




MSP430® Peripheral Driver Library for MSP430i2xx Devices

USER'S GUIDE

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1 Introduction

The Texas Instruments® MSP430® Peripheral Driver Library is a set of drivers for accessing the peripherals found on the MSP430i2xx family of microcontrollers. While they are not drivers in the pure operating system sense (that is, they do not have a common interface and do not connect into a global device driver infrastructure), they do provide a mechanism that makes it easy to use the device's peripherals.

The capabilities and organization of the drivers are governed by the following design goals:

- They are written entirely in C except where absolutely not possible.
- They demonstrate how to use the peripheral in its common mode of operation.
- They are easy to understand.
- They are reasonably efficient in terms of memory and processor usage.
- They are as self-contained as possible.
- Where possible, computations that can be performed at compile time are done there instead of at run time.
- They can be built with more than one tool chain.

Some consequences of these design goals are:

- The drivers are not necessarily as efficient as they could be (from a code size and/or execution speed point of view). While the most efficient piece of code for operating a peripheral would be written in assembly and custom tailored to the specific requirements of the application, further size optimizations of the drivers would make them more difficult to understand.
- The drivers do not support the full capabilities of the hardware. Some of the peripherals provide complex capabilities which cannot be utilized by the drivers in this library, though the existing code can be used as a reference upon which to add support for the additional capabilities.
- The APIs have a means of removing all error checking code. Because the error checking is usually only useful during initial program development, it can be removed to improve code size and speed.

For many applications, the drivers can be used as is. But in some cases, the drivers will have to be enhanced or rewritten in order to meet the functionality, memory, or processing requirements of the application. If so, the existing driver can be used as a reference on how to operate the peripheral.

Some driverlib APIs take in the base address of the corresponding peripheral as the first parameter. This base address is obtained from the msp430 device specific header files (or from the device datasheet). The example code for the various peripherals show how base address is used.

The following tool chains are supported:

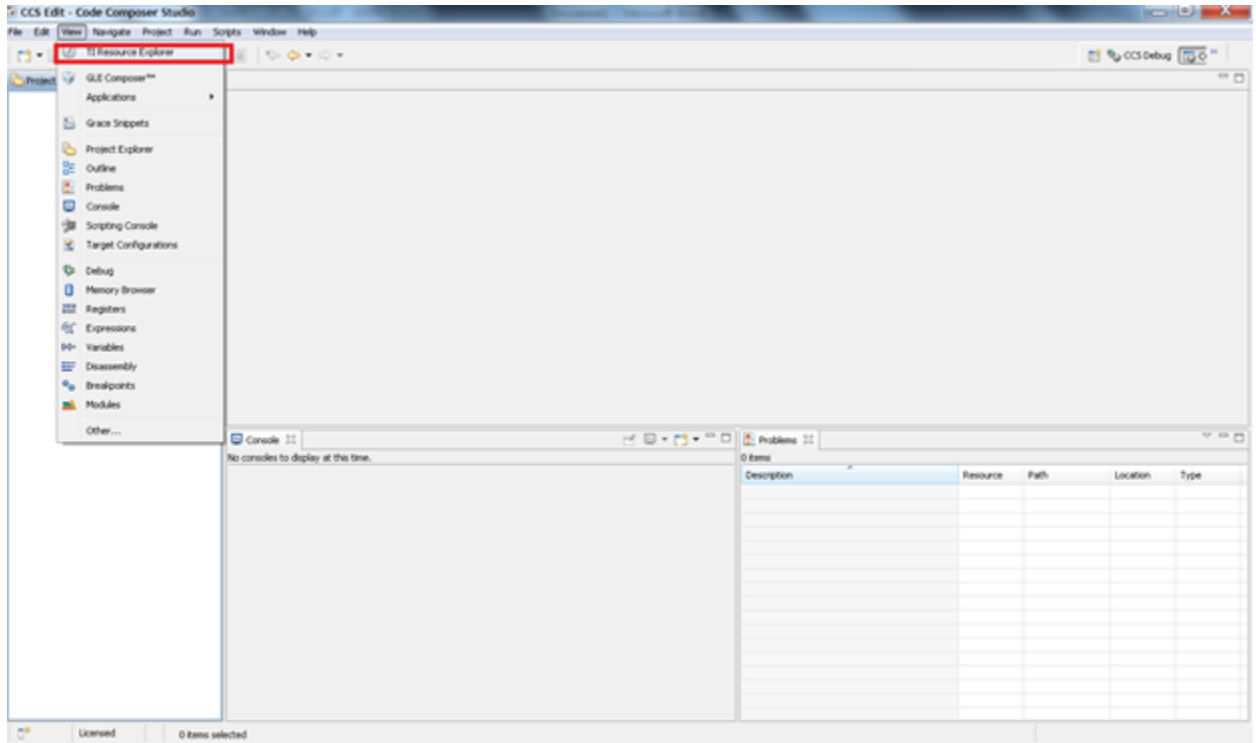
- IAR Embedded Workbench®
- Texas Instruments Code Composer Studio™

Using assert statements to debug

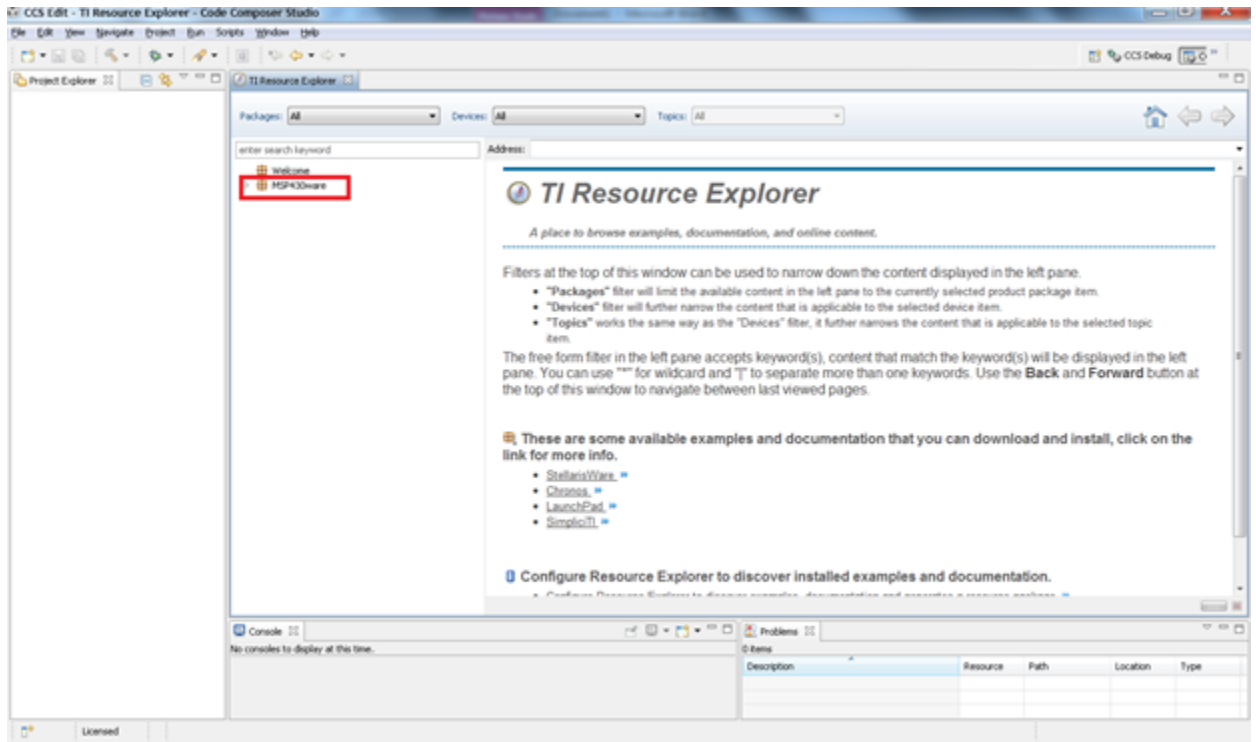
Assert statements are disabled by default. To enable the assert statement edit the `hw_regaccess.h` file in the inc folder. Comment out the statement `define NDEBUG -> //define NDEBUG`. Asserts in CCS work only if the project is optimized for size.

2 Navigating to driverlib through CCS Resource Explorer

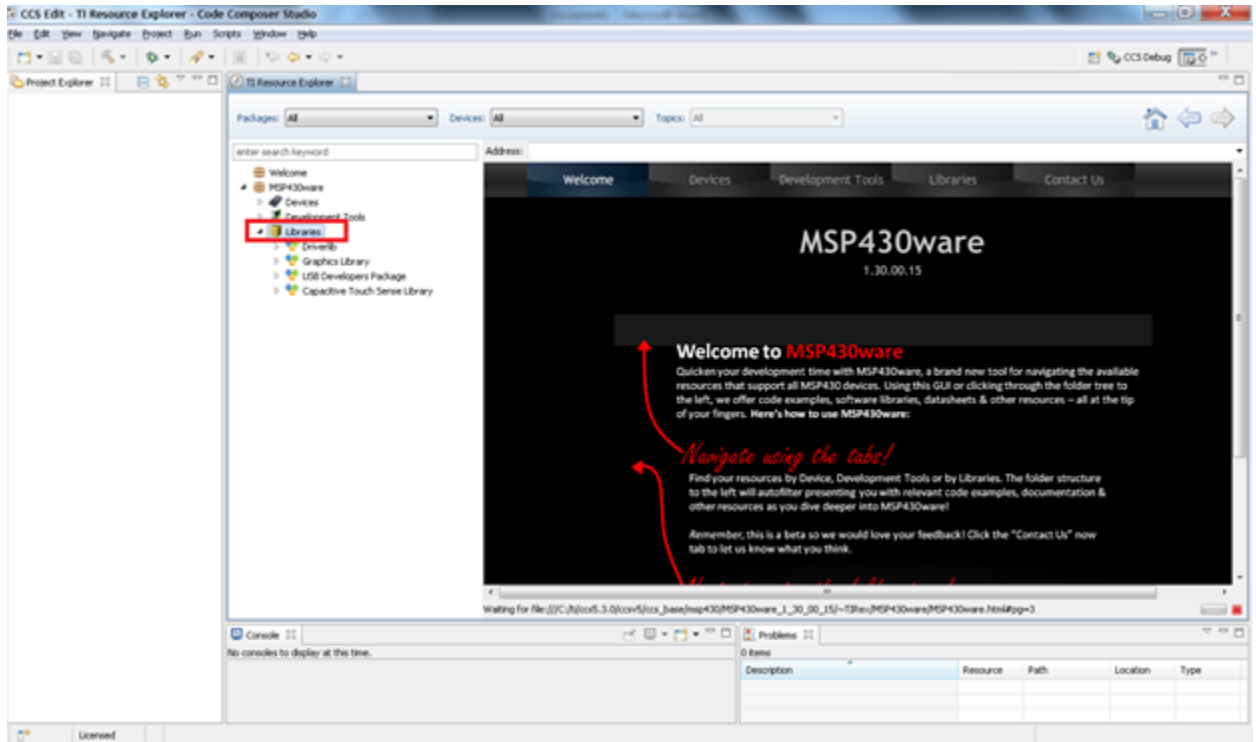
In CCS, click View->TI Resource Explorer

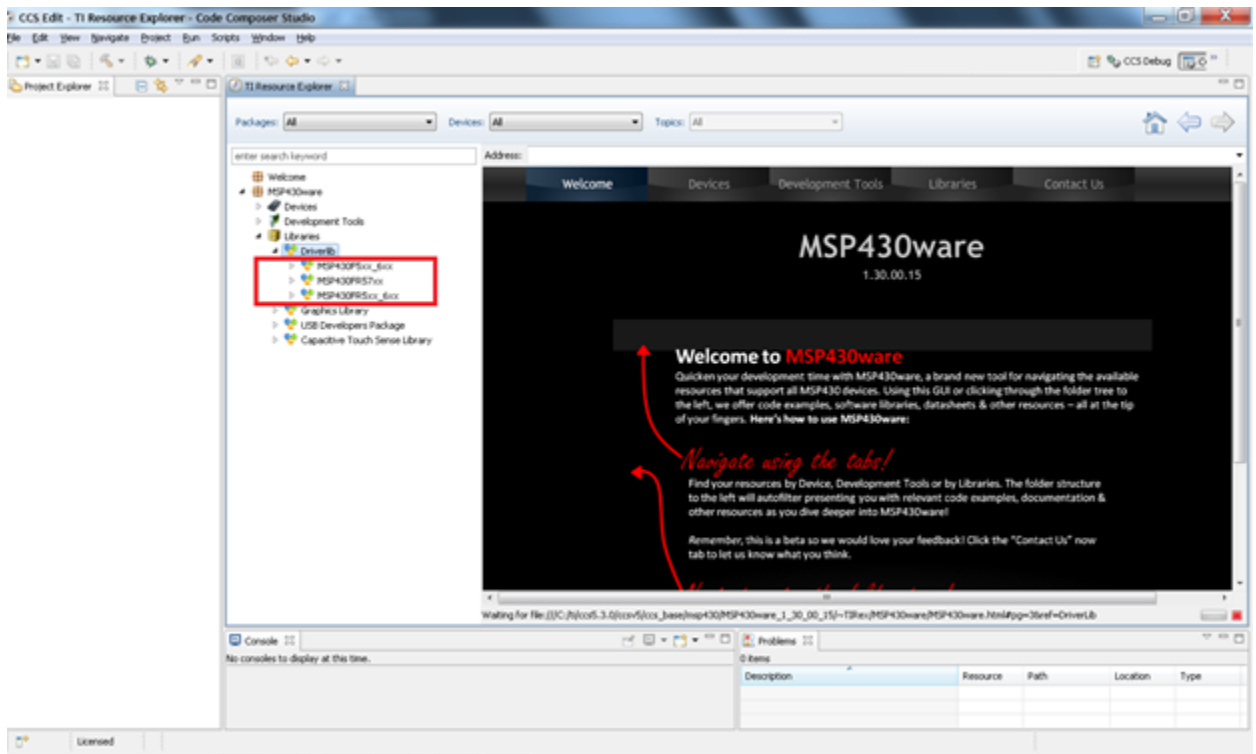


In Resource Explorer View, click on MSP430ware

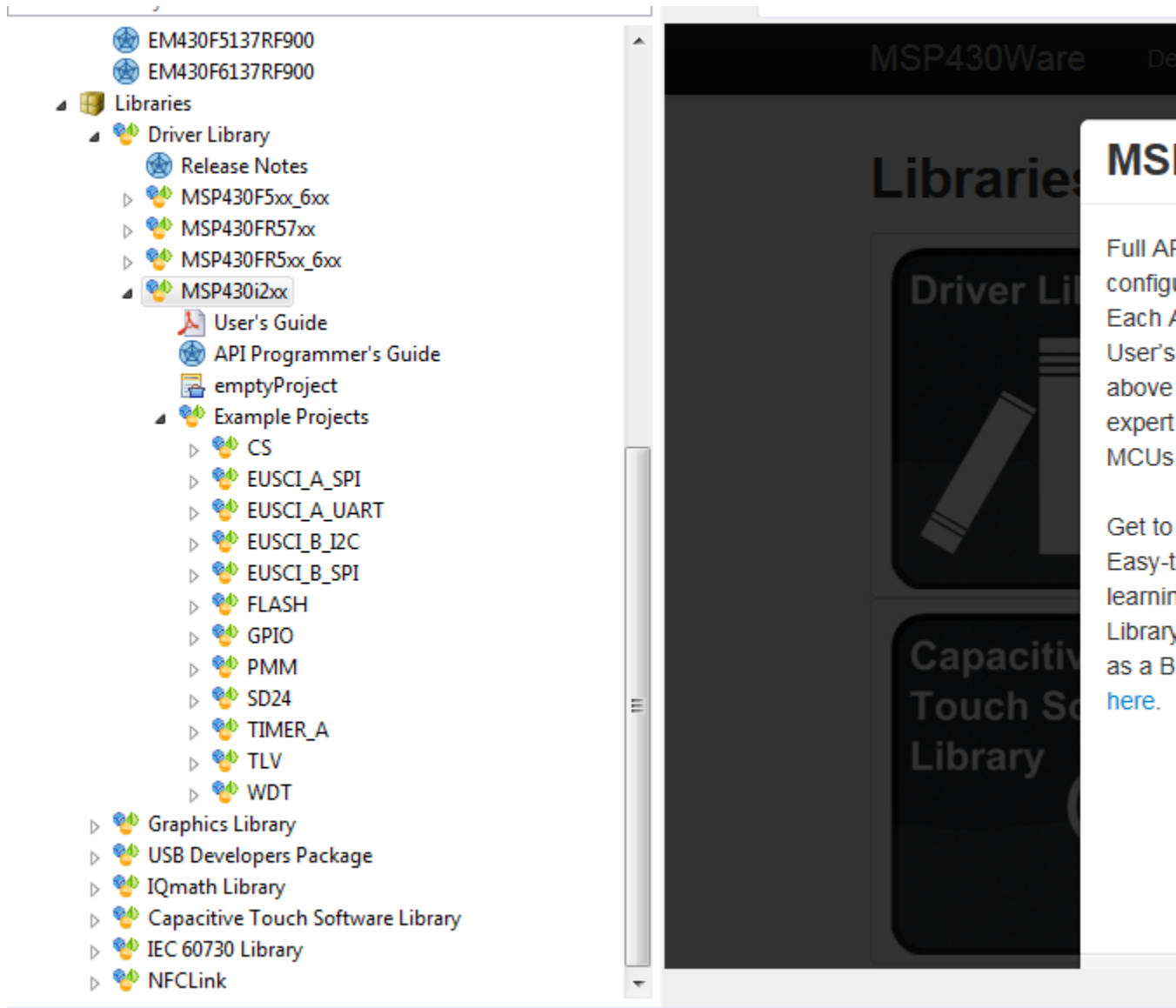


Clicking MSP430ware takes you to the introductory page. The version of the latest MSP430ware installed is available in this page. In this screenshot the version is 1.30.00.15 The various software, collateral, code examples, datasheets and user guides can be navigated by clicking the different topics under MSP430ware. To proceed to driverlib, click on Libraries->Driverlib as shown in the next two screenshots.

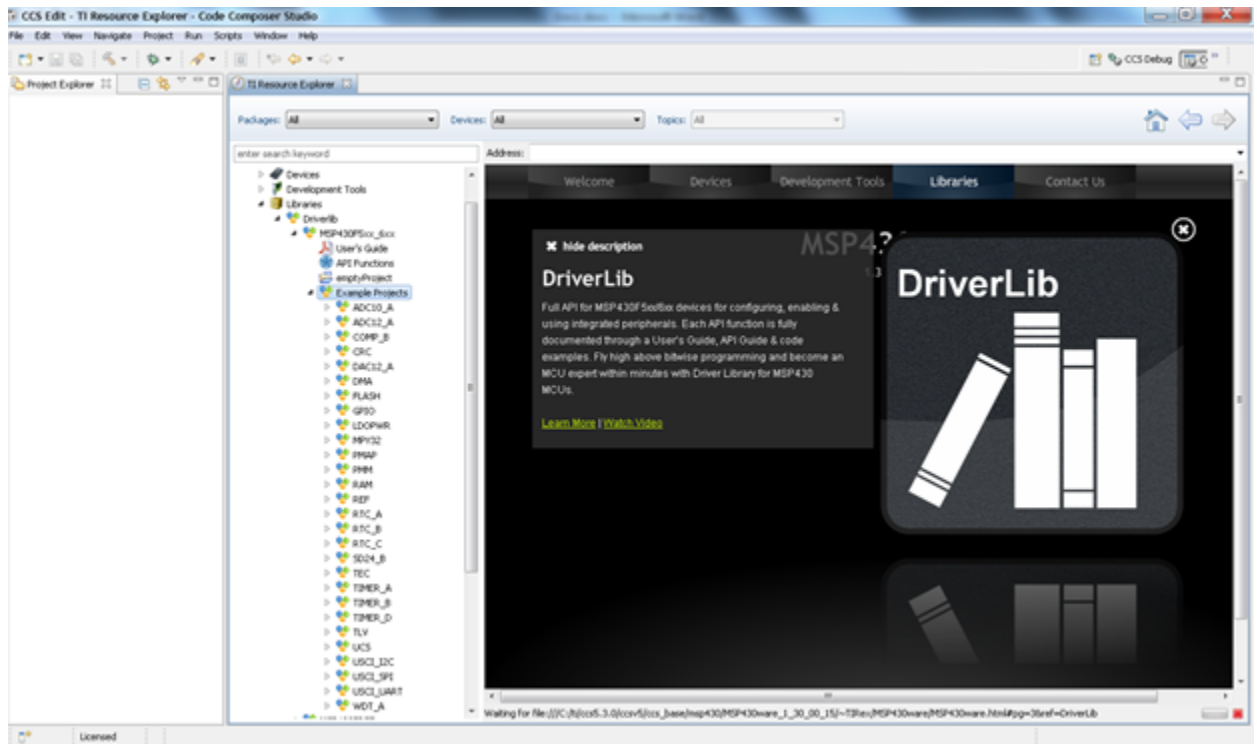




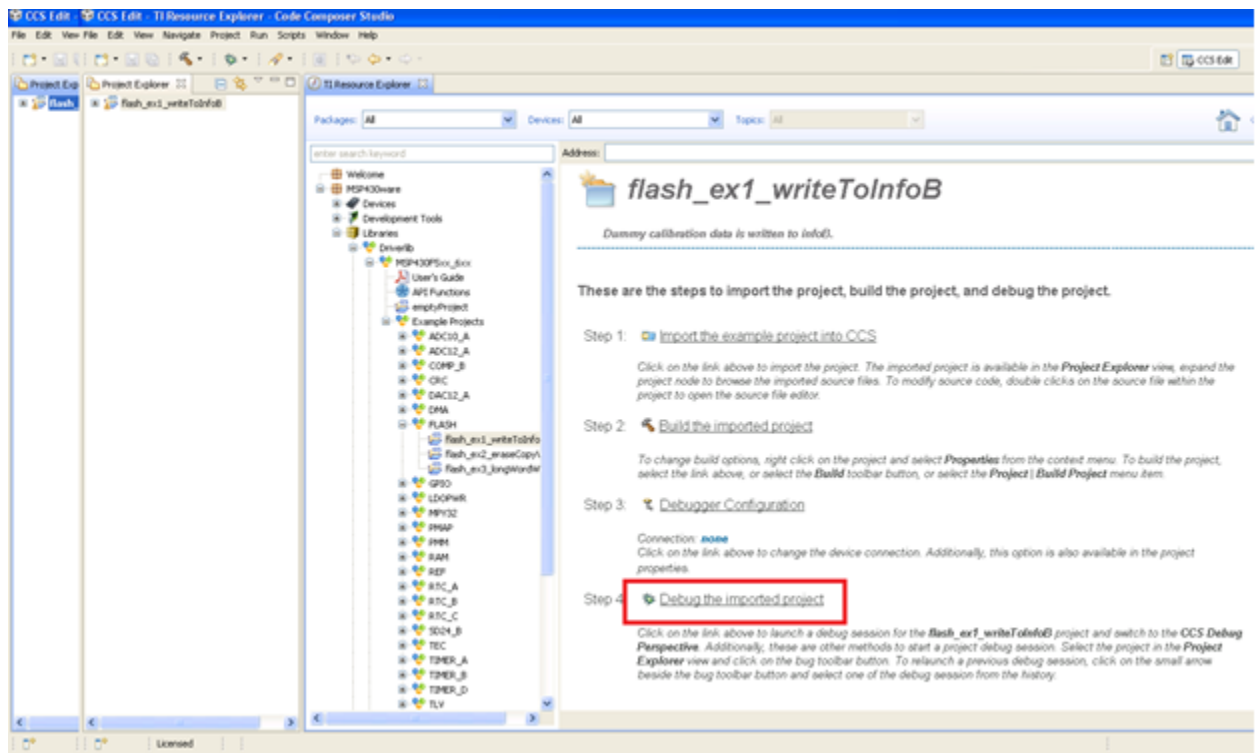
Driverlib is designed per Family. If a common device family user's guide exists for a group of devices, these devices belong to the same 'family'. Currently driverlib is available for the following family of devices. MSP430F5xx_6xx MSP430FR57xx MSP430FR5xx_6xx MSP430i2xx



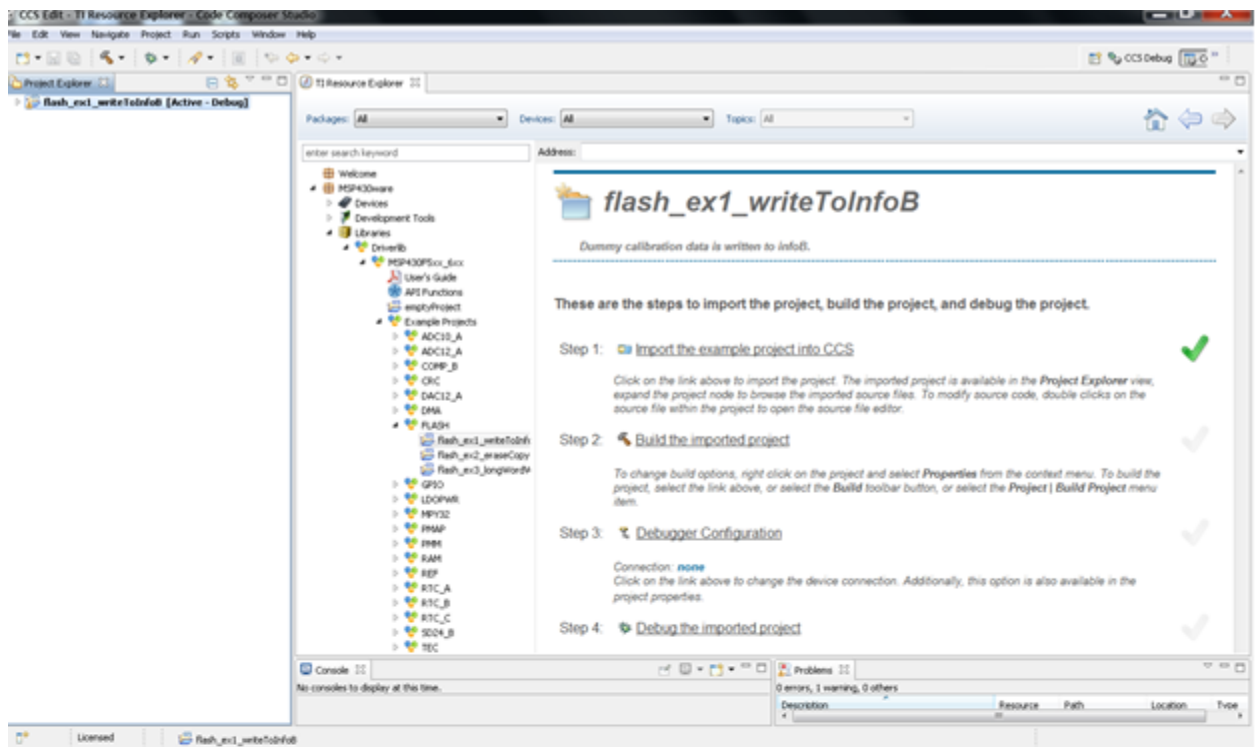
Click on the MSP430i2xx to navigate to the driverlib based example code for that family.



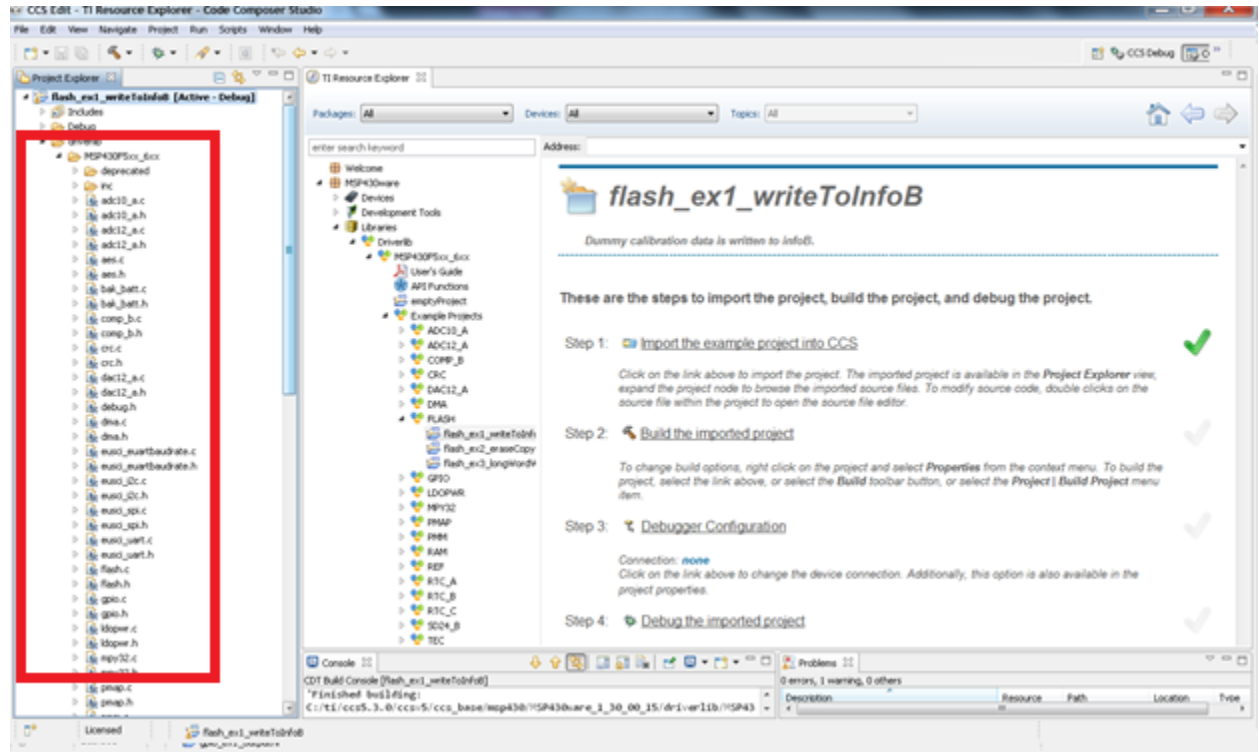
The various peripherals are listed in alphabetical order. The names of peripherals are as in device family user's guide. Clicking on a peripheral name lists the driverlib example code for that peripheral. The screenshot below shows an example when the user clicks on GPIO peripheral.



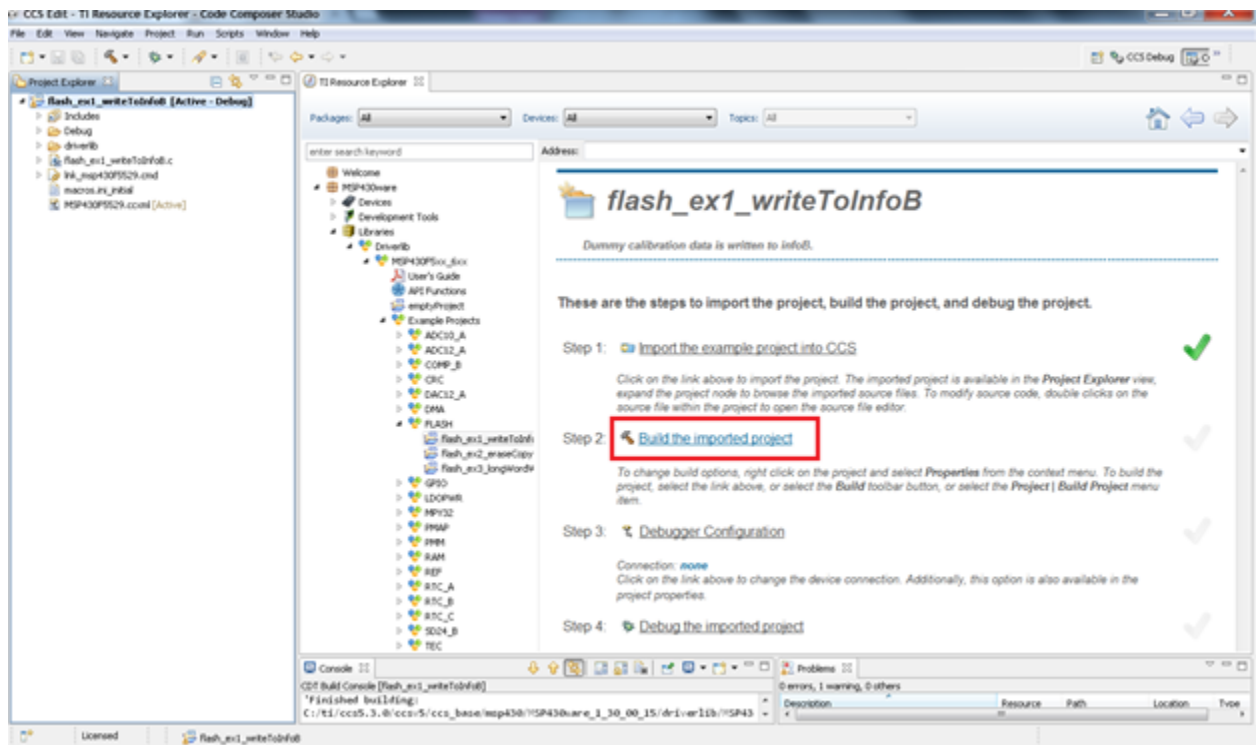
Now click on the specific example you are interested in. On the right side there are options to Import/Build/Download and Debug. Import the project by clicking on the "Import the example project into CCS"



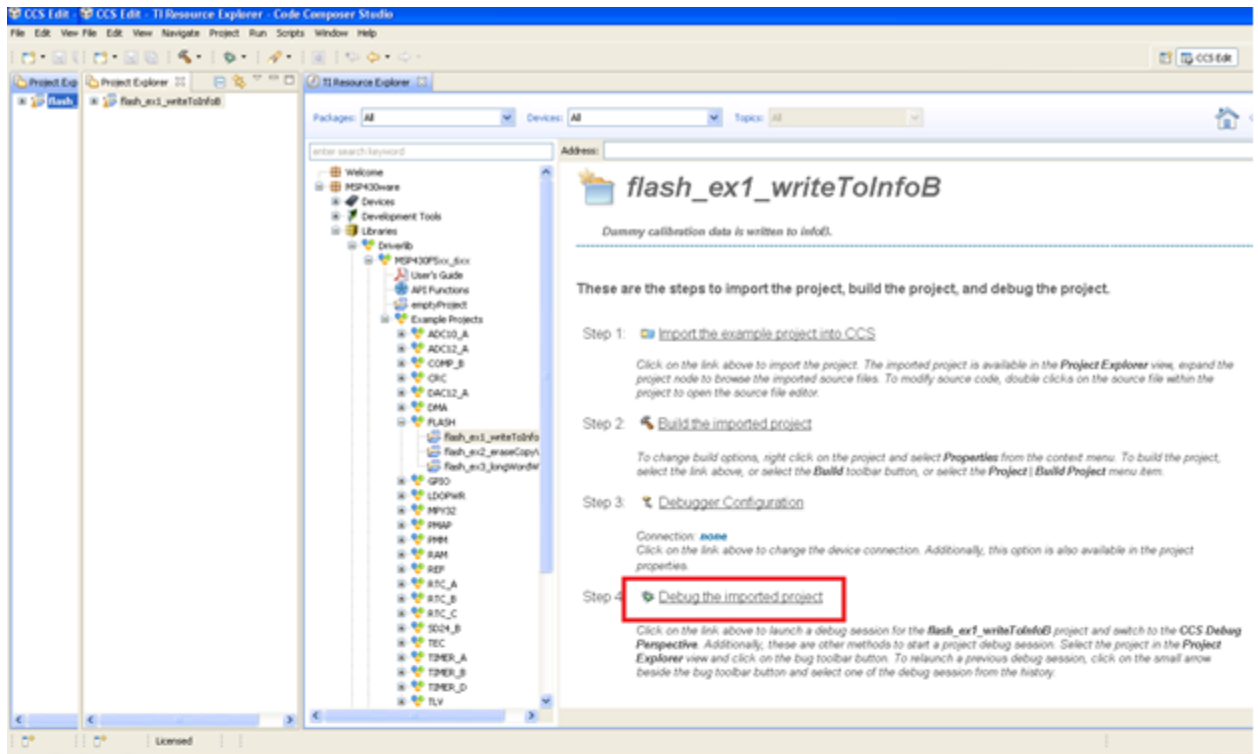
The imported project can be viewed on the left in the Project Explorer. All required driverlib source and header files are included inside the driverlib folder. All driverlib source and header files are linked to the example projects. So if the user modifies any of these source or header files, the original copy of the installed MSP430ware driverlib source and header files get modified.



Now click on Build the imported project on the right to build the example project.

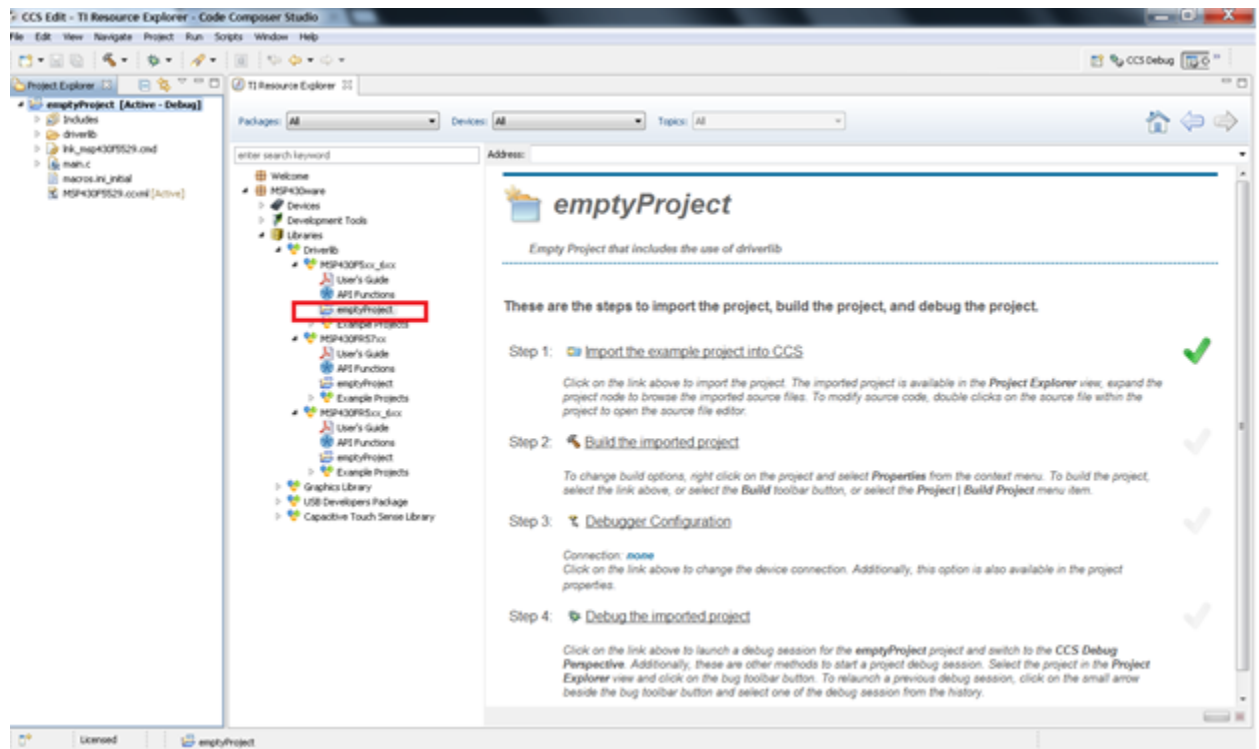


Now click on Build the imported project on the right to build the example project.



The COM port to download to can be changed using the Debugger Configuration option on the right if required.

To get started on a new project we recommend getting started on an empty project we provide. This project has all the driverlib source files, header files, project paths are set by default.

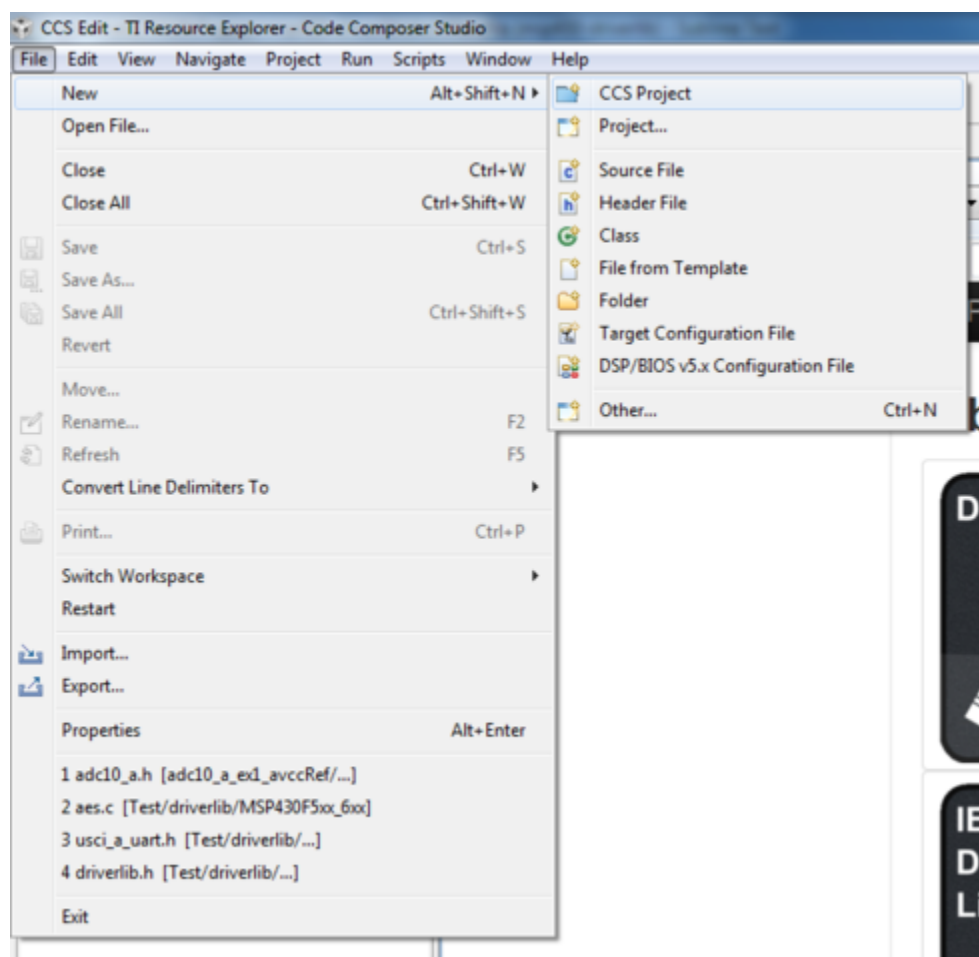


The main.c included with the empty project can be modified to include user code.

3 How to create a new user project that uses Driverlib

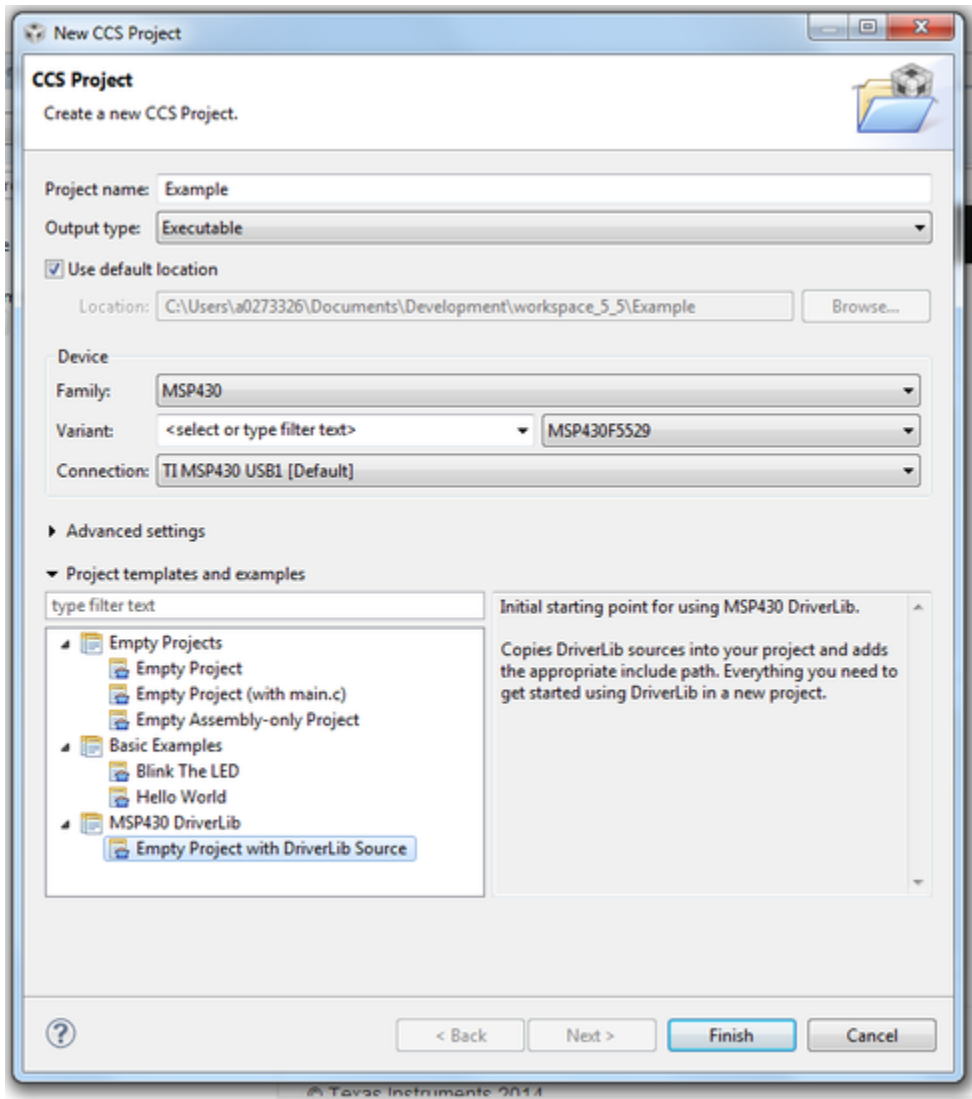
To get started on a new project we recommend using the new project wizard. For driver library to work with the new project wizard CCS must have discovered the driver library RTSC product. For more information refer to the installation steps of the release notes. The new project wizard adds the needed driver library source files and adds the driver library include path.

To open the new project wizard go to File -> New -> CCS Project as seen in the screenshot below.



Once the new project wizard has been opened name your project and choose the device you would like to create a Driver Library project for. The device must be supported by driver library.

Then under "Project templates and examples" choose "Empty Project with DriverLib Source" as seen below.

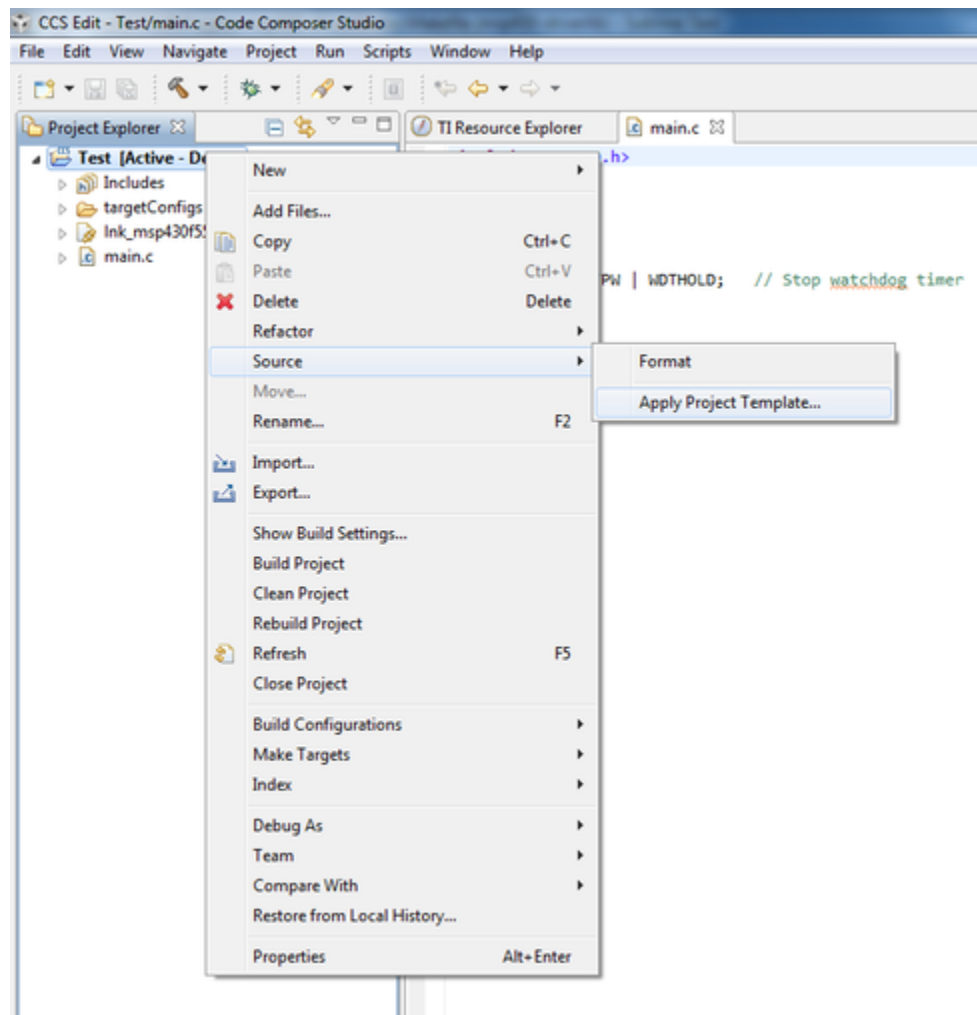


Finally click "Finish" and begin developing with your Driver Library enabled project.

4 How to include driverlib into your existing project

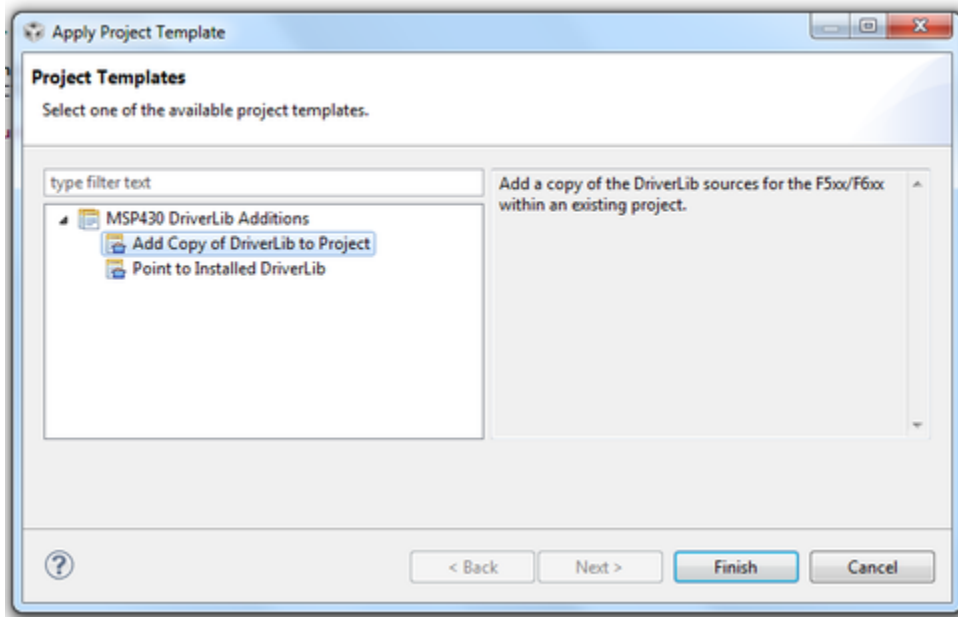
To add driver library to an existing project we recommend using CCS project templates. For driver library to work with project templates CCS must have discovered the driver library RTSC product. For more information refer to the installation steps of the release notes. CCS project templates adds the needed driver library source files and adds the driver library include path.

To apply a project template right click on an existing project then go to Source -> Apply Project Template as seen in the screenshot below.



In the "Apply Project Template" dialog box under "MSP430 DriverLib Additions" choose either "Add Local Copy" or "Point to Installed DriverLib" as seen in the screenshot below. Most users will want to add a local copy which copies the DriverLib source into the project and sets the compiler settings needed.

Pointing to an installed DriverLib is for advanced users who are including a static library in their project and want to add the DriverLib header files to their include path.



Click "Finish" and start developing with driver library in your project.

5 Clock System (CS)

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5.1 Introduction

The clock system module supports low system cost and low power consumption. Using four internal clock signals, the user can select the best balance of performance and low power consumption.

The clock module can be configured to operate without any external components, with an external resistor or to bypass the DCO entirely.

Four system clock signals are available from the clock module:

- ACLK - Auxiliary clock. The ACLK is fixed at 32kHz when running using the DCO. If the device is set to DCO bypass mode ACLK runs at the bypass clock frequency / 512.
- MCLK - Master clock. MCLK can be divided by 1, 2, 4, 8 or 16. MCLK is used by the CPU and system.
- SMCLK - Subsystem master clock. SMCLK can be divided by 1, 2, 4, 8 or 16. SMCLK is software selectable by individual peripheral modules.
- SD24CLK - SD24 Clock provides a 1.024-MHz fixed-frequency clock to the Sigma-Delta ADC (SD24). The clock is only delivered when a clock request from SD24 is asserted. If SD24 functionality is needed in DCO bypass mode then the external clock frequency must be 16.384-MHz.

This driver is contained in `cs.c`, with `cs.h` containing the API definitions for use by applications.

5.2 API Functions

Functions

- void [CS_clockSignalInit](#) (uint8_t clockSource, uint8_t clockSourceDivider)
- uint8_t [CS_faultFlagStatus](#) (uint8_t mask)
- uint32_t [CS_getACLK](#) (void)
- uint32_t [CS_getMCLK](#) (void)
- uint32_t [CS_getSMCLK](#) (void)
- void [CS_setupDCO](#) (uint8_t mode)

5.2.1 Detailed Description

The CS API is broken into three groups of functions: those that initialize the clock module, those that determine the clock speeds, and CS fault flag handling.

General CS configuration and initialization are handled by the following APIs:

- [CS_setupDCO\(\)](#)
- [CS_clockSignalInit\(\)](#)

Determining clock speeds are handled by the following APIs:

- [CS_getACLK\(\)](#)
- [CS_getSMCLK\(\)](#)
- [CS_getMCLK\(\)](#)

CS fault flags are handled by:

- [CS_faultFlagStatus\(\)](#)

The CS_getMCLK, CS_getSMCLK or CS_getACLK APIs are only accurate when using the DCO with an internal or external resistor or the bypass clock is at 16.384MHz.

5.2.2 Function Documentation

5.2.2.1 void CS_clockSignalInit (uint8_t *clockSource*, uint8_t *clockSourceDivider*)

Initializes a clock signal with a divider.

Sets up a clock signal with a divider. If the DCO is in bypass mode the frequency will be CLKIN / divider. If the DCO is not in bypass mode the frequency will 16.384MHz / divider.

Parameters:

clockSource Clock signal to initialize Valid values are:

- CS_MCLK
- CS_SMCLK

clockSourceDivider Divider setting for the selected clock signal Valid values are:

- CS_CLOCK_DIVIDER_1
- CS_CLOCK_DIVIDER_2
- CS_CLOCK_DIVIDER_4
- CS_CLOCK_DIVIDER_8
- CS_CLOCK_DIVIDER_16

Returns:

None

5.2.2.2 uint8_t CS_faultFlagStatus (uint8_t *mask*)

Get the DCO fault flag status.

Reads and returns DCO fault flag. The DCO fault flag is set when the DCO is operating in external resistor mode and the DCO detects an abnormality. An abnormality could be if the ROOSC pin is left open or shorted to ground, or if the resistance connected at the ROOSC pin is far away from the recommended value. If the fault persists the DCO automatically switches to the internal resistor mode as a fail-safe mechanism.

Parameters:

mask Mask of fault flags to check Mask value is the logical OR of any of the following:

- **CS_DCO_FAULT_FLAG**

Returns:

Logical OR of any of the following:

- **CS_DCO_FAULT_FLAG**
indicating if the masked fault flags are set

5.2.2.3 uint32_t CS_getACLK (void)

Get the current ACLK frequency in Hz.

This API returns the current ACLK frequency in Hz. It does not work when the device is setup in DCO bypass mode. Also, [CS_setupDCO\(\)](#) should be called before this API so that the DCO has been calibrated and this calculation is accurate.

Returns:

Current ACLK frequency in Hz, 0 when in bypass mode

5.2.2.4 uint32_t CS_getMCLK (void)

Get the current MCLK frequency in Hz.

This API returns the current MCLK frequency in Hz. It does not work when the device is setup in DCO bypass mode. Also, [CS_setupDCO\(\)](#) should be called before this API so that the DCO has been calibrated and this calculation is accurate.

Returns:

Current MCLK frequency in Hz, 0 when in bypass mode

5.2.2.5 uint32_t CS_getSMCLK (void)

Get the current SMCLK frequency in Hz.

This API returns the current SMCLK frequency in Hz. It does not work when the device is setup in DCO bypass mode. Also, [CS_setupDCO\(\)](#) should be called before this API so that the DCO has been calibrated and this calculation is accurate.

Returns:

Current SMCLK frequency in Hz, 0 when in bypass mode

5.2.2.6 void CS_setupDCO (uint8_t mode)

Sets up the DCO using the selected mode.

Sets up the DCO using the selected mode. If the bypass mode is selected than an external digital clock is required on the CLKIN pin to drive all clocks on the device. ACLK frequency is not

programmable and is fixed to the bypass clock frequency divided by 512. For external resistor mode a 20kOhm resistor is recommended at the ROSC pin. External resistor mode offers higher clock accuracy in terms of absolute tolerance and temperature drift compared to the internal resistor mode. Please check your device datasheet for details and ratings for the different modes.

Parameters:

mode Mode to put the DCO into Valid values are:

- **CS_INTERNAL_RESISTOR** - DCO operation with internal resistor
- **CS_EXTERNAL_RESISTOR** - DCO operation with external resistor
- **CS_BYPASS_MODE** - Bypass mode, provide external clock signal

Returns:

None

5.3 Programming Example

The following example shows the configuration of the CS module that sets $SMCLK = DCO / 2$ and $MCLK = DCO / 8$.

```
// Set DCO Frequency to 16.384MHz
CS_setupDCO(CS_INTERNAL_RESISTOR);

// Configure MCLK and SMCLK
CS_clockSignalInit(CS_MCLK, CS_CLOCK_DIVIDER_8);
CS_clockSignalInit(CS_SMCLK, CS_CLOCK_DIVIDER_2);
```


6 EUSCI Universal Asynchronous Receiver/Transmitter (EUSCI_A_UART)

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6.1 Introduction

The MSP430i2xx Driver Library for EUSCI_A_UART features include:

- Odd, even, or non-parity
- Independent transmit and receive shift registers
- Separate transmit and receive buffer registers
- LSB-first or MSB-first data transmit and receive
- Built-in idle-line and address-bit communication protocols for multiprocessor systems
- Receiver start-edge detection for auto wake up from LPMx modes
- Status flags for error detection and suppression
- Status flags for address detection
- Independent interrupt capability for receive and transmit

In UART mode, the eUSCI transmits and receives characters at a bit rate asynchronous to another device. Timing for each character is based on the selected baud rate of the eUSCI. The transmit and receive functions use the same baud-rate frequency.

This driver is contained in `eusci_a_uart.c`, with `eusci_a_uart.h` containing the API definitions for use by applications.

6.2 API Functions

Functions

- void [EUSCI_A_UART_clearInterruptFlag](#) (uint16_t baseAddress, uint8_t mask)
- void [EUSCI_A_UART_disable](#) (uint16_t baseAddress)
- void [EUSCI_A_UART_disableInterrupt](#) (uint16_t baseAddress, uint8_t mask)
- void [EUSCI_A_UART_enable](#) (uint16_t baseAddress)
- void [EUSCI_A_UART_enableInterrupt](#) (uint16_t baseAddress, uint8_t mask)
- uint8_t [EUSCI_A_UART_getInterruptStatus](#) (uint16_t baseAddress, uint8_t mask)
- uint32_t [EUSCI_A_UART_getReceiveBufferAddress](#) (uint16_t baseAddress)
- uint32_t [EUSCI_A_UART_getTransmitBufferAddress](#) (uint16_t baseAddress)
- bool [EUSCI_A_UART_init](#) (uint16_t baseAddress, EUSCI_A_UART_initParam *param)
- uint8_t [EUSCI_A_UART_queryStatusFlags](#) (uint16_t baseAddress, uint8_t mask)
- uint8_t [EUSCI_A_UART_receiveData](#) (uint16_t baseAddress)
- void [EUSCI_A_UART_resetDormant](#) (uint16_t baseAddress)
- void [EUSCI_A_UART_selectDeglitchTime](#) (uint16_t baseAddress, uint16_t deglitchTime)
- void [EUSCI_A_UART_setDormant](#) (uint16_t baseAddress)
- void [EUSCI_A_UART_transmitAddress](#) (uint16_t baseAddress, uint8_t transmitAddress)
- void [EUSCI_A_UART_transmitBreak](#) (uint16_t baseAddress)
- void [EUSCI_A_UART_transmitData](#) (uint16_t baseAddress, uint8_t transmitData)

6.2.1 Detailed Description

The EUSCI_A_UART API provides the set of functions required to implement an interrupt driven EUSCI_A_UART driver. The EUSCI_A_UART initialization with the various modes and features is done by the [EUSCI_A_UART_init\(\)](#). At the end of this function EUSCI_A_UART is initialized and stays disabled. [EUSCI_A_UART_enable\(\)](#) enables the EUSCI_A_UART and the module is now ready for transmit and receive. It is recommended to initialize the EUSCI_A_UART via [EUSCI_A_UART_init\(\)](#), enable the required interrupts and then enable EUSCI_A_UART via [EUSCI_A_UART_enable\(\)](#).

The EUSCI_A_UART API is broken into three groups of functions: those that deal with configuration and control of the EUSCI_A_UART modules, those used to send and receive data.

Configuration and control of the EUSCI_UART are handled by the

- [EUSCI_A_UART_init\(\)](#)
- [EUSCI_A_UART_enable\(\)](#)
- [EUSCI_A_UART_disable\(\)](#)
- [EUSCI_A_UART_setDormant\(\)](#)
- [EUSCI_A_UART_resetDormant\(\)](#)
- [EUSCI_A_UART_selectDeglitchTime\(\)](#)

Sending and receiving data via the EUSCI_UART is handled by the

- [EUSCI_A_UART_transmitData\(\)](#)
- [EUSCI_A_UART_receiveData\(\)](#)
- [EUSCI_A_UART_transmitAddress\(\)](#)
- [EUSCI_A_UART_transmitBreak\(\)](#)

Managing the EUSCI_UART interrupts and status are handled by the

- [EUSCI_A_UART_enableInterrupt\(\)](#)
- [EUSCI_A_UART_disableInterrupt\(\)](#)
- [EUSCI_A_UART_getInterruptStatus\(\)](#)
- [EUSCI_A_UART_clearInterruptFlag\(\)](#)
- [EUSCI_A_UART_queryStatusFlags\(\)](#)

6.2.2 Function Documentation

6.2.2.1 void EUSCI_A_UART_clearInterruptFlag (uint16_t *baseAddress*, uint8_t *mask*)

Clears UART interrupt sources.

The UART interrupt source is cleared, so that it no longer asserts. The highest interrupt flag is automatically cleared when an interrupt vector generator is used.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

mask is a bit mask of the interrupt sources to be cleared. Mask value is the logical OR of any of the following:

- [EUSCI_A_UART_RECEIVE_INTERRUPT_FLAG](#)
- [EUSCI_A_UART_TRANSMIT_INTERRUPT_FLAG](#)
- [EUSCI_A_UART_STARTBIT_INTERRUPT_FLAG](#)
- [EUSCI_A_UART_TRANSMIT_COMPLETE_INTERRUPT_FLAG](#)

Modified bits of **UCAxIFG** register.

Returns:

None

6.2.2.2 void EUSCI_A_UART_disable (uint16_t *baseAddress*)

Disables the UART block.

This will disable operation of the UART block.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

Modified bits are **UCSWRST** of **UCAxCTL1** register.

Returns:

None

6.2.2.3 void EUSCI_A_UART_disableInterrupt (uint16_t *baseAddress*, uint8_t *mask*)

Disables individual UART interrupt sources.

Disables the indicated UART interrupt sources. Only the sources that are enabled can be reflected to the processor interrupt; disabled sources have no effect on the processor.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

mask is the bit mask of the interrupt sources to be disabled. Mask value is the logical OR of any of the following:

- **EUSCI_A_UART_RECEIVE_INTERRUPT** - Receive interrupt
- **EUSCI_A_UART_TRANSMIT_INTERRUPT** - Transmit interrupt
- **EUSCI_A_UART_RECEIVE_ERRONEOUSCHAR_INTERRUPT** - Receive erroneous-character interrupt enable
- **EUSCI_A_UART_BREAKCHAR_INTERRUPT** - Receive break character interrupt enable
- **EUSCI_A_UART_STARTBIT_INTERRUPT** - Start bit received interrupt enable
- **EUSCI_A_UART_TRANSMIT_COMPLETE_INTERRUPT** - Transmit complete interrupt enable

Modified bits of **UCAxCTL1** register and bits of **UCAxIE** register.

Returns:

None

6.2.2.4 void EUSCI_A_UART_enable (uint16_t *baseAddress*)

Enables the UART block.

This will enable operation of the UART block.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

Modified bits are **UCSWRST** of **UCAxCTL1** register.

Returns:

None

6.2.2.5 void EUSCI_A_UART_enableInterrupt (uint16_t *baseAddress*, uint8_t *mask*)

Enables individual UART interrupt sources.

Enables the indicated UART interrupt sources. The interrupt flag is first and then the corresponding interrupt is enabled. Only the sources that are enabled can be reflected to the processor interrupt; disabled sources have no effect on the processor. Does not clear interrupt flags.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

mask is the bit mask of the interrupt sources to be enabled. Mask value is the logical OR of any of the following:

- EUSCI_A_UART_RECEIVE_INTERRUPT - Receive interrupt
- EUSCI_A_UART_TRANSMIT_INTERRUPT - Transmit interrupt
- EUSCI_A_UART_RECEIVE_ERRONEOUSCHAR_INTERRUPT - Receive erroneous-character interrupt enable
- EUSCI_A_UART_BREAKCHAR_INTERRUPT - Receive break character interrupt enable
- EUSCI_A_UART_STARTBIT_INTERRUPT - Start bit received interrupt enable
- EUSCI_A_UART_TRANSMIT_COMPLETE_INTERRUPT - Transmit complete interrupt enable

Modified bits of **UCAxCTL1** register and bits of **UCAxIE** register.

Returns:

None

6.2.2.6 uint8_t EUSCI_A_UART_getInterruptStatus (uint16_t baseAddress, uint8_t mask)

Gets the current UART interrupt status.

This returns the interrupt status for the UART module based on which flag is passed.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

mask is the masked interrupt flag status to be returned. Mask value is the logical OR of any of the following:

- EUSCI_A_UART_RECEIVE_INTERRUPT_FLAG
- EUSCI_A_UART_TRANSMIT_INTERRUPT_FLAG
- EUSCI_A_UART_STARTBIT_INTERRUPT_FLAG
- EUSCI_A_UART_TRANSMIT_COMPLETE_INTERRUPT_FLAG

Modified bits of **UCAxIFG** register.

Returns:

Logical OR of any of the following:

- EUSCI_A_UART_RECEIVE_INTERRUPT_FLAG
 - EUSCI_A_UART_TRANSMIT_INTERRUPT_FLAG
 - EUSCI_A_UART_STARTBIT_INTERRUPT_FLAG
 - EUSCI_A_UART_TRANSMIT_COMPLETE_INTERRUPT_FLAG
- indicating the status of the masked flags

6.2.2.7 uint32_t EUSCI_A_UART_getReceiveBufferAddress (uint16_t baseAddress)

Returns the address of the RX Buffer of the UART for the DMA module.

Returns the address of the UART RX Buffer. This can be used in conjunction with the DMA to store the received data directly to memory.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

Returns:

Address of RX Buffer

6.2.2.8 uint32_t EUSCI_A_UART_getTransmitBufferAddress (uint16_t *baseAddress*)

Returns the address of the TX Buffer of the UART for the DMA module.

Returns the address of the UART TX Buffer. This can be used in conjunction with the DMA to obtain transmitted data directly from memory.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

Returns:

Address of TX Buffer

6.2.2.9 bool EUSCI_A_UART_init (uint16_t *baseAddress*, EUSCI_A_UART_initParam * *param*)

Advanced initialization routine for the UART block. The values to be written into the clockPrescaler, firstModReg, secondModReg and overSampling parameters should be pre-computed and passed into the initialization function.

Upon successful initialization of the UART block, this function will have initialized the module, but the UART block still remains disabled and must be enabled with [EUSCI_A_UART_enable\(\)](#). To calculate values for clockPrescaler, firstModReg, secondModReg and overSampling please use the link below.

http://software-dl.ti.com/msp430/msp430_public_sw/mcu/msp430/MSP430BaudRateConverter/index.html

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

param is the pointer to struct for initialization.

Modified bits are **UCPEN**, **UCPAR**, **UCMSB**, **UC7BIT**, **UCSPB**, **UCMODEx** and **UCSYNC** of **UCAxCTL0** register; bits **UCSSELx** and **UCSWRST** of **UCAxCTL1** register.

Returns:

STATUS_SUCCESS or STATUS_FAIL of the initialization process

6.2.2.10 uint8_t EUSCI_A_UART_queryStatusFlags (uint16_t *baseAddress*, uint8_t *mask*)

Gets the current UART status flags.

This returns the status for the UART module based on which flag is passed.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

mask is the masked interrupt flag status to be returned. Mask value is the logical OR of any of the following:

- EUSCI_A_UART_LISTEN_ENABLE
- EUSCI_A_UART_FRAMING_ERROR
- EUSCI_A_UART_OVERRUN_ERROR
- EUSCI_A_UART_PARITY_ERROR
- EUSCI_A_UART_BREAK_DETECT
- EUSCI_A_UART_RECEIVE_ERROR
- EUSCI_A_UART_ADDRESS_RECEIVED
- EUSCI_A_UART_IDLELINE
- EUSCI_A_UART_BUSY

Modified bits of **UCAxSTAT** register.

Returns:

Logical OR of any of the following:

- EUSCI_A_UART_LISTEN_ENABLE
- EUSCI_A_UART_FRAMING_ERROR
- EUSCI_A_UART_OVERRUN_ERROR
- EUSCI_A_UART_PARITY_ERROR
- EUSCI_A_UART_BREAK_DETECT
- EUSCI_A_UART_RECEIVE_ERROR
- EUSCI_A_UART_ADDRESS_RECEIVED
- EUSCI_A_UART_IDLELINE
- EUSCI_A_UART_BUSY

indicating the status of the masked interrupt flags

6.2.2.11 uint8_t EUSCI_A_UART_receiveData (uint16_t *baseAddress*)

Receives a byte that has been sent to the UART Module.

This function reads a byte of data from the UART receive data Register.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

Modified bits of **UCAxRXBUF** register.

Returns:

Returns the byte received from by the UART module, cast as an uint8_t.

6.2.2.12 void EUSCI_A_UART_resetDormant (uint16_t *baseAddress*)

Re-enables UART module from dormant mode.

Not dormant. All received characters set UCRXIFG.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

Modified bits are **UCDORM** of **UCAxCTL1** register.

Returns:

None

6.2.2.13 void EUSCI_A_UART_selectDeglitchTime (uint16_t *baseAddress*, uint16_t *deglitchTime*)

Sets the deglitch time.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

deglitchTime is the selected deglitch time Valid values are:

- EUSCI_A_UART_DEGLITCH_TIME_2ns
- EUSCI_A_UART_DEGLITCH_TIME_50ns
- EUSCI_A_UART_DEGLITCH_TIME_100ns
- EUSCI_A_UART_DEGLITCH_TIME_200ns

Returns:

None

6.2.2.14 void EUSCI_A_UART_setDormant (uint16_t *baseAddress*)

Sets the UART module in dormant mode.

Puts USCI in sleep mode Only characters that are preceded by an idle-line or with address bit set UCRXIFG. In UART mode with automatic baud-rate detection, only the combination of a break and sync field sets UCRXIFG.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

Modified bits of **UCAxCTL1** register.

Returns:

None

6.2.2.15 void EUSCI_A_UART_transmitAddress (uint16_t *baseAddress*, uint8_t *transmitAddress*)

Transmits the next byte to be transmitted marked as address depending on selected multiprocessor mode.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

transmitAddress is the next byte to be transmitted

Modified bits of **UCAxTXBUF** register and bits of **UCAxCTL1** register.

Returns:

None

6.2.2.16 void EUSCI_A_UART_transmitBreak (uint16_t *baseAddress*)

Transmit break.

Transmits a break with the next write to the transmit buffer. In UART mode with automatic baud-rate detection, EUSCI_A_UART_AUTOMATICBAUDRATE_SYNC(0x55) must be written into UCAxTXBUF to generate the required break/sync fields. Otherwise, DEFAULT_SYNC(0x00) must be written into the transmit buffer. Also ensures module is ready for transmitting the next data.

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

Modified bits of **UCAxTXBUF** register and bits of **UCAxCTL1** register.

Returns:

None

6.2.2.17 void EUSCI_A_UART_transmitData (uint16_t *baseAddress*, uint8_t *transmitData*)

Transmits a byte from the UART Module.

This function will place the supplied data into UART transmit data register to start transmission

Parameters:

baseAddress is the base address of the EUSCI_A_UART module.

transmitData data to be transmitted from the UART module

Modified bits of **UCAxTXBUF** register.

Returns:

None

6.3 Programming Example

The following example shows how to use the EUSCI_A_UART API to initialize the EUSCI_A_UART and start transmitting characters.

```
// Configuration for 115200 UART with SMCLK at 16384000
// These values were generated using the online tool available at:
// http://software-dl.ti.com/msp430/msp430_public_sw/mcu/msp430/MSP430BaudRateConverter/index.html
EUSCI_A_UART_initParam uartConfig = {
    EUSCI_A_UART_CLOCKSOURCE_SMCLK,      // SMCLK Clock Source
    8,                                    // BRDIV = 8
    14,                                    // UCxBRF = 14
    34,                                    // UCxBRS = 34
    EUSCI_A_UART_NO_PARITY,              // No Parity
    EUSCI_A_UART_MSB_FIRST,              // MSB First
    EUSCI_A_UART_ONE_STOP_BIT,           // One stop bit
    EUSCI_A_UART_MODE,                   // UART mode
    EUSCI_A_UART_OVERSAMPLING_BAUDRATE_GENERATION // Oversampling Baudrate
};

WDT_hold(WDT_BASE);

// Setting the DCO to use the internal resistor. DCO will be at 16.384MHz
CS_setupDCO(CS_INTERNAL_RESISTOR);

// SMCLK should be same speed as DCO. SMCLK = 16.384MHz
CS_clockSignalInit(CS_SMCLK, CS_CLOCK_DIVIDER_1);

// Settings P1.2 and P1.3 as UART pins. P1.4 as LED output
GPIO_setAsPeripheralModuleFunctionInputPin(GPIO_PORT_P1,
                                             GPIO_PIN2 | GPIO_PIN3,
                                             GPIO_PRIMARY_MODULE_FUNCTION);

GPIO_setAsOutputPin(GPIO_PORT_P1, GPIO_PIN4);
GPIO_setOutputLowOnPin(GPIO_PORT_P1, GPIO_PIN4);

// Configure and enable the UART peripheral
EUSCI_A_UART_init(EUSCI_A0_BASE, &uartConfig);
EUSCI_A_UART_enable(EUSCI_A0_BASE);

EUSCI_A_UART_enableInterrupt(EUSCI_A0_BASE,
                             EUSCI_A_UART_RECEIVE_INTERRUPT);

while(1) {
    EUSCI_A_UART_transmitData(EUSCI_A0_BASE, TXData);

    // Go to sleep and wait for LPM exit
    __bis_SR_register(LPM0_bits | GIE);
}
```


7 EUSCI Synchronous Peripheral Interface (EUSCI_A_SPI)

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7.1 Introduction

The Serial Peripheral Interface Bus or SPI bus is a synchronous serial data link standard named by Motorola that operates in full duplex mode. Devices communicate in master/slave mode where the master device initiates the data frame.

This library provides the API for handling a SPI communication using EUSCI_A.

The SPI module can be configured as either a master or a slave device.

The SPI module also includes a programmable bit rate clock divider and prescaler to generate the output serial clock derived from the module's input clock.

This driver is contained in `eusci_a_spi.c`, with `eusci_a_spi.h` containing the API definitions for use by applications.

7.2 Functions

Functions

- void [EUSCI_A_SPI_changeClockPhasePolarity](#) (uint16_t baseAddress, uint16_t clockPhase, uint16_t clockPolarity)
- void [EUSCI_A_SPI_changeMasterClock](#) (uint16_t baseAddress, EUSCI_A_SPI_changeMasterClockParam *param)
- void [EUSCI_A_SPI_clearInterruptFlag](#) (uint16_t baseAddress, uint8_t mask)
- void [EUSCI_A_SPI_disable](#) (uint16_t baseAddress)
- void [EUSCI_A_SPI_disableInterrupt](#) (uint16_t baseAddress, uint8_t mask)
- void [EUSCI_A_SPI_enable](#) (uint16_t baseAddress)
- void [EUSCI_A_SPI_enableInterrupt](#) (uint16_t baseAddress, uint8_t mask)
- uint8_t [EUSCI_A_SPI_getInterruptStatus](#) (uint16_t baseAddress, uint8_t mask)
- uint32_t [EUSCI_A_SPI_getReceiveBufferAddress](#) (uint16_t baseAddress)
- uint32_t [EUSCI_A_SPI_getTransmitBufferAddress](#) (uint16_t baseAddress)
- void [EUSCI_A_SPI_initMaster](#) (uint16_t baseAddress, EUSCI_A_SPI_initMasterParam *param)
- void [EUSCI_A_SPI_initSlave](#) (uint16_t baseAddress, EUSCI_A_SPI_initSlaveParam *param)
- uint16_t [EUSCI_A_SPI_isBusy](#) (uint16_t baseAddress)
- uint8_t [EUSCI_A_SPI_receiveData](#) (uint16_t baseAddress)
- void [EUSCI_A_SPI_select4PinFunctionality](#) (uint16_t baseAddress, uint8_t select4PinFunctionality)
- void [EUSCI_A_SPI_transmitData](#) (uint16_t baseAddress, uint8_t transmitData)

7.2.1 Detailed Description

To use the module as a master, the user must call [EUSCI_A_SPI_initMaster\(\)](#) to configure the SPI Master. This is followed by enabling the SPI module using [EUSCI_A_SPI_enable\(\)](#). The interrupts are then enabled (if needed).

It is recommended to enable the SPI module before enabling the interrupts. A data transmit is then initiated using [EUSCI_A_SPI_transmitData\(\)](#) and then when the receive flag is set, the received data is read using [EUSCI_A_SPI_receiveData\(\)](#) and this indicates that an RX/TX operation is complete.

To use the module as a slave, initialization is done using [EUSCI_A_SPI_initSlave\(\)](#) and this is followed by enabling the module using [EUSCI_A_SPI_enable\(\)](#). Following this, the interrupts may be enabled as needed. When the receive flag is

set, data is first transmitted using `EUSCI_A_SPI_transmitData()` and this is followed by a data reception by `EUSCI_A_SPI_receiveData()`

The SPI API is broken into 3 groups of functions: those that deal with status and initialization, those that handle data, and those that manage interrupts.

The status and initialization of the SPI module are managed by

- `EUSCI_A_SPI_initMaster()`
- `EUSCI_A_SPI_initSlave()`
- `EUSCI_A_SPI_disable()`
- `EUSCI_A_SPI_enable()`
- `EUSCI_A_SPI_isBusy()`
- `EUSCI_A_SPI_select4PinFunctionality()`
- `EUSCI_A_SPI_changeClockPhasePolarity()`

Data handling is done by

- `EUSCI_A_SPI_transmitData()`
- `EUSCI_A_SPI_receiveData()`

Interrupts from the SPI module are managed using

- `EUSCI_A_SPI_disableInterrupt()`
- `EUSCI_A_SPI_enableInterrupt()`
- `EUSCI_A_SPI_getInterruptStatus()`
- `EUSCI_A_SPI_clearInterruptFlag()`

7.2.2 Function Documentation

7.2.2.1 `void EUSCI_A_SPI_changeClockPhasePolarity (uint16_t baseAddress, uint16_t clockPhase, uint16_t clockPolarity)`

Changes the SPI clock phase and polarity. At the end of this function call, SPI module is left enabled.

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

clockPhase is clock phase select. Valid values are:

- `EUSCI_A_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON_NEXT` [Default]
- `EUSCI_A_SPI_PHASE_DATA_CAPTURED_ONFIRST_CHANGED_ON_NEXT`

clockPolarity is clock polarity select Valid values are:

- `EUSCI_A_SPI_CLOCKPOLARITY_INACTIVITY_HIGH`
- `EUSCI_A_SPI_CLOCKPOLARITY_INACTIVITY_LOW` [Default]

Modified bits are **UCCKPL**, **UCCKPH** and **UCSWRST** of **UCAxCTLW0** register.

Returns:

None

7.2.2.2 `void EUSCI_A_SPI_changeMasterClock (uint16_t baseAddress, EUSCI_A_SPI_changeMasterClockParam * param)`

Initializes the SPI Master clock. At the end of this function call, SPI module is left enabled.

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

param is the pointer to struct for master clock setting.

Modified bits are **UCSWRST** of **UCAxCTLW0** register.

Returns:

None

7.2.2.3 void EUSCI_A_SPI_clearInterruptFlag (uint16_t *baseAddress*, uint8_t *mask*)

Clears the selected SPI interrupt status flag.

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

mask is the masked interrupt flag to be cleared. Mask value is the logical OR of any of the following:

- **EUSCI_A_SPI_TRANSMIT_INTERRUPT**
- **EUSCI_A_SPI_RECEIVE_INTERRUPT**

Modified bits of **UCAxIFG** register.

Returns:

None

7.2.2.4 void EUSCI_A_SPI_disable (uint16_t *baseAddress*)

Disables the SPI block.

This will disable operation of the SPI block.

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

Modified bits are **UCSWRST** of **UCAxCTLW0** register.

Returns:

None

7.2.2.5 void EUSCI_A_SPI_disableInterrupt (uint16_t *baseAddress*, uint8_t *mask*)

Disables individual SPI interrupt sources.

Disables the indicated SPI interrupt sources. Only the sources that are enabled can be reflected to the processor interrupt; disabled sources have no effect on the processor.

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

mask is the bit mask of the interrupt sources to be disabled. Mask value is the logical OR of any of the following:

- **EUSCI_A_SPI_TRANSMIT_INTERRUPT**
- **EUSCI_A_SPI_RECEIVE_INTERRUPT**

Modified bits of **UCAxIE** register.

Returns:

None

7.2.2.6 void EUSCI_A_SPI_enable (uint16_t *baseAddress*)

Enables the SPI block.

This will enable operation of the SPI block.

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

Modified bits are **UCSWRST** of **UCAxCTLW0** register.

Returns:

None

7.2.2.7 void EUSCI_A_SPI_enableInterrupt (uint16_t *baseAddress*, uint8_t *mask*)

Enables individual SPI interrupt sources.

Enables the indicated SPI interrupt sources. Only the sources that are enabled can be reflected to the processor interrupt; disabled sources have no effect on the processor. Does not clear interrupt flags.

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

mask is the bit mask of the interrupt sources to be enabled. Mask value is the logical OR of any of the following:

- **EUSCI_A_SPI_TRANSMIT_INTERRUPT**
- **EUSCI_A_SPI_RECEIVE_INTERRUPT**

Modified bits of **UCAxIFG** register and bits of **UCAxIE** register.

Returns:

None

7.2.2.8 uint8_t EUSCI_A_SPI_getInterruptStatus (uint16_t *baseAddress*, uint8_t *mask*)

Gets the current SPI interrupt status.

This returns the interrupt status for the SPI module based on which flag is passed.

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

mask is the masked interrupt flag status to be returned. Mask value is the logical OR of any of the following:

- **EUSCI_A_SPI_TRANSMIT_INTERRUPT**
- **EUSCI_A_SPI_RECEIVE_INTERRUPT**

Returns:

Logical OR of any of the following:

- **EUSCI_A_SPI_TRANSMIT_INTERRUPT**
 - **EUSCI_A_SPI_RECEIVE_INTERRUPT**
- indicating the status of the masked interrupts

7.2.2.9 uint32_t EUSCI_A_SPI_getReceiveBufferAddress (uint16_t *baseAddress*)

Returns the address of the RX Buffer of the SPI for the DMA module.

Returns the address of the SPI RX Buffer. This can be used in conjunction with the DMA to store the received data directly to memory.

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

Returns:

the address of the RX Buffer

7.2.2.10 uint32_t EUSCI_A_SPI_getTransmitBufferAddress (uint16_t baseAddress)

Returns the address of the TX Buffer of the SPI for the DMA module.

Returns the address of the SPI TX Buffer. This can be used in conjunction with the DMA to obtain transmitted data directly from memory.

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

Returns:

the address of the TX Buffer

7.2.2.11 void EUSCI_A_SPI_initMaster (uint16_t baseAddress, EUSCI_A_SPI_initMasterParam * param)

Initializes the SPI Master block.

Upon successful initialization of the SPI master block, this function will have set the bus speed for the master, but the SPI Master block still remains disabled and must be enabled with [EUSCI_A_SPI_enable\(\)](#)

Parameters:

baseAddress is the base address of the EUSCI_A_SPI Master module.

param is the pointer to struct for master initialization.

Modified bits are **UCCKPH**, **UCCKPL**, **UC7BIT**, **UCMSB**, **UCSSELx** and **UCSWRST** of **UCAxCTLW0** register.

Returns:

STATUS_SUCCESS

7.2.2.12 void EUSCI_A_SPI_initSlave (uint16_t baseAddress, EUSCI_A_SPI_initSlaveParam * param)

Initializes the SPI Slave block.

Upon successful initialization of the SPI slave block, this function will have initialized the slave block, but the SPI Slave block still remains disabled and must be enabled with [EUSCI_A_SPI_enable\(\)](#)

Parameters:

baseAddress is the base address of the EUSCI_A_SPI Slave module.

param is the pointer to struct for slave initialization.

Modified bits are **UCMSB**, **UCMST**, **UC7BIT**, **UCCKPL**, **UCCKPH**, **UCMODE** and **UCSWRST** of **UCAxCTLW0** register.

Returns:

STATUS_SUCCESS

7.2.2.13 uint16_t EUSCI_A_SPI_isBusy (uint16_t *baseAddress*)

Indicates whether or not the SPI bus is busy.

This function returns an indication of whether or not the SPI bus is busy. This function checks the status of the bus via UCBBUSY bit

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

Returns:

One of the following:

- EUSCI_A_SPI_BUSY
 - EUSCI_A_SPI_NOT_BUSY
- indicating if the EUSCI_A_SPI is busy

7.2.2.14 uint8_t EUSCI_A_SPI_receiveData (uint16_t *baseAddress*)

Receives a byte that has been sent to the SPI Module.

This function reads a byte of data from the SPI receive data Register.

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

Returns:

Returns the byte received from by the SPI module, cast as an uint8_t.

7.2.2.15 void EUSCI_A_SPI_select4PinFunctionality (uint16_t *baseAddress*, uint8_t *select4PinFunctionality*)

Selects 4Pin Functionality.

This function should be invoked only in 4-wire mode. Invoking this function has no effect in 3-wire mode.

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

select4PinFunctionality selects 4 pin functionality Valid values are:

- EUSCI_A_SPI_PREVENT_CONFLICTS_WITH_OTHER_MASTERS
- EUSCI_A_SPI_ENABLE_SIGNAL_FOR_4WIRE_SLAVE

Modified bits are **UCSTEM** of **UCAxCTLW0** register.

Returns:

None

7.2.2.16 void EUSCI_A_SPI_transmitData (uint16_t *baseAddress*, uint8_t *transmitData*)

Transmits a byte from the SPI Module.

This function will place the supplied data into SPI transmit data register to start transmission.

Parameters:

baseAddress is the base address of the EUSCI_A_SPI module.

transmitData data to be transmitted from the SPI module

Returns:

None

7.3 Programming Example

The following example shows how to use the SPI API to configure the SPI module as a master device, and how to do a simple send of data.

```
EUSCI_A_SPI_initMasterParam spiMasterConfig = {
    EUSCI_A_SPI_CLOCKSOURCE_ACLK,           // ACLK Clock Source
    32000,                                   // ACLK = 32kHz
    16000,                                   // SPICLK = 16kHz
    EUSCI_A_SPI_MSB_FIRST,                  // MSB First
    EUSCI_A_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON_NEXT, // Phase
    EUSCI_A_SPI_CLOCKPOLARITY_INACTIVITY_HIGH, // High polarity
    EUSCI_A_SPI_3PIN                         // 3Wire SPI Mode
};

WDT_hold(WDT_BASE);

// Setting P1.1, P1.2 and P1.3 as SPI pins.
GPIO_setAsPeripheralModuleFunctionInputPin(GPIO_PORT_P1,
                                           GPIO_PIN1 | GPIO_PIN2 | GPIO_PIN3,
                                           GPIO_PRIMARY_MODULE_FUNCTION);

// Setting P1.4 as LED Pin
GPIO_setOutputLowOnPin(GPIO_PORT_P1, GPIO_PIN4);
GPIO_setAsOutputPin(GPIO_PORT_P1, GPIO_PIN4);

// Setting the DCO to use the internal resistor. DCO will be at 16.384MHz
// ACLK is at 32kHz
CS_setupDCO(CS_INTERNAL_RESISTOR);

// Configure and enable the SPI peripheral
EUSCI_A_SPI_initMaster(EUSCI_A0_BASE, &spiMasterConfig);
EUSCI_A_SPI_enable(EUSCI_A0_BASE);

// Put the first byte in the transfer buffer
EUSCI_A_SPI_transmitData(EUSCI_A0_BASE, TXData);

EUSCI_A_SPI_enableInterrupt(EUSCI_A0_BASE, EUSCI_A_SPI_RECEIVE_INTERRUPT);

// Go into LPM0 with interrupts enabled
__bis_SR_register(LPM0_bits | GIE);
```

8 EUSCI Synchronous Peripheral Interface (EUSCI_B_SPI)

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8.1 Introduction

The Serial Peripheral Interface Bus or SPI bus is a synchronous serial data link standard named by Motorola that operates in full duplex mode. Devices communicate in master/slave mode where the master device initiates the data frame.

This library provides the API for handling a SPI communication using EUSCI_B.

The SPI module can be configured as either a master or a slave device.

The SPI module also includes a programmable bit rate clock divider and prescaler to generate the output serial clock derived from the module's input clock.

This driver is contained in `eusci_b_spi.c`, with `eusci_b_spi.h` containing the API definitions for use by applications.

8.2 Functions

Functions

- void [EUSCI_B_SPI_changeClockPhasePolarity](#) (uint16_t baseAddress, uint16_t clockPhase, uint16_t clockPolarity)
- void [EUSCI_B_SPI_changeMasterClock](#) (uint16_t baseAddress, EUSCI_B_SPI_changeMasterClockParam *param)
- void [EUSCI_B_SPI_clearInterruptFlag](#) (uint16_t baseAddress, uint8_t mask)
- void [EUSCI_B_SPI_disable](#) (uint16_t baseAddress)
- void [EUSCI_B_SPI_disableInterrupt](#) (uint16_t baseAddress, uint8_t mask)
- void [EUSCI_B_SPI_enable](#) (uint16_t baseAddress)
- void [EUSCI_B_SPI_enableInterrupt](#) (uint16_t baseAddress, uint8_t mask)
- uint8_t [EUSCI_B_SPI_getInterruptStatus](#) (uint16_t baseAddress, uint8_t mask)
- uint32_t [EUSCI_B_SPI_getReceiveBufferAddress](#) (uint16_t baseAddress)
- uint32_t [EUSCI_B_SPI_getTransmitBufferAddress](#) (uint16_t baseAddress)
- void [EUSCI_B_SPI_initMaster](#) (uint16_t baseAddress, EUSCI_B_SPI_initMasterParam *param)
- void [EUSCI_B_SPI_initSlave](#) (uint16_t baseAddress, EUSCI_B_SPI_initSlaveParam *param)
- uint16_t [EUSCI_B_SPI_isBusy](#) (uint16_t baseAddress)
- uint8_t [EUSCI_B_SPI_receiveData](#) (uint16_t baseAddress)
- void [EUSCI_B_SPI_select4PinFunctionality](#) (uint16_t baseAddress, uint8_t select4PinFunctionality)
- void [EUSCI_B_SPI_transmitData](#) (uint16_t baseAddress, uint8_t transmitData)

8.2.1 Detailed Description

To use the module as a master, the user must call [EUSCI_B_SPI_initMaster\(\)](#) to configure the SPI Master. This is followed by enabling the SPI module using [EUSCI_B_SPI_enable\(\)](#). The interrupts are then enabled (if needed).

It is recommended to enable the SPI module before enabling the interrupts. A data transmit is then initiated using [EUSCI_B_SPI_transmitData\(\)](#) and then when the receive flag is set, the received data is read using [EUSCI_B_SPI_receiveData\(\)](#) and this indicates that an RX/TX operation is complete.

To use the module as a slave, initialization is done using [EUSCI_B_SPI_initSlave\(\)](#) and this is followed by enabling the module using [EUSCI_B_SPI_enable\(\)](#). Following this, the interrupts may be enabled as needed. When the receive flag is

set, data is first transmitted using `EUSCI_B_SPI_transmitData()` and this is followed by a data reception by `EUSCI_B_SPI_receiveData()`

The SPI API is broken into 3 groups of functions: those that deal with status and initialization, those that handle data, and those that manage interrupts.

The status and initialization of the SPI module are managed by

- `EUSCI_B_SPI_initMaster()`
- `EUSCI_B_SPI_initSlave()`
- `EUSCI_B_SPI_disable()`
- `EUSCI_B_SPI_enable()`
- `EUSCI_B_SPI_isBusy()`
- `EUSCI_B_SPI_select4PinFunctionality()`
- `EUSCI_B_SPI_changeClockPhasePolarity()`

Data handling is done by

- `EUSCI_B_SPI_transmitData()`
- `EUSCI_B_SPI_receiveData()`

Interrupts from the SPI module are managed using

- `EUSCI_B_SPI_disableInterrupt()`
- `EUSCI_B_SPI_enableInterrupt()`
- `EUSCI_B_SPI_getInterruptStatus()`
- `EUSCI_B_SPI_clearInterruptFlag()`

8.2.2 Function Documentation

8.2.2.1 `void EUSCI_B_SPI_changeClockPhasePolarity (uint16_t baseAddress, uint16_t clockPhase, uint16_t clockPolarity)`

Changes the SPI clock phase and polarity. At the end of this function call, SPI module is left enabled.

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

clockPhase is clock phase select. Valid values are:

- `EUSCI_B_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON_NEXT` [Default]
- `EUSCI_B_SPI_PHASE_DATA_CAPTURED_ONFIRST_CHANGED_ON_NEXT`

clockPolarity is clock polarity select Valid values are:

- `EUSCI_B_SPI_CLOCKPOLARITY_INACTIVITY_HIGH`
- `EUSCI_B_SPI_CLOCKPOLARITY_INACTIVITY_LOW` [Default]

Modified bits are **UCCKPL**, **UCCKPH** and **UCSWRST** of **UCAxCTLW0** register.

Returns:

None

8.2.2.2 `void EUSCI_B_SPI_changeMasterClock (uint16_t baseAddress, EUSCI_B_SPI_changeMasterClockParam * param)`

Initializes the SPI Master clock. At the end of this function call, SPI module is left enabled.

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

param is the pointer to struct for master clock setting.

Modified bits are **UCSWRST** of **UCAxCTLW0** register.

Returns:

None

8.2.2.3 void EUSCI_B_SPI_clearInterruptFlag (uint16_t *baseAddress*, uint8_t *mask*)

Clears the selected SPI interrupt status flag.

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

mask is the masked interrupt flag to be cleared. Mask value is the logical OR of any of the following:

- **EUSCI_B_SPI_TRANSMIT_INTERRUPT**
- **EUSCI_B_SPI_RECEIVE_INTERRUPT**

Modified bits of **UCAxIFG** register.

Returns:

None

8.2.2.4 void EUSCI_B_SPI_disable (uint16_t *baseAddress*)

Disables the SPI block.

This will disable operation of the SPI block.

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

Modified bits are **UCSWRST** of **UCAxCTLW0** register.

Returns:

None

8.2.2.5 void EUSCI_B_SPI_disableInterrupt (uint16_t *baseAddress*, uint8_t *mask*)

Disables individual SPI interrupt sources.

Disables the indicated SPI interrupt sources. Only the sources that are enabled can be reflected to the processor interrupt; disabled sources have no effect on the processor.

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

mask is the bit mask of the interrupt sources to be disabled. Mask value is the logical OR of any of the following:

- **EUSCI_B_SPI_TRANSMIT_INTERRUPT**
- **EUSCI_B_SPI_RECEIVE_INTERRUPT**

Modified bits of **UCAxIE** register.

Returns:

None

8.2.2.6 void EUSCI_B_SPI_enable (uint16_t *baseAddress*)

Enables the SPI block.

This will enable operation of the SPI block.

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

Modified bits are **UCSWRST** of **UCAxCTLW0** register.

Returns:

None

8.2.2.7 void EUSCI_B_SPI_enableInterrupt (uint16_t *baseAddress*, uint8_t *mask*)

Enables individual SPI interrupt sources.

Enables the indicated SPI interrupt sources. Only the sources that are enabled can be reflected to the processor interrupt; disabled sources have no effect on the processor. Does not clear interrupt flags.

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

mask is the bit mask of the interrupt sources to be enabled. Mask value is the logical OR of any of the following:

- **EUSCI_B_SPI_TRANSMIT_INTERRUPT**
- **EUSCI_B_SPI_RECEIVE_INTERRUPT**

Modified bits of **UCAxIFG** register and bits of **UCAxIE** register.

Returns:

None

8.2.2.8 uint8_t EUSCI_B_SPI_getInterruptStatus (uint16_t *baseAddress*, uint8_t *mask*)

Gets the current SPI interrupt status.

This returns the interrupt status for the SPI module based on which flag is passed.

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

mask is the masked interrupt flag status to be returned. Mask value is the logical OR of any of the following:

- **EUSCI_B_SPI_TRANSMIT_INTERRUPT**
- **EUSCI_B_SPI_RECEIVE_INTERRUPT**

Returns:

Logical OR of any of the following:

- **EUSCI_B_SPI_TRANSMIT_INTERRUPT**
 - **EUSCI_B_SPI_RECEIVE_INTERRUPT**
- indicating the status of the masked interrupts

8.2.2.9 uint32_t EUSCI_B_SPI_getReceiveBufferAddress (uint16_t *baseAddress*)

Returns the address of the RX Buffer of the SPI for the DMA module.

Returns the address of the SPI RX Buffer. This can be used in conjunction with the DMA to store the received data directly to memory.

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

Returns:

the address of the RX Buffer

8.2.2.10 uint32_t EUSCI_B_SPI_getTransmitBufferAddress (uint16_t baseAddress)

Returns the address of the TX Buffer of the SPI for the DMA module.

Returns the address of the SPI TX Buffer. This can be used in conjunction with the DMA to obtain transmitted data directly from memory.

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

Returns:

the address of the TX Buffer

8.2.2.11 void EUSCI_B_SPI_initMaster (uint16_t baseAddress, EUSCI_B_SPI_initMasterParam * param)

Initializes the SPI Master block.

Upon successful initialization of the SPI master block, this function will have set the bus speed for the master, but the SPI Master block still remains disabled and must be enabled with [EUSCI_B_SPI_enable\(\)](#)

Parameters:

baseAddress is the base address of the EUSCI_B_SPI Master module.

param is the pointer to struct for master initialization.

Modified bits are **UCCKPH**, **UCCKPL**, **UC7BIT**, **UCMSB**, **UCSSELx** and **UCSWRST** of **UCAxCTLW0** register.

Returns:

STATUS_SUCCESS

8.2.2.12 void EUSCI_B_SPI_initSlave (uint16_t baseAddress, EUSCI_B_SPI_initSlaveParam * param)

Initializes the SPI Slave block.

Upon successful initialization of the SPI slave block, this function will have initialized the slave block, but the SPI Slave block still remains disabled and must be enabled with [EUSCI_B_SPI_enable\(\)](#)

Parameters:

baseAddress is the base address of the EUSCI_B_SPI Slave module.

param is the pointer to struct for slave initialization.

Modified bits are **UCMSB**, **UCMST**, **UC7BIT**, **UCCKPL**, **UCCKPH**, **UCMODE** and **UCSWRST** of **UCAxCTLW0** register.

Returns:

STATUS_SUCCESS

8.2.2.13 uint16_t EUSCI_B_SPI_isBusy (uint16_t *baseAddress*)

Indicates whether or not the SPI bus is busy.

This function returns an indication of whether or not the SPI bus is busy. This function checks the status of the bus via UCBBUSY bit

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

Returns:

One of the following:

- EUSCI_B_SPI_BUSY
 - EUSCI_B_SPI_NOT_BUSY
- indicating if the EUSCI_B_SPI is busy

8.2.2.14 uint8_t EUSCI_B_SPI_receiveData (uint16_t *baseAddress*)

Receives a byte that has been sent to the SPI Module.

This function reads a byte of data from the SPI receive data Register.

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

Returns:

Returns the byte received from by the SPI module, cast as an uint8_t.

8.2.2.15 void EUSCI_B_SPI_select4PinFunctionality (uint16_t *baseAddress*, uint8_t *select4PinFunctionality*)

Selects 4Pin Functionality.

This function should be invoked only in 4-wire mode. Invoking this function has no effect in 3-wire mode.

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

select4PinFunctionality selects 4 pin functionality Valid values are:

- EUSCI_B_SPI_PREVENT_CONFLICTS_WITH_OTHER_MASTERS
- EUSCI_B_SPI_ENABLE_SIGNAL_FOR_4WIRE_SLAVE

Modified bits are **UCSTEM** of **UCAxCTLW0** register.

Returns:

None

8.2.2.16 void EUSCI_B_SPI_transmitData (uint16_t *baseAddress*, uint8_t *transmitData*)

Transmits a byte from the SPI Module.

This function will place the supplied data into SPI transmit data register to start transmission.

Parameters:

baseAddress is the base address of the EUSCI_B_SPI module.

transmitData data to be transmitted from the SPI module

Returns:

None

8.3 Programming Example

The following example shows how to use the SPI API to configure the SPI module as a master device, and how to do a simple send of data.

```
EUSCI_B_SPI_initMasterParam spiMasterConfig = {
    EUSCI_B_SPI_CLOCKSOURCE_ACLK,           // ACLK Clock Source
    32000,                                   // ACLK = 32kHz
    16000,                                   // SPICLK = 16kHz
    EUSCI_B_SPI_MSB_FIRST,                   // MSB First
    EUSCI_B_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON_NEXT, // Phase
    EUSCI_B_SPI_CLOCKPOLARITY_INACTIVITY_HIGH, // High polarity
    EUSCI_B_SPI_3PIN                         // 3Wire SPI Mode
};

WDT_hold(WDT_BASE);

// Setting P1.1, P1.2 and P1.3 as SPI pins.
GPIO_setAsPeripheralModuleFunctionInputPin(GPIO_PORT_P1,
                                           GPIO_PIN1 | GPIO_PIN2 | GPIO_PIN3,
                                           GPIO_PRIMARY_MODULE_FUNCTION);

// Setting P1.4 as LED Pin
GPIO_setOutputLowOnPin(GPIO_PORT_P1, GPIO_PIN4);
GPIO_setAsOutputPin(GPIO_PORT_P1, GPIO_PIN4);

// Setting the DCO to use the internal resistor. DCO will be at 16.384MHz
// ACLK is at 32kHz
CS_setupDCO(CS_INTERNAL_RESISTOR);

// Configure and enable the SPI peripheral
EUSCI_B_SPI_initMaster(EUSCI_B0_BASE, &spiMasterConfig);
EUSCI_B_SPI_enable(EUSCI_B0_BASE);

// Put the first byte in the transfer buffer
EUSCI_B_SPI_transmitData(EUSCI_B0_BASE, TXData);

EUSCI_B_SPI_enableInterrupt(EUSCI_B0_BASE, EUSCI_B_SPI_RECEIVE_INTERRUPT);

// Go into LPM0 with interrupts enabled
__bis_SR_register(LPM0_bits | GIE);
```

9 EUSCI Inter-Integrated Circuit (EUSCI_B_I2C)

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9.1 Introduction

In I2C mode, the eUSCI_B module provides an interface between the device and I2C-compatible devices connected by the two-wire I2C serial bus. External components attached to the I2C bus serially transmit and/or receive serial data to/from the eUSCI_B module through the 2-wire I2C interface. The Inter-Integrated Circuit (I2C) API provides a set of functions for using the MSP430i2xx eUSCI_B_I2C module. Functions are provided to initialize the I2C modules, to send and receive data, obtain status, and to manage interrupts for the I2C modules.

The I2C module provide the ability to communicate to other IC devices over an I2C bus. The I2C bus is specified to support devices that can both transmit and receive (write and read) data. Also, devices on the I2C bus can be designated as either a master or a slave. The driver library EUSCI_B_I2C module supports both sending and receiving data as either a master or a slave, and also supports the simultaneous operation as both a master and a slave.

I2C module can generate interrupts. The I2C module configured as a master will generate interrupts when a transmit or receive operation is completed (or aborted due to an error). The I2C module configured as a slave will generate interrupts when data has been sent or requested by a master.

9.1.1 Master Operations

To drive the master module, the APIs need to be invoked in the following order

- [EUSCI_B_I2C_initMaster\(\)](#)
- [EUSCI_B_I2C_setSlaveAddress\(\)](#)
- [EUSCI_B_I2C_setMode\(\)](#)
- [EUSCI_B_I2C_enable\(\)](#)
- [EUSCI_B_I2C_enableInterrupt\(\)](#) (if interrupts are being used) This may be followed by the APIs for transmit or receive as required

The user must first initialize the I2C module and configure it as a master with a call to [EUSCI_B_I2C_initMaster\(\)](#). That function will set the clock and data rates. This is followed by a call to set the slave address with which the master intends to communicate with using [EUSCI_B_I2C_setSlaveAddress\(\)](#). Then the mode of operation (transmit or receive) is chosen using [EUSCI_B_I2C_setMode\(\)](#). The I2C module may now be enabled using [EUSCI_B_I2C_enable\(\)](#).

It is recommended to enable the EUSCI_B_I2C module before enabling the interrupts. Any transmission or reception of data may be initiated at this point after interrupts are enabled (if any).

The transaction can then be initiated on the bus by calling the transmit or receive related APIs as listed below.

Master Single Byte Transmission

- [EUSCI_B_I2C_masterSendSingleByte\(\)](#)

Master Multiple Byte Transmission

- [EUSCI_B_I2C_masterMultiByteSendStart\(\)](#)
- [EUSCI_B_I2C_masterMultiByteSendNext\(\)](#)
- [EUSCI_B_I2C_masterMultiByteSendStop\(\)](#)

Master Single Byte Reception

- [EUSCI_B_I2C_masterReceiveSingleByte\(\)](#)

Master Multiple Byte Reception

- [EUSCI_B_I2C_masterMultiByteReceiveStart\(\)](#)
- [EUSCI_B_I2C_masterMultiByteReceiveNext\(\)](#)
- [EUSCI_B_I2C_masterMultiByteReceiveFinish\(\)](#)
- [EUSCI_B_I2C_masterMultiByteReceiveStop\(\)](#)

For the interrupt-driven transaction, the user must register an interrupt handler for the I2C devices and enable the I2C interrupt.

9.1.2 Slave Operations

To drive the slave module, the APIs need to be invoked in the following order

- [EUSCI_B_I2C_initSlave\(\)](#)
- [EUSCI_B_I2C_setMode\(\)](#)
- [EUSCI_B_I2C_enable\(\)](#)
- [EUSCI_B_I2C_enableInterrupt\(\)](#) (if interrupts are being used) This may be followed by the APIs for transmit or receive as required

The user must first call the [EUSCI_B_I2C_initSlave\(\)](#) to initialize the slave module in I2C mode and set the slave address. This is followed by a call to set the mode of operation (transmit or receive). The I2C module may now be enabled using [EUSCI_B_I2C_enable\(\)](#) function.

It is recommended to enable the I2C module before enabling the interrupts. Any transmission or reception of data may be initiated at this point after interrupts are enabled (if any).

The transaction can then be initiated on the bus by calling the transmit or receive related APIs as listed below.

Slave Transmission API

- [EUSCI_B_I2C_slaveDataPut\(\)](#)

Slave Reception API

- [EUSCI_B_I2C_slaveDataGet\(\)](#)

For the interrupt-driven transaction, the user must register an interrupt handler for the I2C devices and enable the I2C interrupt.

This driver is contained in `eusci_b_i2c.c`, with `eusci_b_i2c.h` containing the API definitions for use by applications.

9.2 API Functions

Functions

- void [EUSCI_B_I2C_clearInterruptFlag](#) (uint16_t baseAddress, uint16_t mask)
- void [EUSCI_B_I2C_disable](#) (uint16_t baseAddress)
- void [EUSCI_B_I2C_disableInterrupt](#) (uint16_t baseAddress, uint16_t mask)
- void [EUSCI_B_I2C_disableMultiMasterMode](#) (uint16_t baseAddress)
- void [EUSCI_B_I2C_enable](#) (uint16_t baseAddress)
- void [EUSCI_B_I2C_enableInterrupt](#) (uint16_t baseAddress, uint16_t mask)
- void [EUSCI_B_I2C_enableMultiMasterMode](#) (uint16_t baseAddress)
- uint16_t [EUSCI_B_I2C_getInterruptStatus](#) (uint16_t baseAddress, uint16_t mask)
- uint8_t [EUSCI_B_I2C_getMode](#) (uint16_t baseAddress)

- uint32_t [EUSCI_B_I2C_getReceiveBufferAddress](#) (uint16_t baseAddress)
- uint32_t [EUSCI_B_I2C_getTransmitBufferAddress](#) (uint16_t baseAddress)
- void [EUSCI_B_I2C_initMaster](#) (uint16_t baseAddress, EUSCI_B_I2C_initMasterParam *param)
- void [EUSCI_B_I2C_initSlave](#) (uint16_t baseAddress, EUSCI_B_I2C_initSlaveParam *param)
- uint16_t [EUSCI_B_I2C_isBusBusy](#) (uint16_t baseAddress)
- uint16_t [EUSCI_B_I2C_masterIsStartSent](#) (uint16_t baseAddress)
- uint16_t [EUSCI_B_I2C_masterIsStopSent](#) (uint16_t baseAddress)
- uint8_t [EUSCI_B_I2C_masterMultiByteReceiveFinish](#) (uint16_t baseAddress)
- bool [EUSCI_B_I2C_masterMultiByteReceiveFinishWithTimeout](#) (uint16_t baseAddress, uint8_t *txData, uint32_t timeout)
- uint8_t [EUSCI_B_I2C_masterMultiByteReceiveNext](#) (uint16_t baseAddress)
- void [EUSCI_B_I2C_masterMultiByteReceiveStop](#) (uint16_t baseAddress)
- void [EUSCI_B_I2C_masterMultiByteSendFinish](#) (uint16_t baseAddress, uint8_t txData)
- bool [EUSCI_B_I2C_masterMultiByteSendFinishWithTimeout](#) (uint16_t baseAddress, uint8_t txData, uint32_t timeout)
- void [EUSCI_B_I2C_masterMultiByteSendNext](#) (uint16_t baseAddress, uint8_t txData)
- bool [EUSCI_B_I2C_masterMultiByteSendNextWithTimeout](#) (uint16_t baseAddress, uint8_t txData, uint32_t timeout)
- void [EUSCI_B_I2C_masterMultiByteSendStart](#) (uint16_t baseAddress, uint8_t txData)
- bool [EUSCI_B_I2C_masterMultiByteSendStartWithTimeout](#) (uint16_t baseAddress, uint8_t txData, uint32_t timeout)
- void [EUSCI_B_I2C_masterMultiByteSendStop](#) (uint16_t baseAddress)
- bool [EUSCI_B_I2C_masterMultiByteSendStopWithTimeout](#) (uint16_t baseAddress, uint32_t timeout)
- uint8_t [EUSCI_B_I2C_masterReceiveSingleByte](#) (uint16_t baseAddress)
- void [EUSCI_B_I2C_masterReceiveStart](#) (uint16_t baseAddress)
- void [EUSCI_B_I2C_masterSendSingleByte](#) (uint16_t baseAddress, uint8_t txData)
- bool [EUSCI_B_I2C_masterSendSingleByteWithTimeout](#) (uint16_t baseAddress, uint8_t txData, uint32_t timeout)
- void [EUSCI_B_I2C_masterSendStart](#) (uint16_t baseAddress)
- uint8_t [EUSCI_B_I2C_masterSingleReceive](#) (uint16_t baseAddress)
- void [EUSCI_B_I2C_setMode](#) (uint16_t baseAddress, uint8_t mode)
- void [EUSCI_B_I2C_setSlaveAddress](#) (uint16_t baseAddress, uint8_t slaveAddress)
- uint8_t [EUSCI_B_I2C_slaveDataGet](#) (uint16_t baseAddress)
- void [EUSCI_B_I2C_slaveDataPut](#) (uint16_t baseAddress, uint8_t transmitData)

9.2.1 Detailed Description

The eUSCI I2C API is broken into three groups of functions: those that deal with interrupts, those that handle status and initialization, and those that deal with sending and receiving data.

The I2C master and slave interrupts are handled by

- [EUSCI_B_I2C_enableInterrupt\(\)](#)
- [EUSCI_B_I2C_disableInterrupt\(\)](#)
- [EUSCI_B_I2C_clearInterruptFlag\(\)](#)
- [EUSCI_B_I2C_getInterruptStatus\(\)](#)

Status and initialization functions for the I2C modules are

- [EUSCI_B_I2C_initMaster\(\)](#)
- [EUSCI_B_I2C_enable\(\)](#)
- [EUSCI_B_I2C_disable\(\)](#)
- [EUSCI_B_I2C_isBusBusy\(\)](#)
- [EUSCI_B_I2C_isBusy\(\)](#)
- [EUSCI_B_I2C_slaveInit\(\)](#)
- [EUSCI_B_I2C_interruptStatus\(\)](#)
- [EUSCI_B_I2C_setSlaveAddress\(\)](#)

- EUSCI_B_I2C_setMode()
- EUSCI_B_I2C_masterIsStopSent()
- EUSCI_B_I2C_masterIsStartSent()
- EUSCI_B_I2C_selectMasterEnvironmentSelect()

Sending and receiving data from the I2C slave module is handled by

- EUSCI_B_I2C_slaveDataPut()
- EUSCI_B_I2C_slaveDataGet()

Sending and receiving data from the I2C master module is handled by

- EUSCI_B_I2C_masterSendSingleByte()
- EUSCI_B_I2C_masterSendStart()
- EUSCI_B_I2C_masterMultiByteSendStart()
- EUSCI_B_I2C_masterMultiByteSendNext()
- EUSCI_B_I2C_masterMultiByteSendFinish()
- EUSCI_B_I2C_masterMultiByteSendStop()
- EUSCI_B_I2C_masterMultiByteReceiveNext()
- EUSCI_B_I2C_masterMultiByteReceiveFinish()
- EUSCI_B_I2C_masterMultiByteReceiveStop()
- EUSCI_B_I2C_masterReceiveStart()
- EUSCI_B_I2C_masterSingleReceive()

9.2.2 Function Documentation

9.2.2.1 void EUSCI_B_I2C_clearInterruptFlag (uint16_t *baseAddress*, uint16_t *mask*)

Clears I2C interrupt sources.

The I2C interrupt source is cleared, so that it no longer asserts. The highest interrupt flag is automatically cleared when an interrupt vector generator is used.

Parameters:

baseAddress is the base address of the I2C module.

mask is a bit mask of the interrupt sources to be cleared. Mask value is the logical OR of any of the following:

- EUSCI_B_I2C_NAK_INTERRUPT - Not-acknowledge interrupt
- EUSCI_B_I2C_ARBITRATIONLOST_INTERRUPT - Arbitration lost interrupt
- EUSCI_B_I2C_STOP_INTERRUPT - STOP condition interrupt
- EUSCI_B_I2C_START_INTERRUPT - START condition interrupt
- EUSCI_B_I2C_TRANSMIT_INTERRUPT0 - Transmit interrupt0
- EUSCI_B_I2C_TRANSMIT_INTERRUPT1 - Transmit interrupt1
- EUSCI_B_I2C_TRANSMIT_INTERRUPT2 - Transmit interrupt2
- EUSCI_B_I2C_TRANSMIT_INTERRUPT3 - Transmit interrupt3
- EUSCI_B_I2C_RECEIVE_INTERRUPT0 - Receive interrupt0
- EUSCI_B_I2C_RECEIVE_INTERRUPT1 - Receive interrupt1
- EUSCI_B_I2C_RECEIVE_INTERRUPT2 - Receive interrupt2
- EUSCI_B_I2C_RECEIVE_INTERRUPT3 - Receive interrupt3
- EUSCI_B_I2C_BIT9_POSITION_INTERRUPT - Bit position 9 interrupt
- EUSCI_B_I2C_CLOCK_LOW_TIMEOUT_INTERRUPT - Clock low timeout interrupt enable
- EUSCI_B_I2C_BYTE_COUNTER_INTERRUPT - Byte counter interrupt enable

Modified bits of **UCBxIFG** register.

Returns:

None

9.2.2.2 void EUSCI_B_I2C_disable (uint16_t *baseAddress*)

Disables the I2C block.

This will disable operation of the I2C block.

Parameters:

baseAddress is the base address of the USCI I2C module.

Modified bits are **UCSWRST** of **UCBxCTLW0** register.

Returns:

None

9.2.2.3 void EUSCI_B_I2C_disableInterrupt (uint16_t *baseAddress*, uint16_t *mask*)

Disables individual I2C interrupt sources.

Disables the indicated I2C interrupt sources. Only the sources that are enabled can be reflected to the processor interrupt; disabled sources have no effect on the processor.

Parameters:

baseAddress is the base address of the I2C module.

mask is the bit mask of the interrupt sources to be disabled. Mask value is the logical OR of any of the following:

- **EUSCI_B_I2C_NAK_INTERRUPT** - Not-acknowledge interrupt
- **EUSCI_B_I2C_ARBITRATIONLOST_INTERRUPT** - Arbitration lost interrupt
- **EUSCI_B_I2C_STOP_INTERRUPT** - STOP condition interrupt
- **EUSCI_B_I2C_START_INTERRUPT** - START condition interrupt
- **EUSCI_B_I2C_TRANSMIT_INTERRUPT0** - Transmit interrupt0
- **EUSCI_B_I2C_TRANSMIT_INTERRUPT1** - Transmit interrupt1
- **EUSCI_B_I2C_TRANSMIT_INTERRUPT2** - Transmit interrupt2
- **EUSCI_B_I2C_TRANSMIT_INTERRUPT3** - Transmit interrupt3
- **EUSCI_B_I2C_RECEIVE_INTERRUPT0** - Receive interrupt0
- **EUSCI_B_I2C_RECEIVE_INTERRUPT1** - Receive interrupt1
- **EUSCI_B_I2C_RECEIVE_INTERRUPT2** - Receive interrupt2
- **EUSCI_B_I2C_RECEIVE_INTERRUPT3** - Receive interrupt3
- **EUSCI_B_I2C_BIT9_POSITION_INTERRUPT** - Bit position 9 interrupt
- **EUSCI_B_I2C_CLOCK_LOW_TIMEOUT_INTERRUPT** - Clock low timeout interrupt enable
- **EUSCI_B_I2C_BYTE_COUNTER_INTERRUPT** - Byte counter interrupt enable

Modified bits of **UCBxIE** register.

Returns:

None

9.2.2.4 void EUSCI_B_I2C_disableMultiMasterMode (uint16_t *baseAddress*)

Disables Multi Master Mode.

At the end of this function, the I2C module is still disabled till EUSCI_B_I2C_enable is invoked

Parameters:

baseAddress is the base address of the I2C module.

Modified bits are **UCSWRST** and **UCMM** of **UCBxCTLW0** register.

Returns:

None

9.2.2.5 void EUSCI_B_I2C_enable (uint16_t *baseAddress*)

Enables the I2C block.

This will enable operation of the I2C block.

Parameters:

baseAddress is the base address of the USCI I2C module.

Modified bits are **UCSWRST** of **UCBxCTLW0** register.

Returns:

None

9.2.2.6 void EUSCI_B_I2C_enableInterrupt (uint16_t *baseAddress*, uint16_t *mask*)

Enables individual I2C interrupt sources.

Enables the indicated I2C interrupt sources. Only the sources that are enabled can be reflected to the processor interrupt; disabled sources have no effect on the processor.

Parameters:

baseAddress is the base address of the I2C module.

mask is the bit mask of the interrupt sources to be enabled. Mask value is the logical OR of any of the following:

- **EUSCI_B_I2C_NAK_INTERRUPT** - Not-acknowledge interrupt
- **EUSCI_B_I2C_ARBITRATIONLOST_INTERRUPT** - Arbitration lost interrupt
- **EUSCI_B_I2C_STOP_INTERRUPT** - STOP condition interrupt
- **EUSCI_B_I2C_START_INTERRUPT** - START condition interrupt
- **EUSCI_B_I2C_TRANSMIT_INTERRUPT0** - Transmit interrupt0
- **EUSCI_B_I2C_TRANSMIT_INTERRUPT1** - Transmit interrupt1
- **EUSCI_B_I2C_TRANSMIT_INTERRUPT2** - Transmit interrupt2
- **EUSCI_B_I2C_TRANSMIT_INTERRUPT3** - Transmit interrupt3
- **EUSCI_B_I2C_RECEIVE_INTERRUPT0** - Receive interrupt0
- **EUSCI_B_I2C_RECEIVE_INTERRUPT1** - Receive interrupt1
- **EUSCI_B_I2C_RECEIVE_INTERRUPT2** - Receive interrupt2
- **EUSCI_B_I2C_RECEIVE_INTERRUPT3** - Receive interrupt3
- **EUSCI_B_I2C_BIT9_POSITION_INTERRUPT** - Bit position 9 interrupt
- **EUSCI_B_I2C_CLOCK_LOW_TIMEOUT_INTERRUPT** - Clock low timeout interrupt enable
- **EUSCI_B_I2C_BYTE_COUNTER_INTERRUPT** - Byte counter interrupt enable

Modified bits of **UCBxIE** register.

Returns:

None

9.2.2.7 void EUSCI_B_I2C_enableMultiMasterMode (uint16_t *baseAddress*)

Enables Multi Master Mode.

At the end of this function, the I2C module is still disabled till EUSCI_B_I2C_enable is invoked

Parameters:

baseAddress is the base address of the I2C module.

Modified bits are **UCSWRST** and **UCMM** of **UCBxCTLW0** register.

Returns:

None

9.2.2.8 uint16_t EUSCI_B_I2C_getInterruptStatus (uint16_t *baseAddress*, uint16_t *mask*)

Gets the current I2C interrupt status.

This returns the interrupt status for the I2C module based on which flag is passed.

Parameters:

baseAddress is the base address of the I2C module.

mask is the masked interrupt flag status to be returned. Mask value is the logical OR of any of the following:

- EUSCI_B_I2C_NAK_INTERRUPT - Not-acknowledge interrupt
- EUSCI_B_I2C_ARBITRATIONLOST_INTERRUPT - Arbitration lost interrupt
- EUSCI_B_I2C_STOP_INTERRUPT - STOP condition interrupt
- EUSCI_B_I2C_START_INTERRUPT - START condition interrupt
- EUSCI_B_I2C_TRANSMIT_INTERRUPT0 - Transmit interrupt0
- EUSCI_B_I2C_TRANSMIT_INTERRUPT1 - Transmit interrupt1
- EUSCI_B_I2C_TRANSMIT_INTERRUPT2 - Transmit interrupt2
- EUSCI_B_I2C_TRANSMIT_INTERRUPT3 - Transmit interrupt3
- EUSCI_B_I2C_RECEIVE_INTERRUPT0 - Receive interrupt0
- EUSCI_B_I2C_RECEIVE_INTERRUPT1 - Receive interrupt1
- EUSCI_B_I2C_RECEIVE_INTERRUPT2 - Receive interrupt2
- EUSCI_B_I2C_RECEIVE_INTERRUPT3 - Receive interrupt3
- EUSCI_B_I2C_BIT9_POSITION_INTERRUPT - Bit position 9 interrupt
- EUSCI_B_I2C_CLOCK_LOW_TIMEOUT_INTERRUPT - Clock low timeout interrupt enable
- EUSCI_B_I2C_BYTE_COUNTER_INTERRUPT - Byte counter interrupt enable

Returns:

Logical OR of any of the following:

- EUSCI_B_I2C_NAK_INTERRUPT Not-acknowledge interrupt
 - EUSCI_B_I2C_ARBITRATIONLOST_INTERRUPT Arbitration lost interrupt
 - EUSCI_B_I2C_STOP_INTERRUPT STOP condition interrupt
 - EUSCI_B_I2C_START_INTERRUPT START condition interrupt
 - EUSCI_B_I2C_TRANSMIT_INTERRUPT0 Transmit interrupt0
 - EUSCI_B_I2C_TRANSMIT_INTERRUPT1 Transmit interrupt1
 - EUSCI_B_I2C_TRANSMIT_INTERRUPT2 Transmit interrupt2
 - EUSCI_B_I2C_TRANSMIT_INTERRUPT3 Transmit interrupt3
 - EUSCI_B_I2C_RECEIVE_INTERRUPT0 Receive interrupt0
 - EUSCI_B_I2C_RECEIVE_INTERRUPT1 Receive interrupt1
 - EUSCI_B_I2C_RECEIVE_INTERRUPT2 Receive interrupt2
 - EUSCI_B_I2C_RECEIVE_INTERRUPT3 Receive interrupt3
 - EUSCI_B_I2C_BIT9_POSITION_INTERRUPT Bit position 9 interrupt
 - EUSCI_B_I2C_CLOCK_LOW_TIMEOUT_INTERRUPT Clock low timeout interrupt enable
 - EUSCI_B_I2C_BYTE_COUNTER_INTERRUPT Byte counter interrupt enable
- indicating the status of the masked interrupts

9.2.2.9 uint8_t EUSCI_B_I2C_getMode (uint16_t *baseAddress*)

Gets the mode of the I2C device.

Current I2C transmit/receive mode.

Parameters:

baseAddress is the base address of the I2C module.

Modified bits are **UCTR** of **UCBxCTLW0** register.

Returns:

None Return one of the following:

- EUSCI_B_I2C_TRANSMIT_MODE
 - EUSCI_B_I2C_RECEIVE_MODE
- indicating the current mode

9.2.2.10 uint32_t EUSCI_B_I2C_getReceiveBufferAddress (uint16_t *baseAddress*)

Returns the address of the RX Buffer of the I2C for the DMA module.

Returns the address of the I2C RX Buffer. This can be used in conjunction with the DMA to store the received data directly to memory.

Parameters:

baseAddress is the base address of the I2C module.

Returns:

The address of the I2C RX Buffer

9.2.2.11 uint32_t EUSCI_B_I2C_getTransmitBufferAddress (uint16_t *baseAddress*)

Returns the address of the TX Buffer of the I2C for the DMA module.

Returns the address of the I2C TX Buffer. This can be used in conjunction with the DMA to obtain transmitted data directly from memory.

Parameters:

baseAddress is the base address of the I2C module.

Returns:

The address of the I2C TX Buffer

9.2.2.12 void EUSCI_B_I2C_initMaster (uint16_t *baseAddress*, EUSCI_B_I2C_initMasterParam * *param*)

Initializes the I2C Master block.

This function initializes operation of the I2C Master block. Upon successful initialization of the I2C block, this function will have set the bus speed for the master; however I2C module is still disabled till EUSCI_B_I2C_enable is invoked.

Parameters:

baseAddress is the base address of the I2C Master module.

param is the pointer to the struct for master initialization.

Returns:

None

9.2.2.13 void EUSCI_B_I2C_initSlave (uint16_t *baseAddress*, EUSCI_B_I2C_initSlaveParam * *param*)

Initializes the I2C Slave block.

This function initializes operation of the I2C as a Slave mode. Upon successful initialization of the I2C blocks, this function will have set the slave address but the I2C module is still disabled till EUSCI_B_I2C_enable is invoked.

Parameters:

baseAddress is the base address of the I2C Slave module.

param is the pointer to the struct for slave initialization.

Returns:
None

9.2.2.14 uint16_t EUSCI_B_I2C_isBusBusy (uint16_t *baseAddress*)

Indicates whether or not the I2C bus is busy.

This function returns an indication of whether or not the I2C bus is busy. This function checks the status of the bus via UCBBUSY bit in UCBxSTAT register.

Parameters:
baseAddress is the base address of the I2C module.

Returns:
One of the following:

- **EUSCI_B_I2C_BUS_BUSY**
- **EUSCI_B_I2C_BUS_NOT_BUSY**
indicating whether the bus is busy

9.2.2.15 uint16_t EUSCI_B_I2C_masterIsStartSent (uint16_t *baseAddress*)

Indicates whether Start got sent.

This function returns an indication of whether or not Start got sent This function checks the status of the bus via UCTXSTT bit in UCBxCTL1 register.

Parameters:
baseAddress is the base address of the I2C Master module.

Returns:
One of the following:

- **EUSCI_B_I2C_START_SEND_COMPLETE**
- **EUSCI_B_I2C_SENDING_START**
indicating whether the start was sent

9.2.2.16 uint16_t EUSCI_B_I2C_masterIsStopSent (uint16_t *baseAddress*)

Indicates whether STOP got sent.

This function returns an indication of whether or not STOP got sent This function checks the status of the bus via UCTXSTP bit in UCBxCTL1 register.

Parameters:
baseAddress is the base address of the I2C Master module.

Returns:
One of the following:

- **EUSCI_B_I2C_STOP_SEND_COMPLETE**
- **EUSCI_B_I2C_SENDING_STOP**
indicating whether the stop was sent

9.2.2.17 uint8_t EUSCI_B_I2C_masterMultiByteReceiveFinish (uint16_t *baseAddress*)

Finishes multi-byte reception at the Master end.

This function is used by the Master module to initiate completion of a multi-byte reception. This function receives the current byte and initiates the STOP from master to slave.

Parameters:

baseAddress is the base address of the I2C Master module.

Modified bits are **UCTXSTP** of **UCBxCTLW0** register.

Returns:

Received byte at Master end.

9.2.2.18 bool EUSCI_B_I2C_masterMultiByteReceiveFinishWithTimeout (uint16_t *baseAddress*, uint8_t * *txData*, uint32_t *timeout*)

Finishes multi-byte reception at the Master end with timeout.

This function is used by the Master module to initiate completion of a multi-byte reception. This function receives the current byte and initiates the STOP from master to slave.

Parameters:

baseAddress is the base address of the I2C Master module.

txData is a pointer to the location to store the received byte at master end

timeout is the amount of time to wait until giving up

Modified bits are **UCTXSTP** of **UCBxCTLW0** register.

Returns:

STATUS_SUCCESS or STATUS_FAILURE of the reception process

9.2.2.19 uint8_t EUSCI_B_I2C_masterMultiByteReceiveNext (uint16_t *baseAddress*)

Starts multi-byte reception at the Master end one byte at a time.

This function is used by the Master module to receive each byte of a multi- byte reception. This function reads currently received byte.

Parameters:

baseAddress is the base address of the I2C Master module.

Returns:

Received byte at Master end.

9.2.2.20 void EUSCI_B_I2C_masterMultiByteReceiveStop (uint16_t *baseAddress*)

Sends the STOP at the end of a multi-byte reception at the Master end.

This function is used by the Master module to initiate STOP

Parameters:

baseAddress is the base address of the I2C Master module.

Modified bits are **UCTXSTP** of **UCBxCTLW0** register.

Returns:

None

9.2.2.21 void EUSCI_B_I2C_masterMultiByteSendFinish (uint16_t *baseAddress*, uint8_t *txData*)

Finishes multi-byte transmission from Master to Slave.

This function is used by the Master module to send the last byte and STOP. This function transmits the last data byte of a multi-byte transmission to the slave and then sends a stop.

Parameters:

baseAddress is the base address of the I2C Master module.

txData is the last data byte to be transmitted in a multi-byte transmission

Modified bits of **UCBxTXBUF** register and bits of **UCBxCTLW0** register.

Returns:

None

9.2.2.22 bool EUSCI_B_I2C_masterMultiByteSendFinishWithTimeout (uint16_t *baseAddress*, uint8_t *txData*, uint32_t *timeout*)

Finishes multi-byte transmission from Master to Slave with timeout.

This function is used by the Master module to send the last byte and STOP. This function transmits the last data byte of a multi-byte transmission to the slave and then sends a stop.

Parameters:

baseAddress is the base address of the I2C Master module.

txData is the last data byte to be transmitted in a multi-byte transmission

timeout is the amount of time to wait until giving up

Modified bits of **UCBxTXBUF** register and bits of **UCBxCTLW0** register.

Returns:

STATUS_SUCCESS or STATUS_FAILURE of the transmission process.

9.2.2.23 void EUSCI_B_I2C_masterMultiByteSendNext (uint16_t *baseAddress*, uint8_t *txData*)

Continues multi-byte transmission from Master to Slave.

This function is used by the Master module continue each byte of a multi- byte transmission. This function transmits each data byte of a multi-byte transmission to the slave.

Parameters:

baseAddress is the base address of the I2C Master module.

txData is the next data byte to be transmitted

Modified bits of **UCBxTXBUF** register.

Returns:

None

9.2.2.24 bool EUSCI_B_I2C_masterMultiByteSendNextWithTimeout (uint16_t *baseAddress*, uint8_t *txData*, uint32_t *timeout*)

Continues multi-byte transmission from Master to Slave with timeout.

This function is used by the Master module continue each byte of a multi- byte transmission. This function transmits each data byte of a multi-byte transmission to the slave.

Parameters:

baseAddress is the base address of the I2C Master module.

txData is the next data byte to be transmitted

timeout is the amount of time to wait until giving up

Modified bits of **UCBxTXBUF** register.

Returns:

STATUS_SUCCESS or STATUS_FAILURE of the transmission process.

9.2.2.25 void EUSCI_B_I2C_masterMultiByteSendStart (uint16_t *baseAddress*, uint8_t *txData*)

Starts multi-byte transmission from Master to Slave.

This function is used by the master module to start a multi byte transaction.

Parameters:

baseAddress is the base address of the I2C Master module.

txData is the first data byte to be transmitted

Modified bits of **UCBxTXBUF** register, bits of **UCBxCTLW0** register, bits of **UCBxIE** register and bits of **UCBxIFG** register.

Returns:

None

9.2.2.26 bool EUSCI_B_I2C_masterMultiByteSendStartWithTimeout (uint16_t *baseAddress*, uint8_t *txData*, uint32_t *timeout*)

Starts multi-byte transmission from Master to Slave with timeout.

This function is used by the master module to start a multi byte transaction.

Parameters:

baseAddress is the base address of the I2C Master module.

txData is the first data byte to be transmitted

timeout is the amount of time to wait until giving up

Modified bits of **UCBxTXBUF** register, bits of **UCBxCTLW0** register, bits of **UCBxIE** register and bits of **UCBxIFG** register.

Returns:

STATUS_SUCCESS or STATUS_FAILURE of the transmission process.

9.2.2.27 void EUSCI_B_I2C_masterMultiByteSendStop (uint16_t *baseAddress*)

Send STOP byte at the end of a multi-byte transmission from Master to Slave.

This function is used by the Master module send STOP at the end of a multi- byte transmission. This function sends a stop after current transmission is complete.

Parameters:

baseAddress is the base address of the I2C Master module.

Modified bits are **UCTXSTP** of **UCBxCTLW0** register.

Returns:

None

9.2.2.28 bool EUSCI_B_I2C_masterMultiByteSendStopWithTimeout (uint16_t *baseAddress*, uint32_t *timeout*)

Send STOP byte at the end of a multi-byte transmission from Master to Slave with timeout.

This function is used by the Master module send STOP at the end of a multi- byte transmission. This function sends a stop after current transmission is complete.

Parameters:

baseAddress is the base address of the I2C Master module.

timeout is the amount of time to wait until giving up

Modified bits are **UCTXSTP** of **UCBxCTLW0** register.

Returns:

STATUS_SUCCESS or STATUS_FAILURE of the transmission process.

9.2.2.29 uint8_t EUSCI_B_I2C_masterReceiveSingleByte (uint16_t *baseAddress*)

Does single byte reception from Slave.

This function is used by the Master module to receive a single byte. This function sends start and stop, waits for data reception and then receives the data from the slave

Parameters:

baseAddress is the base address of the I2C Master module.

Modified bits of **UCBxTXBUF** register, bits of **UCBxCTLW0** register, bits of **UCBxIE** register and bits of **UCBxIFG** register.

Returns:

STATUS_SUCCESS or STATUS_FAILURE of the transmission process.

9.2.2.30 void EUSCI_B_I2C_masterReceiveStart (uint16_t *baseAddress*)

Starts reception at the Master end.

This function is used by the Master module initiate reception of a single byte. This function sends a start.

Parameters:

baseAddress is the base address of the I2C Master module.

Modified bits are **UCTXSTT** of **UCBxCTLW0** register.

Returns:

None

9.2.2.31 void EUSCI_B_I2C_masterSendSingleByte (uint16_t *baseAddress*, uint8_t *txData*)

Does single byte transmission from Master to Slave.

This function is used by the Master module to send a single byte. This function sends a start, then transmits the byte to the slave and then sends a stop.

Parameters:

baseAddress is the base address of the I2C Master module.

txData is the data byte to be transmitted

Modified bits of **UCBxTXBUF** register, bits of **UCBxCTLW0** register, bits of **UCBxIE** register and bits of **UCBxIFG** register.

Returns:

None

9.2.2.32 bool EUSCI_B_I2C_masterSendSingleByteWithTimeout (uint16_t *baseAddress*, uint8_t *txData*, uint32_t *timeout*)

Does single byte transmission from Master to Slave with timeout.

This function is used by the Master module to send a single byte. This function sends a start, then transmits the byte to the slave and then sends a stop.

Parameters:

baseAddress is the base address of the I2C Master module.

txData is the data byte to be transmitted

timeout is the amount of time to wait until giving up

Modified bits of **UCBxTXBUF** register, bits of **UCBxCTLW0** register, bits of **UCBxIE** register and bits of **UCBxIFG** register.

Returns:

STATUS_SUCCESS or STATUS_FAILURE of the transmission process.

9.2.2.33 void EUSCI_B_I2C_masterSendStart (uint16_t *baseAddress*)

This function is used by the Master module to initiate START.

This function is used by the Master module to initiate START

Parameters:

baseAddress is the base address of the I2C Master module.

Modified bits are **UCTXSTT** of **UCBxCTLW0** register.

Returns:

None

9.2.2.34 uint8_t EUSCI_B_I2C_masterSingleReceive (uint16_t *baseAddress*)

receives a byte that has been sent to the I2C Master Module.

This function reads a byte of data from the I2C receive data Register.

Parameters:

baseAddress is the base address of the I2C Master module.

Returns:

Returns the byte received from by the I2C module, cast as an uint8_t.

9.2.2.35 void EUSCI_B_I2C_setMode (uint16_t *baseAddress*, uint8_t *mode*)

Sets the mode of the I2C device.

When the receive parameter is set to EUSCI_B_I2C_TRANSMIT_MODE, the address will indicate that the I2C module is in receive mode; otherwise, the I2C module is in send mode.

Parameters:

baseAddress is the base address of the USCI I2C module.

mode Mode for the EUSCI_B_I2C module Valid values are:

- EUSCI_B_I2C_TRANSMIT_MODE [Default]
- EUSCI_B_I2C_RECEIVE_MODE

Modified bits are **UCTR** of **UCBxCTLW0** register.

Returns:

None

9.2.2.36 void EUSCI_B_I2C_setSlaveAddress (uint16_t *baseAddress*, uint8_t *slaveAddress*)

Sets the address that the I2C Master will place on the bus.

This function will set the address that the I2C Master will place on the bus when initiating a transaction.

Parameters:

baseAddress is the base address of the USCI I2C module.

slaveAddress 7-bit slave address

Modified bits of **UCBxI2CSA** register.

Returns:

None

9.2.2.37 uint8_t EUSCI_B_I2C_slaveDataGet (uint16_t *baseAddress*)

Receives a byte that has been sent to the I2C Module.

This function reads a byte of data from the I2C receive data Register.

Parameters:

baseAddress is the base address of the I2C Slave module.

Returns:

Returns the byte received from by the I2C module, cast as an uint8_t.

9.2.2.38 void EUSCI_B_I2C_slaveDataPut (uint16_t *baseAddress*, uint8_t *transmitData*)

Transmits a byte from the I2C Module.

This function will place the supplied data into I2C transmit data register to start transmission.

Parameters:

baseAddress is the base address of the I2C Slave module.

transmitData data to be transmitted from the I2C module

Modified bits of **UCBxTXBUF** register.

Returns:
None

9.3 Programming Example

The following example shows how to use the I2C API to send data as a master.

```
EUSCI_B_I2C_initMasterParam i2cConfig = {
    EUSCI_B_I2C_CLOCKSOURCE_SMCLK,           // SMCLK Clock Source
    4096000,                                  // SMCLK = 4.096MHz
    EUSCI_B_I2C_SET_DATA_RATE_400KBPS,       // Desired I2C Clock of 400kHz
    0,                                         // No byte counter threshold
    EUSCI_B_I2C_NO_AUTO_STOP                 // No Autostop
};

WDT_hold(WDT_BASE);

// Setting the DCO to use the internal resistor. DCO will be at 16.384MHz
CS_setupDCO(CS_INTERNAL_RESISTOR);

// Setting SMCLK = DCO / 4 = 4.096 MHz
CS_clockSignalInit(CS_SMCLK, CS_CLOCK_DIVIDER_4);

// Setting P1.6 and P1.7 as I2C pins
GPIO_setAsPeripheralModuleFunctionInputPin(GPIO_PORT_P1,
                                             GPIO_PIN6 | GPIO_PIN7,
                                             GPIO_PRIMARY_MODULE_FUNCTION);

// Setting up I2C communication at 400kHz using SMCLK
EUSCI_B_I2C_initMaster(EUSCI_B0_BASE, &i2cConfig);

// Settings slave address
EUSCI_B_I2C_setSlaveAddress(EUSCI_B0_BASE, SLAVE_ADDRESS);

// Enable the module for operation
EUSCI_B_I2C_enable(EUSCI_B0_BASE);

// Enable needed I2C interrupts
EUSCI_B_I2C_clearInterruptFlag(EUSCI_B0_BASE, EUSCI_B_I2C_TRANSMIT_INTERRUPT0 |
                                             EUSCI_B_I2C_NAK_INTERRUPT);
EUSCI_B_I2C_enableInterrupt(EUSCI_B0_BASE, EUSCI_B_I2C_TRANSMIT_INTERRUPT0 |
                             EUSCI_B_I2C_NAK_INTERRUPT);

while(1) {

    TXByteCtr = 4;
    TXData = 0;

    // Make sure last transaction is done sending
    while(EUSCI_B_I2C_masterIsStopSent(EUSCI_B0_BASE) == EUSCI_B_I2C_SENDING_STOP);

    TXByteCtr--;
    EUSCI_B_I2C_masterMultiByteSendStart(EUSCI_B0_BASE, TXData++);

    // Go to sleep and wait for LPM exit
    __bis_SR_register(LPM0_bits | GIE);
}
```

10 Flash Memory Controller

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10.1 Introduction

The flash memory module has an integrated controller that controls programming and erase operations. Single bits, bytes, or words can be written to flash memory, but a segment is the smallest size of the flash memory that can be erased. The flash memory is partitioned into main and information memory sections. There is no difference in the operation of the main and information memory sections. Code and data can be located in either section. See the device-specific data sheet for the start and end addresses of each bank, when available, and for the complete memory map of a device. This library provides the API for flash segment erase, flash writes and flash operation status check.

This driver is contained in `flash.c`, with `flash.h` containing the API definitions for use by applications.

10.2 API Functions

Functions

- bool [FLASH_eraseCheck](#) (uint8_t *flash_ptr, uint16_t numberOfBytes)
- void [FLASH_lockInfo](#) (void)
- void [FLASH_massErase](#) (uint8_t *flash_ptr)
- void [FLASH_memoryFill32](#) (uint32_t value, uint32_t *flash_ptr, uint16_t count)
- void [FLASH_segmentErase](#) (uint8_t *flash_ptr)
- uint8_t [FLASH_setupClock](#) (uint32_t clockTargetFreq, uint32_t clockSourceFreq, uint16_t clockSource)
- uint8_t [FLASH_status](#) (uint8_t mask)
- void [FLASH_unlockInfo](#) (void)
- void [FLASH_write16](#) (uint16_t *data_ptr, uint16_t *flash_ptr, uint16_t count)
- void [FLASH_write32](#) (uint32_t *data_ptr, uint32_t *flash_ptr, uint16_t count)
- void [FLASH_write8](#) (uint8_t *data_ptr, uint8_t *flash_ptr, uint16_t count)

10.2.1 Detailed Description

[FLASH_segmentErase\(\)](#) helps erase a single segment of the flash memory. A pointer to the flash segment being erased is passed on to this function.

[FLASH_eraseCheck\(\)](#) helps check if a specific number of bytes in flash are currently erased. A pointer to the starting location of the erase check and the number of bytes to be checked is passed into this function.

Depending on the kind of writes being performed to the flash, this library provides APIs for flash writes.

[FLASH_write8\(\)](#) facilitates writing into the flash memory in byte format. [FLASH_write16\(\)](#) facilitates writing into the flash memory in word format. [FLASH_write32\(\)](#) facilitates writing into the flash memory in long format, pass by reference. [FLASH_memoryFill32\(\)](#) facilitates writing into the flash memory in long format, pass by value. [FLASH_status\(\)](#) checks if the flash is currently busy erasing or programming. [FLASH_lockInfo\(\)](#) locks information memory. [FLASH_unlockInfo\(\)](#) unlocks information memory.

The Flash API is broken into 4 groups of functions: those that deal with flash erase, those that write into flash, those that give status of flash, and those that lock/unlock information memory.

The flash erase operations are managed by:

- [FLASH_segmentErase\(\)](#)

- `FLASH_eraseCheck()`
- `FLASH_massErase()`

Flash writes are managed by:

- `FLASH_write8()`
- `FLASH_write16()`
- `FLASH_write32()`
- `FLASH_memoryFill32()`

The status is given by:

- `FLASH_status()`
- `FLASH_eraseCheck()`

The segment of information memory lock/unlock operations are managed by:

- `FLASH_lockInfo()`
- `FLASH_unlockInfo()`

The Flash clock is managed by:

- `FLASH_setupClock()`

10.2.2 Function Documentation

10.2.2.1 `bool FLASH_eraseCheck (uint8_t * flash_ptr, uint16_t numberOfBytes)`

Erase check of the flash memory.

This function checks bytes in flash memory to make sure that they are in an erased state (are set to 0xFF).

Parameters:

flash_ptr is the pointer to the starting location of the erase check
numberOfBytes is the number of bytes to be checked

Returns:

STATUS_SUCCESS or STATUS_FAIL

10.2.2.2 `void FLASH_lockInfo (void)`

Locks the information flash memory segment.

This function is typically called after an erase or write operation on the information flash segment is performed by any of the other API functions in order to re-lock the information flash segment.

Returns:

None

10.2.2.3 `void FLASH_massErase (uint8_t * flash_ptr)`

Erase all flash memory.

This function erases all the flash memory banks. For devices like MSP430i204x, this API erases main memory and information flash memory if the `FLASH_unlockInfo` API was previously executed (otherwise the information flash is not erased). Also note that erasing information flash memory in the MSP430i204x impacts the TLV calibration constants located at the information memory.

Parameters:

flash_ptr is a pointer into the bank to be erased

Returns:

None

10.2.2.4 void FLASH_memoryFill32 (uint32_t *value*, uint32_t * *flash_ptr*, uint16_t *count*)

Write data into the flash memory in 32-bit word format, pass by value.

This function writes a 32-bit data value into flash memory, count times. Assumes the flash memory is already erased and unlocked. FLASH_segmentErase can be used to erase a segment.

Parameters:

value value to fill memory with

flash_ptr is the pointer into which to write the data

count number of times to write the value

Returns:

None

10.2.2.5 void FLASH_segmentErase (uint8_t * *flash_ptr*)

Erase a single segment of the flash memory.

For devices like MSP430i204x, if the specified segment is the information flash segment, the FLASH_unlockInfo API must be called prior to calling this API.

Parameters:

flash_ptr is the pointer into the flash segment to be erased

Returns:

None

10.2.2.6 uint8_t FLASH_setupClock (uint32_t *clockTargetFreq*, uint32_t *clockSourceFreq*, uint16_t *clockSource*)

Sets up the clock for the flash module.

This function sets up the clock for the flash module. This function is typically called before any of the other flash API functions are called.

Parameters:

clockTargetFreq is the target clock source frequency in Hz.

clockSourceFreq is the clock source frequency in Hz.

clockSource is the clock source type for the flash. Valid values are:

- FLASH_MCLK [Default]
- FLASH_SMCLK

Returns:

clock setup result

indicating clock setup succeed or failed

10.2.2.7 uint8_t FLASH_status (uint8_t *mask*)

Check FLASH status to see if it is currently busy erasing or programming.

This function checks the status register to determine if the flash memory is ready for writing.

Parameters:

mask FLASH status to read Mask value is the logical OR of any of the following:

- FLASH_READY_FOR_NEXT_WRITE
- FLASH_ACCESS_VIOLATION_INTERRUPT_FLAG
- FLASH_PASSWORD_WRITTEN_INCORRECTLY
- FLASH_BUSY

Returns:

Logical OR of any of the following:

- FLASH_READY_FOR_NEXT_WRITE
- FLASH_ACCESS_VIOLATION_INTERRUPT_FLAG
- FLASH_PASSWORD_WRITTEN_INCORRECTLY
- FLASH_BUSY

indicating the status of the FLASH

10.2.2.8 void FLASH_unlockInfo (void)

Unlocks the information flash memory segment.

This function must be called before an erase or write operation on the information flash segment is performed by any of the other API functions.

Returns:

None

10.2.2.9 void FLASH_write16 (uint16_t * *data_ptr*, uint16_t * *flash_ptr*, uint16_t *count*)

Write data into the flash memory in 16-bit word format, pass by reference.

This function writes a 16-bit word array of size count into flash memory. Assumes the flash memory is already erased and unlocked. FLASH_segmentErase can be used to erase a segment.

Parameters:

data_ptr is the pointer to the data to be written

flash_ptr is the pointer into which to write the data

count number of times to write the value

Returns:

None

10.2.2.10 void FLASH_write32 (uint32_t * *data_ptr*, uint32_t * *flash_ptr*, uint16_t *count*)

Write data into the flash memory in 32-bit word format, pass by reference.

This function writes a 32-bit array of size count into flash memory. Assumes the flash memory is already erased and unlocked. FLASH_segmentErase can be used to erase a segment.

Parameters:

data_ptr is the pointer to the data to be written

flash_ptr is the pointer into which to write the data

count number of times to write the value

Returns:
None

10.2.2.11 void FLASH_write8 (uint8_t * *data_ptr*, uint8_t * *flash_ptr*, uint16_t *count*)

Write data into the flash memory in byte format, pass by reference.

This function writes a byte array of size count into flash memory. Assumes the flash memory is already erased and unlocked. FLASH_segmentErase can be used to erase a segment.

Parameters:
data_ptr is the pointer to the data to be written
flash_ptr is the pointer into which to write the data
count number of times to write the value

Returns:
None

10.3 Programming Example

The following example shows some flash operations using the APIs

```
do {  
    FLASH_segmentErase((uint8_t *)INFO_START);  
    status = FLASH_eraseCheck((uint8_t *)INFO_START, 128);  
} while(status == STATUS_FAIL);  
  
// Flash write  
FLASH_write32(calibration_data, (uint32_t *) (INFO_START), 1);
```

11 GPIO

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11.1 Introduction

The Digital I/O (GPIO) API provides a set of functions for using the MP430i2xx GPIO module. Functions are provided to setup and enable use of input/output pins, setting them up with or without interrupts and those that access the pin value. The digital I/O features include:

- Independently programmable individual I/Os
- Any combination of input or output
- Individually configurable P1 and P2 interrupts. Some devices may include additional port interrupts.
- Independent input and output data registers
- Individually configurable pullup or pulldown resistors

Devices within the family may have up to twelve digital I/O ports implemented (P1 to P11 and PJ). Most ports contain eight I/O lines; however, some ports may contain less (see the device-specific data sheet for ports available). Each I/O line is individually configurable for input or output direction, and each can be individually read or written.

Ports P1 and P2 always have interrupt capability. Each interrupt for the P1 and P2 I/O lines can be individually enabled and configured to provide an interrupt on a rising or falling edge of an input signal. All P1 I/O lines source a single interrupt vector P1IV, and all P2 I/O lines source a different, single interrupt vector P2IV. On some devices, additional ports with interrupt capability may be available (see the device-specific data sheet for details) and contain their own respective interrupt vectors. Individual ports can be accessed as byte-wide ports or can be combined into word-wide ports and accessed via word formats. Port pairs P1/P2, P3/P4, P5/P6, P7/P8, etc., are associated with the names PA, PB, PC, PD, etc., respectively. All port registers are handled in this manner with this naming convention except for the interrupt vector registers, P1IV and P2IV; that is, PAIV does not exist. When writing to port PA with word operations, all 16 bits are written to the port. When writing to the lower byte of the PA port using byte operations, the upper byte remains unchanged. Similarly, writing to the upper byte of the PA port using byte instructions leaves the lower byte unchanged. When writing to a port that contains less than the maximum number of bits possible, the unused bits are a "don't care". Ports PB, PC, PD, PE, and PF behave similarly.

Reading of the PA port using word operations causes all 16 bits to be transferred to the destination. Reading the lower or upper byte of the PA port (P1 or P2) and storing to memory using byte operations causes only the lower or upper byte to be transferred to the destination, respectively. Reading of the PA port and storing to a general-purpose register using byte operations causes the byte transferred to be written to the least significant byte of the register. The upper significant byte of the destination register is cleared automatically. Ports PB, PC, PD, PE, and PF behave similarly. When reading from ports that contain less than the maximum bits possible, unused bits are read as zeros (similarly for port PJ).

The GPIO pin may be configured as an I/O pin with [GPIO_setAsOutputPin\(\)](#) or [GPIO_setAsInputPin\(\)](#). The GPIO pin may instead be configured to operate in the Peripheral Module assigned function by configuring the GPIO using [GPIO_setAsPeripheralModuleFunctionOutputPin\(\)](#) or [GPIO_setAsPeripheralModuleFunctionInputPin\(\)](#).

This driver is contained in `gpio.c`, with `gpio.h` containing the API definitions for use by applications.

11.2 API Functions

Functions

- void [GPIO_clearInterruptFlag](#) (uint8_t selectedPort, uint16_t selectedPins)
- void [GPIO_disableInterrupt](#) (uint8_t selectedPort, uint16_t selectedPins)
- void [GPIO_enableInterrupt](#) (uint8_t selectedPort, uint16_t selectedPins)
- uint8_t [GPIO_getInputPinValue](#) (uint8_t selectedPort, uint16_t selectedPins)
- uint16_t [GPIO_getInterruptStatus](#) (uint8_t selectedPort, uint16_t selectedPins)

- void `GPIO_interruptEdgeSelect` (uint8_t selectedPort, uint16_t selectedPins, uint8_t edgeSelect)
- void `GPIO_setAsInputPin` (uint8_t selectedPort, uint16_t selectedPins)
- void `GPIO_setAsOutputPin` (uint8_t selectedPort, uint16_t selectedPins)
- void `GPIO_setAsPeripheralModuleFunctionInputPin` (uint8_t selectedPort, uint16_t selectedPins, uint8_t mode)
- void `GPIO_setAsPeripheralModuleFunctionOutputPin` (uint8_t selectedPort, uint16_t selectedPins, uint8_t mode)
- void `GPIO_setOutputHighOnPin` (uint8_t selectedPort, uint16_t selectedPins)
- void `GPIO_setOutputLowOnPin` (uint8_t selectedPort, uint16_t selectedPins)
- void `GPIO_toggleOutputOnPin` (uint8_t selectedPort, uint16_t selectedPins)

11.2.1 Detailed Description

The GPIO API is broken into three groups of functions: those that deal with configuring the GPIO pins, those that deal with interrupts, and those that access the pin value.

The GPIO pins are configured with

- `GPIO_setAsOutputPin()`
- `GPIO_setAsInputPin()`
- `GPIO_setAsInputPinWithPullDownresistor()`
- `GPIO_setAsInputPinWithPullUpresistor()`
- `GPIO_setAsPeripheralModuleFunctionOutputPin()`
- `GPIO_setAsPeripheralModuleFunctionInputPin()`

The GPIO interrupts are handled with

- `GPIO_enableInterrupt()`
- `GPIO_disableInterrupt()`
- `GPIO_clearInterruptFlag()`
- `GPIO_getInterruptStatus()`
- `GPIO_interruptEdgeSelect()`

The GPIO pin state is accessed with

- `GPIO_setOutputHighOnPin()`
- `GPIO_setOutputLowOnPin()`
- `GPIO_toggleOutputOnPin()`
- `GPIO_getInputPinValue()`

11.2.2 Function Documentation

11.2.2.1 void `GPIO_clearInterruptFlag` (uint8_t *selectedPort*, uint16_t *selectedPins*)

This function clears the interrupt flag on the selected pin.

This function clears the interrupt flag on the selected pin. Note that only Port 1, 2, A have this capability.

Parameters:

selectedPort is the selected port. Valid values are:

- `GPIO_PORT_P1`
- `GPIO_PORT_P2`
- `GPIO_PORT_PA`

selectedPins is the specified pin in the selected port. Mask value is the logical OR of any of the following:

- `GPIO_PIN0`
- `GPIO_PIN1`

- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5
- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9
- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

Modified bits of **PxIFG** register.

Returns:

None

11.2.2.2 void GPIO_disableInterrupt (uint8_t *selectedPort*, uint16_t *selectedPins*)

This function disables the port interrupt on the selected pin.

This function disables the port interrupt on the selected pin. Note that only Port 1, 2, A have this capability.

Parameters:

selectedPort is the selected port. Valid values are:

- GPIO_PORT_P1
- GPIO_PORT_P2
- GPIO_PORT_PA

selectedPins is the specified pin in the selected port. Mask value is the logical OR of any of the following:

- GPIO_PIN0
- GPIO_PIN1
- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5
- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9
- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

Modified bits of **PxIE** register.

Returns:

None

11.2.2.3 void GPIO_enableInterrupt (uint8_t *selectedPort*, uint16_t *selectedPins*)

This function enables the port interrupt on the selected pin.

This function enables the port interrupt on the selected pin. Note that only Port 1, 2, A have this capability.

Parameters:

selectedPort is the selected port. Valid values are:

- GPIO_PORT_P1
- GPIO_PORT_P2
- GPIO_PORT_PA

selectedPins is the specified pin in the selected port. Mask value is the logical OR of any of the following:

- GPIO_PIN0
- GPIO_PIN1
- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5
- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9
- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

Modified bits of **PxIE** register.

Returns:

None

11.2.2.4 uint8_t GPIO_getInputPinValue (uint8_t *selectedPort*, uint16_t *selectedPins*)

This function gets the input value on the selected pin.

This function gets the input value on the selected pin.

Parameters:

selectedPort is the selected port. Valid values are:

- GPIO_PORT_P1
- GPIO_PORT_P2
- GPIO_PORT_P3
- GPIO_PORT_P4
- GPIO_PORT_P5
- GPIO_PORT_P6
- GPIO_PORT_P7
- GPIO_PORT_P8
- GPIO_PORT_P9
- GPIO_PORT_P10
- GPIO_PORT_P11
- GPIO_PORT_PA
- GPIO_PORT_PB
- GPIO_PORT_PC
- GPIO_PORT_PD

- GPIO_PORT_PE
- GPIO_PORT_PF
- GPIO_PORT_PJ

selectedPins is the specified pin in the selected port. Valid values are:

- GPIO_PIN0
- GPIO_PIN1
- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5
- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9
- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

Returns:

One of the following:

- GPIO_INPUT_PIN_HIGH
 - GPIO_INPUT_PIN_LOW
- indicating the status of the pin

11.2.2.5 uint16_t GPIO_getInterruptStatus (uint8_t *selectedPort*, uint16_t *selectedPins*)

This function gets the interrupt status of the selected pin.

This function gets the interrupt status of the selected pin. Note that only Port 1, 2, A have this capability.

Parameters:

selectedPort is the selected port. Valid values are:

- GPIO_PORT_P1
- GPIO_PORT_P2
- GPIO_PORT_PA

selectedPins is the specified pin in the selected port. Mask value is the logical OR of any of the following:

- GPIO_PIN0
- GPIO_PIN1
- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5
- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9
- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

Returns:

Logical OR of any of the following:

- GPIO_PIN0
- GPIO_PIN1
- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5
- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9
- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

indicating the interrupt status of the selected pins [Default: 0]

11.2.2.6 void GPIO_interruptEdgeSelect (uint8_t *selectedPort*, uint16_t *selectedPins*, uint8_t *edgeSelect*)

This function selects on what edge the port interrupt flag should be set for a transition.

This function selects on what edge the port interrupt flag should be set for a transition. Values for *edgeSelect* should be GPIO_LOW_TO_HIGH_TRANSITION or GPIO_HIGH_TO_LOW_TRANSITION.

Parameters:

selectedPort is the selected port. Valid values are:

- GPIO_PORT_P1
- GPIO_PORT_P2
- GPIO_PORT_P3
- GPIO_PORT_P4
- GPIO_PORT_P5
- GPIO_PORT_P6
- GPIO_PORT_P7
- GPIO_PORT_P8
- GPIO_PORT_P9
- GPIO_PORT_P10
- GPIO_PORT_P11
- GPIO_PORT_PA
- GPIO_PORT_PB
- GPIO_PORT_PC
- GPIO_PORT_PD
- GPIO_PORT_PE
- GPIO_PORT_PF
- GPIO_PORT_PJ

selectedPins is the specified pin in the selected port. Mask value is the logical OR of any of the following:

- GPIO_PIN0
- GPIO_PIN1
- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5

- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9
- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

edgeSelect specifies what transition sets the interrupt flag Valid values are:

- GPIO_HIGH_TO_LOW_TRANSITION
- GPIO_LOW_TO_HIGH_TRANSITION

Modified bits of **PxIES** register.

Returns:

None

11.2.2.7 void GPIO_setAsInputPin (uint8_t *selectedPort*, uint16_t *selectedPins*)

This function configures the selected Pin as input pin.

This function selected pins on a selected port as input pins.

Parameters:

selectedPort is the selected port. Valid values are:

- GPIO_PORT_P1
- GPIO_PORT_P2
- GPIO_PORT_P3
- GPIO_PORT_P4
- GPIO_PORT_P5
- GPIO_PORT_P6
- GPIO_PORT_P7
- GPIO_PORT_P8
- GPIO_PORT_P9
- GPIO_PORT_P10
- GPIO_PORT_P11
- GPIO_PORT_PA
- GPIO_PORT_PB
- GPIO_PORT_PC
- GPIO_PORT_PD
- GPIO_PORT_PE
- GPIO_PORT_PF
- GPIO_PORT_PJ

selectedPins is the specified pin in the selected port. Mask value is the logical OR of any of the following:

- GPIO_PIN0
- GPIO_PIN1
- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5
- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9

- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

Modified bits of **PxDIR** register, bits of **PxREN** register and bits of **PxSEL** register.

Returns:

None

11.2.2.8 void GPIO_setAsOutputPin (uint8_t *selectedPort*, uint16_t *selectedPins*)

This function configures the selected Pin as output pin.

This function selected pins on a selected port as output pins.

Parameters:

selectedPort is the selected port. Valid values are:

- GPIO_PORT_P1
- GPIO_PORT_P2
- GPIO_PORT_P3
- GPIO_PORT_P4
- GPIO_PORT_P5
- GPIO_PORT_P6
- GPIO_PORT_P7
- GPIO_PORT_P8
- GPIO_PORT_P9
- GPIO_PORT_P10
- GPIO_PORT_P11
- GPIO_PORT_PA
- GPIO_PORT_PB
- GPIO_PORT_PC
- GPIO_PORT_PD
- GPIO_PORT_PE
- GPIO_PORT_PF
- GPIO_PORT_PJ

selectedPins is the specified pin in the selected port. Mask value is the logical OR of any of the following:

- GPIO_PIN0
- GPIO_PIN1
- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5
- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9
- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

Modified bits of **PxDIR** register and bits of **PxSEL** register.

Returns:

None

11.2.2.9 void GPIO_setAsPeripheralModuleFunctionInputPin (uint8_t *selectedPort*, uint16_t *selectedPins*, uint8_t *mode*)

This function configures the peripheral module function in the input direction for the selected pin for either primary, secondary or ternary module function modes.

This function configures the peripheral module function in the input direction for the selected pin for either primary, secondary or ternary module function modes. Accepted values for mode are GPIO_PRIMARY_MODULE_FUNCTION, GPIO_SECONDARY_MODULE_FUNCTION, and GPIO_TERNARY_MODULE_FUNCTION

Parameters:

selectedPort is the selected port. Valid values are:

- GPIO_PORT_P1
- GPIO_PORT_P2
- GPIO_PORT_P3
- GPIO_PORT_P4
- GPIO_PORT_P5
- GPIO_PORT_P6
- GPIO_PORT_P7
- GPIO_PORT_P8
- GPIO_PORT_P9
- GPIO_PORT_P10
- GPIO_PORT_P11
- GPIO_PORT_PA
- GPIO_PORT_PB
- GPIO_PORT_PC
- GPIO_PORT_PD
- GPIO_PORT_PE
- GPIO_PORT_PF
- GPIO_PORT_PJ

selectedPins is the specified pin in the selected port. Mask value is the logical OR of any of the following:

- GPIO_PIN0
- GPIO_PIN1
- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5
- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9
- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

mode is the specified mode that the pin should be configured for the module function. Valid values are:

- GPIO_PRIMARY_MODULE_FUNCTION
- GPIO_SECONDARY_MODULE_FUNCTION
- GPIO_TERNARY_MODULE_FUNCTION

Modified bits of **PxDIR** register and bits of **PxSEL** register.

Returns:

None

11.2.2.10 void GPIO_setAsPeripheralModuleFunctionOutputPin (uint8_t *selectedPort*, uint16_t *selectedPins*, uint8_t *mode*)

This function configures the peripheral module function in the output direction for the selected pin for either primary, secondary or ternary module function modes.

This function configures the peripheral module function in the output direction for the selected pin for either primary, secondary or ternary module function modes. Accepted values for mode are GPIO_PRIMARY_MODULE_FUNCTION, GPIO_SECONDARY_MODULE_FUNCTION, and GPIO_TERNARY_MODULE_FUNCTION

Parameters:

selectedPort is the selected port. Valid values are:

- GPIO_PORT_P1
- GPIO_PORT_P2
- GPIO_PORT_P3
- GPIO_PORT_P4
- GPIO_PORT_P5
- GPIO_PORT_P6
- GPIO_PORT_P7
- GPIO_PORT_P8
- GPIO_PORT_P9
- GPIO_PORT_P10
- GPIO_PORT_P11
- GPIO_PORT_PA
- GPIO_PORT_PB
- GPIO_PORT_PC
- GPIO_PORT_PD
- GPIO_PORT_PE
- GPIO_PORT_PF
- GPIO_PORT_PJ

selectedPins is the specified pin in the selected port. Mask value is the logical OR of any of the following:

- GPIO_PIN0
- GPIO_PIN1
- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5
- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9
- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

mode is the specified mode that the pin should be configured for the module function. Valid values are:

- GPIO_PRIMARY_MODULE_FUNCTION
- GPIO_SECONDARY_MODULE_FUNCTION
- GPIO_TERNARY_MODULE_FUNCTION

Modified bits of **PxDIR** register and bits of **PxSEL** register.

Returns:

None

11.2.2.11 void GPIO_setOutputHighOnPin (uint8_t *selectedPort*, uint16_t *selectedPins*)

This function sets output HIGH on the selected Pin.

This function sets output HIGH on the selected port's pin.

Parameters:

selectedPort is the selected port. Valid values are:

- GPIO_PORT_P1
- GPIO_PORT_P2
- GPIO_PORT_P3
- GPIO_PORT_P4
- GPIO_PORT_P5
- GPIO_PORT_P6
- GPIO_PORT_P7
- GPIO_PORT_P8
- GPIO_PORT_P9
- GPIO_PORT_P10
- GPIO_PORT_P11
- GPIO_PORT_PA
- GPIO_PORT_PB
- GPIO_PORT_PC
- GPIO_PORT_PD
- GPIO_PORT_PE
- GPIO_PORT_PF
- GPIO_PORT_PJ

selectedPins is the specified pin in the selected port. Mask value is the logical OR of any of the following:

- GPIO_PIN0
- GPIO_PIN1
- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5
- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9
- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

Modified bits of **PxOUT** register.

Returns:

None

11.2.2.12 void GPIO_setOutputLowOnPin (uint8_t *selectedPort*, uint16_t *selectedPins*)

This function sets output LOW on the selected Pin.

This function sets output LOW on the selected port's pin.

Parameters:

selectedPort is the selected port. Valid values are:

- GPIO_PORT_P1
- GPIO_PORT_P2
- GPIO_PORT_P3
- GPIO_PORT_P4
- GPIO_PORT_P5
- GPIO_PORT_P6
- GPIO_PORT_P7
- GPIO_PORT_P8
- GPIO_PORT_P9
- GPIO_PORT_P10
- GPIO_PORT_P11
- GPIO_PORT_PA
- GPIO_PORT_PB
- GPIO_PORT_PC
- GPIO_PORT_PD
- GPIO_PORT_PE
- GPIO_PORT_PF
- GPIO_PORT_PJ

selectedPins is the specified pin in the selected port. Mask value is the logical OR of any of the following:

- GPIO_PIN0
- GPIO_PIN1
- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5
- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9
- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

Modified bits of **PxOUT** register.

Returns:

None

11.2.2.13 void GPIO_toggleOutputOnPin (uint8_t *selectedPort*, uint16_t *selectedPins*)

This function toggles the output on the selected Pin.

This function toggles the output on the selected port's pin.

Parameters:

selectedPort is the selected port. Valid values are:

- GPIO_PORT_P1
- GPIO_PORT_P2
- GPIO_PORT_P3
- GPIO_PORT_P4
- GPIO_PORT_P5
- GPIO_PORT_P6
- GPIO_PORT_P7

- GPIO_PORT_P8
- GPIO_PORT_P9
- GPIO_PORT_P10
- GPIO_PORT_P11
- GPIO_PORT_PA
- GPIO_PORT_PB
- GPIO_PORT_PC
- GPIO_PORT_PD
- GPIO_PORT_PE
- GPIO_PORT_PF
- GPIO_PORT_PJ

selectedPins is the specified pin in the selected port. Mask value is the logical OR of any of the following:

- GPIO_PIN0
- GPIO_PIN1
- GPIO_PIN2
- GPIO_PIN3
- GPIO_PIN4
- GPIO_PIN5
- GPIO_PIN6
- GPIO_PIN7
- GPIO_PIN8
- GPIO_PIN9
- GPIO_PIN10
- GPIO_PIN11
- GPIO_PIN12
- GPIO_PIN13
- GPIO_PIN14
- GPIO_PIN15

Modified bits of **PxOUT** register.

Returns:

None

11.3 Programming Example

The following example shows how to use the GPIO API.

```
// Set P1.0 to output direction
GPIO_setAsOutputPin(GPIO_PORT_P1, GPIO_PIN0);

// Set P1.4 to input direction
GPIO_setAsInputPin(GPIO_PORT_P1, GPIO_PIN4);

while (1) {

    // Test P1.4
    if(GPIO_INPUT_PIN_HIGH == GPIO_getInputPinValue(GPIO_PORT_P1, GPIO_PIN4)) {

        // if P1.4 set, set P1.0
        GPIO_setOutputHighOnPin(GPIO_PORT_P1, GPIO_PIN0);
    } else {
        // else reset
        GPIO_setOutputLowOnPin(GPIO_PORT_P1, GPIO_PIN0);
    }
}
```


12 16-Bit Hardware Multiplier (MPY)

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12.1 Introduction

The 16-Bit Hardware Multiplier (MPY) API provides a set of functions for using the MPY module. Functions are provided to setup the MPY module, set the operand registers, and obtain the results.

The MPY Modules does not generate any interrupts.

This driver is contained in `mpy.c`, with `mpy.h` containing the API definitions for use by applications.

12.2 API Functions

Functions

- `uint32_t MPY_getResult (void)`
- `uint16_t MPY_getSumExtension (void)`
- `void MPY_setOperandOne16Bit (uint8_t multiplicationType, uint16_t operand)`
- `void MPY_setOperandOne8Bit (uint8_t multiplicationType, uint8_t operand)`
- `void MPY_setOperandTwo16Bit (uint16_t operand)`
- `void MPY_setOperandTwo8Bit (uint8_t operand)`

12.2.1 Detailed Description

The MPY API is broken into two groups of functions: those that set the operand registers, and those that return the results.

The operand registers are set by

- `MPY_setOperandOne8Bit()`
- `MPY_setOperandOne16Bit()`
- `MPY_setOperandTwo8Bit()`
- `MPY_setOperandTwo16Bit()`

The results can be returned by

- `MPY_getResult()`
- `MPY_getSumExtension()`

12.2.2 Function Documentation

12.2.2.1 `uint32_t MPY_getResult (void)`

Returns an 64-bit result of the last multiplication operation.

This function returns all 64 bits of the result registers

Returns:

The 64-bit result is returned as a `uint64_t` type

12.2.2.2 uint16_t MPY_getSumExtension (void)

Returns the Sum Extension of the last multiplication operation.

This function returns the Sum Extension of the MPY module, which either gives the sign after a signed operation or shows a carry after a multiply- and-accumulate operation. The Sum Extension acts as a check for overflows or underflows.

Returns:

The value of the MPY module Sum Extension.

12.2.2.3 void MPY_setOperandOne16Bit (uint8_t *multiplicationType*, uint16_t *operand*)

Sets an 16-bit value into operand 1.

This function sets the first operand for multiplication and determines what type of operation should be performed. Once the second operand is set, then the operation will begin.

Parameters:

multiplicationType is the type of multiplication to perform once the second operand is set. Valid values are:

- MPY_MULTIPLY_UNSIGNED
- MPY_MULTIPLY_SIGNED
- MPY_MULTIPLYACCUMULATE_UNSIGNED
- MPY_MULTIPLYACCUMULATE_SIGNED

operand is the 16-bit value to load into the 1st operand.

Returns:

None

12.2.2.4 void MPY_setOperandOne8Bit (uint8_t *multiplicationType*, uint8_t *operand*)

Sets an 8-bit value into operand 1.

This function sets the first operand for multiplication and determines what type of operation should be performed. Once the second operand is set, then the operation will begin.

Parameters:

multiplicationType is the type of multiplication to perform once the second operand is set. Valid values are:

- MPY_MULTIPLY_UNSIGNED
- MPY_MULTIPLY_SIGNED
- MPY_MULTIPLYACCUMULATE_UNSIGNED
- MPY_MULTIPLYACCUMULATE_SIGNED

operand is the 8-bit value to load into the 1st operand.

Returns:

None

12.2.2.5 void MPY_setOperandTwo16Bit (uint16_t *operand*)

Sets an 16-bit value into operand 2, which starts the multiplication.

This function sets the second operand of the multiplication operation and starts the operation.

Parameters:

operand is the 16-bit value to load into the 2nd operand.

Returns:

None

12.2.2.6 void MPY_setOperandTwo8Bit (uint8_t *operand*)

Sets an 8-bit value into operand 2, which starts the multiplication.

This function sets the second operand of the multiplication operation and starts the operation.

Parameters:

operand is the 8-bit value to load into the 2nd operand.

Returns:

None

12.3 Programming Example

The following example shows how to initialize and use the MPY API to calculate a 16-bit by 16-bit unsigned multiplication operation.

```
WDT_hold(WDT_BASE);    // Stop WDT

// Set a 16-bit operand into the specific Operand 1 register to specify

// Unsigned multiplication
MPY_setOperandOne16Bit(MPY_MULTIPLY_UNSIGNED,
                      0x1234);
// Set Operand 2 to begin the multiplication operation
MPY_setOperandTwo16Bit(0x5678);
```

13 Power Management Module (PMM)

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13.1 Introduction

The PMM manages all functions related to the power supply and its supervision for the device. Its primary functions are, first, to generate a supply voltage for the core logic and, second, to provide mechanisms for the supervising and monitoring of both the voltage applied to the device (VCC) and the voltage generated for the core (VCORE).

The PMM uses an integrated low-dropout voltage regulator (LDO) to produce a secondary core voltage (VCORE) from the primary voltage applied to the device (VCC). VCore supplies the CPU, memories (flash/RAM), and the digital modules, while VCC supplies the I/Os and analog modules. The VCore output is maintained using a voltage reference generated by the reference block within the PMM. The input or primary side of the regulator is referred to as its high side. The output or secondary side is referred to as its low side.

PMM features include:

- Supply voltage (VCC) range: 2.2 V to 3.6 V
- High-side brownout reset (BORH)
- Supply voltage monitor (VMON) for VCC with programmable threshold levels and monitoring of external pin (VMONIN) against internal reference
- Generation of fixed voltage of 1.8-V for the device core (VCORE)
- Supply voltage supervisor (SVS) for VCore
- Precise 1.16-V reference for the entire device and integrated temperature sensor.

13.2 API Functions

Functions

- void [PMM_calibrateReference](#) (void)
- void [PMM_clearInterrupt](#) (uint8_t mask)
- void [PMM_disableInterrupt](#) (uint8_t mask)
- void [PMM_enableInterrupt](#) (uint8_t mask)
- uint8_t [PMM_getInterruptStatus](#) (uint8_t mask)
- void [PMM_setRegulatorStatus](#) (uint8_t status)
- void [PMM_setupVoltageMonitor](#) (uint8_t voltageMonitorLevel)
- void [PMM_unlockIOConfiguration](#) (void)

13.2.1 Detailed Description

The PMM API is broken into three groups of functions: those for setting up the PMM, those for using LPM4.5 mode and those used for PMM interrupts.

Setting up the PMM is done by:

- [PMM_calibrateReference](#)()
- [PMM_setupVoltageMonitor](#)()

Using LPM4.5 mode is done by:

- `PMM_setRegulatorStatus()`
- `PMM_unlockIOConfiguration()`

Using PMM interrupts is done by:

- `PMM_enableInterrupt()`
- `PMM_disableInterrupt()`
- `PMM_getInterruptStatus()`
- `PMM_clearInterrupt()`

13.2.2 Function Documentation

13.2.2.1 void PMM_calibrateReference (void)

Setup the calibration.

Modified bits of **REFCAL0** register and bits of **REFCAL1** register.

Returns:

None

13.2.2.2 void PMM_clearInterrupt (uint8_t *mask*)

Clears the masked interrupts.

Parameters:

mask ■ **PMM_LPM45_INTERRUPT** - LPM 4.5 Interrupt

Returns:

None

13.2.2.3 void PMM_disableInterrupt (uint8_t *mask*)

Disables interrupts.

Parameters:

mask Mask value is the logical OR of any of the following:
■ **PMM_VMON_INTERRUPT** - Voltage Monitor Interrupt

Returns:

None

13.2.2.4 void PMM_enableInterrupt (uint8_t *mask*)

Enables interrupts.

Parameters:

mask Mask value is the logical OR of any of the following:
■ **PMM_VMON_INTERRUPT** - Voltage Monitor Interrupt

Returns:

None

13.2.2.5 uint8_t PMM_getInterruptStatus (uint8_t *mask*)

Returns the interrupt status.

Parameters:

- mask** Mask value is the logical OR of any of the following:
- **PMM_VMON_INTERRUPT** - Voltage Monitor Interrupt
 - **PMM_LPM45_INTERRUPT** - LPM 4.5 Interrupt

Returns:

Logical OR of any of the following:

- **PMM_VMON_INTERRUPT** Voltage Monitor Interrupt
- **PMM_LPM45_INTERRUPT** LPM 4.5 Interrupt
indicating the status of the masked interrupts

13.2.2.6 void PMM_setRegulatorStatus (uint8_t *status*)

Set the status of the PMM regulator.

Parameters:

- status** Valid values are:
- **PMM_REGULATOR_ON** - Turn the PMM regulator off
 - **PMM_REGULATOR_OFF** - Turn the PMM regulator on
Modified bits are **REGOFF** of **LPM45CTL** register.

Modified bits of **LPM45CTL** register.

Returns:

None

13.2.2.7 void PMM_setupVoltageMonitor (uint8_t *voltageMonitorLevel*)

Sets up the voltage monitor.

Parameters:

- voltageMonitorLevel** Valid values are:
- **PMM_DISABLE_VMON** - Disable the voltage monitor
 - **PMM_DVCC_2350MV** - Compare DVCC to 2350mV
 - **PMM_DVCC_2650MV** - Compare DVCC to 2650mV
 - **PMM_DVCC_2850MV** - Compare DVCC to 2850mV
 - **PMM_VMONIN_1160MV** - Compare VMONIN to 1160mV
Modified bits are **VMONLVLx** of **VMONCTL** register.

Modified bits of **VMONCTL** register.

Returns:

None

13.2.2.8 void PMM_unlockIOConfiguration (void)

Unlocks the IO.

Modified bits are **LOCKLPM45** of **LPM45CTL** register.

Returns:

None

13.3 Programming Example

The following example shows some pmm operations using the APIs

```
//Use the line below to bring the level back to 0
status = PMM_setVCore(PMM_BASE,
    PMMCOREV_0
);

//Set P1.0 to output direction
GPIO_setAsOutputPin(
    GPIO_PORT_P1,
    GPIO_PIN0
);

//continuous loop
while (1)
{
    //Toggle P1.0
    GPIO_toggleOutputOnPin(
        GPIO_PORT_P1,
        GPIO_PIN0
    );
    //Delay
    __delay_cycles(20000);
}
```

14 24-Bit Sigma Delta Converter (SD24)

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14.1 Introduction

The SD24 module consists of up to four independent sigma-delta analog-to-digital converters. The converters are based on second-order oversampling sigma-delta modulators and digital decimation filters. The decimation filters are comb type filters with selectable oversampling ratios of up to 256. Additional filtering can be done in software.

A sigma-delta analog-to-digital converter basically consists of two parts: the analog part - called modulator - and the digital part - a decimation filter. The modulator of the SD24 provides a bit stream of zeros and ones to the digital decimation filter. The digital filter averages the bitstream from the modulator over a given number of bits (specified by the oversampling rate) and provides samples at a reduced rate for further processing to the CPU.

As commonly known averaging can be used to increase the signal-to-noise performance of a conversion. With a conventional ADC each factor-of-4 oversampling can improve the SNR by about 6 dB or 1 bit. To achieve a 16-bit resolution out of a simple 1-bit ADC would require an impractical oversampling rate of $4^{15} = 1.073.741.824$. To overcome this limitation the sigma-delta modulator implements a technique called noise-shaping - due to an implemented feedback-loop and integrators the quantization noise is pushed to higher frequencies and thus much lower oversampling rates are sufficient to achieve high resolutions.

This driver is contained in `sd24.c`, with `sd24.h` containing the API definitions for use by applications.

14.2 API Functions

Functions

- void [SD24_clearInterrupt](#) (uint16_t baseAddress, uint8_t converter, uint16_t mask)
- void [SD24_disableInterrupt](#) (uint16_t baseAddress, uint8_t converter, uint16_t mask)
- void [SD24_enableInterrupt](#) (uint16_t baseAddress, uint8_t converter, uint16_t mask)
- uint16_t [SD24_getHighWordResults](#) (uint16_t baseAddress, uint8_t converter)
- uint16_t [SD24_getInterruptStatus](#) (uint16_t baseAddress, uint8_t converter, uint16_t mask)
- uint32_t [SD24_getResults](#) (uint16_t baseAddress, uint8_t converter)
- void [SD24_init](#) (uint16_t baseAddress, uint8_t referenceSelect)
- void [SD24_initConverter](#) (uint16_t baseAddress, uint16_t converter, uint16_t conversionMode)
- void [SD24_initConverterAdvanced](#) (uint16_t baseAddress, SD24_initConverterAdvancedParam *param)
- void [SD24_setConverterDataFormat](#) (uint16_t baseAddress, uint16_t converter, uint16_t dataFormat)
- void [SD24_setGain](#) (uint16_t baseAddress, uint8_t converter, uint8_t gain)
- void [SD24_setInputChannel](#) (uint16_t baseAddress, uint8_t converter, uint8_t inputChannel)
- void [SD24_setInterruptDelay](#) (uint16_t baseAddress, uint8_t converter, uint8_t interruptDelay)
- void [SD24_setOversampling](#) (uint16_t baseAddress, uint8_t converter, uint16_t oversampleRatio)
- void [SD24_startConverterConversion](#) (uint16_t baseAddress, uint8_t converter)
- void [SD24_stopConverterConversion](#) (uint16_t baseAddress, uint8_t converter)

14.2.1 Detailed Description

The SD24 API is broken into three groups of functions: those that deal with initialization and conversions, those that handle interrupts, and those that handle auxiliary features of the SD24.

The SD24 initialization and conversion functions are

- [SD24_init\(\)](#)
- [SD24_initConverter\(\)](#)
- [SD24_initConverterAdvanced\(\)](#)
- [SD24_startConverterConversion\(\)](#)
- [SD24_stopConverterConversion\(\)](#)
- [SD24_getResults\(\)](#)
- [SD24_getHighWordResults\(\)](#)

The SD24 interrupts are handled by

- [SD24_enableInterrupt\(\)](#)
- [SD24_disableInterrupt\(\)](#)
- [SD24_clearInterrupt\(\)](#)
- [SD24_getInterruptStatus\(\)](#)

Auxiliary features of the SD24 are handled by

- [SD24_setInputChannel\(\)](#)
- [SD24_setConverterDataFormat\(\)](#)
- [SD24_setInterruptDelay\(\)](#)
- [SD24_setOversampling\(\)](#)
- [SD24_setGain\(\)](#)

14.2.2 Function Documentation

14.2.2.1 void SD24_clearInterrupt (uint16_t *baseAddress*, uint8_t *converter*, uint16_t *mask*)

Clears interrupts for the SD24 Module.

This function clears interrupt flags for the SD24 module.

Parameters:

baseAddress is the base address of the SD24 module.

converter is the selected converter. Valid values are:

- [SD24_CONVERTER_0](#)
- [SD24_CONVERTER_1](#)
- [SD24_CONVERTER_2](#)
- [SD24_CONVERTER_3](#)

mask is the bit mask of the converter interrupt sources to clear. Mask value is the logical OR of any of the following:

- [SD24_CONVERTER_INTERRUPT](#)
- [SD24_CONVERTER_OVERFLOW_INTERRUPT](#)

Modified bits are [SD24OVIFGx](#) of [SD24BIFG](#) register.

Returns:

None

14.2.2.2 void SD24_disableInterrupt (uint16_t *baseAddress*, uint8_t *converter*, uint16_t *mask*)

Disables interrupts for the SD24 Module.

This function disables interrupts for the SD24 module.

Parameters:

baseAddress is the base address of the SD24 module.

converter is the selected converter. Valid values are:

- SD24_CONVERTER_0
- SD24_CONVERTER_1
- SD24_CONVERTER_2
- SD24_CONVERTER_3

mask is the bit mask of the converter interrupt sources to be disabled. Mask value is the logical OR of any of the following:

- SD24_CONVERTER_INTERRUPT
- SD24_CONVERTER_OVERFLOW_INTERRUPT

Modified bits are SD24OVIEx of SD24BIE register.

Modified bits of SD24BIE register.

Returns:

None

14.2.2.3 void SD24_enableInterrupt (uint16_t baseAddress, uint8_t converter, uint16_t mask)

Enables interrupts for the SD24 Module.

This function enables interrupts for the SD24 module. Does not clear interrupt flags.

Parameters:

baseAddress is the base address of the SD24 module.

converter is the selected converter. Valid values are:

- SD24_CONVERTER_0
- SD24_CONVERTER_1
- SD24_CONVERTER_2
- SD24_CONVERTER_3

mask is the bit mask of the converter interrupt sources to be enabled. Mask value is the logical OR of any of the following:

- SD24_CONVERTER_INTERRUPT
- SD24_CONVERTER_OVERFLOW_INTERRUPT

Modified bits are SD24OVIEx of SD24BIE register.

Returns:

None

14.2.2.4 uint16_t SD24_getHighWordResults (uint16_t baseAddress, uint8_t converter)

Returns the high word results for a converter.

This function gets the upper 16-bit result from the SD24MEMx register and returns it.

Parameters:

baseAddress is the base address of the SD24 module.

converter selects the converter whose results will be returned. Valid values are:

- SD24_CONVERTER_0
- SD24_CONVERTER_1
- SD24_CONVERTER_2
- SD24_CONVERTER_3

Returns:

Result of conversion

14.2.2.5 uint16_t SD24_getInterruptStatus (uint16_t *baseAddress*, uint8_t *converter*, uint16_t *mask*)

Returns the interrupt status for the SD24 Module.

This function returns interrupt flag statuses for the SD24 module.

Parameters:

baseAddress is the base address of the SD24 module.

converter is the selected converter. Valid values are:

- SD24_CONVERTER_0
- SD24_CONVERTER_1
- SD24_CONVERTER_2
- SD24_CONVERTER_3

mask is the bit mask of the converter interrupt sources to return. Mask value is the logical OR of any of the following:

- SD24_CONVERTER_INTERRUPT
- SD24_CONVERTER_OVERFLOW_INTERRUPT

Returns:

Logical OR of any of the following:

- SD24_CONVERTER_INTERRUPT
 - SD24_CONVERTER_OVERFLOW_INTERRUPT
- indicating the status of the masked interrupts

14.2.2.6 uint32_t SD24_getResults (uint16_t *baseAddress*, uint8_t *converter*)

Returns the results for a converter.

This function gets the results from the SD24MEMx register for upper 16-bit and lower 16-bit results, and concatenates them to form a long. The actual result is a maximum 24 bits.

Parameters:

baseAddress is the base address of the SD24 module.

converter selects the converter who's results will be returned Valid values are:

- SD24_CONVERTER_0
- SD24_CONVERTER_1
- SD24_CONVERTER_2
- SD24_CONVERTER_3

Returns:

Result of conversion

14.2.2.7 void SD24_init (uint16_t *baseAddress*, uint8_t *referenceSelect*)

Initializes the SD24 Module.

This function initializes the SD24 module sigma-delta analog-to-digital conversions. Specifically the function sets up the clock source for the SD24 core to use for conversions. Upon completion of the initialization the SD24 interrupt registers will be reset and the given parameters will be set. The converter configuration settings are independent of this function.

Parameters:

baseAddress is the base address of the SD24 module.

referenceSelect selects the reference source for the SD24 core Valid values are:

- SD24_REF_EXTERNAL [Default]
- SD24_REF_INTERNAL

Modified bits are **SD24REFS** of **SD24BCTL0** register.

Returns:

None

14.2.2.8 void SD24_initConverter (uint16_t *baseAddress*, uint16_t *converter*, uint16_t *conversionMode*)

Configure SD24 converter.

This function initializes a converter of the SD24 module. Upon completion the converter will be ready for a conversion and can be started with the [SD24_startConverterConversion\(\)](#). Additional configuration such as data format can be configured in [SD24_setConverterDataFormat\(\)](#).

Parameters:

baseAddress is the base address of the SD24 module.

converter selects the converter that will be configured. Check check datasheet for available converters on device.

Valid values are:

- SD24_CONVERTER_0
- SD24_CONVERTER_1
- SD24_CONVERTER_2
- SD24_CONVERTER_3

conversionMode determines whether the converter will do continuous samples or a single sample Valid values are:

- SD24_CONTINUOUS_MODE [Default]
- SD24_SINGLE_MODE

Modified bits are SD24SNGL of SD24CCTLx register.

Returns:

None

14.2.2.9 void SD24_initConverterAdvanced (uint16_t *baseAddress*, SD24_initConverterAdvancedParam * *param*)

Configure SD24 converter - Advanced Configure.

This function initializes a converter of the SD24 module. Upon completion the converter will be ready for a conversion and can be started with the [SD24_startConverterConversion\(\)](#).

Parameters:

baseAddress is the base address of the SD24 module.

param is the pointer to struct for converter advanced configuration.

Returns:

None

14.2.2.10 void SD24_setConverterDataFormat (uint16_t *baseAddress*, uint16_t *converter*, uint16_t *dataFormat*)

Set SD24 converter data format.

This function sets the converter format so that the resulting data can be viewed in either binary or 2's complement.

Parameters:

baseAddress is the base address of the SD24 module.

converter selects the converter that will be configured. Check check datasheet for available converters on device.

Valid values are:

- SD24_CONVERTER_0
- SD24_CONVERTER_1
- SD24_CONVERTER_2
- SD24_CONVERTER_3

dataFormat selects how the data format of the results Valid values are:

- SD24_DATA_FORMAT_BINARY [Default]

■ **SD24_DATA_FORMAT_2COMPLEMENT**

Modified bits are **SD24DFx** of **SD24CCTLx** register.

Returns:

None

14.2.2.11 void SD24_setGain (uint16_t *baseAddress*, uint8_t *converter*, uint8_t *gain*)

Configures the gain for the converter.

This function configures the gain for a single converter.

Parameters:

baseAddress is the base address of the SD24 module.

converter selects the converter that will be configured Valid values are:

- **SD24_CONVERTER_0**
- **SD24_CONVERTER_1**
- **SD24_CONVERTER_2**
- **SD24_CONVERTER_3**

gain selects the gain for the converter Valid values are:

- **SD24_GAIN_1** [Default]
- **SD24_GAIN_2**
- **SD24_GAIN_4**
- **SD24_GAIN_8**
- **SD24_GAIN_16**

Modified bits are **SD24GAINx** of **SD24INCTLx** register.

Returns:

None

14.2.2.12 void SD24_setInputChannel (uint16_t *baseAddress*, uint8_t *converter*, uint8_t *inputChannel*)

Configures the input channel.

This function configures the input channel. For MSP430i2xx devices, users can choose either analog input or internal temperature input.

Parameters:

baseAddress is the base address of the SD24 module.

converter selects the converter that will be configured Valid values are:

- **SD24_CONVERTER_0**
- **SD24_CONVERTER_1**
- **SD24_CONVERTER_2**
- **SD24_CONVERTER_3**

inputChannel selects oversampling ratio for the converter Valid values are:

- **SD24_INPUT_CH_ANALOG**
- **SD24_INPUT_CH_TEMPERATURE**

Modified bits are **SD24INCHx** of **SD24INCTLx** register.

Returns:

None

14.2.2.13 void SD24_setInterruptDelay (uint16_t *baseAddress*, uint8_t *converter*, uint8_t *interruptDelay*)

Configures the delay for an interrupt to trigger.

This function configures the delay for the first interrupt service request for the corresponding converter. This feature delays the interrupt request for a completed conversion by up to four conversion cycles allowing the digital filter to settle prior to generating an interrupt request.

Parameters:

baseAddress is the base address of the SD24 module.

converter selects the converter that will be stopped Valid values are:

- SD24_CONVERTER_0
- SD24_CONVERTER_1
- SD24_CONVERTER_2
- SD24_CONVERTER_3

interruptDelay selects the delay for the interrupt Valid values are:

- SD24_FIRST_SAMPLE_INTERRUPT
 - SD24_FOURTH_SAMPLE_INTERRUPT [Default]
- Modified bits are SD24INTDLYx of SD24INCTLx register.

Returns:

None

14.2.2.14 void SD24_setOversampling (uint16_t *baseAddress*, uint8_t *converter*, uint16_t *oversampleRatio*)

Configures the oversampling ratio for a converter.

This function configures the oversampling ratio for a given converter.

Parameters:

baseAddress is the base address of the SD24 module.

converter selects the converter that will be configured Valid values are:

- SD24_CONVERTER_0
- SD24_CONVERTER_1
- SD24_CONVERTER_2
- SD24_CONVERTER_3

oversampleRatio selects oversampling ratio for the converter Valid values are:

- SD24_OVERSAMPLE_32
- SD24_OVERSAMPLE_64
- SD24_OVERSAMPLE_128
- SD24_OVERSAMPLE_256

Modified bits are SD24OSRx of SD24OSRx register.

Returns:

None

14.2.2.15 void SD24_startConverterConversion (uint16_t *baseAddress*, uint8_t *converter*)

Start Conversion for Converter.

This function starts a single converter.

Parameters:

baseAddress is the base address of the SD24 module.

converter selects the converter that will be started Valid values are:

- SD24_CONVERTER_0
 - SD24_CONVERTER_1
 - SD24_CONVERTER_2
 - SD24_CONVERTER_3
- Modified bits are **SD24SC** of **SD24CCTLx** register.

Returns:
None

14.2.2.16 void SD24_stopConverterConversion (uint16_t *baseAddress*, uint8_t *converter*)

Stop Conversion for Converter.

This function stops a single converter.

Parameters:

baseAddress is the base address of the SD24 module.

converter selects the converter that will be stopped Valid values are:

- SD24_CONVERTER_0
 - SD24_CONVERTER_1
 - SD24_CONVERTER_2
 - SD24_CONVERTER_3
- Modified bits are **SD24SC** of **SD24CCTLx** register.

Returns:
None

14.3 Programming Example

The following example shows how to initialize and use the SD24 API to start a single channel, single conversion.

```

unsigned long results;

SD24_init(SD24_BASE, SD24_REF_INTERNAL);           // Select internal REF

SD24_initConverterAdvancedParam param = {0};
param.converter = SD24_CONVERTER_2;                // Select converter
param.conversionMode = SD24_SINGLE_MODE;           // Select single mode
param.groupEnable = SD24_NOT_GROUPED;              // No grouped
param.inputChannel = SD24_INPUT_CH_ANALOG;         // Input from analog signal
param.dataFormat = SD24_DATA_FORMAT_2COMPLEMENT;  // 2's complement data format
param.interruptDelay = SD24_FOURTH_SAMPLE_INTERRUPT; // 4th sample causes interrupt
param.oversampleRatio = SD24_OVERSAMPLE_256;      // Oversampling ratio 256
param.gain = SD24_GAIN_1;                          // Preamplifier gain x1
SD24_initConverterAdvanced(SD24_BASE, &param);

__delay_cycles(0x3600);                            // Delay for 1.5V REF startup

while (1)
{
    SD24_startConverterConversion(SD24_BASE,
                                   SD24_CONVERTER_2);           // Set b

    // Poll interrupt flag for channel 2
    while( SD24_getInterruptStatus(SD24_BASE,
                                    SD24_CONVERTER_2
                                    SD24_CONVERTER_INTERRUPT) == 0 );

```

```
    results = SD24_getResults(SD24_BASE,  
                             SD24_CONVERTER_2);           // Save CH2 results (clears IFG)  
    __no_operation();                                     // SET BREAKPOINT HERE  
}
```


15 Special Function Register (SFR)

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15.1 Introduction

The Special Function Registers API provides a set of functions for using the MSP430i2xx SFR module. Functions are provided to enable and disable interrupts.

This driver is contained in `sfr.c`, with `sfr.h` containing the API definitions for use by applications.

15.2 API Functions

Functions

- void [SFR_clearInterrupt](#) (uint8_t interruptFlagMask)
- void [SFR_disableInterrupt](#) (uint8_t interruptMask)
- void [SFR_enableInterrupt](#) (uint8_t interruptMask)
- uint8_t [SFR_getInterruptStatus](#) (uint8_t interruptFlagMask)

15.2.1 Detailed Description

The SFR interrupts are handled by

- [SFR_enableInterrupt\(\)](#)
- [SFR_disableInterrupt\(\)](#)
- [SFR_getInterruptStatus\(\)](#)
- [SFR_clearInterrupt\(\)](#)

15.2.2 Function Documentation

15.2.2.1 void [SFR_clearInterrupt](#) (uint8_t *interruptFlagMask*)

Clears the selected SFR interrupt flags.

This function clears the status of the selected SFR interrupt flags.

Parameters:

interruptFlagMask is the bit mask of interrupt flags that will be cleared.

- **SFR_NMI_PIN_INTERRUPT** - NMI pin interrupt, if NMI function is chosen
- **SFR_OSCILLATOR_FAULT_INTERRUPT** - Oscillator fault interrupt
- **SFR_WATCHDOG_INTERRUPT** - Watchdog interrupt
- **SFR_EXTERNAL_RESET_INTERRUPT** - External reset interrupt
- **SFR_BROWN_OUT_RESET_INTERRUPT** - Brown out reset interrupt

Returns:

None

15.2.2.2 void SFR_disableInterrupt (uint8_t *interruptMask*)

Disables selected SFR interrupt sources.

This function disables the selected SFR interrupt sources. Only the sources that are enabled can be reflected to the processor interrupt; disabled sources have no effect on the processor.

Parameters:

interruptMask is the bit mask of interrupts that will be disabled.

- **SFR_NMI_PIN_INTERRUPT** - NMI pin interrupt, if NMI function is chosen
- **SFR_OSCILLATOR_FAULT_INTERRUPT** - Oscillator fault interrupt
- **SFR_WATCHDOG_INTERRUPT** - Watchdog interrupt
- **SFR_FLASH_ACCESS_VIOLATION_INTERRUPT** - Flash access violation interrupt

Returns:

None

15.2.2.3 void SFR_enableInterrupt (uint8_t *interruptMask*)

Enables selected SFR interrupt sources.

This function enables the selected SFR interrupt sources. Only the sources that are enabled can be reflected to the processor interrupt; disabled sources have no effect on the processor. Does not clear interrupt flags.

Parameters:

interruptMask is the bit mask of interrupts that will be enabled.

- **SFR_NMI_PIN_INTERRUPT** - NMI pin interrupt, if NMI function is chosen
- **SFR_OSCILLATOR_FAULT_INTERRUPT** - Oscillator fault interrupt
- **SFR_WATCHDOG_INTERRUPT** - Watchdog interrupt
- **SFR_FLASH_ACCESS_VIOLATION_INTERRUPT** - Flash access violation interrupt

Returns:

None

15.2.2.4 uint8_t SFR_getInterruptStatus (uint8_t *interruptFlagMask*)

Returns the status of the selected SFR interrupt flags.

This function returns the status of the selected SFR interrupt flags in a bit mask format matching that passed into the *interruptFlagMask* parameter.

Parameters:

interruptFlagMask is the bit mask of interrupt flags that the status of should be returned.

- **SFR_NMI_PIN_INTERRUPT** - NMI pin interrupt, if NMI function is chosen
- **SFR_OSCILLATOR_FAULT_INTERRUPT** - Oscillator fault interrupt
- **SFR_WATCHDOG_INTERRUPT** - Watchdog interrupt
- **SFR_EXTERNAL_RESET_INTERRUPT** - External reset interrupt
- **SFR_BROWN_OUT_RESET_INTERRUPT** - Brown out reset interrupt

Returns:

A bit mask of the status of the selected interrupt flags.

- **SFR_NMI_PIN_INTERRUPT** NMI pin interrupt, if NMI function is chosen
- **SFR_OSCILLATOR_FAULT_INTERRUPT** Oscillator fault interrupt
- **SFR_WATCHDOG_INTERRUPT** Watchdog interrupt
- **SFR_EXTERNAL_RESET_INTERRUPT** External reset interrupt
- **SFR_BROWN_OUT_RESET_INTERRUPT** Brown out reset interrupt
indicating the status of the masked interrupts

15.3 Programming Example

The following example shows how to initialize and use the SFR API

```
do {  
    // Clear SFR Fault Flag  
    SFR_clearInterrupt(SFR_OSCILLATOR_FAULT_INTERRUPT);  
  
    // Test oscillator fault flag  
} while (SFR_getInterruptStatus(SFR_OSCILLATOR_FAULT_INTERRUPT));
```

16 16-Bit Timer_A (TIMER_A)

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16.1 Introduction

TIMER_A is a 16-bit timer/counter with multiple capture/compare registers. TIMER_A can support multiple capture/compares, PWM outputs, and interval timing. TIMER_A also has extensive interrupt capabilities. Interrupts may be generated from the counter on overflow conditions and from each of the capture/compare registers.

This peripheral API handles Timer A hardware peripheral.

TIMER_A features include:

- Asynchronous 16-bit timer/counter with four operating modes
- Selectable and configurable clock source
- Up to seven configurable capture/compare registers
- Configurable outputs with pulse width modulation (PWM) capability
- Asynchronous input and output latching
- Interrupt vector register for fast decoding of all Timer interrupts

TIMER_A can operate in 3 modes

- Continuous Mode
- Up Mode
- Down Mode

TIMER_A Interrupts may be generated on counter overflow conditions and during capture compare events.

The TIMER_A may also be used to generate PWM outputs. PWM outputs can be generated by initializing the compare mode with `TIMER_A_initCompare()` and the necessary parameters. The PWM may be customized by selecting a desired timer mode (continuous/up/upDown), duty cycle, output mode, timer period etc. The library also provides a simpler way to generate PWM using `TIMER_A_generatePWM()` API. However the level of customization and the kinds of PWM generated are limited in this API. Depending on how complex the PWM is and what level of customization is required, the user can use `TIMER_A_generatePWM()` or a combination of `Timer_initCompare()` and timer start APIs

The TIMER_A API provides a set of functions for dealing with the TIMER_A module. Functions are provided to configure and control the timer, along with functions to modify timer/counter values, and to manage interrupt handling for the timer.

Control is also provided over interrupt sources and events. Interrupts can be generated to indicate that an event has been captured.

This driver is contained in `TIMER_A.c`, with `TIMER_A.h` containing the API definitions for use by applications.

16.2 API Functions

The TIMER_A API is broken into three groups of functions: those that deal with timer configuration and control, those that deal with timer contents, and those that deal with interrupt handling.

TIMER_A configuration and initialization is handled by

- `TIMER_A_startCounter()`
- `TIMER_A_configureContinuousMode()`
- `TIMER_A_configureUpMode()`
- `TIMER_A_configureUpDownMode()`

- TIMER_A_startContinuousMode()
- TIMER_A_startUpMode()
- TIMER_A_startUpDownMode()
- TIMER_A_initCapture()
- TIMER_A_initCompare()
- TIMER_A_clear()
- TIMER_A_stop()

TIMER_A outputs are handled by

- TIMER_A_getSynchronizedCaptureCompareInput()
- TIMER_A_getOutputForOutputModeOutBitValue()
- TIMER_A_setOutputForOutputModeOutBitValue()
- TIMER_A_generatePWM()
- TIMER_A_getCaptureCompareCount()
- TIMER_A_setCompareValue()
- TIMER_A_getCounterValue()

The interrupt handler for the TIMER_A interrupt is managed with

- TIMER_A_enableInterrupt()
- TIMER_A_disableInterrupt()
- TIMER_A_getInterruptStatus()
- TIMER_A_enableCaptureCompareInterrupt()
- TIMER_A_disableCaptureCompareInterrupt()
- TIMER_A_getCaptureCompareInterruptStatus()
- TIMER_A_clearCaptureCompareInterruptFlag()
- TIMER_A_clearTimerInterruptFlag()

16.3 Programming Example

The following example shows some TIMER_A operations using the APIs

```
{
    //Start TIMER_A
    TIMER_A_configureUpDownMode( TIMER_A1_BASE,
        TIMER_A_CLOCKSOURCE_SMCLK,
        TIMER_A_CLOCKSOURCE_DIVIDER_1,
        TIMER_PERIOD,
        TIMER_A_TAIE_INTERRUPT_DISABLE,
        TIMER_A_CCIE_CCR0_INTERRUPT_DISABLE,
        TIMER_A_DO_CLEAR
    );

    TIMER_A_startCounter( TIMER_A1_BASE,
        TIMER_A_UPDOWN_MODE
    );

    //Initialize compare registers to generate PWM1
    TIMER_A_initCompare(TIMER_A1_BASE,
        TIMER_A_CAPTURECOMPARE_REGISTER_1,
        TIMER_A_CAPTURECOMPARE_INTERRUPT_ENABLE,
        TIMER_A_OUTPUTMODE_TOGGLE_SET,
        DUTY_CYCLE1
    );
    //Initialize compare registers to generate PWM2
```

```
TIMER_A_initCompare(TIMER_A1_BASE,
    TIMER_A_CAPTURECOMPARE_REGISTER_2,
    TIMER_A_CAPTURECOMPARE_INTERRUPT_DISABLE,
    TIMER_A_OUTPUTMODE_TOGGLE_SET,
    DUTY_CYCLE2
);

//Enter LPM0
__bis_SR_register(LPM0_bits);

//For debugger
__no_operation();
}
```

17 Tag Length Value (TLV)

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17.1 Introduction

The TLV structure is a table stored in flash memory that contains device-specific information. It contains important information for using and calibrating the device. A list of the contents of the TLV is available in the device-specific data sheet (in the TLV section), and an explanation on its functionality is available in the MSP430i2xx Family User's Guide.

This driver is contained in `tlv.c`, with `tlv.h` containing the API definitions for use by applications.

17.2 API Functions

Functions

- void [TLV_getInfo](#) (uint8_t tag, uint8_t *length, uint16_t **data_address)
- bool [TLV_performChecksumCheck](#) (void)

17.2.1 Detailed Description

The APIs that help in querying the information in the TLV structure are listed

- [TLV_getInfo\(\)](#) This function retrieves the value of a tag and the length of the tag.
- [TLV_performChecksumCheck\(\)](#) This function performs a CRC check on the TLV.

17.2.2 Function Documentation

17.2.2.1 void [TLV_getInfo](#) (uint8_t tag, uint8_t * length, uint16_t ** data_address)

Gets TLV Info.

The TLV structure uses a tag or base address to identify segments of the table where information is stored. This can be used to retrieve calibration constants for the device or find out more information about the device. This function retrieves the address of a tag and the length of the tag request. Please check the device datasheet for tags available on your device.

Parameters:

tag represents the tag for which the information needs to be retrieved. Valid values are:

- **TLV_CHECKSUM**
- **TLV_TAG_DIE_RECORD**
- **TLV_LENGTH_DIE_RECORD**
- **TLV_WAFER_LOT_ID**
- **TLV_DIE_X_POSITION**
- **TLV_DIE_Y_POSITION**
- **TLV_TEST_RESULTS**
- **TLV_REF_CALIBRATION_TAG**
- **TLV_REF_CALIBRATION_LENGTH**
- **TLV_REF_CALIBRATION_REFCAL1**

- TLV_REF_CALIBRATION_REFCAL0
- TLV_DCO_CALIBRATION_TAG
- TLV_DCO_CALIBRATION_LENGTH
- TLV_DCO_CALIBRATION_CSIRFCAL
- TLV_DCO_CALIBRATION_CSIRTCAL
- TLV_DCO_CALIBRATION_CSERFCAL
- TLV_DCO_CALIBRATION_CSERTCAL
- TLV_SD24_CALIBRATION_TAG
- TLV_SD24_CALIBRATION_LENGTH
- TLV_SD24_CALIBRATION_SD24TRIM

length Acts as a return through indirect reference. The function retrieves the value of the TLV tag length. This value is pointed to by *length and can be used by the application level once the function is called.

data_address acts as a return through indirect reference. Once the function is called data_address points to the pointer that holds the value retrieved from the specified TLV tag.

Returns:

None

17.2.2.2 bool TLV_performChecksumCheck (void)

Performs checksum check on TLV.

The 2's complement checksum is calculated on the data stored in the TLV. If the calculated checksum is equal to the checksum stored in the TLV then the user knows that the TLV has not been corrupted. This API can be used after a BOR before writing configuration constants to the appropriate registers.

Returns:

true if checksum of TLV matches value stored in TLV, false otherwise

17.3 Programming Example

The following example shows some tlv operations using the APIs

```
bool result;

// Stop the WDT
WDT_hold(WDT_BASE);

// Check the TLV checksum
result = TLV_performChecksumCheck();

// Turn on LED if test passed
if(result) {
    GPIO_setOutputHighOnPin(GPIO_PORT_P1, GPIO_PIN4);
} else {
    GPIO_setOutputLowOnPin(GPIO_PORT_P1, GPIO_PIN4);
}

// LED for indicating checksum result
GPIO_setAsOutputPin(GPIO_PORT_P1, GPIO_PIN4);
```


18 WatchDog Timer (WDT)

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18.1 Introduction

The Watchdog Timer (WDT) API provides a set of functions for using the WDT module. Functions are provided to initialize the WatchDog in either timer interval mode, or watchdog mode, with selectable clock sources and dividers to define the timer interval.

The WDT module can generate only 1 kind of interrupt in timer interval mode. If in watchdog mode, then the WDT module will assert a reset once the timer has finished.

This driver is contained in `wdt.c`, with `wdt.h` containing the API definitions for use by applications.

18.2 API Functions

Functions

- void [WDT_hold](#) (uint16_t baseAddress)
- void [WDT_intervalTimerInit](#) (uint16_t baseAddress, uint8_t clockSelect, uint8_t clockDivider)
- void [WDT_resetTimer](#) (uint16_t baseAddress)
- void [WDT_start](#) (uint16_t baseAddress)
- void [WDT_watchdogTimerInit](#) (uint16_t baseAddress, uint8_t clockSelect, uint8_t clockDivider)

18.2.1 Detailed Description

The WDT API is one group that controls the WDT module.

- [WDT_hold\(\)](#)
- [WDT_start\(\)](#)
- [WDT_resetTimer\(\)](#)
- [WDT_watchdogTimerInit\(\)](#)
- [WDT_intervalTimerInit\(\)](#)

18.2.2 Function Documentation

18.2.2.1 void [WDT_hold](#) (uint16_t *baseAddress*)

Holds the Watchdog Timer.

This function stops the watchdog timer from running, that way no interrupt or PUC is asserted.

Parameters:

baseAddress is the base address of the WDT module.

Returns:

None

18.2.2.2 void WDT_intervalTimerInit (uint16_t *baseAddress*, uint8_t *clockSelect*, uint8_t *clockDivider*)

Sets the clock source for the Watchdog Timer in timer interval mode.

This function sets the watchdog timer as timer interval mode, which will assert an interrupt without causing a PUC.

Parameters:

baseAddress is the base address of the WDT module.

clockSelect is the clock source that the watchdog timer will use.

■ **WDT_CLOCKSOURCE_SMCLK** [Default]

■ **WDT_CLOCKSOURCE_ACLK**

Modified bits are **WDTSSEL** of **WDTCTL** register.

clockDivider is the divider of the clock source, in turn setting the watchdog timer interval.

■ **WDT_CLOCKDIVIDER_32K** [Default]

■ **WDT_CLOCKDIVIDER_8192**

■ **WDT_CLOCKDIVIDER_512**

■ **WDT_CLOCKDIVIDER_64**

Modified bits are **WDTIS** and **WDTHOLD** of **WDTCTL** register.

Returns:

None

18.2.2.3 void WDT_resetTimer (uint16_t *baseAddress*)

Resets the timer counter of the Watchdog Timer.

This function resets the watchdog timer to 0x0000h.

Parameters:

baseAddress is the base address of the WDT module.

Returns:

None

18.2.2.4 void WDT_start (uint16_t *baseAddress*)

Starts the Watchdog Timer.

This function starts the watchdog timer functionality to start counting again.

Parameters:

baseAddress is the base address of the WDT module.

Returns:

None

18.2.2.5 void WDT_watchdogTimerInit (uint16_t *baseAddress*, uint8_t *clockSelect*, uint8_t *clockDivider*)

Sets the clock source for the Watchdog Timer in watchdog mode.

This function sets the watchdog timer in watchdog mode, which will cause a PUC when the timer overflows. When in the mode, a PUC can be avoided with a call to [WDT_resetTimer\(\)](#) before the timer runs out.

Parameters:

baseAddress is the base address of the WDT module.

clockSelect is the clock source that the watchdog timer will use.

- **WDT_CLOCKSOURCE_SMCLK** [Default]
- **WDT_CLOCKSOURCE_ACLK**

Modified bits are **WDTSEL** of **WDTCTL** register.

clockDivider is the divider of the clock source, in turn setting the watchdog timer interval.

- **WDT_CLOCKDIVIDER_32K** [Default]
- **WDT_CLOCKDIVIDER_8192**
- **WDT_CLOCKDIVIDER_512**
- **WDT_CLOCKDIVIDER_64**

Modified bits are **WDTIS** and **WDTHOLD** of **WDTCTL** register.

Returns:

None

18.3 Programming Example

The following example shows how to initialize and use the WDT to expire every 32ms.

```
// Stop the WDT
WDT_hold(WDT_BASE);

// Check if WDT caused reset
if(SFR_getInterruptStatus(SFR_WATCHDOG_INTERRUPT)) {
    SFR_clearInterrupt(SFR_WATCHDOG_INTERRUPT);
    GPIO_setOutputLowOnPin(GPIO_PORT_P1, GPIO_PIN4);
}

GPIO_setAsOutputPin(GPIO_PORT_P1, GPIO_PIN4);

// Setup DCO to use internal resistor. DCO calibrated at 16.384 MHz
CS_setupDCO(CS_INTERNAL_RESISTOR);

// Setup SMCLK as DCO / 16 = 1.024 MHz
CS_clockSignalInit(CS_SMCLK, CS_CLOCK_DIVIDER_16);

// Configure interval to SMCLK / 32768 = 32ms
WDT_watchdogTimerInit(WDT_BASE,
                      WDT_CLOCKSOURCE_SMCLK,
                      WDT_CLOCKDIVIDER_32K);
WDT_resetTimer(WDT_BASE);
```

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