.3.4 #define SERIAL_MANAGER_HANDLE_SIZE (SERIAL_MANAGER_HANDLE_SIZE_TEMP + 12U)

Definition of serial manager handle size.

58.3.5 #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

name	The name string of the serial manager handle.

58.3.6 #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

name	The name string of the serial manager write handle.

58.3.7 #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

name	The name string of the serial manager read handle.

58.3.8 #define SERIAL_MANAGER_TASK_PRIORITY (2U)

58.3.9 #define SERIAL_MANAGER_TASK_STACK_SIZE (1000U)

58.4 Enumeration Type Documentation

58.4.1 enum serial_port_type_t

Enumerator

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.
kSerialPort_None Serial port is none.

58.4.2 enum serial_manager_type_t

Enumerator

kSerialManager_NonBlocking None blocking handle.
kSerialManager_Blocking Blocking handle.

58.4.3 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.

58.5 Function Documentation

58.5.1 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

serialHandle	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 uint32_t serialHandle[((SERIAL_MANAGER_HANDLE_SIZE + sizeof(uint32_t) - 1U) / sizeof(uint32_t))];
config	Pointer to user-defined configuration structure.

Return values

kStatus_SerialManager_Error	An error occurred.
kStatus_SerialManager_Success	The Serial Manager module initialization succeed.

58.5.2 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

serialHandle	The serial manager module handle pointer.

Return values

kStatus_SerialManager_-Success	The serial manager de-initialization succeed.
kStatus_SerialManager_-Busy	Opened reading or writing handle is not closed.

58.5.3 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

serialHandle	The serial manager module handle pointer. The handle should be 4 byte aligned, because unaligned access doesn't be supported on some devices.
writeHandle	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 uint32_t writeHandle[((SERIAL_MANAGER_WRITE_HANDLE_SIZE + sizeof(uint32_t) - 1U) / sizeof(uint32_t))];

Return values

kStatus_SerialManager_-Error	An error occurred.
kStatus_SerialManager_-HandleConflict	The writing handle was opened.

kStatus_SerialManager_-Success	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);
*
```

58.5.4 serial_manager_status_t SerialManager_CloseWriteHandle (serial_write_handle_t *writeHandle*)

This function Closes a writing handle for the serial manager module.

Parameters

writeHandle	The serial manager module writing handle pointer.

Return values

kStatus_SerialManager_-Success	The writing handle is closed.

58.5.5 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

serialHandle	The serial manager module handle pointer. The handle should be 4 byte aligned, because unaligned access doesn't be supported on some devices.
readHandle	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 uint32_t readHandle[((SERIAL_MANAGER_READ_HANDLE_SIZE + sizeof(uint32_t) - 1U) / sizeof(uint32_t))];

Return values

kStatus_SerialManager_Error	An error occurred.
kStatus_SerialManager_Success	The reading handle is opened.
kStatus_SerialManager_Busy	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));
*
```

58.5.6 serial_manager_status_t SerialManager_CloseReadHandle (serial_read_handle_t *readHandle*)

This function Closes a reading for the serial manager module.

Parameters

readHandle	The serial manager module reading handle pointer.

Return values

kStatus_SerialManager_-Success	The reading handle is closed.

58.5.7 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

writeHandle	The serial manager module handle pointer.
buffer	Start address of the data to write.
length	Length of the data to write.

Return values

kStatus_SerialManager_-Success	Successfully sent all data.
kStatus_SerialManager_-Busy	Previous transmission still not finished; data not all sent yet.
kStatus_SerialManager_-Error	An error occurred.

58.5.8 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

readHandle	The serial manager module handle pointer.
buffer	Start address of the data to store the received data.
length	The length of the data to be received.

Return values

kStatus_SerialManager_-Success	Successfully received all data.
kStatus_SerialManager_-Busy	Previous transmission still not finished; data not all received yet.
kStatus_SerialManager_-Error	An error occurred.

58.5.9 serial_manager_status_t SerialManager_EnterLowpower (serial_handle_t *serialHandle*)

This function is used to prepare to enter low power consumption.

Parameters

serialHandle	The serial manager module handle pointer.

Return values

kStatus_SerialManager_-Success	Successful operation.

58.5.10 serial_manager_status_t SerialManager_ExitLowpower (serial_handle_t *serialHandle*)

This function is used to restore from low power consumption.

Parameters

serialHandle	The serial manager module handle pointer.

Return values

kStatus_SerialManager_-Success	Successful operation.

58.5.11 static bool SerialManager_needPollingIsr (void) [inline], [static]

This function is used to check if need polling ISR.

Return values

TRUE	if need polling.

58.6 Serial Port Uart

58.6.1 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 confgure 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

58.6.2 Enumeration Type Documentation

58.6.2.1 enum serial_port_uart_parity_mode_t

Enumerator

kSerialManager_UartParityDisabled Parity disabled.
kSerialManager_UartParityEven Parity even enabled.
kSerialManager_UartParityOdd Parity odd enabled.

58.6.2.2 enum serial_port_uart_stop_bit_count_t

Enumerator

kSerialManager_UartOneStopBit One stop bit.
kSerialManager_UartTwoStopBit Two stop bits.

58.7 Serial Port USB

58.7.1 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.

58.7.2 Data Structure Documentation

58.7.2.1 struct serial_port_usb_cdc_config_t

Data Fields

- serial_port_usb_cdc_controller_index_t controllerIndex
  controller index

58.7.3 Enumeration Type Documentation

58.7.3.1 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.

58.7.4 USB Device Configuration

58.8 Serial Port SWO

58.8.1 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

58.8.2 Data Structure Documentation

58.8.2.1 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.

58.8.3 Enumeration Type Documentation

58.8.3.1 enum serial_port_swo_protocol_t

Enumerator

kSerialManager_SwoProtocolManchester SWO Manchester protocol.
kSerialManager_SwoProtocolNrz SWO UART/NRZ protocol.

58.8.4 CODEC Adapter

58.8.4.1 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 }
  codec type

58.8.4.2 Enumeration Type Documentation

58.8.4.2.1 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

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