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MCUXpresso SDK API Reference Manual

NXP Semiconductors

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Chapter 1
Introduction

The MCUXpresso Software Development Kit (MCUXpresso SDK) is a collection of software enablement for NXP Microcontrollers that includes peripheral drivers, multicore support and integrated RTOS support for FreeRTOS™ . In addition to the base enablement, the MCUXpresso SDK is augmented with demo applications, driver example projects, and API documentation to help users quickly leverage the support provided by MCUXpresso SDK. The `MCUXpresso SDK Web Builder` is available to provide access to all MCUXpresso SDK packages. See the *MCUXpresso Software Development Kit (SD-K) 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 RT-OS 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 RT-OS 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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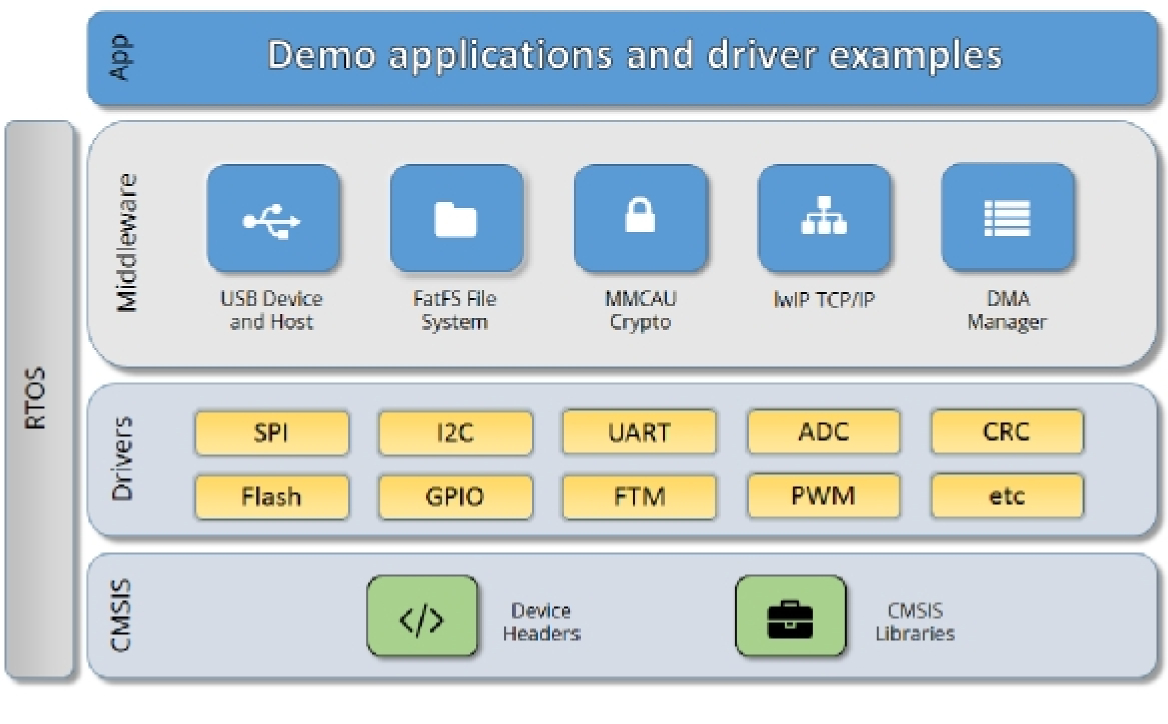
Chapter 3
Architectural Overview

This chapter provides the architectural overview for the MCUXpresso Software Development Kit (MCU-Xpresso 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 sim_clock_config_t
  SIM configuration structure for clock setting. More...
- struct osc_config_t
  OSC Initialization Configuration Structure. More...
- struct ics_config_t
  ICS configuration structure. More...

Macros

- #define ICS_CONFIG_CHECK_PARAM 0U
  Configures whether to check a parameter in a function.
- #define FSL_SDK_DISABLE_DRIVER_CLOCK_CONTROL 0
  Configure whether driver controls clock.
- #define UART_CLOCKS
  Clock ip name array for UART.
- #define ADC_CLOCKS
  Clock ip name array for ADC16.
- #define IRQ_CLOCKS
  Clock ip name array for IRQ.
- #define KBI_CLOCKS
  Clock ip name array for KBI.
- #define SPI_CLOCKS
  Clock ip name array for SPI.
- #define I2C_CLOCKS
  Clock ip name array for I2C.
- #define FTM_CLOCKS
  Clock ip name array for FTM.
- #define ACMP_CLOCKS

Clock ip name array for CMP.
- #define CRC_CLOCKS
  Clock ip name array for CRC.
- #define PWT_CLOCKS
  Clock ip name array for PWT.
- #define PIT_CLOCKS
  Clock ip name array for PIT.
- #define RTC_CLOCKS
  Clock ip name array for RTC.
- #define MSCAN_CLOCKS
  Clock ip name array for MSCAN.
- #define LPO_CLK_FREQ 1000U
  LPO clock frequency.

Enumerations

- enum clock_name_t {
  kCLOCK_CoreSysClk,
  kCLOCK_PlatClk,
  kCLOCK_BusClk,
  kCLOCK_FlashClk,
  kCLOCK_Osc0ErClk,
  kCLOCK_ICSFixedFreqClk,
  kCLOCK_ICSInternalRefClk,
  kCLOCK_ICSFllClk,
  kCLOCK_ICSOutClk,
  kCLOCK_TimerClk,
  kCLOCK_LpoClk }
  Clock name used to get clock frequency.
- enum clock_ip_name_t
  Clock gate name used for CLOCK_EnableClock/CLOCK_DisableClock.
- enum _osc_work_mode {
  kOSC_ModeExt = 0U,
  kOSC_ModeOscLowPower = OSC_CR_OSCOS_MASK,
  kOSC_ModeOscHighGain = OSC_CR_HGO_MASK | OSC_CR_OSCOS_MASK }
  OSC work mode.
- enum _osc_enable_mode {
  kOSC_Enable = OSC_CR_OSCEN_MASK,
  kOSC_EnableInStop = OSC_CR_OSCSTEN_MASK }
  OSC enable mode.
- enum ics_fll_src_t {
  kICS_FllSrcExternal,
  kICS_FllSrcInternal }
  ICS FLL reference clock source select.
- enum ics_clkout_src_t {
  kICS_ClkOutSrcFll,
  kICS_ClkOutSrcInternal,
  kICS_ClkOutSrcExternal }

ICSOUT clock source.
- enum _ics_status {
kStatus_ICS_ModeUnreachable = MAKE_STATUS(kStatusGroup_ICS, 0),
kStatus_ICS_SourceUsed = MAKE_STATUS(kStatusGroup_ICS, 1) }
ICS status.
- enum _ics_irclk_enable_mode {
kICS_IrclkDisable = 0U,
kICS_IrclkEnable = ICS_C1_IRCLKEN_MASK,
kICS_IrclkEnableInStop = ICS_C1_IREFSTEN_MASK }
ICS internal reference clock (ICSIRCLK) enable mode definition.
- enum ics_mode_t {
kICS_ModeFEI = 0U,
kICS_ModeFBI,
kICS_ModeBILP,
kICS_ModeFEE,
kICS_ModeFBE,
kICS_ModeBELP,
kICS_ModeError }
ICS mode definitions.

Functions

- 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_SetOutDiv (uint32_t outdiv1, uint32_t outdiv2, uint32_t outdiv3)
clock divider
- uint32_t CLOCK_GetFreq (clock_name_t clockName)
Gets the clock frequency for a specific clock name.
- uint32_t CLOCK_GetCoreSysClkFreq (void)
Get the core clock or system clock frequency.
- uint32_t CLOCK_GetBusClkFreq (void)
Get the bus clock frequency.
- uint32_t CLOCK_GetFlashClkFreq (void)
Get the flash clock frequency.
- uint32_t CLOCK_GetOsc0ErClkFreq (void)
Get the OSC0 external reference clock frequency (OSC0ERCLK).
- void CLOCK_SetSimConfig (sim_clock_config_t const *config)
Set the clock configure in SIM module.
- static void CLOCK_SetSimSafeDivs (void)
Set the system clock dividers in SIM to safe value.

Variables

- volatile uint32_t g_xtal0Freq
External XTAL0 (OSC0) clock frequency.

Driver version

- #define FSL_CLOCK_DRIVER_VERSION (MAKE_VERSION(2, 2, 1))
  CLOCK driver version 2.2.1.

ICS frequency functions.

- uint32_t CLOCK_GetICSOutClkFreq (void)
  Gets the ICS output clock (ICSOUTCLK) frequency.
- uint32_t CLOCK_GetFllFreq (void)
  Gets the ICS FLL clock (ICSFLLCLK) frequency.
- uint32_t CLOCK_GetInternalRefClkFreq (void)
  Gets the ICS internal reference clock (ICSIRCLK) frequency.
- uint32_t CLOCK_GetICSFixedFreqClkFreq (void)
  Gets the ICS fixed frequency clock (ICSFFCLK) frequency.
- uint32_t CLOCK_GetTimerClkFreq (void)
  Gets the Timer(FTM/PWT) clock frequency.

ICS clock configuration.

- static void CLOCK_SetLowPowerEnable (bool enable)
  Enables or disables the ICS low power.
- static void CLOCK_SetInternalRefClkConfig (uint8_t enableMode)
  Configures the Internal Reference clock (ICSIRCLK).
- static void CLOCK_SetFllExtRefDiv (uint8_t rdiv)
  Set the FLL external reference clock divider value.

ICS clock lock monitor functions.

- static void CLOCK_SetOsc0MonitorMode (bool enable)
  Sets the OSC0 clock monitor mode.

OSC configuration

- void CLOCK_InitOsc0 (osc_config_t const *config)
  Initializes the OSC0.
- void CLOCK_DeinitOsc0 (void)
  Deinitializes the OSC0.

External clock frequency

- static void CLOCK_SetXtal0Freq (uint32_t freq)
  Sets the XTAL0 frequency based on board settings.
- static void CLOCK_SetOsc0Enable (uint8_t enable)
  Sets the OSC enable.

ICS mode functions.

- ics_mode_t CLOCK_GetMode (void)
  Gets the current ICS mode.

- status_t CLOCK_SetFeiMode (uint8_t bDiv)
  Sets the ICS to FEI mode.
- status_t CLOCK_SetFeeMode (uint8_t bDiv, uint8_t rDiv)
  Sets the ICS to FEE mode.
- status_t CLOCK_SetFbiMode (uint8_t bDiv)
  Sets the ICS to FBI mode.
- status_t CLOCK_SetFbeMode (uint8_t bDiv, uint8_t rDiv)
  Sets the ICS to FBE mode.
- status_t CLOCK_SetBilpMode (uint8_t bDiv)
  Sets the ICS to BILP mode.
- status_t CLOCK_SetBelpMode (uint8_t bDiv)
  Sets the ICS to BELP mode.
- status_t CLOCK_BootToFeiMode (uint8_t bDiv)
  Sets the ICS to FEI mode during system boot up.
- status_t CLOCK_BootToFeeMode (uint8_t bDiv, uint8_t rDiv)
  Sets the ICS to FEE mode during system bootup.
- status_t CLOCK_BootToBilpMode (uint8_t bDiv)
  Sets the ICS to BILP mode during system boot up.
- status_t CLOCK_BootToBelpMode (uint8_t bDiv)
  Sets the ICS to BELP mode during system boot up.
- status_t CLOCK_SetIcsConfig (ics_config_t const ∗config)
  Sets the ICS to a target mode.

4.2 Data Structure Documentation

4.2.1 struct sim_clock_config_t

Data Fields

- uint8_t outDiv1
  OUTDIV1.
- uint8_t outDiv2
  OUTDIV2.
- uint8_t outDiv3
  OUTDIV3.
- uint8_t busClkPrescaler
  A option prescaler for bus clock.

4.2.2 struct osc_config_t

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

1. freq: The external frequency.
2. workMode: The OSC module mode.
3. enableMode: The OSC enable mode.

Data Fields

- uint32_t freq
  External clock frequency.
- uint8_t workMode
  OSC work mode setting.
- uint8_t enableMode
  Configuration for OSCERCLK.

Field Documentation

(1) uint32_t osc_config_t::freq

(2) uint8_t osc_config_t::workMode

(3) uint8_t osc_config_t::enableMode

4.2.3 struct ics_config_t

When porting to a new board, set the following members according to the board setting:

1. icsMode: ICS mode
2. irClkEnableMode: ICSIRCLK enable mode
3. rDiv: If the FLL uses the external reference clock, set this value to ensure that the external reference clock divided by rDiv is in the 31.25 kHz to 39.0625 kHz range.
4. bDiv, this divider determine the ISCOUT clock

Data Fields

- ics_mode_t icsMode
  ICS mode.
- uint8_t irClkEnableMode
  ICSIRCLK enable mode.
- uint8_t rDiv
  Divider for external reference clock, ICS_C1[RDIV].
- uint8_t bDiv
  Divider for ICS output clock ICS_C2[BDIV].

Field Documentation

(1) ics_mode_t ics_config_t::icsMode

(2) uint8_t ics_config_t::irClkEnableMode

(3) uint8_t ics_config_t::rDiv

(4) uint8_t ics_config_t::bDiv

4.3 Macro Definition Documentation

4.3.1 #define ICS_CONFIG_CHECK_PARAM 0U

Some ICS settings must be changed with conditions, for example:

1. ICSIRCLK settings, such as the source, divider, and the trim value should not change when ICSIRCLK is used as a system clock source.
2. ICS_C7[OSCSEL] should not be changed when the external reference clock is used as a system clock source. For example, in FBE/BELP/PBE modes.
3. The users should only switch between the supported clock modes.

ICS functions check the parameter and ICS status before setting, if not allowed to change, the functions return error. The parameter checking increases code size, if code size is a critical requirement, change ICS_CONFIG_CHECK_PARAM to 0 to disable parameter checking.

4.3.2 #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.

4.3.3 #define FSL_CLOCK_DRIVER_VERSION (MAKE_VERSION(2, 2, 1))

4.3.4 #define UART_CLOCKS

Value:

```
{                                            \
        kCLOCK_Uart0, kCLOCK_Uart1, kCLOCK_Uart2 \
    }
```

4.3.5 #define ADC_CLOCKS

Value:

```
{               \
        kCLOCK_Adc0 \
    }
```

4.3.6 #define IRQ_CLOCKS

Value:

```
{                 \
        kCLOCK_Irq0 \
    }
```

4.3.7 #define KBI_CLOCKS

Value:

```
{                               \
        kCLOCK_Kbi0, kCLOCK_Kbi1 \
    }
```

4.3.8 #define SPI_CLOCKS

Value:

```
{                               \
        kCLOCK_Spi0, kCLOCK_Spi1 \
    }
```

4.3.9 #define I2C_CLOCKS

Value:

```
{                               \
        kCLOCK_I2c0, kCLOCK_I2c1 \
    }
```

4.3.10 #define FTM_CLOCKS

Value:

```
{                                            \
        kCLOCK_Ftm0, kCLOCK_Ftm1, kCLOCK_Ftm2 \
    }
```

4.3.11 #define ACMP_CLOCKS

Value:

```
{                               \
        kCLOCK_Acmp0, kCLOCK_Acmp1 \
    }
```

4.3.12 #define CRC_CLOCKS

Value:

```
{                \
        kCLOCK_Crc0, \
    }
```

4.3.13 #define PWT_CLOCKS

Value:

```
{                \
        kCLOCK_Pwt0, \
    }
```

4.3.14 #define PIT_CLOCKS

Value:

```
{                \
        kCLOCK_Pit0, \
    }
```

4.3.15 #define RTC_CLOCKS

Value:

```
{                \
        kCLOCK_Rtc0, \
    }
```

4.3.16 #define MSCAN_CLOCKS

Value:

```
{                   \
        kCLOCK_Mscan0, \
    }
```

4.4 Enumeration Type Documentation

4.4.1 enum clock_name_t

Enumerator

kCLOCK_CoreSysClk Core/system clock.
kCLOCK_PlatClk Platform clock.
kCLOCK_BusClk Bus clock.
kCLOCK_FlashClk Flash clock.
kCLOCK_Osc0ErClk OSC0 external reference clock (OSC0ERCLK)
kCLOCK_ICSFixedFreqClk ICS fixed frequency clock (ICSFFCLK)
kCLOCK_ICSInternalRefClk ICS internal reference clock (ICSIRCLK)
kCLOCK_ICSFllClk ICSFLLCLK.
kCLOCK_ICSOutClk ICS Output clock.
kCLOCK_TimerClk TIMER clock for FTM and PWT.
kCLOCK_LpoClk LPO clock.

4.4.2 enum clock_ip_name_t

4.4.3 enum _osc_work_mode

Enumerator

kOSC_ModeExt OSC source from external clock.
kOSC_ModeOscLowPower Oscillator low freq low power.
kOSC_ModeOscHighGain Oscillator low freq high gain.

4.4.4 enum _osc_enable_mode

Enumerator

kOSC_Enable Enable.
kOSC_EnableInStop Enable in stop mode.

4.4.5 enum ics_fll_src_t

Enumerator

kICS_FllSrcExternal External reference clock is selected.
kICS_FllSrcInternal The slow internal reference clock is selected.

4.4.6 enum ics_clkout_src_t

Enumerator

kICS_ClkOutSrcFll Output of the FLL is selected (reset default)
kICS_ClkOutSrcInternal Internal reference clock is selected, FLL is bypassed.
kICS_ClkOutSrcExternal External reference clock is selected, FLL is bypassed.

4.4.7 enum _ics_status

Enumerator

kStatus_ICS_ModeUnreachable Can't switch to target mode.
kStatus_ICS_SourceUsed Can't change the clock source because it is in use.

4.4.8 enum _ics_irclk_enable_mode

Enumerator

kICS_IrclkDisable ICSIRCLK disable.
kICS_IrclkEnable ICSIRCLK enable.
kICS_IrclkEnableInStop ICSIRCLK enable in stop mode.

4.4.9 enum ics_mode_t

Enumerator

kICS_ModeFEI FEI - FLL Engaged Internal.
kICS_ModeFBI FBI - FLL Bypassed Internal.
kICS_ModeBILP BILP - Bypassed Low Power Internal.
kICS_ModeFEE FEE - FLL Engaged External.
kICS_ModeFBE FBE - FLL Bypassed External.
kICS_ModeBELP BELP - Bypassed Low Power External.
kICS_ModeError Unknown mode.

4.5 Function Documentation

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

Parameters

name	Which clock to enable, see clock_ip_name_t.

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

Parameters

name	Which clock to disable, see clock_ip_name_t.

4.5.3 static void CLOCK_SetOutDiv (uint32_t *outdiv1*, uint32_t *outdiv2*, uint32_t *outdiv3*) [inline], [static]

Set the SIM_CLKDIV[OUTDIV1], SIM_CLKDIV[OUTDIV2], SIM_CLKDIV[OUTDIV3]. Carefully configure the OUTDIV1 and OUTDIV2 to avoid bus clock frequency higher than 24MHZ.

Parameters

outdiv1	Clock 1 output divider value.
outdiv2	Clock 2 output divider value.
outdiv3	Clock 3 output divider value.

4.5.4 uint32_t CLOCK_GetFreq (clock_name_t *clockName*)

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

Parameters

clockName	Clock names defined in clock_name_t

Returns

Clock frequency value in Hertz

4.5.5 uint32_t CLOCK_GetCoreSysClkFreq (void)

Returns

Clock frequency in Hz.

4.5.6 uint32_t CLOCK_GetBusClkFreq (void)

Returns

Clock frequency in Hz.

4.5.7 uint32_t CLOCK_GetFlashClkFreq (void)

Returns

Clock frequency in Hz.

4.5.8 uint32_t CLOCK_GetOsc0ErClkFreq (void)

Returns

Clock frequency in Hz.

4.5.9 void CLOCK_SetSimConfig (sim_clock_config_t const * *config*)

This function sets system layer clock settings in SIM module.

Parameters

config	Pointer to the configure structure.

4.5.10 static void CLOCK_SetSimSafeDivs (void) [inline], [static]

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

4.5.11 uint32_t CLOCK_GetICSOutClkFreq (void)

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

Returns

The frequency of ICSOUTCLK.

4.5.12 uint32_t CLOCK_GetFllFreq (void)

This function gets the ICS FLL clock frequency in Hz based on the current ICS register value. The FLL is enabled in FEI/FBI/FEE/FBE mode and disabled in low power state in other modes.

Returns

The frequency of ICSFLLCLK.

4.5.13 uint32_t CLOCK_GetInternalRefClkFreq (void)

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

Returns

The frequency of ICSIRCLK.

4.5.14 uint32_t CLOCK_GetICSFixedFreqClkFreq (void)

This function gets the ICS fixed frequency clock frequency in Hz based on the current ICS register value.

Returns

The frequency of ICSFFCLK.

4.5.15 uint32_t CLOCK_GetTimerClkFreq (void)

This function gets the Timer clock frequency in Hz based on the current ICSOUTCLK.

Returns

The frequency of Timer(FTM/PWT) clock.

4.5.16 static void CLOCK_SetLowPowerEnable (bool *enable*) [inline], [static]

Enabling the ICS low power disables the PLL and FLL in bypass modes. In other words, in FBE and PBE modes, enabling low power sets the ICS to BELP mode. In FBI and PBI modes, enabling low power sets the ICS to BILP mode. When disabling the ICS low power, the PLL or FLL are enabled based on ICS settings.

Parameters

enable	True to enable ICS low power, false to disable ICS low power.

4.5.17 static void CLOCK_SetInternalRefClkConfig (uint8_t *enableMode*) [inline], [static]

This function sets the ICSIRCLK base on parameters. This function also sets whether the `ICSIRCLK` is enabled in stop mode.

Parameters

enableMode	ICSIRCLK enable mode, OR'ed value of _ics_irclk_enable_mode.

4.5.18 static void CLOCK_SetFllExtRefDiv (uint8_t *rdiv*) [inline], [static]

Sets the FLL external reference clock divider value, the register ICS_C1[RDIV]. Resulting frequency must be in the range 31.25KHZ to 39.0625KHZ.

Parameters

rdiv	The FLL external reference clock divider value, ICS_C1[RDIV].

4.5.19 static void CLOCK_SetOsc0MonitorMode (bool *enable*) [inline], [static]

This function sets the OSC0 clock monitor mode.

Parameters

enable	true to enable clock monitor, false to disable clock monitor.

4.5.20 void CLOCK_InitOsc0 (osc_config_t const * *config*)

This function initializes the OSC0 according to the board configuration.

Parameters

config	Pointer to the OSC0 configuration structure.

4.5.21 void CLOCK_DeinitOsc0 (void)

This function deinitializes the OSC0.

4.5.22 static void CLOCK_SetXtal0Freq (uint32_t *freq*) [inline], [static]

Parameters

freq	The XTAL0/EXTAL0 input clock frequency in Hz.

4.5.23 static void CLOCK_SetOsc0Enable (uint8_t *enable*) [inline], [static]

Parameters

enable	osc enable mode.

4.5.24 ics_mode_t CLOCK_GetMode (void)

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

Returns

Current ICS mode or error code; See ics_mode_t.

4.5.25 status_t CLOCK_SetFeiMode (uint8_t *bDiv*)

This function sets the ICS to FEI mode. If setting to FEI mode fails from the current mode, this function returns an error.

Parameters

bDiv	bus clock divider

Return values

kStatus_ICS_Mode-Unreachable	Could not switch to the target mode.
kStatus_Success	Switched to the target mode successfully.

4.5.26 status_t CLOCK_SetFeeMode (uint8_t *bDiv*, uint8_t *rDiv*)

This function sets the ICS to FEE mode. If setting to FEE mode fails from the current mode, this function returns an error.

Parameters

bDiv	bus clock divider
rDiv	FLL reference clock divider setting, RDIV.

Return values

kStatus_ICS_Mode-Unreachable	Could not switch to the target mode.
kStatus_Success	Switched to the target mode successfully.

4.5.27 status_t CLOCK_SetFbiMode (uint8_t *bDiv*)

This function sets the ICS to FBI mode. If setting to FBI mode fails from the current mode, this function returns an error.

Parameters

bDiv	bus clock divider

Return values

kStatus_ICS_Mode-Unreachable	Could not switch to the target mode.
kStatus_Success	Switched to the target mode successfully.

4.5.28 status_t CLOCK_SetFbeMode (uint8_t *bDiv,* uint8_t *rDiv*)

This function sets the ICS to FBE mode. If setting to FBE mode fails from the current mode, this function returns an error.

Parameters

bDiv	bus clock divider
rDiv	FLL reference clock divider setting, RDIV.

Return values

kStatus_ICS_Mode-Unreachable	Could not switch to the target mode.
kStatus_Success	Switched to the target mode successfully.

4.5.29 status_t CLOCK_SetBilpMode (uint8_t *bDiv*)

This function sets the ICS to BILP mode. If setting to BILP mode fails from the current mode, this function returns an error.

Parameters

bDiv	bus clock divider

Return values

kStatus_ICS_Mode-Unreachable	Could not switch to the target mode.
kStatus_Success	Switched to the target mode successfully.

4.5.30 status_t CLOCK_SetBelpMode (uint8_t *bDiv*)

This function sets the ICS to BELP mode. If setting to BELP mode fails from the current mode, this function returns an error.

Parameters

bDiv	bus clock divider

Return values

kStatus_ICS_Mode-Unreachable	Could not switch to the target mode.
kStatus_Success	Switched to the target mode successfully.

4.5.31 status_t CLOCK_BootToFeiMode (uint8_t *bDiv*)

This function sets the ICS to FEI mode from the reset mode. It can also be used to set up ICS during system boot up.

Parameters

bDiv	bus clock divider.

Return values

kStatus_ICS_Mode-Unreachable	Could not switch to the target mode.
kStatus_Success	Switched to the target mode successfully.

4.5.32 status_t CLOCK_BootToFeeMode (uint8_t *bDiv*, uint8_t *rDiv*)

This function sets ICS to FEE mode from the reset mode. It can also be used to set up the ICS during system boot up.

Parameters

bDiv	bus clock divider.
rDiv	FLL reference clock divider setting, RDIV.

Return values

kStatus_ICS_Mode-Unreachable	Could not switch to the target mode.
kStatus_Success	Switched to the target mode successfully.

4.5.33 status_t CLOCK_BootToBilpMode (uint8_t *bDiv*)

This function sets the ICS to BILP mode from the reset mode. It can also be used to set up the ICS during system boot up.

Parameters

bDiv	bus clock divider.

Return values

kStatus_ICS_SourceUsed	Could not change ICSIRCLK setting.
kStatus_Success	Switched to the target mode successfully.

4.5.34 status_t CLOCK_BootToBelpMode (uint8_t *bDiv*)

This function sets the ICS to BELP mode from the reset mode. It can also be used to set up the ICS during system boot up.

Parameters

bDiv	bus clock divider.

Return values

kStatus_ICS_Mode-Unreachable	Could not switch to the target mode.
kStatus_Success	Switched to the target mode successfully.

4.5.35 status_t CLOCK_SetIcsConfig (ics_config_t const * *config*)

This function sets ICS to a target mode defined by the configuration structure. If switching to the target mode fails, this function chooses the correct path.

Parameters

config	Pointer to the target ICS mode configuration structure.

Returns

Return kStatus_Success if switched successfully; Otherwise, it returns an error code _ics_status.

Note

If the external clock is used in the target mode, ensure that it is enabled. For example, if the OSC0 is used, set up OSC0 correctly before calling this function.

4.6 Variable Documentation

4.6.1 volatile uint32_t g_xtal0Freq

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

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

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

Chapter 5
PORT Driver

5.1 Overview

This driver configures the PORT, including function mux, filter, pull up or down, and so on.

Enumerations

- enum port_module_t {
  kPORT_NMI = SIM_SOPT0_NMIE_SHIFT,
  kPORT_RESET = SIM_SOPT0_RSTPE_SHIFT,
  kPORT_SWDE = SIM_SOPT0_SWDE_SHIFT,
  kPORT_IRQ = (SIM_PINSEL0_IRQPS_SHIFT | (3 << PORT_MODULEPS_BITWIDTH_OFFSET)),
  kPORT_RTC = (SIM_PINSEL0_RTCPS_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET)),
  kPORT_I2C0 = (SIM_PINSEL0_I2C0PS_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET)),
  kPORT_SPI0 = (SIM_PINSEL0_SPI0PS_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET)),
  kPORT_UART0 = (SIM_PINSEL0_UART0PS_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET)),
  kPORT_FTM0CH0 = (SIM_PINSEL0_FTM0PS0_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET)),
  kPORT_FTM0CH1 = (SIM_PINSEL0_FTM0PS1_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET)),
  kPORT_FTM1CH0 = (SIM_PINSEL0_FTM1PS0_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET)),
  kPORT_FTM1CH1 = (SIM_PINSEL0_FTM1PS1_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET)),
  kPORT_FTM0CLK = (SIM_PINSEL0_FTM0CLKPS_SHIFT | (2 << PORT_MODULEPS_BITWIDTH_OFFSET)),
  kPORT_FTM1CLK = (SIM_PINSEL0_FTM1CLKPS_SHIFT | (2 << PORT_MODULEPS_BITWIDTH_OFFSET)),
  kPORT_FTM2CLK = (SIM_PINSEL0_FTM2CLKPS_SHIFT | (2 << PORT_MODULEPS_BITWIDTH_OFFSET)),
  kPORT_PWTCLK = (SIM_PINSEL0_PWTCLKPS_SHIFT | (2 << PORT_MODULEPS_BITWIDTH_OFFSET)),
  kPORT_FTM2CH0 = (SIM_PINSEL1_FTM2PS0_SHIFT | (2 << PORT_MODULEPS_BITWIDTH_OFFSET) | PORT_PINSEL_REG_OFFSET),
  kPORT_FTM2CH1 = (SIM_PINSEL1_FTM2PS1_SHIFT | (2 << PORT_MODULEPS_BITWI-

DTH_OFFSET) | PORT_PINSEL_REG_OFFSET),
kPORT_FTM2CH2 = (SIM_PINSEL1_FTM2PS2_SHIFT | (2 << PORT_MODULEPS_BITWIDTH_OFFSET) | PORT_PINSEL_REG_OFFSET),
kPORT_FTM2CH3 = (SIM_PINSEL1_FTM2PS3_SHIFT | (2 << PORT_MODULEPS_BITWIDTH_OFFSET) | PORT_PINSEL_REG_OFFSET),
kPORT_FTM2CH4 = (SIM_PINSEL1_FTM2PS4_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET) | PORT_PINSEL_REG_OFFSET),
kPORT_FTM2CH5 = (SIM_PINSEL1_FTM2PS5_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET) | PORT_PINSEL_REG_OFFSET),
kPORT_I2C1 = (SIM_PINSEL1_I2C1PS_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET) | PORT_PINSEL_REG_OFFSET),
kPORT_SPI1 = (SIM_PINSEL1_SPI1PS_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET) | PORT_PINSEL_REG_OFFSET),
kPORT_UART1 = (SIM_PINSEL1_UART1PS_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET) | PORT_PINSEL_REG_OFFSET),
kPORT_UART2 = (SIM_PINSEL1_UART2PS_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET) | PORT_PINSEL_REG_OFFSET),
kPORT_PWTIN0 = (SIM_PINSEL1_PWTIN0PS_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET) | PORT_PINSEL_REG_OFFSET),
kPORT_PWTIN1 = (SIM_PINSEL1_PWTIN1PS_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET) | PORT_PINSEL_REG_OFFSET),
kPORT_MSCAN = (SIM_PINSEL1_MSCANPS_SHIFT | (1 << PORT_MODULEPS_BITWIDTH_OFFSET) | PORT_PINSEL_REG_OFFSET) }

Module or peripheral for port pin selection.

- enum port_type_t {
kPORT_PTA = 0U,
kPORT_PTB = 1U,
kPORT_PTC = 2U,
kPORT_PTD = 3U,
kPORT_PTE = 4U,
kPORT_PTF = 5U,
kPORT_PTG = 6U,
kPORT_PTH = 7U,
kPORT_PTI = 8U }

  Port type.
- enum port_pin_index_t {
kPORT_PinIdx0 = 0U,
kPORT_PinIdx1 = 1U,
kPORT_PinIdx2 = 2U,
kPORT_PinIdx3 = 3U,
kPORT_PinIdx4 = 4U,
kPORT_PinIdx5 = 5U,
kPORT_PinIdx6 = 6U,
kPORT_PinIdx7 = 7U }

  Pin number, Notice this index enum has been deprecated and it will be removed in the next release.

- enum port_pin_select_t {

kPORT_NMI_OTHERS = 0U,
kPORT_NMI_NMIE = 1U,
kPORT_RST_OTHERS = 0U,
kPORT_RST_RSTPE = 1U,
kPORT_SWDE_OTHERS = 0U,
kPORT_SWDE_SWDE = 1U,
kPORT_IRQ_PTA5 = 0U,
kPORT_IRQ_PTI0 = 1U,
kPORT_IRQ_PTI1 = 2U,
kPORT_IRQ_PTI2 = 3U,
kPORT_IRQ_PTI3 = 4U,
kPORT_IRQ_PTI4 = 5U,
kPORT_IRQ_PTI5 = 6U,
kPORT_IRQ_PTI6 = 7U,
kPORT_RTCO_PTC4 = 0U,
kPORT_RTCO_PTC5 = 1U,
kPORT_I2C0_SCLPTA3_SDAPTA2 = 0U,
kPORT_I2C0_SCLPTB7_SDAPTB6 = 1U,
kPORT_SPI0_SCKPTB2_MOSIPTB3_MISOPTB4_PCSPTB5 = 0U,
kPORT_SPI0_SCKPTE0_MOSIPTE1_MISOPTE2_PCSPTE3,
kPORT_UART0_RXPTB0_TXPTB1 = 0U,
kPORT_UART0_RXPTA2_TXPTA3 = 1U,
kPORT_FTM0_CH0_PTA0 = 0U,
kPORT_FTM0_CH0_PTB2 = 1U,
kPORT_FTM0_CH1_PTA1 = 0U,
kPORT_FTM0_CH1_PTB3 = 1U,
kPORT_FTM0CLK_TCLK0 = 0U,
kPORT_FTM0CLK_TCLK1 = 1U,
kPORT_FTM0CLK_TCLK2 = 2U,
kPORT_FTM1CLK_TCLK0 = 0U,
kPORT_FTM1CLK_TCLK1 = 1U,
kPORT_FTM1CLK_TCLK2 = 2U,
kPORT_FTM2CLK_TCLK0 = 0U,
kPORT_FTM2CLK_TCLK1 = 1U,
kPORT_FTM2CLK_TCLK2 = 2U,
kPORT_PWTCLK_TCLK0 = 0U,
kPORT_PWTCLK_TCLK1 = 1U,
kPORT_PWTCLK_TCLK2 = 2U,
kPORT_FTM1_CH0_PTC4 = 0U,
kPORT_FTM1_CH0_PTH2 = 1U,
kPORT_FTM1_CH1_PTC5 = 0U,
kPORT_FTM1_CH1_PTE7 = 1U,
kPORT_FTM2_CH0_PTC0 = 0U,
kPORT_FTM2_CH0_PTH0 = 1U,
kPORT_FTM2_CH0_PTF0 = 2U,
kPORT_FTM2_CH1_PTC1 = 0U,
kPORT_FTM2_CH1_PTH1 = 1U,
kPORT_FTM2_CH1_PTF1 = 2U,
kPORT_FTM2_CH2_PTC2 = 0U,

kPORT_MSCAN_TXPTE7_RXPTH2 = 1U }
  Pin selection.
- enum port_filter_pin_t {
  kPORT_FilterPTA = PORT_IOFLT0_FLTA_SHIFT,
  kPORT_FilterPTB = PORT_IOFLT0_FLTB_SHIFT,
  kPORT_FilterPTC = PORT_IOFLT0_FLTC_SHIFT,
  kPORT_FilterPTD = PORT_IOFLT0_FLTD_SHIFT,
  kPORT_FilterPTE = PORT_IOFLT0_FLTE_SHIFT,
  kPORT_FilterPTF = PORT_IOFLT0_FLTF_SHIFT,
  kPORT_FilterPTG = PORT_IOFLT0_FLTG_SHIFT,
  kPORT_FilterPTH = PORT_IOFLT0_FLTH_SHIFT,
  kPORT_FilterRST = PORT_IOFLT0_FLTRST_SHIFT,
  kPORT_FilterKBI0 = PORT_IOFLT0_FLTKBI0_SHIFT,
  kPORT_FilterKBI1 = PORT_IOFLT0_FLTKBI1_SHIFT,
  kPORT_FilterNMI = PORT_IOFLT0_FLTNMI_SHIFT,
  kPORT_FilterPTI = PORT_IOFLT1_FLTI_SHIFT + PORT_FILTER_REG_OFFSET,
  kPORT_FilterIRQ = PORT_IOFLT1_FLTIRQ_SHIFT + PORT_FILTER_REG_OFFSET,
  kPORT_FilterFTM0 = PORT_IOFLT1_FLTFTM0_SHIFT + PORT_FILTER_REG_OFFSET,
  kPORT_FilterFTM1 = PORT_IOFLT1_FLTFTM1_SHIFT + PORT_FILTER_REG_OFFSET,
  kPORT_FilterPWT = PORT_IOFLT1_FLTPWT_SHIFT + PORT_FILTER_REG_OFFSET,
  kPORT_FilterI2C0 = PORT_IOFLT1_FLTI2C0_SHIFT + PORT_FILTER_REG_OFFSET,
  kPORT_FilterI2C1 = PORT_IOFLT1_FLTI2C1_SHIFT + PORT_FILTER_REG_OFFSET }
  The PORT pins for input glitch filter configure.
- enum port_filter_select_t {
  kPORT_BUSCLK_OR_NOFILTER = 0U,
  kPORT_FILTERDIV1 = 1U,
  kPORT_FILTERDIV2 = 2U,
  kPORT_FILTERDIV3_OR_BUSCLK = 3U }
  The Filter selection for input pins.
- enum port_highdrive_pin_t {
  kPORT_HighDrive_PTB4 = PORT_HDRVE_PTB4_MASK,
  kPORT_HighDrive_PTB5 = PORT_HDRVE_PTB5_MASK,
  kPORT_HighDrive_PTD0 = PORT_HDRVE_PTD0_MASK,
  kPORT_HighDrive_PTD1 = PORT_HDRVE_PTD1_MASK,
  kPORT_HighDrive_PTE0 = PORT_HDRVE_PTE0_MASK,
  kPORT_HighDrive_PTE1 = PORT_HDRVE_PTE1_MASK,
  kPORT_HighDrive_PTH0 = PORT_HDRVE_PTH0_MASK,
  kPORT_HighDrive_PTH1 = PORT_HDRVE_PTH1_MASK }
  Port pin for high driver enable/disable control.

Driver version

- #define FSL_PORT_DRIVER_VERSION (MAKE_VERSION(2, 0, 3))
  Version 2.0.3.

Configuration

- void PORT_SetPinSelect (port_module_t module, port_pin_select_t pin)
  Selects pin for modules.
- void PORT_SetFilterSelect (PORT_Type *base, port_filter_pin_t port, port_filter_select_t filter)
  Selects the glitch filter for input pins.
- static void PORT_SetFilterDIV1WidthThreshold (PORT_Type *base, uint8_t threshold)
  Sets the width threshold for glitch filter division set 1.
- static void PORT_SetFilterDIV2WidthThreshold (PORT_Type *base, uint8_t threshold)
  Sets the width threshold for glitch filter division set 2.
- static void PORT_SetFilterDIV3WidthThreshold (PORT_Type *base, uint8_t threshold)
  Sets the width threshold for glitch filter division set 3.
- void PORT_SetPinPullUpEnable (PORT_Type *base, port_type_t port, uint8_t num, bool enable)
  Enables or disables the port pull up.
- static void PORT_SetHighDriveEnable (PORT_Type *base, port_highdrive_pin_t pin, bool enable)
  Set High drive for port pins.

5.2 Macro Definition Documentation

5.2.1 #define FSL_PORT_DRIVER_VERSION (MAKE_VERSION(2, 0, 3))

5.3 Enumeration Type Documentation

5.3.1 enum port_module_t

Enumerator

kPORT_NMI NMI port pin select.
kPORT_RESET RESET pin select.
kPORT_SWDE Single wire debug port pin.
kPORT_IRQ IRQ port pin select.
kPORT_RTC RTC port pin select.
kPORT_I2C0 I2C0 Port pin select.
kPORT_SPI0 SPI0 port pin select.
kPORT_UART0 UART0 port pin select.
kPORT_FTM0CH0 FTM0_CH0 port pin select.
kPORT_FTM0CH1 FTM0_CH1 port pin select.
kPORT_FTM1CH0 FTM1_CH0 port pin select.
kPORT_FTM1CH1 FTM1_CH1 port pin select.
kPORT_FTM0CLK FTM0 Clock pin select.
kPORT_FTM1CLK FTM1 Clock pin select.
kPORT_FTM2CLK FTM2 Clock pin select.
kPORT_PWTCLK PWT Clock pin select.
kPORT_FTM2CH0 FTM2_CH0 port pin select.
kPORT_FTM2CH1 FTM2_CH1 port pin select.
kPORT_FTM2CH2 FTM2_CH2 port pin select.
kPORT_FTM2CH3 FTM2_CH3 port pin select.
kPORT_FTM2CH4 FTM2_CH4 port pin select.

kPORT_FTM2CH5 FTM2_CH5 port pin select.
kPORT_I2C1 I2C1 port pin select.
kPORT_SPI1 SPI1 port pin select.
kPORT_UART1 UART1 port pin select.
kPORT_UART2 UART2 port pin select.
kPORT_PWTIN0 PWT_IN0 port pin select.
kPORT_PWTIN1 PWT_IN1 port pin select.
kPORT_MSCAN MSCAN port pin select.

5.3.2 enum port_type_t

Enumerator

kPORT_PTA PORT PTA.
kPORT_PTB PORT PTB.
kPORT_PTC PORT PTC.
kPORT_PTD PORT PTD.
kPORT_PTE PORT PTE.
kPORT_PTF PORT PTF.
kPORT_PTG PORT PTG.
kPORT_PTH PORT PTH.
kPORT_PTI PORT PTI.

5.3.3 enum port_pin_index_t

Enumerator

kPORT_PinIdx0 PORT PIN index 0.
kPORT_PinIdx1 PORT PIN index 1.
kPORT_PinIdx2 PORT PIN index 2.
kPORT_PinIdx3 PORT PIN index 3.
kPORT_PinIdx4 PORT PIN index 4.
kPORT_PinIdx5 PORT PIN index 5.
kPORT_PinIdx6 PORT PIN index 6.
kPORT_PinIdx7 PORT PIN index 7.

5.3.4 enum port_pin_select_t

Enumerator

kPORT_NMI_OTHERS PTB4/FTM2_CH4 etc function as PTB4/FTM2_CH4 etc.

kPORT_NMI_NMIE PTB4/FTM2_CH4 etc function as NMI.
kPORT_RST_OTHERS PTA5/IRQ etc function as PTA5/IRQ etc.
kPORT_RST_RSTPE PTA5/IRQ etc function as REST.
kPORT_SWDE_OTHERS PTA4/ACMP0 etc function as PTA4/ACMP0 etc.
kPORT_SWDE_SWDE PTA4/ACMP0 etc function as SWD.
kPORT_IRQ_PTA5 IRQ is mapped to PTA5.
kPORT_IRQ_PTI0 IRQ is mapped to PTI0.
kPORT_IRQ_PTI1 IRQ is mapped to PTI1.
kPORT_IRQ_PTI2 IRQ is mapped to PTI2.
kPORT_IRQ_PTI3 IRQ is mapped to PTI3.
kPORT_IRQ_PTI4 IRQ is mapped to PTI4.
kPORT_IRQ_PTI5 IRQ is mapped to PTI5.
kPORT_IRQ_PTI6 IRQ is mapped to PTI6.
kPORT_RTCO_PTC4 RTCO is mapped to PTC4.
kPORT_RTCO_PTC5 RTCO is mapped to RTC5.
kPORT_I2C0_SCLPTA3_SDAPTA2 I2C0_SCL and I2C0_SDA are mapped on PTA3 and PTA2, respectively.
kPORT_I2C0_SCLPTB7_SDAPTB6 I2C0_SCL and I2C0_SDA are mapped on PTB7 and PTB6, respectively.
kPORT_SPI0_SCKPTB2_MOSIPTB3_MISOPTB4_PCSPTB5 SPI0_SCK/MOSI/MISO/PCS0 are mapped on PTB2/PTB3/PTB4/PTB5.
kPORT_SPI0_SCKPTE0_MOSIPTE1_MISOPTE2_PCSPTE3 SPI0_SCK/MOSI/MISO/PCS0 are mapped on PTE0/PTE1/PTE2/PTE3.
kPORT_UART0_RXPTB0_TXPTB1 UART0_RX and UART0_TX are mapped on PTB0 and PT-B1.
kPORT_UART0_RXPTA2_TXPTA3 UART0_RX and UART0_TX are mapped on PTA2 and PT-A3.
kPORT_FTM0_CH0_PTA0 FTM0_CH0 channels are mapped on PTA0.
kPORT_FTM0_CH0_PTB2 FTM0_CH0 channels are mapped on PTB2.
kPORT_FTM0_CH1_PTA1 FTM0_CH1 channels are mapped on PTA1.
kPORT_FTM0_CH1_PTB3 FTM0_CH1 channels are mapped on PTB3.
kPORT_FTM0CLK_TCLK0 FTM0 CLK using the TCLK0 pin.
kPORT_FTM0CLK_TCLK1 FTM0 CLK using the TCLK1 pin.
kPORT_FTM0CLK_TCLK2 FTM0 CLK using the TCLK2 pin.
kPORT_FTM1CLK_TCLK0 FTM1 CLK using the TCLK0 pin.
kPORT_FTM1CLK_TCLK1 FTM1 CLK using the TCLK1 pin.
kPORT_FTM1CLK_TCLK2 FTM1 CLK using the TCLK2 pin.
kPORT_FTM2CLK_TCLK0 FTM2 CLK using the TCLK0 pin.
kPORT_FTM2CLK_TCLK1 FTM2 CLK using the TCLK1 pin.
kPORT_FTM2CLK_TCLK2 FTM2 CLK using the TCLK2 pin.
kPORT_PWTCLK_TCLK0 PWT CLK using the TCLK0 pin.
kPORT_PWTCLK_TCLK1 PWT CLK using the TCLK1 pin.
kPORT_PWTCLK_TCLK2 PWT CLK using the TCLK2 pin.
kPORT_FTM1_CH0_PTC4 FTM1_CH0 channels are mapped on PTC4.
kPORT_FTM1_CH0_PTH2 FTM1_CH0 channels are mapped on PTH2.

kPORT_FTM1_CH1_PTC5 FTM1_CH1 channels are mapped on PTC5.
kPORT_FTM1_CH1_PTE7 FTM1_CH1 channels are mapped on PTE7.
kPORT_FTM2_CH0_PTC0 FTM2_CH0 channels are mapped on PTC0.
kPORT_FTM2_CH0_PTH0 FTM2_CH0 channels are mapped on PTH0.
kPORT_FTM2_CH0_PTF0 FTM2_CH0 channels are mapped on PTF0.
kPORT_FTM2_CH1_PTC1 FTM2_CH1 channels are mapped on PTC1.
kPORT_FTM2_CH1_PTH1 FTM2_CH1 channels are mapped on PTH1.
kPORT_FTM2_CH1_PTF1 FTM2_CH1 channels are mapped on PTF1.
kPORT_FTM2_CH2_PTC2 FTM2_CH2 channels are mapped on PTC2.
kPORT_FTM2_CH2_PTD0 FTM2_CH2 channels are mapped on PTD0.
kPORT_FTM2_CH2_PTG4 FTM2_CH2 channels are mapped on PTG4.
kPORT_FTM2_CH3_PTC3 FTM2_CH3 channels are mapped on PTC3.
kPORT_FTM2_CH3_PTD1 FTM2_CH3 channels are mapped on PTD1.
kPORT_FTM2_CH3_PTG5 FTM2_CH3 channels are mapped on PTG5.
kPORT_FTM2_CH4_PTB4 FTM2_CH4 channels are mapped on PTB4.
kPORT_FTM2_CH4_PTG6 FTM2_CH4 channels are mapped on PTG6.
kPORT_FTM2_CH5_PTB5 FTM2_CH5 channels are mapped on PTB5.
kPORT_FTM2_CH5_PTG7 FTM2_CH5 channels are mapped on PTG7.
kPORT_I2C1_SCLPTE1_SDAPTE0 I2C1_SCL and I2C1_SDA are mapped on PTE1 and PTE0, respectively.
kPORT_I2C1_SCLPTH4_SDAPTH3 I2C1_SCL and I2C1_SDA are mapped on PTH4 and PTH3, respectively.
kPORT_SPI1_SCKPTD0_MOSIPTD1_MISOPTD2_PCSPTD3 SPI1_SCK/MOSI/MISO/PCS0 are mapped on PTD0/PTD1/PTD2/PTD3.
kPORT_SPI1_SCKPTG4_MOSIPTG5_MISOPTG6_PCSPTG7 SPI1_SCK/MOSI/MISO/PCS0 are mapped on PTG4/PTG5/PTG6/PTG7.
kPORT_UART1_RXPTC7_TXPTC6 UART1_RX and UART1_TX are mapped on PTC7 and PTC6.
kPORT_UART1_RXPTF3_TXPTF2 UART1_RX and UART1_TX are mapped on PTF3 and PTF2.
kPORT_UART2_RXPTD7_TXPTD6 UART2_RX and UART2_TX are mapped on PTD7 and PTD6.
kPORT_UART2_RXPTI1_TXPTI0 UART2_RX and UART2_TX are mapped on PTI1 and PTI0.
kPORT_PWTIN0_PTD5 PWTIN0 is mapped to PTD5.
kPORT_PWTIN0_PTE2 PWTIN0 is mapped to PTE2.
kPORT_PWTIN1_PTB0 PWTIN0 is mapped to PTB0.
kPORT_PWTIN1_PTH7 PWTIN0 is mapped to PTH7.
kPORT_MSCAN_TXPTC7_RXPTC6 CAN_TX, RXis mapped to PTC7, PTC6.
kPORT_MSCAN_TXPTE7_RXPTH2 CAN_TX, RXis mapped to PTE7, PTH2.

5.3.5 enum port_filter_pin_t

Enumerator

kPORT_FilterPTA Filter for input from PTA.
kPORT_FilterPTB Filter for input from PTB.
kPORT_FilterPTC Filter for input from PTC.
kPORT_FilterPTD Filter for input from PTD.
kPORT_FilterPTE Filter for input from PTE.
kPORT_FilterPTF Filter for input from PTF.
kPORT_FilterPTG Filter for input from PTG.
kPORT_FilterPTH Filter for input from PTH.
kPORT_FilterRST Filter for input from RESET/IRQ.
kPORT_FilterKBI0 Filter for input from KBI0.
kPORT_FilterKBI1 Filter for input from KBI1.
kPORT_FilterNMI Filter for input from NMI.
kPORT_FilterPTI Filter for input from PTI.
kPORT_FilterIRQ Filter for input from IRQ.
kPORT_FilterFTM0 Filter for input from FTM0.
kPORT_FilterFTM1 Filter for input form FTM1.
kPORT_FilterPWT Filter for input from PWT.
kPORT_FilterI2C0 Filter for input form I2C0.
kPORT_FilterI2C1 Filter for input from I2C1.

5.3.6 enum port_filter_select_t

Enumerator

kPORT_BUSCLK_OR_NOFILTER Filter section BUSCLK for PTA∼PTH,= or no filter for RES-T/KBI0/KBI1/NMI/IRQ/FTM0/FTM1/PWT/I2C0/I2C1.
kPORT_FILTERDIV1 Filter Division Set 1.
kPORT_FILTERDIV2 Filter Division Set 2.
kPORT_FILTERDIV3_OR_BUSCLK Filter Division Set 3 for NMI/KBI1/KNI0/IRQ/PTA∼PT-H/PWT/FTM0/FTM1/IRQ/PTI or BUSCLK for I2C0/I2C1/.

5.3.7 enum port_highdrive_pin_t

Enumerator

kPORT_HighDrive_PTB4 PTB4.
kPORT_HighDrive_PTB5 PTB5.
kPORT_HighDrive_PTD0 PTD0.
kPORT_HighDrive_PTD1 PTD1.

kPORT_HighDrive_PTE0 PTE0.
kPORT_HighDrive_PTE1 PTE1.
kPORT_HighDrive_PTH0 PTH0.
kPORT_HighDrive_PTH1 PTH1.

5.4 Function Documentation

5.4.1 void PORT_SetPinSelect (port_module_t *module*, port_pin_select_t *pin*)

This API is used to select the port pin for the module with multiple port pin selection. For example the FTM Channel 0 can be mapped to ether PTA0 or PTB2. Select FTM channel 0 map to PTA0 port pin as:

```
* PORT_SetPinSelect(kPORT_FTM0CH0,
      kPORT_FTM0_CH0_PTA0);
*
```

Note

This API doesn't support to select specified ALT for a given port pin. The ALT feature is automatically selected by hardware according to the ALT priority: Low -----> high: Alt1, Alt2, . . . when peripheral modules has been enabled.

If you want to select a specified ALT for a given port pin, please add two more steps after calling PORT-_SetPinSelect:

1. Enable module or the port control in the module for the ALT you want to select. For I2C ALT feature:all port enable is controlled by the module enable, so set IICEN in I2CX_C1 to enable the port pins for I2C feature. For KBI ALT feature:each port pin is controlled independently by each bit in KBIx_PE. set related bit in this register to enable the KBI feature in the port pin.
2. Make sure there is no module enabled with higher priority than the ALT module feature you want to select.

Parameters

module	Modules for pin selection. For NMI/RST module are write-once attribute after reset.
pin	Port pin selection for modules.

5.4.2 void PORT_SetFilterSelect (PORT_Type ∗ *base*, port_filter_pin_t *port*, port_filter_select_t *filter*)

Parameters

base	PORT peripheral base pointer.
port	PORT pin, see "port_filter_pin_t".
filter	Filter select, see "port_filter_select_t".

5.4.3 static void PORT_SetFilterDIV1WidthThreshold (PORT_Type * *base,* uint8_t *threshold*) [inline], [static]

'

Parameters

base	PORT peripheral base pointer.
threshold	PORT glitch filter width threshold, take refer to reference manual for detail information. 0 - LPOCLK 1 - LPOCLK/2 2 - LPOCLK/4 3 - LPOCLK/8 4 - LPOCLK/16 5 - LPOCLK/32 6 - LPOCLK/64 7 - LPOCLK/128

5.4.4 static void PORT_SetFilterDIV2WidthThreshold (PORT_Type * *base,* uint8_t *threshold*) [inline], [static]

'

Parameters

base	PORT peripheral base pointer.
threshold	PORT glitch filter width threshold, take refer to reference manual for detail information. 0 - BUSCLK/32 1 - BUSCLK/64 2 - BUSCLK/128 3 - BUSCLK/256 4 - BUSCLK/512 5 - BUSCLK/1024 6 - BUSCLK/2048 7 - BUSCLK/4096

5.4.5 static void PORT_SetFilterDIV3WidthThreshold (PORT_Type * *base,* uint8_t *threshold*) [inline], [static]

'

Parameters

base	PORT peripheral base pointer.
threshold	PORT glitch filter width threshold, take refer to reference manual for detail information. 0 - BUSCLK/2 1 - BUSCLK/4 2 - BUSCLK/8 3 - BUSCLK/16

5.4.6 void PORT_SetPinPullUpEnable (PORT_Type * *base*, port_type_t *port*, uint8_t *num*, bool *enable*)

Parameters

base	PORT peripheral base pointer.
port	PORT type, such as PTA/PTB/PTC etc, see "port_type_t".
num	PORT pin number, such as 0, 1, 2... For PTI, only PTI0 $\sim$ PTI6 pins are supported. so when set pull up feature for PTI, please don't set number 7. see reference manual for more details.
enable	Enable or disable the pull up feature switch.

5.4.7 static void PORT_SetHighDriveEnable (PORT_Type * *base*, port_highdrive_pin_t *pin*, bool *enable*) [inline], [static]

Parameters

base	PORT peripheral base pointer.
pin	PORT pin support high drive.
enable	Enable or disable the high driver feature switch.

Chapter 6
ACMP: Analog Comparator Driver

6.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Comparator (ACMP) module of MCUXpresso SDK devices.

6.2 Typical use case

6.2.1 Normal Configuration

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

6.2.2 Interrupt Configuration

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

Data Structures

- struct acmp_config_t
  Configuration for ACMP. More...
- struct acmp_dac_config_t
  Configuration for Internal DAC. More...

Enumerations

- enum acmp_hysterisis_mode_t {
  kACMP_HysterisisLevel1 = 0U,
  kACMP_HysterisisLevel2 = 1U }
  Analog Comparator Hysterisis Selection.
- enum acmp_reference_voltage_source_t {
  kACMP_VrefSourceVin1 = 0U,
  kACMP_VrefSourceVin2 = 1U }
  DAC Voltage Reference source.
- enum acmp_interrupt_mode_t {
  kACMP_OutputFallingInterruptMode = 0U,
  kACMP_OutputRisingInterruptMode = 1U,
  kACMP_OutputBothEdgeInterruptMode = 3U }
  The sensitivity modes of the interrupt trigger.

- enum acmp_input_channel_selection_t {
kACMP_ExternalReference0 = 0U,
kACMP_ExternalReference1 = 1U,
kACMP_ExternalReference2 = 2U,
kACMP_InternalDACOutput = 3U }
The ACMP input channel selection.
- enum _acmp_status_flags {
kACMP_InterruptFlag = ACMP_CS_ACF_MASK,
kACMP_OutputFlag = ACMP_CS_ACO_MASK }
The ACMP status flags.

Driver version

- #define FSL_ACMP_DRIVER_VERSION (MAKE_VERSION(2U, 0U, 2U))
ACMP driver version 2.0.2.

Initialization and deinitialization

- void ACMP_Init (ACMP_Type ∗base, const acmp_config_t ∗config)
Initialize the ACMP.
- void ACMP_Deinit (ACMP_Type ∗base)
De-Initialize the ACMP.
- void ACMP_GetDefaultConfig (acmp_config_t ∗config)
Gets the default configuration for ACMP.
- static void ACMP_Enable (ACMP_Type ∗base, bool enable)
Enable/Disable the ACMP module.
- void ACMP_EnableInterrupt (ACMP_Type ∗base, acmp_interrupt_mode_t mode)
Enable the ACMP interrupt and determines the sensitivity modes of the interrupt trigger.
- static void ACMP_DisableInterrupt (ACMP_Type ∗base)
Disable the ACMP interrupt.
- void ACMP_SetChannelConfig (ACMP_Type ∗base, acmp_input_channel_selection_t PositiveInput, acmp_input_channel_selection_t negativeInout)
Configure the ACMP positive and negative input channel.
- void **ACMP_SetDACConfig** (ACMP_Type ∗base, const acmp_dac_config_t ∗config)
- void ACMP_EnableInputPin (ACMP_Type ∗base, uint32_t mask, bool enable)
Enable/Disable ACMP input pin.
- static uint8_t ACMP_GetStatusFlags (ACMP_Type ∗base)
Get ACMP status flags.
- static void ACMP_ClearInterruptFlags (ACMP_Type ∗base)
Clear interrupts status flag.

6.3 Data Structure Documentation

6.3.1 struct acmp_config_t

Data Fields

- bool enablePinOut
The comparator output is available on the associated pin.

- acmp_hysterisis_mode_t hysteresisMode
  Hysteresis mode.

Field Documentation

(1) bool acmp_config_t::enablePinOut

(2) acmp_hysterisis_mode_t acmp_config_t::hysteresisMode

6.3.2 struct acmp_dac_config_t

Data Fields

- uint8_t DACValue
  Value for DAC Output Voltage.
- acmp_reference_voltage_source_t referenceVoltageSource
  Supply voltage reference source.

Field Documentation

(1) uint8_t acmp_dac_config_t::DACValue

Available range is 0-63.

(2) acmp_reference_voltage_source_t acmp_dac_config_t::referenceVoltageSource

6.4 Macro Definition Documentation

6.4.1 #define FSL_ACMP_DRIVER_VERSION (MAKE_VERSION(2U, 0U, 2U))

6.5 Enumeration Type Documentation

6.5.1 enum acmp_hysterisis_mode_t

Enumerator

kACMP_HysterisisLevel1 ACMP hysterisis is 20mv. >
kACMP_HysterisisLevel2 ACMP hysterisis is 30mv. >

6.5.2 enum acmp_reference_voltage_source_t

Enumerator

kACMP_VrefSourceVin1 The DAC selects Bandgap as the reference.
kACMP_VrefSourceVin2 The DAC selects VDDA as the reference.

6.5.3 enum acmp_interrupt_mode_t

Enumerator

kACMP_OutputFallingInterruptMode ACMP interrupt on output falling edge. >
kACMP_OutputRisingInterruptMode ACMP interrupt on output rising edge. >
kACMP_OutputBothEdgeInterruptMode ACMP interrupt on output falling or rising edge. >

6.5.4 enum acmp_input_channel_selection_t

Enumerator

kACMP_ExternalReference0 External reference 0 is selected to as input channel. >
kACMP_ExternalReference1 External reference 1 is selected to as input channel. >
kACMP_ExternalReference2 External reference 2 is selected to as input channel. >
kACMP_InternalDACOutput Internal DAC putput is selected to as input channel. >

6.5.5 enum _acmp_status_flags

Enumerator

kACMP_InterruptFlag ACMP interrupt on output valid edge. >
kACMP_OutputFlag The current value of the analog comparator output. >

6.6 Function Documentation

6.6.1 void ACMP_Init (ACMP_Type * *base*, const acmp_config_t * *config*)

The default configuration can be got by calling ACMP_GetDefaultConfig().

Parameters

base	ACMP peripheral base address.
config	Pointer to ACMP configuration structure.

6.6.2 void ACMP_Deinit (ACMP_Type * *base*)

Parameters

base	ACMP peripheral basic address.

6.6.3 void ACMP_GetDefaultConfig (acmp_config_t * *config*)

This function initializes the user configuration structure to default value. The default value are: Example:

```
*   config->enablePinOut = false;
*   config->hysteresisMode = kACMP_HysterisisLevel1;
*
```

Parameters

config	Pointer to ACMP configuration structure.

6.6.4 static void ACMP_Enable (ACMP_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	ACMP peripheral base address.
enable	Switcher to enable/disable ACMP module.

6.6.5 void ACMP_EnableInterrupt (ACMP_Type * *base*, acmp_interrupt_mode_t *mode*)

Parameters

base	ACMP peripheral base address.
mode	Select one interrupt mode to generate interrupt.

6.6.6 static void ACMP_DisableInterrupt (ACMP_Type * *base*) [inline], [static]

Parameters

base	ACMP peripheral base address.

6.6.7 void ACMP_SetChannelConfig (ACMP_Type ∗ *base*, acmp_input_channel_selection_t *PositiveInput*, acmp_input_channel_selection_t *negativeInout*)

Parameters

base	ACMP peripheral base address.
PositiveInput	ACMP Positive Input Select. Refer to "acmp_input_channel_selection_t".
negativeInout	ACMP Negative Input Select. Refer to "acmp_input_channel_selection_t".

6.6.8 void ACMP_EnableInputPin (ACMP_Type ∗ *base*, uint32_t *mask*, bool *enable*)

```
The API controls if the corresponding ACMP external pin can be driven by an analog input
```

Parameters

base	ACMP peripheral base address.
mask	The mask of the pin associated with channel ADx. Valid range is AD0:0x1U ∼ AD3:0x4U. For example: If enable AD0, AD1 and AD2 pins, mask should be set to 0x7U(0x1 | 0x2 | 0x4).
enable	Switcher to enable/disable ACMP module.

6.6.9 static uint8_t ACMP_GetStatusFlags (ACMP_Type ∗ *base*) [inline], [static]

Parameters

base	ACMP peripheral base address.

Returns

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

6.6.10 static void ACMP_ClearInterruptFlags (ACMP_Type * *base*) [inline], [static]

Parameters

base	ACMP peripheral base address.

Chapter 7
ADC: 12-bit Analog to Digital Converter Driver

7.1 Overview

The MCUXpresso SDK provides a peripheral driver for the 12-bit Analog to Digital Converter (ADC) module of MCUXpresso SDK devices.

7.2 Typical use case

7.2.1 Interrupt Configuration

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

7.2.2 Polling Configuration

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

Data Structures

- struct adc_config_t
  ADC converter configuration. More...
- struct adc_hardware_compare_config_t
  ADC hardware comparison configuration. More...
- struct adc_fifo_config_t
  ADC FIFO configuration. More...
- struct adc_channel_config_t
  ADC channel conversion configuration. More...

Macros

- #define FSL_ADC_DRIVER_VERSION (MAKE_VERSION(2, 1, 0))
  ADC driver version.

Enumerations

- enum adc_reference_voltage_source_t {
  kADC_ReferenceVoltageSourceAlt0 = 0U,
  kADC_ReferenceVoltageSourceAlt1 = 1U }
  Reference voltage source.

- enum adc_clock_divider_t {
kADC_ClockDivider1 = 0U,
kADC_ClockDivider2 = 1U,
kADC_ClockDivider4 = 2U,
kADC_ClockDivider8 = 3U }
Clock divider for the converter.
- enum adc_resolution_mode_t {
kADC_Resolution8BitMode = 0U,
kADC_Resolution10BitMode = 1U,
kADC_Resolution12BitMode = 2U }
ADC converter resolution mode.
- enum adc_clock_source_t {
kADC_ClockSourceAlt0 = 0U,
kADC_ClockSourceAlt1 = 1U,
kADC_ClockSourceAlt2 = 2U,
kADC_ClockSourceAlt3 = 3U }
ADC input Clock source.
- enum adc_compare_mode_t {
kADC_CompareDisableMode = 0U,
kADC_CompareLessMode = 2U,
kADC_CompareGreaterOrEqualMode = 3U }
Compare function mode.
- enum _adc_status_flags {
kADC_ActiveFlag = ADC_SC2_ADACT_MASK,
kADC_FifoEmptyFlag = ADC_SC2_FEMPTY_MASK,
kADC_FifoFullFlag = ADC_SC2_FFULL_MASK }
ADC status flags mask.
- enum adc_hardware_trigger_mask_mode_t {
kADC_HWTriggerMaskDisableMode,
kADC_HWTriggerMaskAutoMode = 1U,
kADC_HWTriggerMaskEnableMode }
Hardware tigger mask mode.

Initialization

- void ADC_Init (ADC_Type ∗base, const adc_config_t ∗config)
Initializes the ADC module.
- void ADC_Deinit (ADC_Type ∗base)
De-initialize the ADC module.
- void ADC_GetDefaultConfig (adc_config_t ∗config)
Gets an available pre-defined settings for the converter's configuration.
- static void ADC_EnableHardwareTrigger (ADC_Type ∗base, bool enable)
Enable the hardware trigger mode.
- void ADC_SetHardwareCompare (ADC_Type ∗base, const adc_hardware_compare_config_t ∗config)
Configure the hardware compare mode.
- void ADC_SetFifoConfig (ADC_Type ∗base, const adc_fifo_config_t ∗config)
Configure the Fifo mode.

- void ADC_GetDefaultFIFOConfig (adc_fifo_config_t ∗config)
  Gets an available pre-defined settings for the FIFO's configuration.
- void ADC_SetChannelConfig (ADC_Type ∗base, const adc_channel_config_t ∗config)
  Configures the conversion channel.
- bool ADC_GetChannelStatusFlags (ADC_Type ∗base)
  Get the status flags of channel.
- uint32_t ADC_GetStatusFlags (ADC_Type ∗base)
  Get the ADC status flags.
- static void ADC_EnableAnalogInput (ADC_Type ∗base, uint32_t mask, bool enable)
  Disables the I/O port control of the pins used as analog inputs.
- static uint32_t ADC_GetChannelConversionValue (ADC_Type ∗base)
  Gets the conversion value.
- static void **ADC_SetHardwareTriggerMaskMode** (ADC_Type ∗base, adc_hardware_trigger_mask_mode_t mode)

7.3 Data Structure Documentation

7.3.1 struct adc_config_t

Data Fields

- adc_reference_voltage_source_t referenceVoltageSource
  Selects the voltage reference source used for conversions.
- bool enableLowPower
  Enable low power mode.
- bool enableLongSampleTime
  Enable long sample time mode.
- adc_clock_divider_t clockDivider
  Select the divider of input clock source.
- adc_resolution_mode_t ResolutionMode
  Select the sample resolution mode.
- adc_clock_source_t clockSource
  Select the input Clock source.

Field Documentation

(1) adc_reference_voltage_source_t adc_config_t::referenceVoltageSource

>

(2) bool adc_config_t::enableLowPower

The power is reduced at the expense of maximum clock speed. >

(3) bool adc_config_t::enableLongSampleTime

>

(4) adc_clock_divider_t adc_config_t::clockDivider

>

(5) adc_resolution_mode_t adc_config_t::ResolutionMode

>

(6) adc_clock_source_t adc_config_t::clockSource

>

7.3.2 struct adc_hardware_compare_config_t

Data Fields

- uint32_t compareValue
  Setting the compare value.
- adc_compare_mode_t compareMode
  Setting the compare mode.

Field Documentation

(1) uint32_t adc_hardware_compare_config_t::compareValue

The value are compared to the conversion result. >

(2) adc_compare_mode_t adc_hardware_compare_config_t::compareMode

Refer to "adc_compare_mode_t". >

7.3.3 struct adc_fifo_config_t

Data Fields

- bool enableHWTriggerMultConv
  The field is valid when FIFO is enabled.Enable hardware trigger multiple conversion.
- bool enableFifoScanMode
  The field is valid when FIFO is enabled.
- bool enableCompareAndMode
  The field is valid when FIFO is enabled.
- uint32_t FifoDepth
  Setting the depth of FIFO.

Field Documentation

(1) bool adc_fifo_config_t::enableHWTriggerMultConv

One hardware trigger pulse triggers multiple conversions in fifo mode. >

(2) bool adc_fifo_config_t::enableFifoScanMode

Enable the FIFO scan mode. If enable, ADC will repeat using the first FIFO channel as the conversion channel until the result FIFO is fulfilled. >

(3) bool adc_fifo_config_t::enableCompareAndMode

If enable, ADC will AND all of compare triggers and set COCO after all of compare triggers occur. If disable, ADC will OR all of compare triggers and set COCO after at least one of compare trigger occurs. >

(4) uint32_t adc_fifo_config_t::FifoDepth

Depth of fifo is FifoDepth + 1. When FifoDepth = 0U, the FIFO is DISABLED. When FifoDepth is set to nonzero, the FIFO function is ENABLED and the depth is indicated by the FifoDepth field. >

7.3.4 struct adc_channel_config_t

Data Fields

- uint32_t channelNumber
  Setting the conversion channel number.
- bool enableContinuousConversion
  enables continuous conversions.
- bool enableInterruptOnConversionCompleted
  Generate an interrupt request once the conversion is completed.

Field Documentation

(1) uint32_t adc_channel_config_t::channelNumber

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

(2) bool adc_channel_config_t::enableContinuousConversion

>

(3) bool adc_channel_config_t::enableInterruptOnConversionCompleted

7.4 Macro Definition Documentation

7.4.1 #define FSL_ADC_DRIVER_VERSION (MAKE_VERSION(2, 1, 0))

Version 2.1.0.

7.5 Enumeration Type Documentation

7.5.1 enum adc_reference_voltage_source_t

Enumerator

kADC_ReferenceVoltageSourceAlt0 Default voltage reference pin pair (VREFH/VREFL). >
kADC_ReferenceVoltageSourceAlt1 Analog supply pin pair (VDDA/VSSA). >

7.5.2 enum adc_clock_divider_t

Enumerator

kADC_ClockDivider1 Divide ration = 1, and clock rate = Input clock. >
kADC_ClockDivider2 Divide ration = 2, and clock rate = Input clock / 2. >
kADC_ClockDivider4 Divide ration = 3, and clock rate = Input clock / 4. >
kADC_ClockDivider8 Divide ration = 4, and clock rate = Input clock / 8. >

7.5.3 enum adc_resolution_mode_t

Enumerator

kADC_Resolution8BitMode 8-bit conversion (N = 8). >
kADC_Resolution10BitMode 10-bit conversion (N = 10) >
kADC_Resolution12BitMode 12-bit conversion (N = 12) >

7.5.4 enum adc_clock_source_t

Enumerator

kADC_ClockSourceAlt0 Bus clock. >
kADC_ClockSourceAlt1 Bus clock divided by 2. >
kADC_ClockSourceAlt2 Alternate clock (ALTCLK). >
kADC_ClockSourceAlt3 Asynchronous clock (ADACK). >

7.5.5 enum adc_compare_mode_t

Enumerator

kADC_CompareDisableMode Compare function disabled. >
kADC_CompareLessMode Compare triggers when input is less than compare level. >
kADC_CompareGreaterOrEqualMode Compare triggers when input is greater than or equal to compare level. >

7.5.6 enum _adc_status_flags

Enumerator

kADC_ActiveFlag Indicates that a conversion is in progress. >
kADC_FifoEmptyFlag Indicates that ADC result FIFO have no valid new data. >
kADC_FifoFullFlag Indicates that ADC result FIFO is full. >

7.5.7 enum adc_hardware_trigger_mask_mode_t

Enumerator

kADC_HWTriggerMaskDisableMode Hardware trigger mask disable and hardware trigger can trigger ADC conversion. >
kADC_HWTriggerMaskAutoMode Hardware trigger mask automatically when data fifo is not empty. >
kADC_HWTriggerMaskEnableMode Hardware trigger mask enable and hardware trigger cannot trigger ADC conversion. >

7.6 Function Documentation

7.6.1 void ADC_Init (ADC_Type ∗ *base*, const adc_config_t ∗ *config*)

Parameters

base	ADC peripheral base address.
config	Pointer to configuration structure. See "adc_config_t".

7.6.2 void ADC_Deinit (ADC_Type ∗ *base*)

Parameters

base	ADC peripheral base address.

7.6.3 void ADC_GetDefaultConfig (adc_config_t * *config*)

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

```
*   config->referenceVoltageSource = kADC_ReferenceVoltageSourceAlt0;
*   config->enableLowPower = false;
*   config->enableLongSampleTime = false;
*   config->clockDivider = kADC_ClockDivider1;
*   config->ResolutionMode = kADC_Resolution8BitMode;
*   config->clockSource = kADC_ClockSourceAlt0;
*
```

Parameters

config	Pointer to the configuration structure.

7.6.4 static void ADC_EnableHardwareTrigger (ADC_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	ADC peripheral base address.
enable	Switcher of the hardware trigger feature. "true" means enabled, "false" means not enabled.

7.6.5 void ADC_SetHardwareCompare (ADC_Type * *base*, const adc_hardware_compare_config_t * *config*)

The compare function can be configured to check for an upper or lower limit. After the input is sampled and converted, the result is added to the complement of the compare value (ADC_CV).

Parameters

base	ADC peripheral base address.
config	Pointer to "adc_hardware_compare_config_t" structure.

7.6.6 void ADC_SetFifoConfig (ADC_Type * *base*, const adc_fifo_config_t * *config*)

The ADC module supports FIFO operation to minimize the interrupts to CPU in order to reduce CP-U loading in ADC interrupt service routines. This module contains two FIFOs to buffer analog input channels and analog results respectively.

Parameters

base	ADC peripheral base address.
config	Pointer to "adc_fifo_config_t" structure.

7.6.7 void ADC_GetDefaultFIFOConfig (adc_fifo_config_t * *config*)

Parameters

config	Pointer to the FIFO configuration structure, please refer to adc_fifo_config_t for details.

7.6.8 void ADC_SetChannelConfig (ADC_Type * *base*, const adc_channel_config_t * *config*)

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

Parameters

base	ADC peripheral base address.
config	Pointer to "adc_channel_config_t" structure.

7.6.9 bool ADC_GetChannelStatusFlags (ADC_Type * *base*)

Parameters

base	ADC peripheral base address.

Returns

"True" means conversion has completed and "false" means conversion has not completed.

7.6.10 uint32_t ADC_GetStatusFlags (ADC_Type * *base*)

Parameters

base	ADC peripheral base address.

Returns

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

7.6.11 static void ADC_EnableAnalogInput (ADC_Type * *base,* uint32_t *mask,* bool *enable*) [inline], [static]

When a pin control register bit is set, the following conditions are forced for the associated MCU pin: -The output buffer is forced to its high impedance state. -The input buffer is disabled. A read of the I/O port returns a zero for any pin with its input buffer disabled. -The pullup is disabled.

Parameters

base	ADC peripheral base address.
mask	The mask of the pin associated with channel ADx. Valid range is AD0:0x1U ∼ AD15:0x8000U. For example: If enable AD0, AD1 and AD2 pins, mask should be set to 0x7U.
enable	The "true" means enabled, "false" means not enabled.

7.6.12 static uint32_t ADC_GetChannelConversionValue (ADC_Type * *base*) [inline], [static]

Parameters

base	ADC peripheral base address.

Returns

Conversion value.

Chapter 8
Common Driver

8.1 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**()

8.2 Macro Definition Documentation

8.2.1 #define FSL_DRIVER_TRANSFER_DOUBLE_WEAK_IRQ 1

8.2.2 #define MAKE_STATUS(*group*, *code*) ((((group)∗100L) + (code)))

8.2.3 #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
```

8.2.4 #define FSL_COMMON_DRIVER_VERSION (MAKE_VERSION(2, 3, 1))

8.2.5 #define DEBUG_CONSOLE_DEVICE_TYPE_NONE 0U

8.2.6 #define DEBUG_CONSOLE_DEVICE_TYPE_UART 1U

8.2.7 #define DEBUG_CONSOLE_DEVICE_TYPE_LPUART 2U

8.2.8 #define DEBUG_CONSOLE_DEVICE_TYPE_LPSCI 3U

8.2.9 #define DEBUG_CONSOLE_DEVICE_TYPE_USBCDC 4U

8.2.10 #define DEBUG_CONSOLE_DEVICE_TYPE_FLEXCOMM 5U

8.2.11 #define DEBUG_CONSOLE_DEVICE_TYPE_IUART 6U

8.2.12 #define DEBUG_CONSOLE_DEVICE_TYPE_VUSART 7U

8.2.13 #define DEBUG_CONSOLE_DEVICE_TYPE_MINI_USART 8U

8.2.14 #define DEBUG_CONSOLE_DEVICE_TYPE_SWO 9U

8.2.15 #define DEBUG_CONSOLE_DEVICE_TYPE_QSCI 10U

8.2.16 #define ARRAY_SIZE(*x*) (sizeof(x) / sizeof((x)[0]))

8.3 Typedef Documentation

8.3.1 typedef int32_t status_t

8.4 Enumeration Type Documentation

8.4.1 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.

8.4.2 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.

8.5 Function Documentation

8.5.1 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.

8.5.2 void SDK_Free (void * *ptr*)

Parameters

ptr	The memory to be release.

8.5.3 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 9
FTMRx Flash Driver

9.1 Overview

The flash provides the FTMRx Flash driver of MCUXpresso SDK devices with the FTMRx Flash module inside. The flash driver provides general APIs to handle specific operations on the FTMRx Flash module. The user can use those APIs directly in the application. In addition, it provides internal functions called by the driver. Although these functions are not meant to be called from the user's application directly, the APIs can still be used.

Data Structures

- struct pflash_protection_status_t
  PFlash protection status - full. More...
- struct flash_prefetch_speculation_status_t
  Flash prefetch speculation status. More...
- struct flash_protection_config_t
  Active flash protection information for the current operation. More...
- struct flash_operation_config_t
  Active flash information for the current operation. More...
- union function_run_command_t
  Flash execute-in-RAM command. More...
- struct flash_execute_in_ram_function_config_t
  Flash execute-in-RAM function information. More...
- struct flash_config_t
  Flash driver state information. More...

Typedefs

- typedef void(∗ flash_callback_t)(void)
  A callback type used for the Pflash block.

Enumerations

- enum flash_user_margin_value_t {
  kFLASH_ReadMarginValueNormal = 0x0000U,
  kFLASH_UserMarginValue1 = 0x0001U,
  kFLASH_UserMarginValue0 = 0x0002U }
  Enumeration for supported flash user margin levels.
- enum flash_factory_margin_value_t {
  kFLASH_FactoryMarginValue1 = 0x0003U,
  kFLASH_FactoryMarginValue0 = 0x0004U }
  Enumeration for supported factory margin levels.

- enum flash_margin_value_t {
kFLASH_MarginValueNormal,
kFLASH_MarginValueUser,
kFLASH_MarginValueFactory,
kFLASH_MarginValueInvalid }
Enumeration for supported flash margin levels.
- enum flash_security_state_t {
kFLASH_SecurityStateNotSecure,
kFLASH_SecurityStateBackdoorEnabled,
kFLASH_SecurityStateBackdoorDisabled }
Enumeration for the three possible flash security states.
- enum flash_protection_state_t {
kFLASH_ProtectionStateUnprotected,
kFLASH_ProtectionStateProtected,
kFLASH_ProtectionStateMixed }
Enumeration for the three possible flash protection levels.
- enum flash_property_tag_t {
kFLASH_PropertyPflashSectorSize = 0x00U,
kFLASH_PropertyPflashTotalSize = 0x01U,
kFLASH_PropertyPflashBlockSize = 0x02U,
kFLASH_PropertyPflashBlockCount = 0x03U,
kFLASH_PropertyPflashBlockBaseAddr = 0x04U,
kFLASH_PropertyPflashFacSupport = 0x05U,
kFLASH_PropertyEepromTotalSize = 0x15U,
kFLASH_PropertyFlashMemoryIndex = 0x20U,
kFLASH_PropertyFlashCacheControllerIndex = 0x21U,
kFLASH_PropertyEepromBlockBaseAddr = 0x22U,
kFLASH_PropertyEepromSectorSize = 0x23U,
kFLASH_PropertyEepromBlockSize = 0x24U,
kFLASH_PropertyEepromBlockCount = 0x25U,
kFLASH_PropertyFlashClockFrequency = 0x26U }
Enumeration for various flash properties.
- enum {
kFLASH_ExecuteInRamFunctionMaxSizeInWords = 16U,
kFLASH_ExecuteInRamFunctionTotalNum = 2U }
Constants for execute-in-RAM flash function.
- enum flash_memory_index_t {
kFLASH_MemoryIndexPrimaryFlash = 0x00U,
kFLASH_MemoryIndexSecondaryFlash = 0x01U }
Enumeration for the flash memory index.
- enum flash_cache_controller_index_t {
kFLASH_CacheControllerIndexForCore0 = 0x00U,
kFLASH_CacheControllerIndexForCore1 = 0x01U }
Enumeration for the flash cache controller index.
- enum flash_prefetch_speculation_option_t
Enumeration for the two possible options of flash prefetch speculation.
- enum flash_cache_clear_process_t {

kFLASH_CacheClearProcessPre = 0x00U,
kFLASH_CacheClearProcessPost = 0x01U }
Flash cache clear process code.

Flash version

- enum _flash_driver_version_constants {
  kFLASH_DriverVersionName = 'F',
  kFLASH_DriverVersionMajor = 2,
  kFLASH_DriverVersionMinor = 1,
  kFLASH_DriverVersionBugfix = 1 }
  Flash driver version for ROM.
- #define MAKE_VERSION(major, minor, bugfix) (((major) << 16) | ((minor) << 8) | (bugfix))
  Constructs the version number for drivers.
- #define FSL_FLASH_DRIVER_VERSION (MAKE_VERSION(2, 1, 2))
  Flash driver version for SDK.

Flash configuration

- #define FLASH_SSD_CONFIG_ENABLE_EEPROM_SUPPORT 0
  Indicates whether to support EEPROM in the Flash driver.
- #define FLASH_SSD_IS_EEPROM_ENABLED FLASH_SSD_CONFIG_ENABLE_EEPROM_-SUPPORT
  Indicates whether the EEPROM is enabled in the Flash driver.
- #define FLASH_SSD_CONFIG_ENABLE_SECONDARY_FLASH_SUPPORT 1
  Indicates whether to support Secondary flash in the Flash driver.
- #define FLASH_SSD_IS_SECONDARY_FLASH_ENABLED (0)
  Indicates whether the secondary flash is supported in the Flash driver.
- #define FLASH_DRIVER_IS_FLASH_RESIDENT 1
  Flash driver location.
- #define FLASH_DRIVER_IS_EXPORTED 0
  Flash Driver Export option.
- #define FLASH_ENABLE_STALLING_FLASH_CONTROLLER 1
  Enable flash stalling controller.

Flash status

- enum {
kStatus_FLASH_Success = MAKE_STATUS(kStatusGroupGeneric, 0),
kStatus_FLASH_InvalidArgument = MAKE_STATUS(kStatusGroupGeneric, 4),
kStatus_FLASH_SizeError = MAKE_STATUS(kStatusGroupFlashDriver, 0),
kStatus_FLASH_AlignmentError,
kStatus_FLASH_AddressError = MAKE_STATUS(kStatusGroupFlashDriver, 2),
kStatus_FLASH_AccessError,
kStatus_FLASH_ProtectionViolation,
kStatus_FLASH_CommandFailure,
kStatus_FLASH_UnknownProperty = MAKE_STATUS(kStatusGroupFlashDriver, 6),
kStatus_FLASH_EraseKeyError = MAKE_STATUS(kStatusGroupFlashDriver, 7),
kStatus_FLASH_RegionExecuteOnly,
kStatus_FLASH_ExecuteInRamFunctionNotReady,
kStatus_FLASH_PartitionStatusUpdateFailure,
kStatus_FLASH_SetFlexramAsEepromError,
kStatus_FLASH_RecoverFlexramAsRamError,
kStatus_FLASH_SetFlexramAsRamError = MAKE_STATUS(kStatusGroupFlashDriver, 13),
kStatus_FLASH_RecoverFlexramAsEepromError,
kStatus_FLASH_CommandNotSupported = MAKE_STATUS(kStatusGroupFlashDriver, 15),
kStatus_FLASH_SwapSystemNotInUninitialized,
kStatus_FLASH_SwapIndicatorAddressError,
kStatus_FLASH_ReadOnlyProperty = MAKE_STATUS(kStatusGroupFlashDriver, 18),
kStatus_FLASH_InvalidPropertyValue,
kStatus_FLASH_InvalidSpeculationOption,
kStatus_FLASH_ClockDivider = MAKE_STATUS(kStatusGroupFlashDriver, 21),
kStatus_FLASH_EepromDoubleBitFault,
kStatus_FLASH_EepromSingleBitFault }
Flash driver status codes.
- #define kStatusGroupGeneric 0
Flash driver status group.
- #define **kStatusGroupFlashDriver** 1
- #define MAKE_STATUS(group, code) ((((group)∗100) + (code)))
Constructs a status code value from a group and a code number.

Flash API key

- enum _flash_driver_api_keys { kFLASH_ApiEraseKey = FOUR_CHAR_CODE('k', 'f', 'e', 'k') }
Enumeration for Flash driver API keys.
- #define FOUR_CHAR_CODE(a, b, c, d) (((d) << 24) | ((c) << 16) | ((b) << 8) | ((a)))
Constructs the four character code for the Flash driver API key.

Initialization

- status_t FLASH_Init (flash_config_t ∗config)
Initializes the global flash properties structure members.
- status_t FLASH_SetCallback (flash_config_t ∗config, flash_callback_t callback)

Sets the desired flash callback function.
- status_t FLASH_PrepareExecuteInRamFunctions (flash_config_t ∗config)
  Prepares flash execute-in-RAM functions.

Erasing

- status_t FLASH_EraseAll (flash_config_t ∗config, uint32_t key)
  Erases entire flash.
- status_t FLASH_Erase (flash_config_t ∗config, uint32_t start, uint32_t lengthInBytes, uint32_t key)
  Erases the flash sectors encompassed by parameters passed into function.
- status_t FLASH_EraseAllUnsecure (flash_config_t ∗config, uint32_t key)
  Erases the entire flash, including protected sectors.

Programming

- status_t FLASH_Program (flash_config_t ∗config, uint32_t start, uint32_t ∗src, uint32_t lengthInBytes)
  Programs flash with data at locations passed in through parameters.
- status_t FLASH_ProgramOnce (flash_config_t ∗config, uint32_t index, uint32_t ∗src, uint32_t lengthInBytes)
  Programs Program Once Field through parameters.

Reading

- status_t FLASH_ReadOnce (flash_config_t ∗config, uint32_t index, uint32_t ∗dst, uint32_t lengthInBytes)
  Reads the Program Once Field through parameters.

Security

- status_t FLASH_GetSecurityState (flash_config_t ∗config, flash_security_state_t ∗state)
  Returns the security state via the pointer passed into the function.
- status_t FLASH_SecurityBypass (flash_config_t ∗config, const uint8_t ∗backdoorKey)
  Allows users to bypass security with a backdoor key.

Verification

- status_t FLASH_VerifyEraseAll (flash_config_t ∗config, flash_margin_value_t margin)
  Verifies erasure of the entire flash at a specified margin level.
- status_t FLASH_VerifyErase (flash_config_t ∗config, uint32_t start, uint32_t lengthInBytes, flash_margin_value_t margin)
  Verifies an erasure of the desired flash area at a specified margin level.

Protection

- status_t FLASH_IsProtected (flash_config_t ∗config, uint32_t start, uint32_t lengthInBytes, flash_protection_state_t ∗protection_state)
  Returns the protection state of the desired flash area via the pointer passed into the function.

Properties

- status_t FLASH_GetProperty (flash_config_t *config, flash_property_tag_t whichProperty, uint32_t *value)
  Returns the desired flash property.
- status_t FLASH_SetProperty (flash_config_t *config, flash_property_tag_t whichProperty, uint32_t value)
  Sets the desired flash property.

Flash Protection Utilities

- status_t FLASH_PflashSetProtection (flash_config_t *config, pflash_protection_status_t *protectStatus)
  Sets the PFlash Protection to the intended protection status.
- status_t FLASH_PflashGetProtection (flash_config_t *config, pflash_protection_status_t *protectStatus)
  Gets the PFlash protection status.

Flash Speculation Utilities

- status_t FLASH_PflashSetPrefetchSpeculation (flash_prefetch_speculation_status_t *speculationStatus)
  Sets the PFlash prefetch speculation to the intended speculation status.
- status_t FLASH_PflashGetPrefetchSpeculation (flash_prefetch_speculation_status_t *speculationStatus)
  Gets the PFlash prefetch speculation status.

9.2 Data Structure Documentation

9.2.1 struct pflash_protection_status_t

Data Fields

- uint8_t fprotvalue
  FPROT[7:0] .

Field Documentation

(1) uint8_t pflash_protection_status_t::fprotvalue

9.2.2 struct flash_prefetch_speculation_status_t

Data Fields

- flash_prefetch_speculation_option_t instructionOption
  Instruction speculation.
- flash_prefetch_speculation_option_t dataOption
  Data speculation.

Field Documentation

(1) flash_prefetch_speculation_option_t flash_prefetch_speculation_status_t::instructionOption

(2) flash_prefetch_speculation_option_t flash_prefetch_speculation_status_t::dataOption

9.2.3 struct flash_protection_config_t

Data Fields

- uint32_t lowRegionStart
  Start address of flash protection low region.
- uint32_t lowRegionEnd
  End address of flash protection low region.
- uint32_t highRegionStart
  Start address of flash protection high region.
- uint32_t highRegionEnd
  End address of flash protection high region.

Field Documentation

(1) uint32_t flash_protection_config_t::lowRegionStart

(2) uint32_t flash_protection_config_t::lowRegionEnd

(3) uint32_t flash_protection_config_t::highRegionStart

(4) uint32_t flash_protection_config_t::highRegionEnd

9.2.4 struct flash_operation_config_t

Data Fields

- uint32_t convertedAddress
  A converted address for the current flash type.
- uint32_t activeSectorSize
  A sector size of the current flash type.
- uint32_t activeBlockSize
  A block size of the current flash type.
- uint32_t blockWriteUnitSize
  The write unit size.
- uint32_t sectorCmdAddressAligment
  An erase sector command address alignment.
- uint32_t sectionCmdAddressAligment
  A program/verify section command address alignment.
- uint32_t programCmdAddressAligment
  A program flash command address alignment.

Field Documentation

(1) uint32_t flash_operation_config_t::convertedAddress

(2) uint32_t flash_operation_config_t::activeSectorSize

(3) uint32_t flash_operation_config_t::activeBlockSize

(4) uint32_t flash_operation_config_t::blockWriteUnitSize

(5) uint32_t flash_operation_config_t::sectorCmdAddressAligment

(6) uint32_t flash_operation_config_t::sectionCmdAddressAligment

(7) uint32_t flash_operation_config_t::programCmdAddressAligment

9.2.5 union function_run_command_t

9.2.6 struct flash_execute_in_ram_function_config_t

Data Fields

- uint32_t activeFunctionCount
  Number of available execute-in-RAM functions.
- function_run_command_t runCmdFuncAddr
  Execute-in-RAM function: flash_run_command.

Field Documentation

(1) uint32_t flash_execute_in_ram_function_config_t::activeFunctionCount

(2) function_run_command_t flash_execute_in_ram_function_config_t::runCmdFuncAddr

9.2.7 struct flash_config_t

An instance of this structure is allocated by the user of the flash driver and passed into each of the driver APIs.

Data Fields

- uint32_t PFlashBlockBase
  A base address of the first PFlash block.
- uint32_t PFlashTotalSize
  The size of the combined PFlash block.
- uint8_t PFlashBlockCount
  A number of PFlash blocks.
- uint8_t FlashMemoryIndex
  0 - primary flash; 1 - secondary flash
- uint8_t FlashCacheControllerIndex

0 - Controller for core 0; 1 - Controller for core 1
- uint8_t Reserved0
  Reserved field 0.
- uint32_t PFlashSectorSize
  The size in bytes of a sector of PFlash.
- flash_callback_t PFlashCallback
  The callback function for the flash API.
- uint32_t ∗ flashExecuteInRamFunctionInfo
  An information structure of the flash execute-in-RAM function.
- uint32_t EEpromTotalSize
  For the FlexNVM device, this is the size in bytes of the EEPROM area which was partitioned from FlexRAM.
- uint32_t EEpromBlockBase
  This is the base address of the Eeprom.
- uint8_t EEpromBlockCount
  A number of EEPROM blocks.
- uint8_t EEpromSectorSize
  The size in bytes of a sector of EEPROM.
- uint8_t Reserved1 [2]
  Reserved field 1.
- uint32_t PFlashClockFreq
  The flash peripheral clock frequency.
- uint32_t PFlashMarginLevel
  The margin level.

Field Documentation

(1) uint32_t flash_config_t::PFlashTotalSize

(2) uint8_t flash_config_t::PFlashBlockCount

(3) uint32_t flash_config_t::PFlashSectorSize

(4) flash_callback_t flash_config_t::PFlashCallback

(5) uint32_t∗ flash_config_t::flashExecuteInRamFunctionInfo

(6) uint32_t flash_config_t::EEpromTotalSize

For the non-FlexNVM device, this field is unused

(7) uint32_t flash_config_t::EEpromBlockBase

For the non-Eeprom device, this field is unused

(8) uint8_t flash_config_t::EEpromBlockCount

For the non-Eeprom device, this field is unused

(9) uint8_t flash_config_t::EEpromSectorSize

For the non-Eeprom device, this field is unused

9.3 Macro Definition Documentation

9.3.1 #define MAKE_VERSION(*major*, *minor*, *bugfix*) (((major) << 16) | ((minor) << 8) | (bugfix))

9.3.2 #define FSL_FLASH_DRIVER_VERSION (MAKE_VERSION(2, 1, 2))

Version 2.1.2.

9.3.3 #define FLASH_SSD_CONFIG_ENABLE_EEPROM_SUPPORT 0

Disables the EEPROM support.

9.3.4 #define FLASH_SSD_CONFIG_ENABLE_SECONDARY_FLASH_SUPPORT 1

Enables the secondary flash support by default.

9.3.5 #define FLASH_DRIVER_IS_FLASH_RESIDENT 1

Used for the flash resident application.

9.3.6 #define FLASH_DRIVER_IS_EXPORTED 0

Used for the MCUXpresso SDK application.

9.3.7 #define kStatusGroupGeneric 0

9.3.8 #define MAKE_STATUS(*group*, *code*) ((((group)*100) + (code)))

9.3.9 #define FOUR_CHAR_CODE(*a*, *b*, *c*, *d*) (((d) << 24) | ((c) << 16) | ((b) << 8) | ((a)))

9.4 Enumeration Type Documentation

9.4.1 enum _flash_driver_version_constants

Enumerator

kFLASH_DriverVersionName Flash driver version name.
kFLASH_DriverVersionMajor Major flash driver version.
kFLASH_DriverVersionMinor Minor flash driver version.
kFLASH_DriverVersionBugfix Bugfix for flash driver version.

9.4.2 anonymous enum

Enumerator

kStatus_FLASH_Success API is executed successfully.
kStatus_FLASH_InvalidArgument Invalid argument.
kStatus_FLASH_SizeError Error size.
kStatus_FLASH_AlignmentError Parameter is not aligned with the specified baseline.
kStatus_FLASH_AddressError Address is out of range.
kStatus_FLASH_AccessError Invalid instruction codes and out-of bound addresses.
kStatus_FLASH_ProtectionViolation The program/erase operation is requested to execute on protected areas.
kStatus_FLASH_CommandFailure Run-time error during command execution.
kStatus_FLASH_UnknownProperty Unknown property.
kStatus_FLASH_EraseKeyError API erase key is invalid.
kStatus_FLASH_RegionExecuteOnly The current region is execute-only.
kStatus_FLASH_ExecuteInRamFunctionNotReady Execute-in-RAM function is not available.
kStatus_FLASH_PartitionStatusUpdateFailure Failed to update partition status.
kStatus_FLASH_SetFlexramAsEepromError Failed to set FlexRAM as EEPROM.
kStatus_FLASH_RecoverFlexramAsRamError Failed to recover FlexRAM as RAM.
kStatus_FLASH_SetFlexramAsRamError Failed to set FlexRAM as RAM.
kStatus_FLASH_RecoverFlexramAsEepromError Failed to recover FlexRAM as EEPROM.
kStatus_FLASH_CommandNotSupported Flash API is not supported.
kStatus_FLASH_SwapSystemNotInUninitialized Swap system is not in an uninitialzed state.
kStatus_FLASH_SwapIndicatorAddressError The swap indicator address is invalid.
kStatus_FLASH_ReadOnlyProperty The flash property is read-only.
kStatus_FLASH_InvalidPropertyValue The flash property value is out of range.
kStatus_FLASH_InvalidSpeculationOption The option of flash prefetch speculation is invalid.
kStatus_FLASH_ClockDivider Flash clock prescaler is wrong.
kStatus_FLASH_EepromDoubleBitFault A double bit fault was detected in the stored parity.
kStatus_FLASH_EepromSingleBitFault A single bit fault was detected in the stored parity.

9.4.3 enum _flash_driver_api_keys

Note

The resulting value is built with a byte order such that the string being readable in expected order when viewed in a hex editor, if the value is treated as a 32-bit little endian value.

Enumerator

kFLASH_ApiEraseKey Key value used to validate all flash erase APIs.

9.4.4 enum flash_user_margin_value_t

Enumerator

kFLASH_ReadMarginValueNormal Use the 'normal' read level for 1s.
kFLASH_UserMarginValue1 Apply the 'User' margin to the normal read-1 level.
kFLASH_UserMarginValue0 Apply the 'User' margin to the normal read-0 level.

9.4.5 enum flash_factory_margin_value_t

Enumerator

kFLASH_FactoryMarginValue1 Apply the 'Factory' margin to the normal read-1 level.
kFLASH_FactoryMarginValue0 Apply the 'Factory' margin to the normal read-0 level.

9.4.6 enum flash_margin_value_t

Enumerator

kFLASH_MarginValueNormal Use the 'normal' read level for 1s.
kFLASH_MarginValueUser Apply the 'User' margin to the normal read-1 level.
kFLASH_MarginValueFactory Apply the 'Factory' margin to the normal read-1 level.
kFLASH_MarginValueInvalid Not real margin level, Used to determine the range of valid margin level.

9.4.7 enum flash_security_state_t

Enumerator

kFLASH_SecurityStateNotSecure Flash is not secure.
kFLASH_SecurityStateBackdoorEnabled Flash backdoor is enabled.
kFLASH_SecurityStateBackdoorDisabled Flash backdoor is disabled.

9.4.8 enum flash_protection_state_t

Enumerator

kFLASH_ProtectionStateUnprotected Flash region is not protected.
kFLASH_ProtectionStateProtected Flash region is protected.
kFLASH_ProtectionStateMixed Flash is mixed with protected and unprotected region.

9.4.9 enum flash_property_tag_t

Enumerator

kFLASH_PropertyPflashSectorSize Pflash sector size property.
kFLASH_PropertyPflashTotalSize Pflash total size property.
kFLASH_PropertyPflashBlockSize Pflash block size property.
kFLASH_PropertyPflashBlockCount Pflash block count property.
kFLASH_PropertyPflashBlockBaseAddr Pflash block base address property.
kFLASH_PropertyPflashFacSupport Pflash fac support property.
kFLASH_PropertyEepromTotalSize EEPROM total size property.
kFLASH_PropertyFlashMemoryIndex Flash memory index property.
kFLASH_PropertyFlashCacheControllerIndex Flash cache controller index property.
kFLASH_PropertyEepromBlockBaseAddr EEPROM block base address property.
kFLASH_PropertyEepromSectorSize EEPROM sector size property.
kFLASH_PropertyEepromBlockSize EEPROM block size property.
kFLASH_PropertyEepromBlockCount EEPROM block count property.
kFLASH_PropertyFlashClockFrequency Flash peripheral clock property.

9.4.10 anonymous enum

_flash_execute_in_ram_function_constants

Enumerator

kFLASH_ExecuteInRamFunctionMaxSizeInWords The maximum size of execute-in-RAM function.
kFLASH_ExecuteInRamFunctionTotalNum Total number of execute-in-RAM functions.

9.4.11 enum flash_memory_index_t

Enumerator

kFLASH_MemoryIndexPrimaryFlash Current flash memory is primary flash.
kFLASH_MemoryIndexSecondaryFlash Current flash memory is secondary flash.

9.4.12 enum flash_cache_controller_index_t

Enumerator

kFLASH_CacheControllerIndexForCore0 Current flash cache controller is for core 0.
kFLASH_CacheControllerIndexForCore1 Current flash cache controller is for core 1.

9.4.13 enum flash_cache_clear_process_t

Enumerator

kFLASH_CacheClearProcessPre Pre flash cache clear process.
kFLASH_CacheClearProcessPost Post flash cache clear process.

9.5 Function Documentation

9.5.1 status_t FLASH_Init (flash_config_t * *config*)

This function checks and initializes the Flash module for the other Flash APIs.

Parameters

config	Pointer to the storage for the driver runtime state.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_InvalidArgument	An invalid argument is provided.
kStatus_FLASH_ClockDivider	Flash clock prescaler is wrong.
kStatus_FLASH_ExecuteInRamFunctionNotReady	Execute-in-RAM function is not available.

9.5.2 status_t FLASH_SetCallback (flash_config_t * *config*, flash_callback_t *callback*)

Parameters

config	Pointer to the storage for the driver runtime state.
callback	A callback function to be stored in the driver.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.

9.5.3 status_t FLASH_PrepareExecuteInRamFunctions (flash_config_t ∗ *config*)

Parameters

config	Pointer to the storage for the driver runtime state.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.

9.5.4 status_t FLASH_EraseAll (flash_config_t ∗ *config,* uint32_t *key*)

Parameters

config	Pointer to the storage for the driver runtime state.
key	A value used to validate all flash erase APIs.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.

kStatus_FLASH_Erase-KeyError	API erase key is invalid.
kStatus_FLASH_Execute-InRamFunctionNotReady	Execute-in-RAM function is not available.
kStatus_FLASH_Access-Error	Invalid instruction codes and out-of bounds addresses.
kStatus_FLASH_-ProtectionViolation	The program/erase operation is requested to execute on protected areas.
kStatus_FLASH_-CommandFailure	Run-time error during command execution.
kStatus_FLASH_Eeprom-SingleBitFault	EEPROM single bit fault error code.
kStatus_FLASH_Eeprom-DoubleBitFault	EEPROM double bit fault error code.

9.5.5 status_t FLASH_Erase (flash_config_t * *config*, uint32_t *start*, uint32_t *lengthInBytes*, uint32_t *key*)

This function erases the appropriate number of flash sectors based on the desired start address and length.

Parameters

config	The pointer to the storage for the driver runtime state.
start	The start address of the desired flash memory to be erased. The start address does not need to be sector-aligned but must be word-aligned.
lengthInBytes	The length, given in bytes (not words or long-words) to be erased. Must be word-aligned.
key	The value used to validate all flash erase APIs.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.

kStatus_FLASH_-AlignmentError	The parameter is not aligned with the specified baseline.
kStatus_FLASH_Address-Error	The address is out of range.
kStatus_FLASH_Erase-KeyError	The API erase key is invalid.
kStatus_FLASH_Execute-InRamFunctionNotReady	Execute-in-RAM function is not available.
kStatus_FLASH_Access-Error	Invalid instruction codes and out-of bounds addresses.
kStatus_FLASH_-ProtectionViolation	The program/erase operation is requested to execute on protected areas.
kStatus_FLASH_-CommandFailure	Run-time error during the command execution.

9.5.6 status_t FLASH_EraseAllUnsecure (flash_config_t * *config*, uint32_t *key*)

Parameters

config	Pointer to the storage for the driver runtime state.
key	A value used to validate all flash erase APIs.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.
kStatus_FLASH_Erase-KeyError	API erase key is invalid.
kStatus_FLASH_Execute-InRamFunctionNotReady	Execute-in-RAM function is not available.
kStatus_FLASH_Access-Error	Invalid instruction codes and out-of bounds addresses.

kStatus_FLASH_-ProtectionViolation	The program/erase operation is requested to execute on protected areas.
kStatus_FLASH_-CommandFailure	Run-time error during command execution.
kStatus_FLASH_Eeprom-SingleBitFault	EEPROM single bit fault error code.
kStatus_FLASH_Eeprom-DoubleBitFault	EEPROM double bit fault error code.

9.5.7 status_t FLASH_Program (flash_config_t * *config*, uint32_t *start*, uint32_t * *src*, uint32_t *lengthInBytes*)

This function programs the flash memory with the desired data for a given flash area as determined by the start address and the length.

Parameters

config	A pointer to the storage for the driver runtime state.
start	The start address of the desired flash memory to be programmed. Must be word-aligned.
src	A pointer to the source buffer of data that is to be programmed into the flash.
lengthInBytes	The length, given in bytes (not words or long-words), to be programmed. Must be word-aligned.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.
kStatus_FLASH_-AlignmentError	Parameter is not aligned with the specified baseline.
kStatus_FLASH_Address-Error	Address is out of range.

kStatus_FLASH_Execute-InRamFunctionNotReady	Execute-in-RAM function is not available.
kStatus_FLASH_Access-Error	Invalid instruction codes and out-of bounds addresses.
kStatus_FLASH_-ProtectionViolation	The program/erase operation is requested to execute on protected areas.
kStatus_FLASH_-CommandFailure	Run-time error during the command execution.

9.5.8 status_t FLASH_ProgramOnce (flash_config_t * *config*, uint32_t *index*, uint32_t * *src*, uint32_t *lengthInBytes*)

This function programs the Program Once Field with the desired data for a given flash area as determined by the index and length.

Parameters

config	A pointer to the storage for the driver runtime state.
index	The index indicating which area of the Program Once Field to be programmed.
src	A pointer to the source buffer of data that is to be programmed into the Program Once Field.
lengthInBytes	The length, given in bytes (not words or long-words), to be programmed. Must be word-aligned.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.
kStatus_FLASH_Execute-InRamFunctionNotReady	Execute-in-RAM function is not available.
kStatus_FLASH_Access-Error	Invalid instruction codes and out-of bounds addresses.

kStatus_FLASH_-ProtectionViolation	The program/erase operation is requested to execute on protected areas.
kStatus_FLASH_-CommandFailure	Run-time error during the command execution.

9.5.9 status_t FLASH_ReadOnce (flash_config_t * *config*, uint32_t *index*, uint32_t * *dst*, uint32_t *lengthInBytes*)

This function reads the read once feild with given index and length.

Parameters

config	A pointer to the storage for the driver runtime state.
index	The index indicating the area of program once field to be read.
dst	A pointer to the destination buffer of data that is used to store data to be read.
lengthInBytes	The length, given in bytes (not words or long-words), to be programmed. Must be word-aligned.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.
kStatus_FLASH_Execute-InRamFunctionNotReady	Execute-in-RAM function is not available.
kStatus_FLASH_Access-Error	Invalid instruction codes and out-of bounds addresses.
kStatus_FLASH_-ProtectionViolation	The program/erase operation is requested to execute on protected areas.
kStatus_FLASH_-CommandFailure	Run-time error during the command execution.

9.5.10 status_t FLASH_GetSecurityState (flash_config_t * *config*, flash_security_state_t * *state*)

This function retrieves the current flash security status, including the security enabling state and the backdoor key enabling state.

Parameters

config	A pointer to storage for the driver runtime state.
state	A pointer to the value returned for the current security status code:

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.

9.5.11 status_t FLASH_SecurityBypass (flash_config_t * *config*, const uint8_t * *backdoorKey*)

If the MCU is in secured state, this function unsecures the MCU by comparing the provided backdoor key with ones in the flash configuration field.

Parameters

config	A pointer to the storage for the driver runtime state.
backdoorKey	A pointer to the user buffer containing the backdoor key.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.
kStatus_FLASH_Execute-InRamFunctionNotReady	Execute-in-RAM function is not available.
kStatus_FLASH_Access-Error	Invalid instruction codes and out-of bounds addresses.
kStatus_FLASH_-ProtectionViolation	The program/erase operation is requested to execute on protected areas.
kStatus_FLASH_-CommandFailure	Run-time error during the command execution.

9.5.12 status_t FLASH_VerifyEraseAll (flash_config_t * *config*, flash_margin_value_t *margin*)

This function checks whether the flash is erased to the specified read margin level.

Parameters

config	A pointer to the storage for the driver runtime state.
margin	Read margin choice.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_InvalidArgument	An invalid argument is provided.
kStatus_FLASH_ExecuteInRamFunctionNotReady	Execute-in-RAM function is not available.
kStatus_FLASH_AccessError	Invalid instruction codes and out-of bounds addresses.
kStatus_FLASH_ProtectionViolation	The program/erase operation is requested to execute on protected areas.
kStatus_FLASH_CommandFailure	Run-time error during the command execution.
kStatus_FLASH_EepromSingleBitFault	EEPROM single bit fault error code.
kStatus_FLASH_EepromDoubleBitFault	EEPROM double bit fault error code.

9.5.13 status_t FLASH_VerifyErase (flash_config_t * *config*, uint32_t *start*, uint32_t *lengthInBytes*, flash_margin_value_t *margin*)

This function checks the appropriate number of flash sectors based on the desired start address and length to check whether the flash is erased to the specified read margin level.

Parameters

config	A pointer to the storage for the driver runtime state.
margin	Read margin choice.
start	The start address of the desired flash memory to be verified. The start address does not need to be sector-aligned but must be word-aligned.

lengthInBytes	The length, given in bytes (not words or long-words), to be verified. Must be word-aligned.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.
kStatus_FLASH_-AlignmentError	Parameter is not aligned with specified baseline.
kStatus_FLASH_Address-Error	Address is out of range.
kStatus_FLASH_Execute-InRamFunctionNotReady	Execute-in-RAM function is not available.
kStatus_FLASH_Access-Error	Invalid instruction codes and out-of bounds addresses.
kStatus_FLASH_-ProtectionViolation	The program/erase operation is requested to execute on protected areas.
kStatus_FLASH_-CommandFailure	Run-time error during the command execution.

9.5.14 status_t FLASH_IsProtected (flash_config_t * *config,* uint32_t *start,* uint32_t *lengthInBytes,* flash_protection_state_t * *protection_state*)

This function retrieves the current flash protect status for a given flash area as determined by the start address and length.

Parameters

config	A pointer to the storage for the driver runtime state.
start	The start address of the desired flash memory to be checked. Must be word-aligned.
lengthInBytes	The length, given in bytes (not words or long-words) to be checked. Must be word-aligned.
protection_-state	A pointer to the value returned for the current protection status code for the desired flash area.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.
kStatus_FLASH_-AlignmentError	Parameter is not aligned with specified baseline.
kStatus_FLASH_Address-Error	The address is out of range.

9.5.15 status_t FLASH_GetProperty (flash_config_t * *config*, flash_property_tag_t *whichProperty*, uint32_t * *value*)

Parameters

config	A pointer to the storage for the driver runtime state.
whichProperty	The desired property from the list of properties in enum flash_property_tag_t
value	A pointer to the value returned for the desired flash property.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.
kStatus_FLASH_-UnknownProperty	An unknown property tag.

9.5.16 status_t FLASH_SetProperty (flash_config_t * *config*, flash_property_tag_t *whichProperty*, uint32_t *value*)

Parameters

config	A pointer to the storage for the driver runtime state.

whichProperty	The desired property from the list of properties in enum flash_property_tag_t
value	A to set for the desired flash property.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.
kStatus_FLASH_-UnknownProperty	An unknown property tag.
kStatus_FLASH_Invalid-PropertyValue	An invalid property value.
kStatus_FLASH_Read-OnlyProperty	An read-only property tag.

9.5.17 status_t FLASH_PflashSetProtection (flash_config_t ∗ *config*, pflash_protection_status_t ∗ *protectStatus*)

Parameters

config	A pointer to storage for the driver runtime state.
protectStatus	The expected protect status to set to the PFlash protection register.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_Invalid-Argument	An invalid argument is provided.
kStatus_FLASH_-CommandFailure	Run-time error during command execution.

9.5.18 status_t FLASH_PflashGetProtection (flash_config_t ∗ *config*, pflash_protection_status_t ∗ *protectStatus*)

Parameters

config	A pointer to the storage for the driver runtime state.
protectStatus	Protect status returned by the PFlash IP.

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_InvalidArgument	An invalid argument is provided.

9.5.19 status_t FLASH_PflashSetPrefetchSpeculation (flash_prefetch_speculation_status_t * *speculationStatus*)

Parameters

speculationStatus	The expected protect status to set to the PFlash protection register. Each bit is

Return values

kStatus_FLASH_Success	API was executed successfully.
kStatus_FLASH_InvalidSpeculationOption	An invalid speculation option argument is provided.

9.5.20 status_t FLASH_PflashGetPrefetchSpeculation (flash_prefetch_speculation_status_t * *speculationStatus*)

Parameters

speculationStatus	Speculation status returned by the PFlash IP.

Return values

kStatus_FLASH_Success	API was executed successfully.

Chapter 10
FTM: FlexTimer Driver

10.1 Overview

The MCUXpresso SDK provides a driver for the FlexTimer Module (FTM) of MCUXpresso SDK devices.

10.2 Function groups

The FTM driver supports the generation of PWM signals, input capture, dual edge capture, output compare, and quadrature decoder modes. The driver also supports configuring each of the FTM fault inputs.

10.2.1 Initialization and deinitialization

The function FTM_Init() initializes the FTM with specified configurations. The function FTM_GetDefaultConfig() gets the default configurations. The initialization function configures the FTM for the requested register update mode for registers with buffers. It also sets up the FTM's fault operation mode and FTM behavior in the BDM mode.

The function FTM_Deinit() disables the FTM counter and turns off the module clock.

10.2.2 PWM Operations

The function FTM_SetupPwm() sets up FTM channels for the PWM output. The function sets up the PWM signal properties for multiple channels. 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 the 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 FTM_UpdatePwmDutycycle() updates the PWM signal duty cycle of a particular FTM channel.

The function FTM_UpdateChnlEdgeLevelSelect() updates the level select bits of a particular FTM channel. This can be used to disable the PWM output when making changes to the PWM signal.

10.2.3 Input capture operations

The function FTM_SetupInputCapture() sets up an FTM channel for the input capture. The user can specify the capture edge and a filter value to be used when processing the input signal.

The function FTM_SetupDualEdgeCapture() can be used to measure the pulse width of a signal. A channel pair is used during capture with the input signal coming through a channel n. The user can specify whether to use one-shot or continuous capture, the capture edge for each channel, and any filter value to be used when processing the input signal.

10.2.4 Output compare operations

The function FTM_SetupOutputCompare() sets up an FTM channel for the output comparison. The user can specify the channel output on a successful comparison and a comparison value.

10.2.5 Quad decode

The function FTM_SetupQuadDecode() sets up FTM channels 0 and 1 for quad decoding. The user can specify the quad decoding mode, polarity, and filter properties for each input signal.

10.2.6 Fault operation

The function FTM_SetupFault() sets up the properties for each fault. The user can specify the fault polarity and whether to use a filter on a fault input. The overall fault filter value and fault control mode are set up during initialization.

10.3 Register Update

Some of the FTM registers have buffers. The driver supports various methods to update these registers with the content of the register buffer. The registers can be updated using the PWM synchronized loading or an intermediate point loading. 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/ftmMultiple PWM synchronization update modes can be used by providing an OR'ed list of options available in the enumeration ftm_pwm_sync_method_t to the pwmSyncMode field.

When using an intermediate reload points, the PWM synchnronization is not required. Multiple reload points can be used by providing an OR'ed list of options available in the enumeration ftm_reload_point_t to the reloadPoints field.

The driver initialization function sets up the appropriate bits in the FTM module based on the register update options selected.

If software PWM synchronization is used, the below function can be used to initiate a software trigger. Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOARD>/driver_examples/ftm

10.4 Typical use case

10.4.1 PWM output

Output a PWM signal on two FTM channels with different duty cycles. Periodically update the PWM signal duty cycle. Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOARD>/driver_examples/ftm

Data Structures

- struct ftm_chnl_pwm_signal_param_t
    Options to configure a FTM channel's PWM signal. More...
- struct ftm_chnl_pwm_config_param_t
    Options to configure a FTM channel using precise setting. More...
- struct ftm_dual_edge_capture_param_t
    FlexTimer dual edge capture parameters. More...
- struct ftm_phase_params_t
    FlexTimer quadrature decode phase parameters. More...
- struct ftm_fault_param_t
    Structure is used to hold the parameters to configure a FTM fault. More...
- struct ftm_config_t
    FTM configuration structure. More...

Enumerations

- enum ftm_chnl_t {
  kFTM_Chnl_0 = 0U,
  kFTM_Chnl_1,
  kFTM_Chnl_2,
  kFTM_Chnl_3,
  kFTM_Chnl_4,
  kFTM_Chnl_5,
  kFTM_Chnl_6,
  kFTM_Chnl_7 }
    List of FTM channels.
- enum ftm_fault_input_t {
  kFTM_Fault_0 = 0U,
  kFTM_Fault_1,
  kFTM_Fault_2,
  kFTM_Fault_3 }
    List of FTM faults.
- enum ftm_pwm_mode_t {
  kFTM_EdgeAlignedPwm = 0U,
  kFTM_CenterAlignedPwm,
  kFTM_EdgeAlignedCombinedPwm,
  kFTM_CenterAlignedCombinedPwm,
  kFTM_AsymmetricalCombinedPwm }
    FTM PWM operation modes.
- enum ftm_pwm_level_select_t {

kFTM_NoPwmSignal = 0U,
kFTM_LowTrue,
kFTM_HighTrue }
FTM PWM output pulse mode: high-true, low-true or no output.

- enum ftm_output_compare_mode_t {
kFTM_NoOutputSignal = (1U << FTM_CnSC_MSA_SHIFT),
kFTM_ToggleOnMatch = ((1U << FTM_CnSC_MSA_SHIFT) | (1U << FTM_CnSC_ELSA_SHIFT)),
kFTM_ClearOnMatch = ((1U << FTM_CnSC_MSA_SHIFT) | (2U << FTM_CnSC_ELSA_SHIFT)),
kFTM_SetOnMatch = ((1U << FTM_CnSC_MSA_SHIFT) | (3U << FTM_CnSC_ELSA_SHIFT)) }
FlexTimer output compare mode.
- enum ftm_input_capture_edge_t {
kFTM_RisingEdge = (1U << FTM_CnSC_ELSA_SHIFT),
kFTM_FallingEdge = (2U << FTM_CnSC_ELSA_SHIFT),
kFTM_RiseAndFallEdge = (3U << FTM_CnSC_ELSA_SHIFT) }
FlexTimer input capture edge.
- enum ftm_dual_edge_capture_mode_t {
kFTM_OneShot = 0U,
kFTM_Continuous = (1U << FTM_CnSC_MSA_SHIFT) }
FlexTimer dual edge capture modes.
- enum ftm_quad_decode_mode_t {
kFTM_QuadPhaseEncode = 0U,
kFTM_QuadCountAndDir }
FlexTimer quadrature decode modes.
- enum ftm_phase_polarity_t {
kFTM_QuadPhaseNormal = 0U,
kFTM_QuadPhaseInvert }
FlexTimer quadrature phase polarities.
- enum ftm_deadtime_prescale_t {
kFTM_Deadtime_Prescale_1 = 1U,
kFTM_Deadtime_Prescale_4,
kFTM_Deadtime_Prescale_16 }
FlexTimer pre-scaler factor for the dead time insertion.
- enum ftm_clock_source_t {
kFTM_SystemClock = 1U,
kFTM_FixedClock,
kFTM_ExternalClock }
FlexTimer clock source selection.
- enum ftm_clock_prescale_t {

kFTM_Prescale_Divide_1 = 0U,
kFTM_Prescale_Divide_2,
kFTM_Prescale_Divide_4,
kFTM_Prescale_Divide_8,
kFTM_Prescale_Divide_16,
kFTM_Prescale_Divide_32,
kFTM_Prescale_Divide_64,
kFTM_Prescale_Divide_128 }
FlexTimer pre-scaler factor selection for the clock source.
- enum ftm_bdm_mode_t {
kFTM_BdmMode_0 = 0U,
kFTM_BdmMode_1,
kFTM_BdmMode_2,
kFTM_BdmMode_3 }
Options for the FlexTimer behaviour in BDM Mode.
- enum ftm_fault_mode_t {
kFTM_Fault_Disable = 0U,
kFTM_Fault_EvenChnls,
kFTM_Fault_AllChnlsMan,
kFTM_Fault_AllChnlsAuto }
Options for the FTM fault control mode.
- enum ftm_external_trigger_t {
kFTM_Chnl0Trigger = (1U << 4),
kFTM_Chnl1Trigger = (1U << 5),
kFTM_Chnl2Trigger = (1U << 0),
kFTM_Chnl3Trigger = (1U << 1),
kFTM_Chnl4Trigger = (1U << 2),
kFTM_Chnl5Trigger = (1U << 3),
kFTM_InitTrigger = (1U << 6) }
FTM external trigger options.
- enum ftm_pwm_sync_method_t {
kFTM_SoftwareTrigger = FTM_SYNC_SWSYNC_MASK,
kFTM_HardwareTrigger_0 = FTM_SYNC_TRIG0_MASK,
kFTM_HardwareTrigger_1 = FTM_SYNC_TRIG1_MASK,
kFTM_HardwareTrigger_2 = FTM_SYNC_TRIG2_MASK }
FlexTimer PWM sync options to update registers with buffer.
- enum ftm_reload_point_t {

kFTM_Chnl0Match = (1U << 0),
kFTM_Chnl1Match = (1U << 1),
kFTM_Chnl2Match = (1U << 2),
kFTM_Chnl3Match = (1U << 3),
kFTM_Chnl4Match = (1U << 4),
kFTM_Chnl5Match = (1U << 5),
kFTM_Chnl6Match = (1U << 6),
kFTM_Chnl7Match = (1U << 7),
kFTM_CntMax = (1U << 8),
kFTM_CntMin = (1U << 9),
kFTM_HalfCycMatch = (1U << 10) }
  FTM options available as loading point for register reload.
- enum ftm_interrupt_enable_t {
kFTM_Chnl0InterruptEnable = (1U << 0),
kFTM_Chnl1InterruptEnable = (1U << 1),
kFTM_Chnl2InterruptEnable = (1U << 2),
kFTM_Chnl3InterruptEnable = (1U << 3),
kFTM_Chnl4InterruptEnable = (1U << 4),
kFTM_Chnl5InterruptEnable = (1U << 5),
kFTM_Chnl6InterruptEnable = (1U << 6),
kFTM_Chnl7InterruptEnable = (1U << 7),
kFTM_FaultInterruptEnable = (1U << 8),
kFTM_TimeOverflowInterruptEnable = (1U << 9),
kFTM_ReloadInterruptEnable = (1U << 10) }
  List of FTM interrupts.
- enum ftm_status_flags_t {
kFTM_Chnl0Flag = (1U << 0),
kFTM_Chnl1Flag = (1U << 1),
kFTM_Chnl2Flag = (1U << 2),
kFTM_Chnl3Flag = (1U << 3),
kFTM_Chnl4Flag = (1U << 4),
kFTM_Chnl5Flag = (1U << 5),
kFTM_Chnl6Flag = (1U << 6),
kFTM_Chnl7Flag = (1U << 7),
kFTM_FaultFlag = (1U << 8),
kFTM_TimeOverflowFlag = (1U << 9),
kFTM_ChnlTriggerFlag = (1U << 10),
kFTM_ReloadFlag = (1U << 11) }
  List of FTM flags.

Functions

- void FTM_SetupFaultInput (FTM_Type ∗base, ftm_fault_input_t faultNumber, const ftm_fault_param_t ∗faultParams)
  Sets up the working of the FTM fault inputs protection.
- static void FTM_SetGlobalTimeBaseOutputEnable (FTM_Type ∗base, bool enable)

Enables or disables the FTM global time base signal generation to other FTMs.
- static void FTM_SetOutputMask (FTM_Type ∗base, ftm_chnl_t chnlNumber, bool mask)
  Sets the FTM peripheral timer channel output mask.
- static void FTM_SetSoftwareTrigger (FTM_Type ∗base, bool enable)
  Enables or disables the FTM software trigger for PWM synchronization.
- static void FTM_SetWriteProtection (FTM_Type ∗base, bool enable)
  Enables or disables the FTM write protection.

Driver version

- #define FSL_FTM_DRIVER_VERSION (MAKE_VERSION(2, 5, 0))
  FTM driver version 2.5.0.

Initialization and deinitialization

- status_t FTM_Init (FTM_Type ∗base, const ftm_config_t ∗config)
  Ungates the FTM clock and configures the peripheral for basic operation.
- void FTM_Deinit (FTM_Type ∗base)
  Gates the FTM clock.
- void FTM_GetDefaultConfig (ftm_config_t ∗config)
  Fills in the FTM configuration structure with the default settings.
- static ftm_clock_prescale_t FTM_CalculateCounterClkDiv (FTM_Type ∗base, uint32_t counterPeriod_Hz, uint32_t srcClock_Hz)
  brief Calculates the counter clock prescaler.

Channel mode operations

- status_t FTM_SetupPwm (FTM_Type ∗base, const ftm_chnl_pwm_signal_param_t ∗chnlParams, uint8_t numOfChnls, ftm_pwm_mode_t mode, uint32_t pwmFreq_Hz, uint32_t srcClock_Hz)
  Configures the PWM signal parameters.
- status_t FTM_UpdatePwmDutycycle (FTM_Type ∗base, ftm_chnl_t chnlNumber, ftm_pwm_mode_t currentPwmMode, uint8_t dutyCyclePercent)
  Updates the duty cycle of an active PWM signal.
- void FTM_UpdateChnlEdgeLevelSelect (FTM_Type ∗base, ftm_chnl_t chnlNumber, uint8_t level)
  Updates the edge level selection for a channel.
- status_t FTM_SetupPwmMode (FTM_Type ∗base, const ftm_chnl_pwm_config_param_t ∗chnlParams, uint8_t numOfChnls, ftm_pwm_mode_t mode)
  Configures the PWM mode parameters.
- void FTM_SetupInputCapture (FTM_Type ∗base, ftm_chnl_t chnlNumber, ftm_input_capture_edge_t captureMode, uint32_t filterValue)
  Enables capturing an input signal on the channel using the function parameters.
- void FTM_SetupOutputCompare (FTM_Type ∗base, ftm_chnl_t chnlNumber, ftm_output_compare_mode_t compareMode, uint32_t compareValue)
  Configures the FTM to generate timed pulses.
- void FTM_SetupDualEdgeCapture (FTM_Type ∗base, ftm_chnl_t chnlPairNumber, const ftm_dual_edge_capture_param_t ∗edgeParam, uint32_t filterValue)
  Configures the dual edge capture mode of the FTM.

Interrupt Interface

- void FTM_EnableInterrupts (FTM_Type *base, uint32_t mask)
  Enables the selected FTM interrupts.
- void FTM_DisableInterrupts (FTM_Type *base, uint32_t mask)
  Disables the selected FTM interrupts.
- uint32_t FTM_GetEnabledInterrupts (FTM_Type *base)
  Gets the enabled FTM interrupts.

Status Interface

- uint32_t FTM_GetStatusFlags (FTM_Type *base)
  Gets the FTM status flags.
- void FTM_ClearStatusFlags (FTM_Type *base, uint32_t mask)
  Clears the FTM status flags.

Read and write the timer period

- static void FTM_SetTimerPeriod (FTM_Type *base, uint32_t ticks)
  Sets the timer period in units of ticks.
- static uint32_t FTM_GetCurrentTimerCount (FTM_Type *base)
  Reads the current timer counting value.
- static uint32_t FTM_GetInputCaptureValue (FTM_Type *base, ftm_chnl_t chnlNumber)
  Reads the captured value.

Timer Start and Stop

- static void FTM_StartTimer (FTM_Type *base, ftm_clock_source_t clockSource)
  Starts the FTM counter.
- static void FTM_StopTimer (FTM_Type *base)
  Stops the FTM counter.

Software output control

- static void FTM_SetSoftwareCtrlEnable (FTM_Type *base, ftm_chnl_t chnlNumber, bool value)
  Enables or disables the channel software output control.
- static void FTM_SetSoftwareCtrlVal (FTM_Type *base, ftm_chnl_t chnlNumber, bool value)
  Sets the channel software output control value.

Channel pair operations

- static void FTM_SetFaultControlEnable (FTM_Type *base, ftm_chnl_t chnlPairNumber, bool value)
  This function enables/disables the fault control in a channel pair.
- static void FTM_SetDeadTimeEnable (FTM_Type *base, ftm_chnl_t chnlPairNumber, bool value)
  This function enables/disables the dead time insertion in a channel pair.
- static void FTM_SetComplementaryEnable (FTM_Type *base, ftm_chnl_t chnlPairNumber, bool value)
  This function enables/disables complementary mode in a channel pair.
- static void FTM_SetInvertEnable (FTM_Type *base, ftm_chnl_t chnlPairNumber, bool value)
  This function enables/disables inverting control in a channel pair.

Quad Decoder

- void FTM_SetupQuadDecode (FTM_Type ∗base, const ftm_phase_params_t ∗phaseAParams, const ftm_phase_params_t ∗phaseBParams, ftm_quad_decode_mode_t quadMode)
  Configures the parameters and activates the quadrature decoder mode.
- static void FTM_SetQuadDecoderModuloValue (FTM_Type ∗base, uint32_t startValue, uint32_t overValue)
  Sets the modulo values for Quad Decoder.
- static uint32_t FTM_GetQuadDecoderCounterValue (FTM_Type ∗base)
  Gets the current Quad Decoder counter value.
- static void FTM_ClearQuadDecoderCounterValue (FTM_Type ∗base)
  Clears the current Quad Decoder counter value.

10.5 Data Structure Documentation

10.5.1 struct ftm_chnl_pwm_signal_param_t

Data Fields

- ftm_chnl_t chnlNumber
  The channel/channel pair number.
- ftm_pwm_level_select_t level
  PWM output active level select.
- uint8_t dutyCyclePercent
  PWM pulse width, value should be between 0 to 100 0 = inactive signal(0% duty cycle)...
- uint8_t firstEdgeDelayPercent
  Used only in kFTM_AsymmetricalCombinedPwm mode to generate an asymmetrical PWM.
- bool enableComplementary
  Used only in combined PWM mode.
- bool enableDeadtime
  Used only in combined PWM mode with enable complementary.

Field Documentation

(1) ftm_chnl_t ftm_chnl_pwm_signal_param_t::chnlNumber

In combined mode, this represents the channel pair number.

(2) ftm_pwm_level_select_t ftm_chnl_pwm_signal_param_t::level

(3) uint8_t ftm_chnl_pwm_signal_param_t::dutyCyclePercent

100 = always active signal (100% duty cycle).

(4) uint8_t ftm_chnl_pwm_signal_param_t::firstEdgeDelayPercent

Specifies the delay to the first edge in a PWM period. If unsure leave as 0; Should be specified as a percentage of the PWM period

(5) bool ftm_chnl_pwm_signal_param_t::enableComplementary

true: The combined channels output complementary signals; false: The combined channels output same signals;

(6) bool ftm_chnl_pwm_signal_param_t::enableDeadtime

true: The deadtime insertion in this pair of channels is enabled; false: The deadtime insertion in this pair of channels is disabled.

10.5.2 struct ftm_chnl_pwm_config_param_t

Data Fields

- ftm_chnl_t chnlNumber
  The channel/channel pair number.
- ftm_pwm_level_select_t level
  PWM output active level select.
- uint16_t dutyValue
  PWM pulse width, the uint of this value is timer ticks.
- uint16_t firstEdgeValue
  Used only in kFTM_AsymmetricalCombinedPwm mode to generate an asymmetrical PWM.
- bool enableComplementary
  Used only in combined PWM mode.
- bool enableDeadtime
  Used only in combined PWM mode with enable complementary.

Field Documentation

(1) ftm_chnl_t ftm_chnl_pwm_config_param_t::chnlNumber

In combined mode, this represents the channel pair number.

(2) ftm_pwm_level_select_t ftm_chnl_pwm_config_param_t::level

(3) uint16_t ftm_chnl_pwm_config_param_t::dutyValue

(4) uint16_t ftm_chnl_pwm_config_param_t::firstEdgeValue

Specifies the delay to the first edge in a PWM period. If unsure leave as 0, uint of this value is timer ticks.

(5) bool ftm_chnl_pwm_config_param_t::enableComplementary

true: The combined channels output complementary signals; false: The combined channels output same signals;

(6) bool ftm_chnl_pwm_config_param_t::enableDeadtime

true: The deadtime insertion in this pair of channels is enabled; false: The deadtime insertion in this pair of channels is disabled.

10.5.3 struct ftm_dual_edge_capture_param_t

Data Fields

- ftm_dual_edge_capture_mode_t mode
  Dual Edge Capture mode.
- ftm_input_capture_edge_t currChanEdgeMode
  Input capture edge select for channel n.
- ftm_input_capture_edge_t nextChanEdgeMode
  Input capture edge select for channel n+1.

10.5.4 struct ftm_phase_params_t

Data Fields

- bool enablePhaseFilter
  True: enable phase filter; false: disable filter.
- uint32_t phaseFilterVal
  Filter value, used only if phase filter is enabled.
- ftm_phase_polarity_t phasePolarity
  Phase polarity.

10.5.5 struct ftm_fault_param_t

Data Fields

- bool enableFaultInput
  True: Fault input is enabled; false: Fault input is disabled.
- bool faultLevel
  True: Fault polarity is active low; in other words, '0' indicates a fault; False: Fault polarity is active high.
- bool useFaultFilter
  True: Use the filtered fault signal; False: Use the direct path from fault input.

10.5.6 struct ftm_config_t

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

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

Data Fields

- ftm_clock_prescale_t prescale
  FTM clock prescale value.
- ftm_bdm_mode_t bdmMode
  FTM behavior in BDM mode.
- uint32_t pwmSyncMode
  Synchronization methods to use to update buffered registers; Multiple update modes can be used by providing an OR'ed list of options available in enumeration ftm_pwm_sync_method_t.
- uint32_t reloadPoints
  FTM reload points; When using this, the PWM synchronization is not required.
- ftm_fault_mode_t faultMode
  FTM fault control mode.
- uint8_t faultFilterValue
  Fault input filter value.
- ftm_deadtime_prescale_t deadTimePrescale
  The dead time prescalar value.
- uint32_t deadTimeValue
  The dead time value deadTimeValue's available range is 0-1023 when register has DTVALEX, otherwise its available range is 0-63.
- uint32_t extTriggers
  External triggers to enable.
- uint8_t chnlInitState
  Defines the initialization value of the channels in OUTINT register.
- uint8_t chnlPolarity
  Defines the output polarity of the channels in POL register.
- bool useGlobalTimeBase
  True: Use of an external global time base is enabled; False: disabled.

Field Documentation

(1) uint32_t ftm_config_t::pwmSyncMode

(2) uint32_t ftm_config_t::reloadPoints

Multiple reload points can be used by providing an OR'ed list of options available in enumeration ftm_reload_point_t.

(3) uint32_t ftm_config_t::deadTimeValue

(4) uint32_t ftm_config_t::extTriggers

Multiple trigger sources can be enabled by providing an OR'ed list of options available in enumeration ftm_external_trigger_t.

10.6 Macro Definition Documentation

10.6.1 #define FSL_FTM_DRIVER_VERSION (MAKE_VERSION(2, 5, 0))

10.7 Enumeration Type Documentation

10.7.1 enum ftm_chnl_t

Note

Actual number of available channels is SoC dependent

Enumerator

kFTM_Chnl_0 FTM channel number 0.
kFTM_Chnl_1 FTM channel number 1.
kFTM_Chnl_2 FTM channel number 2.
kFTM_Chnl_3 FTM channel number 3.
kFTM_Chnl_4 FTM channel number 4.
kFTM_Chnl_5 FTM channel number 5.
kFTM_Chnl_6 FTM channel number 6.
kFTM_Chnl_7 FTM channel number 7.

10.7.2 enum ftm_fault_input_t

Enumerator

kFTM_Fault_0 FTM fault 0 input pin.
kFTM_Fault_1 FTM fault 1 input pin.
kFTM_Fault_2 FTM fault 2 input pin.
kFTM_Fault_3 FTM fault 3 input pin.

10.7.3 enum ftm_pwm_mode_t

Enumerator

kFTM_EdgeAlignedPwm Edge-aligned PWM.
kFTM_CenterAlignedPwm Center-aligned PWM.
kFTM_EdgeAlignedCombinedPwm Edge-aligned combined PWM.
kFTM_CenterAlignedCombinedPwm Center-aligned combined PWM.
kFTM_AsymmetricalCombinedPwm Asymmetrical combined PWM.

10.7.4 enum ftm_pwm_level_select_t

Enumerator

kFTM_NoPwmSignal No PWM output on pin.
kFTM_LowTrue Low true pulses.
kFTM_HighTrue High true pulses.

10.7.5 enum ftm_output_compare_mode_t

Enumerator

kFTM_NoOutputSignal No channel output when counter reaches CnV.
kFTM_ToggleOnMatch Toggle output.
kFTM_ClearOnMatch Clear output.
kFTM_SetOnMatch Set output.

10.7.6 enum ftm_input_capture_edge_t

Enumerator

kFTM_RisingEdge Capture on rising edge only.
kFTM_FallingEdge Capture on falling edge only.
kFTM_RiseAndFallEdge Capture on rising or falling edge.

10.7.7 enum ftm_dual_edge_capture_mode_t

Enumerator

kFTM_OneShot One-shot capture mode.
kFTM_Continuous Continuous capture mode.

10.7.8 enum ftm_quad_decode_mode_t

Enumerator

kFTM_QuadPhaseEncode Phase A and Phase B encoding mode.
kFTM_QuadCountAndDir Count and direction encoding mode.

10.7.9 enum ftm_phase_polarity_t

Enumerator

kFTM_QuadPhaseNormal Phase input signal is not inverted.
kFTM_QuadPhaseInvert Phase input signal is inverted.

10.7.10 enum ftm_deadtime_prescale_t

Enumerator

kFTM_Deadtime_Prescale_1 Divide by 1.
kFTM_Deadtime_Prescale_4 Divide by 4.
kFTM_Deadtime_Prescale_16 Divide by 16.

10.7.11 enum ftm_clock_source_t

Enumerator

kFTM_SystemClock System clock selected.
kFTM_FixedClock Fixed frequency clock.
kFTM_ExternalClock External clock.

10.7.12 enum ftm_clock_prescale_t

Enumerator

kFTM_Prescale_Divide_1 Divide by 1.
kFTM_Prescale_Divide_2 Divide by 2.
kFTM_Prescale_Divide_4 Divide by 4.
kFTM_Prescale_Divide_8 Divide by 8.
kFTM_Prescale_Divide_16 Divide by 16.
kFTM_Prescale_Divide_32 Divide by 32.
kFTM_Prescale_Divide_64 Divide by 64.
kFTM_Prescale_Divide_128 Divide by 128.

10.7.13 enum ftm_bdm_mode_t

Enumerator

kFTM_BdmMode_0 FTM counter stopped, CH(n)F bit can be set, FTM channels in functional mode, writes to MOD,CNTIN and C(n)V registers bypass the register buffers.

kFTM_BdmMode_1 FTM counter stopped, CH(n)F bit is not set, FTM channels outputs are forced to their safe value , writes to MOD,CNTIN and C(n)V registers bypass the register buffers.
kFTM_BdmMode_2 FTM counter stopped, CH(n)F bit is not set, FTM channels outputs are frozen when chip enters in BDM mode, writes to MOD,CNTIN and C(n)V registers bypass the register buffers.
kFTM_BdmMode_3 FTM counter in functional mode, CH(n)F bit can be set, FTM channels in functional mode, writes to MOD,CNTIN and C(n)V registers is in fully functional mode.

10.7.14 enum ftm_fault_mode_t

Enumerator

kFTM_Fault_Disable Fault control is disabled for all channels.
kFTM_Fault_EvenChnls Enabled for even channels only(0,2,4,6) with manual fault clearing.
kFTM_Fault_AllChnlsMan Enabled for all channels with manual fault clearing.
kFTM_Fault_AllChnlsAuto Enabled for all channels with automatic fault clearing.

10.7.15 enum ftm_external_trigger_t

Note

Actual available external trigger sources are SoC-specific

Enumerator

kFTM_Chnl0Trigger Generate trigger when counter equals chnl 0 CnV reg.
kFTM_Chnl1Trigger Generate trigger when counter equals chnl 1 CnV reg.
kFTM_Chnl2Trigger Generate trigger when counter equals chnl 2 CnV reg.
kFTM_Chnl3Trigger Generate trigger when counter equals chnl 3 CnV reg.
kFTM_Chnl4Trigger Generate trigger when counter equals chnl 4 CnV reg.
kFTM_Chnl5Trigger Generate trigger when counter equals chnl 5 CnV reg.
kFTM_InitTrigger Generate Trigger when counter is updated with CNTIN.

10.7.16 enum ftm_pwm_sync_method_t

Enumerator

kFTM_SoftwareTrigger Software triggers PWM sync.
kFTM_HardwareTrigger_0 Hardware trigger 0 causes PWM sync.
kFTM_HardwareTrigger_1 Hardware trigger 1 causes PWM sync.
kFTM_HardwareTrigger_2 Hardware trigger 2 causes PWM sync.

10.7.17 enum ftm_reload_point_t

Note

Actual available reload points are SoC-specific

Enumerator

kFTM_Chnl0Match Channel 0 match included as a reload point.
kFTM_Chnl1Match Channel 1 match included as a reload point.
kFTM_Chnl2Match Channel 2 match included as a reload point.
kFTM_Chnl3Match Channel 3 match included as a reload point.
kFTM_Chnl4Match Channel 4 match included as a reload point.
kFTM_Chnl5Match Channel 5 match included as a reload point.
kFTM_Chnl6Match Channel 6 match included as a reload point.
kFTM_Chnl7Match Channel 7 match included as a reload point.
kFTM_CntMax Use in up-down count mode only, reload when counter reaches the maximum value.

kFTM_CntMin Use in up-down count mode only, reload when counter reaches the minimum value.

kFTM_HalfCycMatch Available on certain SoC's, half cycle match reload point.

10.7.18 enum ftm_interrupt_enable_t

Note

Actual available interrupts are SoC-specific

Enumerator

kFTM_Chnl0InterruptEnable Channel 0 interrupt.
kFTM_Chnl1InterruptEnable Channel 1 interrupt.
kFTM_Chnl2InterruptEnable Channel 2 interrupt.
kFTM_Chnl3InterruptEnable Channel 3 interrupt.
kFTM_Chnl4InterruptEnable Channel 4 interrupt.
kFTM_Chnl5InterruptEnable Channel 5 interrupt.
kFTM_Chnl6InterruptEnable Channel 6 interrupt.
kFTM_Chnl7InterruptEnable Channel 7 interrupt.
kFTM_FaultInterruptEnable Fault interrupt.
kFTM_TimeOverflowInterruptEnable Time overflow interrupt.
kFTM_ReloadInterruptEnable Reload interrupt; Available only on certain SoC's.

10.7.19 enum ftm_status_flags_t

Note

Actual available flags are SoC-specific

Enumerator

kFTM_Chnl0Flag Channel 0 Flag.
kFTM_Chnl1Flag Channel 1 Flag.
kFTM_Chnl2Flag Channel 2 Flag.
kFTM_Chnl3Flag Channel 3 Flag.
kFTM_Chnl4Flag Channel 4 Flag.
kFTM_Chnl5Flag Channel 5 Flag.
kFTM_Chnl6Flag Channel 6 Flag.
kFTM_Chnl7Flag Channel 7 Flag.
kFTM_FaultFlag Fault Flag.
kFTM_TimeOverflowFlag Time overflow Flag.
kFTM_ChnlTriggerFlag Channel trigger Flag.
kFTM_ReloadFlag Reload Flag; Available only on certain SoC's.

10.8 Function Documentation

10.8.1 status_t FTM_Init (FTM_Type * *base*, const ftm_config_t * *config*)

Note

This API should be called at the beginning of the application which is using the FTM driver. If the FTM instance has only TPM features, please use the TPM driver.

Parameters

base	FTM peripheral base address
config	Pointer to the user configuration structure.

Returns

kStatus_Success indicates success; Else indicates failure.

10.8.2 void FTM_Deinit (FTM_Type * *base*)

Parameters

base	FTM peripheral base address

10.8.3 void FTM_GetDefaultConfig (ftm_config_t * *config*)

The default values are:

```
*   config->prescale = kFTM_Prescale_Divide_1;
*   config->bdmMode = kFTM_BdmMode_0;
*   config->pwmSyncMode = kFTM_SoftwareTrigger;
*   config->reloadPoints = 0;
*   config->faultMode = kFTM_Fault_Disable;
*   config->faultFilterValue = 0;
*   config->deadTimePrescale = kFTM_Deadtime_Prescale_1;
*   config->deadTimeValue =  0;
*   config->extTriggers = 0;
*   config->chnlInitState = 0;
*   config->chnlPolarity = 0;
*   config->useGlobalTimeBase = false;
*
```

Parameters

config	Pointer to the user configuration structure.

10.8.4 static ftm_clock_prescale_t FTM_CalculateCounterClkDiv (FTM_Type * *base*, uint32_t *counterPeriod_Hz*, uint32_t *srcClock_Hz*) [inline], [static]

This function calculates the values for SC[PS] bit.

param base FTM peripheral base address param counterPeriod_Hz The desired frequency in Hz which corresponding to the time when the counter reaches the mod value param srcClock_Hz FTM counter clock in Hz

return Calculated clock prescaler value, see ftm_clock_prescale_t.

10.8.5 status_t FTM_SetupPwm (FTM_Type * *base*, const ftm_chnl_pwm_signal_param_t * *chnlParams*, uint8_t *numOfChnls*, ftm_pwm_mode_t *mode*, uint32_t *pwmFreq_Hz*, uint32_t *srcClock_Hz*)

Call this function to configure the PWM signal period, mode, duty cycle, and edge. Use this function to configure all FTM channels that are used to output a PWM signal.

Parameters

base	FTM peripheral base address
chnlParams	Array of PWM channel parameters to configure the channel(s)
numOfChnls	Number of channels to configure; This should be the size of the array passed in
mode	PWM operation mode, options available in enumeration ftm_pwm_mode_t
pwmFreq_Hz	PWM signal frequency in Hz
srcClock_Hz	FTM counter clock in Hz

Returns

kStatus_Success if the PWM setup was successful kStatus_Error on failure

10.8.6 status_t FTM_UpdatePwmDutycycle (FTM_Type ∗ *base,* ftm_chnl_t *chnlNumber,* ftm_pwm_mode_t *currentPwmMode,* uint8_t *dutyCyclePercent*)

Parameters

base	FTM peripheral base address
chnlNumber	The channel/channel pair number. In combined mode, this represents the channel pair number
currentPwm-Mode	The current PWM mode set during PWM setup
dutyCycle-Percent	New PWM pulse width; The value should be between 0 to 100 0=inactive signal(0% duty cycle)... 100=active signal (100% duty cycle)

Returns

kStatus_Success if the PWM update was successful kStatus_Error on failure

10.8.7 void FTM_UpdateChnlEdgeLevelSelect (FTM_Type ∗ *base,* ftm_chnl_t *chnlNumber,* uint8_t *level*)

Parameters

base	FTM peripheral base address
chnlNumber	The channel number
level	The level to be set to the ELSnB:ELSnA field; Valid values are 00, 01, 10, 11. See the Kinetis SoC reference manual for details about this field.

10.8.8 status_t FTM_SetupPwmMode (FTM_Type * *base*, const ftm_chnl_pwm_config_param_t * *chnlParams*, uint8_t *numOfChnls*, ftm_pwm_mode_t *mode*)

Call this function to configure the PWM signal mode, duty cycle in ticks, and edge. Use this function to configure all FTM channels that are used to output a PWM signal. Please note that: This API is similar with FTM_SetupPwm() API, but will not set the timer period, and this API will set channel match value in timer ticks, not period percent.

Parameters

base	FTM peripheral base address
chnlParams	Array of PWM channel parameters to configure the channel(s)
numOfChnls	Number of channels to configure; This should be the size of the array passed in
mode	PWM operation mode, options available in enumeration ftm_pwm_mode_t

Returns

kStatus_Success if the PWM setup was successful kStatus_Error on failure

10.8.9 void FTM_SetupInputCapture (FTM_Type * *base*, ftm_chnl_t *chnlNumber*, ftm_input_capture_edge_t *captureMode*, uint32_t *filterValue*)

When the edge specified in the captureMode argument occurs on the channel, the FTM counter is captured into the CnV register. The user has to read the CnV register separately to get this value. The filter function is disabled if the filterVal argument passed in is 0. The filter function is available only for channels 0, 1, 2, 3.

Parameters

base	FTM peripheral base address
chnlNumber	The channel number
captureMode	Specifies which edge to capture
filterValue	Filter value, specify 0 to disable filter. Available only for channels 0-3.

10.8.10 void FTM_SetupOutputCompare (FTM_Type ∗ *base*, ftm_chnl_t *chnlNumber*, ftm_output_compare_mode_t *compareMode*, uint32_t *compareValue*)

When the FTM counter matches the value of compareVal argument (this is written into CnV reg), the channel output is changed based on what is specified in the compareMode argument.

Parameters

base	FTM peripheral base address
chnlNumber	The channel number
compareMode	Action to take on the channel output when the compare condition is met
compareValue	Value to be programmed in the CnV register.

10.8.11 void FTM_SetupDualEdgeCapture (FTM_Type ∗ *base*, ftm_chnl_t *chnlPairNumber*, const ftm_dual_edge_capture_param_t ∗ *edgeParam*, uint32_t *filterValue*)

This function sets up the dual edge capture mode on a channel pair. The capture edge for the channel pair and the capture mode (one-shot or continuous) is specified in the parameter argument. The filter function is disabled if the filterVal argument passed is zero. The filter function is available only on channels 0 and 2. The user has to read the channel CnV registers separately to get the capture values.

Parameters

base	FTM peripheral base address
chnlPair-Number	The FTM channel pair number; options are 0, 1, 2, 3

edgeParam	Sets up the dual edge capture function
filterValue	Filter value, specify 0 to disable filter. Available only for channel pair 0 and 1.

10.8.12 void FTM_SetupFaultInput (FTM_Type ∗ *base*, ftm_fault_input_t *faultNumber*, const ftm_fault_param_t ∗ *faultParams*)

FTM can have up to 4 fault inputs. This function sets up fault parameters, fault level, and input filter.

Parameters

base	FTM peripheral base address
faultNumber	FTM fault to configure.
faultParams	Parameters passed in to set up the fault

10.8.13 void FTM_EnableInterrupts (FTM_Type ∗ *base*, uint32_t *mask*)

Parameters

base	FTM peripheral base address
mask	The interrupts to enable. This is a logical OR of members of the enumeration ftm_interrupt_enable_t

10.8.14 void FTM_DisableInterrupts (FTM_Type ∗ *base*, uint32_t *mask*)

Parameters

base	FTM peripheral base address
mask	The interrupts to enable. This is a logical OR of members of the enumeration ftm_interrupt_enable_t

10.8.15 uint32_t FTM_GetEnabledInterrupts (FTM_Type ∗ *base*)

Parameters

base	FTM peripheral base address

Returns

The enabled interrupts. This is the logical OR of members of the enumeration ftm_interrupt_enable-_t

10.8.16 uint32_t FTM_GetStatusFlags (FTM_Type * *base*)

Parameters

base	FTM peripheral base address

Returns

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

10.8.17 void FTM_ClearStatusFlags (FTM_Type * *base*, uint32_t *mask*)

Parameters

base	FTM peripheral base address
mask	The status flags to clear. This is a logical OR of members of the enumeration ftm_-status_flags_t

10.8.18 static void FTM_SetTimerPeriod (FTM_Type * *base*, uint32_t *ticks*) [inline], [static]

Timers counts from 0 until it equals the count value set here. The count value is written to the MOD register.

Note

1. This API allows the user to use the FTM module as a timer. Do not mix usage of this API with FTM's PWM setup API's.
2. Call the utility macros provided in the fsl_common.h to convert usec or msec to ticks.

Parameters

base	FTM peripheral base address
ticks	A timer period in units of ticks, which should be equal or greater than 1.

10.8.19 static uint32_t FTM_GetCurrentTimerCount (FTM_Type * *base*) [inline], [static]

This function returns the real-time timer counting value in a range from 0 to a timer period.

Note

Call the utility macros provided in the fsl_common.h to convert ticks to usec or msec.

Parameters

base	FTM peripheral base address

Returns

The current counter value in ticks

10.8.20 static uint32_t FTM_GetInputCaptureValue (FTM_Type * *base,* ftm_chnl_t *chnlNumber*) [inline], [static]

This function returns the captured value of a FTM channel configured in input capture or dual edge capture mode.

Note

Call the utility macros provided in the fsl_common.h to convert ticks to usec or msec.

Parameters

base	FTM peripheral base address

chnlNumber	Channel to be read

Returns

The captured FTM counter value of the input modes.

10.8.21 static void FTM_StartTimer (FTM_Type * *base,* ftm_clock_source_t *clockSource*) [inline], [static]

Parameters

base	FTM peripheral base address
clockSource	FTM clock source; After the clock source is set, the counter starts running.

10.8.22 static void FTM_StopTimer (FTM_Type * *base*) [inline], [static]

Parameters

base	FTM peripheral base address

10.8.23 static void FTM_SetSoftwareCtrlEnable (FTM_Type * *base,* ftm_chnl_t *chnlNumber,* bool *value*) [inline], [static]

Parameters

base	FTM peripheral base address
chnlNumber	Channel to be enabled or disabled
value	true: channel output is affected by software output control false: channel output is unaffected by software output control

10.8.24 static void FTM_SetSoftwareCtrlVal (FTM_Type * *base,* ftm_chnl_t *chnlNumber,* bool *value*) [inline], [static]

Parameters

base	FTM peripheral base address.
chnlNumber	Channel to be configured
value	true to set 1, false to set 0

10.8.25 static void FTM_SetGlobalTimeBaseOutputEnable (FTM_Type ∗ *base*, bool *enable*) [inline], [static]

Parameters

base	FTM peripheral base address
enable	true to enable, false to disable

10.8.26 static void FTM_SetOutputMask (FTM_Type ∗ *base*, ftm_chnl_t *chnlNumber*, bool *mask*) [inline], [static]

Parameters

base	FTM peripheral base address
chnlNumber	Channel to be configured
mask	true: masked, channel is forced to its inactive state; false: unmasked

10.8.27 static void FTM_SetFaultControlEnable (FTM_Type ∗ *base*, ftm_chnl_t *chnlPairNumber*, bool *value*) [inline], [static]

Parameters

base	FTM peripheral base address
chnlPair-Number	The FTM channel pair number; options are 0, 1, 2, 3

value	true: Enable fault control for this channel pair; false: No fault control

10.8.28 static void FTM_SetDeadTimeEnable (FTM_Type * *base*, ftm_chnl_t *chnlPairNumber*, bool *value*) [inline], [static]

Parameters

base	FTM peripheral base address
chnlPair-Number	The FTM channel pair number; options are 0, 1, 2, 3
value	true: Insert dead time in this channel pair; false: No dead time inserted

10.8.29 static void FTM_SetComplementaryEnable (FTM_Type * *base*, ftm_chnl_t *chnlPairNumber*, bool *value*) [inline], [static]

Parameters

base	FTM peripheral base address
chnlPair-Number	The FTM channel pair number; options are 0, 1, 2, 3
value	true: enable complementary mode; false: disable complementary mode

10.8.30 static void FTM_SetInvertEnable (FTM_Type * *base*, ftm_chnl_t *chnlPairNumber*, bool *value*) [inline], [static]

Parameters

base	FTM peripheral base address
chnlPair-Number	The FTM channel pair number; options are 0, 1, 2, 3

value	true: enable inverting; false: disable inverting

10.8.31 void FTM_SetupQuadDecode (FTM_Type * *base*, const ftm_phase_params_t * *phaseAParams*, const ftm_phase_params_t * *phaseBParams*, ftm_quad_decode_mode_t *quadMode*)

Parameters

base	FTM peripheral base address
phaseAParams	Phase A configuration parameters
phaseBParams	Phase B configuration parameters
quadMode	Selects encoding mode used in quadrature decoder mode

10.8.32 static void FTM_SetQuadDecoderModuloValue (FTM_Type * *base*, uint32_t *startValue*, uint32_t *overValue*) [inline], [static]

The modulo values configure the minimum and maximum values that the Quad decoder counter can reach. After the counter goes over, the counter value goes to the other side and decrease/increase again.

Parameters

base	FTM peripheral base address.
startValue	The low limit value for Quad Decoder counter.
overValue	The high limit value for Quad Decoder counter.

10.8.33 static uint32_t FTM_GetQuadDecoderCounterValue (FTM_Type * *base*) [inline], [static]

Parameters

base	FTM peripheral base address.

Returns

Current quad Decoder counter value.

10.8.34 static void FTM_ClearQuadDecoderCounterValue (FTM_Type * base) [inline], [static]

The counter is set as the initial value.

Parameters

base	FTM peripheral base address.

10.8.35 static void FTM_SetSoftwareTrigger (FTM_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	FTM peripheral base address
enable	true: software trigger is selected, false: software trigger is not selected

10.8.36 static void FTM_SetWriteProtection (FTM_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	FTM peripheral base address
enable	true: Write-protection is enabled, false: Write-protection is disabled

Chapter 11
GPIO: General-Purpose Input/Output Driver

11.1 Overview

Modules

- FGPIO Driver
- GPIO Driver

Data Structures

- struct gpio_pin_config_t
  The GPIO pin configuration structure. More...

Enumerations

- enum gpio_port_num_t
  PORT definition.
- enum gpio_pin_direction_t {
  kGPIO_DigitalInput = 0U,
  kGPIO_DigitalOutput = 1U }
  GPIO direction definition.

Driver version

- #define FSL_GPIO_DRIVER_VERSION (MAKE_VERSION(2, 1, 1))
  GPIO driver version.

11.2 Data Structure Documentation

11.2.1 struct gpio_pin_config_t

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

Data Fields

- gpio_pin_direction_t pinDirection
  GPIO direction, input or output.
- uint8_t outputLogic
  Set a default output logic, which has no use in input.

11.3 Macro Definition Documentation

11.3.1 #define FSL_GPIO_DRIVER_VERSION (MAKE_VERSION(2, 1, 1))

11.4 Enumeration Type Documentation

11.4.1 enum gpio_pin_direction_t

Enumerator

kGPIO_DigitalInput Set current pin as digital input.
kGPIO_DigitalOutput Set current pin as digital output.

11.5 GPIO Driver

11.5.1 Overview

The MCUXpresso SDK provides a peripheral driver for the General-Purpose Input/Output (GPIO) module of MCUXpresso SDK devices.

11.5.2 Typical use case

11.5.2.1 Output Operation

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

11.5.2.2 Input Operation

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

GPIO Configuration

- void GPIO_PinInit (gpio_port_num_t port, uint8_t pin, const gpio_pin_config_t *config)
  Initializes a GPIO pin used by the board.

GPIO Output Operations

- void GPIO_PinWrite (gpio_port_num_t port, uint8_t pin, uint8_t output)
  Sets the output level of the multiple GPIO pins to the logic 1 or 0.
- void GPIO_PortSet (gpio_port_num_t port, uint8_t mask)
  Sets the output level of the multiple GPIO pins to the logic 1.
- void GPIO_PortClear (gpio_port_num_t port, uint8_t mask)
  Sets the output level of the multiple GPIO pins to the logic 0.
- void GPIO_PortToggle (gpio_port_num_t port, uint8_t mask)
  Reverses the current output logic of the multiple GPIO pins.

GPIO Input Operations

- uint32_t GPIO_PinRead (gpio_port_num_t port, uint8_t pin)
  Reads the current input value of the GPIO port.

11.5.3 Function Documentation

11.5.3.1 void GPIO_PinInit (gpio_port_num_t *port*, uint8_t *pin*, const gpio_pin_config_t ∗ *config*)

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

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

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

Parameters

port	GPIO PORT number, see "gpio_port_num_t". For each group GPIO (GPIOA, GPIOB,etc) control registers, they handles four PORT number controls. GPIOA serial registers -—– PTA 0 ∼ 7, PTB 0 ∼7 ... PTD 0 ∼ 7. GPIOB serial registers -—– PTE 0 ∼ 7, PTF 0 ∼7 ... PTH 0 ∼ 7. ...
pin	GPIO port pin number
config	GPIO pin configuration pointer

11.5.3.2 void GPIO_PinWrite (gpio_port_num_t *port*, uint8_t *pin*, uint8_t *output*)

Parameters

port	GPIO PORT number, see "gpio_port_num_t". For each group GPIO (GPIOA, GPIOB,etc) control registers, they handles four PORT number controls. GPIOA serial registers -—– PTA 0 ∼ 7, PTB 0 ∼7 ... PTD 0 ∼ 7. GPIOB serial registers -—– PTE 0 ∼ 7, PTF 0 ∼7 ... PTH 0 ∼ 7. ...

pin	GPIO pin number
output	GPIO pin output logic level. • 0: corresponding pin output low-logic level. • 1: corresponding pin output high-logic level.

11.5.3.3 void GPIO_PortSet (gpio_port_num_t *port*, uint8_t *mask*)

Parameters

port	GPIO PORT number, see "gpio_port_num_t". For each group GPIO (GPIOA, GPIOB,etc) control registers, they handles four PORT number controls. GPIOA serial registers --— PTA 0 ~ 7, PTB 0 ~7 ... PTD 0 ~ 7. GPIOB serial registers --— PTE 0 ~ 7, PTF 0 ~7 ... PTH 0 ~ 7. ...
mask	GPIO pin number macro

11.5.3.4 void GPIO_PortClear (gpio_port_num_t *port*, uint8_t *mask*)

Parameters

port	GPIO PORT number, see "gpio_port_num_t". For each group GPIO (GPIOA, GPIOB,etc) control registers, they handles four PORT number controls. GPIOA serial registers --— PTA 0 ~ 7, PTB 0 ~7 ... PTD 0 ~ 7. GPIOB serial registers --— PTE 0 ~ 7, PTF 0 ~7 ... PTH 0 ~ 7. ...
mask	GPIO pin number macro

11.5.3.5 void GPIO_PortToggle (gpio_port_num_t *port*, uint8_t *mask*)

Parameters

port	GPIO PORT number, see "gpio_port_num_t". For each group GPIO (GPIOA, GPIOB,etc) control registers, they handles four PORT number controls. GPIOA serial registers --— PTA 0 ~ 7, PTB 0 ~7 ... PTD 0 ~ 7. GPIOB serial registers --— PTE 0 ~ 7, PTF 0 ~7 ... PTH 0 ~ 7. ...

mask	GPIO pin number macro

11.5.3.6 uint32_t GPIO_PinRead (gpio_port_num_t *port,* uint8_t *pin*)

Parameters

port	GPIO PORT number, see "gpio_port_num_t". For each group GPIO (GPIOA, GPIOB,etc) control registers, they handles four PORT number controls. GPIOA serial registers -—– PTA 0 ~ 7, PTB 0 ~7 ... PTD 0 ~ 7. GPIOB serial registers -—– PTE 0 ~ 7, PTF 0 ~7 ... PTH 0 ~ 7. ...
pin	GPIO pin number

Return values

GPIO	port input value • 0: corresponding pin input low-logic level. • 1: corresponding pin input high-logic level.

11.6 FGPIO Driver

11.6.1 Overview

This section describes the programming interface of the FGPIO driver. The FGPIO driver configures the FGPIO module and provides a functional interface to build the GPIO application.

Note

> FGPIO (Fast GPIO) is only available in a few MCUs. FGPIO and GPIO share the same peripheral but use different registers. FGPIO is closer to the core than the regular GPIO and it's faster to read and write.

11.6.2 Typical use case

11.6.2.1 Output Operation

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

11.6.2.2 Input Operation

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

FGPIO Configuration

- void FGPIO_PortInit (gpio_port_num_t port)
  Initializes the FGPIO peripheral.
- void FGPIO_PinInit (gpio_port_num_t port, uint8_t pin, const gpio_pin_config_t *config)
  Initializes a FGPIO pin used by the board.

FGPIO Output Operations

- void FGPIO_PinWrite (gpio_port_num_t port, uint8_t pin, uint8_t output)
  Sets the output level of the multiple FGPIO pins to the logic 1 or 0.
- void FGPIO_PortSet (gpio_port_num_t port, uint8_t mask)
  Sets the output level of the multiple FGPIO pins to the logic 1.
- void FGPIO_PortClear (gpio_port_num_t port, uint8_t mask)
  Sets the output level of the multiple FGPIO pins to the logic 0.
- void FGPIO_PortToggle (gpio_port_num_t port, uint8_t mask)
  Reverses the current output logic of the multiple FGPIO pins.

FGPIO Input Operations

- uint32_t FGPIO_PinRead (gpio_port_num_t port, uint8_t pin)

Reads the current input value of the FGPIO port.

11.6.3 Function Documentation

11.6.3.1 void FGPIO_PortInit (gpio_port_num_t *port*)

This function ungates the FGPIO clock.

Parameters

port	FGPIO PORT number, see "gpio_port_num_t". For each group FGPIO (FGPIOA, FGPIOB,etc) control registers, they handles four PORT number controls. FGPIOA serial registers --— PTA 0 ∼ 7, PTB 0 ∼7 ... PTD 0 ∼ 7. FGPIOB serial registers --— PTE 0 ∼ 7, PTF 0 ∼7 ... PTH 0 ∼ 7. ...

11.6.3.2 void FGPIO_PinInit (gpio_port_num_t *port*, uint8_t *pin*, const gpio_pin_config_t ∗ *config*)

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

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

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

Parameters

port	FGPIO PORT number, see "gpio_port_num_t". For each group FGPIO (FGPIOA, FGPIOB,etc) control registers, they handles four PORT number controls. FGPIOA serial registers --— PTA 0 ∼ 7, PTB 0 ∼7 ... PTD 0 ∼ 7. FGPIOB serial registers --— PTE 0 ∼ 7, PTF 0 ∼7 ... PTH 0 ∼ 7. ...

pin	FGPIO port pin number
config	FGPIO pin configuration pointer

11.6.3.3 void FGPIO_PinWrite (gpio_port_num_t *port,* uint8_t *pin,* uint8_t *output*)

Parameters

port	FGPIO PORT number, see "gpio_port_num_t". For each group FGPIO (FGPIOA, FGPIOB,etc) control registers, they handles four PORT number controls. FGPIOA serial registers -–— PTA 0 ∼ 7, PTB 0 ∼7 ... PTD 0 ∼ 7. FGPIOB serial registers -–— PTE 0 ∼ 7, PTF 0 ∼7 ... PTH 0 ∼ 7. ...
pin	FGPIO pin number
output	FGPIOpin output logic level. • 0: corresponding pin output low-logic level. • 1: corresponding pin output high-logic level.

11.6.3.4 void FGPIO_PortSet (gpio_port_num_t *port,* uint8_t *mask*)

Parameters

port	FGPIO PORT number, see "gpio_port_num_t". For each group FGPIO (FGPIOA, FGPIOB,etc) control registers, they handles four PORT number controls. FGPIOA serial registers -–— PTA 0 ∼ 7, PTB 0 ∼7 ... PTD 0 ∼ 7. FGPIOB serial registers -–— PTE 0 ∼ 7, PTF 0 ∼7 ... PTH 0 ∼ 7. ...
mask	FGPIO pin number macro

11.6.3.5 void FGPIO_PortClear (gpio_port_num_t *port,* uint8_t *mask*)

Parameters

port	FGPIO PORT number, see "gpio_port_num_t". For each group FGPIO (FGPIOA, FGPIOB,etc) control registers, they handles four PORT number controls. FGPIOA serial registers -–— PTA 0 ∼ 7, PTB 0 ∼7 ... PTD 0 ∼ 7. FGPIOB serial registers -–— PTE 0 ∼ 7, PTF 0 ∼7 ... PTH 0 ∼ 7. ...

mask	FGPIO pin number macro

11.6.3.6 void FGPIO_PortToggle (gpio_port_num_t *port*, uint8_t *mask*)

Parameters

port	FGPIO PORT number, see "gpio_port_num_t". For each group FGPIO (FGPIOA, FGPIOB,etc) control registers, they handles four PORT number controls. FGPIOA serial registers --— PTA 0 ∼ 7, PTB 0 ∼7 ... PTD 0 ∼ 7. FGPIOB serial registers --— PTE 0 ∼ 7, PTF 0 ∼7 ... PTH 0 ∼ 7. ...
mask	FGPIO pin number macro

11.6.3.7 uint32_t FGPIO_PinRead (gpio_port_num_t *port*, uint8_t *pin*)

Parameters

port	FGPIO PORT number, see "gpio_port_num_t". For each group FGPIO (FGPIOA, FGPIOB,etc) control registers, they handles four PORT number controls. FGPIOA serial registers --— PTA 0 ∼ 7, PTB 0 ∼7 ... PTD 0 ∼ 7. FGPIOB serial registers --— PTE 0 ∼ 7, PTF 0 ∼7 ... PTH 0 ∼ 7. ...
pin	FGPIO pin number

Return values

FGPIO	port input value • 0: corresponding pin input low-logic level. • 1: corresponding pin input high-logic level.

Chapter 12
I2C: Inter-Integrated Circuit Driver

12.1 Overview

Modules

- I2C CMSIS Driver
- I2C Driver

12.2 I2C Driver

12.2.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Inter-Integrated Circuit (I2C) module of MCUXpresso SDK devices.

The I2C driver includes functional APIs and transactional APIs.

Functional APIs target the low-level APIs. Functional APIs can be used for the I2C master/slave initialization/configuration/operation for optimization/customization purpose. Using the functional APIs requires knowing the I2C master peripheral and how to organize functional APIs to meet the application requirements. The I2C functional operation groups provide the functional APIs set.

Transactional APIs target the 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 asynchronous transfer. This means that the functions I2C_MasterTransferNonBlocking() set up the interrupt non-blocking transfer. When the transfer completes, the upper layer is notified through a callback function with the status.

12.2.2 Typical use case

12.2.2.1 Master Operation in functional method

Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOARD>/driver_examples/i2c

12.2.2.2 Master Operation in interrupt transactional method

Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOARD>/driver_examples/i2c

12.2.2.3 Master Operation in DMA transactional method

Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOARD>/driver_examples/i2c

12.2.2.4 Slave Operation in functional method

Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOARD>/driver_examples/i2c

12.2.2.5 Slave Operation in interrupt transactional method

Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOARD>/driver_examples/i2c

Data Structures

- struct i2c_master_config_t
  I2C master user configuration. More...
- struct i2c_slave_config_t
  I2C slave user configuration. More...
- struct i2c_master_transfer_t
  I2C master transfer structure. More...
- struct i2c_master_handle_t
  I2C master handle structure. More...
- struct i2c_slave_transfer_t
  I2C slave transfer structure. More...
- struct i2c_slave_handle_t
  I2C slave 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.
- #define I2C_MASTER_FACK_CONTROL 0U /∗ Default defines to zero means master will send ack automatically. ∗/
  Mater Fast ack control, control if master needs to manually write ack, this is used to low the speed of transfer for SoCs with feature FSL_FEATURE_I2C_HAS_DOUBLE_BUFFERING.

Typedefs

- typedef void(∗ i2c_master_transfer_callback_t)(I2C_Type ∗base, i2c_master_handle_t ∗handle, status_t status, void ∗userData)
  I2C master transfer callback typedef.
- typedef void(∗ i2c_slave_transfer_callback_t)(I2C_Type ∗base, i2c_slave_transfer_t ∗xfer, void ∗userData)
  I2C slave transfer callback typedef.

Enumerations

- enum {
  kStatus_I2C_Busy = MAKE_STATUS(kStatusGroup_I2C, 0),
  kStatus_I2C_Idle = MAKE_STATUS(kStatusGroup_I2C, 1),
  kStatus_I2C_Nak = MAKE_STATUS(kStatusGroup_I2C, 2),
  kStatus_I2C_ArbitrationLost = MAKE_STATUS(kStatusGroup_I2C, 3),
  kStatus_I2C_Timeout = MAKE_STATUS(kStatusGroup_I2C, 4),
  kStatus_I2C_Addr_Nak = MAKE_STATUS(kStatusGroup_I2C, 5) }
  I2C status return codes.

- enum _i2c_flags {
kI2C_ReceiveNakFlag = I2C_S_RXAK_MASK,
kI2C_IntPendingFlag = I2C_S_IICIF_MASK,
kI2C_TransferDirectionFlag = I2C_S_SRW_MASK,
kI2C_RangeAddressMatchFlag = I2C_S_RAM_MASK,
kI2C_ArbitrationLostFlag = I2C_S_ARBL_MASK,
kI2C_BusBusyFlag = I2C_S_BUSY_MASK,
kI2C_AddressMatchFlag = I2C_S_IAAS_MASK,
kI2C_TransferCompleteFlag = I2C_S_TCF_MASK,
kI2C_StopDetectFlag = I2C_FLT_STOPF_MASK << 8,
kI2C_StartDetectFlag = I2C_FLT_STARTF_MASK << 8 }
I2C peripheral flags.
- enum _i2c_interrupt_enable {
kI2C_GlobalInterruptEnable = I2C_C1_IICIE_MASK,
kI2C_StartStopDetectInterruptEnable = I2C_FLT_SSIE_MASK }
I2C feature interrupt source.
- enum i2c_direction_t {
kI2C_Write = 0x0U,
kI2C_Read = 0x1U }
The direction of master and slave transfers.
- enum i2c_slave_address_mode_t {
kI2C_Address7bit = 0x0U,
kI2C_RangeMatch = 0X2U }
Addressing mode.
- enum _i2c_master_transfer_flags {
kI2C_TransferDefaultFlag = 0x0U,
kI2C_TransferNoStartFlag = 0x1U,
kI2C_TransferRepeatedStartFlag = 0x2U,
kI2C_TransferNoStopFlag = 0x4U }
I2C transfer control flag.
- enum i2c_slave_transfer_event_t {
kI2C_SlaveAddressMatchEvent = 0x01U,
kI2C_SlaveTransmitEvent = 0x02U,
kI2C_SlaveReceiveEvent = 0x04U,
kI2C_SlaveTransmitAckEvent = 0x08U,
kI2C_SlaveStartEvent = 0x10U,
kI2C_SlaveCompletionEvent = 0x20U,
kI2C_SlaveGenaralcallEvent = 0x40U,
kI2C_SlaveAllEvents }
Set of events sent to the callback for nonblocking slave transfers.
- enum { kClearFlags = kI2C_ArbitrationLostFlag | kI2C_IntPendingFlag | kI2C_StartDetectFlag | kI2C_StopDetectFlag }
Common sets of flags used by the driver.

Driver version

- #define FSL_I2C_DRIVER_VERSION (MAKE_VERSION(2, 0, 9))
  I2C driver version.

Initialization and deinitialization

- void I2C_MasterInit (I2C_Type ∗base, const i2c_master_config_t ∗masterConfig, uint32_t srcClock_Hz)
  Initializes the I2C peripheral.
- void I2C_SlaveInit (I2C_Type ∗base, const i2c_slave_config_t ∗slaveConfig, uint32_t srcClock_Hz)
  Initializes the I2C peripheral.
- void I2C_MasterDeinit (I2C_Type ∗base)
  De-initializes the I2C master peripheral.
- void I2C_SlaveDeinit (I2C_Type ∗base)
  De-initializes the I2C slave peripheral.
- uint32_t I2C_GetInstance (I2C_Type ∗base)
  Get instance number for I2C module.
- void I2C_MasterGetDefaultConfig (i2c_master_config_t ∗masterConfig)
  Sets the I2C master configuration structure to default values.
- void I2C_SlaveGetDefaultConfig (i2c_slave_config_t ∗slaveConfig)
  Sets the I2C slave configuration structure to default values.
- static void I2C_Enable (I2C_Type ∗base, bool enable)
  Enables or disables the I2C peripheral operation.

Status

- uint32_t I2C_MasterGetStatusFlags (I2C_Type ∗base)
  Gets the I2C status flags.
- static uint32_t I2C_SlaveGetStatusFlags (I2C_Type ∗base)
  Gets the I2C status flags.
- static void I2C_MasterClearStatusFlags (I2C_Type ∗base, uint32_t statusMask)
  Clears the I2C status flag state.
- static void I2C_SlaveClearStatusFlags (I2C_Type ∗base, uint32_t statusMask)
  Clears the I2C status flag state.

Interrupts

- void I2C_EnableInterrupts (I2C_Type ∗base, uint32_t mask)
  Enables I2C interrupt requests.
- void I2C_DisableInterrupts (I2C_Type ∗base, uint32_t mask)
  Disables I2C interrupt requests.

DMA Control

- static uint32_t I2C_GetDataRegAddr (I2C_Type *base)
  Gets the I2C tx/rx data register address.

Bus Operations

- void I2C_MasterSetBaudRate (I2C_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)
  Sets the I2C master transfer baud rate.
- status_t I2C_MasterStart (I2C_Type *base, uint8_t address, i2c_direction_t direction)
  Sends a START on the I2C bus.
- status_t I2C_MasterStop (I2C_Type *base)
  Sends a STOP signal on the I2C bus.
- status_t I2C_MasterRepeatedStart (I2C_Type *base, uint8_t address, i2c_direction_t direction)
  Sends a REPEATED START on the I2C bus.
- status_t I2C_MasterWriteBlocking (I2C_Type *base, const uint8_t *txBuff, size_t txSize, uint32_t flags)
  Performs a polling send transaction on the I2C bus.
- status_t I2C_MasterReadBlocking (I2C_Type *base, uint8_t *rxBuff, size_t rxSize, uint32_t flags)
  Performs a polling receive transaction on the I2C bus.
- status_t I2C_SlaveWriteBlocking (I2C_Type *base, const uint8_t *txBuff, size_t txSize)
  Performs a polling send transaction on the I2C bus.
- status_t I2C_SlaveReadBlocking (I2C_Type *base, uint8_t *rxBuff, size_t rxSize)
  Performs a polling receive transaction on the I2C bus.
- status_t I2C_MasterTransferBlocking (I2C_Type *base, i2c_master_transfer_t *xfer)
  Performs a master polling transfer on the I2C bus.

Transactional

- void I2C_MasterTransferCreateHandle (I2C_Type *base, i2c_master_handle_t *handle, i2c_master_transfer_callback_t callback, void *userData)
  Initializes the I2C handle which is used in transactional functions.
- status_t I2C_MasterTransferNonBlocking (I2C_Type *base, i2c_master_handle_t *handle, i2c_master_transfer_t *xfer)
  Performs a master interrupt non-blocking transfer on the I2C bus.
- status_t I2C_MasterTransferGetCount (I2C_Type *base, i2c_master_handle_t *handle, size_t *count)
  Gets the master transfer status during a interrupt non-blocking transfer.
- status_t I2C_MasterTransferAbort (I2C_Type *base, i2c_master_handle_t *handle)
  Aborts an interrupt non-blocking transfer early.
- void I2C_MasterTransferHandleIRQ (I2C_Type *base, void *i2cHandle)
  Master interrupt handler.
- void I2C_SlaveTransferCreateHandle (I2C_Type *base, i2c_slave_handle_t *handle, i2c_slave_transfer_callback_t callback, void *userData)
  Initializes the I2C handle which is used in transactional functions.
- status_t I2C_SlaveTransferNonBlocking (I2C_Type *base, i2c_slave_handle_t *handle, uint32_t eventMask)

Starts accepting slave transfers.
- void I2C_SlaveTransferAbort (I2C_Type ∗base, i2c_slave_handle_t ∗handle)
  Aborts the slave transfer.
- status_t I2C_SlaveTransferGetCount (I2C_Type ∗base, i2c_slave_handle_t ∗handle, size_t ∗count)
  Gets the slave transfer remaining bytes during a interrupt non-blocking transfer.
- void I2C_SlaveTransferHandleIRQ (I2C_Type ∗base, void ∗i2cHandle)
  Slave interrupt handler.

12.2.3 Data Structure Documentation

12.2.3.1 struct i2c_master_config_t

Data Fields

- bool enableMaster
  Enables the I2C peripheral at initialization time.
- bool enableStopHold
  Controls the stop hold enable.
- uint32_t baudRate_Bps
  Baud rate configuration of I2C peripheral.
- uint8_t glitchFilterWidth
  Controls the width of the glitch.

Field Documentation

(1) bool i2c_master_config_t::enableMaster

(2) bool i2c_master_config_t::enableStopHold

(3) uint32_t i2c_master_config_t::baudRate_Bps

(4) uint8_t i2c_master_config_t::glitchFilterWidth

12.2.3.2 struct i2c_slave_config_t

Data Fields

- bool enableSlave
  Enables the I2C peripheral at initialization time.
- bool enableGeneralCall
  Enables the general call addressing mode.
- bool enableWakeUp
  Enables/disables waking up MCU from low-power mode.
- bool enableBaudRateCtl
  Enables/disables independent slave baud rate on SCL in very fast I2C modes.
- uint16_t slaveAddress
  A slave address configuration.
- uint16_t upperAddress
  A maximum boundary slave address used in a range matching mode.

- i2c_slave_address_mode_t addressingMode
  An addressing mode configuration of i2c_slave_address_mode_config_t.
- uint32_t sclStopHoldTime_ns
  the delay from the rising edge of SCL (I2C clock) to the rising edge of SDA (I2C data) while SCL is high (stop condition), SDA hold time and SCL start hold time are also configured according to the SCL stop hold time.

Field Documentation

(1) bool i2c_slave_config_t::enableSlave

(2) bool i2c_slave_config_t::enableGeneralCall

(3) bool i2c_slave_config_t::enableWakeUp

(4) bool i2c_slave_config_t::enableBaudRateCtl

(5) uint16_t i2c_slave_config_t::slaveAddress

(6) uint16_t i2c_slave_config_t::upperAddress

(7) i2c_slave_address_mode_t i2c_slave_config_t::addressingMode

(8) uint32_t i2c_slave_config_t::sclStopHoldTime_ns

12.2.3.3 struct i2c_master_transfer_t

Data Fields

- uint32_t flags
  A transfer flag which controls the transfer.
- uint8_t slaveAddress
  7-bit slave address.
- i2c_direction_t direction
  A transfer direction, read or write.
- uint32_t subaddress
  A sub address.
- uint8_t subaddressSize
  A size of the command buffer.
- uint8_t ∗volatile data
  A transfer buffer.
- volatile size_t dataSize
  A transfer size.

Field Documentation

(1) uint32_t i2c_master_transfer_t::flags

(2) uint8_t i2c_master_transfer_t::slaveAddress

(3) i2c_direction_t i2c_master_transfer_t::direction

(4) uint32_t i2c_master_transfer_t::subaddress

Transferred MSB first.

(5) uint8_t i2c_master_transfer_t::subaddressSize

(6) uint8_t* volatile i2c_master_transfer_t::data

(7) volatile size_t i2c_master_transfer_t::dataSize

12.2.3.4 struct _i2c_master_handle

I2C master handle typedef.

Data Fields

- i2c_master_transfer_t transfer
  I2C master transfer copy.
- size_t transferSize
  Total bytes to be transferred.
- uint8_t state
  A transfer state maintained during transfer.
- i2c_master_transfer_callback_t completionCallback
  A callback function called when the transfer is finished.
- void * userData
  A callback parameter passed to the callback function.

Field Documentation

(1) i2c_master_transfer_t i2c_master_handle_t::transfer

(2) size_t i2c_master_handle_t::transferSize

(3) uint8_t i2c_master_handle_t::state

(4) i2c_master_transfer_callback_t i2c_master_handle_t::completionCallback

(5) void* i2c_master_handle_t::userData

12.2.3.5 struct i2c_slave_transfer_t

Data Fields

- i2c_slave_transfer_event_t event
  A reason that the callback is invoked.
- uint8_t *volatile data
  A transfer buffer.
- volatile size_t dataSize

A transfer size.
- status_t completionStatus
  Success or error code describing how the transfer completed.
- size_t transferredCount
  A number of bytes actually transferred since the start or since the last repeated start.

Field Documentation

(1) i2c_slave_transfer_event_t i2c_slave_transfer_t::event

(2) uint8_t* volatile i2c_slave_transfer_t::data

(3) volatile size_t i2c_slave_transfer_t::dataSize

(4) status_t i2c_slave_transfer_t::completionStatus

Only applies for kI2C_SlaveCompletionEvent.

(5) size_t i2c_slave_transfer_t::transferredCount

12.2.3.6 struct _i2c_slave_handle

I2C slave handle typedef.

Data Fields

- volatile bool isBusy
  Indicates whether a transfer is busy.
- i2c_slave_transfer_t transfer
  I2C slave transfer copy.
- uint32_t eventMask
  A mask of enabled events.
- i2c_slave_transfer_callback_t callback
  A callback function called at the transfer event.
- void * userData
  A callback parameter passed to the callback.

Field Documentation

(1) volatile bool i2c_slave_handle_t::isBusy

(2) i2c_slave_transfer_t i2c_slave_handle_t::transfer

(3) uint32_t i2c_slave_handle_t::eventMask

(4) i2c_slave_transfer_callback_t i2c_slave_handle_t::callback

(5) void* i2c_slave_handle_t::userData

12.2.4 Macro Definition Documentation

12.2.4.1 #define FSL_I2C_DRIVER_VERSION (MAKE_VERSION(2, 0, 9))

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

12.2.5 Typedef Documentation

12.2.5.1 typedef void(∗ i2c_master_transfer_callback_t)(I2C_Type ∗base, i2c_master_handle_t ∗handle, status_t status, void ∗userData)

12.2.5.2 typedef void(∗ i2c_slave_transfer_callback_t)(I2C_Type ∗base, i2c_slave_transfer_t ∗xfer, void ∗userData)

12.2.6 Enumeration Type Documentation

12.2.6.1 anonymous enum

Enumerator

kStatus_I2C_Busy I2C is busy with current transfer.
kStatus_I2C_Idle Bus is Idle.
kStatus_I2C_Nak NAK received during transfer.
kStatus_I2C_ArbitrationLost Arbitration lost during transfer.
kStatus_I2C_Timeout Timeout polling status flags.
kStatus_I2C_Addr_Nak NAK received during the address probe.

12.2.6.2 enum _i2c_flags

Note

These enumerations are meant to be OR'd together to form a bit mask.

Enumerator

kI2C_ReceiveNakFlag I2C receive NAK flag.
kI2C_IntPendingFlag I2C interrupt pending flag. This flag can be cleared.
kI2C_TransferDirectionFlag I2C transfer direction flag.
kI2C_RangeAddressMatchFlag I2C range address match flag.
kI2C_ArbitrationLostFlag I2C arbitration lost flag. This flag can be cleared.
kI2C_BusBusyFlag I2C bus busy flag.
kI2C_AddressMatchFlag I2C address match flag.
kI2C_TransferCompleteFlag I2C transfer complete flag.

kI2C_StopDetectFlag I2C stop detect flag. This flag can be cleared.
kI2C_StartDetectFlag I2C start detect flag. This flag can be cleared.

12.2.6.3 enum _i2c_interrupt_enable

Enumerator

kI2C_GlobalInterruptEnable I2C global interrupt.
kI2C_StartStopDetectInterruptEnable I2C start&stop detect interrupt.

12.2.6.4 enum i2c_direction_t

Enumerator

kI2C_Write Master transmits to the slave.
kI2C_Read Master receives from the slave.

12.2.6.5 enum i2c_slave_address_mode_t

Enumerator

kI2C_Address7bit 7-bit addressing mode.
kI2C_RangeMatch Range address match addressing mode.

12.2.6.6 enum _i2c_master_transfer_flags

Enumerator

kI2C_TransferDefaultFlag A transfer starts with a start signal, stops with a stop signal.
kI2C_TransferNoStartFlag A transfer starts without a start signal, only support write only or write+read with no start flag, do not support read only with no start flag.
kI2C_TransferRepeatedStartFlag A transfer starts with a repeated start signal.
kI2C_TransferNoStopFlag A transfer ends without a stop signal.

12.2.6.7 enum i2c_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 I2C_SlaveTransferNonBlocking() to specify which events to enable. Then, when the slave callback is invoked, it is passed the current event through its *transfer* parameter.

Note

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

Enumerator

kI2C_SlaveAddressMatchEvent Received the slave address after a start or repeated start.
kI2C_SlaveTransmitEvent A callback is requested to provide data to transmit (slave-transmitter role).
kI2C_SlaveReceiveEvent A callback is requested to provide a buffer in which to place received data (slave-receiver role).
kI2C_SlaveTransmitAckEvent A callback needs to either transmit an ACK or NACK.
kI2C_SlaveStartEvent A start/repeated start was detected.
kI2C_SlaveCompletionEvent A stop was detected or finished transfer, completing the transfer.
kI2C_SlaveGenaralcallEvent Received the general call address after a start or repeated start.
kI2C_SlaveAllEvents A bit mask of all available events.

12.2.6.8 anonymous enum

Enumerator

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

12.2.7 Function Documentation

12.2.7.1 void I2C_MasterInit (I2C_Type ∗ *base*, const i2c_master_config_t ∗ *masterConfig*, uint32_t *srcClock_Hz*)

Call this API to ungate the I2C clock and configure the I2C with master configuration.

Note

This API should be called at the beginning of the application. Otherwise, any operation to the I2C module can cause a hard fault because the clock is not enabled. The configuration structure can be custom filled or it can be set with default values by using the I2C_MasterGetDefaultConfig(). After calling this API, the master is ready to transfer. This is an example.

```
* i2c_master_config_t config = {
* .enableMaster = true,
* .enableStopHold = false,
* .highDrive = false,
* .baudRate_Bps = 100000,
* .glitchFilterWidth = 0
* };
* I2C_MasterInit(I2C0, &config, 12000000U);
*
```

Parameters

base	I2C base pointer
masterConfig	A pointer to the master configuration structure
srcClock_Hz	I2C peripheral clock frequency in Hz

12.2.7.2 void I2C_SlaveInit (I2C_Type ∗ *base*, const i2c_slave_config_t ∗ *slaveConfig*, uint32_t *srcClock_Hz*)

Call this API to ungate the I2C clock and initialize the I2C with the slave configuration.

Note

This API should be called at the beginning of the application. Otherwise, any operation to the I2C module can cause a hard fault because the clock is not enabled. The configuration structure can partly be set with default values by I2C_SlaveGetDefaultConfig() or it can be custom filled by the user. This is an example.

```
* i2c_slave_config_t config = {
* .enableSlave = true,
* .enableGeneralCall = false,
* .addressingMode = kI2C_Address7bit,
* .slaveAddress = 0x1DU,
* .enableWakeUp = false,
* .enablehighDrive = false,
* .enableBaudRateCtl = false,
* .sclStopHoldTime_ns = 4000
* };
* I2C_SlaveInit(I2C0, &config, 12000000U);
*
```

Parameters

base	I2C base pointer
slaveConfig	A pointer to the slave configuration structure
srcClock_Hz	I2C peripheral clock frequency in Hz

12.2.7.3 void I2C_MasterDeinit (I2C_Type ∗ *base*)

Call this API to gate the I2C clock. The I2C master module can't work unless the I2C_MasterInit is called.

Parameters

base	I2C base pointer

12.2.7.4 void I2C_SlaveDeinit (I2C_Type ∗ *base*)

Calling this API gates the I2C clock. The I2C slave module can't work unless the I2C_SlaveInit is called to enable the clock.

Parameters

base	I2C base pointer

12.2.7.5 uint32_t I2C_GetInstance (I2C_Type ∗ *base*)

Parameters

base	I2C peripheral base address.

12.2.7.6 void I2C_MasterGetDefaultConfig (i2c_master_config_t ∗ *masterConfig*)

The purpose of this API is to get the configuration structure initialized for use in the I2C_Master-Configure(). Use the initialized structure unchanged in the I2C_MasterConfigure() or modify the structure before calling the I2C_MasterConfigure(). This is an example.

```
* i2c_master_config_t config;
* I2C_MasterGetDefaultConfig(&config);
*
```

Parameters

masterConfig	A pointer to the master configuration structure.

12.2.7.7 void I2C_SlaveGetDefaultConfig (i2c_slave_config_t ∗ *slaveConfig*)

The purpose of this API is to get the configuration structure initialized for use in the I2C_SlaveConfigure(). Modify fields of the structure before calling the I2C_SlaveConfigure(). This is an example.

```
* i2c_slave_config_t config;
* I2C_SlaveGetDefaultConfig(&config);
*
```

Parameters

slaveConfig	A pointer to the slave configuration structure.

12.2.7.8 static void I2C_Enable (I2C_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	I2C base pointer
enable	Pass true to enable and false to disable the module.

12.2.7.9 uint32_t I2C_MasterGetStatusFlags (I2C_Type * *base*)

Parameters

base	I2C base pointer

Returns

status flag, use status flag to AND _i2c_flags to get the related status.

12.2.7.10 static uint32_t I2C_SlaveGetStatusFlags (I2C_Type * *base*) [inline], [static]

Parameters

base	I2C base pointer

Returns

status flag, use status flag to AND _i2c_flags to get the related status.

12.2.7.11 static void I2C_MasterClearStatusFlags (I2C_Type * *base,* uint32_t *statusMask*) [inline], [static]

The following status register flags can be cleared kI2C_ArbitrationLostFlag and kI2C_IntPendingFlag.

Parameters

base	I2C base pointer
statusMask	The status flag mask, defined in type i2c_status_flag_t. The parameter can be any combination of the following values: • kI2C_StartDetectFlag (if available) • kI2C_StopDetectFlag (if available) • kI2C_ArbitrationLostFlag • kI2C_IntPendingFlagFlag

12.2.7.12 static void I2C_SlaveClearStatusFlags (I2C_Type ∗ *base*, uint32_t *statusMask*) [inline], [static]

The following status register flags can be cleared kI2C_ArbitrationLostFlag and kI2C_IntPendingFlag

Parameters

base	I2C base pointer
statusMask	The status flag mask, defined in type i2c_status_flag_t. The parameter can be any combination of the following values: • kI2C_StartDetectFlag (if available) • kI2C_StopDetectFlag (if available) • kI2C_ArbitrationLostFlag • kI2C_IntPendingFlagFlag

12.2.7.13 void I2C_EnableInterrupts (I2C_Type ∗ *base*, uint32_t *mask*)

Parameters

base	I2C base pointer
mask	interrupt source The parameter can be combination of the following source if defined: • kI2C_GlobalInterruptEnable • kI2C_StopDetectInterruptEnable/kI2C_StartDetectInterruptEnable • kI2C_SdaTimeoutInterruptEnable

12.2.7.14 void I2C_DisableInterrupts (I2C_Type ∗ *base*, uint32_t *mask*)

Parameters

base	I2C base pointer
mask	interrupt source The parameter can be combination of the following source if defined: • kI2C_GlobalInterruptEnable • kI2C_StopDetectInterruptEnable/kI2C_StartDetectInterruptEnable • kI2C_SdaTimeoutInterruptEnable

12.2.7.15 static uint32_t I2C_GetDataRegAddr (I2C_Type ∗ *base*) [inline], [static]

This API is used to provide a transfer address for I2C DMA transfer configuration.

Parameters

base	I2C base pointer

Returns

data register address

12.2.7.16 void I2C_MasterSetBaudRate (I2C_Type ∗ *base*, uint32_t *baudRate_Bps*, uint32_t *srcClock_Hz*)

Parameters

base	I2C base pointer
baudRate_Bps	the baud rate value in bps
srcClock_Hz	Source clock

12.2.7.17 status_t I2C_MasterStart (I2C_Type ∗ *base*, uint8_t *address*, i2c_direction_t *direction*)

This function is used to initiate a new master mode transfer by sending the START signal. The slave address is sent following the I2C START signal.

Parameters

base	I2C peripheral base pointer
address	7-bit slave device address.
direction	Master transfer directions(transmit/receive).

Return values

kStatus_Success	Successfully send the start signal.
kStatus_I2C_Busy	Current bus is busy.

12.2.7.18 status_t I2C_MasterStop (I2C_Type ∗ *base*)

Return values

kStatus_Success	Successfully send the stop signal.
kStatus_I2C_Timeout	Send stop signal failed, timeout.

12.2.7.19 status_t I2C_MasterRepeatedStart (I2C_Type ∗ *base*, uint8_t *address*, i2c_direction_t *direction*)

Parameters

base	I2C peripheral base pointer
address	7-bit slave device address.
direction	Master transfer directions(transmit/receive).

Return values

kStatus_Success	Successfully send the start signal.
kStatus_I2C_Busy	Current bus is busy but not occupied by current I2C master.

12.2.7.20 status_t I2C_MasterWriteBlocking (I2C_Type ∗ *base*, const uint8_t ∗ *txBuff*, size_t *txSize*, uint32_t *flags*)

Parameters

base	The I2C peripheral base pointer.
txBuff	The pointer to the data to be transferred.
txSize	The length in bytes of the data to be transferred.
flags	Transfer control flag to decide whether need to send a stop, use kI2C_Transfer-DefaultFlag to issue a stop and kI2C_TransferNoStop to not send a stop.

Return values

kStatus_Success	Successfully complete the data transmission.
kStatus_I2C_Arbitration-Lost	Transfer error, arbitration lost.
kStataus_I2C_Nak	Transfer error, receive NAK during transfer.

12.2.7.21 status_t I2C_MasterReadBlocking (I2C_Type ∗ *base*, uint8_t ∗ *rxBuff*, size_t *rxSize*, uint32_t *flags*)

Note

The I2C_MasterReadBlocking function stops the bus before reading the final byte. Without stopping the bus prior for the final read, the bus issues another read, resulting in garbage data being read into the data register.

Parameters

base	I2C peripheral base pointer.
rxBuff	The pointer to the data to store the received data.
rxSize	The length in bytes of the data to be received.
flags	Transfer control flag to decide whether need to send a stop, use kI2C_Transfer-DefaultFlag to issue a stop and kI2C_TransferNoStop to not send a stop.

Return values

kStatus_Success	Successfully complete the data transmission.

kStatus_I2C_Timeout	Send stop signal failed, timeout.

12.2.7.22 status_t I2C_SlaveWriteBlocking (I2C_Type ∗ *base*, const uint8_t ∗ *txBuff*, size_t *txSize*)

Parameters

base	The I2C peripheral base pointer.
txBuff	The pointer to the data to be transferred.
txSize	The length in bytes of the data to be transferred.

Return values

kStatus_Success	Successfully complete the data transmission.
kStatus_I2C_ArbitrationLost	Transfer error, arbitration lost.
kStataus_I2C_Nak	Transfer error, receive NAK during transfer.

12.2.7.23 status_t I2C_SlaveReadBlocking (I2C_Type ∗ *base*, uint8_t ∗ *rxBuff*, size_t *rxSize*)

Parameters

base	I2C peripheral base pointer.
rxBuff	The pointer to the data to store the received data.
rxSize	The length in bytes of the data to be received.

Return values

kStatus_Success	Successfully complete data receive.
kStatus_I2C_Timeout	Wait status flag timeout.

12.2.7.24 status_t I2C_MasterTransferBlocking (I2C_Type ∗ *base*, i2c_master_transfer_t ∗ *xfer*)

Note

The API does not return until the transfer succeeds or fails due to arbitration lost or receiving a NAK.

Parameters

base	I2C peripheral base address.
xfer	Pointer to the transfer structure.

Return values

kStatus_Success	Successfully complete the data transmission.
kStatus_I2C_Busy	Previous transmission still not finished.
kStatus_I2C_Timeout	Transfer error, wait signal timeout.
kStatus_I2C_Arbitration-Lost	Transfer error, arbitration lost.
kStataus_I2C_Nak	Transfer error, receive NAK during transfer.

12.2.7.25 void I2C_MasterTransferCreateHandle (I2C_Type * *base*, i2c_master_handle_t * *handle*, i2c_master_transfer_callback_t *callback*, void * *userData*)

Parameters

base	I2C base pointer.
handle	pointer to i2c_master_handle_t structure to store the transfer state.
callback	pointer to user callback function.
userData	user parameter passed to the callback function.

12.2.7.26 status_t I2C_MasterTransferNonBlocking (I2C_Type * *base*, i2c_master_handle_t * *handle*, i2c_master_transfer_t * *xfer*)

Note

Calling the API returns immediately after transfer initiates. The user needs to call I2C_MasterGet-TransferCount to poll the transfer status to check whether the transfer is finished. If the return status is not kStatus_I2C_Busy, the transfer is finished.

Parameters

base	I2C base pointer.
handle	pointer to i2c_master_handle_t structure which stores the transfer state.
xfer	pointer to i2c_master_transfer_t structure.

Return values

kStatus_Success	Successfully start the data transmission.
kStatus_I2C_Busy	Previous transmission still not finished.
kStatus_I2C_Timeout	Transfer error, wait signal timeout.

12.2.7.27 status_t I2C_MasterTransferGetCount (I2C_Type ∗ *base*, i2c_master_handle_t ∗ *handle*, size_t ∗ *count*)

Parameters

base	I2C base pointer.
handle	pointer to i2c_master_handle_t structure which stores the transfer state.
count	Number of bytes transferred so far by the non-blocking transaction.

Return values

kStatus_InvalidArgument	count is Invalid.
kStatus_Success	Successfully return the count.

12.2.7.28 status_t I2C_MasterTransferAbort (I2C_Type ∗ *base*, 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	I2C base pointer.
handle	pointer to i2c_master_handle_t structure which stores the transfer state

Return values

kStatus_I2C_Timeout	Timeout during polling flag.
kStatus_Success	Successfully abort the transfer.

12.2.7.29 void I2C_MasterTransferHandleIRQ (I2C_Type * *base*, void * *i2cHandle*)

Parameters

base	I2C base pointer.
i2cHandle	pointer to i2c_master_handle_t structure.

12.2.7.30 void I2C_SlaveTransferCreateHandle (I2C_Type * *base*, i2c_slave_handle_t * *handle*, i2c_slave_transfer_callback_t *callback*, void * *userData*)

Parameters

base	I2C base pointer.
handle	pointer to i2c_slave_handle_t structure to store the transfer state.
callback	pointer to user callback function.
userData	user parameter passed to the callback function.

12.2.7.31 status_t I2C_SlaveTransferNonBlocking (I2C_Type * *base*, i2c_slave_handle_t * *handle*, uint32_t *eventMask*)

Call this API after calling the I2C_SlaveInit() and I2C_SlaveTransferCreateHandle() to start processing transactions driven by an I2C master. The slave monitors the I2C bus and passes events to the callback that was passed into the call to I2C_SlaveTransferCreateHandle(). The callback is always invoked from the interrupt context.

The set of events received by the callback is customizable. To do so, set the *eventMask* parameter to the OR'd combination of i2c_slave_transfer_event_t enumerators for the events you wish to receive. The k-I2C_SlaveTransmitEvent and kLPI2C_SlaveReceiveEvent events are always enabled and do not need to be included in the mask. Alternatively, pass 0 to get a default set of only the transmit and receive events that are always enabled. In addition, the kI2C_SlaveAllEvents constant is provided as a convenient way to enable all events.

Parameters

base	The I2C peripheral base address.
handle	Pointer to i2c_slave_handle_t structure which stores the transfer state.
eventMask	Bit mask formed by OR'ing together i2c_slave_transfer_event_t enumerators to specify which events to send to the callback. Other accepted values are 0 to get a default set of only the transmit and receive events, and kI2C_SlaveAllEvents to enable all events.

Return values

kStatus_Success	Slave transfers were successfully started.
kStatus_I2C_Busy	Slave transfers have already been started on this handle.

12.2.7.32 void I2C_SlaveTransferAbort (I2C_Type * *base*, i2c_slave_handle_t * *handle*)

Note

This API can be called at any time to stop slave for handling the bus events.

Parameters

base	I2C base pointer.
handle	pointer to i2c_slave_handle_t structure which stores the transfer state.

12.2.7.33 status_t I2C_SlaveTransferGetCount (I2C_Type * *base*, i2c_slave_handle_t * *handle*, size_t * *count*)

Parameters

base	I2C base pointer.
handle	pointer to i2c_slave_handle_t structure.
count	Number of bytes transferred so far by the non-blocking transaction.

Return values

kStatus_InvalidArgument	count is Invalid.
kStatus_Success	Successfully return the count.

12.2.7.34 void I2C_SlaveTransferHandleIRQ (I2C_Type * *base*, void * *i2cHandle*)

Parameters

base	I2C base pointer.
i2cHandle	pointer to i2c_slave_handle_t structure which stores the transfer state

12.3 I2C CMSIS Driver

This section describes the programming interface of the I2C 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 I2C 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.

12.3.1 I2C CMSIS Driver

12.3.1.1 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;
```

12.3.1.2 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;
        }
    }

/* Init DMAMUX and DMA/EDMA. */
    DMAMUX_Init(EXAMPLE_I2C_DMAMUX_BASEADDR)
```

```
#if defined(FSL_FEATURE_SOC_DMA_COUNT) && FSL_FEATURE_SOC_DMA_COUNT > 0U
    DMA_Init(EXAMPLE_I2C_DMA_BASEADDR);
#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_I2C_DMA_BASEADDR, &edmaConfig);
#endif /* FSL_FEATURE_SOC_EDMA_COUNT */

    /*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;
```

12.3.1.3 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;
```

12.4 IRQ: external interrupt (IRQ) module

The MCUXpresso SDK provides a peripheral driver for the external interrupt (IRQ) module of MCUXpresso SDK devices.

12.4.1 IRQ Operations

12.4.1.1 IRQ Initialization Operation

The IRQ Initialize is to initialize for common configure: gate the IRQ clock, configure enabled IRQ pins for pullup, edge select and detect mode, then enable the IRQ module. The IRQ Deinitialize is used to ungate the clock.

12.4.1.2 IRQ Basic Operation

The IRQ provides the function to enable/disable interrupts. IRQ still provides functions to get and clear IRQF flags.

12.4.2 Typical use case

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

Chapter 13
KBI: Keyboard interrupt Driver

13.1 Overview

The MCUXpresso SDK provides a peripheral driver for the keyboard interrupt block of MCUXpresso SDK devices.

13.2 KBI Operations

13.2.1 KBI Initialization Operation

The KBI Initialize is to initialize for common configure: gate the KBI clock, configure enabled KBI pins, and enable the interrupt. The KBI Deinitialize is to disable the interrupt/pins and ungate the clock.

13.2.2 KBI Basic Operation

The KBI provide the function to enable/disable interrupts. KBI still provide functions to get and clear status flags.

13.3 Typical use case

Data Structures

- struct kbi_config_t
  KBI configuration. More...

Enumerations

- enum kbi_detect_mode_t {
  kKBI_EdgesDetect = 0,
  kKBI_EdgesLevelDetect }
  KBI detection mode.

Driver version

- #define FSL_KBI_DRIVER_VERSION (MAKE_VERSION(2, 0, 3))
  KBI driver version.

Initialization and De-initialization

- void KBI_Init (KBI_Type ∗base, kbi_config_t ∗configure)
  KBI initialize.
- void KBI_Deinit (KBI_Type ∗base)
  Deinitializes the KBI module and gates the clock.

KBI Basic Operation

- static void KBI_EnableInterrupts (KBI_Type *base)
  Enables the interrupt.
- static void KBI_DisableInterrupts (KBI_Type *base)
  Disables the interrupt.
- static bool KBI_IsInterruptRequestDetected (KBI_Type *base)
  Gets the KBI interrupt event status.
- static void KBI_ClearInterruptFlag (KBI_Type *base)
  Clears KBI status flag.
- static uint32_t KBI_GetSourcePinStatus (KBI_Type *base)
  Gets the KBI Source pin status.

13.4 Data Structure Documentation

13.4.1 struct kbi_config_t

Data Fields

- uint32_t pinsEnabled
  The eight kbi pins, set 1 to enable the corresponding KBI interrupt pins.
- uint32_t pinsEdge
  The edge selection for each kbi pin: 1 – rinsing edge, 0 – falling edge.
- kbi_detect_mode_t mode
  The kbi detection mode.

Field Documentation

(1) uint32_t kbi_config_t::pinsEnabled

(2) uint32_t kbi_config_t::pinsEdge

(3) kbi_detect_mode_t kbi_config_t::mode

13.5 Macro Definition Documentation

13.5.1 #define FSL_KBI_DRIVER_VERSION (MAKE_VERSION(2, 0, 3))

13.6 Enumeration Type Documentation

13.6.1 enum kbi_detect_mode_t

Enumerator

kKBI_EdgesDetect The keyboard detects edges only.
kKBI_EdgesLevelDetect The keyboard detects both edges and levels.

13.7 Function Documentation

13.7.1 void KBI_Init (KBI_Type ∗ *base,* kbi_config_t ∗ *configure*)

This function ungates the KBI clock and initializes KBI. This function must be called before calling any other KBI driver functions.

Parameters

base	KBI peripheral base address.
configure	The KBI configuration structure pointer.

13.7.2 void KBI_Deinit (KBI_Type * *base*)

This function gates the KBI clock. As a result, the KBI module doesn't work after calling this function.

Parameters

base	KBI peripheral base address.

13.7.3 static void KBI_EnableInterrupts (KBI_Type * *base*) [inline], [static]

Parameters

base	KBI peripheral base address.

13.7.4 static void KBI_DisableInterrupts (KBI_Type * *base*) [inline], [static]

Parameters

base	KBI peripheral base address.

13.7.5 static bool KBI_IsInterruptRequestDetected (KBI_Type * *base*) [inline], [static]

Parameters

base	KBI peripheral base address.

Returns

The status of the KBI interrupt request is detected.

13.7.6 static void KBI_ClearInterruptFlag (KBI_Type * *base*) [inline], [static]

Parameters

base	KBI peripheral base address.

13.7.7 static uint32_t KBI_GetSourcePinStatus (KBI_Type * *base*) [inline], [static]

Parameters

base	KBI peripheral base address.

Returns

The status indicates the active pin defined as keyboard interrupt which is pushed.

Chapter 14
MSCAN: Scalable Controller Area Network

14.1 Overview

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

Modules

- MSCAN Driver

14.2 MSCAN Driver

14.2.1 Overview

This section describes the programming interface of the MSCAN driver. The MSCAN driver configures MSCAN module and provides functional and transactional interfaces to build the MSCAN application.

14.2.2 Typical use case

14.2.2.1 Message Buffer Send Operation

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

14.2.2.2 Message Buffer Receive Operation

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

14.2.2.3 Receive FIFO Operation

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

14.2.2.4 Calculate

Provides static functions to calculate improved timing configuration.

The feature need to be enabled by user like that.

```
#define FSL_FEATURE_FLEXCAN_HAS_IMPROVED_TIMING_CONFIG (1)
```

Data Structures

- struct MSCAN_IDR1Type
  MSCAN IDR1 struct. More...
- struct MSCAN_IDR3Type
  MSCAN IDR3 struct. More...
- union IDR1_3_UNION
  MSCAN idr1 and idr3 union. More...
- struct MSCAN_ExtendIDType
  MSCAN extend ID struct. More...
- struct MSCAN_StandardIDType
  MSCAN standard ID struct. More...
- struct mscan_mb_t

MsCAN message buffer structure. *More...*
- struct mscan_frame_t
  MsCAN frame structure. *More...*
- struct mscan_idfilter_config_t
  MsCAN module acceptance filter configuration structure. *More...*
- struct mscan_config_t
  MsCAN module configuration structure. *More...*
- struct mscan_timing_config_t
  MsCAN protocol timing characteristic configuration structure. *More...*
- struct mscan_mb_transfer_t
  MSCAN Message Buffer transfer. *More...*
- struct mscan_handle_t
  MsCAN handle structure. *More...*

Macros

- #define MSCAN_RX_MB_STD_MASK(id)
  MsCAN Rx Message Buffer Mask helper macro.
- #define MSCAN_RX_MB_EXT_MASK(id)
  Extend Rx Message Buffer Mask helper macro.

Typedefs

- typedef void(∗ mscan_transfer_callback_t)(MSCAN_Type ∗base, mscan_handle_t ∗handle, status_t status, void ∗userData)
  MsCAN transfer callback function.

Enumerations

- enum {
  kStatus_MSCAN_TxBusy = MAKE_STATUS(kStatusGroup_MSCAN, 0),
  kStatus_MSCAN_TxIdle = MAKE_STATUS(kStatusGroup_MSCAN, 1),
  kStatus_MSCAN_TxSwitchToRx,
  kStatus_MSCAN_RxBusy = MAKE_STATUS(kStatusGroup_MSCAN, 3),
  kStatus_MSCAN_RxIdle = MAKE_STATUS(kStatusGroup_MSCAN, 4),
  kStatus_MSCAN_RxOverflow = MAKE_STATUS(kStatusGroup_MSCAN, 5),
  kStatus_MSCAN_RxFifoBusy = MAKE_STATUS(kStatusGroup_MSCAN, 6),
  kStatus_MSCAN_RxFifoIdle = MAKE_STATUS(kStatusGroup_MSCAN, 7),
  kStatus_MSCAN_RxFifoOverflow = MAKE_STATUS(kStatusGroup_MSCAN, 8),
  kStatus_MSCAN_RxFifoWarning = MAKE_STATUS(kStatusGroup_MSCAN, 9),
  kStatus_MSCAN_ErrorStatus = MAKE_STATUS(kStatusGroup_MSCAN, 10),
  kStatus_MSCAN_UnHandled = MAKE_STATUS(kStatusGroup_MSCAN, 11) }
  FlexCAN transfer status.
- enum mscan_frame_format_t {
  kMSCAN_FrameFormatStandard = 0x0U,

kMSCAN_FrameFormatExtend = 0x1U }
MsCAN frame format.
- enum mscan_frame_type_t {
kMSCAN_FrameTypeData = 0x0U,
kMSCAN_FrameTypeRemote = 0x1U }
MsCAN frame type.
- enum mscan_clock_source_t {
kMSCAN_ClkSrcOsc = 0x0U,
kMSCAN_ClkSrcBus = 0x1U }
MsCAN clock source.
- enum mscan_busoffrec_mode_t {
kMSCAN_BusoffrecAuto = 0x0U,
kMSCAN_BusoffrecUsr = 0x1U }
MsCAN bus-off recovery mode.
- enum _mscan_tx_buffer_empty_flag {
kMSCAN_TxBuf0Empty = 0x1U,
kMSCAN_TxBuf1Empty = 0x2U,
kMSCAN_TxBuf2Empty = 0x4U,
kMSCAN_TxBufFull = 0x0U }
MsCAN Tx buffer empty flag.
- enum mscan_id_filter_mode_t {
kMSCAN_Filter32Bit = 0x0U,
kMSCAN_Filter16Bit = 0x1U,
kMSCAN_Filter8Bit = 0x2U,
kMSCAN_FilterClose = 0x3U }
MsCAN id filter mode.
- enum _mscan_interrupt_enable {
kMSCAN_WakeUpInterruptEnable = MSCAN_CANRIER_WUPIE_MASK,
kMSCAN_StatusChangeInterruptEnable = MSCAN_CANRIER_CSCIE_MASK,
kMSCAN_RxStatusChangeInterruptEnable = MSCAN_CANRIER_RSTATE_MASK,
kMSCAN_TxStatusChangeInterruptEnable = MSCAN_CANRIER_TSTATE_MASK,
kMSCAN_OverrunInterruptEnable = MSCAN_CANRIER_OVRIE_MASK,
kMSCAN_RxFullInterruptEnable = MSCAN_CANRIER_RXFIE_MASK,
kMSCAN_TxEmptyInterruptEnable = MSCAN_CANTIER_TXEIE_MASK }
MsCAN interrupt configuration structure, default settings all disabled.

Driver version

- #define FSL_MSCAN_DRIVER_VERSION (MAKE_VERSION(2, 0, 7))
MsCAN driver version.

Initialization and deinitialization

- void MSCAN_Init (MSCAN_Type ∗base, const mscan_config_t ∗config, uint32_t sourceClock_Hz)
Initializes a MsCAN instance.

- void MSCAN_Deinit (MSCAN_Type ∗base)
  De-initializes a MsCAN instance.
- void MSCAN_GetDefaultConfig (mscan_config_t ∗config)
  Gets the default configuration structure.

Configuration.

- static uint8_t MSCAN_GetTxBufferEmptyFlag (MSCAN_Type ∗base)
  Get the transmit buffer empty status.
- static void MSCAN_TxBufferSelect (MSCAN_Type ∗base, uint8_t txBuf)
  The selection of the actual transmit message buffer.
- static uint8_t MSCAN_GetTxBufferSelect (MSCAN_Type ∗base)
  Get the actual transmit message buffer.
- static void MSCAN_TxBufferLaunch (MSCAN_Type ∗base, uint8_t txBuf)
  Clear TFLG to schedule for transmission.
- static uint8_t MSCAN_GetTxBufferStatusFlags (MSCAN_Type ∗base, uint8_t mask)
  Get Tx buffer status flag.
- static uint8_t MSCAN_GetRxBufferFullFlag (MSCAN_Type ∗base)
  Check Receive Buffer Full Flag.
- static void MSCAN_ClearRxBufferFullFlag (MSCAN_Type ∗base)
  Clear Receive buffer Full flag.
- static uint8_t **MSCAN_ReadRIDR0** (MSCAN_Type ∗base)
- static uint8_t **MSCAN_ReadRIDR1** (MSCAN_Type ∗base)
- static uint8_t **MSCAN_ReadRIDR2** (MSCAN_Type ∗base)
- static uint8_t **MSCAN_ReadRIDR3** (MSCAN_Type ∗base)
- static void **MSCAN_WriteTIDR0** (MSCAN_Type ∗base, uint8_t id)
- static void **MSCAN_WriteTIDR1** (MSCAN_Type ∗base, uint8_t id)
- static void **MSCAN_WriteTIDR2** (MSCAN_Type ∗base, uint8_t id)
- static void **MSCAN_WriteTIDR3** (MSCAN_Type ∗base, uint8_t id)
- static void **MSCAN_SetIDFilterMode** (MSCAN_Type ∗base, mscan_id_filter_mode_t mode)
- static void **MSCAN_WriteIDAR0** (MSCAN_Type ∗base, uint8_t ∗pID)
- static void **MSCAN_WriteIDAR1** (MSCAN_Type ∗base, uint8_t ∗pID)
- static void **MSCAN_WriteIDMR0** (MSCAN_Type ∗base, uint8_t ∗pID)
- static void **MSCAN_WriteIDMR1** (MSCAN_Type ∗base, uint8_t ∗pID)
- void MSCAN_SetTimingConfig (MSCAN_Type ∗base, const mscan_timing_config_t ∗config)
  Sets the MsCAN protocol timing characteristic.

Status

- static uint8_t MSCAN_GetTxBufEmptyFlags (MSCAN_Type ∗base)
  Gets the MsCAN Tx buffer empty flags.

Interrupts

- static void MSCAN_EnableTxInterrupts (MSCAN_Type ∗base, uint8_t mask)
  Enables MsCAN Transmitter interrupts according to the provided mask.
- static void MSCAN_DisableTxInterrupts (MSCAN_Type ∗base, uint8_t mask)
  Disables MsCAN Transmitter interrupts according to the provided mask.

- static void MSCAN_EnableRxInterrupts (MSCAN_Type *base, uint8_t mask)
  Enables MsCAN Receiver interrupts according to the provided mask.
- static void MSCAN_DisableRxInterrupts (MSCAN_Type *base, uint8_t mask)
  Disables MsCAN Receiver interrupts according to the provided mask.
- static void MSCAN_AbortTxRequest (MSCAN_Type *base, uint8_t mask)
  Abort MsCAN Tx request.

Bus Operations

- static void MSCAN_Enable (MSCAN_Type *base, bool enable)
  Enables or disables the MsCAN module operation.
- status_t MSCAN_WriteTxMb (MSCAN_Type *base, mscan_frame_t *pTxFrame)
  Writes a MsCAN Message to the Transmit Message Buffer.
- status_t MSCAN_ReadRxMb (MSCAN_Type *base, mscan_frame_t *pRxFrame)
  Reads a MsCAN Message from Receive Message Buffer.

Transactional

- void MSCAN_TransferCreateHandle (MSCAN_Type *base, mscan_handle_t *handle, mscan_transfer_callback_t callback, void *userData)
  Initializes the MsCAN handle.
- status_t MSCAN_TransferSendBlocking (MSCAN_Type *base, mscan_frame_t *pTxFrame)
  Performs a polling send transaction on the CAN bus.
- status_t MSCAN_TransferReceiveBlocking (MSCAN_Type *base, mscan_frame_t *pRxFrame)
  Performs a polling receive transaction on the CAN bus.
- status_t MSCAN_TransferSendNonBlocking (MSCAN_Type *base, mscan_handle_t *handle, mscan_mb_transfer_t *xfer)
  Sends a message using IRQ.
- status_t MSCAN_TransferReceiveNonBlocking (MSCAN_Type *base, mscan_handle_t *handle, mscan_mb_transfer_t *xfer)
  Receives a message using IRQ.
- void MSCAN_TransferAbortSend (MSCAN_Type *base, mscan_handle_t *handle, uint8_t mask)
  Aborts the interrupt driven message send process.
- void MSCAN_TransferAbortReceive (MSCAN_Type *base, mscan_handle_t *handle, uint8_t mask)
  Aborts the interrupt driven message receive process.
- void MSCAN_TransferHandleIRQ (MSCAN_Type *base, mscan_handle_t *handle)
  MSCAN IRQ handle function.

14.2.3 Data Structure Documentation

14.2.3.1 struct MSCAN_IDR1Type

Data Fields

- uint8_t EID17_15: 3

Extended Format Identifier 17-15.
- uint8_t R_TEIDE: 1
  ID Extended.
- uint8_t R_TSRR: 1
  Substitute Remote Request.
- uint8_t EID20_18_OR_SID2_0: 3
  Extended Format Identifier 18-20 or standard format bit 0-2.

14.2.3.2 struct MSCAN_IDR3Type

Data Fields

- uint8_t ERTR: 1
  Remote Transmission Request.
- uint8_t EID6_0: 7
  Extended Format Identifier 6-0.

14.2.3.3 union IDR1_3_UNION

Data Fields

- MSCAN_IDR1Type IDR1
  structure for identifier 1
- MSCAN_IDR3Type IDR3
  structure for identifier 3
- uint8_t Bytes
  bytes

14.2.3.4 struct MSCAN_ExtendIDType

Data Fields

- uint32_t EID6_0: 7
  ID[0:6].
- uint32_t EID14_7: 8
  ID[14:7].
- uint32_t EID17_15: 3
  ID[17:15].
- uint32_t EID20_18: 3
  ID[20:18].
- uint32_t EID28_21: 8
  ID[28:21].

14.2.3.5 struct MSCAN_StandardIDType

Data Fields

- uint32_t EID2_0: 3
  ID[0:2].
- uint32_t EID10_3: 8
  ID[10:3].

14.2.3.6 struct mscan_mb_t

Data Fields

- uint8_t EIDR0
  Extended Identifier Register 0.
- uint8_t EIDR1
  Extended Identifier Register 1.
- uint8_t EIDR2
  Extended Identifier Register 2.
- uint8_t EIDR3
  Extended Identifier Register 3.
- uint8_t EDSR [8]
  Extended Data Segment Register.
- uint8_t DLR
  data length field
- uint8_t BPR
  Buffer Priority Register.
- uint8_t TSRH
  Time Stamp Register High.
- uint8_t TSRL
  Time Stamp Register Low.

14.2.3.7 struct mscan_frame_t

Data Fields

- union {
    MSCAN_StandardIDType StdID
      standard format
    MSCAN_ExtendIDType ExtID
      extend format
    uint32_t ID
      Identifire with 32 bit format.
  } ID_Type

  identifier union
- uint8_t DLR
  data length

- uint8_t BPR
  transmit buffer priority
- mscan_frame_type_t type
  remote frame or data frame
- mscan_frame_format_t format
  extend frame or standard frame
- uint8_t TSRH
  time stamp high byte
- uint8_t TSRL
  time stamp low byte
- uint8_t DSR [8]
  data segment
- uint32_t dataWord0
  MSCAN Frame payload word0.
- uint32_t dataWord1
  MSCAN Frame payload word1.
- uint8_t dataByte0
  MSCAN Frame payload byte0.
- uint8_t dataByte1
  MSCAN Frame payload byte1.
- uint8_t dataByte2
  MSCAN Frame payload byte2.
- uint8_t dataByte3
  MSCAN Frame payload byte3.
- uint8_t dataByte4
  MSCAN Frame payload byte4.
- uint8_t dataByte5
  MSCAN Frame payload byte5.
- uint8_t dataByte6
  MSCAN Frame payload byte6.
- uint8_t dataByte7
  MSCAN Frame payload byte7.

Field Documentation

(1) uint32_t mscan_frame_t::dataWord0

(2) uint32_t mscan_frame_t::dataWord1

(3) uint8_t mscan_frame_t::dataByte0

(4) uint8_t mscan_frame_t::dataByte1

(5) uint8_t mscan_frame_t::dataByte2

(6) uint8_t mscan_frame_t::dataByte3

(7) uint8_t mscan_frame_t::dataByte4

(8) uint8_t mscan_frame_t::dataByte5

(9) uint8_t mscan_frame_t::dataByte6

(10) uint8_t mscan_frame_t::dataByte7

14.2.3.8 struct mscan_idfilter_config_t

Data Fields

- mscan_id_filter_mode_t filterMode
  MSCAN Identifier Acceptance Filter Mode.
- uint32_t u32IDAR0
  MSCAN Identifier Acceptance Register n of First Bank.
- uint32_t u32IDAR1
  MSCAN Identifier Acceptance Register n of Second Bank.
- uint32_t u32IDMR0
  MSCAN Identifier Mask Register n of First Bank.
- uint32_t u32IDMR1
  MSCAN Identifier Mask Register n of Second Bank.

14.2.3.9 struct mscan_config_t

Data Fields

- uint32_t baudRate
  MsCAN baud rate in bps.
- bool enableTimer
  Enable or Disable free running timer.
- bool enableWakeup
  Enable or Disable Wakeup Mode.
- mscan_clock_source_t clkSrc
  Clock source for MsCAN Protocol Engine.
- bool enableLoopBack
  Enable or Disable Loop Back Self Test Mode.
- bool enableListen
  Enable or Disable Listen Only Mode.
- mscan_busoffrec_mode_t busoffrecMode
  Bus-Off Recovery Mode.

Field Documentation

(1) uint32_t mscan_config_t::baudRate

(2) bool mscan_config_t::enableTimer

(3) bool mscan_config_t::enableWakeup

(4) mscan_clock_source_t mscan_config_t::clkSrc

(5) bool mscan_config_t::enableLoopBack

(6) bool mscan_config_t::enableListen

(7) mscan_busoffrec_mode_t mscan_config_t::busoffrecMode

14.2.3.10 struct mscan_timing_config_t

Data Fields

- uint8_t priDiv
  Baud rate prescaler.
- uint8_t sJumpwidth
  Sync Jump Width.
- uint8_t timeSeg1
  Time Segment 1.
- uint8_t timeSeg2
  Time Segment 2.
- uint8_t samp
  Number of samples per bit time.

Field Documentation

(1) uint8_t mscan_timing_config_t::priDiv

(2) uint8_t mscan_timing_config_t::sJumpwidth

(3) uint8_t mscan_timing_config_t::timeSeg1

(4) uint8_t mscan_timing_config_t::timeSeg2

(5) uint8_t mscan_timing_config_t::samp

14.2.3.11 struct mscan_mb_transfer_t

Data Fields

- mscan_frame_t ∗ frame
  The buffer of CAN Message to be transfer.
- uint8_t mask
  The mask of Tx buffer.

Field Documentation

(1) mscan_frame_t∗ mscan_mb_transfer_t::frame

(2) uint8_t mscan_mb_transfer_t::mask

14.2.3.12 struct _mscan_handle

MsCAN handle structure definition.

Data Fields

- mscan_transfer_callback_t callback
  Callback function.
- void * userData
  MsCAN callback function parameter.
- mscan_frame_t *volatile mbFrameBuf
  The buffer for received data from Message Buffers.
- volatile uint8_t mbStateTx
  Message Buffer transfer state.
- volatile uint8_t mbStateRx
  Message Buffer transfer state.

Field Documentation

(1) mscan_transfer_callback_t mscan_handle_t::callback

(2) void* mscan_handle_t::userData

(3) mscan_frame_t* volatile mscan_handle_t::mbFrameBuf

(4) volatile uint8_t mscan_handle_t::mbStateTx

(5) volatile uint8_t mscan_handle_t::mbStateRx

14.2.4 Macro Definition Documentation

14.2.4.1 #define FSL_MSCAN_DRIVER_VERSION (MAKE_VERSION(2, 0, 7))

14.2.4.2 #define MSCAN_RX_MB_STD_MASK(*id*)

Value:

```
((uint32_t)((((uint32_t)(id)&0x7) << 21) | \
                ((((uint32_t)(id) >> 3) & 0xFF) << 24)))
```

Standard Rx Message Buffer Mask helper macro.

14.2.4.3 #define MSCAN_RX_MB_EXT_MASK(*id*)

Value:

```
((uint32_t)(((((uint32_t)(id) >> 21) & 0xFF) << 24) | ((((uint32_t)(id) >> 18) & 0x7) << 21) | \
                ((((uint32_t)(id) >> 15) & 0x7) << 16) | (((((uint32_t)(id) >> 7) & 0xFF)) << 8) | \
                (((uint32_t)(id)&0x7F) << 1)))
```

14.2.5 Typedef Documentation

14.2.5.1 typedef void(∗ mscan_transfer_callback_t)(MSCAN_Type ∗base, mscan_handle_t ∗handle, status_t status, void ∗userData)

The MsCAN transfer callback returns a value from the underlying layer. If the status equals to kStatus_-MSCAN_ErrorStatus, the result parameter is the Content of MsCAN status register which can be used to get the working status(or error status) of MsCAN module. If the status equals to other MsCAN Message Buffer transfer status, the result is the index of Message Buffer that generate transfer event. If the status equals to other MsCAN Message Buffer transfer status, the result is meaningless and should be Ignored.

14.2.6 Enumeration Type Documentation

14.2.6.1 anonymous enum

Enumerator

kStatus_MSCAN_TxBusy Tx Message Buffer is Busy.
kStatus_MSCAN_TxIdle Tx Message Buffer is Idle.
kStatus_MSCAN_TxSwitchToRx Remote Message is send out and Message buffer changed to Receive one.
kStatus_MSCAN_RxBusy Rx Message Buffer is Busy.
kStatus_MSCAN_RxIdle Rx Message Buffer is Idle.
kStatus_MSCAN_RxOverflow Rx Message Buffer is Overflowed.
kStatus_MSCAN_RxFifoBusy Rx Message FIFO is Busy.
kStatus_MSCAN_RxFifoIdle Rx Message FIFO is Idle.
kStatus_MSCAN_RxFifoOverflow Rx Message FIFO is overflowed.
kStatus_MSCAN_RxFifoWarning Rx Message FIFO is almost overflowed.
kStatus_MSCAN_ErrorStatus FlexCAN Module Error and Status.
kStatus_MSCAN_UnHandled UnHadled Interrupt asserted.

14.2.6.2 enum mscan_frame_format_t

Enumerator

kMSCAN_FrameFormatStandard Standard frame format attribute.
kMSCAN_FrameFormatExtend Extend frame format attribute.

14.2.6.3 enum mscan_frame_type_t

Enumerator

kMSCAN_FrameTypeData Data frame type attribute.
kMSCAN_FrameTypeRemote Remote frame type attribute.

14.2.6.4 enum mscan_clock_source_t

Enumerator

kMSCAN_ClkSrcOsc MsCAN Protocol Engine clock from Oscillator.
kMSCAN_ClkSrcBus MsCAN Protocol Engine clock from Bus Clock.

14.2.6.5 enum mscan_busoffrec_mode_t

Enumerator

kMSCAN_BusoffrecAuto MsCAN automatic bus-off recovery.
kMSCAN_BusoffrecUsr MsCAN bus-off recovery upon user request.

14.2.6.6 enum _mscan_tx_buffer_empty_flag

Enumerator

kMSCAN_TxBuf0Empty MsCAN Tx Buffer 0 empty.
kMSCAN_TxBuf1Empty MsCAN Tx Buffer 1 empty.
kMSCAN_TxBuf2Empty MsCAN Tx Buffer 2 empty.
kMSCAN_TxBufFull MsCAN Tx Buffer all not empty.

14.2.6.7 enum mscan_id_filter_mode_t

Enumerator

kMSCAN_Filter32Bit Two 32-bit acceptance filters.
kMSCAN_Filter16Bit Four 16-bit acceptance filters.
kMSCAN_Filter8Bit Eight 8-bit acceptance filters.
kMSCAN_FilterClose Filter closed.

14.2.6.8 enum _mscan_interrupt_enable

This structure contains the settings for all of the MsCAN Module interrupt configurations.

Enumerator

kMSCAN_WakeUpInterruptEnable Wake Up interrupt.
kMSCAN_StatusChangeInterruptEnable Status change interrupt.
kMSCAN_RxStatusChangeInterruptEnable Rx status change interrupt.
kMSCAN_TxStatusChangeInterruptEnable Tx status change interrupt.
kMSCAN_OverrunInterruptEnable Overrun interrupt.
kMSCAN_RxFullInterruptEnable Rx buffer full interrupt.
kMSCAN_TxEmptyInterruptEnable Tx buffer empty interrupt.

14.2.7 Function Documentation

14.2.7.1 void MSCAN_Init (MSCAN_Type * *base*, const mscan_config_t * *config*, uint32_t *sourceClock_Hz*)

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

```
*   mscan_config_t mscanConfig;
*   mscanConfig.clkSrc              = kMSCAN_ClkSrcOsc;
*   mscanConfig.baudRate            = 1250000U;
*   mscanConfig.enableTimer         = false;
*   mscanConfig.enableLoopBack      = false;
*   mscanConfig.enableWakeup        = false;
*   mscanConfig.enableListen        = false;
*   mscanConfig.busoffrecMode       = kMSCAN_BusoffrecAuto;
*   mscanConfig.filterConfig.filterMode = kMSCAN_Filter32Bit;
*   MSCAN_Init(MSCAN, &mscanConfig, 8000000UL);
*
```

Parameters

base	MsCAN peripheral base address.
config	Pointer to the user-defined configuration structure.
sourceClock_-Hz	MsCAN Protocol Engine clock source frequency in Hz.

14.2.7.2 void MSCAN_Deinit (MSCAN_Type * *base*)

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

Parameters

base	MsCAN peripheral base address.

14.2.7.3 void MSCAN_GetDefaultConfig (mscan_config_t * *config*)

This function initializes the MsCAN configuration structure to default values.

Parameters

config	Pointer to the MsCAN configuration structure.

14.2.7.4 static uint8_t MSCAN_GetTxBufferEmptyFlag (MSCAN_Type * *base*) [inline], [static]

This flag indicates that the associated transmit message buffer is empty.

Parameters

base	MsCAN peripheral base address.

14.2.7.5 static void MSCAN_TxBufferSelect (MSCAN_Type * *base*, uint8_t *txBuf*) [inline], [static]

To get the next available transmit buffer, read the CANTFLG register and write its value back into the CANTBSEL register.

Parameters

base	MsCAN peripheral base address.
txBuf	The value read from CANTFLG.

14.2.7.6 static uint8_t MSCAN_GetTxBufferSelect (MSCAN_Type * *base*) [inline], [static]

After write TFLG value back into the CANTBSEL register, read again CANBSEL to get the actual trasnsmit message buffer.

Parameters

base	MsCAN peripheral base address.

14.2.7.7 static void MSCAN_TxBufferLaunch (MSCAN_Type * *base*, uint8_t *txBuf*) [inline], [static]

The CPU must clear the flag after a message is set up in the transmit buffer and is due for transmission.

Parameters

base	MsCAN peripheral base address.
txBuf	Message buffer(s) to be cleared.

14.2.7.8 static uint8_t MSCAN_GetTxBufferStatusFlags (MSCAN_Type * *base*, uint8_t *mask*) [inline], [static]

The bit is set after successful transmission.

Parameters

base	MsCAN peripheral base address.
mask	Message buffer(s) mask.

14.2.7.9 static uint8_t MSCAN_GetRxBufferFullFlag (MSCAN_Type * *base*) [inline], [static]

RXF is set by the MSCAN when a new message is shifted in the receiver FIFO. This flag indicates whether the shifted buffer is loaded with a correctly received message.

Parameters

base	MsCAN peripheral base address.

14.2.7.10 static void MSCAN_ClearRxBufferFullFlag (MSCAN_Type * *base*) [inline], [static]

After the CPU has read that message from the RxFG buffer in the receiver FIFO The RXF flag must be cleared to release the buffer.

Parameters

base	MsCAN peripheral base address.

14.2.7.11 void MSCAN_SetTimingConfig (MSCAN_Type * *base*, const mscan_timing_config_t * *config*)

This function gives user settings to CAN bus timing characteristic. The function is for an experienced user. For less experienced users, call the MSCAN_Init() and fill the baud rate field with a desired value. This provides the default timing characteristics to the module.

Note that calling MSCAN_SetTimingConfig() overrides the baud rate set in MSCAN_Init().

Parameters

base	MsCAN peripheral base address.
config	Pointer to the timing configuration structure.

14.2.7.12 static uint8_t MSCAN_GetTxBufEmptyFlags (MSCAN_Type * *base*) [inline], [static]

This function gets MsCAN Tx buffer empty flags. It's returned as the value of the enumerators _mscan_-tx_buffer_empty_flag.

Parameters

base	MsCAN peripheral base address.

Returns

Tx buffer empty flags in the _mscan_tx_buffer_empty_flag.

14.2.7.13 static void MSCAN_EnableTxInterrupts (MSCAN_Type * *base*, uint8_t *mask*) [inline], [static]

This function enables the MsCAN Tx empty interrupts according to the mask.

Parameters

base	MsCAN peripheral base address.
mask	The Tx interrupts mask to enable.

14.2.7.14 static void MSCAN_DisableTxInterrupts (MSCAN_Type * *base*, uint8_t *mask*) [inline], [static]

This function disables the MsCAN Tx emtpy interrupts according to the mask.

Parameters

base	MsCAN peripheral base address.
mask	The Tx interrupts mask to disable.

14.2.7.15 static void MSCAN_EnableRxInterrupts (MSCAN_Type * *base*, uint8_t *mask*) [inline], [static]

This function enables the MsCAN Rx interrupts according to the provided mask which is a logical OR of enumeration members, see _mscan_interrupt_enable.

Parameters

base	MsCAN peripheral base address.
mask	The interrupts to enable. Logical OR of _mscan_interrupt_enable.

14.2.7.16 static void MSCAN_DisableRxInterrupts (MSCAN_Type * *base*, uint8_t *mask*) [inline], [static]

This function disables the MsCAN Rx interrupts according to the provided mask which is a logical OR of enumeration members, see _mscan_interrupt_enable.

Parameters

base	MsCAN peripheral base address.
mask	The interrupts to disable. Logical OR of _mscan_interrupt_enable.

14.2.7.17 static void MSCAN_AbortTxRequest (MSCAN_Type * *base*, uint8_t *mask*) [inline], [static]

This function allows abort request of queued messages.

Parameters

base	MsCAN peripheral base address.
mask	The Tx mask to abort.

14.2.7.18 static void MSCAN_Enable (MSCAN_Type * *base*, bool *enable*) [inline], [static]

This function enables or disables the MsCAN module.

Parameters

base	MsCAN base pointer.
enable	true to enable, false to disable.

14.2.7.19 status_t MSCAN_WriteTxMb (MSCAN_Type * *base*, mscan_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	MsCAN peripheral base address.
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.

14.2.7.20 status_t MSCAN_ReadRxMb (MSCAN_Type * *base*, mscan_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	MsCAN peripheral base address.
pRxFrame	Pointer to CAN message frame structure for reception.

Return values

kStatus_Success	- Rx Message Buffer is full and has been read successfully.

kStatus_Fail	- Rx Message Buffer is empty.

14.2.7.21 void MSCAN_TransferCreateHandle (MSCAN_Type * *base*, mscan_handle_t * *handle*, mscan_transfer_callback_t *callback*, void * *userData*)

This function initializes the MsCAN handle, which can be used for other MsCAN transactional APIs. Usually, for a specified MsCAN instance, call this API once to get the initialized handle.

Parameters

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

14.2.7.22 status_t MSCAN_TransferSendBlocking (MSCAN_Type * *base*, mscan_frame_t * *pTxFrame*)

Note that a transfer handle does not need to be created before calling this API.

Parameters

base	MsCAN peripheral base pointer.
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.

14.2.7.23 status_t MSCAN_TransferReceiveBlocking (MSCAN_Type * *base*, mscan_frame_t * *pRxFrame*)

Note that a transfer handle does not need to be created before calling this API.

Parameters

base	MsCAN peripheral base pointer.
pRxFrame	Pointer to CAN message frame to be received.

Return values

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

14.2.7.24 status_t MSCAN_TransferSendNonBlocking (MSCAN_Type * *base*, mscan_handle_t * *handle*, mscan_mb_transfer_t * *xfer*)

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	MsCAN peripheral base address.
handle	MsCAN handle pointer.
xfer	MsCAN Message Buffer transfer structure. See the mscan_mb_transfer_t.

Return values

kStatus_Success	Start Tx Message Buffer sending process successfully.
kStatus_Fail	Write Tx Message Buffer failed.

14.2.7.25 status_t MSCAN_TransferReceiveNonBlocking (MSCAN_Type * *base*, mscan_handle_t * *handle*, mscan_mb_transfer_t * *xfer*)

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	MsCAN peripheral base address.

handle	MsCAN handle pointer.
xfer	MsCAN Message Buffer transfer structure. See the mscan_mb_transfer_t.

Return values

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

14.2.7.26 void MSCAN_TransferAbortSend (MSCAN_Type ∗ *base*, mscan_handle_t ∗ *handle*, uint8_t *mask*)

This function aborts the interrupt driven message send process.

Parameters

base	MsCAN peripheral base address.
handle	MsCAN handle pointer.
mask	The MsCAN Tx Message Buffer mask.

14.2.7.27 void MSCAN_TransferAbortReceive (MSCAN_Type ∗ *base*, mscan_handle_t ∗ *handle*, uint8_t *mask*)

This function aborts the interrupt driven message receive process.

Parameters

base	MsCAN peripheral base address.
handle	MsCAN handle pointer.
mask	The MsCAN Rx Message Buffer mask.

14.2.7.28 void MSCAN_TransferHandleIRQ (MSCAN_Type ∗ *base*, mscan_handle_t ∗ *handle*)

This function handles the MSCAN Error, the Message Buffer, and the Rx FIFO IRQ request.

Parameters

base	MSCAN peripheral base address.
handle	MSCAN handle pointer.

Chapter 15
PIT: Periodic Interrupt Timer

15.1 Overview

The MCUXpresso SDK provides a driver for the Periodic Interrupt Timer (PIT) of MCUXpresso SDK devices.

15.2 Function groups

The PIT driver supports operating the module as a time counter.

15.2.1 Initialization and deinitialization

The function PIT_Init() initializes the PIT with specified configurations. The function PIT_GetDefault-Config() 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.

15.2.2 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.

15.2.3 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.

15.2.4 Status

Provides functions to get and clear the PIT status.

15.2.5 Interrupt

Provides functions to enable/disable PIT interrupts and get current enabled interrupts.

15.3 Typical use case

15.3.1 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.

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.

15.4 Data Structure Documentation

15.4.1 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

15.5 Enumeration Type Documentation

15.5.1 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.

15.5.2 enum pit_interrupt_enable_t

Enumerator

kPIT_TimerInterruptEnable Timer interrupt enable.

15.5.3 enum pit_status_flags_t

Enumerator

kPIT_TimerFlag Timer flag.

15.6 Function Documentation

15.6.1 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

15.6.2 void PIT_Deinit (PIT_Type ∗ *base*)

Parameters

base	PIT peripheral base address

15.6.3 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.

15.6.4 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.

15.6.5 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

15.6.6 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

15.6.7 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

15.6.8 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

15.6.9 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

15.6.10 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

15.6.11 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

15.6.12 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.

15.6.13 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.

Chapter 16
PWT: Pulse Width Timer

16.1 Overview

The MCUXpresso SDK provides a driver for the Pulse Width Timer (PWT) of MCUXpresso SDK devices.

16.2 Function groups

The PWT driver supports capture or measure the pulse width mapping on its input channels. The counter of PWT has two selectable clock sources, Timer clock and alternative clock. PWT module supports programmable positive or negative pulse edges, and programmable interrupt generation upon pulse width values or counter overflow.

16.2.1 Initialization and deinitialization

The function PWT_Init() initializes the PWT with specified configurations. The function PWT_GetDefaultConfig() gets the default configurations. The initialization function configures the PWT for the requested register update mode for register with buffers.

The function PWT_Deinit() disables the PWT counter and turns off the module clock.

16.2.2 Reset

The function PWT_Reset() is built into PWT as a mechanism used to reset/restart the pulse width timer.

16.2.3 Status

Provides functions to get and clear the PWT status.

16.2.4 Interrupt

Provides functions to enable/disable PWT interrupts and get current enabled interrupts.

16.2.5 Start & Stop timer

The function PWT_StartTimer() starts the PWT time counter.

The function PWT_StopTimer() stops the PWT time counter.

16.2.6 GetInterrupt

Provides functions to generate Overflow/Pulse Width Data Ready Interrupt.

16.2.7 Get Timer value

The function PWT_GetCurrentTimerCount() is set to read the current counter value.

The function PWT_ReadPositivePulseWidth() is set to read the positive pulse width.

The function PWT_ReadNegativePulseWidth() is set to read the negative pulse width.

16.2.8 PWT Operations

Input capture operations

The input capture operations sets up an channel for input capture.

The function EdgeCapture can be used to measure the pulse width of a signal. A channel is used during capture with the input signal coming through a channel n. The capture edge for each channel, and any filter value to be used when processing the input signal.

16.3 Typical use case

16.3.1 PWT measure

This is an example code to measure the pulse width:

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

Data Structures

- struct pwt_config_t
  PWT configuration structure. More...

Macros

- #define FSL_PWT_DRIVER_VERSION (MAKE_VERSION(2, 0, 1))
  Version 2.0.1.

Enumerations

- enum pwt_clock_source_t {
  kPWT_TimerClock = 0U,
  kPWT_AlternativeClock }
  PWT clock source selection.

- enum pwt_clock_prescale_t {
  kPWT_Prescale_Divide_1 = 0U,
  kPWT_Prescale_Divide_2,
  kPWT_Prescale_Divide_4,
  kPWT_Prescale_Divide_8,
  kPWT_Prescale_Divide_16,
  kPWT_Prescale_Divide_32,
  kPWT_Prescale_Divide_64,
  kPWT_Prescale_Divide_128 }
  PWT prescaler factor selection for clock source.
- enum pwt_input_edge_t {
  kPWT_StartFall_CaptureFall_Edge = 0U,
  kPWT_StartRise_CaptureRiseAndFall_Edge,
  kPWT_StartFall_CaptureRiseAndFall_Edge,
  kPWT_StartRise_CaptureRise_Edge }
  PWT Input Edge.
- enum pwt_input_select_t {
  kPWT_InputPort_0 = 0U,
  kPWT_InputPort_1,
  kPWT_InputPort_2,
  kPWT_InputPort_3 }
  PWT input port selection.
- enum pwt_interrupt_enable_t {
  kPWT_ModuleInterruptEnable = PWT_R1_PWTIE_MASK,
  kPWT_PulseWidthReadyInterruptEnable = PWT_R1_PRDYIE_MASK,
  kPWT_CounterOverflowInterruptEnable = PWT_R1_POVIE_MASK }
  List of PWT interrupts.
- enum pwt_status_flags_t {
  kPWT_CounterOverflowFlag = PWT_R1_PWTOV_MASK,
  kPWT_PulseWidthValidFlag = PWT_R1_PWTRDY_MASK }
  List of PWT flags.

Functions

- static uint16_t PWT_GetCurrentTimerCount (PWT_Type ∗base)
  Reads the current counter value.
- static uint16_t PWT_ReadPositivePulseWidth (PWT_Type ∗base)
  Reads the positive pulse width.
- static uint16_t PWT_ReadNegativePulseWidth (PWT_Type ∗base)
  Reads the negative pulse width.
- static void PWT_Reset (PWT_Type ∗base)
  Performs a software reset on the PWT module.

Initialization and deinitialization

- void PWT_Init (PWT_Type ∗base, const pwt_config_t ∗config)
  Ungates the PWT clock and configures the peripheral for basic operation.
- void PWT_Deinit (PWT_Type ∗base)

Gates the PWT clock.
- void PWT_GetDefaultConfig (pwt_config_t ∗config)
  Fills in the PWT configuration structure with the default settings.

Interrupt Interface

- static void PWT_EnableInterrupts (PWT_Type ∗base, uint32_t mask)
  Enables the selected PWT interrupts.
- static void PWT_DisableInterrupts (PWT_Type ∗base, uint32_t mask)
  Disables the selected PWT interrupts.
- static uint32_t PWT_GetEnabledInterrupts (PWT_Type ∗base)
  Gets the enabled PWT interrupts.

Status Interface

- static uint32_t PWT_GetStatusFlags (PWT_Type ∗base)
  Gets the PWT status flags.
- static void PWT_ClearStatusFlags (PWT_Type ∗base, uint32_t mask)
  Clears the PWT status flags.

Timer Start and Stop

- static void PWT_StartTimer (PWT_Type ∗base)
  Starts the PWT counter.
- static void PWT_StopTimer (PWT_Type ∗base)
  Stops the PWT counter.

16.4 Data Structure Documentation

16.4.1 struct pwt_config_t

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

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

Data Fields

- pwt_clock_source_t clockSource
  Clock source for the counter.
- pwt_clock_prescale_t prescale
  Pre-scaler to divide down the clock.
- pwt_input_select_t inputSelect
  PWT Pulse input port selection.
- pwt_input_edge_t edge
  PWT Input Edge.

16.5 Enumeration Type Documentation

16.5.1 enum pwt_clock_source_t

Enumerator

kPWT_TimerClock The Timer clock is used as the clock source of PWT counter.
kPWT_AlternativeClock Alternative clock is used as the clock source of PWT counter.

16.5.2 enum pwt_clock_prescale_t

Enumerator

kPWT_Prescale_Divide_1 PWT clock divided by 1.
kPWT_Prescale_Divide_2 PWT clock divided by 2.
kPWT_Prescale_Divide_4 PWT clock divided by 4.
kPWT_Prescale_Divide_8 PWT clock divided by 8.
kPWT_Prescale_Divide_16 PWT clock divided by 16.
kPWT_Prescale_Divide_32 PWT clock divided by 32.
kPWT_Prescale_Divide_64 PWT clock divided by 64.
kPWT_Prescale_Divide_128 PWT clock divided by 128.

16.5.3 enum pwt_input_edge_t

Enumerator

kPWT_StartFall_CaptureFall_Edge The first falling-edge starts the pulse width measurement, and on all the subsequent falling edges, the pulse width is captured.
kPWT_StartRise_CaptureRiseAndFall_Edge The first rising edge starts the pulse width measurement, and on all the subsequent rising and falling edges, the pulse width is captured.
kPWT_StartFall_CaptureRiseAndFall_Edge The first falling edge starts the pulse width measurement, and on all the subsequent rising and falling edges, the pulse width is captured.
kPWT_StartRise_CaptureRise_Edge The first-rising edge starts the pulse width measurement, and on all the subsequent rising edges, the pulse width is captured.

16.5.4 enum pwt_input_select_t

Enumerator

kPWT_InputPort_0 PWT input comes from PWTIN[0].
kPWT_InputPort_1 PWT input comes from PWTIN[1].
kPWT_InputPort_2 PWT input comes from PWTIN[2].
kPWT_InputPort_3 PWT input comes from PWTIN[3].

16.5.5 enum pwt_interrupt_enable_t

Enumerator

kPWT_ModuleInterruptEnable Module Interrupt.
kPWT_PulseWidthReadyInterruptEnable Pulse width data ready interrupt.
kPWT_CounterOverflowInterruptEnable Counter overflow interrupt.

16.5.6 enum pwt_status_flags_t

Enumerator

kPWT_CounterOverflowFlag Counter overflow flag.
kPWT_PulseWidthValidFlag Pulse width valid flag.

16.6 Function Documentation

16.6.1 void PWT_Init (PWT_Type ∗ *base*, const pwt_config_t ∗ *config*)

Note

This API should be called at the beginning of the application using the PWT driver.

Parameters

base	PWT peripheral base address
config	Pointer to the user configuration structure.

16.6.2 void PWT_Deinit (PWT_Type ∗ *base*)

Parameters

base	PWT peripheral base address

16.6.3 void PWT_GetDefaultConfig (pwt_config_t ∗ *config*)

The default values are:

```
*   config->clockSource = kPWT_TimerClock;
*   config->prescale = kPWT_Prescale_Divide_1;
*   config->inputSelect = kPWT_InputPort_0;
*   config->edge = kPWT_StartRise_CaptureRiseAndFall_Edge;
*
```

Parameters

config	Pointer to the user configuration structure.

16.6.4 static void PWT_EnableInterrupts (PWT_Type ∗ *base*, uint32_t *mask*) [inline], [static]

Parameters

base	PWT peripheral base address
mask	The interrupts to enable. This is a logical OR of members of the enumeration pwt_-interrupt_enable_t

16.6.5 static void PWT_DisableInterrupts (PWT_Type ∗ *base*, uint32_t *mask*) [inline], [static]

Parameters

base	PWT peripheral base address
mask	The interrupts to enable. This is a logical OR of members of the enumeration pwt_-interrupt_enable_t

16.6.6 static uint32_t PWT_GetEnabledInterrupts (PWT_Type ∗ *base*) [inline], [static]

Parameters

base	PWT peripheral base address

Returns

The enabled interrupts. This is the logical OR of members of the enumeration pwt_interrupt_enable-_t

16.6.7 static uint32_t PWT_GetStatusFlags (PWT_Type ∗ *base*) [inline], [static]

Parameters

base	PWT peripheral base address

Returns

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

16.6.8 static void PWT_ClearStatusFlags (PWT_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	PWT peripheral base address
mask	The status flags to clear. This is a logical OR of members of the enumeration pwt_-status_flags_t

16.6.9 static void PWT_StartTimer (PWT_Type * *base*) [inline], [static]

Parameters

base	PWT peripheral base address

16.6.10 static void PWT_StopTimer (PWT_Type * *base*) [inline], [static]

Parameters

base	PWT peripheral base address

16.6.11 static uint16_t PWT_GetCurrentTimerCount (PWT_Type * *base*) [inline], [static]

This function returns the timer counting value

Parameters

base	PWT peripheral base address

Returns

Current 16-bit timer counter value

16.6.12 static uint16_t PWT_ReadPositivePulseWidth (PWT_Type * *base*) [inline], [static]

This function reads the low and high registers and returns the 16-bit positive pulse width

Parameters

base	PWT peripheral base address.

Returns

The 16-bit positive pulse width.

16.6.13 static uint16_t PWT_ReadNegativePulseWidth (PWT_Type * *base*) [inline], [static]

This function reads the low and high registers and returns the 16-bit negative pulse width

Parameters

base	PWT peripheral base address.

Returns

The 16-bit negative pulse width.

16.6.14 static void PWT_Reset (PWT_Type * *base*) [inline], [static]

Parameters

base	PWT peripheral base address

Chapter 17
RTC: Real Time Clock

17.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Real Time Clock module of MCUXpresso SDK devices.

17.2 Typical use case

Example use of RTC API. Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOARD>/driver_examples/rtc/

Data Structures

- struct rtc_datetime_t
  Structure is used to hold the date and time. More...
- struct rtc_config_t
  RTC config structure. More...

Typedefs

- typedef void(∗ rtc_alarm_callback_t)(void)
  RTC alarm callback function.

Enumerations

- enum rtc_clock_source_t {
  kRTC_ExternalClock = 0U,
  kRTC_LPOCLK = 1U,
  kRTC_ICSIRCLK = 2U,
  kRTC_BusClock = 3U }
  List of RTC clock source.
- enum rtc_clock_prescaler_t {
  kRTC_ClockDivide_off = 0U,
  kRTC_ClockDivide_1_128 = 1U,
  kRTC_ClockDivide_2_256 = 2U,
  kRTC_ClockDivide_4_512 = 3U,
  kRTC_ClockDivide_8_1024 = 4U,
  kRTC_ClockDivide_16_2048 = 5U,
  kRTC_ClockDivide_32_100 = 6U,
  kRTC_ClockDivide_64_1000 = 7U }
  List of RTC clock prescaler.
- enum rtc_interrupt_enable_t { kRTC_InterruptEnable = RTC_SC_RTIE_MASK }

List of RTC interrupts.
- enum rtc_interrupt_flags_t { kRTC_InterruptFlag = RTC_SC_RTIF_MASK }
  List of RTC Interrupt flags.
- enum rtc_output_enable_t { kRTC_OutputEnable = RTC_SC_RTCO_MASK }
  List of RTC Output.

Driver version

- #define FSL_RTC_DRIVER_VERSION (MAKE_VERSION(2, 0, 4))
  Version 2.0.4.

Initialization and deinitialization

- void RTC_Init (RTC_Type ∗base, const rtc_config_t ∗config)
  Ungates the RTC clock and configures the peripheral for basic operation.
- void RTC_Deinit (RTC_Type ∗base)
  Stops the timer and gate the RTC clock.
- void RTC_GetDefaultConfig (rtc_config_t ∗config)
  Fills in the RTC config struct with the default settings.

Current Time & Alarm

- status_t RTC_SetDatetime (rtc_datetime_t ∗datetime)
  Sets the RTC date and time according to the given time structure.
- void RTC_GetDatetime (rtc_datetime_t ∗datetime)
  Gets the RTC time and stores it in the given time structure.
- void RTC_SetAlarm (uint32_t second)
  Sets the RTC alarm time.
- void RTC_GetAlarm (rtc_datetime_t ∗datetime)
  Returns the RTC alarm time.
- void RTC_SetAlarmCallback (rtc_alarm_callback_t callback)
  Set the RTC alarm callback.

Select Source clock

- static void RTC_SelectSourceClock (RTC_Type ∗base, rtc_clock_source_t clock, rtc_clock_-prescaler_t divide)
  Select Real-Time Clock Source and Clock Prescaler.
- uint32_t RTC_GetDivideValue (RTC_Type ∗base)
  Get the RTC Divide value.

Interrupt Interface

- static void RTC_EnableInterrupts (RTC_Type ∗base, uint32_t mask)
  Enables the selected RTC interrupts.
- static void RTC_DisableInterrupts (RTC_Type ∗base, uint32_t mask)
  Disables the selected RTC interrupts.
- static uint32_t RTC_GetEnabledInterrupts (RTC_Type ∗base)
  Gets the enabled RTC interrupts.
- static uint32_t RTC_GetInterruptFlags (RTC_Type ∗base)

Gets the RTC interrupt flags.
- static void RTC_ClearInterruptFlags (RTC_Type ∗base, uint32_t mask)
  Clears the RTC interrupt flags.

Output Interface

- static void RTC_EnableOutput (RTC_Type ∗base, uint32_t mask)
  Enable the RTC output.
- static void RTC_DisableOutput (RTC_Type ∗base, uint32_t mask)
  Disable the RTC output.

Set module value and Get Count value

- static void RTC_SetModuloValue (RTC_Type ∗base, uint32_t value)
  Set the RTC module value.
- static uint16_t RTC_GetCountValue (RTC_Type ∗base)
  Get the RTC Count value.

17.3 Data Structure Documentation

17.3.1 struct 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 rtc_datetime_t::year

(2) uint8_t rtc_datetime_t::month

(3) uint8_t rtc_datetime_t::day

(4) uint8_t rtc_datetime_t::hour

(5) uint8_t rtc_datetime_t::minute

(6) uint8_t rtc_datetime_t::second

17.3.2 struct rtc_config_t

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

17.4 Typedef Documentation

17.4.1 typedef void(∗ rtc_alarm_callback_t)(void)

17.5 Enumeration Type Documentation

17.5.1 enum rtc_clock_source_t

Enumerator

kRTC_ExternalClock External clock source.
kRTC_LPOCLK Real-time clock source is 1 kHz (LPOCLK)
kRTC_ICSIRCLK Internal reference clock (ICSIRCLK)
kRTC_BusClock Bus clock.

17.5.2 enum rtc_clock_prescaler_t

Enumerator

kRTC_ClockDivide_off Off.
kRTC_ClockDivide_1_128 If RTCLKS = x0, it is 1; if RTCLKS = x1, it is 128.
kRTC_ClockDivide_2_256 If RTCLKS = x0, it is 2; if RTCLKS = x1, it is 256.
kRTC_ClockDivide_4_512 If RTCLKS = x0, it is 4; if RTCLKS = x1, it is 512.
kRTC_ClockDivide_8_1024 If RTCLKS = x0, it is 8; if RTCLKS = x1, it is 1024.
kRTC_ClockDivide_16_2048 If RTCLKS = x0, it is 16; if RTCLKS = x1, it is 2048.
kRTC_ClockDivide_32_100 If RTCLKS = x0, it is 32; if RTCLKS = x1, it is 100.
kRTC_ClockDivide_64_1000 If RTCLKS = x0, it is 64; if RTCLKS = x1, it is 1000.

17.5.3 enum rtc_interrupt_enable_t

Enumerator

kRTC_InterruptEnable Interrupt enable.

17.5.4 enum rtc_interrupt_flags_t

Enumerator

kRTC_InterruptFlag Interrupt flag.

17.5.5 enum rtc_output_enable_t

Enumerator

kRTC_OutputEnable Output enable.

17.6 Function Documentation

17.6.1 void RTC_Init (RTC_Type ∗ *base*, const rtc_config_t ∗ *config*)

Note

This API should be called at the beginning of the application using the RTC driver.

Parameters

base	RTC peripheral base address
config	Pointer to the user's RTC configuration structure.

17.6.2 void RTC_Deinit (RTC_Type ∗ *base*)

Parameters

base	RTC peripheral base address

17.6.3 void RTC_GetDefaultConfig (rtc_config_t ∗ *config*)

The default values are as follows.

```
*     config->clockSource = kRTC_BusClock;
*     config->prescaler = kRTC_ClockDivide_16_2048;
*     config->time_us = 1000000U;
*
```

Parameters

config	Pointer to the user's RTC configuration structure.

17.6.4 status_t RTC_SetDatetime (rtc_datetime_t * *datetime*)

Parameters

datetime	Pointer to the structure where the date and time details are stored.

Returns

kStatus_Success: Success in setting the time and starting the RTC kStatus_InvalidArgument: Error because the datetime format is incorrect

17.6.5 void RTC_GetDatetime (rtc_datetime_t * *datetime*)

Parameters

datetime	Pointer to the structure where the date and time details are stored.

17.6.6 void RTC_SetAlarm (uint32_t *second*)

Parameters

second	Second value. User input the number of second. After seconds user input, alarm occurs.

17.6.7 void RTC_GetAlarm (rtc_datetime_t * *datetime*)

Parameters

datetime	Pointer to the structure where the alarm date and time details are stored.

17.6.8 void RTC_SetAlarmCallback (rtc_alarm_callback_t *callback*)

Parameters

callback	The callback function.

17.6.9 static void RTC_SelectSourceClock (RTC_Type ∗ *base*, rtc_clock_source_t *clock*, rtc_clock_prescaler_t *divide*) [inline], [static]

Parameters

base	RTC peripheral base address
clock	Select RTC clock source
divide	Select RTC clock prescaler value

17.6.10 uint32_t RTC_GetDivideValue (RTC_Type ∗ *base*)

Note

This API should be called after selecting clock source and clock prescaler.

Parameters

base	RTC peripheral base address

Returns

The Divider value. The Divider value depends on clock source and clock prescaler

17.6.11 static void RTC_EnableInterrupts (RTC_Type ∗ *base*, uint32_t *mask*) [inline], [static]

Parameters

base	RTC peripheral base address
mask	The interrupts to enable. This is a logical OR of members of the enumeration rtc_-interrupt_enable_t

17.6.12 static void RTC_DisableInterrupts (RTC_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	PIT peripheral base address
mask	The interrupts to disable. This is a logical OR of members of the enumeration rtc_-interrupt_enable_t

17.6.13 static uint32_t RTC_GetEnabledInterrupts (RTC_Type * *base*) [inline], [static]

Parameters

base	RTC peripheral base address

Returns

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

17.6.14 static uint32_t RTC_GetInterruptFlags (RTC_Type * *base*) [inline], [static]

Parameters

base	RTC peripheral base address

Returns

The interrupt flags. This is the logical OR of members of the enumeration rtc_interrupt_flags_t

17.6.15 static void RTC_ClearInterruptFlags (RTC_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	RTC peripheral base address
mask	The interrupt flags to clear. This is a logical OR of members of the enumeration rtc_interrupt_flags_t

17.6.16 static void RTC_EnableOutput (RTC_Type * *base*, uint32_t *mask*) [inline], [static]

If RTC output is enabled, the RTCO pinout will be toggled when RTC counter overflows

Parameters

base	RTC peripheral base address
mask	The Output to enable. This is a logical OR of members of the enumeration rtc_output_enable_t

17.6.17 static void RTC_DisableOutput (RTC_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

base	RTC peripheral base address
mask	The Output to disable. This is a logical OR of members of the enumeration rtc_output_enable_t

17.6.18 static void RTC_SetModuloValue (RTC_Type * *base*, uint32_t *value*) [inline], [static]

Parameters

base	RTC peripheral base address
value	The Module Value. The RTC Modulo register allows the compare value to be set to any value from 0x0000 to 0xFFFF

17.6.19 static uint16_t RTC_GetCountValue (RTC_Type * base) [inline], [static]

Parameters

base	RTC peripheral base address

Returns

The Count Value. The Count Value is allowed from 0x0000 to 0xFFFF

Chapter 18
SPI: Serial Peripheral Interface Driver

18.1 Overview

Modules

- SPI CMSIS driver
- SPI Driver

18.2 SPI Driver

18.2.1 Overview

SPI driver includes functional APIs and transactional APIs.

Functional APIs are feature/property target low level APIs. Functional APIs can be used for SPI initialization/configuration/operation for optimization/customization purpose. Using the functional API requires the knowledge of the SPI peripheral and how to organize functional APIs to meet the application requirements. All functional API use the peripheral base address as the first parameter. SPI 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 A-PI implementation and write a custom code. All transactional APIs use the spi_handle_t as the first parameter. Initialize the handle by calling the SPI_MasterTransferCreateHandle() or SPI_SlaveTransfer-CreateHandle() API.

Transactional APIs support asynchronous transfer. This means that the functions SPI_MasterTransferNon-Blocking() and SPI_SlaveTransferNonBlocking() set up the interrupt for data transfer. When the transfer completes, the upper layer is notified through a callback function with the kStatus_SPI_Idle status.

18.2.2 Typical use case

18.2.2.1 SPI master transfer using an interrupt method

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

18.2.2.2 SPI Send/receive using a DMA method

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

Data Structures

- struct spi_master_config_t
  SPI master user configure structure. More...
- struct spi_slave_config_t
  SPI slave user configure structure. More...
- struct spi_transfer_t
  SPI transfer structure. More...
- struct spi_master_handle_t
  SPI transfer handle structure. More...

Macros

- #define SPI_DUMMYDATA (0xFFU)
  SPI dummy transfer data, the data is sent while txBuff 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 spi_master_handle_t spi_slave_handle_t
  Slave handle is the same with master handle.
- typedef void(∗ spi_master_callback_t)(SPI_Type ∗base, spi_master_handle_t ∗handle, status_t status, void ∗userData)
  SPI master callback for finished transmit.
- typedef void(∗ spi_slave_callback_t)(SPI_Type ∗base, spi_slave_handle_t ∗handle, status_t status, void ∗userData)
  SPI master callback for finished transmit.

Enumerations

- enum {
  kStatus_SPI_Busy = MAKE_STATUS(kStatusGroup_SPI, 0),
  kStatus_SPI_Idle = MAKE_STATUS(kStatusGroup_SPI, 1),
  kStatus_SPI_Error = MAKE_STATUS(kStatusGroup_SPI, 2),
  kStatus_SPI_Timeout = MAKE_STATUS(kStatusGroup_SPI, 3) }
  Return status for the SPI driver.
- enum spi_clock_polarity_t {
  kSPI_ClockPolarityActiveHigh = 0x0U,
  kSPI_ClockPolarityActiveLow }
  SPI clock polarity configuration.
- enum spi_clock_phase_t {
  kSPI_ClockPhaseFirstEdge = 0x0U,
  kSPI_ClockPhaseSecondEdge }
  SPI clock phase configuration.
- enum spi_shift_direction_t {
  kSPI_MsbFirst = 0x0U,
  kSPI_LsbFirst }
  SPI data shifter direction options.
- enum spi_ss_output_mode_t {
  kSPI_SlaveSelectAsGpio = 0x0U,
  kSPI_SlaveSelectFaultInput = 0x2U,
  kSPI_SlaveSelectAutomaticOutput = 0x3U }
  SPI slave select output mode options.
- enum spi_pin_mode_t {

kSPI_PinModeNormal = 0x0U,
kSPI_PinModeInput = 0x1U,
kSPI_PinModeOutput = 0x3U }
SPI pin mode options.
- enum spi_data_bitcount_mode_t {
kSPI_8BitMode = 0x0U,
kSPI_16BitMode }
SPI data length mode options.
- enum _spi_interrupt_enable {
kSPI_RxFullAndModfInterruptEnable = 0x1U,
kSPI_TxEmptyInterruptEnable = 0x2U,
kSPI_MatchInterruptEnable = 0x4U }
SPI interrupt sources.
- enum _spi_flags {
kSPI_RxBufferFullFlag = SPI_S_SPRF_MASK,
kSPI_MatchFlag = SPI_S_SPMF_MASK,
kSPI_TxBufferEmptyFlag = SPI_S_SPTEF_MASK,
kSPI_ModeFaultFlag = SPI_S_MODF_MASK }
SPI status flags.

Variables

- volatile uint8_t g_spiDummyData [ ]
Global variable for dummy data value setting.

Driver version

- #define FSL_SPI_DRIVER_VERSION (MAKE_VERSION(2, 1, 1))
SPI driver version.

Initialization and deinitialization

- void SPI_MasterGetDefaultConfig (spi_master_config_t ∗config)
Sets the SPI master configuration structure to default values.
- void SPI_MasterInit (SPI_Type ∗base, const spi_master_config_t ∗config, uint32_t srcClock_Hz)
Initializes the SPI with master configuration.
- void SPI_SlaveGetDefaultConfig (spi_slave_config_t ∗config)
Sets the SPI slave configuration structure to default values.
- void SPI_SlaveInit (SPI_Type ∗base, const spi_slave_config_t ∗config)
Initializes the SPI with slave configuration.
- void SPI_Deinit (SPI_Type ∗base)
De-initializes the SPI.
- static void SPI_Enable (SPI_Type ∗base, bool enable)
Enables or disables the SPI.

Status

- uint32_t SPI_GetStatusFlags (SPI_Type *base)
  Gets the status flag.

Interrupts

- void SPI_EnableInterrupts (SPI_Type *base, uint32_t mask)
  Enables the interrupt for the SPI.
- void SPI_DisableInterrupts (SPI_Type *base, uint32_t mask)
  Disables the interrupt for the SPI.

DMA Control

- static uint32_t SPI_GetDataRegisterAddress (SPI_Type *base)
  Gets the SPI tx/rx data register address.

Bus Operations

- uint32_t SPI_GetInstance (SPI_Type *base)
  Get the instance for SPI module.
- static void SPI_SetPinMode (SPI_Type *base, spi_pin_mode_t pinMode)
  Sets the pin mode for transfer.
- void SPI_MasterSetBaudRate (SPI_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)
  Sets the baud rate for SPI transfer.
- static void SPI_SetMatchData (SPI_Type *base, uint32_t matchData)
  Sets the match data for SPI.
- status_t SPI_WriteBlocking (SPI_Type *base, uint8_t *buffer, size_t size)
  Sends a buffer of data bytes using a blocking method.
- void SPI_WriteData (SPI_Type *base, uint16_t data)
  Writes a data into the SPI data register.
- uint16_t SPI_ReadData (SPI_Type *base)
  Gets a data from the SPI data register.
- void SPI_SetDummyData (SPI_Type *base, uint8_t dummyData)
  Set up the dummy data.

Transactional

- void SPI_MasterTransferCreateHandle (SPI_Type *base, spi_master_handle_t *handle, spi_master_callback_t callback, void *userData)
  Initializes the SPI master handle.
- status_t SPI_MasterTransferBlocking (SPI_Type *base, spi_transfer_t *xfer)
  Transfers a block of data using a polling method.
- status_t SPI_MasterTransferNonBlocking (SPI_Type *base, spi_master_handle_t *handle, spi_transfer_t *xfer)

Performs a non-blocking SPI interrupt transfer.
- status_t SPI_MasterTransferGetCount (SPI_Type *base, spi_master_handle_t *handle, size_t *count)
    Gets the bytes of the SPI interrupt transferred.
- void SPI_MasterTransferAbort (SPI_Type *base, spi_master_handle_t *handle)
    Aborts an SPI transfer using interrupt.
- void SPI_MasterTransferHandleIRQ (SPI_Type *base, spi_master_handle_t *handle)
    Interrupts the handler for the SPI.
- void SPI_SlaveTransferCreateHandle (SPI_Type *base, spi_slave_handle_t *handle, spi_slave_callback_t callback, void *userData)
    Initializes the SPI slave handle.
- status_t SPI_SlaveTransferNonBlocking (SPI_Type *base, spi_slave_handle_t *handle, spi_transfer_t *xfer)
    Performs a non-blocking SPI slave interrupt transfer.
- static status_t SPI_SlaveTransferGetCount (SPI_Type *base, spi_slave_handle_t *handle, size_t *count)
    Gets the bytes of the SPI interrupt transferred.
- static void SPI_SlaveTransferAbort (SPI_Type *base, spi_slave_handle_t *handle)
    Aborts an SPI slave transfer using interrupt.
- void SPI_SlaveTransferHandleIRQ (SPI_Type *base, spi_slave_handle_t *handle)
    Interrupts a handler for the SPI slave.

18.2.3 Data Structure Documentation

18.2.3.1 struct spi_master_config_t

Data Fields

- bool enableMaster
    Enable SPI at initialization time.
- bool enableStopInWaitMode
    SPI stop in wait mode.
- spi_clock_polarity_t polarity
    Clock polarity.
- spi_clock_phase_t phase
    Clock phase.
- spi_shift_direction_t direction
    MSB or LSB.
- spi_ss_output_mode_t outputMode
    SS pin setting.
- spi_pin_mode_t pinMode
    SPI pin mode select.
- uint32_t baudRate_Bps
    Baud Rate for SPI in Hz.

18.2.3.2 struct spi_slave_config_t

Data Fields

- bool enableSlave
  Enable SPI at initialization time.
- bool enableStopInWaitMode
  SPI stop in wait mode.
- spi_clock_polarity_t polarity
  Clock polarity.
- spi_clock_phase_t phase
  Clock phase.
- spi_shift_direction_t direction
  MSB or LSB.
- spi_pin_mode_t pinMode
  SPI pin mode select.

18.2.3.3 struct spi_transfer_t

Data Fields

- uint8_t ∗ txData
  Send buffer.
- uint8_t ∗ rxData
  Receive buffer.
- size_t dataSize
  Transfer bytes.
- uint32_t flags
  SPI control flag, useless to SPI.

Field Documentation

(1) uint32_t spi_transfer_t::flags

18.2.3.4 struct _spi_master_handle

Data Fields

- uint8_t ∗volatile txData
  Transfer buffer.
- uint8_t ∗volatile rxData
  Receive buffer.
- volatile size_t txRemainingBytes
  Send data remaining in bytes.
- volatile size_t rxRemainingBytes
  Receive data remaining in bytes.
- volatile uint32_t state
  SPI internal state.
- size_t transferSize
  Bytes to be transferred.

- uint8_t bytePerFrame
  SPI mode, 2bytes or 1byte in a frame.
- uint8_t watermark
  Watermark value for SPI transfer.
- spi_master_callback_t callback
  SPI callback.
- void * userData
  Callback parameter.

18.2.4 Macro Definition Documentation

18.2.4.1 #define FSL_SPI_DRIVER_VERSION (MAKE_VERSION(2, 1, 1))

18.2.4.2 #define SPI_DUMMYDATA (0xFFU)

18.2.4.3 #define SPI_RETRY_TIMES 0U /* Define to zero means keep waiting until the flag is assert/deassert. */

18.2.5 Enumeration Type Documentation

18.2.5.1 anonymous enum

Enumerator

kStatus_SPI_Busy SPI bus is busy.
kStatus_SPI_Idle SPI is idle.
kStatus_SPI_Error SPI error.
kStatus_SPI_Timeout SPI timeout polling status flags.

18.2.5.2 enum spi_clock_polarity_t

Enumerator

kSPI_ClockPolarityActiveHigh Active-high SPI clock (idles low).
kSPI_ClockPolarityActiveLow Active-low SPI clock (idles high).

18.2.5.3 enum spi_clock_phase_t

Enumerator

kSPI_ClockPhaseFirstEdge First edge on SPSCK occurs at the middle of the first cycle of a data transfer.
kSPI_ClockPhaseSecondEdge First edge on SPSCK occurs at the start of the first cycle of a data transfer.

18.2.5.4 enum spi_shift_direction_t

Enumerator

kSPI_MsbFirst Data transfers start with most significant bit.
kSPI_LsbFirst Data transfers start with least significant bit.

18.2.5.5 enum spi_ss_output_mode_t

Enumerator

kSPI_SlaveSelectAsGpio Slave select pin configured as GPIO.
kSPI_SlaveSelectFaultInput Slave select pin configured for fault detection.
kSPI_SlaveSelectAutomaticOutput Slave select pin configured for automatic SPI output.

18.2.5.6 enum spi_pin_mode_t

Enumerator

kSPI_PinModeNormal Pins operate in normal, single-direction mode.
kSPI_PinModeInput Bidirectional mode. Master: MOSI pin is input; Slave: MISO pin is input.
kSPI_PinModeOutput Bidirectional mode. Master: MOSI pin is output; Slave: MISO pin is output.

18.2.5.7 enum spi_data_bitcount_mode_t

Enumerator

kSPI_8BitMode 8-bit data transmission mode
kSPI_16BitMode 16-bit data transmission mode

18.2.5.8 enum _spi_interrupt_enable

Enumerator

kSPI_RxFullAndModfInterruptEnable Receive buffer full (SPRF) and mode fault (MODF) interrupt.
kSPI_TxEmptyInterruptEnable Transmit buffer empty interrupt.
kSPI_MatchInterruptEnable Match interrupt.

18.2.5.9 enum _spi_flags

Enumerator

kSPI_RxBufferFullFlag Read buffer full flag.
kSPI_MatchFlag Match flag.
kSPI_TxBufferEmptyFlag Transmit buffer empty flag.
kSPI_ModeFaultFlag Mode fault flag.

18.2.6 Function Documentation

18.2.6.1 void SPI_MasterGetDefaultConfig (spi_master_config_t * *config*)

The purpose of this API is to get the configuration structure initialized for use in SPI_MasterInit(). User may use the initialized structure unchanged in SPI_MasterInit(), or modify some fields of the structure before calling SPI_MasterInit(). After calling this API, the master is ready to transfer. Example:

```
spi_master_config_t config;
SPI_MasterGetDefaultConfig(&config);
```

Parameters

config	pointer to master config structure

18.2.6.2 void SPI_MasterInit (SPI_Type * *base*, const spi_master_config_t * *config*, uint32_t *srcClock_Hz*)

The configuration structure can be filled by user from scratch, or be set with default values by SPI_MasterGetDefaultConfig(). After calling this API, the slave is ready to transfer. Example

```
spi_master_config_t config = {
.baudRate_Bps = 400000,
...
};
SPI_MasterInit(SPI0, &config);
```

Parameters

base	SPI base pointer

config	pointer to master configuration structure
srcClock_Hz	Source clock frequency.

18.2.6.3 void SPI_SlaveGetDefaultConfig (spi_slave_config_t * *config*)

The purpose of this API is to get the configuration structure initialized for use in SPI_SlaveInit(). Modify some fields of the structure before calling SPI_SlaveInit(). Example:

```
spi_slave_config_t config;
SPI_SlaveGetDefaultConfig(&config);
```

Parameters

config	pointer to slave configuration structure

18.2.6.4 void SPI_SlaveInit (SPI_Type * *base*, const spi_slave_config_t * *config*)

The configuration structure can be filled by user from scratch or be set with default values by SPI_Slave-GetDefaultConfig(). After calling this API, the slave is ready to transfer. Example

```
spi_slave_config_t config = {
.polarity = kSPIClockPolarity_ActiveHigh;
.phase = kSPIClockPhase_FirstEdge;
.direction = kSPIMsbFirst;
...
};
SPI_MasterInit(SPI0, &config);
```

Parameters

base	SPI base pointer
config	pointer to master configuration structure

18.2.6.5 void SPI_Deinit (SPI_Type * *base*)

Calling this API resets the SPI module, gates the SPI clock. The SPI module can't work unless calling the SPI_MasterInit/SPI_SlaveInit to initialize module.

Parameters

base	SPI base pointer

18.2.6.6 static void SPI_Enable (SPI_Type * *base,* bool *enable*) [inline], [static]

Parameters

base	SPI base pointer
enable	pass true to enable module, false to disable module

18.2.6.7 uint32_t SPI_GetStatusFlags (SPI_Type * *base*)

Parameters

base	SPI base pointer

Returns

SPI Status, use status flag to AND _spi_flags could get the related status.

18.2.6.8 void SPI_EnableInterrupts (SPI_Type * *base,* uint32_t *mask*)

Parameters

base	SPI base pointer
mask	SPI interrupt source. The parameter can be any combination of the following values: • kSPI_RxFullAndModfInterruptEnable • kSPI_TxEmptyInterruptEnable • kSPI_MatchInterruptEnable • kSPI_RxFifoNearFullInterruptEnable • kSPI_TxFifoNearEmptyInterruptEnable

18.2.6.9 void SPI_DisableInterrupts (SPI_Type * *base,* uint32_t *mask*)

Parameters

base	SPI base pointer
mask	SPI interrupt source. The parameter can be any combination of the following values: • kSPI_RxFullAndModfInterruptEnable • kSPI_TxEmptyInterruptEnable • kSPI_MatchInterruptEnable • kSPI_RxFifoNearFullInterruptEnable • kSPI_TxFifoNearEmptyInterruptEnable

18.2.6.10 static uint32_t SPI_GetDataRegisterAddress (SPI_Type ∗ *base*) [inline], [static]

This API is used to provide a transfer address for the SPI DMA transfer configuration.

Parameters

base	SPI base pointer

Returns

data register address

18.2.6.11 uint32_t SPI_GetInstance (SPI_Type ∗ *base*)

Parameters

base	SPI base address

18.2.6.12 static void SPI_SetPinMode (SPI_Type ∗ *base*, spi_pin_mode_t *pinMode*) [inline], [static]

Parameters

base	SPI base pointer
pinMode	pin mode for transfer AND _spi_pin_mode could get the related configuration.

18.2.6.13 void SPI_MasterSetBaudRate (SPI_Type ∗ *base*, uint32_t *baudRate_Bps*, uint32_t *srcClock_Hz*)

This is only used in master.

Parameters

base	SPI base pointer
baudRate_Bps	baud rate needed in Hz.
srcClock_Hz	SPI source clock frequency in Hz.

18.2.6.14 static void SPI_SetMatchData (SPI_Type ∗ *base*, uint32_t *matchData*) [inline], [static]

The match data is a hardware comparison value. When the value received in the SPI receive data buffer equals the hardware comparison value, the SPI Match Flag in the S register (S[SPMF]) sets. This can also generate an interrupt if the enable bit sets.

Parameters

base	SPI base pointer
matchData	Match data.

18.2.6.15 status_t SPI_WriteBlocking (SPI_Type ∗ *base*, uint8_t ∗ *buffer*, size_t *size*)

Note

This function blocks via polling until all bytes have been sent.

Parameters

base	SPI base pointer
buffer	The data bytes to send
size	The number of data bytes to send

Returns

kStatus_SPI_Timeout The transfer timed out and was aborted.

18.2.6.16 void SPI_WriteData (SPI_Type * *base*, uint16_t *data*)

Parameters

base	SPI base pointer
data	needs to be write.

18.2.6.17 uint16_t SPI_ReadData (SPI_Type * *base*)

Parameters

base	SPI base pointer

Returns

Data in the register.

18.2.6.18 void SPI_SetDummyData (SPI_Type * *base*, uint8_t *dummyData*)

Parameters

base	SPI peripheral address.
dummyData	Data to be transferred when tx buffer is NULL.

18.2.6.19 void SPI_MasterTransferCreateHandle (SPI_Type * *base*, spi_master_handle_t * *handle*, spi_master_callback_t *callback*, void * *userData*)

This function initializes the SPI master handle which can be used for other SPI master transactional APIs. Usually, for a specified SPI instance, call this API once to get the initialized handle.

Parameters

base	SPI peripheral base address.
handle	SPI handle pointer.
callback	Callback function.
userData	User data.

18.2.6.20 status_t SPI_MasterTransferBlocking (SPI_Type ∗ *base*, spi_transfer_t ∗ *xfer*)

Parameters

base	SPI base pointer
xfer	pointer to spi_xfer_config_t structure

Return values

kStatus_Success	Successfully start a transfer.
kStatus_InvalidArgument	Input argument is invalid.

18.2.6.21 status_t SPI_MasterTransferNonBlocking (SPI_Type * *base*, spi_master_handle_t * *handle*, spi_transfer_t * *xfer*)

Note

The API immediately returns after transfer initialization is finished. Call SPI_GetStatusIRQ() to get the transfer status.
If SPI transfer data frame size is 16 bits, the transfer size cannot be an odd number.

Parameters

base	SPI peripheral base address.
handle	pointer to spi_master_handle_t structure which stores the transfer state
xfer	pointer to spi_xfer_config_t structure

Return values

kStatus_Success	Successfully start a transfer.
kStatus_InvalidArgument	Input argument is invalid.
kStatus_SPI_Busy	SPI is not idle, is running another transfer.

18.2.6.22 status_t SPI_MasterTransferGetCount (SPI_Type * *base*, spi_master_handle_t * *handle*, size_t * *count*)

Parameters

base	SPI peripheral base address.
handle	Pointer to SPI transfer handle, this should be a static variable.
count	Transferred bytes of SPI master.

Return values

kStatus_SPI_Success	Succeed get the transfer count.
kStatus_NoTransferInProgress	There is not a non-blocking transaction currently in progress.

18.2.6.23 void SPI_MasterTransferAbort (SPI_Type * *base*, spi_master_handle_t * *handle*)

Parameters

base	SPI peripheral base address.
handle	Pointer to SPI transfer handle, this should be a static variable.

18.2.6.24 void SPI_MasterTransferHandleIRQ (SPI_Type * *base*, spi_master_handle_t * *handle*)

Parameters

base	SPI peripheral base address.
handle	pointer to spi_master_handle_t structure which stores the transfer state.

18.2.6.25 void SPI_SlaveTransferCreateHandle (SPI_Type * *base*, spi_slave_handle_t * *handle*, spi_slave_callback_t *callback*, void * *userData*)

This function initializes the SPI slave handle which can be used for other SPI slave transactional APIs. Usually, for a specified SPI instance, call this API once to get the initialized handle.

Parameters

base	SPI peripheral base address.
handle	SPI handle pointer.
callback	Callback function.
userData	User data.

18.2.6.26 status_t SPI_SlaveTransferNonBlocking (SPI_Type ∗ *base*, spi_slave_handle_t ∗ *handle*, spi_transfer_t ∗ *xfer*)

Note

The API returns immediately after the transfer initialization is finished. Call SPI_GetStatusIRQ() to get the transfer status.
If SPI transfer data frame size is 16 bits, the transfer size cannot be an odd number.

Parameters

base	SPI peripheral base address.
handle	pointer to spi_slave_handle_t structure which stores the transfer state
xfer	pointer to spi_xfer_config_t structure

Return values

kStatus_Success	Successfully start a transfer.
kStatus_InvalidArgument	Input argument is invalid.
kStatus_SPI_Busy	SPI is not idle, is running another transfer.

18.2.6.27 static status_t SPI_SlaveTransferGetCount (SPI_Type ∗ *base*, spi_slave_handle_t ∗ *handle*, size_t ∗ *count*) [inline], [static]

Parameters

base	SPI peripheral base address.
handle	Pointer to SPI transfer handle, this should be a static variable.
count	Transferred bytes of SPI slave.

Return values

kStatus_SPI_Success	Succeed get the transfer count.
kStatus_NoTransferInProgress	There is not a non-blocking transaction currently in progress.

18.2.6.28 static void SPI_SlaveTransferAbort (SPI_Type * *base*, spi_slave_handle_t * *handle*) [inline], [static]

Parameters

base	SPI peripheral base address.
handle	Pointer to SPI transfer handle, this should be a static variable.

18.2.6.29 void SPI_SlaveTransferHandleIRQ (SPI_Type * *base*, spi_slave_handle_t * *handle*)

Parameters

base	SPI peripheral base address.
handle	pointer to spi_slave_handle_t structure which stores the transfer state

18.2.7 Variable Documentation

18.2.7.1 volatile uint8_t g_spiDummyData[]

18.3 SPI CMSIS driver

This section describes the programming interface of the SPI 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.

18.3.1 Function groups

18.3.1.1 SPI CMSIS GetVersion Operation

This function group will return the SPI CMSIS Driver version to user.

18.3.1.2 SPI CMSIS GetCapabilities Operation

This function group will return the capabilities of this driver.

18.3.1.3 SPI 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.

18.3.1.4 SPI CMSIS Transfer Operation

This function group controls the transfer, master send/receive data, and slave send/receive data.

18.3.1.5 SPI CMSIS Status Operation

This function group gets the SPI transfer status.

18.3.1.6 SPI CMSIS Control Operation

This function can configure 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 other control command.

18.3.2 Typical use case

18.3.2.1 Master Operation

```
/* Variables */
uint8_t masterRxData[TRANSFER_SIZE] = {0U};
uint8_t masterTxData[TRANSFER_SIZE] = {0U};

/*SPI master init*/
Driver_SPI0.Initialize(SPI_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();
```

18.3.2.2 Slave Operation

```
/* Variables */
uint8_t slaveRxData[TRANSFER_SIZE] = {0U};
uint8_t slaveTxData[TRANSFER_SIZE] = {0U};

/*SPI slave init*/
Driver_SPI1.Initialize(SPI_SlaveSignalEvent_t);
Driver_SPI1.PowerControl(ARM_POWER_FULL);
Driver_SPI1.Control(ARM_SPI_MODE_SLAVE, false);

/* Start slave transfer */
Driver_SPI1.Transfer(slaveTxData, slaveRxData, TRANSFER_SIZE);

/* slave power off */
Driver_SPI1.PowerControl(ARM_POWER_OFF);

/* slave uninitialize */
Driver_SPI1.Uninitialize();
```

Chapter 19
TPM: Timer PWM Module

19.1 Overview

The MCUXpresso SDK provides a driver for the Timer PWM Module (TPM) of MCUXpresso SDK devices.

The TPM driver supports the generation of PWM signals, input capture, and output compare modes. On some SoCs, the driver supports the generation of combined PWM signals, dual-edge capture, and quadrature decoder modes. The driver also supports configuring each of the TPM fault inputs. The fault input is available only on some SoCs.

19.2 Introduction of TPM

19.2.1 Initialization and deinitialization

The function TPM_Init() initializes the TPM with a specified configurations. The function TPM_GetDefaultConfig() gets the default configurations. On some SoCs, the initialization function issues a software reset to reset the TPM internal logic. The initialization function configures the TPM's behavior when it receives a trigger input and its operation in doze and debug modes.

The function TPM_Deinit() disables the TPM counter and turns off the module clock.

19.2.2 PWM Operations

The function TPM_SetupPwm() sets up TPM channels for the PWM output. The function can set up the PWM signal properties for multiple channels. Each channel has its own tpm_chnl_pwm_signal_param_t structure that is used to specify the output signals duty cycle and level-mode. However, the same PWM period and PWM mode is applied to all channels requesting a PWM output. The signal duty cycle is provided as a percentage of the PWM period. Its value should be between 0 and 100 where 0=inactive signal (0% duty cycle) and 100=always active signal (100% duty cycle). When generating a combined PWM signal, the channel number passed refers to a channel pair number, for example 0 refers to channel 0 and 1, 1 refers to channels 2 and 3.

The function TPM_UpdatePwmDutycycle() updates the PWM signal duty cycle of a particular TPM channel.

The function TPM_UpdateChnlEdgeLevelSelect() updates the level select bits of a particular TPM channel. This can be used to disable the PWM output when making changes to the PWM signal.

19.2.3 Input capture operations

The function TPM_SetupInputCapture() sets up a TPM channel for input capture. The user can specify the capture edge.

The function TPM_SetupDualEdgeCapture() can be used to measure the pulse width of a signal. This is available only for certain SoCs. A channel pair is used during the capture with the input signal coming through a channel that can be configured. The user can specify the capture edge for each channel and any filter value to be used when processing the input signal.

19.2.4 Output compare operations

The function TPM_SetupOutputCompare() sets up a TPM channel for output comparison. The user can specify the channel output on a successful comparison and a comparison value.

19.2.5 Quad decode

The function TPM_SetupQuadDecode() sets up TPM channels 0 and 1 for quad decode, which is available only for certain SoCs. The user can specify the quad decode mode, polarity, and filter properties for each input signal.

19.2.6 Fault operation

The function TPM_SetupFault() sets up the properties for each fault, which is available only for certain SoCs. The user can specify the fault polarity and whether to use a filter on a fault input. The overall fault filter value and fault control mode are set up during initialization.

19.2.7 Status

Provides functions to get and clear the TPM status.

19.2.8 Interrupt

Provides functions to enable/disable TPM interrupts and get current enabled interrupts.

19.3 Typical use case

19.3.1 PWM output

Output the PWM signal on 2 TPM channels with different duty cycles. Periodically update the PW-M signal duty cycle. Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOAR-D>/driver_examples/tpm

Data Structures

- struct tpm_chnl_pwm_signal_param_t
    Options to configure a TPM channel's PWM signal. More...
- struct tpm_config_t
    TPM config structure. More...

Macros

- #define TPM_MAX_COUNTER_VALUE(x) ((1U != (uint8_t)FSL_FEATURE_TPM_HAS_32BIT_COUNTERn(x)) ? 0xFFFFU : 0xFFFFFFFFU)
    Help macro to get the max counter value.

Enumerations

- enum tpm_chnl_t {
  kTPM_Chnl_0 = 0U,
  kTPM_Chnl_1,
  kTPM_Chnl_2,
  kTPM_Chnl_3,
  kTPM_Chnl_4,
  kTPM_Chnl_5,
  kTPM_Chnl_6,
  kTPM_Chnl_7 }
    List of TPM channels.
- enum tpm_pwm_mode_t {
  kTPM_EdgeAlignedPwm = 0U,
  kTPM_CenterAlignedPwm }
    TPM PWM operation modes.
- enum tpm_pwm_level_select_t {
  kTPM_NoPwmSignal = 0U,
  kTPM_LowTrue,
  kTPM_HighTrue }
    TPM PWM output pulse mode: high-true, low-true or no output.
- enum tpm_chnl_control_bit_mask_t {
  kTPM_ChnlELSnAMask = TPM_CnSC_ELSA_MASK,
  kTPM_ChnlELSnBMask = TPM_CnSC_ELSB_MASK,
  kTPM_ChnlMSAMask = TPM_CnSC_MSA_MASK,
  kTPM_ChnlMSBMask = TPM_CnSC_MSB_MASK }
    List of TPM channel modes and level control bit mask.

- enum tpm_output_compare_mode_t {
  kTPM_NoOutputSignal = (1U << TPM_CnSC_MSA_SHIFT),
  kTPM_ToggleOnMatch = ((1U << TPM_CnSC_MSA_SHIFT) | (1U << TPM_CnSC_ELSA_S-HIFT)),
  kTPM_ClearOnMatch = ((1U << TPM_CnSC_MSA_SHIFT) | (2U << TPM_CnSC_ELSA_SH-IFT)),
  kTPM_SetOnMatch = ((1U << TPM_CnSC_MSA_SHIFT) | (3U << TPM_CnSC_ELSA_SHIF-T)),
  kTPM_HighPulseOutput = ((3U << TPM_CnSC_MSA_SHIFT) | (1U << TPM_CnSC_ELSA_-SHIFT)),
  kTPM_LowPulseOutput = ((3U << TPM_CnSC_MSA_SHIFT) | (2U << TPM_CnSC_ELSA_S-HIFT)) }
  TPM output compare modes.
- enum tpm_input_capture_edge_t {
  kTPM_RisingEdge = (1U << TPM_CnSC_ELSA_SHIFT),
  kTPM_FallingEdge = (2U << TPM_CnSC_ELSA_SHIFT),
  kTPM_RiseAndFallEdge = (3U << TPM_CnSC_ELSA_SHIFT) }
  TPM input capture edge.
- enum tpm_clock_source_t {
  kTPM_SystemClock = 1U,
  kTPM_FixedClock,
  kTPM_ExternalClock }
  TPM clock source selection.
- enum tpm_clock_prescale_t {
  kTPM_Prescale_Divide_1 = 0U,
  kTPM_Prescale_Divide_2,
  kTPM_Prescale_Divide_4,
  kTPM_Prescale_Divide_8,
  kTPM_Prescale_Divide_16,
  kTPM_Prescale_Divide_32,
  kTPM_Prescale_Divide_64,
  kTPM_Prescale_Divide_128 }
  TPM prescale value selection for the clock source.
- enum tpm_interrupt_enable_t {
  kTPM_Chnl0InterruptEnable = (1U << 0),
  kTPM_Chnl1InterruptEnable = (1U << 1),
  kTPM_Chnl2InterruptEnable = (1U << 2),
  kTPM_Chnl3InterruptEnable = (1U << 3),
  kTPM_Chnl4InterruptEnable = (1U << 4),
  kTPM_Chnl5InterruptEnable = (1U << 5),
  kTPM_Chnl6InterruptEnable = (1U << 6),
  kTPM_Chnl7InterruptEnable = (1U << 7),
  kTPM_TimeOverflowInterruptEnable = (1U << 8) }
  List of TPM interrupts.
- enum tpm_status_flags_t {

kTPM_Chnl0Flag = (1U << 0),
kTPM_Chnl1Flag = (1U << 1),
kTPM_Chnl2Flag = (1U << 2),
kTPM_Chnl3Flag = (1U << 3),
kTPM_Chnl4Flag = (1U << 4),
kTPM_Chnl5Flag = (1U << 5),
kTPM_Chnl6Flag = (1U << 6),
kTPM_Chnl7Flag = (1U << 7),
kTPM_TimeOverflowFlag = (1U << 8) }
List of TPM flags.

Driver version

- #define FSL_TPM_DRIVER_VERSION (MAKE_VERSION(2, 2, 0))
  TPM driver version 2.2.0.

Initialization and deinitialization

- void TPM_Init (TPM_Type ∗base, const tpm_config_t ∗config)
  Ungates the TPM clock and configures the peripheral for basic operation.
- void TPM_Deinit (TPM_Type ∗base)
  Stops the counter and gates the TPM clock.
- void TPM_GetDefaultConfig (tpm_config_t ∗config)
  Fill in the TPM config struct with the default settings.
- tpm_clock_prescale_t TPM_CalculateCounterClkDiv (TPM_Type ∗base, uint32_t counterPeriod_Hz, uint32_t srcClock_Hz)
  Calculates the counter clock prescaler.

Channel mode operations

- status_t TPM_SetupPwm (TPM_Type ∗base, const tpm_chnl_pwm_signal_param_t ∗chnlParams, uint8_t numOfChnls, tpm_pwm_mode_t mode, uint32_t pwmFreq_Hz, uint32_t srcClock_Hz)
  Configures the PWM signal parameters.
- status_t TPM_UpdatePwmDutycycle (TPM_Type ∗base, tpm_chnl_t chnlNumber, tpm_pwm_mode_t currentPwmMode, uint8_t dutyCyclePercent)
  Update the duty cycle of an active PWM signal.
- void TPM_UpdateChnlEdgeLevelSelect (TPM_Type ∗base, tpm_chnl_t chnlNumber, uint8_t level)
  Update the edge level selection for a channel.
- static uint8_t TPM_GetChannelContorlBits (TPM_Type ∗base, tpm_chnl_t chnlNumber)
  Get the channel control bits value (mode, edge and level bit fileds).
- static void TPM_DisableChannel (TPM_Type ∗base, tpm_chnl_t chnlNumber)
  Dsiable the channel.
- static void TPM_EnableChannel (TPM_Type ∗base, tpm_chnl_t chnlNumber, uint8_t control)
  Enable the channel according to mode and level configs.
- void TPM_SetupInputCapture (TPM_Type ∗base, tpm_chnl_t chnlNumber, tpm_input_capture_edge_t captureMode)
  Enables capturing an input signal on the channel using the function parameters.
- void TPM_SetupOutputCompare (TPM_Type ∗base, tpm_chnl_t chnlNumber, tpm_output_compare_mode_t compareMode, uint32_t compareValue)

Configures the TPM to generate timed pulses.

Interrupt Interface

- void TPM_EnableInterrupts (TPM_Type ∗base, uint32_t mask)
  Enables the selected TPM interrupts.
- void TPM_DisableInterrupts (TPM_Type ∗base, uint32_t mask)
  Disables the selected TPM interrupts.
- uint32_t TPM_GetEnabledInterrupts (TPM_Type ∗base)
  Gets the enabled TPM interrupts.

Status Interface

- static uint32_t TPM_GetChannelValue (TPM_Type ∗base, tpm_chnl_t chnlNumber)
  Gets the TPM channel value.
- static uint32_t TPM_GetStatusFlags (TPM_Type ∗base)
  Gets the TPM status flags.
- static void TPM_ClearStatusFlags (TPM_Type ∗base, uint32_t mask)
  Clears the TPM status flags.

Read and write the timer period

- static void TPM_SetTimerPeriod (TPM_Type ∗base, uint32_t ticks)
  Sets the timer period in units of ticks.
- static uint32_t TPM_GetCurrentTimerCount (TPM_Type ∗base)
  Reads the current timer counting value.

Timer Start and Stop

- static void TPM_StartTimer (TPM_Type ∗base, tpm_clock_source_t clockSource)
  Starts the TPM counter.
- static void TPM_StopTimer (TPM_Type ∗base)
  Stops the TPM counter.

19.4 Data Structure Documentation

19.4.1 struct tpm_chnl_pwm_signal_param_t

Data Fields

- tpm_chnl_t chnlNumber
  TPM channel to configure.
- tpm_pwm_level_select_t level
  PWM output active level select.
- uint8_t dutyCyclePercent
  PWM pulse width, value should be between 0 to 100 0=inactive signal(0% duty cycle)...

Field Documentation

(1) tpm_chnl_t tpm_chnl_pwm_signal_param_t::chnlNumber

In combined mode (available in some SoC's), this represents the channel pair number

(2) uint8_t tpm_chnl_pwm_signal_param_t::dutyCyclePercent

100=always active signal (100% duty cycle)

19.4.2 struct tpm_config_t

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

The config struct can be made const so it resides in flash

Data Fields

- tpm_clock_prescale_t prescale
  Select TPM clock prescale value.

19.5 Macro Definition Documentation

19.5.1 #define FSL_TPM_DRIVER_VERSION (MAKE_VERSION(2, 2, 0))

19.6 Enumeration Type Documentation

19.6.1 enum tpm_chnl_t

Note

Actual number of available channels is SoC dependent

Enumerator

kTPM_Chnl_0 TPM channel number 0.
kTPM_Chnl_1 TPM channel number 1.
kTPM_Chnl_2 TPM channel number 2.
kTPM_Chnl_3 TPM channel number 3.
kTPM_Chnl_4 TPM channel number 4.
kTPM_Chnl_5 TPM channel number 5.
kTPM_Chnl_6 TPM channel number 6.
kTPM_Chnl_7 TPM channel number 7.

19.6.2 enum tpm_pwm_mode_t

Enumerator

kTPM_EdgeAlignedPwm Edge aligned PWM.
kTPM_CenterAlignedPwm Center aligned PWM.

19.6.3 enum tpm_pwm_level_select_t

Note

When the TPM has PWM pause level select feature, the PWM output cannot be turned off by selecting the output level. In this case, the channel must be closed to close the PWM output.

Enumerator

kTPM_NoPwmSignal No PWM output on pin.
kTPM_LowTrue Low true pulses.
kTPM_HighTrue High true pulses.

19.6.4 enum tpm_chnl_control_bit_mask_t

Enumerator

kTPM_ChnlELSnAMask Channel ELSA bit mask.
kTPM_ChnlELSnBMask Channel ELSB bit mask.
kTPM_ChnlMSAMask Channel MSA bit mask.
kTPM_ChnlMSBMask Channel MSB bit mask.

19.6.5 enum tpm_output_compare_mode_t

Enumerator

kTPM_NoOutputSignal No channel output when counter reaches CnV.
kTPM_ToggleOnMatch Toggle output.
kTPM_ClearOnMatch Clear output.
kTPM_SetOnMatch Set output.
kTPM_HighPulseOutput Pulse output high.
kTPM_LowPulseOutput Pulse output low.

19.6.6 enum tpm_input_capture_edge_t

Enumerator

kTPM_RisingEdge Capture on rising edge only.
kTPM_FallingEdge Capture on falling edge only.
kTPM_RiseAndFallEdge Capture on rising or falling edge.

19.6.7 enum tpm_clock_source_t

Enumerator

kTPM_SystemClock System clock.
kTPM_FixedClock Fixed frequency clock.
kTPM_ExternalClock External TPM_EXTCLK pin clock.

19.6.8 enum tpm_clock_prescale_t

Enumerator

kTPM_Prescale_Divide_1 Divide by 1.
kTPM_Prescale_Divide_2 Divide by 2.
kTPM_Prescale_Divide_4 Divide by 4.
kTPM_Prescale_Divide_8 Divide by 8.
kTPM_Prescale_Divide_16 Divide by 16.
kTPM_Prescale_Divide_32 Divide by 32.
kTPM_Prescale_Divide_64 Divide by 64.
kTPM_Prescale_Divide_128 Divide by 128.

19.6.9 enum tpm_interrupt_enable_t

Enumerator

kTPM_Chnl0InterruptEnable Channel 0 interrupt.
kTPM_Chnl1InterruptEnable Channel 1 interrupt.
kTPM_Chnl2InterruptEnable Channel 2 interrupt.
kTPM_Chnl3InterruptEnable Channel 3 interrupt.
kTPM_Chnl4InterruptEnable Channel 4 interrupt.
kTPM_Chnl5InterruptEnable Channel 5 interrupt.
kTPM_Chnl6InterruptEnable Channel 6 interrupt.
kTPM_Chnl7InterruptEnable Channel 7 interrupt.
kTPM_TimeOverflowInterruptEnable Time overflow interrupt.

19.6.10 enum tpm_status_flags_t

Enumerator

kTPM_Chnl0Flag Channel 0 flag.
kTPM_Chnl1Flag Channel 1 flag.
kTPM_Chnl2Flag Channel 2 flag.
kTPM_Chnl3Flag Channel 3 flag.
kTPM_Chnl4Flag Channel 4 flag.
kTPM_Chnl5Flag Channel 5 flag.
kTPM_Chnl6Flag Channel 6 flag.
kTPM_Chnl7Flag Channel 7 flag.
kTPM_TimeOverflowFlag Time overflow flag.

19.7 Function Documentation

19.7.1 void TPM_Init (TPM_Type * *base*, const tpm_config_t * *config*)

Note

This API should be called at the beginning of the application using the TPM driver.

Parameters

base	TPM peripheral base address
config	Pointer to user's TPM config structure.

19.7.2 void TPM_Deinit (TPM_Type * *base*)

Parameters

base	TPM peripheral base address

19.7.3 void TPM_GetDefaultConfig (tpm_config_t * *config*)

The default values are:

```
*     config->prescale = kTPM_Prescale_Divide_1;
*     config->useGlobalTimeBase = false;
*     config->syncGlobalTimeBase = false;
*     config->dozeEnable = false;
*     config->dbgMode = false;
*     config->enableReloadOnTrigger = false;
*     config->enableStopOnOverflow = false;
```

```
*     config->enableStartOnTrigger = false;
*#if FSL_FEATURE_TPM_HAS_PAUSE_COUNTER_ON_TRIGGER
*     config->enablePauseOnTrigger = false;
*#endif
*     config->triggerSelect = kTPM_Trigger_Select_0;
*#if FSL_FEATURE_TPM_HAS_EXTERNAL_TRIGGER_SELECTION
*     config->triggerSource = kTPM_TriggerSource_External;
*     config->extTriggerPolarity = kTPM_ExtTrigger_Active_High;
*#endif
*#if defined(FSL_FEATURE_TPM_HAS_POL) && FSL_FEATURE_TPM_HAS_POL
*     config->chnlPolarity = 0U;
*#endif
*
```

Parameters

config	Pointer to user's TPM config structure.

19.7.4 tpm_clock_prescale_t TPM_CalculateCounterClkDiv (TPM_Type ∗ *base*, uint32_t *counterPeriod_Hz*, uint32_t *srcClock_Hz*)

This function calculates the values for SC[PS].

Parameters

base	TPM peripheral base address
counterPeriod-_Hz	The desired frequency in Hz which corresponding to the time when the counter reaches the mod value
srcClock_Hz	TPM counter clock in Hz

return Calculated clock prescaler value.

19.7.5 status_t TPM_SetupPwm (TPM_Type ∗ *base*, const tpm_chnl_pwm_signal-_param_t ∗ *chnlParams*, uint8_t *numOfChnls*, tpm_pwm_mode_t *mode*, uint32_t *pwmFreq_Hz*, uint32_t *srcClock_Hz*)

User calls this function to configure the PWM signals period, mode, dutycycle and edge. Use this function to configure all the TPM channels that will be used to output a PWM signal

Parameters

base	TPM peripheral base address

chnlParams	Array of PWM channel parameters to configure the channel(s)
numOfChnls	Number of channels to configure, this should be the size of the array passed in
mode	PWM operation mode, options available in enumeration tpm_pwm_mode_t
pwmFreq_Hz	PWM signal frequency in Hz
srcClock_Hz	TPM counter clock in Hz

Returns

kStatus_Success if the PWM setup was successful, kStatus_Error on failure

19.7.6 status_t TPM_UpdatePwmDutycycle (TPM_Type ∗ *base,* tpm_chnl_t *chnlNumber,* tpm_pwm_mode_t *currentPwmMode,* uint8_t *dutyCyclePercent*)

Parameters

base	TPM peripheral base address
chnlNumber	The channel number. In combined mode, this represents the channel pair number
currentPwm-Mode	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)

Returns

kStatus_Success if the PWM setup was successful, kStatus_Error on failure

19.7.7 void TPM_UpdateChnlEdgeLevelSelect (TPM_Type ∗ *base,* tpm_chnl_t *chnlNumber,* uint8_t *level*)

Note

When the TPM has PWM pause level select feature (FSL_FEATURE_TPM_HAS_PAUSE_LEVEL_SELECT = 1), the PWM output cannot be turned off by selecting the output level. In this case, must use TPM_DisableChannel API to close the PWM output.

Parameters

base	TPM peripheral base address
chnlNumber	The channel number
level	The level to be set to the ELSnB:ELSnA field; valid values are 00, 01, 10, 11. See the appropriate SoC reference manual for details about this field.

19.7.8 static uint8_t TPM_GetChannelContorlBits (TPM_Type * *base*, tpm_chnl_t *chnlNumber*) [inline], [static]

This function disable the channel by clear all mode and level control bits.

Parameters

base	TPM peripheral base address
chnlNumber	The channel number

Returns

The contorl bits value. This is the logical OR of members of the enumeration tpm_chnl_control_bit-_mask_t.

19.7.9 static void TPM_DisableChannel (TPM_Type * *base*, tpm_chnl_t *chnlNumber*) [inline], [static]

This function disable the channel by clear all mode and level control bits.

Parameters

base	TPM peripheral base address
chnlNumber	The channel number

19.7.10 static void TPM_EnableChannel (TPM_Type * *base*, tpm_chnl_t *chnlNumber*, uint8_t *control*) [inline], [static]

This function enable the channel output according to input mode/level config parameters.

Parameters

base	TPM peripheral base address
chnlNumber	The channel number
control	The contorl bits value. This is the logical OR of members of the enumeration tpm_-chnl_control_bit_mask_t.

19.7.11 void TPM_SetupInputCapture (TPM_Type * *base,* tpm_chnl_t *chnlNumber,* tpm_input_capture_edge_t *captureMode*)

When the edge specified in the captureMode argument occurs on the channel, the TPM counter is captured into the CnV register. The user has to read the CnV register separately to get this value.

Parameters

base	TPM peripheral base address
chnlNumber	The channel number
captureMode	Specifies which edge to capture

19.7.12 void TPM_SetupOutputCompare (TPM_Type * *base,* tpm_chnl_t *chnlNumber,* tpm_output_compare_mode_t *compareMode,* uint32_t *compareValue*)

When the TPM counter matches the value of compareVal argument (this is written into CnV reg), the channel output is changed based on what is specified in the compareMode argument.

Parameters

base	TPM peripheral base address
chnlNumber	The channel number
compareMode	Action to take on the channel output when the compare condition is met
compareValue	Value to be programmed in the CnV register.

19.7.13 void TPM_EnableInterrupts (TPM_Type * *base,* uint32_t *mask*)

Parameters

base	TPM peripheral base address
mask	The interrupts to enable. This is a logical OR of members of the enumeration tpm_-interrupt_enable_t

19.7.14 void TPM_DisableInterrupts (TPM_Type * *base,* uint32_t *mask*)

Parameters

base	TPM peripheral base address
mask	The interrupts to disable. This is a logical OR of members of the enumeration tpm_-interrupt_enable_t

19.7.15 uint32_t TPM_GetEnabledInterrupts (TPM_Type * *base*)

Parameters

base	TPM peripheral base address

Returns

The enabled interrupts. This is the logical OR of members of the enumeration tpm_interrupt_enable-_t

19.7.16 static uint32_t TPM_GetChannelValue (TPM_Type * *base,* tpm_chnl_t *chnlNumber*) [inline], [static]

Note

The TPM channel value contain the captured TPM counter value for the input modes or the match value for the output modes.

Parameters

base	TPM peripheral base address
chnlNumber	The channel number

Returns

The channle CnV regisyer value.

19.7.17 static uint32_t TPM_GetStatusFlags (TPM_Type * *base*) [inline], [static]

Parameters

base	TPM peripheral base address

Returns

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

19.7.18 static void TPM_ClearStatusFlags (TPM_Type * *base*, uint32_t *mask*) [inline], [static]

Parameters

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

19.7.19 static void TPM_SetTimerPeriod (TPM_Type * *base*, uint32_t *ticks*) [inline], [static]

Timers counts from 0 until it equals the count value set here. The count value is written to the MOD register.

Note

1. This API allows the user to use the TPM module as a timer. Do not mix usage of this API with TPM's PWM setup API's.
2. Call the utility macros provided in the fsl_common.h to convert usec or msec to ticks.

Parameters

base	TPM peripheral base address
ticks	A timer period in units of ticks, which should be equal or greater than 1.

19.7.20 static uint32_t TPM_GetCurrentTimerCount (TPM_Type * *base*) [inline], [static]

This function returns the real-time timer counting value in a range from 0 to a timer period.

Note

Call the utility macros provided in the fsl_common.h to convert ticks to usec or msec.

Parameters

base	TPM peripheral base address

Returns

The current counter value in ticks

19.7.21 static void TPM_StartTimer (TPM_Type * *base*, tpm_clock_source_t *clockSource*) [inline], [static]

Parameters

base	TPM peripheral base address
clockSource	TPM clock source; once clock source is set the counter will start running

19.7.22 static void TPM_StopTimer (TPM_Type * *base*) [inline], [static]

Parameters

base	TPM peripheral base address

Chapter 20
UART: Universal Asynchronous Receiver/Transmitter Driver

20.1 Overview

Modules

- UART CMSIS Driver
- UART Driver

20.2 UART Driver

20.2.1 Overview

The MCUXpresso SDK provides a peripheral driver for the Universal Asynchronous Receiver/Transmitter (UART) module of MCUXpresso SDK devices.

The UART driver includes functional APIs and transactional APIs.

Functional APIs are used for UART initialization/configuration/operation for optimization/customization purpose. Using the functional API requires the knowledge of the UART peripheral and how to organize functional APIs to meet the application requirements. All functional APIs use the peripheral base address as the first parameter. UART functional operation groups provide the functional API set.

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, see the transactional API implementation and write custom code. All transactional APIs use the uart_handle_t as the second parameter. Initialize the handle by calling the UART_TransferCreateHandle() API.

Transactional APIs support asynchronous transfer, which means that the functions UART_TransferSendNonBlocking() and UART_TransferReceiveNonBlocking() set up an interrupt for data transfer. When the transfer completes, the upper layer is notified through a callback function with the kStatus_UART_TxIdle and kStatus_UART_RxIdle.

Transactional receive APIs support the ring buffer. Prepare the memory for the ring buffer and pass in the start address and size while calling the UART_TransferCreateHandle(). If passing NULL, the ring buffer feature is disabled. When the ring buffer is enabled, the received data is saved to the ring buffer in the background. The UART_TransferReceiveNonBlocking() function first gets data from the ring buffer. If the ring buffer does not have enough data, the function first returns the data in the ring buffer and then saves the received data to user memory. When all data is received, the upper layer is informed through a callback with the kStatus_UART_RxIdle.

If the receive ring buffer is full, the upper layer is informed through a callback with the kStatus_UART_RxRingBufferOverrun. In the callback function, the upper layer reads data out from the ring buffer. If not, existing data is overwritten by the new data.

The ring buffer size is specified when creating the handle. Note that one byte is reserved for the ring buffer maintenance. When creating handle using the following code.

Refer to the driver examples codes located at <SDK_ROOT>/boards/<BOARD>/driver_examples/uart In this example, the buffer size is 32, but only 31 bytes are used for saving data.

20.2.2 Typical use case

20.2.2.1 UART Send/receive using a polling method

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

20.2.2.2 UART Send/receive using an interrupt method

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

20.2.2.3 UART Receive using the ringbuffer feature

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

20.2.2.4 UART Send/Receive using the DMA method

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

Data Structures

- struct uart_config_t
  UART configuration structure. More...
- struct uart_transfer_t
  UART transfer structure. More...
- struct uart_handle_t
  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(* uart_transfer_callback_t)(UART_Type *base, uart_handle_t *handle, status_t status, void *userData)
  UART transfer callback function.

Enumerations

- enum {
kStatus_UART_TxBusy = MAKE_STATUS(kStatusGroup_UART, 0),
kStatus_UART_RxBusy = MAKE_STATUS(kStatusGroup_UART, 1),
kStatus_UART_TxIdle = MAKE_STATUS(kStatusGroup_UART, 2),
kStatus_UART_RxIdle = MAKE_STATUS(kStatusGroup_UART, 3),
kStatus_UART_TxWatermarkTooLarge = MAKE_STATUS(kStatusGroup_UART, 4),
kStatus_UART_RxWatermarkTooLarge = MAKE_STATUS(kStatusGroup_UART, 5),
kStatus_UART_FlagCannotClearManually,
kStatus_UART_Error = MAKE_STATUS(kStatusGroup_UART, 7),
kStatus_UART_RxRingBufferOverrun = MAKE_STATUS(kStatusGroup_UART, 8),
kStatus_UART_RxHardwareOverrun = MAKE_STATUS(kStatusGroup_UART, 9),
kStatus_UART_NoiseError = MAKE_STATUS(kStatusGroup_UART, 10),
kStatus_UART_FramingError = MAKE_STATUS(kStatusGroup_UART, 11),
kStatus_UART_ParityError = MAKE_STATUS(kStatusGroup_UART, 12),
kStatus_UART_BaudrateNotSupport,
kStatus_UART_IdleLineDetected = MAKE_STATUS(kStatusGroup_UART, 14),
kStatus_UART_Timeout = MAKE_STATUS(kStatusGroup_UART, 15) }
  Error codes for the UART driver.
- enum uart_parity_mode_t {
kUART_ParityDisabled = 0x0U,
kUART_ParityEven = 0x2U,
kUART_ParityOdd = 0x3U }
  UART parity mode.
- enum uart_stop_bit_count_t {
kUART_OneStopBit = 0U,
kUART_TwoStopBit = 1U }
  UART stop bit count.
- enum uart_idle_type_select_t {
kUART_IdleTypeStartBit = 0U,
kUART_IdleTypeStopBit = 1U }
  UART idle type select.
- enum _uart_interrupt_enable {
kUART_LinBreakInterruptEnable = (UART_BDH_LBKDIE_MASK),
kUART_RxActiveEdgeInterruptEnable = (UART_BDH_RXEDGIE_MASK),
kUART_TxDataRegEmptyInterruptEnable = (UART_C2_TIE_MASK << 8),
kUART_TransmissionCompleteInterruptEnable = (UART_C2_TCIE_MASK << 8),
kUART_RxDataRegFullInterruptEnable = (UART_C2_RIE_MASK << 8),
kUART_IdleLineInterruptEnable = (UART_C2_ILIE_MASK << 8),
kUART_RxOverrunInterruptEnable = (UART_C3_ORIE_MASK << 16),
kUART_NoiseErrorInterruptEnable = (UART_C3_NEIE_MASK << 16),
kUART_FramingErrorInterruptEnable = (UART_C3_FEIE_MASK << 16),
kUART_ParityErrorInterruptEnable = (UART_C3_PEIE_MASK << 16) }
  UART interrupt configuration structure, default settings all disabled.
- enum {

kUART_TxDataRegEmptyFlag = (UART_S1_TDRE_MASK),
kUART_TransmissionCompleteFlag = (UART_S1_TC_MASK),
kUART_RxDataRegFullFlag = (UART_S1_RDRF_MASK),
kUART_IdleLineFlag = (UART_S1_IDLE_MASK),
kUART_RxOverrunFlag = (UART_S1_OR_MASK),
kUART_NoiseErrorFlag = (UART_S1_NF_MASK),
kUART_FramingErrorFlag = (UART_S1_FE_MASK),
kUART_ParityErrorFlag = (UART_S1_PF_MASK),
kUART_LinBreakFlag,
kUART_RxActiveEdgeFlag,
kUART_RxActiveFlag }
UART status flags.

Functions

- uint32_t UART_GetInstance (UART_Type *base)
  Get the UART instance from peripheral base address.

Variables

- void * s_uartHandle [ ]
  Pointers to uart handles for each instance.
- uart_isr_t s_uartIsr
  Pointer to uart IRQ handler for each instance.

Driver version

- #define FSL_UART_DRIVER_VERSION (MAKE_VERSION(2, 5, 1))
  UART driver version.

Initialization and deinitialization

- status_t UART_Init (UART_Type *base, const uart_config_t *config, uint32_t srcClock_Hz)
  Initializes a UART instance with a user configuration structure and peripheral clock.
- void UART_Deinit (UART_Type *base)
  Deinitializes a UART instance.
- void UART_GetDefaultConfig (uart_config_t *config)
  Gets the default configuration structure.
- status_t UART_SetBaudRate (UART_Type *base, uint32_t baudRate_Bps, uint32_t srcClock_Hz)
  Sets the UART instance baud rate.
- void UART_Enable9bitMode (UART_Type *base, bool enable)
  Enable 9-bit data mode for UART.
- static void UART_Set9thTransmitBit (UART_Type *base)
  Set UART 9th transmit bit.

- static void UART_Clear9thTransmitBit (UART_Type *base)
  Clear UART 9th transmit bit.

Status

- uint32_t UART_GetStatusFlags (UART_Type *base)
  Gets UART status flags.
- status_t UART_ClearStatusFlags (UART_Type *base, uint32_t mask)
  Clears status flags with the provided mask.

Interrupts

- void UART_EnableInterrupts (UART_Type *base, uint32_t mask)
  Enables UART interrupts according to the provided mask.
- void UART_DisableInterrupts (UART_Type *base, uint32_t mask)
  Disables the UART interrupts according to the provided mask.
- uint32_t UART_GetEnabledInterrupts (UART_Type *base)
  Gets the enabled UART interrupts.

Bus Operations

- static void UART_EnableTx (UART_Type *base, bool enable)
  Enables or disables the UART transmitter.
- static void UART_EnableRx (UART_Type *base, bool enable)
  Enables or disables the UART receiver.
- static void UART_WriteByte (UART_Type *base, uint8_t data)
  Writes to the TX register.
- static uint8_t UART_ReadByte (UART_Type *base)
  Reads the RX register directly.
- status_t UART_WriteBlocking (UART_Type *base, const uint8_t *data, size_t length)
  Writes to the TX register using a blocking method.
- status_t UART_ReadBlocking (UART_Type *base, uint8_t *data, size_t length)
  Read RX data register using a blocking method.

Transactional

- void UART_TransferCreateHandle (UART_Type *base, uart_handle_t *handle, uart_transfer_callback_t callback, void *userData)
  Initializes the UART handle.
- void UART_TransferStartRingBuffer (UART_Type *base, uart_handle_t *handle, uint8_t *ringBuffer, size_t ringBufferSize)
  Sets up the RX ring buffer.
- void UART_TransferStopRingBuffer (UART_Type *base, uart_handle_t *handle)
  Aborts the background transfer and uninstalls the ring buffer.
- size_t UART_TransferGetRxRingBufferLength (uart_handle_t *handle)

Get the length of received data in RX ring buffer.
- status_t UART_TransferSendNonBlocking (UART_Type ∗base, uart_handle_t ∗handle, uart_transfer_t ∗xfer)
  Transmits a buffer of data using the interrupt method.
- void UART_TransferAbortSend (UART_Type ∗base, uart_handle_t ∗handle)
  Aborts the interrupt-driven data transmit.
- status_t UART_TransferGetSendCount (UART_Type ∗base, uart_handle_t ∗handle, uint32_t ∗count)
  Gets the number of bytes sent out to bus.
- status_t UART_TransferReceiveNonBlocking (UART_Type ∗base, uart_handle_t ∗handle, uart_transfer_t ∗xfer, size_t ∗receivedBytes)
  Receives a buffer of data using an interrupt method.
- void UART_TransferAbortReceive (UART_Type ∗base, uart_handle_t ∗handle)
  Aborts the interrupt-driven data receiving.
- status_t UART_TransferGetReceiveCount (UART_Type ∗base, uart_handle_t ∗handle, uint32_t ∗count)
  Gets the number of bytes that have been received.
- void UART_TransferHandleIRQ (UART_Type ∗base, void ∗irqHandle)
  UART IRQ handle function.
- void UART_TransferHandleErrorIRQ (UART_Type ∗base, void ∗irqHandle)
  UART Error IRQ handle function.

20.2.3 Data Structure Documentation

20.2.3.1 struct uart_config_t

Data Fields

- uint32_t baudRate_Bps
  UART baud rate.
- uart_parity_mode_t parityMode
  Parity mode, disabled (default), even, odd.
- uart_stop_bit_count_t stopBitCount
  Number of stop bits, 1 stop bit (default) or 2 stop bits.
- uart_idle_type_select_t idleType
  IDLE type select.
- bool enableTx
  Enable TX.
- bool enableRx
  Enable RX.

Field Documentation

(1) uart_idle_type_select_t uart_config_t::idleType

20.2.3.2 struct uart_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* uart_transfer_t::data

(2) uint8_t* uart_transfer_t::rxData

(3) const uint8_t* uart_transfer_t::txData

(4) size_t uart_transfer_t::dataSize

20.2.3.3 struct _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.
- size_t txDataSizeAll
  Size of the data to send out.
- uint8_t *volatile rxData
  Address of remaining data to receive.
- volatile size_t rxDataSize
  Size of the remaining data to receive.
- size_t rxDataSizeAll
  Size of the data to receive.
- uint8_t * rxRingBuffer
  Start address of the receiver ring buffer.
- size_t rxRingBufferSize
  Size of the ring buffer.
- volatile uint16_t rxRingBufferHead
  Index for the driver to store received data into ring buffer.
- volatile uint16_t rxRingBufferTail
  Index for the user to get data from the ring buffer.
- uart_transfer_callback_t callback
  Callback function.
- void * userData
  UART callback function parameter.

- volatile uint8_t txState
  TX transfer state.
- volatile uint8_t rxState
  RX transfer state.

Field Documentation

(1) const uint8_t* volatile uart_handle_t::txData

(2) volatile size_t uart_handle_t::txDataSize

(3) size_t uart_handle_t::txDataSizeAll

(4) uint8_t* volatile uart_handle_t::rxData

(5) volatile size_t uart_handle_t::rxDataSize

(6) size_t uart_handle_t::rxDataSizeAll

(7) uint8_t* uart_handle_t::rxRingBuffer

(8) size_t uart_handle_t::rxRingBufferSize

(9) volatile uint16_t uart_handle_t::rxRingBufferHead

(10) volatile uint16_t uart_handle_t::rxRingBufferTail

(11) uart_transfer_callback_t uart_handle_t::callback

(12) void* uart_handle_t::userData

(13) volatile uint8_t uart_handle_t::txState

20.2.4 Macro Definition Documentation

20.2.4.1 #define FSL_UART_DRIVER_VERSION (MAKE_VERSION(2, 5, 1))

20.2.4.2 #define UART_RETRY_TIMES 0U /* Defining to zero means to keep waiting for the flag until it is assert/deassert. */

20.2.5 Typedef Documentation

20.2.5.1 typedef void(* uart_transfer_callback_t)(UART_Type *base, uart_handle_t *handle, status_t status, void *userData)

20.2.6 Enumeration Type Documentation

20.2.6.1 anonymous enum

Enumerator

kStatus_UART_TxBusy Transmitter is busy.
kStatus_UART_RxBusy Receiver is busy.
kStatus_UART_TxIdle UART transmitter is idle.
kStatus_UART_RxIdle UART receiver is idle.
kStatus_UART_TxWatermarkTooLarge TX FIFO watermark too large.
kStatus_UART_RxWatermarkTooLarge RX FIFO watermark too large.
kStatus_UART_FlagCannotClearManually UART flag can't be manually cleared.
kStatus_UART_Error Error happens on UART.
kStatus_UART_RxRingBufferOverrun UART RX software ring buffer overrun.
kStatus_UART_RxHardwareOverrun UART RX receiver overrun.
kStatus_UART_NoiseError UART noise error.
kStatus_UART_FramingError UART framing error.
kStatus_UART_ParityError UART parity error.
kStatus_UART_BaudrateNotSupport Baudrate is not support in current clock source.
kStatus_UART_IdleLineDetected UART IDLE line detected.
kStatus_UART_Timeout UART times out.

20.2.6.2 enum uart_parity_mode_t

Enumerator

kUART_ParityDisabled Parity disabled.
kUART_ParityEven Parity enabled, type even, bit setting: PE|PT = 10.
kUART_ParityOdd Parity enabled, type odd, bit setting: PE|PT = 11.

20.2.6.3 enum uart_stop_bit_count_t

Enumerator

kUART_OneStopBit One stop bit.
kUART_TwoStopBit Two stop bits.

20.2.6.4 enum uart_idle_type_select_t

Enumerator

kUART_IdleTypeStartBit Start counting after a valid start bit.
kUART_IdleTypeStopBit Start counting after a stop bit.

20.2.6.5 enum _uart_interrupt_enable

This structure contains the settings for all of the UART interrupt configurations.

Enumerator

kUART_LinBreakInterruptEnable LIN break detect interrupt.
kUART_RxActiveEdgeInterruptEnable RX active edge interrupt.
kUART_TxDataRegEmptyInterruptEnable Transmit data register empty interrupt.
kUART_TransmissionCompleteInterruptEnable Transmission complete interrupt.
kUART_RxDataRegFullInterruptEnable Receiver data register full interrupt.
kUART_IdleLineInterruptEnable Idle line interrupt.
kUART_RxOverrunInterruptEnable Receiver overrun interrupt.
kUART_NoiseErrorInterruptEnable Noise error flag interrupt.
kUART_FramingErrorInterruptEnable Framing error flag interrupt.
kUART_ParityErrorInterruptEnable Parity error flag interrupt.

20.2.6.6 anonymous enum

This provides constants for the UART status flags for use in the UART functions.

Enumerator

kUART_TxDataRegEmptyFlag TX data register empty flag.
kUART_TransmissionCompleteFlag Transmission complete flag.
kUART_RxDataRegFullFlag RX data register full flag.
kUART_IdleLineFlag Idle line detect flag.
kUART_RxOverrunFlag RX overrun flag.
kUART_NoiseErrorFlag RX takes 3 samples of each received bit. If any of these samples differ, noise flag sets
kUART_FramingErrorFlag Frame error flag, sets if logic 0 was detected where stop bit expected.
kUART_ParityErrorFlag If parity enabled, sets upon parity error detection.
kUART_LinBreakFlag LIN break detect interrupt flag, sets when LIN break char detected and LIN circuit enabled.
kUART_RxActiveEdgeFlag RX pin active edge interrupt flag,sets when active edge detected.
kUART_RxActiveFlag Receiver Active Flag (RAF), sets at beginning of valid start bit.

20.2.7 Function Documentation

20.2.7.1 uint32_t UART_GetInstance (UART_Type * *base*)

Parameters

base	UART peripheral base address.

Returns

UART instance.

20.2.7.2 status_t UART_Init (UART_Type * *base*, const uart_config_t * *config*, uint32_t *srcClock_Hz*)

This function configures the UART module with the user-defined settings. The user can configure the configuration structure and also get the default configuration by using the UART_GetDefaultConfig() function. The example below shows how to use this API to configure UART.

```
*  uart_config_t uartConfig;
*  uartConfig.baudRate_Bps = 115200U;
*  uartConfig.parityMode = kUART_ParityDisabled;
*  uartConfig.stopBitCount = kUART_OneStopBit;
*  uartConfig.txFifoWatermark = 0;
*  uartConfig.rxFifoWatermark = 1;
*  UART_Init(UART1, &uartConfig, 20000000U);
*
```

Parameters

base	UART peripheral base address.
config	Pointer to the user-defined configuration structure.
srcClock_Hz	UART clock source frequency in HZ.

Return values

kStatus_UART_Baudrate-NotSupport	Baudrate is not support in current clock source.
kStatus_Success	Status UART initialize succeed

20.2.7.3 void UART_Deinit (UART_Type * *base*)

This function waits for TX complete, disables TX and RX, and disables the UART clock.

Parameters

base	UART peripheral base address.

20.2.7.4 void UART_GetDefaultConfig (uart_config_t * *config*)

This function initializes the UART configuration structure to a default value. The default values are as follows. uartConfig->baudRate_Bps = 115200U; uartConfig->bitCountPerChar = kUART_8BitsPerChar; uartConfig->parityMode = kUART_ParityDisabled; uartConfig->stopBitCount = kUART_OneStopBit; uartConfig->txFifoWatermark = 0; uartConfig->rxFifoWatermark = 1; uartConfig->idleType = kUART_IdleTypeStartBit; uartConfig->enableTx = false; uartConfig->enableRx = false;

Parameters

config	Pointer to configuration structure.

20.2.7.5 status_t UART_SetBaudRate (UART_Type * *base*, uint32_t *baudRate_Bps*, uint32_t *srcClock_Hz*)

This function configures the UART module baud rate. This function is used to update the UART module baud rate after the UART module is initialized by the UART_Init.

```
*  UART_SetBaudRate(UART1, 115200U, 20000000U);
*
```

Parameters

base	UART peripheral base address.
baudRate_Bps	UART baudrate to be set.
srcClock_Hz	UART clock source frequency in Hz.

Return values

kStatus_UART_BaudrateNotSupport	Baudrate is not support in the current clock source.

kStatus_Success	Set baudrate succeeded.

20.2.7.6 void UART_Enable9bitMode (UART_Type * *base*, bool *enable*)

This function set the 9-bit mode for UART module. The 9th bit is not used for parity thus can be modified by user.

Parameters

base	UART peripheral base address.
enable	true to enable, flase to disable.

20.2.7.7 static void UART_Set9thTransmitBit (UART_Type * *base*) [inline], [static]

Parameters

base	UART peripheral base address.

20.2.7.8 static void UART_Clear9thTransmitBit (UART_Type * *base*) [inline], [static]

Parameters

base	UART peripheral base address.

20.2.7.9 uint32_t UART_GetStatusFlags (UART_Type * *base*)

This function gets all UART status flags. The flags are returned as the logical OR value of the enumerators _uart_flags. To check a specific status, compare the return value with enumerators in _uart_flags. For example, to check whether the TX is empty, do the following.

```
*     if (kUART_TxDataRegEmptyFlag & UART_GetStatusFlags(UART1))
*     {
*         ...
*     }
*
```

Parameters

base	UART peripheral base address.

Returns

UART status flags which are ORed by the enumerators in the _uart_flags.

20.2.7.10 status_t UART_ClearStatusFlags (UART_Type * *base*, uint32_t *mask*)

This function clears UART status flags with a provided mask. An automatically cleared flag can't be cleared by this function. These flags can only be cleared or set by hardware. kUART_TxDataRegEmptyFlag, kUART_TransmissionCompleteFlag, kUART_RxDataRegFullFlag, kUART_RxActiveFlag, kUART_NoiseErrorInRxDataRegFlag, kUART_ParityErrorInRxDataRegFlag, kUART_TxFifoEmptyFlag,kUART_RxFifoEmptyFlag

Note

that this API should be called when the Tx/Rx is idle. Otherwise it has no effect.

Parameters

base	UART peripheral base address.
mask	The status flags to be cleared; it is logical OR value of _uart_flags.

Return values

kStatus_UART_FlagCannotClearManually	The flag can't be cleared by this function but it is cleared automatically by hardware.
kStatus_Success	Status in the mask is cleared.

20.2.7.11 void UART_EnableInterrupts (UART_Type * *base*, uint32_t *mask*)

This function enables the UART interrupts according to the provided mask. The mask is a logical OR of enumeration members. See _uart_interrupt_enable. For example, to enable TX empty interrupt and RX full interrupt, do the following.

```
*     UART_EnableInterrupts(UART1,
      kUART_TxDataRegEmptyInterruptEnable |
      kUART_RxDataRegFullInterruptEnable);
*
```

Parameters

base	UART peripheral base address.
mask	The interrupts to enable. Logical OR of _uart_interrupt_enable.

20.2.7.12 void UART_DisableInterrupts (UART_Type ∗ *base*, uint32_t *mask*)

This function disables the UART interrupts according to the provided mask. The mask is a logical OR of enumeration members. See _uart_interrupt_enable. For example, to disable TX empty interrupt and RX full interrupt do the following.

```
*     UART_DisableInterrupts(UART1,
      kUART_TxDataRegEmptyInterruptEnable |
      kUART_RxDataRegFullInterruptEnable);
*
```

Parameters

base	UART peripheral base address.
mask	The interrupts to disable. Logical OR of _uart_interrupt_enable.

20.2.7.13 uint32_t UART_GetEnabledInterrupts (UART_Type ∗ *base*)

This function gets the enabled UART interrupts. The enabled interrupts are returned as the logical OR value of the enumerators _uart_interrupt_enable. To check a specific interrupts enable status, compare the return value with enumerators in _uart_interrupt_enable. For example, to check whether TX empty interrupt is enabled, do the following.

```
*     uint32_t enabledInterrupts = UART_GetEnabledInterrupts(UART1);
*
*     if (kUART_TxDataRegEmptyInterruptEnable & enabledInterrupts)
*     {
*         ...
*     }
*
```

Parameters

base	UART peripheral base address.

Returns

UART interrupt flags which are logical OR of the enumerators in _uart_interrupt_enable.

20.2.7.14 static void UART_EnableTx (UART_Type * *base*, bool *enable*) [inline], [static]

This function enables or disables the UART transmitter.

Parameters

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

20.2.7.15 static void UART_EnableRx (UART_Type * *base*, bool *enable*) [inline], [static]

This function enables or disables the UART receiver.

Parameters

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

20.2.7.16 static void UART_WriteByte (UART_Type * *base*, uint8_t *data*) [inline], [static]

This function writes data to the TX register directly. The upper layer must ensure that the TX register is empty or TX FIFO has empty room before calling this function.

Parameters

base	UART peripheral base address.
data	The byte to write.

20.2.7.17 static uint8_t UART_ReadByte (UART_Type * *base*) [inline], [static]

This function reads data from the RX register directly. The upper layer must ensure that the RX register is full or that the TX FIFO has data before calling this function.

Parameters

base	UART peripheral base address.

Returns

The byte read from UART data register.

20.2.7.18 status_t UART_WriteBlocking (UART_Type * *base*, const uint8_t * *data*, size_t *length*)

This function polls the TX register, waits for the TX register to be empty or for the TX FIFO to have room and writes data to the TX buffer.

Parameters

base	UART peripheral base address.
data	Start address of the data to write.
length	Size of the data to write.

Return values

kStatus_UART_Timeout	Transmission timed out and was aborted.
kStatus_Success	Successfully wrote all data.

20.2.7.19 status_t UART_ReadBlocking (UART_Type * *base*, uint8_t * *data*, size_t *length*)

This function polls the RX register, waits for the RX register to be full or for RX FIFO to have data, and reads data from the TX register.

Parameters

base	UART peripheral base address.
data	Start address of the buffer to store the received data.
length	Size of the buffer.

Return values

kStatus_UART_Rx-HardwareOverrun	Receiver overrun occurred while receiving data.
kStatus_UART_Noise-Error	A noise error occurred while receiving data.
kStatus_UART_Framing-Error	A framing error occurred while receiving data.
kStatus_UART_Parity-Error	A parity error occurred while receiving data.
kStatus_UART_Timeout	Transmission timed out and was aborted.

kStatus_Success	Successfully received all data.

20.2.7.20 void UART_TransferCreateHandle (UART_Type * *base*, uart_handle_t * *handle*, uart_transfer_callback_t *callback*, void * *userData*)

This function initializes the UART handle which can be used for other UART transactional APIs. Usually, for a specified UART instance, call this API once to get the initialized handle.

Parameters

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

20.2.7.21 void UART_TransferStartRingBuffer (UART_Type * *base*, 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 are stored into the ring buffer even when the user doesn't call the UART_TransferReceiveNonBlocking() API. If data is already received in the ring buffer, the user can get the received data from the ring buffer directly.

Note

> When using the RX ring buffer, one byte is reserved for internal use. In other words, if `ringBufferSize` is 32, only 31 bytes are used for saving data.

Parameters

base	UART peripheral base address.
handle	UART handle pointer.
ringBuffer	Start address of the ring buffer for background receiving. Pass NULL to disable the ring buffer.
ringBufferSize	Size of the ring buffer.

20.2.7.22 void UART_TransferStopRingBuffer (UART_Type * *base*, uart_handle_t * *handle*)

This function aborts the background transfer and uninstalls the ring buffer.

Parameters

base	UART peripheral base address.
handle	UART handle pointer.

20.2.7.23 size_t UART_TransferGetRxRingBufferLength (uart_handle_t * *handle*)

Parameters

handle	UART handle pointer.

Returns

Length of received data in RX ring buffer.

20.2.7.24 status_t UART_TransferSendNonBlocking (UART_Type * *base,* uart_handle_t * *handle,* 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 the ISR, the UART driver calls the callback function and passes the kStatus_UART_TxIdle as status parameter.

Note

The kStatus_UART_TxIdle is passed to the upper layer when all data is written to the TX register. However, it does not ensure that all data is sent out. Before disabling the TX, check the kUART_-TransmissionCompleteFlag to ensure that the TX is finished.

Parameters

base	UART peripheral base address.
handle	UART handle pointer.
xfer	UART transfer structure. See uart_transfer_t.

Return values

kStatus_Success	Successfully start the data transmission.
kStatus_UART_TxBusy	Previous transmission still not finished; data not all written to TX register yet.
kStatus_InvalidArgument	Invalid argument.

20.2.7.25 void UART_TransferAbortSend (UART_Type * *base,* uart_handle_t * *handle*)

This function aborts the interrupt-driven data sending. The user can get the remainBytes to find out how many bytes are not sent out.

Parameters

base	UART peripheral base address.
handle	UART handle pointer.

20.2.7.26 status_t UART_TransferGetSendCount (UART_Type * *base*, uart_handle_t * *handle*, uint32_t * *count*)

This function gets the number of bytes sent out to bus by using the interrupt method.

Parameters

base	UART peripheral base address.
handle	UART handle pointer.
count	Send bytes count.

Return values

kStatus_NoTransferInProgress	No send in progress.
kStatus_InvalidArgument	The parameter is invalid.
kStatus_Success	Get successfully through the parameter `count`;

20.2.7.27 status_t UART_TransferReceiveNonBlocking (UART_Type * *base*, uart_handle_t * *handle*, uart_transfer_t * *xfer*, size_t * *receivedBytes*)

This function receives data using an interrupt method. This is a non-blocking function, which returns without waiting for all data to be received. If the RX ring buffer is used and not empty, the data in the ring buffer is copied and the parameter `receivedBytes` shows how many bytes are copied from the ring buffer. After copying, if the data in the ring buffer is not enough to read, the receive request is saved by the UART driver. When the new data arrives, the receive request is serviced first. When all data is received, the UART driver notifies the upper layer through a callback function and passes the status parameter kStatus_UART_RxIdle. For example, the upper layer needs 10 bytes but there are only 5 bytes in the ring buffer. The 5 bytes are copied to the xfer->data and this function returns with the parameter `receivedBytes` set to 5. For the left 5 bytes, newly arrived data is saved from the xfer->data[5]. When 5 bytes are received, the UART driver notifies the upper layer. If the RX ring buffer is not enabled, this function enables the RX and RX interrupt to receive data to the xfer->data. When all data is received, the upper layer is notified.

Parameters

base	UART peripheral base address.
handle	UART handle pointer.
xfer	UART transfer structure, see uart_transfer_t.
receivedBytes	Bytes received from the ring buffer directly.

Return values

kStatus_Success	Successfully queue the transfer into transmit queue.
kStatus_UART_RxBusy	Previous receive request is not finished.
kStatus_InvalidArgument	Invalid argument.

20.2.7.28 void UART_TransferAbortReceive (UART_Type ∗ *base,* uart_handle_t ∗ *handle*)

This function aborts the interrupt-driven data receiving. The user can get the remainBytes to know how many bytes are not received yet.

Parameters

base	UART peripheral base address.
handle	UART handle pointer.

20.2.7.29 status_t UART_TransferGetReceiveCount (UART_Type ∗ *base,* uart_handle_t ∗ *handle,* uint32_t ∗ *count*)

This function gets the number of bytes that have been received.

Parameters

base	UART peripheral base address.
handle	UART handle pointer.
count	Receive bytes count.

Return values

kStatus_NoTransferInProgress	No receive in progress.
kStatus_InvalidArgument	Parameter is invalid.
kStatus_Success	Get successfully through the parameter `count`;

20.2.7.30 void UART_TransferHandleIRQ (UART_Type ∗ *base,* void ∗ *irqHandle*)

This function handles the UART transmit and receive IRQ request.

Parameters

base	UART peripheral base address.
irqHandle	UART handle pointer.

20.2.7.31 void UART_TransferHandleErrorIRQ (UART_Type ∗ *base,* void ∗ *irqHandle*)

This function handles the UART error IRQ request.

Parameters

base	UART peripheral base address.
irqHandle	UART handle pointer.

20.2.8 Variable Documentation

20.2.8.1 void∗ s_uartHandle[]

20.2.8.2 uart_isr_t s_uartIsr

20.3 UART CMSIS Driver

This section describes the programming interface of the UART 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 UART 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.

20.3.1 UART CMSIS Driver

20.3.1.1 UART Send/receive using an interrupt method

```
/* UART  callback */
void UART_Callback(uint32_t event)
{
    if (event == ARM_USART_EVENT_SEND_COMPLETE)
    {
        txBufferFull = false;
        txOnGoing = false;
    }

    if (event == ARM_USART_EVENT_RECEIVE_COMPLETE)
    {
        rxBufferEmpty = false;
        rxOnGoing = false;
    }
}
Driver_USART0.Initialize(UART_Callback);
Driver_USART0.PowerControl(ARM_POWER_FULL);
/* Send g_tipString out. */
txOnGoing = true;
Driver_USART0.Send(g_tipString, sizeof(g_tipString) - 1);

/* Wait send finished */
while (txOnGoing)
{
}
```

20.3.1.2 UART Send/Receive using the DMA method

```
/* UART  callback */
void UART_Callback(uint32_t event)
{
    if (event == ARM_USART_EVENT_SEND_COMPLETE)
    {
        txBufferFull = false;
        txOnGoing = false;
    }

    if (event == ARM_USART_EVENT_RECEIVE_COMPLETE)
```

```
    {
        rxBufferEmpty = false;
        rxOnGoing = false;
    }
}

Driver_USART0.Initialize(UART_Callback);
DMAMGR_Init();
Driver_USART0.PowerControl(ARM_POWER_FULL);

/* Send g_tipString out. */
txOnGoing = true;

Driver_USART0.Send(g_tipString, sizeof(g_tipString) - 1);

/* Wait send finished */
while (txOnGoing)
{
}
```

Chapter 21
WDOG8: 8-bit Watchdog Timer

21.1 Overview

The MCUXpresso SDK provides a peripheral driver for the WDOG8 module of MCUXpresso SDK devices.

21.2 Typical use case

```
wdog8_config_t config;
WDOG8_GetDefaultConfig(&config);
config.timeoutValue = 0xffffU;
config.enableWindowMode = true;
config.windowValue = 0x1ffU;
WDOG8_Init(wdog_base,&config);
```

WDOG8 Initialization and De-initialization

- void WDOG8_GetDefaultConfig (wdog8_config_t *config)
  Initializes the WDOG8 configuration structure.
- void WDOG8_Init (WDOG_Type *base, const wdog8_config_t *config)
  Initializes the WDOG8 module.
- void WDOG8_Deinit (WDOG_Type *base)
  De-initializes the WDOG8 module.

WDOG8 functional Operation

- static void WDOG8_Enable (WDOG_Type *base)
  Enables the WDOG8 module.
- static void WDOG8_Disable (WDOG_Type *base)
  Disables the WDOG8 module.
- static void WDOG8_EnableInterrupts (WDOG_Type *base, uint8_t mask)
  Enables the WDOG8 interrupt.
- static void WDOG8_DisableInterrupts (WDOG_Type *base, uint8_t mask)
  Disables the WDOG8 interrupt.
- static uint8_t WDOG8_GetStatusFlags (WDOG_Type *base)
  Gets the WDOG8 all status flags.
- void WDOG8_ClearStatusFlags (WDOG_Type *base, uint8_t mask)
  Clears the WDOG8 flag.
- static void WDOG8_SetTimeoutValue (WDOG_Type *base, uint16_t timeoutCount)
  Sets the WDOG8 timeout value.
- static void WDOG8_SetWindowValue (WDOG_Type *base, uint16_t windowValue)
  Sets the WDOG8 window value.
- static void WDOG8_Unlock (WDOG_Type *base)
  Unlocks the WDOG8 register written.
- static void WDOG8_Refresh (WDOG_Type *base)
  Refreshes the WDOG8 timer.

- static uint16_t WDOG8_GetCounterValue (WDOG_Type *base)
  Gets the WDOG8 counter value.

21.3 Function Documentation

21.3.1 void WDOG8_GetDefaultConfig (wdog8_config_t * *config*)

This function initializes the WDOG8 configuration structure to default values. The default values are:

```
*   wdog8Config->enableWdog8 = true;
*   wdog8Config->clockSource = kWDOG8_ClockSource1;
*   wdog8Config->prescaler = kWDOG8_ClockPrescalerDivide1;
*   wdog8Config->workMode.enableWait = true;
*   wdog8Config->workMode.enableStop = false;
*   wdog8Config->workMode.enableDebug = false;
*   wdog8Config->testMode = kWDOG8_TestModeDisabled;
*   wdog8Config->enableUpdate = true;
*   wdog8Config->enableInterrupt = false;
*   wdog8Config->enableWindowMode = false;
*   wdog8Config->windowValue = 0U;
*   wdog8Config->timeoutValue = 0xFFFFU;
*
```

Parameters

config	Pointer to the WDOG8 configuration structure.

See Also

wdog8_config_t

21.3.2 void WDOG8_Init (WDOG_Type * *base*, const wdog8_config_t * *config*)

This function initializes the WDOG8. To reconfigure the WDOG8 without forcing a reset first, enableUpdate must be set to true in the configuration.

Example:

```
*   wdog8_config_t config;
*   WDOG8_GetDefaultConfig(&config);
*   config.timeoutValue = 0x7ffU;
*   config.enableUpdate = true;
*   WDOG8_Init(wdog_base,&config);
*
```

Parameters

base	WDOG8 peripheral base address.
config	The configuration of the WDOG8.

21.3.3 void WDOG8_Deinit (WDOG_Type * *base*)

This function shuts down the WDOG8. Ensure that the WDOG_CS1.UPDATE is 1, which means that the register update is enabled.

Parameters

base	WDOG8 peripheral base address.

21.3.4 static void WDOG8_Enable (WDOG_Type * *base*) `[inline]`, `[static]`

This function writes a value into the WDOG_CS1 register to enable the WDOG8. The WDOG_CS1 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	WDOG8 peripheral base address.

21.3.5 static void WDOG8_Disable (WDOG_Type * *base*) `[inline]`, `[static]`

This function writes a value into the WDOG_CS1 register to disable the WDOG8. The WDOG_CS1 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	WDOG8 peripheral base address

21.3.6 static void WDOG8_EnableInterrupts (WDOG_Type * *base,* uint8_t *mask*) `[inline]`, `[static]`

This function writes a value into the WDOG_CS1 register to enable the WDOG8 interrupt. The WDOG-_CS1 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	WDOG8 peripheral base address.
mask	The interrupts to enable. The parameter can be a combination of the following source if defined: • kWDOG8_InterruptEnable

21.3.7 static void WDOG8_DisableInterrupts (WDOG_Type ∗ *base,* uint8_t *mask*) [inline], [static]

This function writes a value into the WDOG_CS register to disable the WDOG8 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	WDOG8 peripheral base address.
mask	The interrupts to disabled. The parameter can be a combination of the following source if defined: • kWDOG8_InterruptEnable

21.3.8 static uint8_t WDOG8_GetStatusFlags (WDOG_Type ∗ *base*) [inline], [static]

This function gets all status flags.

Example to get the running flag:

```
*   uint32_t status;
*   status = WDOG8_GetStatusFlags(wdog_base) & kWDOG8_RunningFlag;
*
```

Parameters

base	WDOG8 peripheral base address

Returns

State of the status flag: asserted (true) or not-asserted (false).

See Also

_wdog8_status_flags_t
- true: related status flag has been set.
- false: related status flag is not set.

21.3.9 void WDOG8_ClearStatusFlags (WDOG_Type * *base*, uint8_t *mask*)

This function clears the WDOG8 status flag.

Example to clear an interrupt flag:

```
*   WDOG8_ClearStatusFlags(wdog_base,kWDOG8_InterruptFlag);
*
```

Parameters

base	WDOG8 peripheral base address.
mask	The status flags to clear. The parameter can be any combination of the following values: • kWDOG8_InterruptFlag

21.3.10 static void WDOG8_SetTimeoutValue (WDOG_Type * *base*, uint16_t *timeoutCount*) [inline], [static]

This function writes a timeout value into the WDOG_TOVALH/L register. The WDOG_TOVALH/L 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	WDOG8 peripheral base address
timeoutCount	WDOG8 timeout value, count of WDOG8 clock ticks.

21.3.11 static void WDOG8_SetWindowValue (WDOG_Type * *base*, uint16_t *windowValue*) [inline], [static]

This function writes a window value into the WDOG_WINH/L register. The WDOG_WINH/L 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	WDOG8 peripheral base address.
windowValue	WDOG8 window value.

21.3.12 static void WDOG8_Unlock (WDOG_Type * *base*) [inline], [static]

This function unlocks the WDOG8 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	WDOG8 peripheral base address

21.3.13 static void WDOG8_Refresh (WDOG_Type * *base*) [inline], [static]

This function feeds the WDOG8. This function should be called before the Watchdog timer is in timeout. Otherwise, a reset is asserted.

Parameters

base	WDOG8 peripheral base address

21.3.14 static uint16_t WDOG8_GetCounterValue (WDOG_Type * *base*) [inline], [static]

This function gets the WDOG8 counter value.

Parameters

base	WDOG8 peripheral base address.

Returns

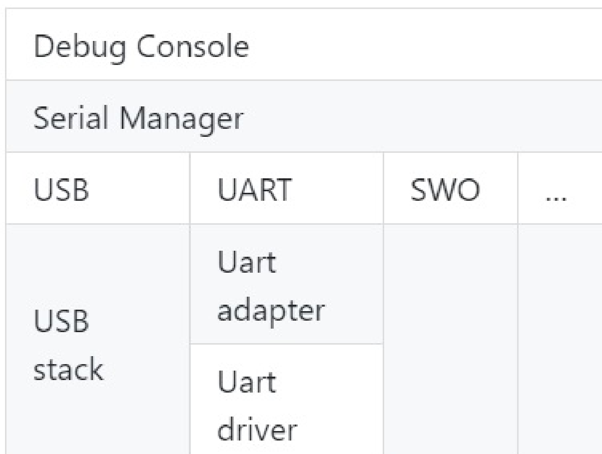
Current WDOG8 counter value.

Chapter 22
Debug Console

22.1 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

22.2 Function groups

22.2.1 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);
```

22.2.2 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 */
```

22.2.3 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 MCU-Xpresso, if the macro SDK_DEBUGCONSOLE_UART is defined, __sys_write and __sys_readc will be used when __REDLIB__ is defined; _write and _read will be used in other cases.The macro does not specifically refer to the 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_TO-OLCHAIN	defined	Low level peripheral*	Low level peripheral
DEBUGCONSOLE_-REDIRECT_TO_TO-OLCHAIN	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.

22.3 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

- 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.

22.4 Macro Definition Documentation

22.4.1 #define DEBUGCONSOLE_REDIRECT_TO_TOOLCHAIN 0U

Select toolchain printf and scanf.

22.4.2 #define DEBUGCONSOLE_REDIRECT_TO_SDK 1U

22.4.3 #define DEBUGCONSOLE_DISABLE 2U

22.4.4 #define SDK_DEBUGCONSOLE DEBUGCONSOLE_REDIRECT_TO_SDK

The macro only support to be redefined in project setting.

22.4.5 #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.

22.5 Function Documentation

22.5.1 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 UAR-T 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

22.5.2 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.

22.5.3 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.

22.5.4 status_t DbgConsole_ExitLowpower (void)

This function is used to restore from low power consumption.

Returns

Indicates whether de-initialization was successful or not.

22.5.5 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.

22.5.6 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.

22.5.7 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.

22.5.8 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.

22.5.9 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.

22.5.10 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.

22.5.11 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.
formatStringArg	Format arguments.

Returns

Returns the number of characters printed or a negative value if an error occurs.

22.5.12 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.

22.5.13 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

22.5.14 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 "".

22.6 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.

22.6.1 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.

22.6.2 Guide Semihosting for Keil µVision

NOTE: Semihosting is not support by MDK-ARM, use the retargeting functionality of MDK-ARM instead.

22.6.3 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.

22.6.4 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.

Chapter 23
Notification Framework

23.1 Overview

This section describes the programming interface of the Notifier driver.

23.2 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.

23.3 Data Structure Documentation

23.3.1 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

23.3.2 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

23.3.3 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

23.4 Typedef Documentation

23.4.1 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.

23.4.2 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.

23.4.3 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.

23.5 Enumeration Type Documentation

23.5.1 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.

23.5.2 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.

23.5.3 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.

23.5.4 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.

23.6 Function Documentation

23.6.1 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.

23.6.2 status_t NOTIFIER_SwitchConfig (notifier_handle_t ∗ *notifierHandle*, uint8_t *configIndex*, notifier_policy_t *policy*)

This function sets the system to the target configuration. Before transition, the Notifier sends notifications to all callbacks registered to the callback table. Callbacks are invoked in the following order: All registered callbacks are notified ordered by index in the callbacks array. The same order is used for before and after switch notifications. The notifications before the configuration switch can be used to obtain confirmation about the change from registered callbacks. If any registered callback denies the configuration change, further execution of this function depends on the notifier policy: the configuration change is either forced (kNOTIFIER_PolicyForcible) or exited (kNOTIFIER_PolicyAgreement). When configuration change is forced, the result of the before switch notifications are ignored. If an agreement is required, if any callback returns an error code, further notifications before switch notifications are cancelled and all already notified callbacks are re-invoked. The index of the callback which returned error code during pre-switch notifications is stored (any error codes during callbacks re-invocation are ignored) and NOTIFIER_GetErrorCallback() can be used to get it. Regardless of the policies, if any callback returns an error code, an error code indicating in which phase the error occurred is returned when NOTIFIER_SwitchConfig() exits.

Parameters

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.

23.6.3 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 24
Shell

24.1 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.

24.2 Function groups

24.2.1 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>");
```

24.2.2 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.

24.2.3 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 ∗shell-Command)
  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.

24.3 Data Structure Documentation

24.3.1 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

24.4 Macro Definition Documentation

24.4.1 #define SHELL_NON_BLOCKING_MODE SERIAL_MANAGER_NON_BLOCKING_MODE

24.4.2 #define SHELL_AUTO_COMPLETE (1U)

24.4.3 #define SHELL_BUFFER_SIZE (64U)

24.4.4 #define SHELL_MAX_ARGS (8U)

24.4.5 #define SHELL_HISTORY_COUNT (3U)

24.4.6 #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

24.4.7 #define SHELL_USE_COMMON_TASK (0U)

24.4.8 #define SHELL_TASK_PRIORITY (2U)

24.4.9 #define SHELL_TASK_STACK_SIZE (1000U)

24.4.10 #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.

24.4.11 #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.

24.4.12 #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".

24.5 Typedef Documentation

24.5.1 typedef shell_status_t(* cmd_function_t)(shell_handle_t shellHandle, int32_t argc, char **argv)

24.6 Enumeration Type Documentation

24.6.1 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.

24.7 Function Documentation

24.7.1 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.

24.7.2 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.

24.7.3 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.

24.7.4 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.

24.7.5 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.

24.7.6 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.

24.7.7 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.

24.7.8 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.

24.7.9 void SHELL_PrintPrompt (shell_handle_t *shellHandle*)

Call this function to print shell prompt.

Parameters

shellHandle	The shell module handle pointer.

Returns

NULL.

24.7.10 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.

24.7.11 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 25
Serial Manager

25.1 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 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.

25.2 Data Structure Documentation

25.2.1 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.

25.2.2 struct serial_manager_callback_message_t

Data Fields

- uint8_t * buffer
  Transferred buffer.
- uint32_t length
  Transferred data length.

25.3 Macro Definition Documentation

25.3.1 #define SERIAL_MANAGER_WRITE_TIME_DELAY_DEFAULT_VALUE (1U)

25.3.2 #define SERIAL_MANAGER_READ_TIME_DELAY_DEFAULT_VALUE (1U)

25.3.3 #define SERIAL_MANAGER_USE_COMMON_TASK (0U)

Macro to determine whether use common task.

25.3.4 #define SERIAL_MANAGER_HANDLE_SIZE (SERIAL_MANAGER_HANDLE_-SIZE_TEMP + 12U)

Definition of serial manager handle size.

25.3.5 #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.

25.3.6 #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.

25.3.7 #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.

25.3.8 #define SERIAL_MANAGER_TASK_PRIORITY (2U)

25.3.9 #define SERIAL_MANAGER_TASK_STACK_SIZE (1000U)

25.4 Enumeration Type Documentation

25.4.1 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.

25.4.2 enum serial_manager_type_t

Enumerator

kSerialManager_NonBlocking None blocking handle.
kSerialManager_Blocking Blocking handle.

25.4.3 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.

25.5 Function Documentation

25.5.1 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.

25.5.2 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.

25.5.3 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_HAN-DLE_DEFINE(writeHandle); or uint32_t writeHandle[((SERIAL_MANAGER_W-RITE_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);
*
```

25.5.4 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.

25.5.5 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_HAND-LE_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));
*
```

25.5.6 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.

25.5.7 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.

25.5.8 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.

25.5.9 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.

25.5.10 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.

25.5.11 static bool SerialManager_needPollingIsr (void) [inline], [static]

This function is used to check if need polling ISR.

Return values

TRUE	if need polling.

25.6 Serial Port Uart

25.6.1 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

25.6.2 Enumeration Type Documentation

25.6.2.1 enum serial_port_uart_parity_mode_t

Enumerator

kSerialManager_UartParityDisabled Parity disabled.
kSerialManager_UartParityEven Parity even enabled.
kSerialManager_UartParityOdd Parity odd enabled.

25.6.2.2 enum serial_port_uart_stop_bit_count_t

Enumerator

kSerialManager_UartOneStopBit One stop bit.
kSerialManager_UartTwoStopBit Two stop bits.

Chapter 26
Irq

26.1 Overview

Modules

- IRQ: external interrupt (IRQ) module

Files

- file fsl_irq.h

Data Structures

- struct irq_config_t
  The IRQ pin configuration structure. More...

Enumerations

- enum irq_edge_t {
  kIRQ_FallingEdgeorLowlevel = 0U,
  kIRQ_RisingEdgeorHighlevel = 1U }
  Interrupt Request (IRQ) Edge Select.
- enum irq_mode_t {
  kIRQ_DetectOnEdgesOnly = 0U,
  kIRQ_DetectOnEdgesAndEdges = 1U }
  Interrupt Request (IRQ) Detection Mode.

Driver version

- #define FSL_IRQ_DRIVER_VERSION (MAKE_VERSION(2, 0, 2))
  Version 2.0.2.

IRQ Configuration

- uint32_t IRQ_GetInstance (IRQ_Type ∗base)
  Get irq instance.
- void IRQ_Init (IRQ_Type ∗base, const irq_config_t ∗config)
  Initializes the IRQ pin used by the board.
- void IRQ_Deinit (IRQ_Type ∗base)
  Deinitialize IRQ peripheral.
- static void IRQ_Enable (IRQ_Type ∗base, bool enable)
  Enable/disable IRQ pin.

IRQ interrupt Operations

- static void IRQ_EnableInterrupt (IRQ_Type ∗base, bool enable)
  Enable/disable IRQ pin interrupt.
- static void IRQ_ClearIRQFlag (IRQ_Type ∗base)
  Clear IRQF flag.
- static uint32_t IRQ_GetIRQFlag (IRQ_Type ∗base)
  Get IRQF flag.

26.2 Data Structure Documentation

26.2.1 struct irq_config_t

Data Fields

- bool enablePullDevice
  Enable/disable the internal pullup device when the IRQ pin is enabled.
- irq_edge_t edgeSelect
  Select the polarity of edges or levels on the IRQ pin that cause IRQF to be set.
- irq_mode_t detectMode
  select either edge-only detection or edge-and-level detection

26.3 Macro Definition Documentation

26.3.1 #define FSL_IRQ_DRIVER_VERSION (MAKE_VERSION(2, 0, 2))

26.4 Enumeration Type Documentation

26.4.1 enum irq_edge_t

Enumerator

kIRQ_FallingEdgeorLowlevel IRQ is falling-edge or falling-edge/low-level sensitive.
kIRQ_RisingEdgeorHighlevel IRQ is rising-edge or rising-edge/high-level sensitive.

26.4.2 enum irq_mode_t

Enumerator

kIRQ_DetectOnEdgesOnly IRQ event is detected only on falling/rising edges.
kIRQ_DetectOnEdgesAndEdges IRQ event is detected on falling/rising edges and low/high levels.

26.5 Function Documentation

26.5.1 uint32_t IRQ_GetInstance (IRQ_Type ∗ *base*)

Parameters

base	IRQ peripheral base pointer

Return values

Irq	instance number.

26.5.2 void IRQ_Init (IRQ_Type * *base*, const irq_config_t * *config*)

To initialize the IRQ pin, define a irq configuration, specify whhether enable pull-up, the edge and detect mode. Then, call the IRQ_Init() function.

This is an example to initialize irq configuration.

```
* irq_config_t config =
* {
*   true,
*   kIRQ_FallingEdgeorLowlevel,
*   kIRQ_DetectOnEdgesOnly
* }
*
```

Parameters

base	IRQ peripheral base pointer
config	IRQ configuration pointer

26.5.3 void IRQ_Deinit (IRQ_Type * *base*)

This function disables the IRQ clock.

Parameters

base	IRQ peripheral base pointer.

Return values

None.	

26.5.4 static void IRQ_Enable (IRQ_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	IRQ peripheral base pointer.
enable	true to enable IRQ pin, else disable IRQ pin.

Return values

None.	

26.5.5 static void IRQ_EnableInterrupt (IRQ_Type * *base*, bool *enable*) [inline], [static]

Parameters

base	IRQ peripheral base pointer.
enable	true to enable IRQF assert interrupt request, else disable.

Return values

None.	

26.5.6 static void IRQ_ClearIRQFlag (IRQ_Type * *base*) [inline], [static]

This function clears the IRQF flag.

Parameters

base	IRQ peripheral base pointer.

Return values

None.	

26.5.7 static uint32_t IRQ_GetIRQFlag (IRQ_Type * *base*) [inline], [static]

This function returns the IRQF flag.

Parameters

base	IRQ peripheral base pointer.

Return values

status	= 0 IRQF flag deasserted. = 1 IRQF flag asserted.

Chapter 27
Data Structure Documentation

27.0.8 wdog8_config_t Struct Reference

Describes WDOG8 configuration structure.

`#include <fsl_wdog8.h>`

Data Fields

- bool enableWdog8
  Enables or disables WDOG8.
- wdog8_clock_source_t clockSource
  Clock source select.
- wdog8_clock_prescaler_t prescaler
  Clock prescaler value.
- wdog8_work_mode_t workMode
  Configures WDOG8 work mode in debug stop and wait mode.
- wdog8_test_mode_t testMode
  Configures WDOG8 test mode.
- bool enableUpdate
  Update write-once register enable.
- bool enableInterrupt
  Enables or disables WDOG8 interrupt.
- bool enableWindowMode
  Enables or disables WDOG8 window mode.
- uint16_t windowValue
  Window value.
- uint16_t timeoutValue
  Timeout value.

27.0.8.1 Detailed Description

27.0.9 wdog8_work_mode_t Struct Reference

Defines WDOG8 work mode.

`#include <fsl_wdog8.h>`

Data Fields

- bool enableWait

Enables or disables WDOG8 in wait mode.

- bool enableStop

  Enables or disables WDOG8 in stop mode.
- bool enableDebug

  Enables or disables WDOG8 in debug mode.

27.0.9.1 Detailed Description

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