MSP430 DriverLib for MSP430F5xx_6xx Devices

User's Guide

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Revision Information

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Table of Contents

1 Introduction

The Texas Instruments® MSP430® Peripheral Driver Library is a set of drivers for accessing the peripherals found on the MSP430 5xx/6xx 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.

Each MSP430ware driverlib API takes 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. When using CCS, the eclipse shortcut "Ctrl + Space" helps. Type __MSP430 and "Ctrl + Space", and the list of base addresses from the included device specific header files is listed.

The following tool chains are supported:

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

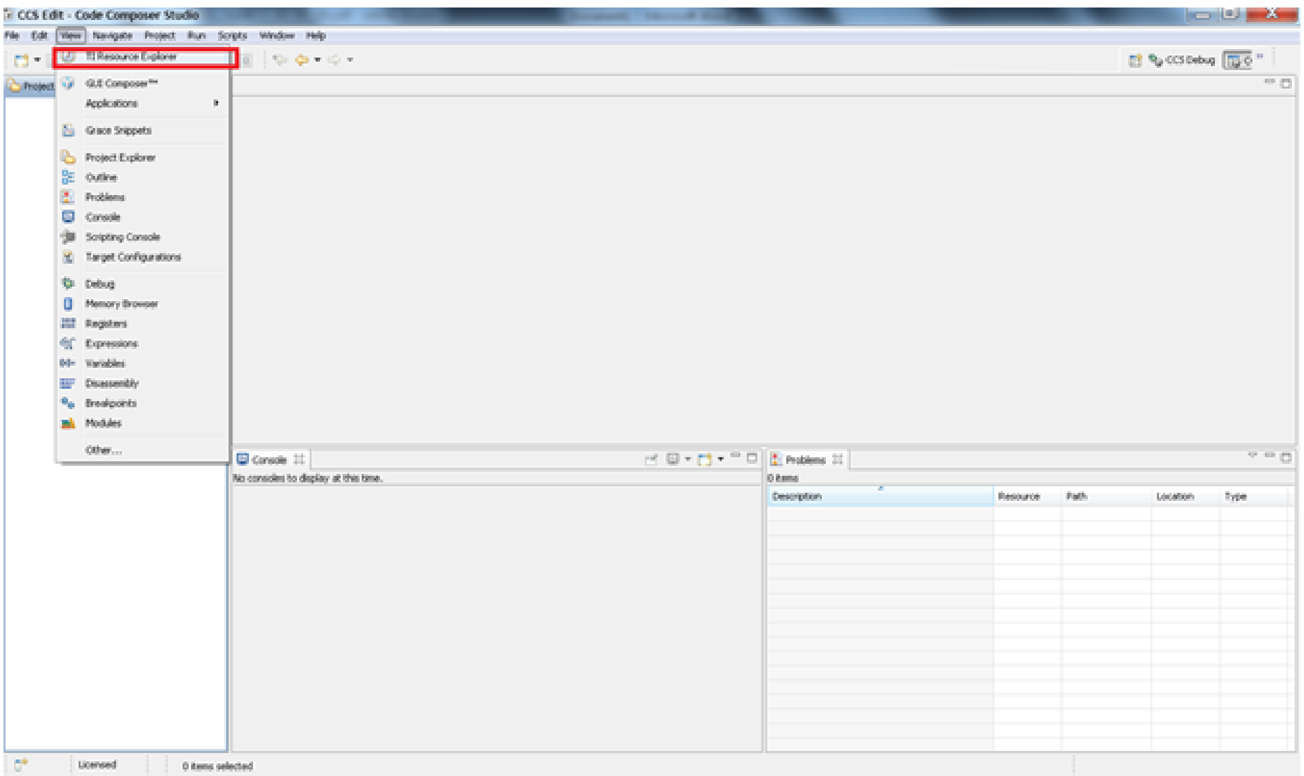
Using assert statements to debug

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.

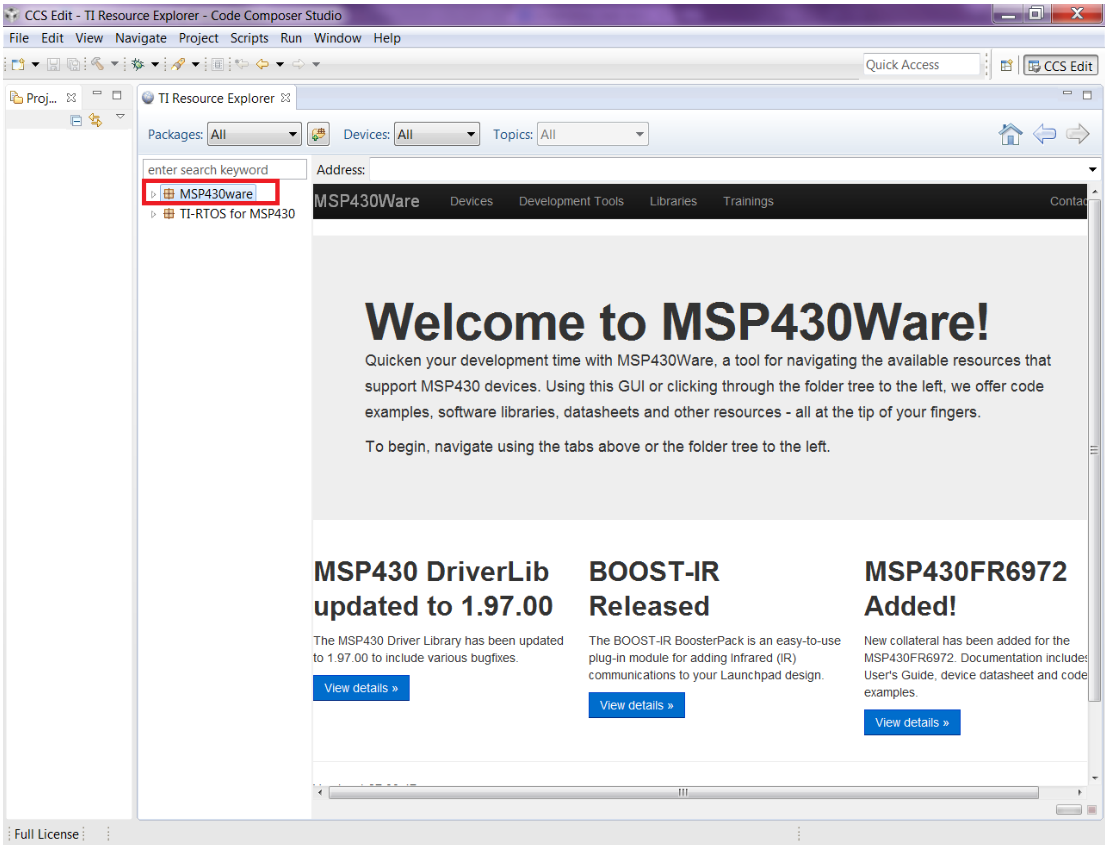
2 Navigating to driverlib through CCS Resource Explorer

2.1 Introduction

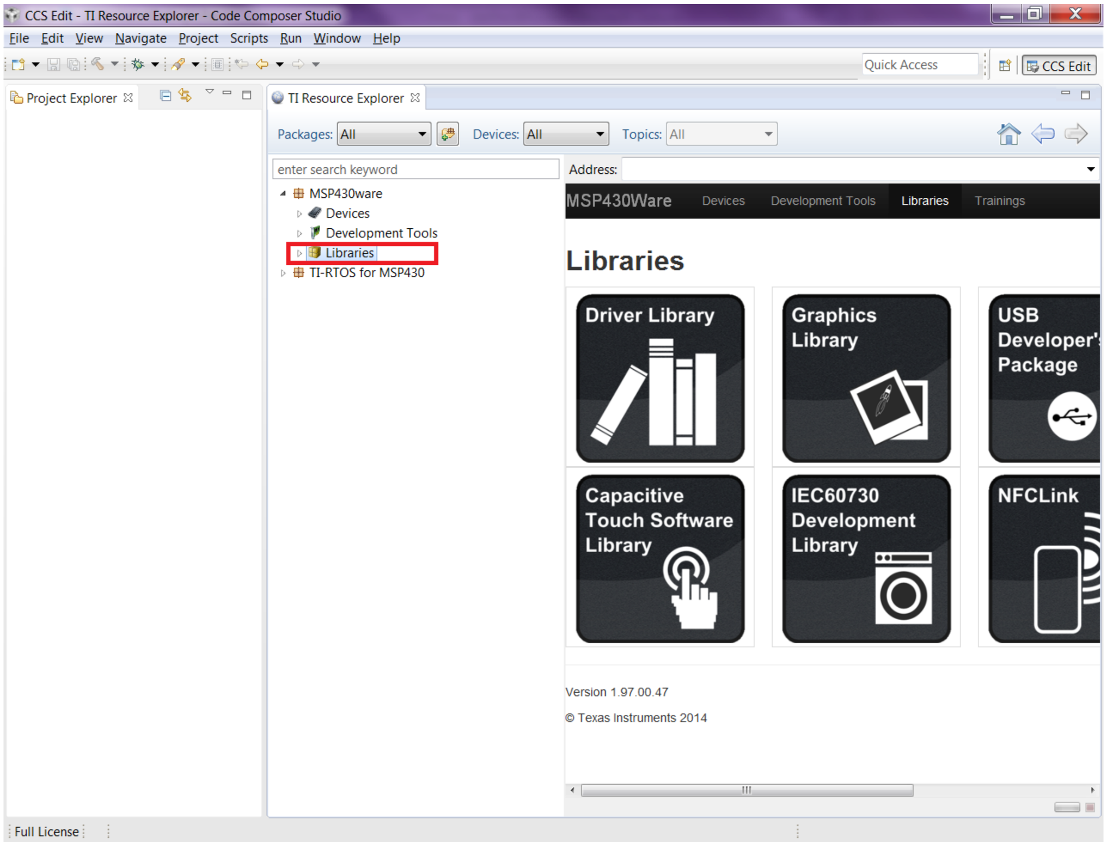
In CCS, click View->TI Resource Explorer



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.


CCS Edit - TI Resource Explorer - Code Composer Studio
File Edit View Navigate Project Scripts Run Window Help
Quick Access
CCS Edit
Project Explorer
TI Resource Explorer
Packages: All
Devices: All
Topics: All
enter search keyword
Address:
MSP430ware
Devices
Development Tools
Libraries
TI-RTOS for MSP430
MSP430Ware
Devices
Development Tools
Libraries
Trainings
Libraries
Driver Library
Graphics Library
USB Developer's Package
Capacitive Touch Software Library
IEC60730 Development Library
NFCLink
Version 1.97.00.47
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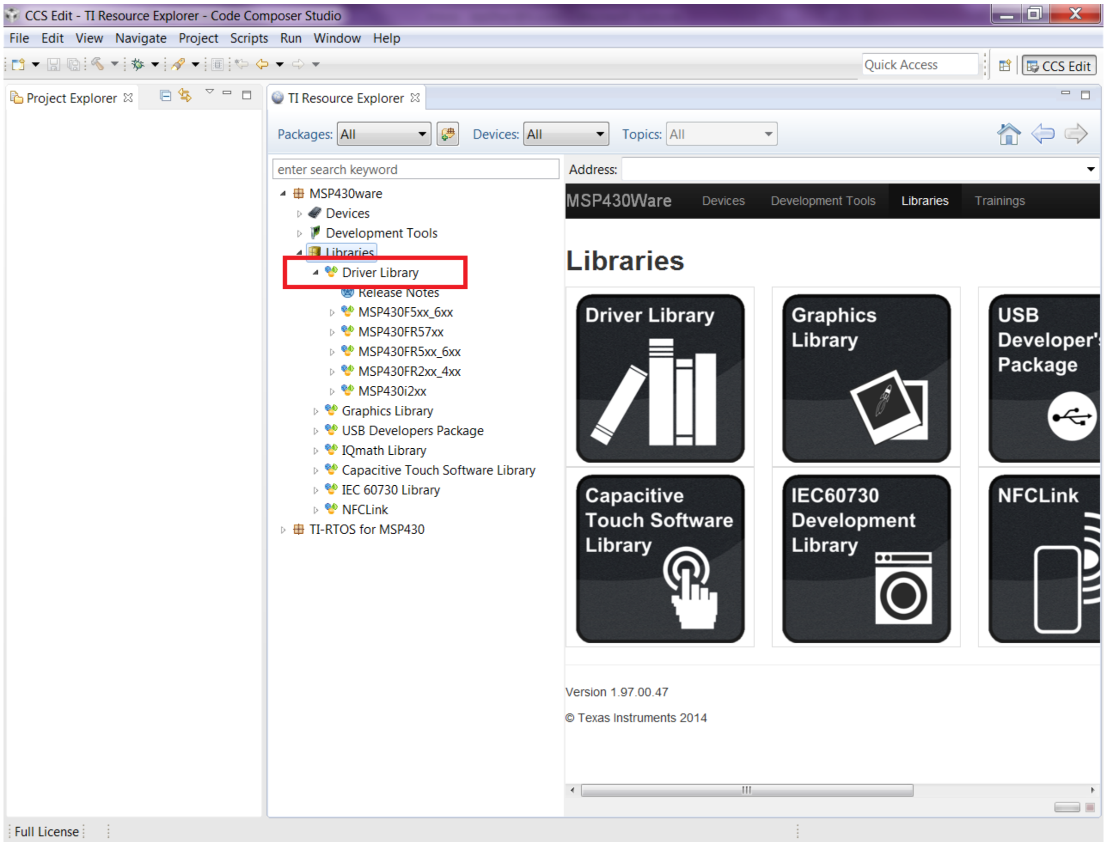
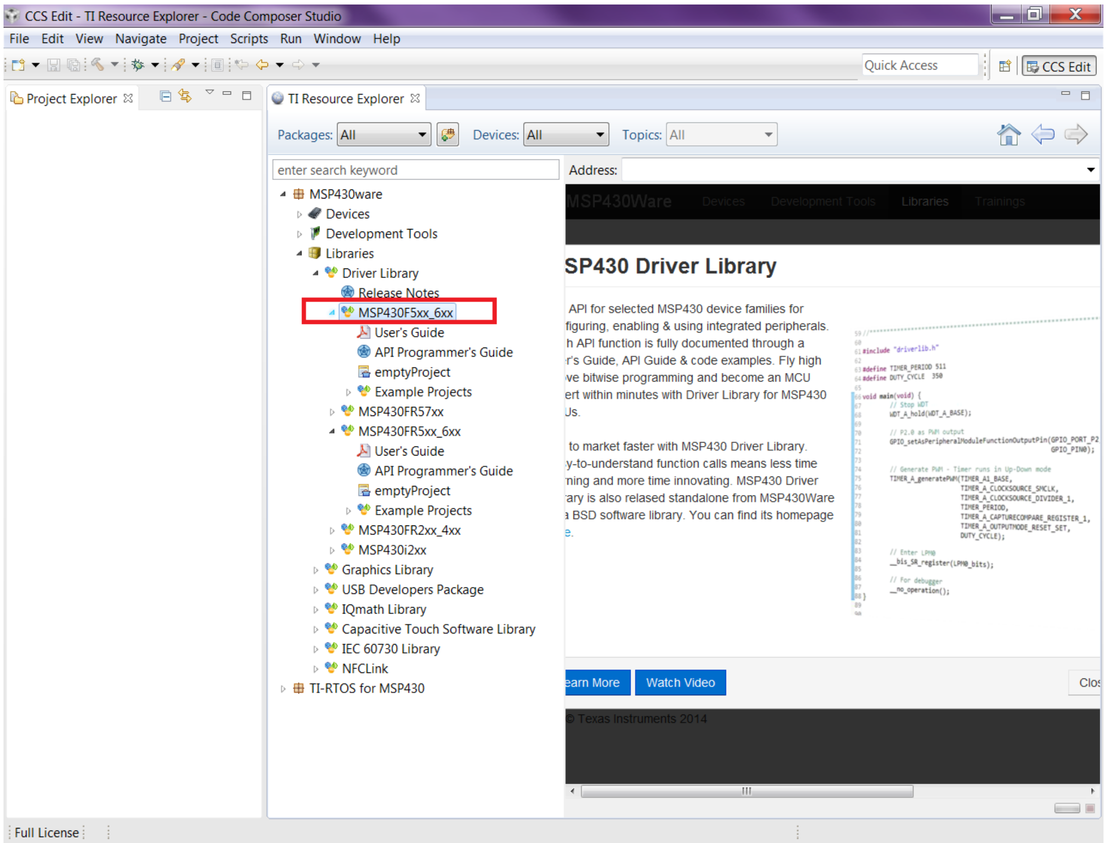
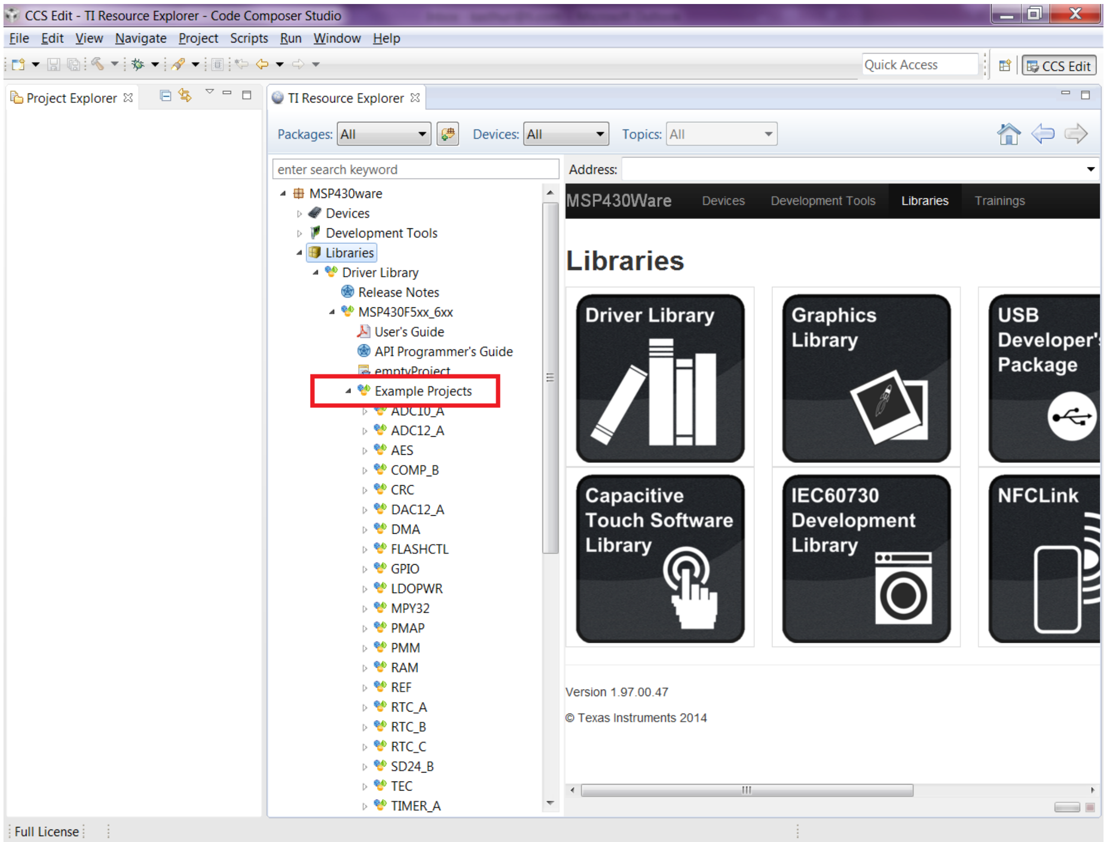


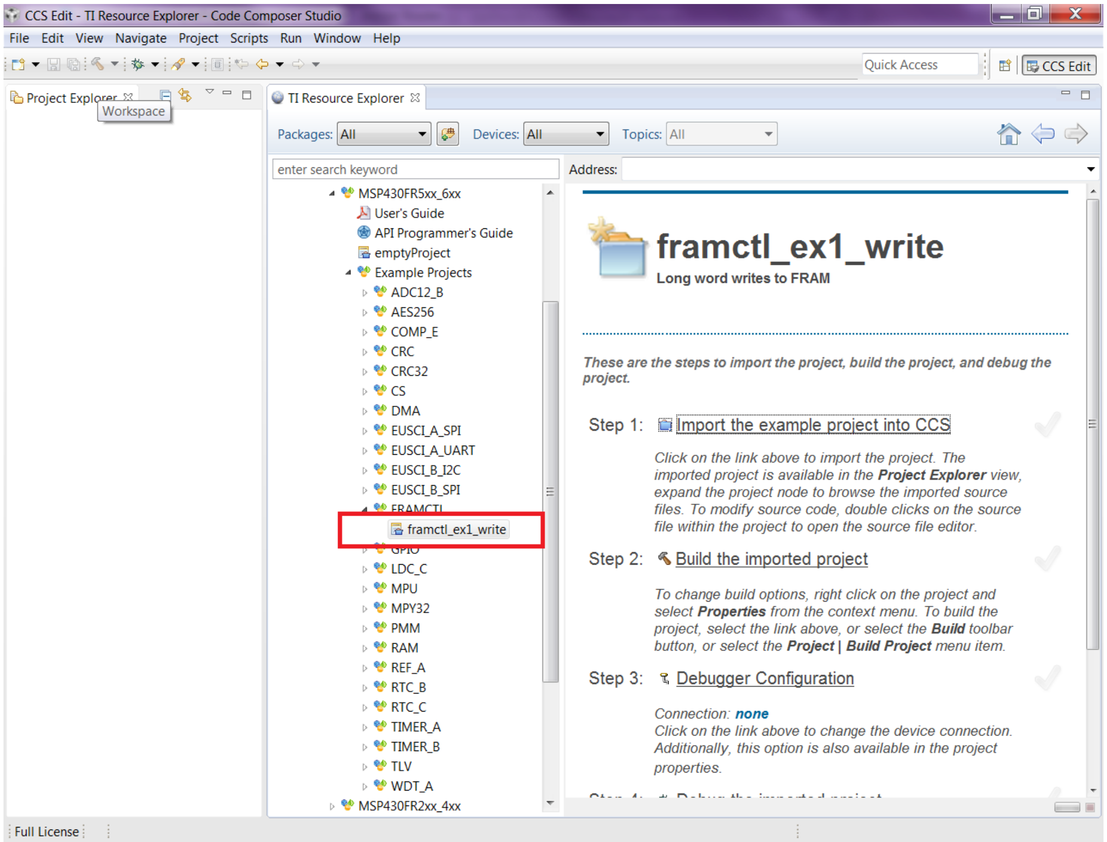
Driverlib is designed per Family. If a common device family user's guide exists for a group of devices, these devices belong to the same 'family'. Currently driverlib is available for the following family of devices. MSP430F5xx_6xx MSP430FR57xx MSP430FR2xx_4xx MSP430FR5xx_6xx MSP430i2xx



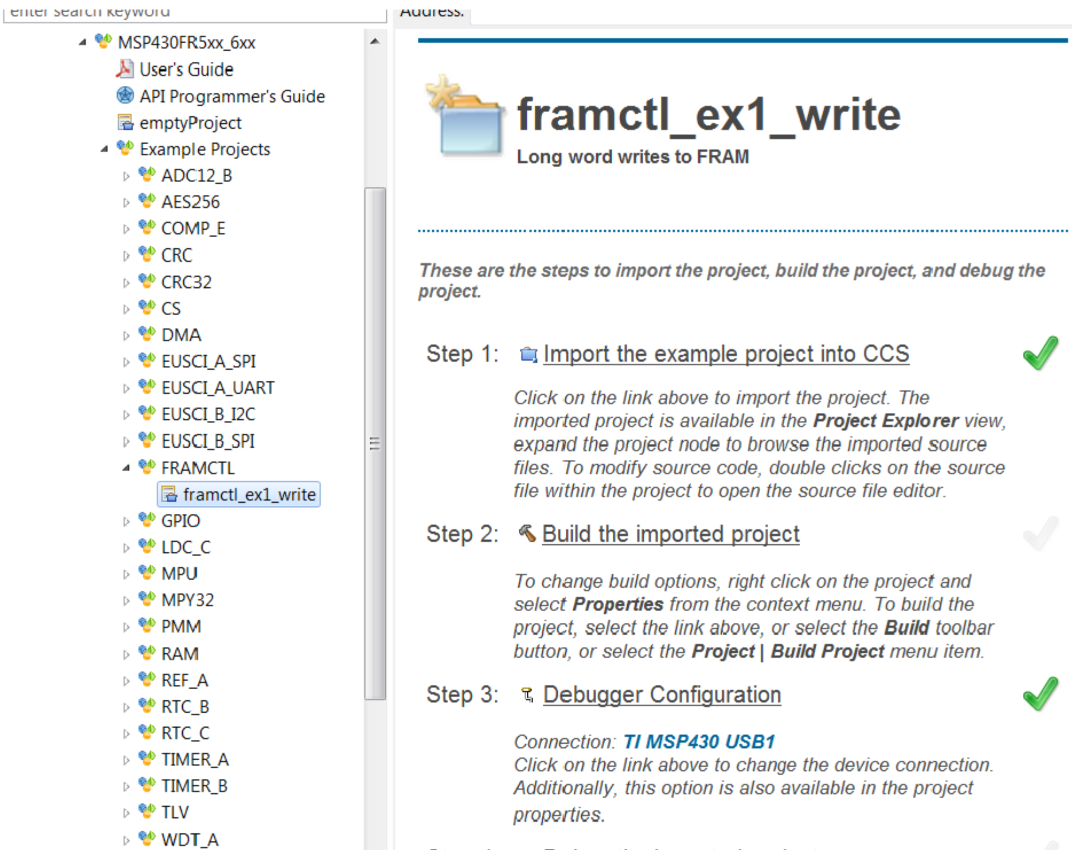
Click on the MSP430F5xx_6xx to navigate to the driverlib based example code for that family.



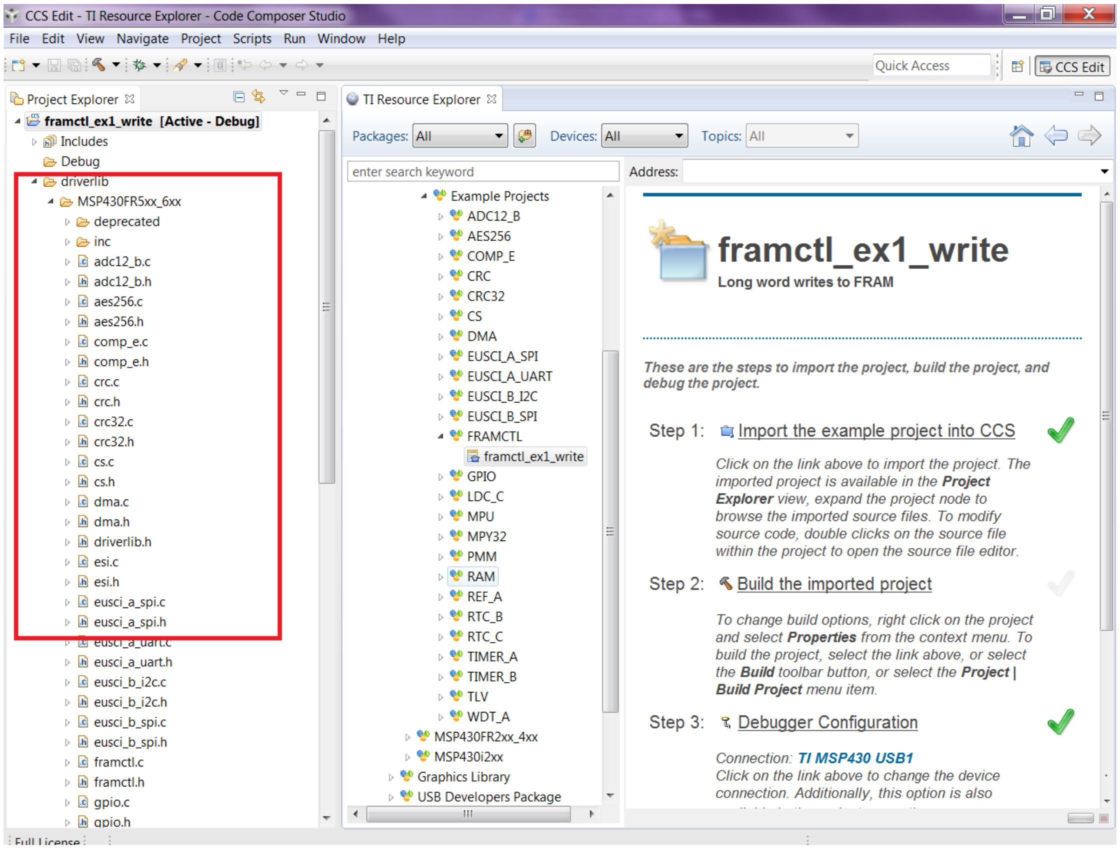
The various peripherals are listed in alphabetical order. The names of peripherals are as in device family user's guide. Clicking on a peripheral name lists the driverlib example code for that peripheral. The screenshot below shows an example when the user clicks on GPIO peripheral.



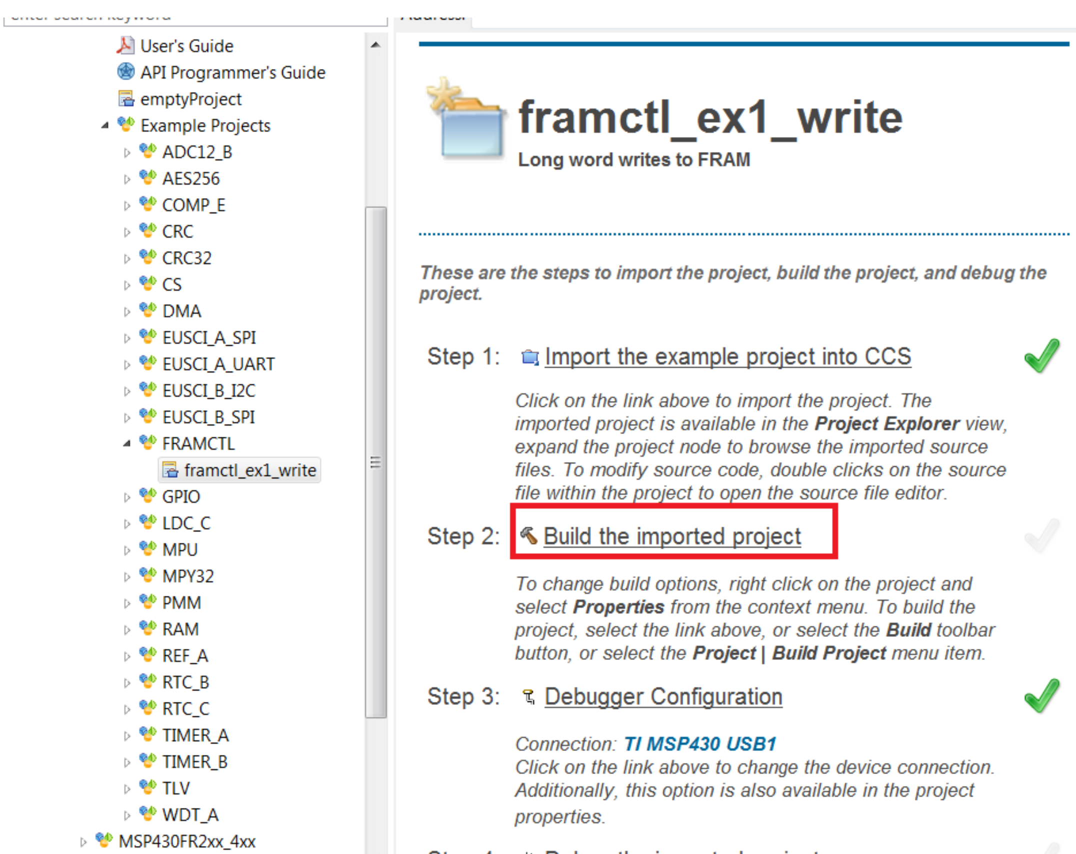
Now click on the specific example you are interested in. On the right side there are options to Import/Build/Download and Debug. Import the project by clicking on the "Import the example project into CCS"



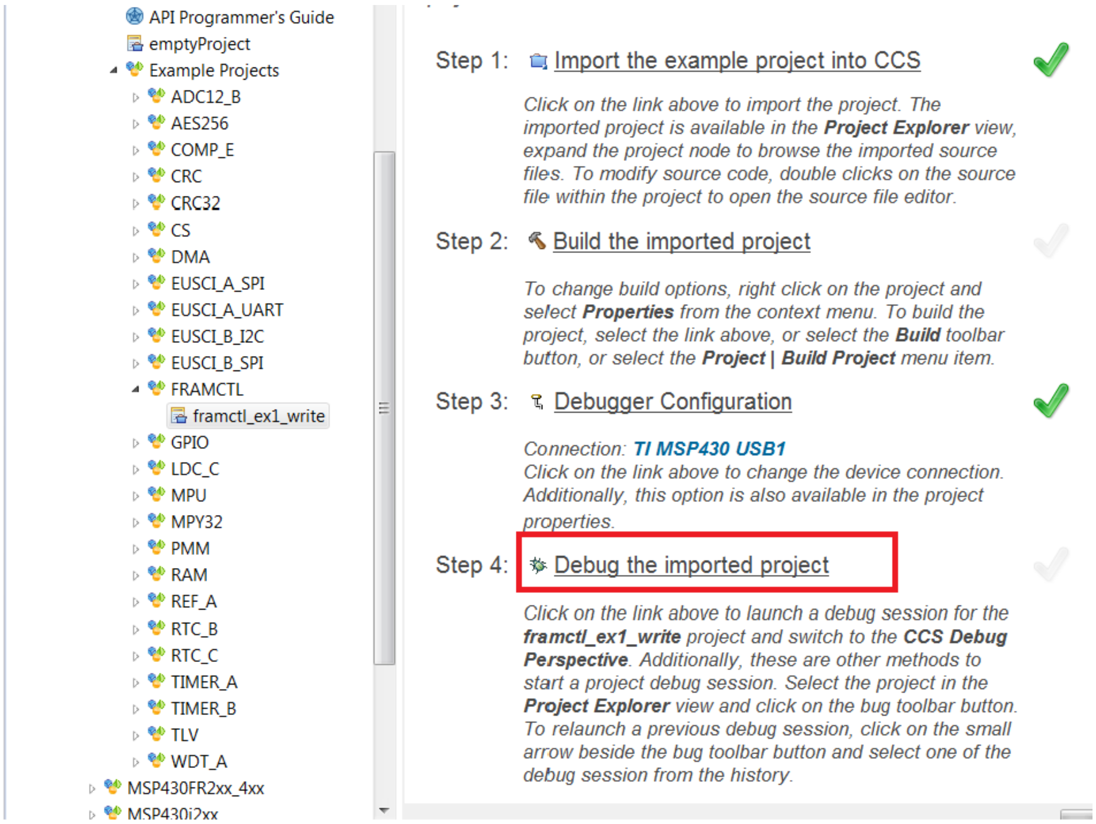
The imported project can be viewed on the left in the Project Explorer. All required driverlib source and header files are included inside the driverlib folder. All driverlib source and header files are linked to the example projects. So if the user modifies any of these source or header files, the original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

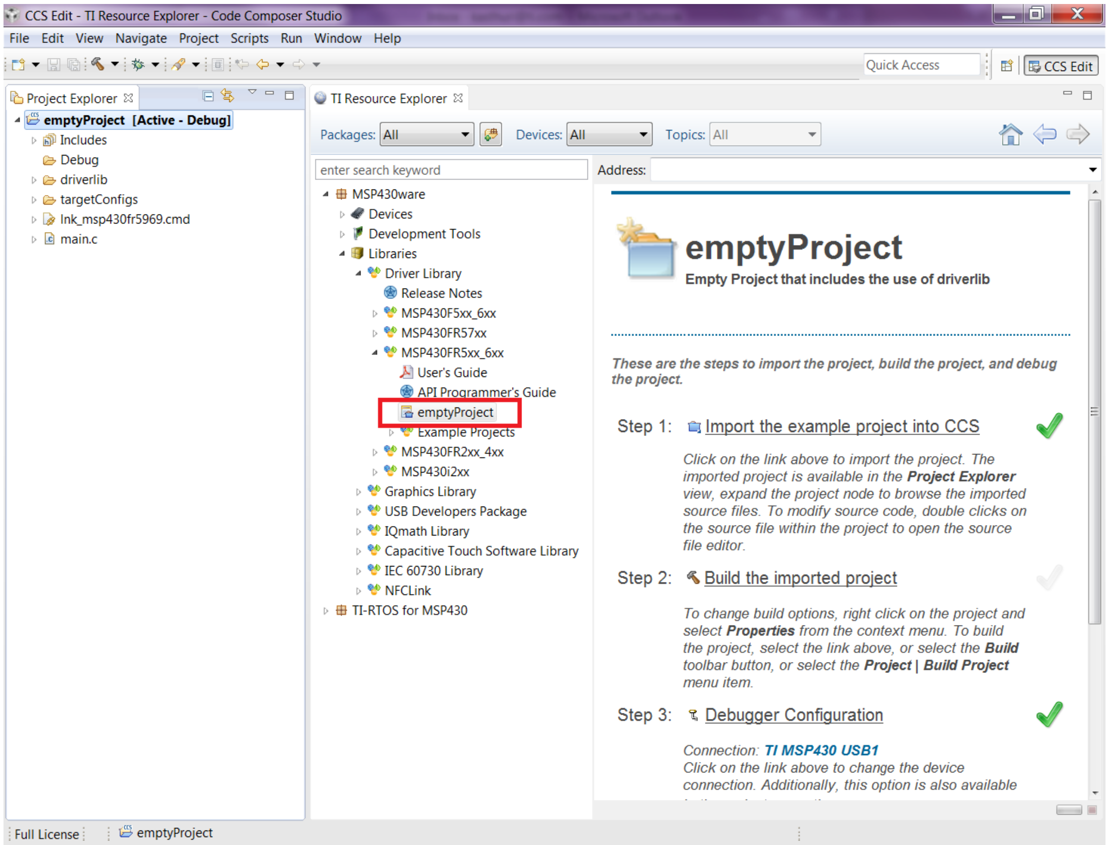


Now click on Build the imported project on the right to build the example project.



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.

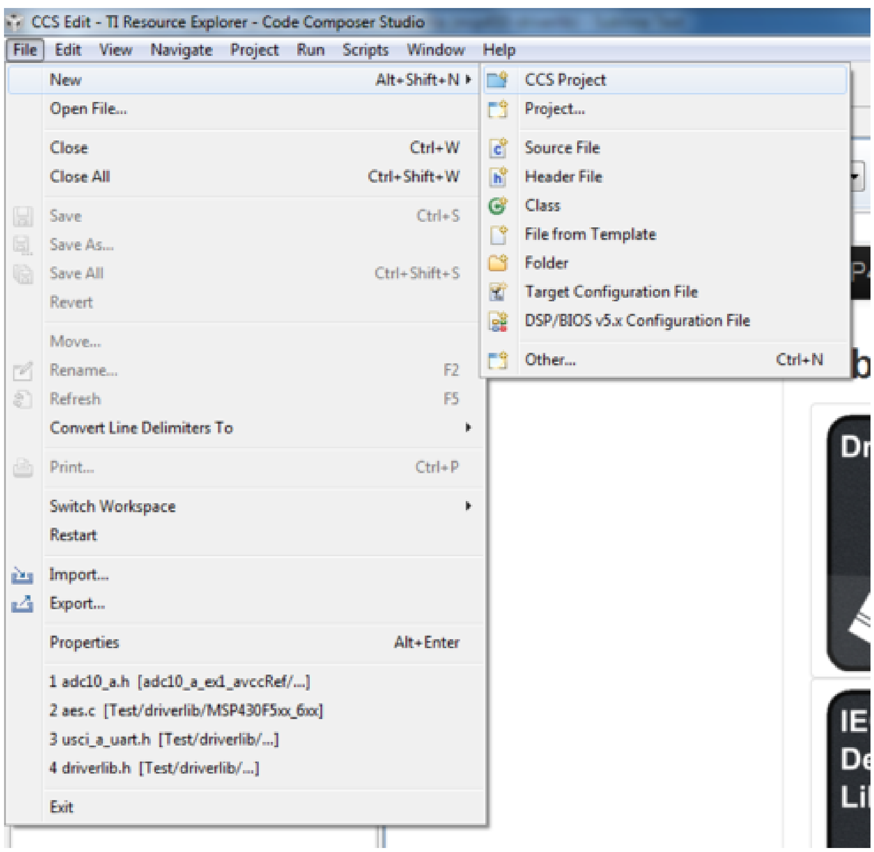


The main.c included with the empty project can be modified to include user code.

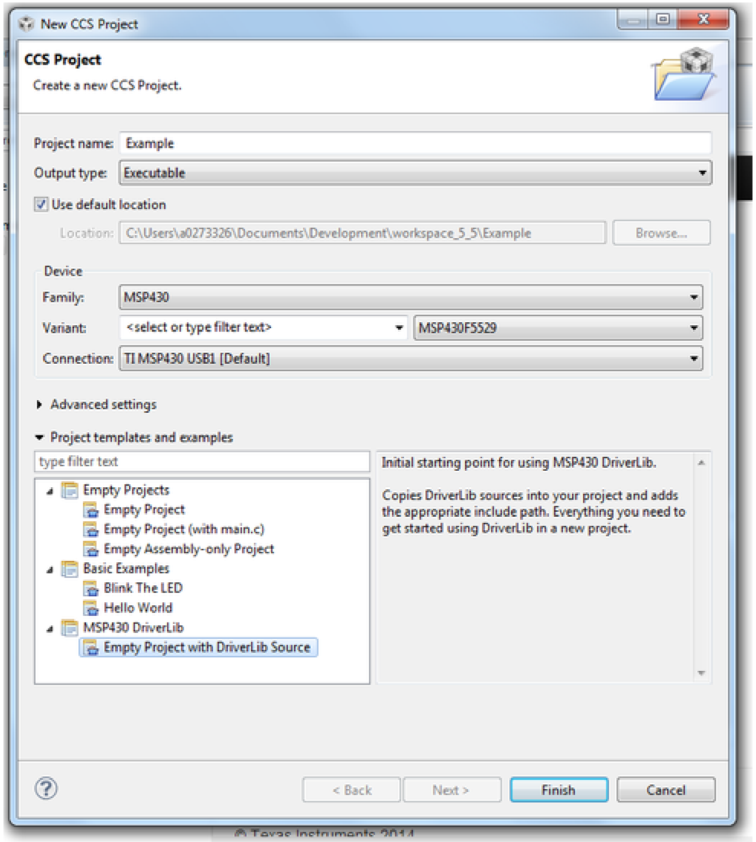
3 How to create a new CCS project that uses Driverlib

3.1 Introduction

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.



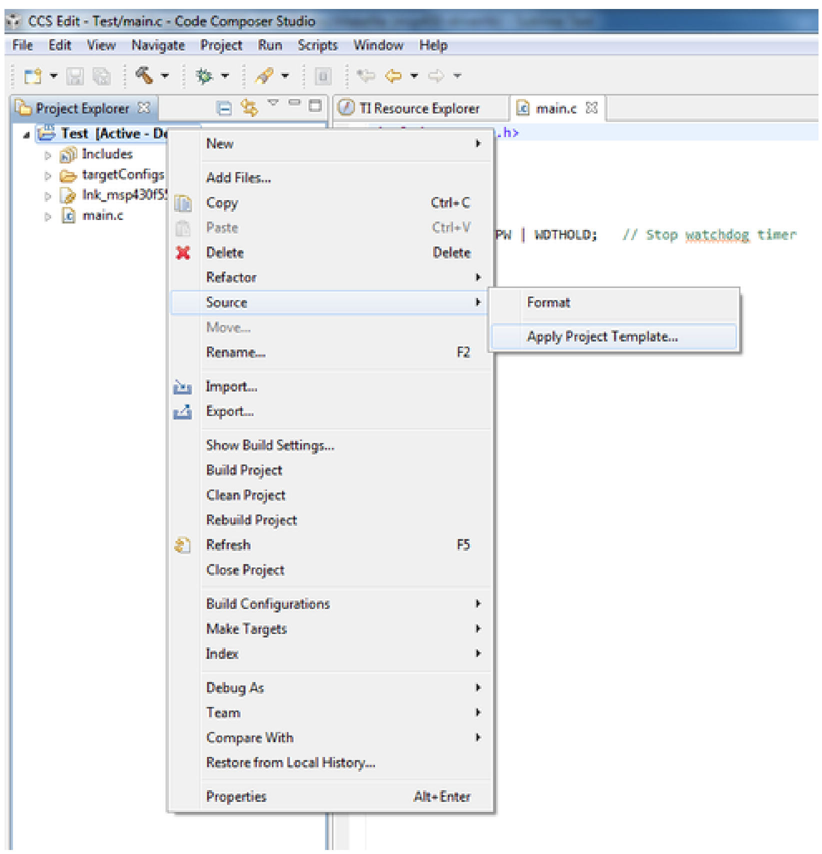
Finally click "Finish" and begin developing with your Driver Library enabled project.

We recommend -O4 compiler settings for more efficient optimizations for projects using driverlib

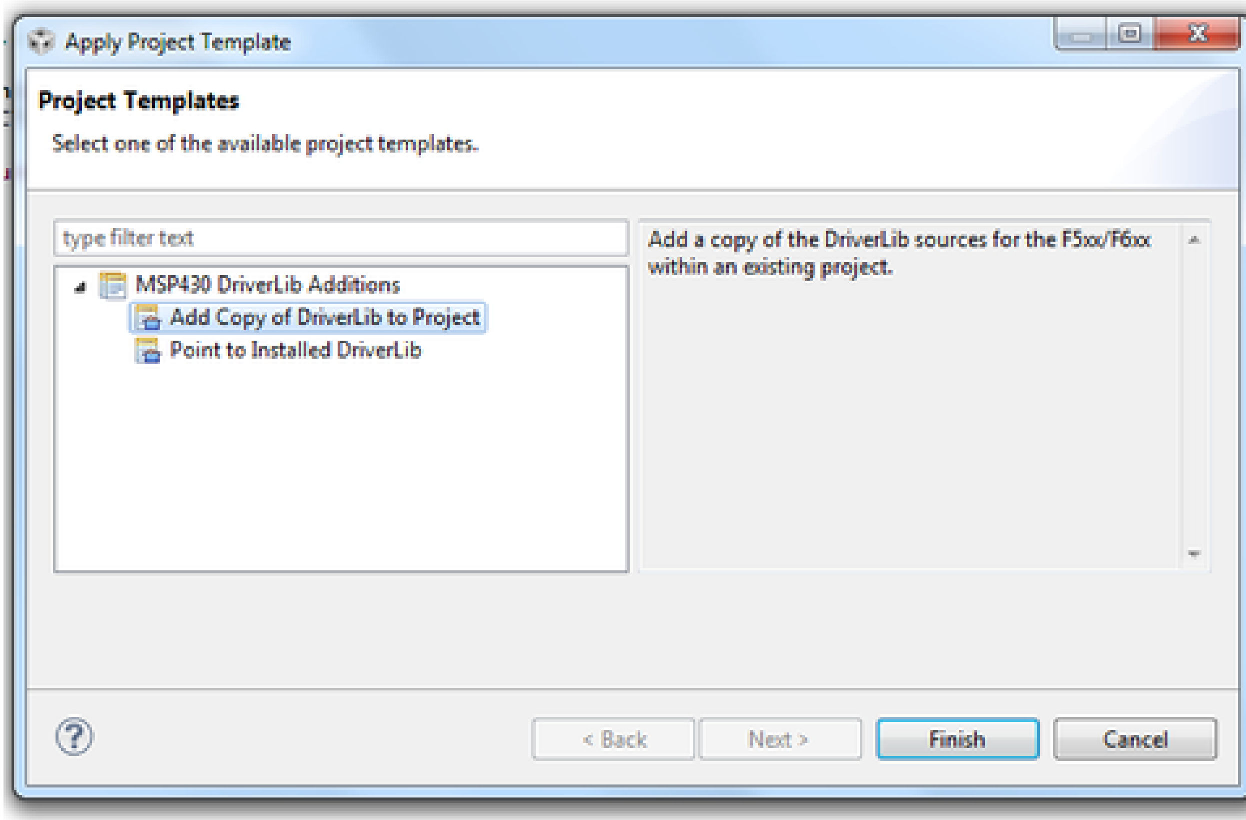
4 How to include driverlib into your existing CCS project

4.1 Introduction

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 advandced users who are including a static library in their project and want to add the DriverLib header files to their include path.

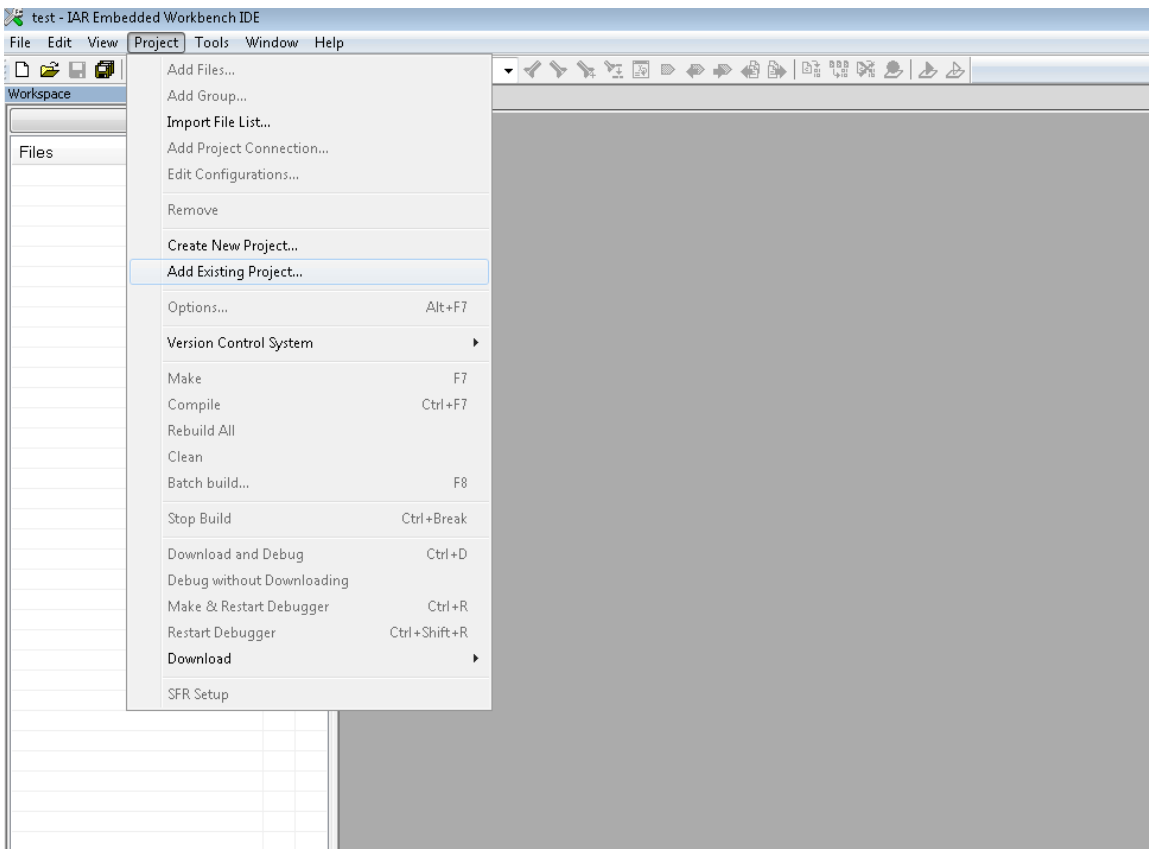


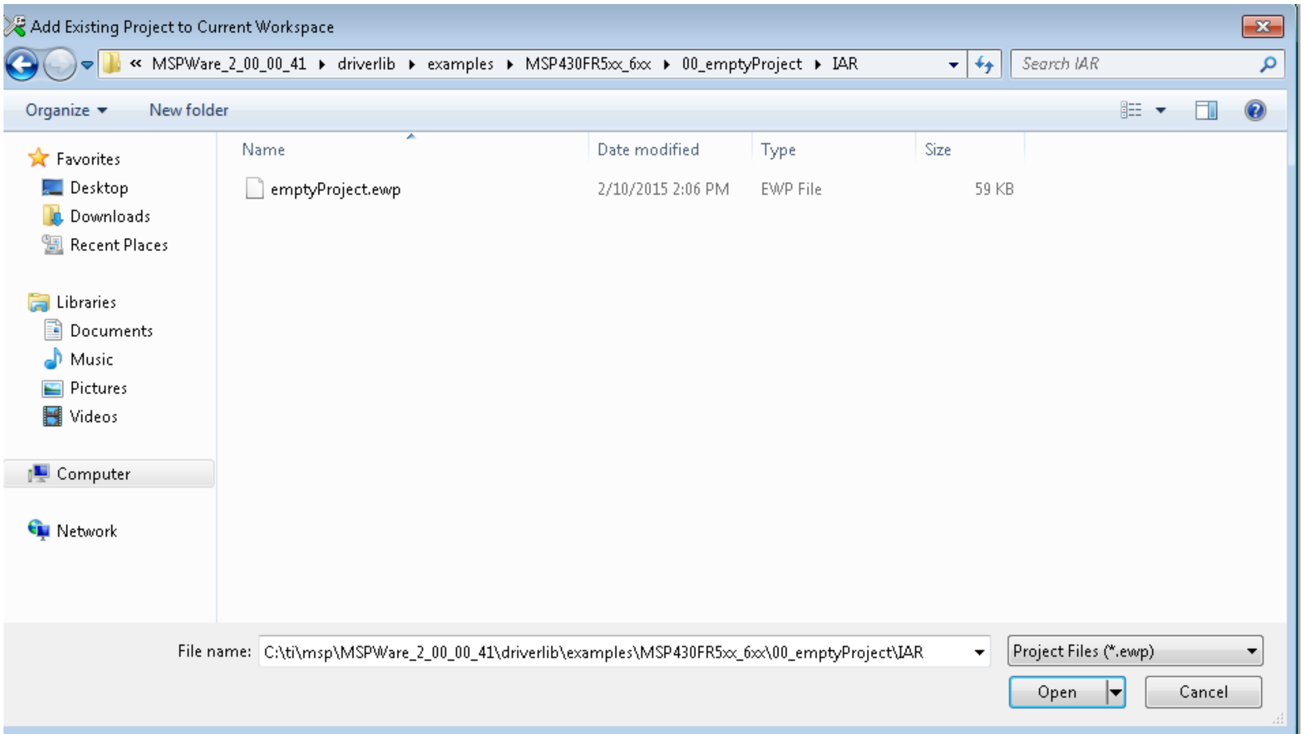
Click "Finish" and start developing with driver library in your project.

5 How to create a new IAR project that uses Driverlib

5.1 Introduction

It is recommended to get started with an Empty Driverlib Project. Browse to the empty project in your device's family. This is available in the driverlib instal folder\00_emptyProject




Add Existing Project to Current Workspace
« MSPWare_2_00_00_41 ▸ driverlib ▸ examples ▸ MSP430FR5xx_6xx ▸ 00_emptyProject ▸ IAR
Search IAR
Organize
New folder
Favorites
Desktop
Downloads
Recent Places
Libraries
Documents
Music
Pictures
Videos
Computer
Network
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Date modified
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emptyProject.ewp
2/10/2015 2:06 PM
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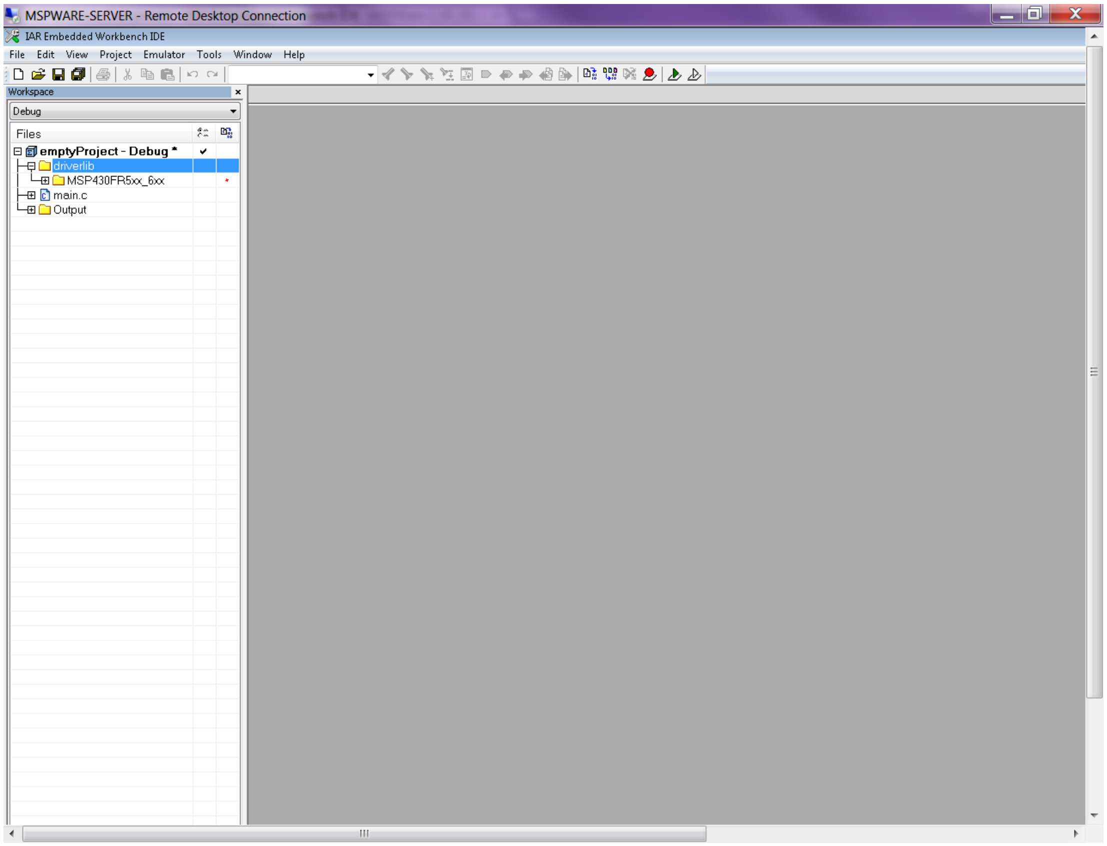
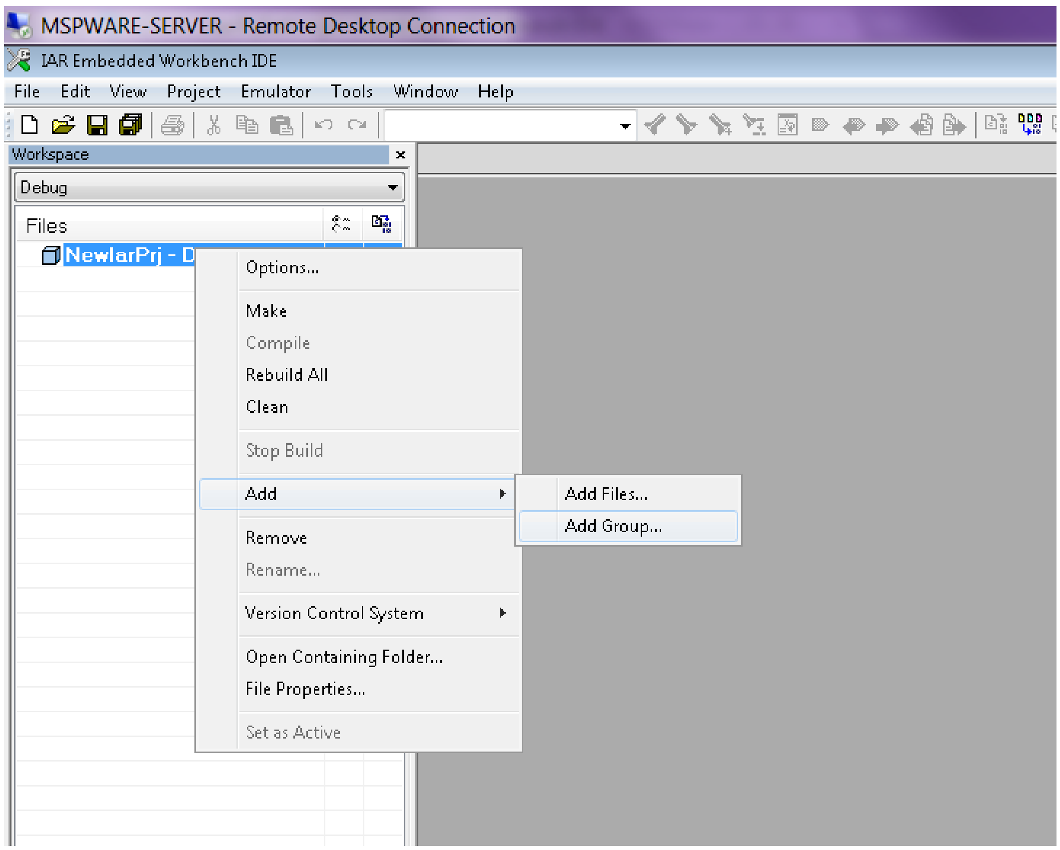
File name:
C:\ti\msp\MSPWare_2_00_00_41\driverlib\examples\MSP430FR5xx_6xx\00_emptyProject\IAR
Project Files (*.ewp)
Open
Cancel


MSPWARE-SERVER - Remote Desktop Connection
IAR Embedded Workbench IDE
File Edit View Project Emulator Tools Window Help
Workspace
Debug
Files
emptyProject - Debug *
driverlib
MSP430FR5xx_6xx
main.c
Output

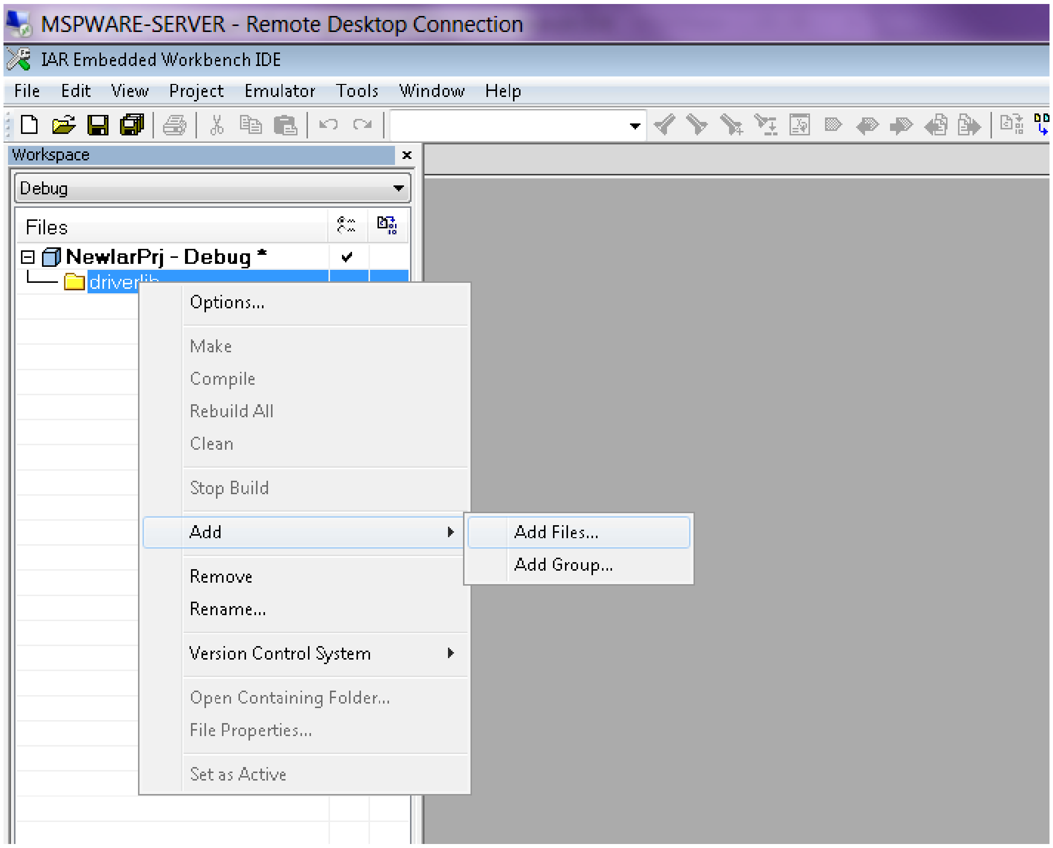
6 How to include driverlib into your existing IAR project

6.1 Introduction

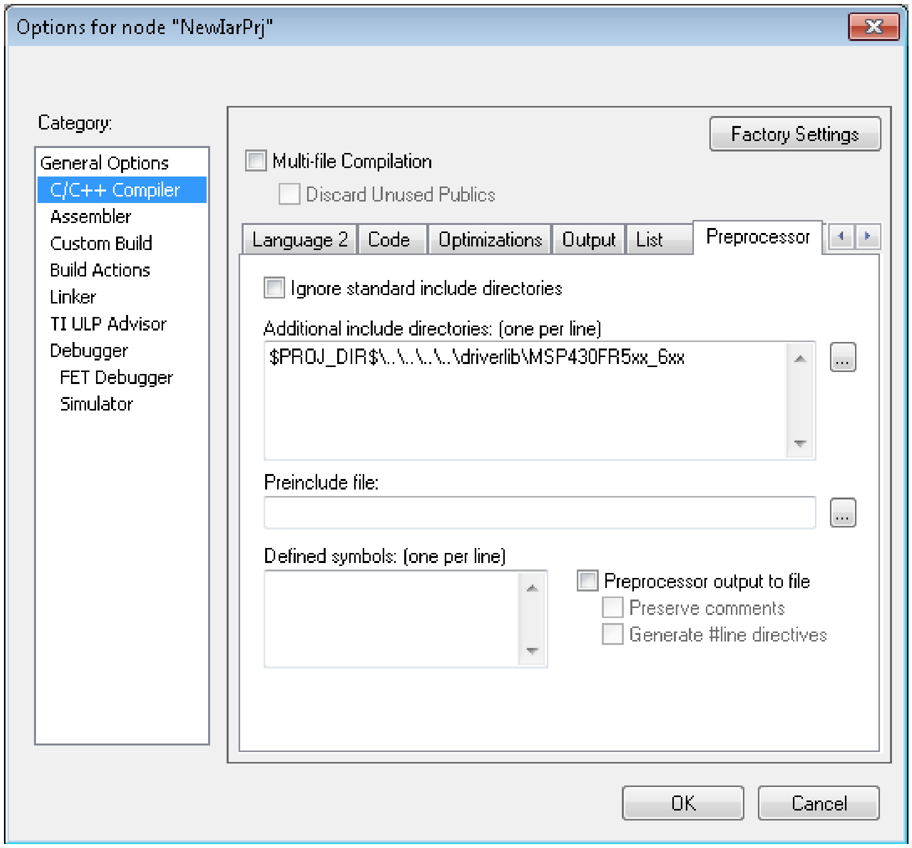
To add driver library to an existing project, right click project click on Add Group - "driverlib"



Now click Add files and browse through driverlib folder and add all source files of the family the device belongs to.



Add another group via "Add Group" and add inc folder. Add all files in the same driverlib family inc folder



Right click on the project, select "Options...", add "$PROJ_DIR$\..\..\..\..\driverlib\MSP430FR5xx_6xx" under "General Options->C/C++ Compiler->Additional include directories: (one per line)". Click "OK" and start developing with driver library in your project.

7 10-Bit Analog-to-Digital Converter (ADC10_A)

7.1 Introduction

The 10-Bit Analog-to-Digital (ADC10_A) API provides a set of functions for using the MSP430Ware ADC10_A modules. Functions are provided to initialize the ADC10_A modules, setup signal sources and reference voltages, and manage interrupts for the ADC10_A modules.

The ADC10_A module provides the ability to convert analog signals into a digital value in respect to given reference voltages. The ADC10_A can generate digital values from 0 to Vcc with an 8- or 10-bit resolution. It operates in 2 different sampling modes, and 4 different conversion modes. The sampling modes are extended sampling and pulse sampling, in extended sampling the sample/hold signal must stay high for the duration of sampling, while in pulse mode a sampling timer is setup to start on a rising edge of the sample/hold signal and sample for a specified amount of clock cycles. The 4 conversion modes are single-channel single conversion, sequence of channels single-conversion, repeated single channel conversions, and repeated sequence of channels conversions.

The ADC10_A module can generate multiple interrupts. An interrupt can be asserted when a conversion is complete, when a conversion is about to overwrite the converted data in the memory buffer before it has been read out, and/or when a conversion is about to start before the last conversion is complete. The ADC10_A also has a window comparator feature which asserts interrupts when the input signal is above a high threshold, below a low threshold, or between the two at any given moment.

7.2 API Functions

Functions

- bool ADC10_A_init (uint16_t baseAddress, uint16_t sampleHoldSignalSourceSelect, uint8_t clockSourceSelect, uint16_t clockSourceDivider)
  Initializes the ADC10_A Module.
- void ADC10_A_enable (uint16_t baseAddress)
  Enables the ADC10_A block.
- void ADC10_A_disable (uint16_t baseAddress)
  Disables the ADC10_A block.
- void ADC10_A_setupSamplingTimer (uint16_t baseAddress, uint16_t clockCycleHoldCount, uint16_t multipleSamplesEnabled)
  Sets up and enables the Sampling Timer Pulse Mode.
- void ADC10_A_disableSamplingTimer (uint16_t baseAddress)
  Disables Sampling Timer Pulse Mode.

- void ADC10_A_configureMemory (uint16_t baseAddress, uint8_t inputSourceSelect, uint8_t positiveRefVoltageSourceSelect, uint8_t negativeRefVoltageSourceSelect)
  Configures the controls of the selected memory buffer.
- void ADC10_A_enableInterrupt (uint16_t baseAddress, uint8_t interruptMask)
  Enables selected ADC10_A interrupt sources.
- void ADC10_A_disableInterrupt (uint16_t baseAddress, uint8_t interruptMask)
  Disables selected ADC10_A interrupt sources.
- void ADC10_A_clearInterrupt (uint16_t baseAddress, uint8_t interruptFlagMask)
  Clears ADC10_A selected interrupt flags.
- uint16_t ADC10_A_getInterruptStatus (uint16_t baseAddress, uint8_t interruptFlagMask)
  Returns the status of the selected memory interrupt flags.
- void ADC10_A_startConversion (uint16_t baseAddress, uint8_t conversionSequenceModeSelect)
  Enables/Starts an Analog-to-Digital Conversion.
- void ADC10_A_disableConversions (uint16_t baseAddress, bool preempt)
  Disables the ADC from converting any more signals.
- int16_t ADC10_A_getResults (uint16_t baseAddress)
  Returns the raw contents of the specified memory buffer.
- void ADC10_A_setResolution (uint16_t baseAddress, uint8_t resolutionSelect)
  Use to change the resolution of the converted data.
- void ADC10_A_setSampleHoldSignalInversion (uint16_t baseAddress, uint16_t invertedSignal)
  Use to invert or un-invert the sample/hold signal.
- void ADC10_A_setDataReadBackFormat (uint16_t baseAddress, uint16_t readBackFormat)
  Use to set the read-back format of the converted data.
- void ADC10_A_enableReferenceBurst (uint16_t baseAddress)
  Enables the reference buffer's burst ability.
- void ADC10_A_disableReferenceBurst (uint16_t baseAddress)
  Disables the reference buffer's burst ability.
- void ADC10_A_setReferenceBufferSamplingRate (uint16_t baseAddress, uint16_t samplingRateSelect)
  Use to set the reference buffer's sampling rate.
- void ADC10_A_setWindowComp (uint16_t baseAddress, uint16_t highThreshold, uint16_t lowThreshold)
  Sets the high and low threshold for the window comparator feature.
- uint32_t ADC10_A_getMemoryAddressForDMA (uint16_t baseAddress)
  Returns the address of the memory buffer for the DMA module.
- uint16_t ADC10_A_isBusy (uint16_t baseAddress)
  Returns the busy status of the ADC10_A core.

7.2.1 Detailed Description

The ADC10_A 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 ADC10_A.

The ADC10_A initialization and conversion functions are

- ADC10_A_init()
- ADC10_A_configureMemory()
- ADC10_A_setupSamplingTimer()

- ADC10_A_disableSamplingTimer()
- ADC10_A_setWindowComp()
- ADC10_A_startConversion()
- ADC10_A_disableConversions()
- ADC10_A_getResults()
- ADC10_A_isBusy()

The ADC10_A interrupts are handled by

- ADC10_A_enableInterrupt()
- ADC10_A_disableInterrupt()
- ADC10_A_clearInterrupt()
- ADC10_A_getInterruptStatus()

Auxiliary features of the ADC10_A are handled by

- ADC10_A_setResolution()
- ADC10_A_setSampleHoldSignalInversion()
- ADC10_A_setDataReadBackFormat()
- ADC10_A_enableReferenceBurst()
- ADC10_A_disableReferenceBurst()
- ADC10_A_setReferenceBufferSamplingRate()
- ADC10_A_getMemoryAddressForDMA()
- ADC10_A_enable()
- ADC10_A_disable()

7.2.2 Function Documentation

ADC10_A_clearInterrupt()

```
void ADC10_A_clearInterrupt (
            uint16_t baseAddress,
            uint8_t interruptFlagMask )
```

Clears ADC10_A selected interrupt flags.

The selected ADC10_A interrupt flags are cleared, so that it no longer asserts. The memory buffer interrupt flags are only cleared when the memory buffer is accessed.

Parameters

baseAddress	is the base address of the ADC10_A module.

Parameters

interruptFlagMask	is a bit mask of the interrupt flags to be cleared. Mask value is the logical OR of any of the following: ■ **ADC10_A_TIMEOVERFLOW_INTFLAG** - Interrupts flag when a new conversion is starting before the previous one has finished ■ **ADC10_A_OVERFLOW_INTFLAG** - Interrupts flag when a new conversion is about to overwrite the previous one ■ **ADC10_A_ABOVETHRESHOLD_INTFLAG** - Interrupts flag when the input signal has gone above the high threshold of the window comparator ■ **ADC10_A_BELOWTHRESHOLD_INTFLAG** - Interrupts flag when the input signal has gone below the low threshold of the low window comparator ■ **ADC10_A_INSIDEWINDOW_INTFLAG** - Interrupts flag when the input signal is in between the high and low thresholds of the window comparator ■ **ADC10_A_COMPLETED_INTFLAG** - Interrupt flag for new conversion data in the memory buffer

Modified bits of **ADC10IFG** register.

Returns

None

ADC10_A_configureMemory()

```
void ADC10_A_configureMemory (
            uint16_t baseAddress,
            uint8_t inputSourceSelect,
            uint8_t positiveRefVoltageSourceSelect,
            uint8_t negativeRefVoltageSourceSelect )
```

Configures the controls of the selected memory buffer.

Maps an input signal conversion into the memory buffer, as well as the positive and negative reference voltages for each conversion being stored into the memory buffer. If the internal reference is used for the positive reference voltage, the internal REF module has to control the voltage level. Note that if a conversion has been started with the startConversion() function, then a call to disableConversions() is required before this function may be called. If conversion is not disabled, this function does nothing.

Parameters

baseAddress	is the base address of the ADC10_A module.

Parameters

inputSourceSelect	is the input that will store the converted data into the specified memory buffer. Valid values are: ■ **ADC10_A_INPUT_A0** [Default] ■ **ADC10_A_INPUT_A1** ■ **ADC10_A_INPUT_A2** ■ **ADC10_A_INPUT_A3** ■ **ADC10_A_INPUT_A4** ■ **ADC10_A_INPUT_A5** ■ **ADC10_A_INPUT_A6** ■ **ADC10_A_INPUT_A7** ■ **ADC10_A_INPUT_A8** ■ **ADC10_A_INPUT_A9** ■ **ADC10_A_INPUT_TEMPSENSOR** ■ **ADC10_A_INPUT_BATTERYMONITOR** ■ **ADC10_A_INPUT_A12** ■ **ADC10_A_INPUT_A13** ■ **ADC10_A_INPUT_A14** ■ **ADC10_A_INPUT_A15** Modified bits are **ADC10INCHx** of **ADC10MCTL0** register.
positiveRefVoltageSourceSelect	is the reference voltage source to set as the upper limit for the conversion that is to be stored in the specified memory buffer. Valid values are: ■ **ADC10_A_VREFPOS_AVCC** [Default] ■ **ADC10_A_VREFPOS_EXT** ■ **ADC10_A_VREFPOS_INT** Modified bits are **ADC10SREF** of **ADC10MCTL0** register.
negativeRefVoltageSourceSelect	is the reference voltage source to set as the lower limit for the conversion that is to be stored in the specified memory buffer. Valid values are: ■ **ADC10_A_VREFNEG_AVSS** ■ **ADC10_A_VREFNEG_EXT** Modified bits are **ADC10SREF** of **ADC10CTL0** register.

Returns

None

ADC10_A_disable()

```
void ADC10_A_disable (
            uint16_t baseAddress )
```

Disables the ADC10_A block.

This will disable operation of the ADC10_A block.

Parameters

baseAddress	is the base address of the ADC10_A module.

Modified bits are **ADC10ON** of **ADC10CTL0** register.

Returns

None

ADC10_A_disableConversions()

```
void ADC10_A_disableConversions (
            uint16_t baseAddress,
            bool preempt )
```

Disables the ADC from converting any more signals.

Disables the ADC from converting any more signals. If there is a conversion in progress, this function can stop it immediately if the preempt parameter is set as ADC10_A_PREEMPTCONVERSION, by changing the conversion mode to single-channel, single-conversion and disabling conversions. If the conversion mode is set as single-channel, single-conversion and this function is called without preemption, then the ADC core conversion status is polled until the conversion is complete before disabling conversions to prevent unpredictable data. If the ADC10_A_startConversion() has been called, then this function has to be called to re-initialize the ADC, reconfigure a memory buffer control, enable/disable the sampling pulse mode, or change the internal reference voltage.

Parameters

baseAddress	is the base address of the ADC10_A module.
preempt	specifies if the current conversion should be pre-empted before the end of the conversion Valid values are: ■ **ADC10_A_COMPLETECONVERSION** - Allows the ADC10_A to end the current conversion before disabling conversions. ■ **ADC10_A_PREEMPTCONVERSION** - Stops the ADC10_A immediately, with unpredictable results of the current conversion. Cannot be used with repeated conversion.

Modified bits of **ADC10CTL1** register and bits of **ADC10CTL0** register.

Returns

None

ADC10_A_disableInterrupt()

```
void ADC10_A_disableInterrupt (
            uint16_t baseAddress,
            uint8_t interruptMask )
```

Disables selected ADC10_A interrupt sources.

Disables the indicated ADC10_A 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 ADC10_A module.
interruptMask	is the bit mask of the memory buffer interrupt sources to be disabled. Mask value is the logical OR of any of the following: ■ **ADC10_A_TIMEOVERFLOW_INT** - Interrupts when a new conversion is starting before the previous one has finished ■ **ADC10_A_OVERFLOW_INT** - Interrupts when a new conversion is about to overwrite the previous one ■ **ADC10_A_ABOVETHRESHOLD_INT** - Interrupts when the input signal has gone above the high threshold of the window comparator ■ **ADC10_A_BELOWTHRESHOLD_INT** - Interrupts when the input signal has gone below the low threshold of the low window comparator ■ **ADC10_A_INSIDEWINDOW_INT** - Interrupts when the input signal is in between the high and low thresholds of the window comparator ■ **ADC10_A_COMPLETED_INT** - Interrupt for new conversion data in the memory buffer

Modified bits of **ADC10IE** register.

Returns

None

ADC10_A_disableReferenceBurst()

```
void ADC10_A_disableReferenceBurst (
            uint16_t baseAddress )
```

Disables the reference buffer's burst ability.

Disables the reference buffer's burst ability, forcing the reference buffer to remain on continuously.

Parameters

baseAddress	is the base address of the ADC10_A module.

Returns

None

ADC10_A_disableSamplingTimer()

```
void ADC10_A_disableSamplingTimer (
            uint16_t baseAddress )
```

Disables Sampling Timer Pulse Mode.

Disables the Sampling Timer Pulse Mode. Note that if a conversion has been started with the startConversion() function, then a call to disableConversions() is required before this function may be called.

Parameters

baseAddress	is the base address of the ADC10_A module.

Returns

None

ADC10_A_enable()

```
void ADC10_A_enable (
            uint16_t baseAddress )
```

Enables the ADC10_A block.

This will enable operation of the ADC10_A block.

Parameters

baseAddress	is the base address of the ADC10_A module.

Modified bits are **ADC10ON** of **ADC10CTL0** register.

Returns

None

ADC10_A_enableInterrupt()

```
void ADC10_A_enableInterrupt (
```

```
            uint16_t baseAddress,
            uint8_t interruptMask )
```

Enables selected ADC10_A interrupt sources.

Enables the indicated ADC10_A 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 ADC10_A module.
interruptMask	is the bit mask of the memory buffer interrupt sources to be enabled. Mask value is the logical OR of any of the following: ■ **ADC10_A_TIMEOVERFLOW_INT** - Interrupts when a new conversion is starting before the previous one has finished ■ **ADC10_A_OVERFLOW_INT** - Interrupts when a new conversion is about to overwrite the previous one ■ **ADC10_A_ABOVETHRESHOLD_INT** - Interrupts when the input signal has gone above the high threshold of the window comparator ■ **ADC10_A_BELOWTHRESHOLD_INT** - Interrupts when the input signal has gone below the low threshold of the low window comparator ■ **ADC10_A_INSIDEWINDOW_INT** - Interrupts when the input signal is in between the high and low thresholds of the window comparator ■ **ADC10_A_COMPLETED_INT** - Interrupt for new conversion data in the memory buffer

Modified bits of **ADC10IE** register.

Returns

None

ADC10_A_enableReferenceBurst()

```
void ADC10_A_enableReferenceBurst (
            uint16_t baseAddress )
```

Enables the reference buffer's burst ability.

Enables the reference buffer's burst ability, allowing the reference buffer to turn off while the ADC is not converting, and automatically turning on when the ADC needs the generated reference voltage for a conversion.

Parameters

baseAddress	is the base address of the ADC10_A module.

Returns

None

ADC10_A_getInterruptStatus()

```
uint16_t ADC10_A_getInterruptStatus (
            uint16_t baseAddress,
            uint8_t interruptFlagMask )
```

Returns the status of the selected memory interrupt flags.

Returns the status of the selected interrupt flags.

Parameters

baseAddress	is the base address of the ADC10_A module.
interruptFlagMask	is a bit mask of the interrupt flags status to be returned. Mask value is the logical OR of any of the following: ■ **ADC10_A_TIMEOVERFLOW_INTFLAG** - Interrupts flag when a new conversion is starting before the previous one has finished ■ **ADC10_A_OVERFLOW_INTFLAG** - Interrupts flag when a new conversion is about to overwrite the previous one ■ **ADC10_A_ABOVETHRESHOLD_INTFLAG** - Interrupts flag when the input signal has gone above the high threshold of the window comparator ■ **ADC10_A_BELOWTHRESHOLD_INTFLAG** - Interrupts flag when the input signal has gone below the low threshold of the low window comparator ■ **ADC10_A_INSIDEWINDOW_INTFLAG** - Interrupts flag when the input signal is in between the high and low thresholds of the window comparator ■ **ADC10_A_COMPLETED_INTFLAG** - Interrupt flag for new conversion data in the memory buffer

Returns

The current interrupt flag status for the corresponding mask.

ADC10_A_getMemoryAddressForDMA()

```
uint32_t ADC10_A_getMemoryAddressForDMA (
            uint16_t baseAddress )
```

Returns the address of the memory buffer for the DMA module.

Returns the address of the memory buffer. This can be used in conjunction with the DMA to store the converted data directly to memory.

Parameters

baseAddress	is the base address of the ADC10_A module.

Returns

The memory address of the memory buffer

ADC10_A_getResults()

```
int16_t ADC10_A_getResults (
            uint16_t baseAddress )
```

Returns the raw contents of the specified memory buffer.

Returns the raw contents of the specified memory buffer. The format of the content depends on the read-back format of the data: if the data is in signed 2's complement format then the contents in the memory buffer will be left-justified with the least-significant bits as 0's, whereas if the data is in unsigned format then the contents in the memory buffer will be right- justified with the most-significant bits as 0's.

Parameters

baseAddress	is the base address of the ADC10_A module.

Returns

A Signed Integer of the contents of the specified memory buffer.

ADC10_A_init()

```
bool ADC10_A_init (
            uint16_t baseAddress,
            uint16_t sampleHoldSignalSourceSelect,
            uint8_t clockSourceSelect,
            uint16_t clockSourceDivider )
```

Initializes the ADC10_A Module.

This function initializes the ADC module to allow for analog-to-digital conversions. Specifically this function sets up the sample-and-hold signal and clock sources for the ADC core to use for conversions. Upon successful completion of the initialization all of the ADC control registers will be reset, excluding the memory controls and reference module bits, the given parameters will be set, and the ADC core will be turned on (Note, that the ADC core only draws power during conversions and remains off when not converting).Note that sample/hold signal sources are device dependent. Note that if re-initializing the ADC after starting a conversion with the startConversion() function, the disableConversion() must be called BEFORE this function can be called.

Parameters

baseAddress	is the base address of the ADC10_A module.

Parameters

sampleHoldSignalSourceSelect	is the signal that will trigger a sample-and-hold for an input signal to be converted. This parameter is device specific and sources should be found in the device's datasheet Valid values are: ■ **ADC10_A_SAMPLEHOLDSOURCE_SC** ■ **ADC10_A_SAMPLEHOLDSOURCE_1** ■ **ADC10_A_SAMPLEHOLDSOURCE_2** ■ **ADC10_A_SAMPLEHOLDSOURCE_3** Modified bits are **ADC10SHSx** of **ADC10CTL1** register.
clockSourceSelect	selects the clock that will be used by the ADC10_A core and the sampling timer if a sampling pulse mode is enabled. Valid values are: ■ **ADC10_A_CLOCKSOURCE_ADC10OSC** [Default] - MODOSC 5 MHz oscillator from the UCS ■ **ADC10_A_CLOCKSOURCE_ACLK** - The Auxiliary Clock ■ **ADC10_A_CLOCKSOURCE_MCLK** - The Master Clock ■ **ADC10_A_CLOCKSOURCE_SMCLK** - The Sub-Master Clock Modified bits are **ADC10SSELx** of **ADC10CTL1** register.

Parameters

clockSourceDivider	selects the amount that the clock will be divided. Valid values are: ■ **ADC10_A_CLOCKDIVIDER_1** [Default] ■ **ADC10_A_CLOCKDIVIDER_2** ■ **ADC10_A_CLOCKDIVIDER_3** ■ **ADC10_A_CLOCKDIVIDER_4** ■ **ADC10_A_CLOCKDIVIDER_5** ■ **ADC10_A_CLOCKDIVIDER_6** ■ **ADC10_A_CLOCKDIVIDER_7** ■ **ADC10_A_CLOCKDIVIDER_8** ■ **ADC10_A_CLOCKDIVIDER_12** ■ **ADC10_A_CLOCKDIVIDER_16** ■ **ADC10_A_CLOCKDIVIDER_20** ■ **ADC10_A_CLOCKDIVIDER_24** ■ **ADC10_A_CLOCKDIVIDER_28** ■ **ADC10_A_CLOCKDIVIDER_32** ■ **ADC10_A_CLOCKDIVIDER_64** ■ **ADC10_A_CLOCKDIVIDER_128** ■ **ADC10_A_CLOCKDIVIDER_192** ■ **ADC10_A_CLOCKDIVIDER_256** ■ **ADC10_A_CLOCKDIVIDER_320** ■ **ADC10_A_CLOCKDIVIDER_384** ■ **ADC10_A_CLOCKDIVIDER_448** ■ **ADC10_A_CLOCKDIVIDER_512** Modified bits are **ADC10DIVx** of **ADC10CTL1** register; bits **ADC10PDIVx** of **ADC10CTL2** register.

Returns

STATUS_SUCCESS or STATUS_FAILURE of the initialization process.

ADC10_A_isBusy()

```
uint16_t ADC10_A_isBusy (
            uint16_t baseAddress )
```

Returns the busy status of the ADC10_A core.

Returns the status of the ADC core if there is a conversion currently taking place.

Parameters

baseAddress	is the base address of the ADC10_A module.

Returns

One of the following:
- **ADC10_A_BUSY**
- **ADC10_A_NOTBUSY**
indicating if there is a conversion currently taking place

ADC10_A_setDataReadBackFormat()

```
void ADC10_A_setDataReadBackFormat (
            uint16_t baseAddress,
            uint16_t readBackFormat )
```

Use to set the read-back format of the converted data.

Sets the format of the converted data: how it will be stored into the memory buffer, and how it should be read back. The format can be set as right-justified (default), which indicates that the number will be unsigned, or left-justified, which indicates that the number will be signed in 2's complement format. This change affects all memory buffers for subsequent conversions.

Parameters

baseAddress	is the base address of the ADC10_A module.
readBackFormat	is the specified format to store the conversions in the memory buffer. Valid values are: ■ **ADC10_A_UNSIGNED_BINARY** [Default] ■ **ADC10_A_SIGNED_2SCOMPLEMENT** Modified bits are **ADC10DF** of **ADC10CTL2** register.

Returns

None

ADC10_A_setReferenceBufferSamplingRate()

```
void ADC10_A_setReferenceBufferSamplingRate (
            uint16_t baseAddress,
            uint16_t samplingRateSelect )
```

Use to set the reference buffer's sampling rate.

Sets the reference buffer's sampling rate to the selected sampling rate. The default sampling rate is maximum of 200-ksps, and can be reduced to a maximum of 50-ksps to conserve power.

Parameters

baseAddress	is the base address of the ADC10_A module.
samplingRateSelect	is the specified maximum sampling rate. Valid values are: ■ **ADC10_A_MAXSAMPLINGRATE_200KSPS** [Default] ■ **ADC10_A_MAXSAMPLINGRATE_50KSPS** Modified bits are **ADC10SR** of **ADC10CTL2** register.

Returns

None

ADC10_A_setResolution()

```
void ADC10_A_setResolution (
            uint16_t baseAddress,
            uint8_t resolutionSelect )
```

Use to change the resolution of the converted data.

This function can be used to change the resolution of the converted data from the default of 12-bits.

Parameters

baseAddress	is the base address of the ADC10_A module.
resolutionSelect	determines the resolution of the converted data. Valid values are: ■ **ADC10_A_RESOLUTION_8BIT** ■ **ADC10_A_RESOLUTION_10BIT** [Default] Modified bits are **ADC10RES** of **ADC10CTL2** register.

Returns

None

ADC10_A_setSampleHoldSignalInversion()

```
void ADC10_A_setSampleHoldSignalInversion (
            uint16_t baseAddress,
            uint16_t invertedSignal )
```

Use to invert or un-invert the sample/hold signal.

This function can be used to invert or un-invert the sample/hold signal. Note that if a conversion has been started with the startConversion() function, then a call to disableConversions() is required before this function may be called.

Parameters

baseAddress	is the base address of the ADC10_A module.
invertedSignal	set if the sample/hold signal should be inverted Valid values are: ■ **ADC10_A_NONINVERTEDSIGNAL** [Default] - a sample-and-hold of an input signal for conversion will be started on a rising edge of the sample/hold signal. ■ **ADC10_A_INVERTEDSIGNAL** - a sample-and-hold of an input signal for conversion will be started on a falling edge of the sample/hold signal. Modified bits are **ADC10ISSH** of **ADC10CTL1** register.

Returns

None

ADC10_A_setupSamplingTimer()

```
void ADC10_A_setupSamplingTimer (
            uint16_t baseAddress,
            uint16_t clockCycleHoldCount,
            uint16_t multipleSamplesEnabled )
```

Sets up and enables the Sampling Timer Pulse Mode.

This function sets up the sampling timer pulse mode which allows the sample/hold signal to trigger a sampling timer to sample-and-hold an input signal for a specified number of clock cycles without having to hold the sample/hold signal for the entire period of sampling. Note that if a conversion has been started with the startConversion() function, then a call to disableConversions() is required before this function may be called.

Parameters

baseAddress	is the base address of the ADC10_A module.

Parameters

clockCycleHoldCount	sets the amount of clock cycles to sample-and- hold for the memory buffer. Valid values are: ■ **ADC10_A_CYCLEHOLD_4_CYCLES** [Default] ■ **ADC10_A_CYCLEHOLD_8_CYCLES** ■ **ADC10_A_CYCLEHOLD_16_CYCLES** ■ **ADC10_A_CYCLEHOLD_32_CYCLES** ■ **ADC10_A_CYCLEHOLD_64_CYCLES** ■ **ADC10_A_CYCLEHOLD_96_CYCLES** ■ **ADC10_A_CYCLEHOLD_128_CYCLES** ■ **ADC10_A_CYCLEHOLD_192_CYCLES** ■ **ADC10_A_CYCLEHOLD_256_CYCLES** ■ **ADC10_A_CYCLEHOLD_384_CYCLES** ■ **ADC10_A_CYCLEHOLD_512_CYCLES** ■ **ADC10_A_CYCLEHOLD_768_CYCLES** ■ **ADC10_A_CYCLEHOLD_1024_CYCLES** Modified bits are **ADC10SHTx** of **ADC10CTL0** register.
multipleSamplesEnabled	allows multiple conversions to start without a trigger signal from the sample/hold signal Valid values are: ■ **ADC10_A_MULTIPLESAMPLESDISABLE** - a timer trigger will be needed to start every ADC conversion. ■ **ADC10_A_MULTIPLESAMPLESENABLE** - during a sequenced and/or repeated conversion mode, after the first conversion, no sample/hold signal is necessary to start subsequent samples. Modified bits are **ADC10MSC** of **ADC10CTL0** register.

Returns

None

ADC10_A_setWindowComp()

```
void ADC10_A_setWindowComp (
            uint16_t baseAddress,
            uint16_t highThreshold,
            uint16_t lowThreshold )
```

Sets the high and low threshold for the window comparator feature.

Sets the high and low threshold for the window comparator feature. Use the ADC10HIIE, ADC10INIE, ADC10LOIE interrupts to utilize this feature.

Parameters

baseAddress	is the base address of the ADC10_A module.
highThreshold	is the upper bound that could trip an interrupt for the window comparator.
lowThreshold	is the lower bound that could trip on interrupt for the window comparator.

Returns

None

ADC10_A_startConversion()

```
void ADC10_A_startConversion (
            uint16_t baseAddress,
            uint8_t conversionSequenceModeSelect )
```

Enables/Starts an Analog-to-Digital Conversion.

This function enables/starts the conversion process of the ADC. If the sample/hold signal source chosen during initialization was ADC10OSC, then the conversion is started immediately, otherwise the chosen sample/hold signal source starts the conversion by a rising edge of the signal. Keep in mind when selecting conversion modes, that for sequenced and/or repeated modes, to keep the sample/hold-and-convert process continuing without a trigger from the sample/hold signal source, the multiple samples must be enabled using the ADC10_A_setupSamplingTimer() function. Also note that when a sequence conversion mode is selected, the first input channel is the one mapped to the memory buffer, the next input channel selected for conversion is one less than the input channel just converted (i.e. A1 comes after A2), until A0 is reached, and if in repeating mode, then the next input channel will again be the one mapped to the memory buffer. Note that after this function is called, the ADC10_A_stopConversions() has to be called to re-initialize the ADC, reconfigure a memory buffer control, enable/disable the sampling timer, or to change the internal reference voltage.

Parameters

baseAddress	is the base address of the ADC10_A module.

Parameters

conversionSequenceModeSelect	determines the ADC operating mode. Valid values are: ■ **ADC10_A_SINGLECHANNEL** [Default] - one-time conversion of a single channel into a single memory buffer ■ **ADC10_A_SEQOFCHANNELS** - one time conversion of multiple channels into the specified starting memory buffer and each subsequent memory buffer up until the conversion is stored in a memory buffer dedicated as the end-of-sequence by the memory's control register ■ **ADC10_A_REPEATED_SINGLECHANNEL** - repeated conversions of one channel into a single memory buffer ■ **ADC10_A_REPEATED_SEQOFCHANNELS** - repeated conversions of multiple channels into the specified starting memory buffer and each subsequent memory buffer up until the conversion is stored in a memory buffer dedicated as the end-of-sequence by the memory's control register Modified bits are **ADC10CONSEQx** of **ADC10CTL1** register.

Returns

None

7.3 Programming Example

The following example shows how to initialize and use the ADC10_A API to start a single channel, single conversion.

```
// Initialize ADC10_A with ADC10_A's built-in oscillator
ADC10_A_init (ADC10_A_BASE,
            ADC10_A_SAMPLEHOLDSOURCE_SC,
            ADC10_A_CLOCKSOURCE_ADC10_AOSC,
            ADC10_A_CLOCKDIVIDEBY_1);

//Switch ON ADC10_A
ADC10_A_enable(ADC10_A_BASE);

// Setup sampling timer to sample-and-hold for 16 clock cycles
ADC10_A_setupSamplingTimer (ADC10_A_BASE,
                          ADC10_A_CYCLEHOLD_16_CYCLES,
                          FALSE);

// Configure the Input to the Memory Buffer with the specified Reference Voltages
ADC10_A_configureMemory (ADC10_A_BASE,
                       ADC10_A_INPUT_A0,
                       ADC10_A_VREF_AVCC, // Vref+ = AVcc
                       ADC10_A_VREF_AVSS  // Vref- = AVss
                       );
while (1)
{
    // Start a single conversion, no repeating or sequences.
```

```
    ADC10_A_startConversion (ADC10_A_BASE,
                            ADC10_A_SINGLECHANNEL);

    // Wait for the Interrupt Flag to assert
    while( !(ADC10_A_getInterruptStatus(ADC10_A_BASE,ADC10_AIFG0)) );

    // Clear the Interrupt Flag and start another conversion
    ADC10_A_clearInterrupt(ADC10_A_BASE,ADC10_AIFG0);
}
```

8 12-Bit Analog-to-Digital Converter (ADC12_A)

8.1 Introduction

The 12-Bit Analog-to-Digital (ADC12_A) API provides a set of functions for using the MSP430Ware ADC12_A modules. Functions are provided to initialize the ADC12_A modules, setup signal sources and reference voltages for each memory buffer, and manage interrupts for the ADC12_A modules.

The ADC12_A module provides the ability to convert analog signals into a digital value in respect to given reference voltages. The ADC12_A can generate digital values from 0 to Vcc with an 8-, 10- or 12-bit resolution, with 16 different memory buffers to store conversion results. It operates in 2 different sampling modes, and 4 different conversion modes. The sampling modes are extended sampling and pulse sampling, in extended sampling the sample/hold signal must stay high for the duration of sampling, while in pulse mode a sampling timer is setup to start on a rising edge of the sample/hold signal and sample for a specified amount of clock cycles. The 4 conversion modes are single-channel single conversion, sequence of channels single-conversion, repeated single channel conversions, and repeated sequence of channels conversions.

The ADC12_A module can generate multiple interrupts. An interrupt can be asserted for each memory buffer when a conversion is complete, or when a conversion is about to overwrite the converted data in any of the memory buffers before it has been read out, and/or when a conversion is about to start before the last conversion is complete.

8.2 API Functions

Functions

- bool ADC12_A_init (uint16_t baseAddress, uint16_t sampleHoldSignalSourceSelect, uint8_t clockSourceSelect, uint16_t clockSourceDivider)
  Initializes the ADC12_A Module.
- void ADC12_A_enable (uint16_t baseAddress)
  Enables the ADC12_A block.
- void ADC12_A_disable (uint16_t baseAddress)
  Disables the ADC12_A block.
- void ADC12_A_setupSamplingTimer (uint16_t baseAddress, uint16_t clockCycleHoldCountLowMem, uint16_t clockCycleHoldCountHighMem, uint16_t multipleSamplesEnabled)
  Sets up and enables the Sampling Timer Pulse Mode.
- void ADC12_A_disableSamplingTimer (uint16_t baseAddress)
  Disables Sampling Timer Pulse Mode.

- void ADC12_A_configureMemory (uint16_t baseAddress, ADC12_A_configureMemoryParam ∗param)
  Configures the controls of the selected memory buffer.
- void ADC12_A_enableInterrupt (uint16_t baseAddress, uint32_t interruptMask)
  Enables selected ADC12_A interrupt sources.
- void ADC12_A_disableInterrupt (uint16_t baseAddress, uint32_t interruptMask)
  Disables selected ADC12_A interrupt sources.
- void ADC12_A_clearInterrupt (uint16_t baseAddress, uint16_t memoryInterruptFlagMask)
  Clears ADC12_A selected interrupt flags.
- uint16_t ADC12_A_getInterruptStatus (uint16_t baseAddress, uint16_t memoryInterruptFlagMask)
  Returns the status of the selected memory interrupt flags.
- void ADC12_A_startConversion (uint16_t baseAddress, uint16_t startingMemoryBufferIndex, uint8_t conversionSequenceModeSelect)
  Enables/Starts an Analog-to-Digital Conversion.
- void ADC12_A_disableConversions (uint16_t baseAddress, bool preempt)
  Disables the ADC from converting any more signals.
- uint16_t ADC12_A_getResults (uint16_t baseAddress, uint8_t memoryBufferIndex)
  A Signed Integer of the contents of the specified memory buffer.
- void ADC12_A_setResolution (uint16_t baseAddress, uint8_t resolutionSelect)
  Use to change the resolution of the converted data.
- void ADC12_A_setSampleHoldSignalInversion (uint16_t baseAddress, uint16_t invertedSignal)
  Use to invert or un-invert the sample/hold signal.
- void ADC12_A_setDataReadBackFormat (uint16_t baseAddress, uint8_t readBackFormat)
  Use to set the read-back format of the converted data.
- void ADC12_A_enableReferenceBurst (uint16_t baseAddress)
  Enables the reference buffer's burst ability.
- void ADC12_A_disableReferenceBurst (uint16_t baseAddress)
  Disables the reference buffer's burst ability.
- void ADC12_A_setReferenceBufferSamplingRate (uint16_t baseAddress, uint8_t samplingRateSelect)
  Use to set the reference buffer's sampling rate.
- uint32_t ADC12_A_getMemoryAddressForDMA (uint16_t baseAddress, uint8_t memoryIndex)
  Returns the address of the specified memory buffer for the DMA module.
- uint16_t ADC12_A_isBusy (uint16_t baseAddress)
  Returns the busy status of the ADC12_A core.

8.2.1 Detailed Description

The ADC12_A 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 ADC12_A.

The ADC12_A initialization and conversion functions are

- ADC12_A_init()
- ADC12_A_configureMemory()
- ADC12_A_setupSamplingTimer()
- ADC12_A_disableSamplingTimer()

- ADC12_A_startConversion()
- ADC12_A_disableConversions()
- ADC12_A_readResults()
- ADC12_A_isBusy()

The ADC12_A interrupts are handled by

- ADC12_A_enableInterrupt()
- ADC12_A_disableInterrupt()
- ADC12_A_clearInterrupt()
- ADC12_A_getInterruptStatus()

Auxiliary features of the ADC12_A are handled by

- ADC12_A_setResolution()
- ADC12_A_setSampleHoldSignalInversion()
- ADC12_A_setDataReadBackFormat()
- ADC12_A_enableReferenceBurst()
- ADC12_A_disableReferenceBurst()
- ADC12_A_setReferenceBufferSamplingRate()
- ADC12_A_getMemoryAddressForDMA()
- ADC12_A_enable()
- ADC12_A_disable()

8.2.2 Function Documentation

ADC12_A_clearInterrupt()

```
void ADC12_A_clearInterrupt (
            uint16_t baseAddress,
            uint16_t memoryInterruptFlagMask )
```

Clears ADC12_A selected interrupt flags.

The selected ADC12_A interrupt flags are cleared, so that it no longer asserts. The memory buffer interrupt flags are only cleared when the memory buffer is accessed. Note that the overflow interrupts do not have an interrupt flag to clear; they must be accessed directly from the interrupt vector.

Parameters

baseAddress	is the base address of the ADC12_A module.

Parameters

memoryInterruptFlagMask	is a bit mask of the interrupt flags to be cleared. Mask value is the logical OR of any of the following: ■ **ADC12_A_IFG0** ■ **ADC12_A_IFG1** ■ **ADC12_A_IFG2** ■ **ADC12_A_IFG3** ■ **ADC12_A_IFG4** ■ **ADC12_A_IFG5** ■ **ADC12_A_IFG6** ■ **ADC12_A_IFG7** ■ **ADC12_A_IFG8** ■ **ADC12_A_IFG9** ■ **ADC12_A_IFG10** ■ **ADC12_A_IFG11** ■ **ADC12_A_IFG12** ■ **ADC12_A_IFG13** ■ **ADC12_A_IFG14** ■ **ADC12_A_IFG15**

Modified bits of **ADC12IFG** register.

Returns

None

ADC12_A_configureMemory()

```
void ADC12_A_configureMemory (
            uint16_t baseAddress,
            ADC12_A_configureMemoryParam * param )
```

Configures the controls of the selected memory buffer.

Maps an input signal conversion into the selected memory buffer, as well as the positive and negative reference voltages for each conversion being stored into this memory buffer. If the internal reference is used for the positive reference voltage, the internal REF module must be used to control the voltage level. Note that if a conversion has been started with the startConversion() function, then a call to disableConversions() is required before this function may be called. If conversion is not disabled, this function does nothing.

Parameters

baseAddress	is the base address of the ADC12_A module.
param	is the pointer to struct for memory configuration.

Returns

None

References ADC12_A_configureMemoryParam::endOfSequence,
ADC12_A_configureMemoryParam::inputSourceSelect,
ADC12_A_configureMemoryParam::memoryBufferControlIndex,
ADC12_A_configureMemoryParam::negativeRefVoltageSourceSelect, and
ADC12_A_configureMemoryParam::positiveRefVoltageSourceSelect.

ADC12_A_disable()

```
void ADC12_A_disable (
            uint16_t baseAddress )
```

Disables the ADC12_A block.

This will disable operation of the ADC12_A block.

Parameters

baseAddress	is the base address of the ADC12_A module.

Modified bits are **ADC12ON** of **ADC12CTL0** register.

Returns

None

ADC12_A_disableConversions()

```
void ADC12_A_disableConversions (
            uint16_t baseAddress,
            bool preempt )
```

Disables the ADC from converting any more signals.

Disables the ADC from converting any more signals. If there is a conversion in progress, this function can stop it immediately if the preempt parameter is set as TRUE, by changing the conversion mode to single-channel, single- conversion and disabling conversions. If the conversion mode is set as single-channel, single-conversion and this function is called without preemption, then the ADC core conversion status is polled until the conversion is complete before disabling conversions to prevent unpredictable data. If the ADC12_A_startConversion() has been called, then this function has to be called to re-initialize the ADC, reconfigure a memory buffer control, enable/disable the sampling pulse mode, or change the internal reference voltage.

Parameters

baseAddress	is the base address of the ADC12_A module.

Parameters

preempt	specifies if the current conversion should be pre-empted before the end of the conversion. Valid values are: ■ **ADC12_A_COMPLETECONVERSION** - Allows the ADC12_A to end the current conversion before disabling conversions. ■ **ADC12_A_PREEMPTCONVERSION** - Stops the ADC12_A immediately, with unpredictable results of the current conversion.

Modified bits of **ADC12CTL1** register and bits of **ADC12CTL0** register.

Returns

None

References ADC12_A_isBusy().

ADC12_A_disableInterrupt()

```
void ADC12_A_disableInterrupt (
            uint16_t baseAddress,
            uint32_t interruptMask )
```

Disables selected ADC12_A interrupt sources.

Disables the indicated ADC12_A 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 ADC12_A module.

Parameters

interruptMask	Mask value is the logical OR of any of the following: ■ **ADC12_A_IE0** ■ **ADC12_A_IE1** ■ **ADC12_A_IE2** ■ **ADC12_A_IE3** ■ **ADC12_A_IE4** ■ **ADC12_A_IE5** ■ **ADC12_A_IE6** ■ **ADC12_A_IE7** ■ **ADC12_A_IE8** ■ **ADC12_A_IE9** ■ **ADC12_A_IE10** ■ **ADC12_A_IE11** ■ **ADC12_A_IE12** ■ **ADC12_A_IE13** ■ **ADC12_A_IE14** ■ **ADC12_A_IE15** ■ **ADC12_A_OVERFLOW_IE** ■ **ADC12_A_CONVERSION_TIME_OVERFLOW_IE**

Modified bits of **ADC12IE** register and bits of **ADC12CTL0** register.

Returns

None

ADC12_A_disableReferenceBurst()

```
void ADC12_A_disableReferenceBurst (
            uint16_t baseAddress )
```

Disables the reference buffer's burst ability.

Disables the reference buffer's burst ability, forcing the reference buffer to remain on continuously.

Parameters

baseAddress	is the base address of the ADC12_A module.

Returns

None

ADC12_A_disableSamplingTimer()

```
void ADC12_A_disableSamplingTimer (
            uint16_t baseAddress )
```

Disables Sampling Timer Pulse Mode.

Disables the Sampling Timer Pulse Mode. Note that if a conversion has been started with the startConversion() function, then a call to disableConversions() is required before this function may be called.

Parameters

baseAddress	is the base address of the ADC12_A module.

Modified bits are **ADC12SHP** of **ADC12CTL0** register.

Returns

None

ADC12_A_enable()

```
void ADC12_A_enable (
            uint16_t baseAddress )
```

Enables the ADC12_A block.

This will enable operation of the ADC12_A block.

Parameters

baseAddress	is the base address of the ADC12_A module.

Modified bits are **ADC12ON** of **ADC12CTL0** register.

Returns

None

ADC12_A_enableInterrupt()

```
void ADC12_A_enableInterrupt (
            uint16_t baseAddress,
            uint32_t interruptMask )
```

Enables selected ADC12_A interrupt sources.

Enables the indicated ADC12_A 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 ADC12_A module.
interruptMask	Mask value is the logical OR of any of the following: ■ **ADC12_A_IE0** ■ **ADC12_A_IE1** ■ **ADC12_A_IE2** ■ **ADC12_A_IE3** ■ **ADC12_A_IE4** ■ **ADC12_A_IE5** ■ **ADC12_A_IE6** ■ **ADC12_A_IE7** ■ **ADC12_A_IE8** ■ **ADC12_A_IE9** ■ **ADC12_A_IE10** ■ **ADC12_A_IE11** ■ **ADC12_A_IE12** ■ **ADC12_A_IE13** ■ **ADC12_A_IE14** ■ **ADC12_A_IE15** ■ **ADC12_A_OVERFLOW_IE** ■ **ADC12_A_CONVERSION_TIME_OVERFLOW_IE**

Modified bits of **ADC12IE** register and bits of **ADC12CTL0** register.

Returns

None

ADC12_A_enableReferenceBurst()

```
void ADC12_A_enableReferenceBurst (
            uint16_t baseAddress )
```

Enables the reference buffer's burst ability.

Enables the reference buffer's burst ability, allowing the reference buffer to turn off while the ADC is not converting, and automatically turning on when the ADC needs the generated reference voltage for a conversion.

Parameters

baseAddress	is the base address of the ADC12_A module.

Returns

None

ADC12_A_getInterruptStatus()

```
uint16_t ADC12_A_getInterruptStatus (
            uint16_t baseAddress,
            uint16_t memoryInterruptFlagMask )
```

Returns the status of the selected memory interrupt flags.

Returns the status of the selected memory interrupt flags. Note that the overflow interrupts do not have an interrupt flag to clear; they must be accessed directly from the interrupt vector.

Parameters

baseAddress	is the base address of the ADC12_A module.
memoryInterruptFlagMask	is a bit mask of the interrupt flags status to be returned. Mask value is the logical OR of any of the following: ■ **ADC12_A_IFG0** ■ **ADC12_A_IFG1** ■ **ADC12_A_IFG2** ■ **ADC12_A_IFG3** ■ **ADC12_A_IFG4** ■ **ADC12_A_IFG5** ■ **ADC12_A_IFG6** ■ **ADC12_A_IFG7** ■ **ADC12_A_IFG8** ■ **ADC12_A_IFG9** ■ **ADC12_A_IFG10** ■ **ADC12_A_IFG11** ■ **ADC12_A_IFG12** ■ **ADC12_A_IFG13** ■ **ADC12_A_IFG14** ■ **ADC12_A_IFG15**

Returns

The current interrupt flag status for the corresponding mask.

ADC12_A_getMemoryAddressForDMA()

```
uint32_t ADC12_A_getMemoryAddressForDMA (
            uint16_t baseAddress,
```

```
uint8_t memoryIndex )
```

Returns the address of the specified memory buffer for the DMA module.

Returns the address of the specified memory buffer. This can be used in conjunction with the DMA to store the converted data directly to memory.

Parameters

baseAddress	is the base address of the ADC12_A module.
memoryIndex	is the memory buffer to return the address of. Valid values are: ■ **ADC12_A_MEMORY_0** [Default] ■ **ADC12_A_MEMORY_1** ■ **ADC12_A_MEMORY_2** ■ **ADC12_A_MEMORY_3** ■ **ADC12_A_MEMORY_4** ■ **ADC12_A_MEMORY_5** ■ **ADC12_A_MEMORY_6** ■ **ADC12_A_MEMORY_7** ■ **ADC12_A_MEMORY_8** ■ **ADC12_A_MEMORY_9** ■ **ADC12_A_MEMORY_10** ■ **ADC12_A_MEMORY_11** ■ **ADC12_A_MEMORY_12** ■ **ADC12_A_MEMORY_13** ■ **ADC12_A_MEMORY_14** ■ **ADC12_A_MEMORY_15**

Returns

address of the specified memory buffer

ADC12_A_getResults()

```
uint16_t ADC12_A_getResults (
            uint16_t baseAddress,
            uint8_t memoryBufferIndex )
```

A Signed Integer of the contents of the specified memory buffer.

Returns the raw contents of the specified memory buffer. The format of the content depends on the read-back format of the data: if the data is in signed 2's complement format then the contents in the memory buffer will be left-justified with the least-significant bits as 0's, whereas if the data is in unsigned format then the contents in the memory buffer will be right- justified with the most-significant bits as 0's.

Parameters

baseAddress	is the base address of the ADC12_A module.
memoryBufferIndex	is the specified Memory Buffer to read. Valid values are: ■ **ADC12_A_MEMORY_0** [Default] ■ **ADC12_A_MEMORY_1** ■ **ADC12_A_MEMORY_2** ■ **ADC12_A_MEMORY_3** ■ **ADC12_A_MEMORY_4** ■ **ADC12_A_MEMORY_5** ■ **ADC12_A_MEMORY_6** ■ **ADC12_A_MEMORY_7** ■ **ADC12_A_MEMORY_8** ■ **ADC12_A_MEMORY_9** ■ **ADC12_A_MEMORY_10** ■ **ADC12_A_MEMORY_11** ■ **ADC12_A_MEMORY_12** ■ **ADC12_A_MEMORY_13** ■ **ADC12_A_MEMORY_14** ■ **ADC12_A_MEMORY_15**

Returns

A signed integer of the contents of the specified memory buffer

ADC12_A_init()

```
bool ADC12_A_init (
            uint16_t baseAddress,
            uint16_t sampleHoldSignalSourceSelect,
            uint8_t clockSourceSelect,
            uint16_t clockSourceDivider )
```

Initializes the ADC12_A Module.

This function initializes the ADC module to allow for analog-to-digital conversions. Specifically this function sets up the sample-and-hold signal and clock sources for the ADC core to use for conversions. Upon successful completion of the initialization all of the ADC control registers will be reset, excluding the memory controls and reference module bits, the given parameters will be set, and the ADC core will be turned on (Note, that the ADC core only draws power during conversions and remains off when not converting).Note that sample/hold signal sources are device dependent. Note that if re-initializing the ADC after starting a conversion with the startConversion() function, the disableConversion() must be called BEFORE this function can be called.

Parameters

baseAddress	is the base address of the ADC12_A module.
sampleHoldSignalSourceSelect	is the signal that will trigger a sample-and-hold for an input signal to be converted. This parameter is device specific and sources should be found in the device's datasheet. Valid values are: ■ **ADC12_A_SAMPLEHOLDSOURCE_SC** [Default] ■ **ADC12_A_SAMPLEHOLDSOURCE_1** ■ **ADC12_A_SAMPLEHOLDSOURCE_2** ■ **ADC12_A_SAMPLEHOLDSOURCE_3** - This parameter is device specific and sources should be found in the device's datasheet. Modified bits are **ADC12SHSx** of **ADC12CTL1** register.
clockSourceSelect	selects the clock that will be used by the ADC12_A core, and the sampling timer if a sampling pulse mode is enabled. Valid values are: ■ **ADC12_A_CLOCKSOURCE_ADC12OSC** [Default] - MODOSC 5 MHz oscillator from the UCS ■ **ADC12_A_CLOCKSOURCE_ACLK** - The Auxiliary Clock ■ **ADC12_A_CLOCKSOURCE_MCLK** - The Master Clock ■ **ADC12_A_CLOCKSOURCE_SMCLK** - The Sub-Master Clock Modified bits are **ADC12SSELx** of **ADC12CTL1** register.

Parameters

clockSourceDivider	selects the amount that the clock will be divided. Valid values are: ■ **ADC12_A_CLOCKDIVIDER_1** [Default] ■ **ADC12_A_CLOCKDIVIDER_2** ■ **ADC12_A_CLOCKDIVIDER_3** ■ **ADC12_A_CLOCKDIVIDER_4** ■ **ADC12_A_CLOCKDIVIDER_5** ■ **ADC12_A_CLOCKDIVIDER_6** ■ **ADC12_A_CLOCKDIVIDER_7** ■ **ADC12_A_CLOCKDIVIDER_8** ■ **ADC12_A_CLOCKDIVIDER_12** ■ **ADC12_A_CLOCKDIVIDER_16** ■ **ADC12_A_CLOCKDIVIDER_20** ■ **ADC12_A_CLOCKDIVIDER_24** ■ **ADC12_A_CLOCKDIVIDER_28** ■ **ADC12_A_CLOCKDIVIDER_32** Modified bits are **ADC12PDIV** of **ADC12CTL2** register; bits **ADC12DIVx** of **ADC12CTL1** register.

Returns

STATUS_SUCCESS or STATUS_FAILURE of the initialization process.

ADC12_A_isBusy()

```
uint16_t ADC12_A_isBusy (
            uint16_t baseAddress )
```

Returns the busy status of the ADC12_A core.

Returns the status of the ADC core if there is a conversion currently taking place.

Parameters

baseAddress	is the base address of the ADC12_A module.

Returns

One of the following:

- **ADC12_A_NOTBUSY**
- **ADC12_A_BUSY**
  indicating if a conversion is taking place

Referenced by ADC12_A_disableConversions().

ADC12_A_setDataReadBackFormat()

```
void ADC12_A_setDataReadBackFormat (
            uint16_t baseAddress,
            uint8_t readBackFormat )
```

Use to set the read-back format of the converted data.

Sets the format of the converted data: how it will be stored into the memory buffer, and how it should be read back. The format can be set as right-justified (default), which indicates that the number will be unsigned, or left-justified, which indicates that the number will be signed in 2's complement format. This change affects all memory buffers for subsequent conversions.

Parameters

baseAddress	is the base address of the ADC12_A module.
readBackFormat	is the specified format to store the conversions in the memory buffer. Valid values are: ■ **ADC12_A_UNSIGNED_BINARY** [Default] ■ **ADC12_A_SIGNED_2SCOMPLEMENT** Modified bits are **ADC12DF** of **ADC12CTL2** register.

Returns

None

ADC12_A_setReferenceBufferSamplingRate()

```
void ADC12_A_setReferenceBufferSamplingRate (
            uint16_t baseAddress,
            uint8_t samplingRateSelect )
```

Use to set the reference buffer's sampling rate.

Sets the reference buffer's sampling rate to the selected sampling rate. The default sampling rate is maximum of 200-ksps, and can be reduced to a maximum of 50-ksps to conserve power.

Parameters

baseAddress	is the base address of the ADC12_A module.
samplingRateSelect	is the specified maximum sampling rate. Valid values are: ■ **ADC12_A_MAXSAMPLINGRATE_200KSPS** [Default] ■ **ADC12_A_MAXSAMPLINGRATE_50KSPS** Modified bits are **ADC12SR** of **ADC12CTL2** register.

Returns

None

ADC12_A_setResolution()

```
void ADC12_A_setResolution (
            uint16_t baseAddress,
            uint8_t resolutionSelect )
```

Use to change the resolution of the converted data.

This function can be used to change the resolution of the converted data from the default of 12-bits.

Parameters

baseAddress	is the base address of the ADC12_A module.
resolutionSelect	determines the resolution of the converted data. Valid values are: ■ **ADC12_A_RESOLUTION_8BIT** ■ **ADC12_A_RESOLUTION_10BIT** ■ **ADC12_A_RESOLUTION_12BIT** [Default] Modified bits are **ADC12RESx** of **ADC12CTL2** register.

Returns

None

ADC12_A_setSampleHoldSignalInversion()

```
void ADC12_A_setSampleHoldSignalInversion (
            uint16_t baseAddress,
            uint16_t invertedSignal )
```

Use to invert or un-invert the sample/hold signal.

This function can be used to invert or un-invert the sample/hold signal. Note that if a conversion has been started with the startConversion() function, then a call to disableConversions() is required before this function may be called.

Parameters

baseAddress	is the base address of the ADC12_A module.
invertedSignal	set if the sample/hold signal should be inverted Valid values are: ■ **ADC12_A_NONINVERTEDSIGNAL** [Default] - a sample-and-hold of an input signal for conversion will be started on a rising edge of the sample/hold signal. ■ **ADC12_A_INVERTEDSIGNAL** - a sample-and-hold of an input signal for conversion will be started on a falling edge of the sample/hold signal. Modified bits are **ADC12ISSH** of **ADC12CTL1** register.

Returns

None

ADC12_A_setupSamplingTimer()

```
void ADC12_A_setupSamplingTimer (
            uint16_t baseAddress,
            uint16_t clockCycleHoldCountLowMem,
            uint16_t clockCycleHoldCountHighMem,
            uint16_t multipleSamplesEnabled )
```

Sets up and enables the Sampling Timer Pulse Mode.

This function sets up the sampling timer pulse mode which allows the sample/hold signal to trigger a sampling timer to sample-and-hold an input signal for a specified number of clock cycles without having to hold the sample/hold signal for the entire period of sampling. Note that if a conversion has been started with the startConversion() function, then a call to disableConversions() is required before this function may be called.

Parameters

baseAddress	is the base address of the ADC12_A module.
clockCycleHoldCountLowMem	sets the amount of clock cycles to sample- and-hold for the higher memory buffers 0-7. Valid values are: ■ **ADC12_A_CYCLEHOLD_4_CYCLES** [Default] ■ **ADC12_A_CYCLEHOLD_8_CYCLES** ■ **ADC12_A_CYCLEHOLD_16_CYCLES** ■ **ADC12_A_CYCLEHOLD_32_CYCLES** ■ **ADC12_A_CYCLEHOLD_64_CYCLES** ■ **ADC12_A_CYCLEHOLD_96_CYCLES** ■ **ADC12_A_CYCLEHOLD_128_CYCLES** ■ **ADC12_A_CYCLEHOLD_192_CYCLES** ■ **ADC12_A_CYCLEHOLD_256_CYCLES** ■ **ADC12_A_CYCLEHOLD_384_CYCLES** ■ **ADC12_A_CYCLEHOLD_512_CYCLES** ■ **ADC12_A_CYCLEHOLD_768_CYCLES** ■ **ADC12_A_CYCLEHOLD_1024_CYCLES** Modified bits are **ADC12SHT0x** of **ADC12CTL0** register.

Parameters

clockCycleHoldCountHighMem	sets the amount of clock cycles to sample-and-hold for the higher memory buffers 8-15. Valid values are: ■ **ADC12_A_CYCLEHOLD_4_CYCLES** [Default] ■ **ADC12_A_CYCLEHOLD_8_CYCLES** ■ **ADC12_A_CYCLEHOLD_16_CYCLES** ■ **ADC12_A_CYCLEHOLD_32_CYCLES** ■ **ADC12_A_CYCLEHOLD_64_CYCLES** ■ **ADC12_A_CYCLEHOLD_96_CYCLES** ■ **ADC12_A_CYCLEHOLD_128_CYCLES** ■ **ADC12_A_CYCLEHOLD_192_CYCLES** ■ **ADC12_A_CYCLEHOLD_256_CYCLES** ■ **ADC12_A_CYCLEHOLD_384_CYCLES** ■ **ADC12_A_CYCLEHOLD_512_CYCLES** ■ **ADC12_A_CYCLEHOLD_768_CYCLES** ■ **ADC12_A_CYCLEHOLD_1024_CYCLES** Modified bits are **ADC12SHT1x** of **ADC12CTL0** register.
multipleSamplesEnabled	allows multiple conversions to start without a trigger signal from the sample/hold signal Valid values are: ■ **ADC12_A_MULTIPLESAMPLESDISABLE** [Default] - a timer trigger will be needed to start every ADC conversion. ■ **ADC12_A_MULTIPLESAMPLESENABLE** - during a sequenced and/or repeated conversion mode, after the first conversion, no sample/hold signal is necessary to start subsequent sample/hold and convert processes. Modified bits are **ADC12MSC** of **ADC12CTL0** register.

Returns

None

ADC12_A_startConversion()

```
void ADC12_A_startConversion (
            uint16_t baseAddress,
            uint16_t startingMemoryBufferIndex,
            uint8_t conversionSequenceModeSelect )
```

Enables/Starts an Analog-to-Digital Conversion.

This function enables/starts the conversion process of the ADC. If the sample/hold signal source chosen during initialization was ADC12OSC, then the conversion is started immediately, otherwise the chosen sample/hold signal source starts the conversion by a rising edge of the signal. Keep in mind when selecting conversion modes, that for sequenced and/or repeated modes, to keep the sample/hold-and-convert process continuing without a trigger from the sample/hold signal source, the multiple samples must be enabled using the ADC12_A_setupSamplingTimer() function. Note that after this function is called, the ADC12_A_disableConversions() has to be called to re-initialize the ADC, reconfigure a memory buffer control, enable/disable the sampling timer, or to change the internal reference voltage.

Parameters

baseAddress	is the base address of the ADC12_A module.
startingMemoryBufferIndex	is the memory buffer that will hold the first or only conversion. Valid values are: ■ **ADC12_A_MEMORY_0** [Default] ■ **ADC12_A_MEMORY_1** ■ **ADC12_A_MEMORY_2** ■ **ADC12_A_MEMORY_3** ■ **ADC12_A_MEMORY_4** ■ **ADC12_A_MEMORY_5** ■ **ADC12_A_MEMORY_6** ■ **ADC12_A_MEMORY_7** ■ **ADC12_A_MEMORY_8** ■ **ADC12_A_MEMORY_9** ■ **ADC12_A_MEMORY_10** ■ **ADC12_A_MEMORY_11** ■ **ADC12_A_MEMORY_12** ■ **ADC12_A_MEMORY_13** ■ **ADC12_A_MEMORY_14** ■ **ADC12_A_MEMORY_15** Modified bits are **ADC12STARTADDx** of **ADC12CTL1** register.

Parameters

conversionSequenceModeSelect	determines the ADC operating mode. Valid values are: ■ **ADC12_A_SINGLECHANNEL** [Default] - one-time conversion of a single channel into a single memory buffer. ■ **ADC12_A_SEQOFCHANNELS** - one time conversion of multiple channels into the specified starting memory buffer and each subsequent memory buffer up until the conversion is stored in a memory buffer dedicated as the end-of-sequence by the memory's control register. ■ **ADC12_A_REPEATED_SINGLECHANNEL** - repeated conversions of one channel into a single memory buffer. ■ **ADC12_A_REPEATED_SEQOFCHANNELS** - repeated conversions of multiple channels into the specified starting memory buffer and each subsequent memory buffer up until the conversion is stored in a memory buffer dedicated as the end-of-sequence by the memory's control register. Modified bits are **ADC12CONSEQx** of **ADC12CTL1** register.

Modified bits of **ADC12CTL1** register and bits of **ADC12CTL0** register.

Returns

None

8.3 Programming Example

The following example shows how to initialize and use the ADC12 API to start a single channel, single conversion.

```
// Initialize ADC12 with ADC12's built-in oscillator
ADC12_A_init (ADC12_A_BASE,
            ADC12_A_SAMPLEHOLDSOURCE_SC,
            ADC12_A_CLOCKSOURCE_ADC12OSC,
            ADC12_A_CLOCKDIVIDEBY_1);

//Switch ON ADC12
ADC12_A_enable(ADC12_A_BASE);

// Setup sampling timer to sample-and-hold for 16 clock cycles
ADC12_A_setupSamplingTimer (ADC12_A_BASE,
                           ADC12_A_CYCLEHOLD_64_CYCLES,
                           ADC12_A_CYCLEHOLD_4_CYCLES,
                           FALSE);

// Configure the Input to the Memory Buffer with the specified Reference Voltages
ADC12_A_configureMemoryParam param = {0};
param.memoryBufferControlIndex = ADC12_A_MEMORY_0;
param.inputSourceSelect = ADC12_A_INPUT_A0;
param.positiveRefVoltageSourceSelect = ADC12_A_VREFPOS_AVCC;
param.negativeRefVoltageSourceSelect = ADC12_A_VREFNEG_AVSS;
```

```
param.endOfSequence = ADC12_A_NOTENDOFSEQUENCE;
ADC12_A_configureMemory(ADC12_A_BASE ,&param);
while (1)
{
    // Start a single conversion, no repeating or sequences.
    ADC12_A_startConversion (ADC12_A_BASE,
                            ADC12_A_MEMORY_0,
                            ADC12_A_SINGLECHANNEL);

    // Wait for the Interrupt Flag to assert
    while( !(ADC12_A_getInterruptStatus(ADC12_A_BASE,ADC12IFG0)) );

    // Clear the Interrupt Flag and start another conversion
    ADC12_A_clearInterrupt(ADC12_A_BASE,ADC12IFG0);
}
```

9 Advanced Encryption Standard (AES)

9.1 Introduction

The AES accelerator module performs encryption and decryption of 128-bit data with 128-bit keys according to the advanced encryption standard (AES) (FIPS PUB 197) in hardware. The AES accelerator features are:

- Encryption and decryption according to AES FIPS PUB 197 with 128-bit key
- On-the-fly key expansion for encryption and decryption
- Off-line key generation for decryption
- Byte and word access to key, input, and output data
- AES ready interrupt flag The AES256 accelerator module performs encryption and decryption of 128-bit data with 128-/192-/256-bit keys according to the advanced encryption standard (AES) (FIPS PUB 197) in hardware. The AES accelerator features are: AES encryption 128 bit - 168 cycles 192 bit - 204 cycles 256 bit - 234 cycles AES decryption 128 bit - 168 cycles 192 bit - 206 cycles 256 bit - 234 cycles
- On-the-fly key expansion for encryption and decryption
- Offline key generation for decryption
- Shadow register storing the initial key for all key lengths
- Byte and word access to key, input data, and output data
- AES ready interrupt flag

9.2 API Functions

Functions

- uint8_t AES_setCipherKey (uint16_t baseAddress, const uint8_t ∗CipherKey)
  Loads a 128 bit cipher key to AES module.
- uint8_t AES_encryptData (uint16_t baseAddress, const uint8_t ∗Data, uint8_t ∗encryptedData)
  Encrypts a block of data using the AES module.
- uint8_t AES_decryptData (uint16_t baseAddress, const uint8_t ∗Data, uint8_t ∗decryptedData)
  Decrypts a block of data using the AES module.
- uint8_t AES_setDecipherKey (uint16_t baseAddress, const uint8_t ∗CipherKey)
  Sets the decipher key The API.
- void AES_clearInterrupt (uint16_t baseAddress)
  Clears the AES ready interrupt flag.
- uint32_t AES_getInterruptStatus (uint16_t baseAddress)

Gets the AES ready interrupt flag status.
- void AES_enableInterrupt (uint16_t baseAddress)
  Enables AES ready interrupt.
- void AES_disableInterrupt (uint16_t baseAddress)
  Disables AES ready interrupt.
- void AES_reset (uint16_t baseAddress)
  Resets AES Module immediately.
- uint8_t AES_startEncryptData (uint16_t baseAddress, const uint8_t ∗Data, uint8_t ∗encryptedData)
  Starts an encryption process on the AES module.
- uint8_t AES_startDecryptData (uint16_t baseAddress, const uint8_t ∗Data)
  Decrypts a block of data using the AES module.
- uint8_t AES_startSetDecipherKey (uint16_t baseAddress, const uint8_t ∗CipherKey)
  Loads the decipher key.
- uint8_t AES_getDataOut (uint16_t baseAddress, uint8_t ∗OutputData)
  Reads back the output data from AES module.
- uint8_t AES_isBusy (uint16_t baseAddress)
  Gets the AES module busy status.
- void AES_clearErrorFlag (uint16_t baseAddress)
  Clears the AES error flag.
- uint32_t AES_getErrorFlagStatus (uint16_t baseAddress)
  Gets the AES error flag status.
- uint8_t AES_startDecryptDataUsingEncryptionKey (uint16_t baseAddress, const uint8_t ∗Data)
  DEPRECATED Starts an decryption process on the AES module.
- uint8_t AES_decryptDataUsingEncryptionKey (uint16_t baseAddress, const uint8_t ∗Data, uint8_t ∗decryptedData)
  DEPRECATED Decrypts a block of data using the AES module.

9.2.1 Detailed Description

The AES module APIs are

- AES_setCipherKey()
- AES_encryptData()
- AES_decryptDataUsingEncryptionKey()
- AES_setDecipherKey()
- AES_decryptData()
- AES_reset()
- AES_startEncryptData()
- AES_startDecryptDataUsingEncryptionKey()
- AES_startDecryptData()
- AES_startSetDecipherKey()
- AES_getDataOut()

The AES interrupt handler functions

- AES_enableInterrupt()
- AES_disableInterrupt()
- AES_clearInterrupt()
- AES_getInterruptStatus

9.2.2 Function Documentation

AES_clearErrorFlag()

```
void AES_clearErrorFlag (
            uint16_t baseAddress )
```

Clears the AES error flag.

Clears the AES error flag that results from a key or data being written while the AES module is busy. Modified bit is AESERRFG of AESACTL0 register.

Parameters

baseAddress	is the base address of the AES module.

Modified bits are **AESERRFG** of **AESACTL0** register.

Returns

None

AES_clearInterrupt()

```
void AES_clearInterrupt (
            uint16_t baseAddress )
```

Clears the AES ready interrupt flag.

This function clears the AES ready interrupt flag. This flag is automatically cleared when AESADOUT is read, or when AESAKEY or AESADIN is written. This function should be used when the flag needs to be reset and it has not been automatically cleared by one of the previous actions.

Parameters

baseAddress	is the base address of the AES module.

Modified bits are **AESRDYIFG** of **AESACTL0** register.

Returns

None

AES_decryptData()

```
uint8_t AES_decryptData (
            uint16_t baseAddress,
            const uint8_t * Data,
            uint8_t * decryptedData )
```

Decrypts a block of data using the AES module.

This function requires a pre-generated decryption key. A key can be loaded and pre-generated by using function **AES_startSetDecipherKey()** or **AES_setDecipherKey()**. The decryption takes 167 MCLK.

Parameters

baseAddress	is the base address of the AES module.
Data	is a pointer to an uint8_t array with a length of 16 bytes that contains encrypted data to be decrypted.
decryptedData	is a pointer to an uint8_t array with a length of 16 bytes in that the decrypted data will be written.

Returns

STATUS_SUCCESS

AES_decryptDataUsingEncryptionKey()

```
uint8_t AES_decryptDataUsingEncryptionKey (
            uint16_t baseAddress,
            const uint8_t * Data,
            uint8_t * decryptedData )
```

DEPRECATED Decrypts a block of data using the AES module.

This function can be used to decrypt data by using the same key as used for a previous performed encryption. The decryption takes 214 MCLK.

Parameters

baseAddress	is the base address of the AES module.
Data	is a pointer to an uint8_t array with a length of 16 bytes that contains encrypted data to be decrypted.
decryptedData	is a pointer to an uint8_t array with a length of 16 bytes in that the decrypted data will be written.

Returns

STATUS_SUCCESS

AES_disableInterrupt()

```
void AES_disableInterrupt (
            uint16_t baseAddress )
```

Disables AES ready interrupt.

Disables AES ready interrupt. This interrupt is reset by a PUC, but not reset by AES_reset.

Parameters

baseAddress	is the base address of the AES module.

Modified bits are **AESRDYIE** of **AESACTL0** register.

Returns

None

AES_enableInterrupt()

```
void AES_enableInterrupt (
            uint16_t baseAddress )
```

Enables AES ready interrupt.

Enables AES ready interrupt. This interrupt is reset by a PUC, but not reset by AES_reset. Does not clear interrupt flags.

Parameters

baseAddress	is the base address of the AES module.

Modified bits are **AESRDYIE** of **AESACTL0** register.

Returns

None

AES_encryptData()

```
uint8_t AES_encryptData (
            uint16_t baseAddress,
            const uint8_t * Data,
            uint8_t * encryptedData )
```

Encrypts a block of data using the AES module.

The cipher key that is used for encryption should be loaded in advance by using function **AES_setCipherKey()**

Parameters

baseAddress	is the base address of the AES module.
Data	is a pointer to an uint8_t array with a length of 16 bytes that contains data to be encrypted.
encryptedData	is a pointer to an uint8_t array with a length of 16 bytes in that the encrypted data will be written.

Returns

STATUS_SUCCESS

AES_getDataOut()

```
uint8_t AES_getDataOut (
            uint16_t baseAddress,
            uint8_t * OutputData )
```

Reads back the output data from AES module.

This function is meant to use after an encryption or decryption process that was started and finished by initiating an interrupt by use of the **AES_startEncryptData()** or **AES_startDecryptData()** functions.

Parameters

baseAddress	is the base address of the AES module.
OutputData	is a pointer to an uint8_t array with a length of 16 bytes in which the output data of the AES module is available. If AES module is busy returns NULL.

Returns

STATUS_SUCCESS if AES is not busy, STATUS_FAIL if it is busy

AES_getErrorFlagStatus()

```
uint32_t AES_getErrorFlagStatus (
            uint16_t baseAddress )
```

Gets the AES error flag status.

Checks the AES error flag that results from a key or data being written while the AES module is busy. If the flag is set, it needs to be cleared using AES_clearErrorFlag.

Parameters

baseAddress	is the base address of the AES module.

Returns

One of the following:

- **AES_ERROR_OCCURRED**
- **AES_NO_ERROR**
  indicating if AESAKEY or AESADIN were written while an AES operation was in progress

AES_getInterruptStatus()

```
uint32_t AES_getInterruptStatus (
            uint16_t baseAddress )
```

Gets the AES ready interrupt flag status.

This function checks the AES ready interrupt flag. This flag is automatically cleared when AESADOUT is read, or when AESAKEY or AESADIN is written. This function can be used to confirm that this has been done.

Parameters

baseAddress	is the base address of the AES module.

Returns

uint32_t - AES_READY_INTERRUPT or 0x00.

AES_isBusy()

```
uint8_t AES_isBusy (
            uint16_t baseAddress )
```

Gets the AES module busy status.

Gets the AES module busy status. If a key or data are written while the AES module is busy, an error flag will be thrown.

Parameters

baseAddress	is the base address of the AES module.

Returns

One of the following:
- **AES_BUSY**
- **AES_NOT_BUSY**
indicating if encryption/decryption/key generation is taking place

AES_reset()

```
void AES_reset (
            uint16_t baseAddress )
```

Resets AES Module immediately.

This function performs a software reset on the AES Module, note that this does not affect the AES ready interrupt.

Parameters

baseAddress	is the base address of the AES module.

Modified bits are **AESSWRST** of **AESACTL0** register.

Returns

None

AES_setCipherKey()

```
uint8_t AES_setCipherKey (
            uint16_t baseAddress,
            const uint8_t * CipherKey )
```

Loads a 128 bit cipher key to AES module.

This function loads a 128 bit cipher key to AES module.

Parameters

baseAddress	is the base address of the AES module.
CipherKey	is a pointer to an uint8_t array with a length of 16 bytes that contains a 128 bit cipher key.

Returns

STATUS_SUCCESS

AES_setDecipherKey()

```
uint8_t AES_setDecipherKey (
```

```
uint16_t baseAddress,
const uint8_t * CipherKey )
```

Sets the decipher key The API.

The API **AES_startSetDecipherKey()** or **AES_setDecipherKey()** must be invoked before invoking **AES_setDecipherKey()**.

Parameters

baseAddress	is the base address of the AES module.
CipherKey	is a pointer to an uint8_t array with a length of 16 bytes that contains the initial AES key.

Returns

STATUS_SUCCESS

AES_startDecryptData()

```
uint8_t AES_startDecryptData (
            uint16_t baseAddress,
            const uint8_t * Data )
```

Decrypts a block of data using the AES module.

This is the non-blocking equivalent of AES_decryptData(). This function requires a pre-generated decryption key. A key can be loaded and pre- generated by using function **AES_setDecipherKey()** or **AES_startSetDecipherKey()**. The decryption takes 167 MCLK. It is recommended to use interrupt to check for procedure completion then using AES_getDataOut() API to retrieve the decrypted data.

Parameters

baseAddress	is the base address of the AES module.
Data	is a pointer to an uint8_t array with a length of 16 bytes that contains encrypted data to be decrypted.

Returns

STATUS_SUCCESS

AES_startDecryptDataUsingEncryptionKey()

```
uint8_t AES_startDecryptDataUsingEncryptionKey (
            uint16_t baseAddress,
            const uint8_t * Data )
```

DEPRECATED Starts an decryption process on the AES module.

This is the non-blocking equivalent of AES_decryptDataUsingEncryptionKey(). This function can be used to decrypt data by using the same key as used for a previous performed encryption. The decryption takes 214 MCLK.

Parameters

baseAddress	is the base address of the AES module.
Data	is a pointer to an uint8_t array with a length of 16 bytes that contains encrypted data to be decrypted.

Returns

STATUS_SUCCESS

AES_startEncryptData()

```
uint8_t AES_startEncryptData (
            uint16_t baseAddress,
            const uint8_t * Data,
            uint8_t * encryptedData )
```

Starts an encryption process on the AES module.

This is the non-blocking equivalent of AES_encryptData(). The cipher key that is used for decryption should be loaded in advance by using function **AES_setCipherKey()**. It is recommended to use interrupt to check for procedure completion then using AES_getDataOut() API to retrieve the encrypted data.

Parameters

baseAddress	is the base address of the AES module.
Data	is a pointer to an uint8_t array with a length of 16 bytes that contains data to be encrypted.
encryptedData	is a pointer to an uint8_t array with a length of 16 bytes in that the encrypted data will be written.

Returns

STATUS_SUCCESS

AES_startSetDecipherKey()

```
uint8_t AES_startSetDecipherKey (
            uint16_t baseAddress,
            const uint8_t * CipherKey )
```

Loads the decipher key.

This is the non-blocking equivalent of AES_setDecipherKey(). The API **AES_startSetDecipherKey()** or **AES_setDecipherKey()** must be invoked before invoking **AES_startSetDecipherKey()**.

Parameters

baseAddress	is the base address of the AES module.
CipherKey	is a pointer to an uint8_t array with a length of 16 bytes that contains the initial AES key.

Returns

STATUS_SUCCESS

9.3 Programming Example

The following example shows some AES operations using the APIs

```
unsigned char Data[16] =        {   0x30, 0x31, 0x32, 0x33,
                                    0x34, 0x35, 0x36, 0x37,
                                    0x38, 0x39, 0x0A, 0x0B,
                                    0x0C, 0x0D, 0x0E, 0x0F  };
unsigned char CipherKey[16] =   {   0xAA, 0xBB, 0x02, 0x03,
                                    0x04, 0x05, 0x06, 0x07,
                                    0x08, 0x09, 0x0A, 0x0B,
                                    0x0C, 0x0D, 0x0E, 0x0F  };
unsigned char DataAES[16];      // Encrypted data
unsigned char DataunAES[16];    // Decrypted data

// Load a cipher key to module
AES_setCipherKey(AES_BASE, CipherKey);

// Encrypt data with preloaded cipher key
AES_encryptData(AES_BASE, Data, DataAES);

// Decrypt data with keys that were generated during encryption - takes 214 MCLK
// This function will generate all round keys needed for decryption first and then
// the encryption process starts
AES_decryptDataUsingEncryptionKey(AES_BASE, DataAES, DataunAES);
```

10 Battery Backup System

10.1 Introduction

The Battery Backup System (BATBCK) API provides a set of functions for using the MSP430Ware BATBCK modules. Functions are provided to handle the backup Battery sub-system, initialize and enable the backup Battery charger, and control access to and from the backup RAM space.

The BATBCK module offers no interrupt, and is used only to control the Battery backup sub-system, Battery charger, and backup RAM space.

10.2 API Functions

The BATBCK API is divided into three groups: one that handles the Battery backup sub-system, one that controls the charger, and one that controls access to and from the backup RAM space.

The BATBCK sub-system controls are handled by

- BattBak_unlockBackupSubSystem()
- BattBak_enableBackupSupplyToADC()
- BattBak_disableBackupSupplyToADC()
- BattBak_switchToBackupSupplyManually()
- BattBak_disable()

The BATBCK charger is controlled by

- BattBak_initAndEnableCharger()
- BattBak_disableCharger()

The backup RAM space is accessed by

- BattBak_setBackupRAMData()
- BattBak_getBackupRAMData()

11 Comparator (COMP_B)

11.1 Introduction

The Comparator B (COMP_B) API provides a set of functions for using the MSP430Ware COMP_B modules. Functions are provided to initialize the COMP_B modules, setup reference voltages for input, and manage interrupts for the COMP_B modules.

The COMP_B module provides the ability to compare two analog signals and use the output in software and on an output pin. The output represents whether the signal on the positive terminal is higher than the signal on the negative terminal. The COMP_B may be used to generate a hysteresis. There are 16 different inputs that can be used, as well as the ability to short 2 input together. The COMP_B module also has control over the REF module to generate a reference voltage as an input.

The COMP_B module can generate multiple interrupts. An interrupt may be asserted for the output, with separate interrupts on whether the output rises, or falls.

11.2 API Functions

Functions

- bool Comp_B_init (uint16_t baseAddress, Comp_B_initParam ∗param)
  Initializes the Comp_B Module.
- void Comp_B_configureReferenceVoltage (uint16_t baseAddress, Comp_B_configureReferenceVoltageParam ∗param)
  Generates a Reference Voltage to the terminal selected during initialization.
- void Comp_B_enableInterrupt (uint16_t baseAddress, uint16_t interruptMask)
  Enables selected Comp_B interrupt sources.
- void Comp_B_disableInterrupt (uint16_t baseAddress, uint16_t interruptMask)
  Disables selected Comp_B interrupt sources.
- void Comp_B_clearInterrupt (uint16_t baseAddress, uint16_t interruptFlagMask)
  Clears Comp_B interrupt flags.
- uint8_t Comp_B_getInterruptStatus (uint16_t baseAddress, uint16_t interruptFlagMask)
  Gets the current Comp_B interrupt status.
- void Comp_B_setInterruptEdgeDirection (uint16_t baseAddress, uint16_t edgeDirection)
  Explicitly sets the edge direction that would trigger an interrupt.
- void Comp_B_toggleInterruptEdgeDirection (uint16_t baseAddress)
  Toggles the edge direction that would trigger an interrupt.
- void Comp_B_enable (uint16_t baseAddress)
  Turns on the Comp_B module.
- void Comp_B_disable (uint16_t baseAddress)
  Turns off the Comp_B module.
- void Comp_B_shortInputs (uint16_t baseAddress)

Shorts the two input pins chosen during initialization.

- void Comp_B_unshortInputs (uint16_t baseAddress)

  Disables the short of the two input pins chosen during initialization.
- void Comp_B_disableInputBuffer (uint16_t baseAddress, uint8_t inputPort)

  Disables the input buffer of the selected input port to effectively allow for analog signals.
- void Comp_B_enableInputBuffer (uint16_t baseAddress, uint8_t inputPort)

  Enables the input buffer of the selected input port to allow for digital signals.
- void Comp_B_swapIO (uint16_t baseAddress)

  Toggles the bit that swaps which terminals the inputs go to, while also inverting the output of the Comp_B.
- uint16_t Comp_B_outputValue (uint16_t baseAddress)

  Returns the output value of the Comp_B module.
- void Comp_B_selectReferenceVoltage (uint16_t baseAddress, uint16_t selectType, uint16_t selectVRef)

  Modifies how comparator output selects between VREF0 or VREF1.

11.2.1 Detailed Description

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

The COMP_B initialization and output functions are

- Comp_B_init()
- Comp_B_configureReferenceVoltage()
- Comp_B_selectReferenceVoltage()
- Comp_B_enable()
- Comp_B_disable()
- Comp_B_outputValue()

The COMP_B interrupts are handled by

- Comp_B_enableInterrupt()
- Comp_B_disableInterrupt()
- Comp_B_clearInterrupt()
- Comp_B_getInterruptStatus()
- Comp_B_setInterruptEdgeDirection()
- Comp_B_toggleInterruptEdgeDirection()

Auxiliary features of the COMP_B are handled by

- Comp_B_shortInputs()
- Comp_B_unshortInputs()
- Comp_B_disableInputBuffer()
- Comp_B_enableInputBuffer()
- Comp_B_swapIO()

11.2.2 Function Documentation

Comp_B_clearInterrupt()

```
void Comp_B_clearInterrupt (
            uint16_t baseAddress,
            uint16_t interruptFlagMask )
```

Clears Comp_B interrupt flags.

The Comp_B 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 COMP_B module.
interruptFlagMask	is a bit mask of the interrupt sources to be cleared. Mask value is the logical OR of any of the following: ■ **COMP_B_OUTPUT_FLAG** - Output interrupt ■ **COMP_B_OUTPUTINVERTED_FLAG** - Output interrupt inverted polarity Modified bits of **CBINT** register.

Returns

None

Comp_B_configureReferenceVoltage()

```
void Comp_B_configureReferenceVoltage (
            uint16_t baseAddress,
            Comp_B_configureReferenceVoltageParam * param )
```

Generates a Reference Voltage to the terminal selected during initialization.

Use this function to generate a voltage to serve as a reference to the terminal selected at initialization. The voltage is determined by the equation: Vbase $*$ (Numerator / 32). If the upper and lower limit voltage numerators are equal, then a static reference is defined, whereas they are different then a hysteresis effect is generated.

Parameters

baseAddress	is the base address of the COMP_B module.
param	is the pointer to struct for reference voltage configuration.

Returns

None

References Comp_B_configureReferenceVoltageParam::lowerLimitSupplyVoltageFractionOf32, Comp_B_configureReferenceVoltageParam::referenceAccuracy, Comp_B_configureReferenceVoltageParam::supplyVoltageReferenceBase, and Comp_B_configureReferenceVoltageParam::upperLimitSupplyVoltageFractionOf32.

Comp_B_disable()

```
void Comp_B_disable (
            uint16_t baseAddress )
```

Turns off the Comp_B module.

This function clears the CBON bit disabling the operation of the Comp_B module, saving from excess power consumption.

Parameters

baseAddress	is the base address of the COMP_B module.

Returns

None

Comp_B_disableInputBuffer()

```
void Comp_B_disableInputBuffer (
            uint16_t baseAddress,
            uint8_t inputPort )
```

Disables the input buffer of the selected input port to effectively allow for analog signals.

This function sets the bit to disable the buffer for the specified input port to allow for analog signals from any of the Comp_B input pins. This bit is automatically set when the input is initialized to be used with the Comp_B module. This function should be used whenever an analog input is connected to one of these pins to prevent parasitic voltage from causing unexpected results.

Parameters

baseAddress	is the base address of the COMP_B module.

Parameters

inputPort	is the port in which the input buffer will be disabled. Valid values are: ■ **COMP_B_INPUT0** [Default] ■ **COMP_B_INPUT1** ■ **COMP_B_INPUT2** ■ **COMP_B_INPUT3** ■ **COMP_B_INPUT4** ■ **COMP_B_INPUT5** ■ **COMP_B_INPUT6** ■ **COMP_B_INPUT7** ■ **COMP_B_INPUT8** ■ **COMP_B_INPUT9** ■ **COMP_B_INPUT10** ■ **COMP_B_INPUT11** ■ **COMP_B_INPUT12** ■ **COMP_B_INPUT13** ■ **COMP_B_INPUT14** ■ **COMP_B_INPUT15** ■ **COMP_B_VREF** Modified bits are **CBPDx** of **CBCTL3** register.

Returns

None

Comp_B_disableInterrupt()

```
void Comp_B_disableInterrupt (
            uint16_t baseAddress,
            uint16_t interruptMask )
```

Disables selected Comp_B interrupt sources.

Disables the indicated Comp_B 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 COMP_B module.
interruptMask	is the bit mask of the interrupt sources to be disabled. Mask value is the logical OR of any of the following: ■ **COMP_B_OUTPUT_INT** - Output interrupt ■ **COMP_B_OUTPUTINVERTED_INT** - Output interrupt inverted polarity Modified bits of **CBINT** register.

Returns

None

Comp_B_enable()

```
void Comp_B_enable (
            uint16_t baseAddress )
```

Turns on the Comp_B module.

This function sets the bit that enables the operation of the Comp_B module.

Parameters

baseAddress	is the base address of the COMP_B module.

Returns

None

Comp_B_enableInputBuffer()

```
void Comp_B_enableInputBuffer (
            uint16_t baseAddress,
            uint8_t inputPort )
```

Enables the input buffer of the selected input port to allow for digital signals.

This function clears the bit to enable the buffer for the specified input port to allow for digital signals from any of the Comp_B input pins. This should not be reset if there is an analog signal connected to the specified input pin to prevent from unexpected results.

Parameters

baseAddress	is the base address of the COMP_B module.

Parameters

inputPort	is the port in which the input buffer will be enabled. Valid values are: ■ **COMP_B_INPUT0** [Default] ■ **COMP_B_INPUT1** ■ **COMP_B_INPUT2** ■ **COMP_B_INPUT3** ■ **COMP_B_INPUT4** ■ **COMP_B_INPUT5** ■ **COMP_B_INPUT6** ■ **COMP_B_INPUT7** ■ **COMP_B_INPUT8** ■ **COMP_B_INPUT9** ■ **COMP_B_INPUT10** ■ **COMP_B_INPUT11** ■ **COMP_B_INPUT12** ■ **COMP_B_INPUT13** ■ **COMP_B_INPUT14** ■ **COMP_B_INPUT15** ■ **COMP_B_VREF** Modified bits are **CBPDx** of **CBCTL3** register.

Returns

None

Comp_B_enableInterrupt()

```
void Comp_B_enableInterrupt (
            uint16_t baseAddress,
            uint16_t interruptMask )
```

Enables selected Comp_B interrupt sources.

Enables the indicated Comp_B 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 COMP_B module.

Parameters

interruptMask	is the bit mask of the interrupt sources to be enabled. Mask value is the logical OR of any of the following: ■ **COMP_B_OUTPUT_INT** - Output interrupt ■ **COMP_B_OUTPUTINVERTED_INT** - Output interrupt inverted polarity Modified bits of **CBINT** register.

Returns

None

Comp_B_getInterruptStatus()

```
uint8_t Comp_B_getInterruptStatus (
            uint16_t baseAddress,
            uint16_t interruptFlagMask )
```

Gets the current Comp_B interrupt status.

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

Parameters

baseAddress	is the base address of the COMP_B module.
interruptFlagMask	is the masked interrupt flag status to be returned. Mask value is the logical OR of any of the following: ■ **COMP_B_OUTPUT_FLAG** - Output interrupt ■ **COMP_B_OUTPUTINVERTED_FLAG** - Output interrupt inverted polarity

Returns

Logical OR of any of the following:
- **COMP_B_OUTPUT_FLAG** Output interrupt
- **COMP_B_OUTPUTINVERTED_FLAG** Output interrupt inverted polarity indicating the status of the masked interrupts

Comp_B_init()

```
bool Comp_B_init (
            uint16_t baseAddress,
            Comp_B_initParam * param )
```

Initializes the Comp_B Module.

Upon successful initialization of the Comp_B module, this function will have reset all necessary register bits and set the given options in the registers. To actually use the Comp_B module, the

Comp_B_enable() function must be explicitly called before use. If a Reference Voltage is set to a terminal, the Voltage should be set using the Comp_B_setReferenceVoltage() function.

Parameters

baseAddress	is the base address of the COMP_B module.
param	is the pointer to struct for initialization.

Returns

STATUS_SUCCESS or STATUS_FAILURE of the initialization process.

References Comp_B_initParam::invertedOutputPolarity, Comp_B_initParam::negativeTerminalInput, Comp_B_initParam::outputFilterEnableAndDelayLevel, Comp_B_initParam::positiveTerminalInput, and Comp_B_initParam::powerModeSelect.

Comp_B_outputValue()

```
uint16_t Comp_B_outputValue (
            uint16_t baseAddress )
```

Returns the output value of the Comp_B module.

Returns the output value of the Comp_B module.

Parameters

baseAddress	is the base address of the COMP_B module.

Returns

One of the following:
- **COMP_B_LOW**
- **COMP_B_HIGH**
  indicating the output value of the Comp_B module

Comp_B_selectReferenceVoltage()

```
void Comp_B_selectReferenceVoltage (
            uint16_t baseAddress,
            uint16_t selectType,
            uint16_t selectVRef )
```

Modifies how comparator output selects between VREF0 or VREF1.

Only applicable in certain Comp_B reference sources. Consult Comp_B_configureReferenceVoltage for details. If COMP_B_VREF_AUTO_SELECT, then comparator output state chooses between VREF0 and VREF1. If COMP_B_VREF_MANUAL_SELECT, then selectVRef param chooses.

Parameters

baseAddress	is the base address of the COMP_B module.
selectType	determines whether VREF instance is chosen automatically or manually Valid values are: ■ **COMP_B_VREF_AUTO_SELECT** [Default] - VREF instance is chosen by comparator output state. ■ **COMP_B_VREF_MANUAL_SELECT** - VREF instance is chosen by user (CBCTL1. CBMRVL bit) Modified bits are **CBMRVS** of **CBCTL1** register.
selectVRef	selects VREF0 or VREF1. Only applicable if VREF instance is set up to be chosen manually Valid values are: ■ **COMP_B_SELECT_VREF0** [Default] ■ **COMP_B_SELECT_VREF1** Modified bits are **CBMRVL** of **CBCTL1** register.

Comp_B_setInterruptEdgeDirection()

```
void Comp_B_setInterruptEdgeDirection (
            uint16_t baseAddress,
            uint16_t edgeDirection )
```

Explicitly sets the edge direction that would trigger an interrupt.

This function will set which direction the output will have to go, whether rising or falling, to generate an interrupt based on a non-inverted interrupt.

Parameters

baseAddress	is the base address of the COMP_B module.
edgeDirection	determines which direction the edge would have to go to generate an interrupt based on the non-inverted interrupt flag. Valid values are: ■ **COMP_B_RISINGEDGE** [Default] - sets the bit to generate an interrupt when the output of the Comp_B falls from LOW to HIGH if the normal interrupt bit is set(and HIGH to LOW if the inverted interrupt enable bit is set). ■ **COMP_B_FALLINGEDGE** - sets the bit to generate an interrupt when the output of the Comp_B rises from HIGH to LOW if the normal interrupt bit is set(and LOW to HIGH if the inverted interrupt enable bit is set). Modified bits are **CBIES** of **CBCTL1** register.

Returns

None

Comp_B_shortInputs()

```
void Comp_B_shortInputs (
            uint16_t baseAddress )
```

Shorts the two input pins chosen during initialization.

This function sets the bit that shorts the devices attached to the input pins chosen from the initialization of the Comp_B.

Parameters

baseAddress	is the base address of the COMP_B module.

Returns

None

Comp_B_swapIO()

```
void Comp_B_swapIO (
            uint16_t baseAddress )
```

Toggles the bit that swaps which terminals the inputs go to, while also inverting the output of the Comp_B.

This function toggles the bit that controls which input goes to which terminal. After initialization, this bit is set to 0, after toggling it once the inputs are routed to the opposite terminal and the output is inverted.

Parameters

baseAddress	is the base address of the COMP_B module.

Returns

None

Comp_B_toggleInterruptEdgeDirection()

```
void Comp_B_toggleInterruptEdgeDirection (
            uint16_t baseAddress )
```

Toggles the edge direction that would trigger an interrupt.

This function will toggle which direction the output will have to go, whether rising or falling, to generate an interrupt based on a non-inverted interrupt. If the direction was rising, it is now falling, if it was falling, it is now rising.

Parameters

baseAddress	is the base address of the COMP_B module.

Returns

None

Comp_B_unshortInputs()

```
void Comp_B_unshortInputs (
            uint16_t baseAddress )
```

Disables the short of the two input pins chosen during initialization.

This function clears the bit that shorts the devices attached to the input pins chosen from the initialization of the Comp_B.

Parameters

baseAddress	is the base address of the COMP_B module.

Returns

None

11.3 Programming Example

The following example shows how to initialize and use the COMP_B API to turn on an LED when the input to the positive terminal is higher than the input to the negative terminal.

```
// Initialize the Comparator B module
/* Base Address of Comparator B,
  Pin CB0 to Positive(+) Terminal,
  Reference Voltage to Negative(-) Terminal,
  Normal Power Mode,
  Output Filter On with minimal delay,
  Non-Inverted Output Polarity
*/
Comp_B_initParam param = {0};
param.positiveTerminalInput = COMP_B_INPUT0;
param.negativeTerminalInput = COMP_B_VREF;
param.powerModeSelect = COMP_B_POWERMODE_NORMALMODE;
param.outputFilterEnableAndDelayLevel = COMP_B_FILTEROUTPUT_DLYLVL1;
param.invertedOutputPolarity = COMP_B_NORMALOUTPUTPOLARITY;
Comp_B_init(COMP_B_BASE, &param);

// Set the reference voltage that is being supplied to the (-) terminal
/* Base Address of Comparator B,
 Reference Voltage of 2.0 V,
 Upper Limit of 2.0*(32/32) = 2.0V,
 Lower Limit of 2.0*(32/32) = 2.0V
*/
Comp_B_setReferenceVoltage(COMP_B_BASE,
```

```
                          COMP_B_VREFBASE2_5V,
                          32,
                          32
                          );

// Allow power to Comparator module
Comp_B_enable(COMP_B_BASE);

// delay for the reference to settle
__delay_cycles(75);
```

12 Cyclical Redundancy Check (CRC)

12.1 Introduction

The Cyclic Redundancy Check (CRC) API provides a set of functions for using the MSP430Ware CRC module. Functions are provided to initialize the CRC and create a CRC signature to check the validity of data. This is mostly useful in the communication of data, or as a startup procedure to as a more complex and accurate check of data.

The CRC module offers no interrupts and is used only to generate CRC signatures to verify against pre-made CRC signatures (Checksums).

12.2 API Functions

Functions

- void CRC_setSeed (uint16_t baseAddress, uint16_t seed)
  Sets the seed for the CRC.
- void CRC_set16BitData (uint16_t baseAddress, uint16_t dataIn)
  Sets the 16 bit data to add into the CRC module to generate a new signature.
- void CRC_set8BitData (uint16_t baseAddress, uint8_t dataIn)
  Sets the 8 bit data to add into the CRC module to generate a new signature.
- void CRC_set16BitDataReversed (uint16_t baseAddress, uint16_t dataIn)
  Translates the 16 bit data by reversing the bits in each byte and then sets this data to add into the CRC module to generate a new signature.
- void CRC_set8BitDataReversed (uint16_t baseAddress, uint8_t dataIn)
  Translates the 8 bit data by reversing the bits in each byte and then sets this data to add into the CRC module to generate a new signature.
- uint16_t CRC_getData (uint16_t baseAddress)
  Returns the value currently in the Data register.
- uint16_t CRC_getResult (uint16_t baseAddress)
  Returns the value pf the Signature Result.
- uint16_t CRC_getResultBitsReversed (uint16_t baseAddress)
  Returns the bit-wise reversed format of the Signature Result.

12.2.1 Detailed Description

The CRC API is one group that controls the CRC module. The APIs that are used to set the seed and data are

- CRC_setSeed()
- CRC_set16BitData()

- CRC_set8BitData()
- CRC_set16BitDataReversed()
- CRC_set8BitDataReversed()
- CRC_setSeed()

The APIs that are used to get the data and results are

- CRC_getData()
- CRC_getResult()
- CRC_getResultBitsReversed()

12.2.2 Function Documentation

CRC_getData()

```
uint16_t CRC_getData (
        uint16_t baseAddress )
```

Returns the value currently in the Data register.

This function returns the value currently in the data register. If set in byte bits reversed format, then the translated data would be returned.

Parameters

baseAddress	is the base address of the CRC module.

Returns

The value currently in the data register

CRC_getResult()

```
uint16_t CRC_getResult (
        uint16_t baseAddress )
```

Returns the value pf the Signature Result.

This function returns the value of the signature result generated by the CRC.

Parameters

baseAddress	is the base address of the CRC module.

Returns

The value currently in the data register

CRC_getResultBitsReversed()

```
uint16_t CRC_getResultBitsReversed (
            uint16_t baseAddress )
```

Returns the bit-wise reversed format of the Signature Result.

This function returns the bit-wise reversed format of the Signature Result.

Parameters

baseAddress	is the base address of the CRC module.

Returns

The bit-wise reversed format of the Signature Result

CRC_set16BitData()

```
void CRC_set16BitData (
            uint16_t baseAddress,
            uint16_t dataIn )
```

Sets the 16 bit data to add into the CRC module to generate a new signature.

This function sets the given data into the CRC module to generate the new signature from the current signature and new data.

Parameters

baseAddress	is the base address of the CRC module.
dataIn	is the data to be added, through the CRC module, to the signature. Modified bits are **CRCDI** of **CRCDI** register.

Returns

None

CRC_set16BitDataReversed()

```
void CRC_set16BitDataReversed (
            uint16_t baseAddress,
            uint16_t dataIn )
```

Translates the 16 bit data by reversing the bits in each byte and then sets this data to add into the CRC module to generate a new signature.

This function first reverses the bits in each byte of the data and then generates the new signature from the current signature and new translated data.

Parameters

baseAddress	is the base address of the CRC module.
dataIn	is the data to be added, through the CRC module, to the signature. Modified bits are **CRCDIRB** of **CRCDIRB** register.

Returns

None

CRC_set8BitData()

```
void CRC_set8BitData (
            uint16_t baseAddress,
            uint8_t dataIn )
```

Sets the 8 bit data to add into the CRC module to generate a new signature.

This function sets the given data into the CRC module to generate the new signature from the current signature and new data.

Parameters

baseAddress	is the base address of the CRC module.
dataIn	is the data to be added, through the CRC module, to the signature. Modified bits are **CRCDI** of **CRCDI** register.

Returns

None

CRC_set8BitDataReversed()

```
void CRC_set8BitDataReversed (
            uint16_t baseAddress,
            uint8_t dataIn )
```

Translates the 8 bit data by reversing the bits in each byte and then sets this data to add into the CRC module to generate a new signature.

This function first reverses the bits in each byte of the data and then generates the new signature from the current signature and new translated data.

Parameters

baseAddress	is the base address of the CRC module.
dataIn	is the data to be added, through the CRC module, to the signature. Modified bits are **CRCDIRB** of **CRCDIRB** register.

Returns

None

CRC_setSeed()

```
void CRC_setSeed (
            uint16_t baseAddress,
            uint16_t seed )
```

Sets the seed for the CRC.

This function sets the seed for the CRC to begin generating a signature with the given seed and all passed data. Using this function resets the CRC signature.

Parameters

baseAddress	is the base address of the CRC module.
seed	is the seed for the CRC to start generating a signature from. Modified bits are **CRCINIRES** of **CRCINIRES** register.

Returns

None

12.3 Programming Example

The following example shows how to initialize and use the CRC API to generate a CRC signature on an array of data.

```
unsigned int crcSeed = 0xBEEF;
unsigned int data[] = {0x0123,
                       0x4567,
                       0x8910,
                       0x1112,
                       0x1314};
unsigned int crcResult;
int i;

// Stop WDT
WDT_hold(WDT_A_BASE);

// Set P1.0 as an output
GPIO_setAsOutputPin(GPIO_PORT_P1,
                    GPIO_PIN0);

// Set the CRC seed
CRC_setSeed(CRC_BASE,
            crcSeed);

for (i = 0; i < 5; i++)
{
//Add all of the values into the CRC signature
CRC_set16BitData(CRC_BASE,
    data[i]);
}

// Save the current CRC signature checksum to be compared for later
crcResult = CRC_getResult(CRC_BASE);
```

13 16-Bit Sigma Delta Converter (CTSD16)

13.1 Introduction

The CTSD16 module consists of up to seven independent sigma-delta analog-to-digital multi-input and multi-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 CTSD16 with fixed frequency 1.024Mhz, 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 415 = 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.

13.2 API Functions

The CTSD16 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 CTSD16.

The CTSD16 initialization and conversion functions are

- CTSD16_init()
- CTSD16_initConverter()
- CTSD16_initConverterAdvanced()
- CTSD16_stopConverterConversion()
- CTSD16_startConverterConversion()
- CTSD16_getResults()

The CTSD16 interrupts are handled by

- CTSD16_enableInterrupt()
- CTSD16_disableInterrupt()

- CTSD16_clearInterrupt()
- CTSD16_getInterruptStatus()

Auxiliary features of the CTSD16 are handled by

- CTSD16_setInputChannel()
- CTSD16_setDataFormat()
- CTSD16_setInterruptDelay()
- CTSD16_setConversionDelay()
- CTSD16_setOversampling()
- CTSD16_setGain()
- CTSD16_setRailToRailInput()
- CTSD16_isRailToRailInputReady()

13.3 Programming Example

The following example shows how to initialize and use the CTSD16 API to start a single channel, single conversion.

```
uint16_t  result;

// Initialize CTSD16 using internal reference and internal resistor for clock
CTSD16_init(CTSD16_BASE,
        CTSD16_RTR_INPUT_CHARGEPUMP_BURST_REQUEST_DISABLE, CTSD16_REF_INTERNAL);

// Initialize converter 0: AD0+ / AD0- as input, 2s complement, channel 9
CTSD16_initConverterParam convParam = {0};
convParam.converter = CTSD16_CONVERTER_0;
convParam.conversionMode = CTSD16_SINGLE_MODE;
convParam.groupEnable = CTSD16_NOT_GROUPED;
convParam.inputChannel = CTSD16_INPUT_CH9;
convParam.dataFormat = CTSD16_DATA_FORMAT_2COMPLEMENT;
convParam.railToRailInput = CTSD16_RTR_INPUT_DISABLE;
convParam.interruptDelay = CTSD16_FOURTH_SAMPLE_INTERRUPT;
convParam.oversampleRatio = CTSD16_OVERSAMPLE_256;
convParam.gain = CTSD16_GAIN_1;
CTSD16_initConverter(CTSD16_BASE, &convParam);

// Delay ~120us for 1.2V ref to settle
__delay_cycles(2000);

while(1) {
     // Set bit to start conversion
    CTSD16_startConverterConversion(CTSD16_BASE, CTSD16_CONVERTER_0);

    // Poll IFG until conversion completes
    while(!CTSD16_getInterruptStatus(CTSD16_BASE, CTSD16_CONVERTER_0, CTSD16_CONVERTER_INTERRUPT));

    // Save CTSD16 conversion results
    result = CTSD16_getResults(CTSD16_BASE, CTSD16_CONVERTER_0);
}
```

14 12-bit Digital-to-Analog Converter (DAC12_A)

14.1 Introduction

The 12-Bit Digital-to-Analog (DAC12_A) API provides a set of functions for using the MSP430Ware DAC12_A modules. Functions are provided to initialize setup the DAC12_A modules, calibrate the output signal, and manage the interrupts for the DAC12_A modules.

The DAC12_A module provides the ability to convert digital values into an analog signal for output to a pin. The DAC12_A can generate signals from 0 to Vcc from an 8- or 12-bit value. There can be one or two DAC12_A modules in a device, and if there are two they can be grouped together to create two analog signals in simultaneously. There are 3 ways to latch data in to the DAC module, and those are by software with the startConversion API function call, as well as by the Timer A output of CCR1 or Timer B output of CCR2.

The calibration API will unlock and start calibration, then wait for the calibration to end before locking it back up, all in one API. There are also functions to read out the calibration data, as well as be able to set it manually.

The DAC12_A module can generate one interrupt for each DAC module. It will generate the interrupt when the data has been latched into the DAC module to be output into an analog signal.

14.2 API Functions

Functions

- bool DAC12_A_init (uint16_t baseAddress, DAC12_A_initParam ∗param)
  Initializes the DAC12_A module with the specified settings.
- void DAC12_A_setAmplifierSetting (uint16_t baseAddress, uint8_t submoduleSelect, uint8_t amplifierSetting)
  Sets the amplifier settings for the Vref+ and Vout buffers.
- void DAC12_A_disable (uint16_t baseAddress, uint8_t submoduleSelect)
  Clears the amplifier settings to disable the DAC12_A module.
- void DAC12_A_enableGrouping (uint16_t baseAddress)
  Enables grouping of two DAC12_A modules in a dual DAC12_A system.
- void DAC12_A_disableGrouping (uint16_t baseAddress)
  Disables grouping of two DAC12_A modules in a dual DAC12_A system.
- void DAC12_A_enableInterrupt (uint16_t baseAddress, uint8_t submoduleSelect)
  Enables the DAC12_A module interrupt source.
- void DAC12_A_disableInterrupt (uint16_t baseAddress, uint8_t submoduleSelect)
  Disables the DAC12_A module interrupt source.
- uint16_t DAC12_A_getInterruptStatus (uint16_t baseAddress, uint8_t submoduleSelect)

Returns the status of the DAC12_A module interrupt flag.

- void DAC12_A_clearInterrupt (uint16_t baseAddress, uint8_t submoduleSelect)
  Clears the DAC12_A module interrupt flag.
- void DAC12_A_calibrateOutput (uint16_t baseAddress, uint8_t submoduleSelect)
  Calibrates the output offset.
- uint16_t DAC12_A_getCalibrationData (uint16_t baseAddress, uint8_t submoduleSelect)
  Returns the calibrated offset of the output buffer.
- void DAC12_A_setCalibrationOffset (uint16_t baseAddress, uint8_t submoduleSelect, uint16_t calibrationOffsetValue)
  Returns the calibrated offset of the output buffer.
- void DAC12_A_enableConversions (uint16_t baseAddress, uint8_t submoduleSelect)
  Enables triggers to start conversions.
- void DAC12_A_setData (uint16_t baseAddress, uint8_t submoduleSelect, uint16_t data)
  Sets the given data into the buffer to be converted.
- void DAC12_A_disableConversions (uint16_t baseAddress, uint8_t submoduleSelect)
  Disables triggers to start conversions.
- void DAC12_A_setResolution (uint16_t baseAddress, uint8_t submoduleSelect, uint16_t resolutionSelect)
  Sets the resolution to be used by the DAC12_A module.
- void DAC12_A_setInputDataFormat (uint16_t baseAddress, uint8_t submoduleSelect, uint8_t inputJustification, uint8_t inputSign)
  Sets the input data format for the DAC12_A module.
- uint32_t DAC12_A_getDataBufferMemoryAddressForDMA (uint16_t baseAddress, uint8_t submoduleSelect)
  Returns the address of the specified DAC12_A data buffer for the DMA module.

14.2.1 Detailed Description

The DAC12_A API is broken into three groups of functions: those that deal with initialization and conversions, those that deal with calibration of the output, and those that handle interrupts.

The DAC12_A initialization and conversion functions are

- DAC12_A_init()
- DAC12_A_setAmplifierSetting()
- DAC12_A_disable()
- DAC12_A_enableGrouping()
- DAC12_A_disableGrouping()
- DAC12_A_enableConversions()
- DAC12_A_setData()
- DAC12_A_disableConversions()
- DAC12_A_setResolution()
- DAC12_A_setInputDataFormat()
- DAC12_A_getDataBufferMemoryAddressForDMA()

Calibration features of the DAC12_A are handled by

- DAC12_A_calibrateOutput()
- DAC12_A_getCalibrationData()

- DAC12_A_setCalibrationOffset()

The DAC12_A interrupts are handled by

- DAC12_A_enableInterrupt()
- DAC12_A_disableInterrupt()
- DAC12_A_getInterruptStatus()
- DAC12_A_clearInterrupt()

14.2.2 Function Documentation

DAC12_A_calibrateOutput()

```
void DAC12_A_calibrateOutput (
            uint16_t baseAddress,
            uint8_t submoduleSelect )
```

Calibrates the output offset.

This function disables the calibration lock, starts the calibration, whats for the calibration to complete, and then re-locks the calibration lock. Please note, this function should be called after initializing the dac12 module, and before using it.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**

Modified bits are **DAC12CALON** of **DAC12_xCTL0** register; bits **DAC12PW** of **DAC12_xCALCTL** register.

Returns

None

DAC12_A_clearInterrupt()

```
void DAC12_A_clearInterrupt (
            uint16_t baseAddress,
            uint8_t submoduleSelect )
```

Clears the DAC12_A module interrupt flag.

The DAC12_A module interrupt flag is cleared, so that it no longer asserts. Note that an interrupt is not thrown when DAC12_A_TRIGGER_ENCBYPASS has been set for the parameter conversionTriggerSelect in initialization.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**

Modified bits are **DAC12IFG** of **DAC12_xCTL0** register.

Returns

None

DAC12_A_disable()

```
void DAC12_A_disable (
            uint16_t baseAddress,
            uint8_t submoduleSelect )
```

Clears the amplifier settings to disable the DAC12_A module.

This function clears the amplifier settings for the selected DAC12_A module to disable the DAC12_A module.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**

Modified bits are **DAC12AMP_7** of **DAC12_xCTL0** register.

Returns

None

DAC12_A_disableConversions()

```
void DAC12_A_disableConversions (
            uint16_t baseAddress,
            uint8_t submoduleSelect )
```

Disables triggers to start conversions.

This function is used to disallow triggers to start a conversion. Note that this function does not have any affect if DAC12_A_TRIGGER_ENCBYPASS was set for the conversionTriggerSelect parameter during initialization.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**

Modified bits are **DAC12ENC** of **DAC12_xCTL0** register.

Returns

None

DAC12_A_disableGrouping()

```
void DAC12_A_disableGrouping (
            uint16_t baseAddress )
```

Disables grouping of two DAC12_A modules in a dual DAC12_A system.

This function disables grouping of two DAC12_A modules in a dual DAC12_A system.

Parameters

baseAddress	is the base address of the DAC12_A module.

Returns

None

DAC12_A_disableInterrupt()

```
void DAC12_A_disableInterrupt (
            uint16_t baseAddress,
            uint8_t submoduleSelect )
```

Disables the DAC12_A module interrupt source.

Enables the DAC12_A module interrupt source. 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 DAC12_A module.

Parameters

submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**

Returns

None

DAC12_A_enableConversions()

```
void DAC12_A_enableConversions (
            uint16_t baseAddress,
            uint8_t submoduleSelect )
```

Enables triggers to start conversions.

This function is used to allow triggers to start a conversion. Note that this function does not need to be used if DAC12_A_TRIGGER_ENCBYPASS was set for the conversionTriggerSelect parameter during initialization. If DAC grouping is enabled, this has to be called for both DAC's.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**

Modified bits are **DAC12ENC** of **DAC12_xCTL0** register.

Returns

None

DAC12_A_enableGrouping()

```
void DAC12_A_enableGrouping (
            uint16_t baseAddress )
```

Enables grouping of two DAC12_A modules in a dual DAC12_A system.

This function enables grouping two DAC12_A modules in a dual DAC12_A system. Both DAC12_A modules will work in sync, converting data at the same time. To convert data, the same trigger should be set for both DAC12_A modules during initialization (which should not be

DAC12_A_TRIGGER_ENCBYPASS), the enableConversions() function needs to be called with both DAC12_A modules, and data needs to be set for both DAC12_A modules separately.

Parameters

baseAddress	is the base address of the DAC12_A module.

Modified bits are **DAC12GRP** of **DAC12_xCTL0** register.

Returns

None

DAC12_A_enableInterrupt()

```
void DAC12_A_enableInterrupt (
            uint16_t baseAddress,
            uint8_t submoduleSelect )
```

Enables the DAC12_A module interrupt source.

This function to enable the DAC12_A module interrupt, which throws an interrupt when the data buffer is available for new data to be set. Only the sources that are enabled can be reflected to the processor interrupt; disabled sources have no effect on the processor. Note that an interrupt is not thrown when DAC12_A_TRIGGER_ENCBYPASS has been set for the parameter conversionTriggerSelect in initialization. Does not clear interrupt flags.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**

Returns

None

DAC12_A_getCalibrationData()

```
uint16_t DAC12_A_getCalibrationData (
            uint16_t baseAddress,
            uint8_t submoduleSelect )
```

Returns the calibrated offset of the output buffer.

This function returns the calibrated offset of the output buffer. The output buffer offset is used to obtain accurate results from the output pin. This function should only be used while the calibration lock is enabled. Only the lower byte of the word of the register is returned, and the value is between -128 and +127.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**

Returns

The calibrated offset of the output buffer.

DAC12_A_getDataBufferMemoryAddressForDMA()

```
uint32_t DAC12_A_getDataBufferMemoryAddressForDMA (
            uint16_t baseAddress,
            uint8_t submoduleSelect )
```

Returns the address of the specified DAC12_A data buffer for the DMA module.

Returns the address of the specified memory buffer. This can be used in conjunction with the DMA to obtain the data directly from memory.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**

Returns

The address of the specified memory buffer

DAC12_A_getInterruptStatus()

```
uint16_t DAC12_A_getInterruptStatus (
            uint16_t baseAddress,
            uint8_t submoduleSelect )
```

Returns the status of the DAC12_A module interrupt flag.

This function returns the status of the DAC12_A module interrupt flag. Note that an interrupt is not thrown when DAC12_A_TRIGGER_ENCBYPASS has been set for the conversionTriggerSelect parameter in initialization.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**

Returns

One of the following:
- **DAC12_A_INT_ACTIVE**
- **DAC12_A_INT_INACTIVE**
  indicating the status for the selected DAC12_A module

DAC12_A_init()

```
bool DAC12_A_init (
            uint16_t baseAddress,
            DAC12_A_initParam * param )
```

Initializes the DAC12_A module with the specified settings.

This function initializes the DAC12_A module with the specified settings. Upon successful completion of the initialization of this module the control registers and interrupts of this module are all reset, and the specified variables will be set. Please note, that if conversions are enabled with the enableConversions() function, then disableConversions() must be called before re-initializing the DAC12_A module with this function.

Parameters

baseAddress	is the base address of the DAC12_A module.
param	is the pointer to struct for initialization.

Returns

STATUS_SUCCESS or STATUS_FAILURE of the initialization process.

References DAC12_A_initParam::amplifierSetting, DAC12_A_initParam::conversionTriggerSelect, DAC12_A_initParam::outputSelect, DAC12_A_initParam::outputVoltageMultiplier, DAC12_A_initParam::positiveReferenceVoltage, and DAC12_A_initParam::submoduleSelect.

DAC12_A_setAmplifierSetting()

```
void DAC12_A_setAmplifierSetting (
            uint16_t baseAddress,
```

```
uint8_t submoduleSelect,
uint8_t amplifierSetting )
```

Sets the amplifier settings for the Vref+ and Vout buffers.

This function sets the amplifier settings of the DAC12_A module for the Vref+ and Vout buffers without re-initializing the DAC12_A module. This can be used to disable the control of the pin by the DAC12_A module.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**
amplifierSetting	is the setting of the settling speed and current of the Vref+ and the Vout buffer. Valid values are: ■ **DAC12_A_AMP_OFF_PINOUTHIGHZ** [Default] - Initialize the DAC12_A Module with settings, but do not turn it on. ■ **DAC12_A_AMP_OFF_PINOUTLOW** - Initialize the DAC12_A Module with settings, and allow it to take control of the selected output pin to pull it low (Note: this takes control away port mapping module). ■ **DAC12_A_AMP_LOWIN_LOWOUT** - Select a slow settling speed and current for Vref+ input buffer and for Vout output buffer. ■ **DAC12_A_AMP_LOWIN_MEDOUT** - Select a slow settling speed and current for Vref+ input buffer and a medium settling speed and current for Vout output buffer. ■ **DAC12_A_AMP_LOWIN_HIGHOUT** - Select a slow settling speed and current for Vref+ input buffer and a high settling speed and current for Vout output buffer. ■ **DAC12_A_AMP_MEDIN_MEDOUT** - Select a medium settling speed and current for Vref+ input buffer and for Vout output buffer. ■ **DAC12_A_AMP_MEDIN_HIGHOUT** - Select a medium settling speed and current for Vref+ input buffer and a high settling speed and current for Vout output buffer. ■ **DAC12_A_AMP_HIGHIN_HIGHOUT** - Select a high settling speed and current for Vref+ input buffer and for Vout output buffer.

Returns

None

DAC12_A_setCalibrationOffset()

```
void DAC12_A_setCalibrationOffset (
            uint16_t baseAddress,
            uint8_t submoduleSelect,
```

```
uint16_t calibrationOffsetValue )
```

Returns the calibrated offset of the output buffer.

This function is used to manually set the calibration offset value. The calibration is automatically unlocked and re-locked to be able to allow for the offset value to be set.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**
calibrationOffsetValue	calibration offset value

Modified bits are **DAC12LOCK** of **DAC12_xCALDAT** register; bits **DAC12PW** of **DAC12_xCTL0** register; bits **DAC12PW** of **DAC12_xCALCTL** register.

Returns

None

DAC12_A_setData()

```
void DAC12_A_setData (
            uint16_t baseAddress,
            uint8_t submoduleSelect,
            uint16_t data )
```

Sets the given data into the buffer to be converted.

This function is used to set the given data into the data buffer of the DAC12_A module. The data given should be in the format set (12-bit Unsigned, Right-justified by default). Note if DAC12_A_TRIGGER_ENCBYPASS was set for the conversionTriggerSelect during initialization then using this function will set the data and automatically trigger a conversion. If any other trigger was set during initialization, then the DAC12_A_enableConversions() function needs to be called before a conversion can be started. If grouping DAC's and DAC12_A_TRIGGER_ENC was set during initialization, then both data buffers must be set before a conversion will be started.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**
data	is the data to be set into the DAC12_A data buffer to be converted. Modified bits are **DAC12_DATA** of **DAC12_xDAT** register.

Modified bits of **DAC12_xDAT** register.

Returns

None

DAC12_A_setInputDataFormat()

```
void DAC12_A_setInputDataFormat (
            uint16_t baseAddress,
            uint8_t submoduleSelect,
            uint8_t inputJustification,
            uint8_t inputSign )
```

Sets the input data format for the DAC12_A module.

This function sets the input format for the binary data to be converted.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**
inputJustification	is the justification of the data to be converted. Valid values are: ■ **DAC12_A_JUSTIFICATION_RIGHT** [Default] ■ **DAC12_A_JUSTIFICATION_LEFT** Modified bits are **DAC12DFJ** of **DAC12_xCTL1** register.
inputSign	is the sign of the data to be converted. Valid values are: ■ **DAC12_A_UNSIGNED_BINARY** [Default] ■ **DAC12_A_SIGNED_2SCOMPLEMENT** Modified bits are **DAC12DF** of **DAC12_xCTL0** register.

Returns

None

DAC12_A_setResolution()

```
void DAC12_A_setResolution (
            uint16_t baseAddress,
            uint8_t submoduleSelect,
            uint16_t resolutionSelect )
```

Sets the resolution to be used by the DAC12_A module.

This function sets the resolution of the data to be converted.

Parameters

baseAddress	is the base address of the DAC12_A module.
submoduleSelect	decides which DAC12_A sub-module to configure. Valid values are: ■ **DAC12_A_SUBMODULE_0** ■ **DAC12_A_SUBMODULE_1**
resolutionSelect	is the resolution to use for conversions. Valid values are: ■ **DAC12_A_RESOLUTION_8BIT** ■ **DAC12_A_RESOLUTION_12BIT** [Default] Modified bits are **DAC12RES** of **DAC12_xCTL0** register.

Modified bits are **DAC12ENC** and **DAC12RES** of **DAC12_xCTL0** register.

Returns

None

14.3 Programming Example

The following example shows how to initialize and use the DAC12_A API to output a 1.5V analog signal.

```
DAC12_A_initParam param = {0};
param.submoduleSelect = DAC12_A_SUBMODULE_0;
param.outputSelect = DAC12_A_OUTPUT_1;
param.positiveReferenceVoltage = DAC12_A_VREF_AVCC;
param.outputVoltageMultiplier = DAC12_A_VREFx1;
param.amplifierSetting = DAC12_A_AMP_MEDIN_MEDOUT;
param.conversionTriggerSelect = DAC12_A_TRIGGER_ENCBYPASS;
DAC12_A_init(DAC12_A_BASE, &param);


// Calibrate output buffer for DAC12_A_0
DAC12_A_calibrateOutput(DAC12_A_BASE,
                        DAC12_A_SUBMODULE_0);

DAC12_A_setData(DAC12_A_BASE,
            DAC12_A_SUBMODULE_0,          // Set 0x7FF (~1.5V)
            0x7FF                        // into data buffer for DAC12_A_0
            );
```

15 Direct Memory Access (DMA)

15.1 Introduction

The Direct Memory Access (DMA) API provides a set of functions for using the MSP430Ware DMA modules. Functions are provided to initialize and setup each DMA channel with the source and destination addresses, manage the interrupts for each channel, and set bits that affect all DMA channels.

The DMA module provides the ability to move data from one address in the device to another, and that includes other peripheral addresses to RAM or vice-versa, all without the actual use of the CPU. Please be advised, that the DMA module does halt the CPU for 2 cycles while transferring, but does not have to edit any registers or anything. The DMA can transfer by bytes or words at a time, and will automatically increment or decrement the source or destination address if desired. There are also 6 different modes to transfer by, including single-transfer, block-transfer, and burst-block-transfer, as well as repeated versions of those three different kinds which allows transfers to be repeated without having re-enable transfers.

The DMA settings that affect all DMA channels include prioritization, from a fixed priority to dynamic round-robin priority. Another setting that can be changed is when transfers occur, the CPU may be in a read-modify-write operation which can be disastrous to time sensitive material, so this can be disabled. And Non-Maskable-Interrupts can indeed be maskable to the DMA module if not enabled.

The DMA module can generate one interrupt per channel. The interrupt is only asserted when the specified amount of transfers has been completed. With single-transfer, this occurs when that many single transfers have occurred, while with block or burst-block transfers, once the block is completely transferred the interrupt is asserted.

15.2 API Functions

Functions

- void DMA_init (DMA_initParam ∗param)
  Initializes the specified DMA channel.
- void DMA_setTransferSize (uint8_t channelSelect, uint16_t transferSize)
  Sets the specified amount of transfers for the selected DMA channel.
- uint16_t DMA_getTransferSize (uint8_t channelSelect)
  Gets the amount of transfers for the selected DMA channel.
- void DMA_setSrcAddress (uint8_t channelSelect, uint32_t srcAddress, uint16_t directionSelect)
  Sets source address and the direction that the source address will move after a transfer.
- void DMA_setDstAddress (uint8_t channelSelect, uint32_t dstAddress, uint16_t directionSelect)

Sets the destination address and the direction that the destination address will move after a transfer.

- void DMA_enableTransfers (uint8_t channelSelect)
  Enables transfers to be triggered.
- void DMA_disableTransfers (uint8_t channelSelect)
  Disables transfers from being triggered.
- void DMA_startTransfer (uint8_t channelSelect)
  Starts a transfer if using the default trigger source selected in initialization.
- void DMA_enableInterrupt (uint8_t channelSelect)
  Enables the DMA interrupt for the selected channel.
- void DMA_disableInterrupt (uint8_t channelSelect)
  Disables the DMA interrupt for the selected channel.
- uint16_t DMA_getInterruptStatus (uint8_t channelSelect)
  Returns the status of the interrupt flag for the selected channel.
- void DMA_clearInterrupt (uint8_t channelSelect)
  Clears the interrupt flag for the selected channel.
- uint16_t DMA_getNMIAbortStatus (uint8_t channelSelect)
  Returns the status of the NMIAbort for the selected channel.
- void DMA_clearNMIAbort (uint8_t channelSelect)
  Clears the status of the NMIAbort to proceed with transfers for the selected channel.
- void DMA_disableTransferDuringReadModifyWrite (void)
  Disables the DMA from stopping the CPU during a Read-Modify-Write Operation to start a transfer.
- void DMA_enableTransferDuringReadModifyWrite (void)
  Enables the DMA to stop the CPU during a Read-Modify-Write Operation to start a transfer.
- void DMA_enableRoundRobinPriority (void)
  Enables Round Robin prioritization.
- void DMA_disableRoundRobinPriority (void)
  Disables Round Robin prioritization.
- void DMA_enableNMIAbort (void)
  Enables a NMI to interrupt a DMA transfer.
- void DMA_disableNMIAbort (void)
  Disables any NMI from interrupting a DMA transfer.

15.2.1 Detailed Description

The DMA API is broken into three groups of functions: those that deal with initialization and transfers, those that handle interrupts, and those that affect all DMA channels.

The DMA initialization and transfer functions are: DMA_init() DMA_setSrcAddress() DMA_setDstAddress() DMA_enableTransfers() DMA_disableTransfers() DMA_startTransfer() DMA_setTransferSize() DMA_getTransferSize()

The DMA interrupts are handled by: DMA_enableInterrupt() DMA_disableInterrupt() DMA_getInterruptStatus() DMA_clearInterrupt() DMA_getNMIAbortStatus() DMA_clearNMIAbort()

Features of the DMA that affect all channels are handled by: DMA_disableTransferDuringReadModifyWrite() DMA_enableTransferDuringReadModifyWrite() DMA_enableRoundRobinPriority() DMA_disableRoundRobinPriority() DMA_enableNMIAbort() DMA_disableNMIAbort()

15.2.2 Function Documentation

DMA_clearInterrupt()

```
void DMA_clearInterrupt (
            uint8_t channelSelect )
```

Clears the interrupt flag for the selected channel.

This function clears the DMA interrupt flag is cleared, so that it no longer asserts.

Parameters

channelSelect	is the specified channel to clear the interrupt flag for. Valid values are: ■ **DMA_CHANNEL_0** ■ **DMA_CHANNEL_1** ■ **DMA_CHANNEL_2** ■ **DMA_CHANNEL_3** ■ **DMA_CHANNEL_4** ■ **DMA_CHANNEL_5** ■ **DMA_CHANNEL_6** ■ **DMA_CHANNEL_7**

Returns

None

DMA_clearNMIAbort()

```
void DMA_clearNMIAbort (
            uint8_t channelSelect )
```

Clears the status of the NMIAbort to proceed with transfers for the selected channel.

This function clears the status of the NMI Abort flag for the selected channel to allow for transfers on the channel to continue.

Parameters

channelSelect	is the specified channel to clear the NMI Abort flag for. Valid values are: ■ **DMA_CHANNEL_0** ■ **DMA_CHANNEL_1** ■ **DMA_CHANNEL_2** ■ **DMA_CHANNEL_3** ■ **DMA_CHANNEL_4** ■ **DMA_CHANNEL_5** ■ **DMA_CHANNEL_6** ■ **DMA_CHANNEL_7**

Returns

None

DMA_disableInterrupt()

```
void DMA_disableInterrupt (
            uint8_t channelSelect )
```

Disables the DMA interrupt for the selected channel.

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

Parameters

channelSelect	is the specified channel to disable the interrupt for. Valid values are: ■ **DMA_CHANNEL_0** ■ **DMA_CHANNEL_1** ■ **DMA_CHANNEL_2** ■ **DMA_CHANNEL_3** ■ **DMA_CHANNEL_4** ■ **DMA_CHANNEL_5** ■ **DMA_CHANNEL_6** ■ **DMA_CHANNEL_7**

Returns

None

DMA_disableNMIAbort()

```
void DMA_disableNMIAbort (
            void )
```

Disables any NMI from interrupting a DMA transfer.

This function disables NMI's from interrupting any DMA transfer currently in progress.

Returns

None

DMA_disableRoundRobinPriority()

```
void DMA_disableRoundRobinPriority (
            void )
```

Disables Round Robin prioritization.

This function disables Round Robin Prioritization, enabling static prioritization of the DMA channels. In static prioritization, the DMA channels are prioritized with the lowest DMA channel index having the highest priority (i.e. DMA Channel 0 has the highest priority).

Returns

None

DMA_disableTransferDuringReadModifyWrite()

```
void DMA_disableTransferDuringReadModifyWrite (
            void )
```

Disables the DMA from stopping the CPU during a Read-Modify-Write Operation to start a transfer.

This function allows the CPU to finish any read-modify-write operations it may be in the middle of before transfers of and DMA channel stop the CPU.

Returns

None

DMA_disableTransfers()

```
void DMA_disableTransfers (
            uint8_t channelSelect )
```

Disables transfers from being triggered.

This function disables transfer from being triggered for the selected channel. This function should be called before any re-initialization of the selected DMA channel.

Parameters

channelSelect	is the specified channel to disable transfers for. Valid values are: ■ **DMA_CHANNEL_0** ■ **DMA_CHANNEL_1** ■ **DMA_CHANNEL_2** ■ **DMA_CHANNEL_3** ■ **DMA_CHANNEL_4** ■ **DMA_CHANNEL_5** ■ **DMA_CHANNEL_6** ■ **DMA_CHANNEL_7**

Returns

None

DMA_enableInterrupt()

```
void DMA_enableInterrupt (
            uint8_t channelSelect )
```

Enables the DMA interrupt for the selected channel.

Enables the DMA interrupt source. 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

channelSelect	is the specified channel to enable the interrupt for. Valid values are: ■ **DMA_CHANNEL_0** ■ **DMA_CHANNEL_1** ■ **DMA_CHANNEL_2** ■ **DMA_CHANNEL_3** ■ **DMA_CHANNEL_4** ■ **DMA_CHANNEL_5** ■ **DMA_CHANNEL_6** ■ **DMA_CHANNEL_7**

Returns

None

DMA_enableNMIAbort()

```
void DMA_enableNMIAbort (
            void )
```

Enables a NMI to interrupt a DMA transfer.

This function allow NMI's to interrupting any DMA transfer currently in progress and stops any future transfers to begin before the NMI is done processing.

Returns

None

DMA_enableRoundRobinPriority()

```
void DMA_enableRoundRobinPriority (
            void )
```

Enables Round Robin prioritization.

This function enables Round Robin Prioritization of DMA channels. In the case of Round Robin Prioritization, the last DMA channel to have transferred data then has the last priority, which comes into play when multiple DMA channels are ready to transfer at the same time.

Returns

None

DMA_enableTransferDuringReadModifyWrite()

```
void DMA_enableTransferDuringReadModifyWrite (
            void )
```

Enables the DMA to stop the CPU during a Read-Modify-Write Operation to start a transfer.

This function allows the DMA to stop the CPU in the middle of a read- modify-write operation to transfer data.

Returns

None

DMA_enableTransfers()

```
void DMA_enableTransfers (
            uint8_t channelSelect )
```

Enables transfers to be triggered.

This function enables transfers upon appropriate trigger of the selected trigger source for the selected channel.

Parameters

channelSelect	is the specified channel to enable transfer for. Valid values are: ■ **DMA_CHANNEL_0** ■ **DMA_CHANNEL_1** ■ **DMA_CHANNEL_2** ■ **DMA_CHANNEL_3** ■ **DMA_CHANNEL_4** ■ **DMA_CHANNEL_5** ■ **DMA_CHANNEL_6** ■ **DMA_CHANNEL_7**

Returns

None

DMA_getInterruptStatus()

```
uint16_t DMA_getInterruptStatus (
            uint8_t channelSelect )
```

Returns the status of the interrupt flag for the selected channel.

Returns the status of the interrupt flag for the selected channel.

Parameters

channelSelect	is the specified channel to return the interrupt flag status from. Valid values are: ■ **DMA_CHANNEL_0** ■ **DMA_CHANNEL_1** ■ **DMA_CHANNEL_2** ■ **DMA_CHANNEL_3** ■ **DMA_CHANNEL_4** ■ **DMA_CHANNEL_5** ■ **DMA_CHANNEL_6** ■ **DMA_CHANNEL_7**

Returns

One of the following:
- **DMA_INT_INACTIVE**
- **DMA_INT_ACTIVE**
indicating the status of the current interrupt flag

DMA_getNMIAbortStatus()

```
uint16_t DMA_getNMIAbortStatus (
        uint8_t channelSelect )
```

Returns the status of the NMIAbort for the selected channel.

This function returns the status of the NMI Abort flag for the selected channel. If this flag has been set, it is because a transfer on this channel was aborted due to a interrupt from an NMI.

Parameters

channelSelect	is the specified channel to return the status of the NMI Abort flag for. Valid values are: ■ **DMA_CHANNEL_0** ■ **DMA_CHANNEL_1** ■ **DMA_CHANNEL_2** ■ **DMA_CHANNEL_3** ■ **DMA_CHANNEL_4** ■ **DMA_CHANNEL_5** ■ **DMA_CHANNEL_6** ■ **DMA_CHANNEL_7**

Returns

One of the following:
- **DMA_NOTABORTED**
- **DMA_ABORTED**
indicating the status of the NMIAbort for the selected channel

DMA_getTransferSize()

```
uint16_t DMA_getTransferSize (
        uint8_t channelSelect )
```

Gets the amount of transfers for the selected DMA channel.

This function gets the amount of transfers for the selected DMA channel without having to reinitialize the DMA channel.

Parameters

channelSelect	is the specified channel to set source address direction for. Valid values are: ■ **DMA_CHANNEL_0** ■ **DMA_CHANNEL_1** ■ **DMA_CHANNEL_2** ■ **DMA_CHANNEL_3** ■ **DMA_CHANNEL_4** ■ **DMA_CHANNEL_5** ■ **DMA_CHANNEL_6** ■ **DMA_CHANNEL_7**

Returns

the amount of transfers

DMA_init()

```
void DMA_init (
            DMA_initParam * param )
```

Initializes the specified DMA channel.

This function initializes the specified DMA channel. Upon successful completion of initialization of the selected channel the control registers will be cleared and the given variables will be set. Please note, if transfers have been enabled with the enableTransfers() function, then a call to disableTransfers() is necessary before re-initialization. Also note, that the trigger sources are device dependent and can be found in the device family data sheet. The amount of DMA channels available are also device specific.

Parameters

param	is the pointer to struct for initialization.

Returns

STATUS_SUCCESS or STATUS_FAILURE of the initialization process.

References DMA_initParam::channelSelect, DMA_initParam::transferModeSelect, DMA_initParam::transferSize, DMA_initParam::transferUnitSelect, DMA_initParam::triggerSourceSelect, and DMA_initParam::triggerTypeSelect.

DMA_setDstAddress()

```
void DMA_setDstAddress (
            uint8_t channelSelect,
            uint32_t dstAddress,
```

```
            uint16_t directionSelect )
```

Sets the destination address and the direction that the destination address will move after a transfer.

This function sets the destination address and the direction that the destination address will move after a transfer is complete. It may be incremented, decremented, or unchanged.

Parameters

channelSelect	is the specified channel to set the destination address direction for. Valid values are: ■ **DMA_CHANNEL_0** ■ **DMA_CHANNEL_1** ■ **DMA_CHANNEL_2** ■ **DMA_CHANNEL_3** ■ **DMA_CHANNEL_4** ■ **DMA_CHANNEL_5** ■ **DMA_CHANNEL_6** ■ **DMA_CHANNEL_7**
dstAddress	is the address of where the data will be transferred to. Modified bits are **DMAxDA** of **DMAxDA** register.
directionSelect	is the specified direction of the destination address after a transfer. Valid values are: ■ **DMA_DIRECTION_UNCHANGED** ■ **DMA_DIRECTION_DECREMENT** ■ **DMA_DIRECTION_INCREMENT** Modified bits are **DMADSTINCR** of **DMAxCTL** register.

Returns

None

DMA_setSrcAddress()

```
void DMA_setSrcAddress (
            uint8_t channelSelect,
            uint32_t srcAddress,
            uint16_t directionSelect )
```

Sets source address and the direction that the source address will move after a transfer.

This function sets the source address and the direction that the source address will move after a transfer is complete. It may be incremented, decremented or unchanged.

Parameters

channelSelect	is the specified channel to set source address direction for. Valid values are: ■ **DMA_CHANNEL_0** ■ **DMA_CHANNEL_1** ■ **DMA_CHANNEL_2** ■ **DMA_CHANNEL_3** ■ **DMA_CHANNEL_4** ■ **DMA_CHANNEL_5** ■ **DMA_CHANNEL_6** ■ **DMA_CHANNEL_7**
srcAddress	is the address of where the data will be transferred from. Modified bits are **DMAxSA** of **DMAxSA** register.
directionSelect	is the specified direction of the source address after a transfer. Valid values are: ■ **DMA_DIRECTION_UNCHANGED** ■ **DMA_DIRECTION_DECREMENT** ■ **DMA_DIRECTION_INCREMENT** Modified bits are **DMASRCINCR** of **DMAxCTL** register.

Returns

None

DMA_setTransferSize()

```
void DMA_setTransferSize (
            uint8_t channelSelect,
            uint16_t transferSize )
```

Sets the specified amount of transfers for the selected DMA channel.

This function sets the specified amount of transfers for the selected DMA channel without having to reinitialize the DMA channel.

Parameters

channelSelect	is the specified channel to set source address direction for. Valid values are: ■ **DMA_CHANNEL_0** ■ **DMA_CHANNEL_1** ■ **DMA_CHANNEL_2** ■ **DMA_CHANNEL_3** ■ **DMA_CHANNEL_4** ■ **DMA_CHANNEL_5** ■ **DMA_CHANNEL_6** ■ **DMA_CHANNEL_7**
transferSize	is the amount of transfers to complete in a block transfer mode, as well as how many transfers to complete before the interrupt flag is set. Valid value is between 1-65535, if 0, no transfers will occur. Modified bits are **DMAxSZ** of **DMAxSZ** register.

Returns

None

DMA_startTransfer()

```
void DMA_startTransfer (
            uint8_t channelSelect )
```

Starts a transfer if using the default trigger source selected in initialization.

This functions triggers a transfer of data from source to destination if the trigger source chosen from initialization is the DMA_TRIGGERSOURCE_0. Please note, this function needs to be called for each (repeated-)single transfer, and when transferAmount of transfers have been complete in (repeated-)block transfers.

Parameters

channelSelect	is the specified channel to start transfers for. Valid values are: ■ **DMA_CHANNEL_0** ■ **DMA_CHANNEL_1** ■ **DMA_CHANNEL_2** ■ **DMA_CHANNEL_3** ■ **DMA_CHANNEL_4** ■ **DMA_CHANNEL_5** ■ **DMA_CHANNEL_6** ■ **DMA_CHANNEL_7**

Returns

None

15.3 Programming Example

The following example shows how to initialize and use the DMA API to transfer words from one spot in RAM to another.

```
// Initialize and Setup DMA Channel 0
/*
 * Base Address of the DMA Module
 * Configure DMA channel 0
 * Configure channel for repeated block transfers
 * DMA interrupt flag will be set after every 16 transfers
 * Use DMA_startTransfer() function to trigger transfers
 * Transfer Word-to-Word
 * Trigger upon Rising Edge of Trigger Source Signal
 */
DMA_initParam param = {0};
param.channelSelect = DMA_CHANNEL_0;
param.transferModeSelect = DMA_TRANSFER_REPEATED_BLOCK;
param.transferSize = 16;
param.triggerSourceSelect = DMA_TRIGGERSOURCE_0;
param.transferUnitSelect = DMA_SIZE_SRCWORD_DSTWORD;
param.triggerTypeSelect = DMA_TRIGGER_RISINGEDGE;
DMA_init(&param);
/*
 * Base Address of the DMA Module
 * Configure DMA channel 0
 * Use 0x1C00 as source
 * Increment source address after every transfer
 */
DMA_setSrcAddress(DMA_CHANNEL_0,
                  0x1C00,
                  DMA_DIRECTION_INCREMENT);
/*
 * Base Address of the DMA Module
 * Configure DMA channel 0
 * Use 0x1C20 as destination
 * Increment destination address after every transfer
 */
DMA_setDstAddress(DMA_CHANNEL_0,
                  0x1C20,
                  DMA_DIRECTION_INCREMENT);

// Enable transfers on DMA channel 0
DMA_enableTransfers(DMA_CHANNEL_0);

while(1)
{
  // Start block transfer on DMA channel 0
  DMA_startTransfer(DMA_CHANNEL_0);
}
```

16 EUSCI Universal Asynchronous Receiver/Transmitter (EUSCI_A_UART)

16.1 Introduction

The MSP430Ware library for UART mode 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 USCI 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 USCI. The transmit and receive functions use the same baud-rate frequency.

16.2 API Functions

Functions

- 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 clockPrescalar, firstModReg, secondModReg and overSampling parameters should be pre-computed and passed into the initialization function.
- void EUSCI_A_UART_transmitData (uint16_t baseAddress, uint8_t transmitData)
  Transmits a byte from the UART Module.Please note that if TX interrupt is disabled, this function manually polls the TX IFG flag waiting for an indication that it is safe to write to the transmit buffer and does not time-out.
- uint8_t EUSCI_A_UART_receiveData (uint16_t baseAddress)
  Receives a byte that has been sent to the UART Module.
- void EUSCI_A_UART_enableInterrupt (uint16_t baseAddress, uint8_t mask)
  Enables individual UART interrupt sources.
- void EUSCI_A_UART_disableInterrupt (uint16_t baseAddress, uint8_t mask)
  Disables individual UART interrupt sources.
- uint8_t EUSCI_A_UART_getInterruptStatus (uint16_t baseAddress, uint8_t mask)

Gets the current UART interrupt status.
- void EUSCI_A_UART_clearInterrupt (uint16_t baseAddress, uint16_t mask)
  Clears UART interrupt sources.
- void EUSCI_A_UART_enable (uint16_t baseAddress)
  Enables the UART block.
- void EUSCI_A_UART_disable (uint16_t baseAddress)
  Disables the UART block.
- uint8_t EUSCI_A_UART_queryStatusFlags (uint16_t baseAddress, uint8_t mask)
  Gets the current UART status flags.
- void EUSCI_A_UART_setDormant (uint16_t baseAddress)
  Sets the UART module in dormant mode.
- void EUSCI_A_UART_resetDormant (uint16_t baseAddress)
  Re-enables UART module from dormant mode.
- 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.
- void EUSCI_A_UART_transmitBreak (uint16_t baseAddress)
  Transmit break.
- uint32_t EUSCI_A_UART_getReceiveBufferAddress (uint16_t baseAddress)
  Returns the address of the RX Buffer of the UART for the DMA module.
- uint32_t EUSCI_A_UART_getTransmitBufferAddress (uint16_t baseAddress)
  Returns the address of the TX Buffer of the UART for the DMA module.
- void EUSCI_A_UART_selectDeglitchTime (uint16_t baseAddress, uint16_t deglitchTime)
  Sets the deglitch time.

16.2.1 Detailed Description

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

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

Configuration and control of the EUSI_UART are handled by the

- EUSCI_A_UART_init()
- EUSCI_A_UART_initAdvance()
- 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 EUSI_UART is handled by the

- EUSCI_A_UART_transmitData()
- EUSCI_A_UART_receiveData()
- EUSCI_A_UART_transmitAddress()
- EUSCI_A_UART_transmitBreak()
- EUSCI_A_UART_getTransmitBufferAddress()
- EUSCI_A_UART_getTransmitBufferAddress()

Managing the EUSI_UART interrupts and status are handled by the

- EUSCI_A_UART_enableInterrupt()
- EUSCI_A_UART_disableInterrupt()
- EUSCI_A_UART_getInterruptStatus()
- EUSCI_A_UART_clearInterrupt()
- EUSCI_A_UART_queryStatusFlags()

16.2.2 Function Documentation

EUSCI_A_UART_clearInterrupt()

```
void EUSCI_A_UART_clearInterrupt (
            uint16_t baseAddress,
            uint16_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

EUSCI_A_UART_disable()

```
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

EUSCI_A_UART_disableInterrupt()

```
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

EUSCI_A_UART_enable()

```
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

EUSCI_A_UART_enableInterrupt()

```
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.

Parameters

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

EUSCI_A_UART_getInterruptStatus()

```
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

EUSCI_A_UART_getReceiveBufferAddress()

```
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

EUSCI_A_UART_getTransmitBufferAddress()

```
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

EUSCI_A_UART_init()

```
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 clockPrescalar, 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 clockPrescalar, 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

References EUSCI_A_UART_initParam::clockPrescalar, EUSCI_A_UART_initParam::firstModReg, EUSCI_A_UART_initParam::msborLsbFirst, EUSCI_A_UART_initParam::numberofStopBits, EUSCI_A_UART_initParam::overSampling, EUSCI_A_UART_initParam::parity, EUSCI_A_UART_initParam::secondModReg, EUSCI_A_UART_initParam::selectClockSource, and EUSCI_A_UART_initParam::uartMode.

EUSCI_A_UART_queryStatusFlags()

```
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

EUSCI_A_UART_receiveData()

```
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.

EUSCI_A_UART_resetDormant()

```
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

EUSCI_A_UART_selectDeglitchTime()

```
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

EUSCI_A_UART_setDormant()

```
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

EUSCI_A_UART_transmitAddress()

```
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

EUSCI_A_UART_transmitBreak()

```
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

EUSCI_A_UART_transmitData()

```
void EUSCI_A_UART_transmitData (
```

```
uint16_t baseAddress,
uint8_t transmitData )
```

Transmits a byte from the UART Module.Please note that if TX interrupt is disabled, this function manually polls the TX IFG flag waiting for an indication that it is safe to write to the transmit buffer and does not time-out.

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

16.3 Programming Example

The following example shows how to use the EUSI_UART API to initialize the EUSI_UART, transmit characters, and receive characters.

```
// Configure UART
  EUSCI_A_UART_initParam param = {0};
  param.selectClockSource = EUSCI_A_UART_CLOCKSOURCE_ACLK;
  param.clockPrescalar = 15;
  param.firstModReg = 0;
  param.secondModReg = 68;
  param.parity = EUSCI_A_UART_NO_PARITY;
  param.msborLsbFirst = EUSCI_A_UART_LSB_FIRST;
  param.numberofStopBits = EUSCI_A_UART_ONE_STOP_BIT;
  param.uartMode = EUSCI_A_UART_MODE;
  param.overSampling = EUSCI_A_UART_LOW_FREQUENCY_BAUDRATE_GENERATION;

  if (STATUS_FAIL == EUSCI_A_UART_init(EUSCI_A0_BASE, &param)) {
      return;
  }

  EUSCI_A_UART_enable(EUSCI_A0_BASE);

  // Enable USCI_A0 RX interrupt
  EUSCI_A_UART_enableInterrupt(EUSCI_A0_BASE,
        EUSCI_A_UART_RECEIVE_INTERRUPT);
```

17 EUSCI Synchronous Peripheral Interface (EUSCI_A_SPI)

17.1 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.

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.

17.2 Functions

Functions

- void EUSCI_A_SPI_initMaster (uint16_t baseAddress, EUSCI_A_SPI_initMasterParam ∗param)
  Initializes the SPI Master block.
- void EUSCI_A_SPI_select4PinFunctionality (uint16_t baseAddress, uint16_t select4PinFunctionality)
  Selects 4Pin Functionality.
- 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.
- void EUSCI_A_SPI_initSlave (uint16_t baseAddress, EUSCI_A_SPI_initSlaveParam ∗param)
  Initializes the SPI Slave block.
- 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.
- void EUSCI_A_SPI_transmitData (uint16_t baseAddress, uint8_t transmitData)
  Transmits a byte from the SPI Module.
- uint8_t EUSCI_A_SPI_receiveData (uint16_t baseAddress)
  Receives a byte that has been sent to the SPI Module.
- void EUSCI_A_SPI_enableInterrupt (uint16_t baseAddress, uint16_t mask)
  Enables individual SPI interrupt sources.
- void EUSCI_A_SPI_disableInterrupt (uint16_t baseAddress, uint16_t mask)
  Disables individual SPI interrupt sources.

- uint8_t EUSCI_A_SPI_getInterruptStatus (uint16_t baseAddress, uint8_t mask)
  Gets the current SPI interrupt status.
- void EUSCI_A_SPI_clearInterrupt (uint16_t baseAddress, uint16_t mask)
  Clears the selected SPI interrupt status flag.
- void EUSCI_A_SPI_enable (uint16_t baseAddress)
  Enables the SPI block.
- void EUSCI_A_SPI_disable (uint16_t baseAddress)
  Disables the SPI block.
- uint32_t EUSCI_A_SPI_getReceiveBufferAddress (uint16_t baseAddress)
  Returns the address of the RX Buffer of the SPI for the DMA module.
- uint32_t EUSCI_A_SPI_getTransmitBufferAddress (uint16_t baseAddress)
  Returns the address of the TX Buffer of the SPI for the DMA module.
- uint16_t EUSCI_A_SPI_isBusy (uint16_t baseAddress)
  Indicates whether or not the SPI bus is busy.

17.2.1 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_masterChangeClock()
- 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_clearInterrupt()

DMA related

- EUSCI_A_SPI_getReceiveBufferAddressForDMA()
- EUSCI_A_SPI_getTransmitBufferAddressForDMA()

17.2.2 Function Documentation

EUSCI_A_SPI_changeClockPhasePolarity()

```
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

EUSCI_A_SPI_changeMasterClock()

```
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

References EUSCI_A_SPI_changeMasterClockParam::clockSourceFrequency, and EUSCI_A_SPI_changeMasterClockParam::desiredSpiClock.

EUSCI_A_SPI_clearInterrupt()

```
void EUSCI_A_SPI_clearInterrupt (
            uint16_t baseAddress,
            uint16_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

EUSCI_A_SPI_disable()

```
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

EUSCI_A_SPI_disableInterrupt()

```
void EUSCI_A_SPI_disableInterrupt (
            uint16_t baseAddress,
            uint16_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

EUSCI_A_SPI_enable()

```
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

EUSCI_A_SPI_enableInterrupt()

```
void EUSCI_A_SPI_enableInterrupt (
            uint16_t baseAddress,
            uint16_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

EUSCI_A_SPI_getInterruptStatus()

```
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

EUSCI_A_SPI_getReceiveBufferAddress()

```
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

EUSCI_A_SPI_getTransmitBufferAddress()

```
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

EUSCI_A_SPI_initMaster()

```
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

References EUSCI_A_SPI_initMasterParam::clockPhase, EUSCI_A_SPI_initMasterParam::clockPolarity, EUSCI_A_SPI_initMasterParam::clockSourceFrequency, EUSCI_A_SPI_initMasterParam::desiredSpiClock, EUSCI_A_SPI_initMasterParam::msbFirst, EUSCI_A_SPI_initMasterParam::selectClockSource, and EUSCI_A_SPI_initMasterParam::spiMode.

EUSCI_A_SPI_initSlave()

```
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

References EUSCI_A_SPI_initSlaveParam::clockPhase, EUSCI_A_SPI_initSlaveParam::clockPolarity, EUSCI_A_SPI_initSlaveParam::msbFirst, and EUSCI_A_SPI_initSlaveParam::spiMode.

EUSCI_A_SPI_isBusy()

```
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

EUSCI_A_SPI_receiveData()

```
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.

EUSCI_A_SPI_select4PinFunctionality()

```
void EUSCI_A_SPI_select4PinFunctionality (
            uint16_t baseAddress,
            uint16_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.

Parameters

select4PinFunctionality	selects 4 pin functionality Valid values are: ■ **EUSCI_A_SPI_PREVENT_CONFLICTS_WITH_OTHER_MA↩ STERS** ■ **EUSCI_A_SPI_ENABLE_SIGNAL_FOR_4WIRE_SLAVE**

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

Returns

None

EUSCI_A_SPI_transmitData()

```
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

17.3 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.

```
//Initialize slave to MSB first, inactive high clock polarity and 3 wire SPI
EUSCI_A_SPI_initSlaveParam param = {0};
param.msbFirst = EUSCI_A_SPI_MSB_FIRST;
param.clockPhase = EUSCI_A_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON_NEXT;
param.clockPolarity = EUSCI_A_SPI_CLOCKPOLARITY_INACTIVITY_HIGH;
param.spiMode = EUSCI_A_SPI_3PIN;
EUSCI_A_SPI_initSlave(EUSCI_A0_BASE, &param);


//Enable SPI Module
EUSCI_A_SPI_enable(EUSCI_A0_BASE);

//Enable Receive interrupt
EUSCI_A_SPI_enableInterrupt(EUSCI_A0_BASE,
        EUSCI_A_SPI_RECEIVE_INTERRUPT
        );
```

18 EUSCI Synchronous Peripheral Interface (EUSCI_B_SPI)

18.1 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.

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.

18.2 Functions

Functions

- void EUSCI_B_SPI_initMaster (uint16_t baseAddress, EUSCI_B_SPI_initMasterParam ∗param)
  Initializes the SPI Master block.
- void EUSCI_B_SPI_select4PinFunctionality (uint16_t baseAddress, uint16_t select4PinFunctionality)
  Selects 4Pin Functionality.
- 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.
- void EUSCI_B_SPI_initSlave (uint16_t baseAddress, EUSCI_B_SPI_initSlaveParam ∗param)
  Initializes the SPI Slave block.
- 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.
- void EUSCI_B_SPI_transmitData (uint16_t baseAddress, uint8_t transmitData)
  Transmits a byte from the SPI Module.
- uint8_t EUSCI_B_SPI_receiveData (uint16_t baseAddress)
  Receives a byte that has been sent to the SPI Module.
- void EUSCI_B_SPI_enableInterrupt (uint16_t baseAddress, uint16_t mask)
  Enables individual SPI interrupt sources.
- void EUSCI_B_SPI_disableInterrupt (uint16_t baseAddress, uint16_t mask)
  Disables individual SPI interrupt sources.

- uint8_t EUSCI_B_SPI_getInterruptStatus (uint16_t baseAddress, uint8_t mask)
  Gets the current SPI interrupt status.
- void EUSCI_B_SPI_clearInterrupt (uint16_t baseAddress, uint16_t mask)
  Clears the selected SPI interrupt status flag.
- void EUSCI_B_SPI_enable (uint16_t baseAddress)
  Enables the SPI block.
- void EUSCI_B_SPI_disable (uint16_t baseAddress)
  Disables the SPI block.
- uint32_t EUSCI_B_SPI_getReceiveBufferAddress (uint16_t baseAddress)
  Returns the address of the RX Buffer of the SPI for the DMA module.
- uint32_t EUSCI_B_SPI_getTransmitBufferAddress (uint16_t baseAddress)
  Returns the address of the TX Buffer of the SPI for the DMA module.
- uint16_t EUSCI_B_SPI_isBusy (uint16_t baseAddress)
  Indicates whether or not the SPI bus is busy.

18.2.1 Detailed Description

To use the module as a master, the user must call EUSCI_B_SPI_masterInit() 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_slaveInit() 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_masterInit()
- EUSCI_B_SPI_slaveInit()
- EUSCI_B_SPI_disable()
- EUSCI_B_SPI_enable()
- EUSCI_B_SPI_masterChangeClock()
- 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_clearInterrupt()

DMA related

- EUSCI_B_SPI_getReceiveBufferAddressForDMA()
- EUSCI_B_SPI_getTransmitBufferAddressForDMA()

18.2.2 Function Documentation

EUSCI_B_SPI_changeClockPhasePolarity()

```
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

EUSCI_B_SPI_changeMasterClock()

```
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

References EUSCI_B_SPI_changeMasterClockParam::clockSourceFrequency, and EUSCI_B_SPI_changeMasterClockParam::desiredSpiClock.

EUSCI_B_SPI_clearInterrupt()

```
void EUSCI_B_SPI_clearInterrupt (
            uint16_t baseAddress,
            uint16_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

EUSCI_B_SPI_disable()

```
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

EUSCI_B_SPI_disableInterrupt()

```
void EUSCI_B_SPI_disableInterrupt (
            uint16_t baseAddress,
            uint16_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

EUSCI_B_SPI_enable()

```
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

EUSCI_B_SPI_enableInterrupt()

```
void EUSCI_B_SPI_enableInterrupt (
            uint16_t baseAddress,
            uint16_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

EUSCI_B_SPI_getInterruptStatus()

```
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

EUSCI_B_SPI_getReceiveBufferAddress()

```
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

EUSCI_B_SPI_getTransmitBufferAddress()

```
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

EUSCI_B_SPI_initMaster()

```
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

References EUSCI_B_SPI_initMasterParam::clockPhase, EUSCI_B_SPI_initMasterParam::clockPolarity, EUSCI_B_SPI_initMasterParam::clockSourceFrequency, EUSCI_B_SPI_initMasterParam::desiredSpiClock, EUSCI_B_SPI_initMasterParam::msbFirst, EUSCI_B_SPI_initMasterParam::selectClockSource, and EUSCI_B_SPI_initMasterParam::spiMode.

EUSCI_B_SPI_initSlave()

```
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

References EUSCI_B_SPI_initSlaveParam::clockPhase, EUSCI_B_SPI_initSlaveParam::clockPolarity, EUSCI_B_SPI_initSlaveParam::msbFirst, and EUSCI_B_SPI_initSlaveParam::spiMode.

EUSCI_B_SPI_isBusy()

```
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

EUSCI_B_SPI_receiveData()

```
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.

EUSCI_B_SPI_select4PinFunctionality()

```
void EUSCI_B_SPI_select4PinFunctionality (
            uint16_t baseAddress,
            uint16_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.

Parameters

select4PinFunctionality	selects 4 pin functionality Valid values are: ▪ **EUSCI_B_SPI_PREVENT_CONFLICTS_WITH_OTHER_MA←STERS** ▪ **EUSCI_B_SPI_ENABLE_SIGNAL_FOR_4WIRE_SLAVE**

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

Returns

None

EUSCI_B_SPI_transmitData()

```
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

18.3 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.

```
//Initialize slave to MSB first, inactive high clock polarity and 3 wire SPI
EUSCI_B_SPI_initSlaveParam param = {0};
param.msbFirst = EUSCI_B_SPI_MSB_FIRST;
param.clockPhase = EUSCI_B_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON_NEXT;
param.clockPolarity = EUSCI_B_SPI_CLOCKPOLARITY_INACTIVITY_HIGH;
param.spiMode = EUSCI_B_SPI_3PIN;
EUSCI_B_SPI_initSlave(EUSCI_B0_BASE, &param);

//Enable SPI Module
EUSCI_B_SPI_enable(EUSCI_B0_BASE);

//Enable Receive interrupt
EUSCI_B_SPI_enableInterrupt(EUSCI_B0_BASE,
        EUSCI_B_SPI_RECEIVE_INTERRUPT
        );
```

19 EUSCI Inter-Integrated Circuit (EUSCI_B_I2C)

19.1 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 MSP430Ware I2C modules. 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 MSP430Ware I2C modules support both sending and receiving data as either a master or a slave, and also support 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.

19.2 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_masterSendMultiByteStart()
- EUSCI_B_I2C_masterSendMultiByteNext()
- EUSCI_B_I2C_masterSendMultiByteStop()

Master Single Byte Reception

- EUSCI_B_I2C_masterReceiveSingleByte()

Master Multiple Byte Reception

- EUSCI_B_I2C_masterMultiByteReceiveStart()
- EUSCI_B_I2C_masterReceiveMultiByteNext()
- EUSCI_B_I2C_masterReceiveMultiByteFinish()
- EUSCI_B_I2C_masterReceiveMultiByteStop()

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

19.3 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. 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_slavePutData()

Slave Reception API

- EUSCI_B_I2C_slaveGetData()

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

19.4 API Functions

Functions

- void EUSCI_B_I2C_initMaster (uint16_t baseAddress, EUSCI_B_I2C_initMasterParam ∗param)
  Initializes the I2C Master block.
- void EUSCI_B_I2C_initSlave (uint16_t baseAddress, EUSCI_B_I2C_initSlaveParam ∗param)
  Initializes the I2C Slave block.
- void EUSCI_B_I2C_enable (uint16_t baseAddress)
  Enables the I2C block.
- void EUSCI_B_I2C_disable (uint16_t baseAddress)
  Disables the I2C block.
- void EUSCI_B_I2C_setSlaveAddress (uint16_t baseAddress, uint8_t slaveAddress)
  Sets the address that the I2C Master will place on the bus.
- void EUSCI_B_I2C_setMode (uint16_t baseAddress, uint16_t mode)
  Sets the mode of the I2C device.
- uint8_t EUSCI_B_I2C_getMode (uint16_t baseAddress)
  Gets the mode of the I2C device.
- void EUSCI_B_I2C_slavePutData (uint16_t baseAddress, uint8_t transmitData)
  Transmits a byte from the I2C Module.
- uint8_t EUSCI_B_I2C_slaveGetData (uint16_t baseAddress)
  Receives a byte that has been sent to the I2C Module.
- uint16_t EUSCI_B_I2C_isBusBusy (uint16_t baseAddress)
  Indicates whether or not the I2C bus is busy.
- uint16_t EUSCI_B_I2C_masterIsStopSent (uint16_t baseAddress)
  Indicates whether STOP got sent.
- uint16_t EUSCI_B_I2C_masterIsStartSent (uint16_t baseAddress)
  Indicates whether Start got sent.
- void EUSCI_B_I2C_enableInterrupt (uint16_t baseAddress, uint16_t mask)
  Enables individual I2C interrupt sources.
- void EUSCI_B_I2C_disableInterrupt (uint16_t baseAddress, uint16_t mask)
  Disables individual I2C interrupt sources.
- void EUSCI_B_I2C_clearInterrupt (uint16_t baseAddress, uint16_t mask)
  Clears I2C interrupt sources.
- uint16_t EUSCI_B_I2C_getInterruptStatus (uint16_t baseAddress, uint16_t mask)
  Gets the current I2C interrupt status.
- void EUSCI_B_I2C_masterSendSingleByte (uint16_t baseAddress, uint8_t txData)
  Does single byte transmission from Master to Slave.
- uint8_t EUSCI_B_I2C_masterReceiveSingleByte (uint16_t baseAddress)
  Does single byte reception from Slave.
- bool EUSCI_B_I2C_masterSendSingleByteWithTimeout (uint16_t baseAddress, uint8_t txData, uint32_t timeout)
  Does single byte transmission from Master to Slave with timeout.
- void EUSCI_B_I2C_masterSendMultiByteStart (uint16_t baseAddress, uint8_t txData)

Starts multi-byte transmission from Master to Slave.
- bool EUSCI_B_I2C_masterSendMultiByteStartWithTimeout (uint16_t baseAddress, uint8_t txData, uint32_t timeout)
  Starts multi-byte transmission from Master to Slave with timeout.
- void EUSCI_B_I2C_masterSendMultiByteNext (uint16_t baseAddress, uint8_t txData)
  Continues multi-byte transmission from Master to Slave.
- bool EUSCI_B_I2C_masterSendMultiByteNextWithTimeout (uint16_t baseAddress, uint8_t txData, uint32_t timeout)
  Continues multi-byte transmission from Master to Slave with timeout.
- void EUSCI_B_I2C_masterSendMultiByteFinish (uint16_t baseAddress, uint8_t txData)
  Finishes multi-byte transmission from Master to Slave.
- bool EUSCI_B_I2C_masterSendMultiByteFinishWithTimeout (uint16_t baseAddress, uint8_t txData, uint32_t timeout)
  Finishes multi-byte transmission from Master to Slave with timeout.
- void EUSCI_B_I2C_masterSendStart (uint16_t baseAddress)
  This function is used by the Master module to initiate START.
- void EUSCI_B_I2C_masterSendMultiByteStop (uint16_t baseAddress)
  Send STOP byte at the end of a multi-byte transmission from Master to Slave.
- bool EUSCI_B_I2C_masterSendMultiByteStopWithTimeout (uint16_t baseAddress, uint32_t timeout)
  Send STOP byte at the end of a multi-byte transmission from Master to Slave with timeout.
- void EUSCI_B_I2C_masterReceiveStart (uint16_t baseAddress)
  Starts reception at the Master end.
- uint8_t EUSCI_B_I2C_masterReceiveMultiByteNext (uint16_t baseAddress)
  Starts multi-byte reception at the Master end one byte at a time.
- uint8_t EUSCI_B_I2C_masterReceiveMultiByteFinish (uint16_t baseAddress)
  Finishes multi-byte reception at the Master end.
- bool EUSCI_B_I2C_masterReceiveMultiByteFinishWithTimeout (uint16_t baseAddress, uint8_t ∗txData, uint32_t timeout)
  Finishes multi-byte reception at the Master end with timeout.
- void EUSCI_B_I2C_masterReceiveMultiByteStop (uint16_t baseAddress)
  Sends the STOP at the end of a multi-byte reception at the Master end.
- void EUSCI_B_I2C_enableMultiMasterMode (uint16_t baseAddress)
  Enables Multi Master Mode.
- void EUSCI_B_I2C_disableMultiMasterMode (uint16_t baseAddress)
  Disables Multi Master Mode.
- uint8_t EUSCI_B_I2C_masterReceiveSingle (uint16_t baseAddress)
  receives a byte that has been sent to the I2C Master Module.
- uint32_t EUSCI_B_I2C_getReceiveBufferAddress (uint16_t baseAddress)
  Returns the address of the RX Buffer of the I2C for the DMA module.
- uint32_t EUSCI_B_I2C_getTransmitBufferAddress (uint16_t baseAddress)
  Returns the address of the TX Buffer of the I2C for the DMA module.
- void EUSCI_B_I2C_setTimeout (uint16_t baseAddress, uint16_t timeout)
  Enforces a timeout if the I2C clock is held low longer than a defined time.

19.4.1 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_clearInterrupt
- 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_initSlave
- 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_slavePutData
- EUSCI_B_I2C_slaveGetData

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

- EUSCI_B_I2C_masterSendSingleByte
- EUSCI_B_I2C_masterSendStart
- EUSCI_B_I2C_masterSendMultiByteStart
- EUSCI_B_I2C_masterSendMultiByteNext
- EUSCI_B_I2C_masterSendMultiByteFinish
- EUSCI_B_I2C_masterSendMultiByteStop
- EUSCI_B_I2C_masterReceiveMultiByteNext
- EUSCI_B_I2C_masterReceiveMultiByteFinish
- EUSCI_B_I2C_masterReceiveMultiByteStop
- EUSCI_B_I2C_masterReceiveStart
- EUSCI_B_I2C_masterReceiveSingle

19.4.2 Function Documentation

EUSCI_B_I2C_clearInterrupt()

```
void EUSCI_B_I2C_clearInterrupt (
```

```
            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

EUSCI_B_I2C_disable()

```
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

EUSCI_B_I2C_disableInterrupt()

```
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

EUSCI_B_I2C_disableMultiMasterMode()

```
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

EUSCI_B_I2C_enable()

```
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

EUSCI_B_I2C_enableInterrupt()

```
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

EUSCI_B_I2C_enableMultiMasterMode()

```
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

EUSCI_B_I2C_getInterruptStatus()

```
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

EUSCI_B_I2C_getMode()

```
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

One of the following:
- **EUSCI_B_I2C_TRANSMIT_MODE**
- **EUSCI_B_I2C_RECEIVE_MODE**
  indicating the current mode

EUSCI_B_I2C_getReceiveBufferAddress()

```
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

EUSCI_B_I2C_getTransmitBufferAddress()

```
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

EUSCI_B_I2C_initMaster()

```
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

References EUSCI_B_I2C_initMasterParam::autoSTOPGeneration, EUSCI_B_I2C_initMasterParam::byteCounterThreshold, EUSCI_B_I2C_initMasterParam::dataRate, EUSCI_B_I2C_initMasterParam::i2cClk, and EUSCI_B_I2C_initMasterParam::selectClockSource.

EUSCI_B_I2C_initSlave()

```
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

References EUSCI_B_I2C_initSlaveParam::slaveAddress, EUSCI_B_I2C_initSlaveParam::slaveAddressOffset, and EUSCI_B_I2C_initSlaveParam::slaveOwnAddressEnable.

EUSCI_B_I2C_isBusBusy()

```
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

EUSCI_B_I2C_masterIsStartSent()

```
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

EUSCI_B_I2C_masterIsStopSent()

```
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

EUSCI_B_I2C_masterReceiveMultiByteFinish()

```
uint8_t EUSCI_B_I2C_masterReceiveMultiByteFinish (
```

```
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.

EUSCI_B_I2C_masterReceiveMultiByteFinishWithTimeout()

```
bool EUSCI_B_I2C_masterReceiveMultiByteFinishWithTimeout (
            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

EUSCI_B_I2C_masterReceiveMultiByteNext()

```
uint8_t EUSCI_B_I2C_masterReceiveMultiByteNext (
            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.

EUSCI_B_I2C_masterReceiveMultiByteStop()

```
void EUSCI_B_I2C_masterReceiveMultiByteStop (
            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

EUSCI_B_I2C_masterReceiveSingle()

```
uint8_t EUSCI_B_I2C_masterReceiveSingle (
            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.

EUSCI_B_I2C_masterReceiveSingleByte()

```
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.

EUSCI_B_I2C_masterReceiveStart()

```
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

EUSCI_B_I2C_masterSendMultiByteFinish()

```
void EUSCI_B_I2C_masterSendMultiByteFinish (
            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

EUSCI_B_I2C_masterSendMultiByteFinishWithTimeout()

```
bool EUSCI_B_I2C_masterSendMultiByteFinishWithTimeout (
            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.

EUSCI_B_I2C_masterSendMultiByteNext()

```
void EUSCI_B_I2C_masterSendMultiByteNext (
            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

EUSCI_B_I2C_masterSendMultiByteNextWithTimeout()

```
bool EUSCI_B_I2C_masterSendMultiByteNextWithTimeout (
            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.

EUSCI_B_I2C_masterSendMultiByteStart()

```
void EUSCI_B_I2C_masterSendMultiByteStart (
            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

EUSCI_B_I2C_masterSendMultiByteStartWithTimeout()

```
bool EUSCI_B_I2C_masterSendMultiByteStartWithTimeout (
            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.

EUSCI_B_I2C_masterSendMultiByteStop()

```
void EUSCI_B_I2C_masterSendMultiByteStop (
            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

EUSCI_B_I2C_masterSendMultiByteStopWithTimeout()

```
bool EUSCI_B_I2C_masterSendMultiByteStopWithTimeout (
            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.

EUSCI_B_I2C_masterSendSingleByte()

```
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

EUSCI_B_I2C_masterSendSingleByteWithTimeout()

```
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.

EUSCI_B_I2C_masterSendStart()

```
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

EUSCI_B_I2C_setMode()

```
void EUSCI_B_I2C_setMode (
            uint16_t baseAddress,
            uint16_t mode )
```

Sets the mode of the I2C device.

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

EUSCI_B_I2C_setSlaveAddress()

```
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

EUSCI_B_I2C_setTimeout()

```
void EUSCI_B_I2C_setTimeout (
            uint16_t baseAddress,
            uint16_t timeout )
```

Enforces a timeout if the I2C clock is held low longer than a defined time.

By using this function, the UCCLTOIFG interrupt will trigger if the clock is held low longer than this defined time. It is possible to detect the situation, when a clock is stretched by a master or slave for too long. The user can then handle this issue by, for example, resetting the eUSCI_B module. It is possible to select one of three predefined times for the clock low timeout.

Parameters

baseAddress	is the base address of the I2C module.
timeout	how long the clock can be low before a timeout triggers. Enables generation of the UCCLTOIFG interrupt. Valid values are: ■ **EUSCI_B_I2C_TIMEOUT_DISABLE** [Default] ■ **EUSCI_B_I2C_TIMEOUT_28_MS** ■ **EUSCI_B_I2C_TIMEOUT_31_MS** ■ **EUSCI_B_I2C_TIMEOUT_34_MS**

Modified bits are **UCCLTO** of **UCBxCTLW1** register; bits **UCSWRST** of **UCBxCTLW0** register.

Returns

None

EUSCI_B_I2C_slaveGetData()

```
uint8_t EUSCI_B_I2C_slaveGetData (
            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.

EUSCI_B_I2C_slavePutData()

```
void EUSCI_B_I2C_slavePutData (
            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

19.5 Programming Example

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

```
//Initialize Slave
 EUSCI_B_I2C_initSlaveParam param = {0};
 param.slaveAddress = 0x48;
 param.slaveAddressOffset = EUSCI_B_I2C_OWN_ADDRESS_OFFSET0;
 param.slaveOwnAddressEnable = EUSCI_B_I2C_OWN_ADDRESS_ENABLE;
 EUSCI_B_I2C_initSlave(EUSCI_B0_BASE, &param);

 EUSCI_B_I2C_enable(EUSCI_B0_BASE);

 EUSCI_B_I2C_enableInterrupt(EUSCI_B0_BASE,
         EUSCI_B_I2C_TRANSMIT_INTERRUPT0 +
         EUSCI_B_I2C_STOP_INTERRUPT);
```

20 FlashCtl - Flash Memory Controller

20.1 Introduction

The flash memory is byte, word, and long-word addressable and programmable. The flash memory module has an integrated controller that controls programming and erase operations. The flash main memory is partitioned into 512-byte segments. 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. The difference between the sections is the segment size. There are four information memory segments, A through D. Each information memory segment contains 128 bytes and can be erased individually. The bootstrap loader (BSL) memory consists of four segments, A through D. Each BSL memory segment contains 512 bytes and can be erased individually. The main memory segment size is 512 byte. 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.

20.2 API Functions

Functions

- void FlashCtl_eraseSegment (uint8_t ∗flash_ptr)
  Erase a single segment of the flash memory.
- void FlashCtl_eraseBank (uint8_t ∗flash_ptr)
  Erase a single bank of the flash memory.
- void FlashCtl_performMassErase (uint8_t ∗flash_ptr)
  Erase all flash memory.
- bool FlashCtl_performEraseCheck (uint8_t ∗flash_ptr, uint16_t numberOfBytes)
  Erase check of the flash memory.
- void FlashCtl_write8 (uint8_t ∗data_ptr, uint8_t ∗flash_ptr, uint16_t count)
  Write data into the flash memory in byte format, pass by reference.
- void FlashCtl_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.
- void FlashCtl_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.
- void FlashCtl_fillMemory32 (uint32_t value, uint32_t ∗flash_ptr, uint16_t count)
  Write data into the flash memory in 32-bit word format, pass by value.
- uint8_t FlashCtl_getStatus (uint8_t mask)
  Check FlashCtl status to see if it is currently busy erasing or programming.
- void FlashCtl_lockInfoA (void)
  Locks the information flash memory segment A.

- void FlashCtl_unlockInfoA (void)
  Unlocks the information flash memory segment A.

20.2.1 Detailed Description

FlashCtl_eraseSegment helps erase a single segment of the flash memory. A pointer to the flash segment being erased is passed on to this function.

FlashCtl_performEraseCheck 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.

FlashCtl_write8 facilitates writing into the flash memory in byte format. FlashCtl_write16 facilitates writing into the flash memory in word format. FlashCtl_write32 facilitates writing into the flash memory in long format, pass by reference. FlashCtl_fillMemory32 facilitates writing into the flash memory in long format, pass by value. FlashCtl_getStatus checks if the flash is currently busy erasing or programming. FlashCtl_lockInfoA locks segment A of information memory. FlashCtl_unlockInfoA unlocks segment A of 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 segment A of information memory.

The flash erase operations are managed by

- FlashCtl_eraseSegment()
- FlashCtl_eraseBank()

Flash writes are managed by

- FlashCtl_write8()
- FlashCtl_write16()
- FlashCtl_write32()
- FlashCtl_fillMemory32()

The status is given by

- FlashCtl_getStatus()
- FlashCtl_performEraseCheck()

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

- FlashCtl_lockInfoA()
- FlashCtl_unlockInfoA()

20.2.2 Function Documentation

FlashCtl_eraseBank()

```
void FlashCtl_eraseBank (
```

```
uint8_t * flash_ptr )
```

Erase a single bank of the flash memory.

This function erases a single bank of the flash memory. This API will erase the entire flash if device contains only one flash bank.

Parameters

flash_ptr	is a pointer into the bank to be erased

Returns

None

FlashCtl_eraseSegment()

```
void FlashCtl_eraseSegment (
            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

FlashCtl_fillMemory32()

```
void FlashCtl_fillMemory32 (
            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. FlashCtl_eraseSegment 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

FlashCtl_getStatus()

```
uint8_t FlashCtl_getStatus (
            uint8_t mask )
```

Check FlashCtl 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	FLASHCTL status to read Mask value is the logical OR of any of the following: ■ **FLASHCTL_READY_FOR_NEXT_WRITE** ■ **FLASHCTL_ACCESS_VIOLATION_INTERRUPT_FLAG** ■ **FLASHCTL_PASSWORD_WRITTEN_INCORRECTLY** ■ **FLASHCTL_BUSY**

Returns

Logical OR of any of the following:

- **FLASHCTL_READY_FOR_NEXT_WRITE**
- **FLASHCTL_ACCESS_VIOLATION_INTERRUPT_FLAG**
- **FLASHCTL_PASSWORD_WRITTEN_INCORRECTLY**
- **FLASHCTL_BUSY**
  indicating the status of the FlashCtl

FlashCtl_lockInfoA()

```
void FlashCtl_lockInfoA (
            void )
```

Locks the information flash memory segment A.

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

FlashCtl_performEraseCheck()

```
bool FlashCtl_performEraseCheck (
            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

FlashCtl_performMassErase()

```
void FlashCtl_performMassErase (
            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

FlashCtl_unlockInfoA()

```
void FlashCtl_unlockInfoA (
            void )
```

Unlocks the information flash memory segment A.

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

FlashCtl_write16()

```
void FlashCtl_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. FlashCtl_eraseSegment 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

FlashCtl_write32()

```
void FlashCtl_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. FlashCtl_eraseSegment 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

FlashCtl_write8()

```
void FlashCtl_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. FlashCtl_eraseSegment 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

20.3 Programming Example

The following example shows some flash operations using the APIs

```
do{
    FlashCtl_eraseSegment(FlashCtl_BASE,
                          (unsigned char *)INFOD_START
                          );
    status = FlashCtl_performEraseCheck(FlashCtl_BASE,
                                   (unsigned char *)INFOD_START,
                                   128
                                   );
    }while(status == STATUS_FAIL);

    //Flash write
    FlashCtl_write32(FlashCtl_BASE,
                  calibration_data,
                  (unsigned long *)(INFOD_START),1);
```

21 GPIO

21.1 Introduction

The Digital I/O (GPIO) API provides a set of functions for using the MSP430Ware GPIO modules. 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. Each I/O line is individually configurable for pullup or pulldown resistors, as well as, configurable drive strength, full or reduced. PJ contains only four I/O lines.

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(), GPIO_setAsInputPin(), GPIO_setAsInputPinWithPullDownResistor() or GPIO_setAsInputPinWithPullUpResistor(). 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().

21.2 API Functions

Functions

- void GPIO_setAsOutputPin (uint8_t selectedPort, uint16_t selectedPins)
  This function configures the selected Pin as output pin.
- void GPIO_setAsInputPin (uint8_t selectedPort, uint16_t selectedPins)
  This function configures the selected Pin as input pin.
- void GPIO_setAsPeripheralModuleFunctionOutputPin (uint8_t selectedPort, uint16_t selectedPins)
  This function configures the peripheral module function in the output direction for the selected pin.
- void GPIO_setAsPeripheralModuleFunctionInputPin (uint8_t selectedPort, uint16_t selectedPins)
  This function configures the peripheral module function in the input direction for the selected pin.
- void GPIO_setOutputHighOnPin (uint8_t selectedPort, uint16_t selectedPins)
  This function sets output HIGH on the selected Pin.
- void GPIO_setOutputLowOnPin (uint8_t selectedPort, uint16_t selectedPins)
  This function sets output LOW on the selected Pin.
- void GPIO_toggleOutputOnPin (uint8_t selectedPort, uint16_t selectedPins)
  This function toggles the output on the selected Pin.
- void GPIO_setAsInputPinWithPullDownResistor (uint8_t selectedPort, uint16_t selectedPins)
  This function sets the selected Pin in input Mode with Pull Down resistor.
- void GPIO_setAsInputPinWithPullUpResistor (uint8_t selectedPort, uint16_t selectedPins)
  This function sets the selected Pin in input Mode with Pull Up resistor.
- uint8_t GPIO_getInputPinValue (uint8_t selectedPort, uint16_t selectedPins)
  This function gets the input value on the selected pin.
- void GPIO_enableInterrupt (uint8_t selectedPort, uint16_t selectedPins)
  This function enables the port interrupt on the selected pin.
- void GPIO_disableInterrupt (uint8_t selectedPort, uint16_t selectedPins)
  This function disables the port interrupt on the selected pin.
- uint16_t GPIO_getInterruptStatus (uint8_t selectedPort, uint16_t selectedPins)
  This function gets the interrupt status of the selected pin.
- void GPIO_clearInterrupt (uint8_t selectedPort, uint16_t selectedPins)
  This function clears the interrupt flag on the selected pin.
- void GPIO_selectInterruptEdge (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.
- void GPIO_setDriveStrength (uint8_t selectedPort, uint16_t selectedPins, uint8_t driveStrength)
  This function sets the drive strength for the selected port pin.

21.2.1 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_setDriveStrength()
- GPIO_setAsPeripheralModuleFunctionOutputPin()
- GPIO_setAsPeripheralModuleFunctionInputPin()

The GPIO interrupts are handled with

- GPIO_enableInterrupt()
- GPIO_disableInterrupt()
- GPIO_clearInterrupt()
- GPIO_getInterruptStatus()
- GPIO_selectInterruptEdge()

The GPIO pin state is accessed with

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

21.2.2 Function Documentation

GPIO_clearInterrupt()

```
void GPIO_clearInterrupt (
            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. Please refer to family user's guide for available ports with interrupt capability.

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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**

Modified bits of **PxIFG** register.

Returns

None

GPIO_disableInterrupt()

```
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. Please refer to family user's guide for available ports with interrupt capability.

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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**

Modified bits of **PxIE** register.

Returns

None

GPIO_enableInterrupt()

```
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. Please refer to family user's guide for available ports with interrupt capability.

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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**

Modified bits of **PxIE** register.

Returns

None

GPIO_getInputPinValue()

```
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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**

Returns

One of the following:

- **GPIO_INPUT_PIN_HIGH**
- **GPIO_INPUT_PIN_LOW**
  indicating the status of the pin

GPIO_getInterruptStatus()

```
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. Please refer to family user's guide for available ports with interrupt capability.

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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**

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**
- **GPIO_PIN_ALL8**

- **GPIO_PIN_ALL16**
  indicating the interrupt status of the selected pins [Default: 0]

GPIO_selectInterruptEdge()

```
void GPIO_selectInterruptEdge (
            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. Please refer to family user's guide for available ports with interrupt capability.

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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**
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

GPIO_setAsInputPin()

```
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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**

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

Returns

None

GPIO_setAsInputPinWithPullDownResistor()

```
void GPIO_setAsInputPinWithPullDownResistor (
            uint8_t selectedPort,
            uint16_t selectedPins )
```

This function sets the selected Pin in input Mode with Pull Down resistor.

This function sets the selected Pin in input Mode with Pull Down resistor.

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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**

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

Returns

None

GPIO_setAsInputPinWithPullUpResistor()

```
void GPIO_setAsInputPinWithPullUpResistor (
            uint8_t selectedPort,
            uint16_t selectedPins )
```

This function sets the selected Pin in input Mode with Pull Up resistor.

This function sets the selected Pin in input Mode with Pull Up resistor.

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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**

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

Returns

None

GPIO_setAsOutputPin()

```
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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**

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

Returns

None

GPIO_setAsPeripheralModuleFunctionInputPin()

```
void GPIO_setAsPeripheralModuleFunctionInputPin (
            uint8_t selectedPort,
            uint16_t selectedPins )
```

This function configures the peripheral module function in the input direction for the selected pin.

This function configures the peripheral module function in the input direction for the selected pin for either primary, secondary or ternary module function modes. Note that MSP430F5xx/6xx family doesn't support these function modes.

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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**

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

Returns

None

GPIO_setAsPeripheralModuleFunctionOutputPin()

```
void GPIO_setAsPeripheralModuleFunctionOutputPin (
            uint8_t selectedPort,
            uint16_t selectedPins )
```

This function configures the peripheral module function in the output direction for the selected pin.

This function configures the peripheral module function in the output direction for the selected pin for either primary, secondary or ternary module function modes. Note that MSP430F5xx/6xx family doesn't support these function modes.

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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**

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

Returns

None

GPIO_setDriveStrength()

```
void GPIO_setDriveStrength (
            uint8_t selectedPort,
            uint16_t selectedPins,
            uint8_t driveStrength )
```

This function sets the drive strength for the selected port pin.

his function sets the drive strength for the selected port pin. Acceptable values for driveStrength are GPIO_REDUCED_OUTPUT_DRIVE_STRENGTH and GPIO_FULL_OUTPUT_DRIVE_STRENGTH.

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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**
driveStrength	specifies the drive strength of the pin Valid values are: ■ **GPIO_REDUCED_OUTPUT_DRIVE_STRENGTH** ■ **GPIO_FULL_OUTPUT_DRIVE_STRENGTH**

Modified bits of **PxDS** register.

Returns

None

GPIO_setOutputHighOnPin()

```
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**

Parameters

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** ▪ **GPIO_PIN_ALL8** ▪ **GPIO_PIN_ALL16**

Modified bits of **PxOUT** register.

Returns

None

GPIO_setOutputLowOnPin()

```
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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**

Modified bits of **PxOUT** register.

Returns

None

GPIO_toggleOutputOnPin()

```
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**

Parameters

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** ■ **GPIO_PIN_ALL8** ■ **GPIO_PIN_ALL16**

Modified bits of **PxOUT** register.

Returns

None

21.3 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
                    );
  }
}
```

22 LCD$_B$$Controller$

22.1 Introduction

The LCD_B Controller APIs provides a set of functions for using the LCD_B module. Main functions include initialization, LCD enable/disable, charge pump config, voltage settings and memory/blinking memory writing.

LCD_B only supports static/2-mux/3-mux/4-mux and no low-power waveform feature.

22.2 API Functions

The LCD_B API is broken into four groups of functions: those that deal with the basic setup and pin config, those that handle change pump, VLCD voltage and source, those that set memory and blinking memory, and those auxiliary functions.

The LCD_B setup and pin config functions are

- LCD_B_init()
- LCD_B_on()
- LCD_B_off()
- LCD_B_setPinAsLCDFunction()
- LCD_B_setPinAsPortFunction()
- LCD_B_setPinAsLCDFunctionEx()

The LCD_B charge pump, VLCD voltage/source functions are

- LCD_B_enableChargePump()
- LCD_B_disableChargePump()
- LCD_B_configureChargePump()
- LCD_B_selectBias()
- LCD_B_selectChargePumpReference()
- LCD_B_setVLCDSource()
- LCD_B_setVLCDVoltage()

The LCD_B memory/blinking memory setting funtions are

- LCD_B_clearAllMemory()
- LCD_B_clearAllBlinkingMemory()
- LCD_B_selectDisplayMemory()
- LCD_B_setBlinkingControl()

- LCD_B_setMemory()
- LCD_B_updateMemory()
- LCD_B_toggleMemory()
- LCD_B_clearMemory()
- LCD_B_setBlinkingMemory()
- LCD_B_updateBlinkingMemory()
- LCD_B_toggleBlinkingMemory()
- LCD_B_clearBlinkingMemory()

The LCD_B auxiliary functions are

- LCD_B_clearInterrupt()
- LCD_B_getInterruptStatus()
- LCD_B_enableInterrupt()
- LCD_B_disableInterrupt()

22.3 Programming Example

The following example shows how to initialize a 4-mux LCD and display "09" on the LCD screen.

```
// Set pin to LCD function
LCD_B_setPinAsLCDFunctionEx(LCD_B_BASE, LCD_B_SEGMENT_LINE_0, LCD_B_SEGMENT_LINE_21);
LCD_B_setPinAsLCDFunctionEx(LCD_B_BASE, LCD_B_SEGMENT_LINE_26, LCD_B_SEGMENT_LINE_43);

LCD_B_InitParam initParams = {0};
initParams.clockSource = LCD_B_CLOCKSOURCE_ACLK;
initParams.clockDivider = LCD_B_CLOLKDIVIDER_1;
initParams.clockPrescalar = LCD_B_CLOCKPRESCALAR_16;
initParams.muxRate = LCD_B_4_MUX;
initParams.waveforms = LCD_B_LOW_POWER_WAVEFORMS;
initParams.segments = LCD_B_SEGMENTS_ENABLED;

LCD_B_init(LCD_B_BASE, &initParams);

// LCD Operation - VLCD generated internally, V2-V4 generated internally, v5 to ground
LCD_B_setVLCDSource(LCD_B_BASE, LCD_B_VLCD_GENERATED_INTERNALLY,
      LCD_B_V2V3V4_GENERATED_INTERNALLY_NOT_SWITCHED_TO_PINS,
     LCD_B_V5_VSS);

// Set VLCD voltage to 2.60v
LCD_B_setVLCDVoltage(LCD_B_BASE, LCD_B_CHARGEPUMP_VOLTAGE_2_60V_OR_2_17VREF);

// Enable charge pump and select internal reference for it
LCD_B_enableChargePump(LCD_B_BASE);
LCD_B_selectChargePumpReference(LCD_B_BASE, LCD_B_INTERNAL_REFERNCE_VOLTAGE);

LCD_B_configChargePump(LCD_B_BASE, LCD_B_SYNCHRONIZATION_ENABLED, 0);

// Clear LCD memory
LCD_B_clearMemory(LCD_B_BASE);

// Display "09"
LCD_B_setMemory(LCD_B_BASE, LCD_B_SEGMENT_LINE_8, 0xC);
LCD_B_setMemory(LCD_B_BASE, LCD_B_SEGMENT_LINE_9, 0xF);

LCD_B_setMemory(LCD_B_BASE, LCD_B_SEGMENT_LINE_12, 0x7);
LCD_B_setMemory(LCD_B_BASE, LCD_B_SEGMENT_LINE_13, 0xF);

//Turn LCD on
LCD_B_on(LCD_B_BASE);
```

23 LDO-PWR

23.1 Introduction

The features of the LDO-PWR module include:

- Integrated 3.3-V LDO regulator with sufficient output to power the entire MSP430 microcontroller and system circuitry from 5-V external supply
- Current-limiting capability on 3.3-V LDO output with detection flag and interrupt generation
- LDO input voltage detection flag and interrupt generation

The LDO-PWR power system incorporates an integrated 3.3-V LDO regulator that allows the entire MSP430 microcontroller to be powered from nominal 5-V LDOI when it is made available from the system. Alternatively, the power system can supply power only to other components within the system, or it can be unused altogether.

23.2 API Functions

Functions

- void LDOPWR_unLockConfiguration (uint16_t baseAddress)
  Unlocks the configuration registers and enables write access.
- void LDOPWR_lockConfiguration (uint16_t baseAddress)
  Locks the configuration registers and disables write access.
- void LDOPWR_enablePort_U_inputs (uint16_t baseAddress)
  Enables Port U inputs.
- void LDOPWR_disablePort_U_inputs (uint16_t baseAddress)
  Disables Port U inputs.
- void LDOPWR_enablePort_U_outputs (uint16_t baseAddress)
  Enables Port U outputs.
- void LDOPWR_disablePort_U_outputs (uint16_t baseAddress)
  Disables Port U inputs.
- uint8_t LDOPWR_getPort_U1_inputData (uint16_t baseAddress)
  Returns PU.1 input data.
- uint8_t LDOPWR_getPort_U0_inputData (uint16_t baseAddress)
  Returns PU.0 input data.
- uint8_t LDOPWR_getPort_U1_outputData (uint16_t baseAddress)
  Returns PU.1 output data.
- uint8_t LDOPWR_getPort_U0_outputData (uint16_t baseAddress)
  Returns PU.0 output data.
- void LDOPWR_setPort_U1_outputData (uint16_t baseAddress, uint8_t value)
  Sets PU.1 output data.
- void LDOPWR_setPort_U0_outputData (uint16_t baseAddress, uint8_t value)

Sets PU.0 output data.
- void LDOPWR_togglePort_U1_outputData (uint16_t baseAddress)
  Toggles PU.1 output data.
- void LDOPWR_togglePort_U0_outputData (uint16_t baseAddress)
  Toggles PU.0 output data.
- void LDOPWR_enableInterrupt (uint16_t baseAddress, uint16_t mask)
  Enables LDO-PWR module interrupts.
- void LDOPWR_disableInterrupt (uint16_t baseAddress, uint16_t mask)
  Disables LDO-PWR module interrupts.
- void LDOPWR_enable (uint16_t baseAddress)
  Enables LDO-PWR module.
- void LDOPWR_disable (uint16_t baseAddress)
  Disables LDO-PWR module.
- uint8_t LDOPWR_getInterruptStatus (uint16_t baseAddress, uint16_t mask)
  Returns the interrupt status of LDO-PWR module interrupts.
- void LDOPWR_clearInterrupt (uint16_t baseAddress, uint16_t mask)
  Clears the interrupt status of LDO-PWR module interrupts.
- uint8_t LDOPWR_isLDOInputValid (uint16_t baseAddress)
  Returns if the the LDOI is valid and within bounds.
- void LDOPWR_enableOverloadAutoOff (uint16_t baseAddress)
  Enables the LDO overload auto-off.
- void LDOPWR_disableOverloadAutoOff (uint16_t baseAddress)
  Disables the LDO overload auto-off.
- uint8_t LDOPWR_getOverloadAutoOffStatus (uint16_t baseAddress)
  Returns if the LDOI overload auto-off is enabled or disabled.

23.2.1 Detailed Description

The LDOPWR configuration is handled by

- LDOPWR_unLockConfiguration()
- LDOPWR_lockConfiguration()
- LDOPWR_enablePort_U_inputs()
- LDOPWR_disablePort_U_inputs()
- LDOPWR_enablePort_U_outputs()
- LDOPWR_disablePort_U_outputs()
- LDOPWR_enable()
- LDOPWR_disable()
- LDOPWR_enableOverloadAutoOff()
- LDOPWR_disableOverloadAutoOff()

Handling the read/write of output data is handled by

- LDOPWR_getPort_U1_inputData()
- LDOPWR_getPort_U0_inputData()
- LDOPWR_getPort_U1_outputData()
- LDOPWR_getPort_U0_outputData()
- LDOPWR_getOverloadAutoOffStatus()

- LDOPWR_setPort_U0_outputData()
- LDOPWR_togglePort_U1_outputData()
- LDOPWR_togglePort_U0_outputData()
- LDOPWR_setPort_U1_outputData()

The interrupt and status operations are handled by

- LDOPWR_enableInterrupt()
- LDOPWR_disableInterrupt()
- LDOPWR_getInterruptStatus()
- LDOPWR_clearInterrupt()
- LDOPWR_isLDOInputValid()
- LDOPWR_getOverloadAutoOffStatus()

23.2.2 Function Documentation

LDOPWR_clearInterrupt()

```
void LDOPWR_clearInterrupt (
            uint16_t baseAddress,
            uint16_t mask )
```

Clears the interrupt status of LDO-PWR module interrupts.

Parameters

baseAddress	is the base address of the LDOPWR module.
mask	mask of interrupts to clear the status of Mask value is the logical OR of any of the following: ■ **LDOPWR_LDOI_VOLTAGE_GOING_OFF_INTERRUPT** ■ **LDOPWR_LDOI_VOLTAGE_COMING_ON_INTERRUPT** ■ **LDOPWR_LDO_OVERLOAD_INDICATION_INTERRUPT**

Modified bits of **LDOPWRCTL** register.

Returns

None

LDOPWR_disable()

```
void LDOPWR_disable (
            uint16_t baseAddress )
```

Disables LDO-PWR module.

Parameters

baseAddress	is the base address of the LDOPWR module.

Modified bits of **LDOPWRCTL** register.

Returns

None

LDOPWR_disableInterrupt()

```
void LDOPWR_disableInterrupt (
            uint16_t baseAddress,
            uint16_t mask )
```

Disables LDO-PWR module interrupts.

Parameters

baseAddress	is the base address of the LDOPWR module.
mask	mask of interrupts to disable Mask value is the logical OR of any of the following: ■ **LDOPWR_LDOI_VOLTAGE_GOING_OFF_INTERRUPT** ■ **LDOPWR_LDOI_VOLTAGE_COMING_ON_INTERRUPT** ■ **LDOPWR_LDO_OVERLOAD_INDICATION_INTERRUPT**

Modified bits of **LDOPWRCTL** register.

Returns

None

LDOPWR_disableOverloadAutoOff()

```
void LDOPWR_disableOverloadAutoOff (
            uint16_t baseAddress )
```

Disables the LDO overload auto-off.

Parameters

baseAddress	is the base address of the LDOPWR module.

Modified bits of **LDOPWRCTL** register.

Returns

None

LDOPWR_disablePort_U_inputs()

```
void LDOPWR_disablePort_U_inputs (
            uint16_t baseAddress )
```

Disables Port U inputs.

Parameters

baseAddress	is the base address of the LDOPWR module.

Modified bits of **PUCTL** register.

Returns

None

LDOPWR_disablePort_U_outputs()

```
void LDOPWR_disablePort_U_outputs (
            uint16_t baseAddress )
```

Disables Port U inputs.

Parameters

baseAddress	is the base address of the LDOPWR module.

Modified bits of **PUCTL** register.

Returns

None

LDOPWR_enable()

```
void LDOPWR_enable (
            uint16_t baseAddress )
```

Enables LDO-PWR module.

Parameters

baseAddress	is the base address of the LDOPWR module.

Modified bits of **LDOPWRCTL** register.

Returns

None

LDOPWR_enableInterrupt()

```
void LDOPWR_enableInterrupt (
            uint16_t baseAddress,
            uint16_t mask )
```

Enables LDO-PWR module interrupts.

Does not clear interrupt flags.

Parameters

baseAddress	is the base address of the LDOPWR module.
mask	mask of interrupts to enable Mask value is the logical OR of any of the following: ■ **LDOPWR_LDOI_VOLTAGE_GOING_OFF_INTERRUPT** ■ **LDOPWR_LDOI_VOLTAGE_COMING_ON_INTERRUPT** ■ **LDOPWR_LDO_OVERLOAD_INDICATION_INTERRUPT**

Modified bits of **LDOPWRCTL** register.

Returns

None

LDOPWR_enableOverloadAutoOff()

```
void LDOPWR_enableOverloadAutoOff (
            uint16_t baseAddress )
```

Enables the LDO overload auto-off.

Parameters

baseAddress	is the base address of the LDOPWR module.

Modified bits of **LDOPWRCTL** register.

Returns

None

LDOPWR_enablePort_U_inputs()

```
void LDOPWR_enablePort_U_inputs (
            uint16_t baseAddress )
```

Enables Port U inputs.

Parameters

baseAddress	is the base address of the LDOPWR module.

Modified bits of **PUCTL** register.

Returns

None

LDOPWR_enablePort_U_outputs()

```
void LDOPWR_enablePort_U_outputs (
            uint16_t baseAddress )
```

Enables Port U outputs.

Parameters

baseAddress	is the base address of the LDOPWR module.

Modified bits of **PUCTL** register.

Returns

None

LDOPWR_getInterruptStatus()

```
uint8_t LDOPWR_getInterruptStatus (
            uint16_t baseAddress,
            uint16_t mask )
```

Returns the interrupt status of LDO-PWR module interrupts.

Parameters

baseAddress	is the base address of the LDOPWR module.

Parameters

mask	mask of interrupts to get the status of Mask value is the logical OR of any of the following: ■ **LDOPWR_LDOI_VOLTAGE_GOING_OFF_INTERRUPT** ■ **LDOPWR_LDOI_VOLTAGE_COMING_ON_INTERRUPT** ■ **LDOPWR_LDO_OVERLOAD_INDICATION_INTERRUPT**

Returns

Logical OR of any of the following:
- **LDOPWR_LDOI_VOLTAGE_GOING_OFF_INTERRUPT**
- **LDOPWR_LDOI_VOLTAGE_COMING_ON_INTERRUPT**
- **LDOPWR_LDO_OVERLOAD_INDICATION_INTERRUPT**
  indicating the status of the masked interrupts

LDOPWR_getOverloadAutoOffStatus()

```
uint8_t LDOPWR_getOverloadAutoOffStatus (
            uint16_t baseAddress )
```

Returns if the LDOI overload auto-off is enabled or disabled.

Parameters

baseAddress	is the base address of the LDOPWR module.

Returns

One of the following:
- **LDOPWR_AUTOOFF_ENABLED**
- **LDOPWR_AUTOOFF_DISABLED**

LDOPWR_getPort_U0_inputData()

```
uint8_t LDOPWR_getPort_U0_inputData (
            uint16_t baseAddress )
```

Returns PU.0 input data.

Parameters

baseAddress	is the base address of the LDOPWR module.

Returns

One of the following:
- **LDOPWR_PORTU_PIN_HIGH**
- **LDOPWR_PORTU_PIN_LOW**

LDOPWR_getPort_U0_outputData()

```
uint8_t LDOPWR_getPort_U0_outputData (
            uint16_t baseAddress )
```

Returns PU.0 output data.

Parameters

baseAddress	is the base address of the LDOPWR module.

Returns

One of the following:
- **LDOPWR_PORTU_PIN_HIGH**
- **LDOPWR_PORTU_PIN_LOW**

LDOPWR_getPort_U1_inputData()

```
uint8_t LDOPWR_getPort_U1_inputData (
            uint16_t baseAddress )
```

Returns PU.1 input data.

Parameters

baseAddress	is the base address of the LDOPWR module.

Returns

One of the following:
- **LDOPWR_PORTU_PIN_HIGH**
- **LDOPWR_PORTU_PIN_LOW**

LDOPWR_getPort_U1_outputData()

```
uint8_t LDOPWR_getPort_U1_outputData (
            uint16_t baseAddress )
```

Returns PU.1 output data.

Parameters

baseAddress	is the base address of the LDOPWR module.

Returns

One of the following:
- **LDOPWR_PORTU_PIN_HIGH**
- **LDOPWR_PORTU_PIN_LOW**

LDOPWR_isLDOInputValid()

```
uint8_t LDOPWR_isLDOInputValid (
            uint16_t baseAddress )
```

Returns if the the LDOI is valid and within bounds.

Parameters

baseAddress	is the base address of the LDOPWR module.

Returns

One of the following:
- **LDOPWR_LDO_INPUT_VALID**
- **LDOPWR_LDO_INPUT_INVALID**

LDOPWR_lockConfiguration()

```
void LDOPWR_lockConfiguration (
            uint16_t baseAddress )
```

Locks the configuration registers and disables write access.

Parameters

baseAddress	is the base address of the LDOPWR module.

Modified bits of **LDOKEYPID** register.

Returns

None

LDOPWR_setPort_U0_outputData()

```
void LDOPWR_setPort_U0_outputData (
```

```
            uint16_t baseAddress,
            uint8_t value )
```

Sets PU.0 output data.

Parameters

baseAddress	is the base address of the LDOPWR module.
value	Valid values are: ■ **LDOPWR_PORTU_PIN_HIGH** ■ **LDOPWR_PORTU_PIN_LOW**

Modified bits of **PUCTL** register.

Returns

None

LDOPWR_setPort_U1_outputData()

```
void LDOPWR_setPort_U1_outputData (
            uint16_t baseAddress,
            uint8_t value )
```

Sets PU.1 output data.

Parameters

baseAddress	is the base address of the LDOPWR module.
value	Valid values are: ■ **LDOPWR_PORTU_PIN_HIGH** ■ **LDOPWR_PORTU_PIN_LOW**

Modified bits of **PUCTL** register.

Returns

None

LDOPWR_togglePort_U0_outputData()

```
void LDOPWR_togglePort_U0_outputData (
            uint16_t baseAddress )
```

Toggles PU.0 output data.

Parameters

baseAddress	is the base address of the LDOPWR module.

Modified bits of **PUCTL** register.

Returns

None

LDOPWR_togglePort_U1_outputData()

```
void LDOPWR_togglePort_U1_outputData (
            uint16_t baseAddress )
```

Toggles PU.1 output data.

Parameters

baseAddress	is the base address of the LDOPWR module.

Modified bits of **PUCTL** register.

Returns

None

LDOPWR_unLockConfiguration()

```
void LDOPWR_unLockConfiguration (
            uint16_t baseAddress )
```

Unlocks the configuration registers and enables write access.

Parameters

baseAddress	is the base address of the LDOPWR module.

Modified bits of **LDOKEYPID** register.

Returns

None

23.3 Programming Example

The following example shows how to use the LDO-PWR API.

```
{
  // Enable access to config registers
  LDOPWR_unLockConfiguration(LDOPWR_BASE);

  // Configure PU.0 as output pins
  LDOPWR_enablePort_U_outputs(LDOPWR_BASE);

  //Set PU.1 = high
  LDOPWR_setPort_U1_outputData(LDOPWR_BASE,
                               LDOPWR_PORTU_PIN_HIGH
                                  );

  //Set PU.0 = low
  LDOPWR_setPort_U0_outputData(LDOPWR_BASE,
                               LDOPWR_PORTU_PIN_LOW
                               );

  // Enable LDO overload indication interrupt
  LDOPWR_enableInterrupt(LDOPWR_BASE,
                         LDOPWR_LDO_OVERLOAD_INDICATION_INTERRUPT
                         );

  // Disable access to config registers
  LDOPWR_lockConfiguration(LDOPWR_BASE);

  // continuous loop
  while(1)
  {
    // Delay
    for(i=50000;i>0;i--);

    // Enable access to config registers
    LDOPWR_unLockConfiguration(LDOPWR_BASE);

    // XOR PU.0/1
    LDOPWR_togglePort_U1_outputData(LDOPWR_BASE);
    LDOPWR_togglePort_U0_outputData(LDOPWR_BASE);

    // Disable access to config registers
    LDOPWR_lockConfiguration(LDOPWR_BASE);
  }
}


//******************************************************************************
//
// This is the LDO_PWR_VECTOR interrupt vector service routine.
//
//******************************************************************************
__interrupt void LDOInterruptHandler(void)
{
  if(LDOPWR_getInterruptStatus(LDOPWR_BASE,
                               LDOPWR_LDO_OVERLOAD_INDICATION_INTERRUPT
                               ))

  {
    // Enable access to config registers
    LDOPWR_unLockConfiguration(LDOPWR_BASE);

   // Software clear IFG
    LDOPWR_clearInterrupt(LDOPWR_BASE,
                                LDOPWR_LDO_OVERLOAD_INDICATION_INTERRUPT
                                );

   // Disable access to config registers
   LDOPWR_lockConfiguration(LDOPWR_BASE);

   // Over load indication; take necessary steps in application firmware
   while(1);

  }
}
```

24 32-Bit Hardware Multiplier (MPY32)

24.1 Introduction

The 32-Bit Hardware Multiplier (MPY32) API provides a set of functions for using the MSP430Ware MPY32 modules. Functions are provided to setup the MPY32 modules, set the operand registers, and obtain the results.

The MPY32 Modules does not generate any interrupts.

24.2 API Functions

Functions

- void MPY32_setWriteDelay (uint16_t writeDelaySelect)
  Sets the write delay setting for the MPY32 module.
- void MPY32_enableSaturationMode (void)
  Enables Saturation Mode.
- void MPY32_disableSaturationMode (void)
  Disables Saturation Mode.
- uint8_t MPY32_getSaturationMode (void)
  Gets the Saturation Mode.
- void MPY32_enableFractionalMode (void)
  Enables Fraction Mode.
- void MPY32_disableFractionalMode (void)
  Disables Fraction Mode.
- uint8_t MPY32_getFractionalMode (void)
  Gets the Fractional Mode.
- void MPY32_setOperandOne8Bit (uint8_t multiplicationType, uint8_t operand)
  Sets an 8-bit value into operand 1.
- void MPY32_setOperandOne16Bit (uint8_t multiplicationType, uint16_t operand)
  Sets an 16-bit value into operand 1.
- void MPY32_setOperandOne24Bit (uint8_t multiplicationType, uint32_t operand)
  Sets an 24-bit value into operand 1.
- void MPY32_setOperandOne32Bit (uint8_t multiplicationType, uint32_t operand)
  Sets an 32-bit value into operand 1.
- void MPY32_setOperandTwo8Bit (uint8_t operand)
  Sets an 8-bit value into operand 2, which starts the multiplication.
- void MPY32_setOperandTwo16Bit (uint16_t operand)
  Sets an 16-bit value into operand 2, which starts the multiplication.
- void MPY32_setOperandTwo24Bit (uint32_t operand)
  Sets an 24-bit value into operand 2, which starts the multiplication.
- void MPY32_setOperandTwo32Bit (uint32_t operand)

Sets an 32-bit value into operand 2, which starts the multiplication.
- uint64_t MPY32_getResult (void)
  Returns an 64-bit result of the last multiplication operation.
- uint16_t MPY32_getSumExtension (void)
  Returns the Sum Extension of the last multiplication operation.
- uint16_t MPY32_getCarryBitValue (void)
  Returns the Carry Bit of the last multiplication operation.
- void MPY32_clearCarryBitValue (void)
  Clears the Carry Bit of the last multiplication operation.
- void MPY32_preloadResult (uint64_t result)
  Preloads the result register.

24.2.1 Detailed Description

The MPY32 API is broken into three groups of functions: those that control the settings, those that set the operand registers, and those that return the results, sum extension, and carry bit value.

The settings are handled by

- MPY32_setWriteDelay()
- MPY32_enableSaturationMode()
- MPY32_disableSaturationMode()
- MPY32_enableFractionalMode()
- MPY32_disableFractionalMode()
- MPY32_preloadResult()

The operand registers are set by

- MPY32_setOperandOne8Bit()
- MPY32_setOperandOne16Bit()
- MPY32_setOperandOne24Bit()
- MPY32_setOperandOne32Bit()
- MPY32_setOperandTwo8Bit()
- MPY32_setOperandTwo16Bit()
- MPY32_setOperandTwo24Bit()
- MPY32_setOperandTwo32Bit()

The results can be returned by

- MPY32_getResult()
- MPY32_getSumExtension()
- MPY32_getCarryBitValue()
- MPY32_getSaturationMode()
- MPY32_getFractionalMode()

24.2.2 Function Documentation

MPY32_clearCarryBitValue()

```
void MPY32_clearCarryBitValue (
            void )
```

Clears the Carry Bit of the last multiplication operation.

This function clears the Carry Bit of the MPY module

Returns

The value of the MPY32 module Carry Bit 0x0 or 0x1.

MPY32_disableFractionalMode()

```
void MPY32_disableFractionalMode (
            void )
```

Disables Fraction Mode.

This function disables fraction mode.

Returns

None

MPY32_disableSaturationMode()

```
void MPY32_disableSaturationMode (
            void )
```

Disables Saturation Mode.

This function disables saturation mode, which allows the raw result of the MPY result registers to be returned.

Returns

None

MPY32_enableFractionalMode()

```
void MPY32_enableFractionalMode (
            void )
```

Enables Fraction Mode.

This function enables fraction mode.

Returns

None

MPY32_enableSaturationMode()

```
void MPY32_enableSaturationMode (
            void )
```

Enables Saturation Mode.

This function enables saturation mode. When this is enabled, the result read out from the MPY result registers is converted to the most-positive number in the case of an overflow, or the most-negative number in the case of an underflow. Please note, that the raw value in the registers does not reflect the result returned, and if the saturation mode is disabled, then the raw value of the registers will be returned instead.

Returns

None

MPY32_getCarryBitValue()

```
uint16_t MPY32_getCarryBitValue (
            void )
```

Returns the Carry Bit of the last multiplication operation.

This function returns the Carry Bit of the MPY module, which either gives the sign after a signed operation or shows a carry after a multiply- and- accumulate operation.

Returns

The value of the MPY32 module Carry Bit 0x0 or 0x1.

MPY32_getFractionalMode()

```
uint8_t MPY32_getFractionalMode (
            void )
```

Gets the Fractional Mode.

This function gets the current fractional mode.

Returns

Gets the fractional mode Return one of the following:
- **MPY32_FRACTIONAL_MODE_DISABLED**
- **MPY32_FRACTIONAL_MODE_ENABLED**
  Gets the Fractional Mode

MPY32_getResult()

```
uint64_t MPY32_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

MPY32_getSaturationMode()

```
uint8_t MPY32_getSaturationMode (
            void )
```

Gets the Saturation Mode.

This function gets the current saturation mode.

Returns

Gets the Saturation Mode Return one of the following:

- **MPY32_SATURATION_MODE_DISABLED**
- **MPY32_SATURATION_MODE_ENABLED**
  Gets the Saturation Mode

MPY32_getSumExtension()

```
uint16_t MPY32_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 MPY32 module Sum Extension.

MPY32_preloadResult()

```
void MPY32_preloadResult (
            uint64_t result )
```

Preloads the result register.

This function Preloads the result register

Parameters

result	value to preload the result register to

Returns

None

MPY32_setOperandOne16Bit()

```
void MPY32_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: ■ **MPY32_MULTIPLY_UNSIGNED** ■ **MPY32_MULTIPLY_SIGNED** ■ **MPY32_MULTIPLYACCUMULATE_UNSIGNED** ■ **MPY32_MULTIPLYACCUMULATE_SIGNED**
operand	is the 16-bit value to load into the 1st operand.

Returns

None

MPY32_setOperandOne24Bit()

```
void MPY32_setOperandOne24Bit (
            uint8_t multiplicationType,
            uint32_t operand )
```

Sets an 24-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: ■ **MPY32_MULTIPLY_UNSIGNED** ■ **MPY32_MULTIPLY_SIGNED** ■ **MPY32_MULTIPLYACCUMULATE_UNSIGNED** ■ **MPY32_MULTIPLYACCUMULATE_SIGNED**
operand	is the 24-bit value to load into the 1st operand.

Returns

None

MPY32_setOperandOne32Bit()

```
void MPY32_setOperandOne32Bit (
            uint8_t multiplicationType,
            uint32_t operand )
```

Sets an 32-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: ■ **MPY32_MULTIPLY_UNSIGNED** ■ **MPY32_MULTIPLY_SIGNED** ■ **MPY32_MULTIPLYACCUMULATE_UNSIGNED** ■ **MPY32_MULTIPLYACCUMULATE_SIGNED**
operand	is the 32-bit value to load into the 1st operand.

Returns

None

MPY32_setOperandOne8Bit()

```
void MPY32_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: ■ **MPY32_MULTIPLY_UNSIGNED** ■ **MPY32_MULTIPLY_SIGNED** ■ **MPY32_MULTIPLYACCUMULATE_UNSIGNED** ■ **MPY32_MULTIPLYACCUMULATE_SIGNED**

Parameters

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

Returns

None

MPY32_setOperandTwo16Bit()

```
void MPY32_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

MPY32_setOperandTwo24Bit()

```
void MPY32_setOperandTwo24Bit (
            uint32_t operand )
```

Sets an 24-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 24-bit value to load into the 2nd operand.

Returns

None

MPY32_setOperandTwo32Bit()

```
void MPY32_setOperandTwo32Bit (
            uint32_t operand )
```

Sets an 32-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 32-bit value to load into the 2nd operand.

Returns

None

MPY32_setOperandTwo8Bit()

```
void MPY32_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

MPY32_setWriteDelay()

```
void MPY32_setWriteDelay (
            uint16_t writeDelaySelect )
```

Sets the write delay setting for the MPY32 module.

This function sets up a write delay to the MPY module's registers, which holds any writes to the registers until all calculations are complete. There are two different settings, one which waits for 32-bit results to be ready, and one which waits for 64-bit results to be ready. This prevents unpredicatble results if registers are changed before the results are ready.

Parameters

writeDelaySelect	delays the write to any MPY32 register until the selected bit size of result has been written. Valid values are: ■ **MPY32_WRITEDELAY_OFF** [Default] - writes are not delayed ■ **MPY32_WRITEDELAY_32BIT** - writes are delayed until a 32-bit result is available in the result registers ■ **MPY32_WRITEDELAY_64BIT** - writes are delayed until a 64-bit result is available in the result registers Modified bits are **MPYDLY32** and **MPYDLYWRTEN** of **MPY32CTL0** register.

Returns

None

24.3 Programming Example

The following example shows how to initialize and use the MPY32 API to calculate a 16-bit by 16-bit unsigned multiplication operation.

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

// Set a 16-bit Operand into the specific Operand 1 register to specify
 // unsigned multiplication
MPY32_setOperandOne16Bit(MPY32_MULTIPLY_UNSIGNED,
                         0x1234);
// Set Operand 2 to begin the multiplication operation
MPY32_setOperandTwo16Bit(0x5678);

__bis_SR_register(LPM4_bits);            // Enter LPM4
__no_operation();                        // BREAKPOINT HERE to verify the
                                          // correct result in the registers
```

25 Operational Amplifier (OA)

25.1 Introduction

The OA operational amplifiers can be used to support front-end analog signal conditioning prior to analogto-digital conversion, as well as, other general purpose applications.

Features of the OA include

- Single-supply, low-current operation
- Software selectable rail-to-rail input
- Rail-to-rail output
- Input switches on positive and negative inputs individually software selectable
- Internal voltage follower setting
- Low impedance ground switches individually software selectable (not available on all devices)

25.2 API Functions

The OA API is broken into two groups of functions: those that deal with initialization and and those that are used to obtain the status of the OA

The OA initialization functions are

- OA_openSwitch()
- OA_closeSwitch()
- OA_enableRailToRailInput()
- OA_disableRailToRailInput()
- OA_disableAmplifierMode()
- OA_enableAmplifierMode()

OA status can be obtained by

- OA_getSwitchStatus()
- OA_getRailToRailInputReadyStatus()
- OA_getRailToRailInputStatus()
- OA_getAmplifierModeStatus()

25.3 Programming Example

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

```
// Select OA0IP0 as "+" input
// Select OA0IN0 as "-" input
OA_closeSwitch(OA_BASE,
        OA_POSITIVE_INPUT_TERMINAL_SWITCH0,
        OA_NEGATIVE_INPUT_TERMINAL_SWITCH0,
        OA_GROUND_NONE
        );

// Enable OA0 amplifier
OA_enableAmplifierMode(OA_BASE);
```

26 Port Mapping Controller

26.1 Introduction

The port mapping controller allows the flexible and re-configurable mapping of digital functions to port pins. The port mapping controller features are:

- Configuration protected by write access key.
- Default mapping provided for each port pin (device-dependent, the device pinout in the device-specific data sheet).
- Mapping can be reconfigured during runtime.
- Each output signal can be mapped to several output pins.

26.2 API Functions

Functions

- void PMAP_initPorts (uint16_t baseAddress, PMAP_initPortsParam ∗param)
  This function configures the MSP430 Port Mapper.

26.2.1 Detailed Description

The MSP430ware API that configures Port Mapping is PMAP_initPorts()

It needs the following data to configure port mapping. portMapping - pointer to init Data PxMAPy - pointer start of first Port Mapper to initialize numberOfPorts - number of Ports to initialize portMapReconfigure - to enable/disable reconfiguration

26.2.2 Function Documentation

PMAP_initPorts()

```
void PMAP_initPorts (
            uint16_t baseAddress,
            PMAP_initPortsParam * param )
```

This function configures the MSP430 Port Mapper.

This function port maps a set of pins to a new set.

Modified bits of **PMAPKETID** register and bits of **PMAPCTL** register.

Returns

None

References PMAP_initPortsParam::numberOfPorts, PMAP_initPortsParam::portMapping, PMAP_initPortsParam::portMapReconfigure, and PMAP_initPortsParam::PxMAPy.

26.3 Programming Example

The following example shows some Port Mapping Controller operations using the APIs

```
const unsigned char port_mapping[] = {
    //Port P4:
    PM_TB0CCR0A,
    PM_TB0CCR1A,
    PM_TB0CCR2A,
    PM_TB0CCR3A,
    PM_TB0CCR4A,
    PM_TB0CCR5A,
    PM_TB0CCR6A,
    PM_NONE
};

//CONFIGURE PORTS- pass the port_mapping array, start @ P4MAP01, initialize
//a single port, do not allow run-time reconfiguration of port mapping

PMAP_initPortsParam initPortsParams = {0};
initPortsParam.portMapping = port_mapping;
initPortsParam.PxMAPy = (uint8_t *)&P4MAP01;
initPortsParam.numberOfPorts = 1;
initPortsParam.portMapReconfigure = PMAP_DISABLE_RECONFIGURATION;
PMAP_initPorts(PMAP_CTRL_BASE, &initPortsParam);
```

27 Power Management Module (PMM)

27.1 Introduction

The PMM manages the following internal circuitry:

- An integrated low-dropout voltage regulator (LDO) that produces a secondary core voltage (VCORE) from the primary voltage that is applied to the device (DVCC)
- Supply voltage supervisors (SVS) and supply voltage monitors (SVM) for the primary voltage (DVCC) and the secondary voltage (VCORE). The SVS and SVM include programmable threshold levels and power-fail indicators. Therefore, the PMM plays a crucial role in defining the maximum performance, valid voltage conditions, and current consumption for an application running on an MSP430x5xx or MSP430x6xx device. The secondary voltage that is generated by the integrated LDO, VCORE, is programmable to one of four core voltage levels, shown as 0, 1, 2, and 3. Each increase in VCORE allows the CPU to operate at a higher maximum frequency. The values of these frequencies are specified in the device-specific data sheet. This feature allows the user the flexibility to trade power consumption in active and low-power modes for different degrees of maximum performance and minimum supply voltage.

NOTE: To align with the nomenclature in the MSP430x5xx/MSP430x6xx Family User's Guide, the primary voltage domain (DVCC) is referred to as the high-side voltage (SvsH/SVMH) and the secondary voltage domain (VCORE) is referred to as the low-side voltage (SvsL/SvmL).

Moving between the different VCORE voltages requires a specific sequence of events and can be done only one level at a time; for example, to change from level 0 to level 3, the application code must step through level 1 and level 2.

VCORE increase:

1. SvmL monitor level is incremented.
2. VCORE level is incremented.
3. The SvmL Level Reached Interrupt Flag (SVSMLVLRIFG) in the PMMIFG register is polled. When asserted, SVSMLVLRIFG indicates that the VCORE voltage has reached its next level.
4. SvsL is increased. SvsL is changed last, because if SVSL were incremented prior to VCORE, it would potentially cause a reset.

VCORE decrease:

1. Decrement SvmL and SVSL levels.
2. Decrement VCORE. The PMM_setVCore() function appropriately handles an increase or decrease of the core voltage. NOTE: The procedure recommended above provides a workaround for the erratum FLASH37. See the device-specific erratasheet to determine if a device is affected by FLASH37. The workaround is also highlighted in the source code for the PMM library

Recommended SVS and SVM Settings The SVS and SVM on both the high side and the low side are enabled in normal performance mode following a brown-out reset condition. The device is held in reset until the SVS and SVM verify that the external and core voltages meet the minimum requirements of the default core voltage, which is level zero. The SVS and SVM remain enabled unless disabled by the firmware. The low-side SVS and SVM are useful for verifying the startup conditions and for verifying any modification to the core voltage. However, in their default mode, they prevent the CPU from executing code on wake-up from low-power modes 2, 3, and 4 for a full 150 s, not 5 s. This is because, in their default states, the SVSL and SvmL are powered down in the low-power mode of the PMM and need time for their comparators to wake and stabilize before they can verify the voltage condition and release the CPU for execution. Note that the high-side SVS and SVM do not influence the wake time from low-power modes. If the wake-up from low-power modes needs to be shortened to 5 s, the SVSL and SvmL should be disabled after the initialization of the core voltage at the beginning of the application. Disabling SVSL and SvmL prevents them from gating the CPU on wake-up from LPM2, LPM3, and LPM4. The application is still protected on the high side with SvsH and SVMH. The PMM_setVCore() function automatically enables and disables the SVS and SVM as necessary if a non-zero core voltage level is required. If the application does not require a change in the core voltage (that is, when the target MCLK is less than 8 MHz), the PMM_disableSVSLSvmL() and PMM_enableSvsHReset() macros can be used to disable the low-side SVS and SVM circuitry and enable only the high-side SVS POR reset, respectively.

Setting SVS/SVM Threshold Levels The voltage thresholds for the SVS and SVM modules are programmable. On the high side, there are two bit fields that control these threshold levels: the SvsHRVL and SVSMHRRL. The SvsHRVL field defines the voltage threshold at which the SvsH triggers a reset (also known as the SvsH ON voltage level). The SVSMHRRL field defines the voltage threshold at which the SvsH releases the device from a reset (also known as SvsH OFF voltage level). The MSP430x5xx/MSP430x6xx Family User's Guide (SLAU208) [1] recommends the settings shown in Table 1 when setting these bits. The PMM_setVCore() function follows these recommendations and ensures that the SVS levels match the core voltage levels that are used.

Advanced SVS Controls and Trade-offs In addition to the default SVS settings that are provided with the PMM_setVCore() function, the SVS/SVM modules can be optimized for wake-up speed, response time (propagation delay), and current consumption, as needed. The following controls can be optimized for the SVS/SVM modules:

- Protection in low power modes - LPM2, LPM3, and LPM4
- Wake-up time from LPM2, LPM3, and LPM4
- Response time to react to an SVS event Selecting the LPM option, wake-up time, and response time that is best suited for the application is left to the user. A few typical examples illustrate the trade-offs: Case A: The most robust protection that stays on in LPMs and has the fastest response and wake-up time consumes the most power. Case B: With SVS high side active only in AM, no protection in LPMs, slow wake-up, and slow response time has SVS protection with the least current consumption. Case C: An optimized case is described - turn off the low-side monitor and supervisor, thereby saving power while keeping response time fast on the high side to help with timing critical applications. The user can call the PMM_setVCore() function, which configures SVS/SVM high side and low side with the recommended or default configurations, or can call the APIs provided to control the parameters as the application demands.

Any writes to the SVSMLCTL and SVSMHCTL registers require a delay time for these registers to settle before the new settings take effect. This delay time is dependent on whether the SVS and SVM modules are configured for normal or full performance. See device-specific data sheet for exact delay times.

27.2 API Functions

Functions

- void PMM_enableSvsL (void)
  Enables the low-side SVS circuitry.
- void PMM_disableSvsL (void)
  Disables the low-side SVS circuitry.
- void PMM_enableSvmL (void)
  Enables the low-side SVM circuitry.
- void PMM_disableSvmL (void)
  Disables the low-side SVM circuitry.
- void PMM_enableSvsH (void)
  Enables the high-side SVS circuitry.
- void PMM_disableSvsH (void)
  Disables the high-side SVS circuitry.
- void PMM_enableSvmH (void)
  Enables the high-side SVM circuitry.
- void PMM_disableSvmH (void)
  Disables the high-side SVM circuitry.
- void PMM_enableSvsLSvmL (void)
  Enables the low-side SVS and SVM circuitry.
- void PMM_disableSvsLSvmL (void)
  Disables the low-side SVS and SVM circuitry.
- void PMM_enableSvsHSvmH (void)
  Enables the high-side SVS and SVM circuitry.
- void PMM_disableSvsHSvmH (void)
  Disables the high-side SVS and SVM circuitry.
- void PMM_enableSvsLReset (void)
  Enables the POR signal generation when a low-voltage event is registered by the low-side SVS.
- void PMM_disableSvsLReset (void)
  Disables the POR signal generation when a low-voltage event is registered by the low-side SVS.
- void PMM_enableSvmLInterrupt (void)
  Enables the interrupt generation when a low-voltage event is registered by the low-side SVM.
- void PMM_disableSvmLInterrupt (void)
  Disables the interrupt generation when a low-voltage event is registered by the low-side SVM.
- void PMM_enableSvsHReset (void)
  Enables the POR signal generation when a low-voltage event is registered by the high-side SVS.
- void PMM_disableSvsHReset (void)
  Disables the POR signal generation when a low-voltage event is registered by the high-side SVS.
- void PMM_enableSvmHInterrupt (void)
  Enables the interrupt generation when a low-voltage event is registered by the high-side SVM.
- void PMM_disableSvmHInterrupt (void)
  Disables the interrupt generation when a low-voltage event is registered by the high-side SVM.
- void PMM_clearPMMIFGS (void)
  Clear all interrupt flags for the PMM.
- void PMM_enableSvsLInLPMFastWake (void)
  Enables supervisor low side in LPM with twake-up-fast from LPM2, LPM3, and LPM4.
- void PMM_enableSvsLInLPMSlowWake (void)
  Enables supervisor low side in LPM with twake-up-slow from LPM2, LPM3, and LPM4.
- void PMM_disableSvsLInLPMFastWake (void)
  Disables supervisor low side in LPM with twake-up-fast from LPM2, LPM3, and LPM4.

- void PMM_disableSvsLInLPMSlowWake (void)
  Disables supervisor low side in LPM with twake-up-slow from LPM2, LPM3, and LPM4.
- void PMM_enableSvsHInLPMNormPerf (void)
  Enables supervisor high side in LPM with tpd = 20 s(1)
- void PMM_enableSvsHInLPMFullPerf (void)
  Enables supervisor high side in LPM with tpd = 2.5 s(1)
- void PMM_disableSvsHInLPMNormPerf (void)
  Disables supervisor high side in LPM with tpd = 20 s(1)
- void PMM_disableSvsHInLPMFullPerf (void)
  Disables supervisor high side in LPM with tpd = 2.5 s(1)
- void PMM_optimizeSvsLInLPMFastWake (void)
  Optimized to provide twake-up-fast from LPM2, LPM3, and LPM4 with least power.
- void PMM_optimizeSvsHInLPMFullPerf (void)
  Optimized to provide tpd = 2.5 s(1) in LPM with least power.
- uint16_t PMM_setVCoreUp (uint8_t level)
  Increase Vcore by one level.
- uint16_t PMM_setVCoreDown (uint8_t level)
  Decrease Vcore by one level.
- bool PMM_setVCore (uint8_t level)
  Set Vcore to expected level.
- uint16_t PMM_getInterruptStatus (uint16_t mask)
  Returns interrupt status.

27.2.1 Detailed Description

PMM_enableSvsL() / **PMM_disableSvsL()** Enables or disables the low-side SVS circuitry

PMM_enableSvmL() / **PMM_disableSvmL()** Enables or disables the low-side SVM circuitry

PMM_enableSvsH() / **PMM_disableSvsH()** Enables or disables the high-side SVS circuitry

PMM_enableSVMH() / **PMM_disableSVMH()** Enables or disables the high-side SVM circuitry

PMM_enableSvsLSvmL() / **PMM_disableSvsLSvmL()** Enables or disables the low-side SVS and SVM circuitry

PMM_enableSvsHSvmH() / **PMM_disableSvsHSvmH()** Enables or disables the high-side SVS and SVM circuitry

PMM_enableSvsLReset() / **PMM_disableSvsLReset()** Enables or disables the POR signal generation when a low-voltage event is registered by the low-side SVS

PMM_enableSvmLInterrupt() / **PMM_disableSvmLInterrupt()** Enables or disables the interrupt generation when a low-voltage event is registered by the low-side SVM

PMM_enableSvsHReset() / **PMM_disableSvsHReset()** Enables or disables the POR signal generation when a low-voltage event is registered by the high-side SVS

PMM_enableSVMHInterrupt() / **PMM_disableSVMHInterrupt()** Enables or disables the interrupt generation when a low-voltage event is registered by the high-side SVM

PMM_clearPMMIFGS() Clear all interrupt flags for the PMM

PMM_enableSvsLInLPMFastWake() Enables supervisor low side in LPM with twake-up-fast from LPM2, LPM3, and LPM4

PMM_enableSvsLInLPMSlowWake() Enables supervisor low side in LPM with twake-up-slow from LPM2, LPM3, and LPM4

PMM_disableSvsLInLPMFastWake() Disables supervisor low side in LPM with twake-up-fast from LPM2, LPM3, and LPM4

PMM_disableSvsLInLPMSlowWake() Disables supervisor low side in LPM with twake-up-slow from LPM2, LPM3, and LPM4

PMM_enableSvsHInLPMNormPerf() Enables supervisor high side in LPM with tpd = 20 s(1)

PMM_enableSvsHInLPMFullPerf() Enables supervisor high side in LPM with tpd = 2.5 s(1)

PMM_disableSvsHInLPMNormPerf() Disables supervisor high side in LPM with tpd = 20 s(1)

PMM_disableSvsHInLPMFullPerf() Disables supervisor high side in LPM with tpd = 2.5 s(1)

PMM_optimizeSvsLInLPMFastWake() Optimized to provide twake-up-fast from LPM2, LPM3, and LPM4 with least power

PMM_optimizeSvsHInLPMFullPerf() Optimized to provide tpd = 2.5 s(1) in LPM with least power

PMM_getInterruptStatus() Returns interrupt status of the PMM module

PMM_setVCore() Sets the appropriate VCORE level. Calls the PMM_setVCoreUp() or PMM_setVCoreDown() function the required number of times depending on the current VCORE level, because the levels must be stepped through individually. A status indicator equal to STATUS_SUCCESS or STATUS_FAIL that indicates a valid or invalid VCORE transition, respectively. An invalid VCORE transition exists if DVCC is less than the minimum required voltage for the target VCORE voltage.

27.2.2 Function Documentation

PMM_clearPMMIFGS()

```
void PMM_clearPMMIFGS (
            void )
```

Clear all interrupt flags for the PMM.

Modified bits of **PMMCTL0** register and bits of **PMMIFG** register.

Returns

None

PMM_disableSvmH()

```
void PMM_disableSvmH (
            void )
```

Disables the high-side SVM circuitry.

Modified bits of **PMMCTL0** register and bits of **SVSMHCTL** register.

Returns

None

PMM_disableSvmHInterrupt()

```
void PMM_disableSvmHInterrupt (
            void )
```

Disables the interrupt generation when a low-voltage event is registered by the high-side SVM.

Modified bits of **PMMCTL0** register and bits of **PMMIE** register.

Returns

None

PMM_disableSvmL()

```
void PMM_disableSvmL (
            void )
```

Disables the low-side SVM circuitry.

Modified bits of **PMMCTL0** register and bits of **SVSMLCTL** register.

Returns

None

PMM_disableSvmLInterrupt()

```
void PMM_disableSvmLInterrupt (
            void )
```

Disables the interrupt generation when a low-voltage event is registered by the low-side SVM.

Modified bits of **PMMCTL0** register and bits of **PMMIE** register.

Returns

None

PMM_disableSvsH()

```
void PMM_disableSvsH (
            void )
```

Disables the high-side SVS circuitry.

Modified bits of **PMMCTL0** register and bits of **SVSMHCTL** register.

Returns

None

PMM_disableSvsHInLPMFullPerf()

```
void PMM_disableSvsHInLPMFullPerf (
            void )
```

Disables supervisor high side in LPM with tpd = 2.5 s(1)

Modified bits of **PMMCTL0** register and bits of **SVSMHCTL** register.

Returns

None

PMM_disableSvsHInLPMNormPerf()

```
void PMM_disableSvsHInLPMNormPerf (
            void )
```

Disables supervisor high side in LPM with tpd = 20 s(1)

Modified bits of **PMMCTL0** register and bits of **SVSMHCTL** register.

Returns

None

PMM_disableSvsHReset()

```
void PMM_disableSvsHReset (
            void )
```

Disables the POR signal generation when a low-voltage event is registered by the high-side SVS.

Modified bits of **PMMCTL0** register and bits of **PMMIE** register.

Returns

None

PMM_disableSvsHSvmH()

```
void PMM_disableSvsHSvmH (
            void )
```

Disables the high-side SVS and SVM circuitry.

Modified bits of **PMMCTL0** register and bits of **SVSMHCTL** register.

Returns

None

PMM_disableSvsL()

```
void PMM_disableSvsL (
            void )
```

Disables the low-side SVS circuitry.

Modified bits of **PMMCTL0** register and bits of **SVSMLCTL** register.

Returns

None

PMM_disableSvsLInLPMFastWake()

```
void PMM_disableSvsLInLPMFastWake (
            void )
```

Disables supervisor low side in LPM with twake-up-fast from LPM2, LPM3, and LPM4.

Modified bits of **PMMCTL0** register and bits of **SVSMLCTL** register.

Returns

None

PMM_disableSvsLInLPMSlowWake()

```
void PMM_disableSvsLInLPMSlowWake (
            void )
```

Disables supervisor low side in LPM with twake-up-slow from LPM2, LPM3, and LPM4.

Modified bits of **PMMCTL0** register and bits of **SVSMLCTL** register.

Returns

None

PMM_disableSvsLReset()

```
void PMM_disableSvsLReset (
            void )
```

Disables the POR signal generation when a low-voltage event is registered by the low-side SVS.

Modified bits of **PMMCTL0** register and bits of **PMMIE** register.

Returns

None

PMM_disableSvsLSvmL()

```
void PMM_disableSvsLSvmL (
            void )
```

Disables the low-side SVS and SVM circuitry.

Modified bits of **PMMCTL0** register and bits of **SVSMLCTL** register.

Returns

None

PMM_enableSvmH()

```
void PMM_enableSvmH (
            void )
```

Enables the high-side SVM circuitry.

Modified bits of **PMMCTL0** register and bits of **SVSMHCTL** register.

Returns

None

PMM_enableSvmHInterrupt()

```
void PMM_enableSvmHInterrupt (
            void )
```

Enables the interrupt generation when a low-voltage event is registered by the high-side SVM.

Modified bits of **PMMCTL0** register and bits of **PMMIE** register.

Returns

None

PMM_enableSvmL()

```
void PMM_enableSvmL (
            void )
```

Enables the low-side SVM circuitry.

Modified bits of **PMMCTL0** register and bits of **SVSMLCTL** register.

Returns

None

PMM_enableSvmLInterrupt()

```
void PMM_enableSvmLInterrupt (
            void )
```

Enables the interrupt generation when a low-voltage event is registered by the low-side SVM.

Modified bits of **PMMCTL0** register and bits of **PMMIE** register.

Returns

None

PMM_enableSvsH()

```
void PMM_enableSvsH (
            void )
```

Enables the high-side SVS circuitry.

Modified bits of **PMMCTL0** register and bits of **SVSMHCTL** register.

Returns

None

PMM_enableSvsHInLPMFullPerf()

```
void PMM_enableSvsHInLPMFullPerf (
            void )
```

Enables supervisor high side in LPM with tpd = 2.5 s(1)

Modified bits of **PMMCTL0** register and bits of **SVSMHCTL** register.

Returns

None

PMM_enableSvsHInLPMNormPerf()

```
void PMM_enableSvsHInLPMNormPerf (
            void )
```

Enables supervisor high side in LPM with tpd = 20 s(1)

Modified bits of **PMMCTL0** register and bits of **SVSMHCTL** register.

Returns

None

PMM_enableSvsHReset()

```
void PMM_enableSvsHReset (
            void )
```

Enables the POR signal generation when a low-voltage event is registered by the high-side SVS.

Modified bits of **PMMCTL0** register and bits of **PMMIE** register.

Returns

None

PMM_enableSvsHSvmH()

```
void PMM_enableSvsHSvmH (
            void )
```

Enables the high-side SVS and SVM circuitry.

Modified bits of **PMMCTL0** register and bits of **SVSMHCTL** register.

Returns

None

PMM_enableSvsL()

```
void PMM_enableSvsL (
            void )
```

Enables the low-side SVS circuitry.

Modified bits of **PMMCTL0** register and bits of **SVSMLCTL** register.

Returns

None

PMM_enableSvsLInLPMFastWake()

```
void PMM_enableSvsLInLPMFastWake (
            void )
```

Enables supervisor low side in LPM with twake-up-fast from LPM2, LPM3, and LPM4.

Modified bits of **PMMCTL0** register and bits of **SVSMLCTL** register.

Returns

None

PMM_enableSvsLInLPMSlowWake()

```
void PMM_enableSvsLInLPMSlowWake (
            void )
```

Enables supervisor low side in LPM with twake-up-slow from LPM2, LPM3, and LPM4.

Modified bits of **PMMCTL0** register and bits of **SVSMLCTL** register.

Returns

None

PMM_enableSvsLReset()

```
void PMM_enableSvsLReset (
            void )
```

Enables the POR signal generation when a low-voltage event is registered by the low-side SVS.

Modified bits of **PMMCTL0** register and bits of **PMMIE** register.

Returns

None

PMM_enableSvsLSvmL()

```
void PMM_enableSvsLSvmL (
            void )
```

Enables the low-side SVS and SVM circuitry.

Modified bits of **PMMCTL0** register and bits of **SVSMLCTL** register.

Returns

None

PMM_getInterruptStatus()

```
uint16_t PMM_getInterruptStatus (
            uint16_t mask )
```

Returns interrupt status.

Parameters

mask	is the mask for specifying the required flag Mask value is the logical OR of any of the following: ■ **PMM_SVSMLDLYIFG** ■ **PMM_SVMLIFG** ■ **PMM_SVMLVLRIFG** ■ **PMM_SVSMHDLYIFG** ■ **PMM_SVMHIFG** ■ **PMM_SVMHVLRIFG** ■ **PMM_PMMBORIFG** ■ **PMM_PMMRSTIFG** ■ **PMM_PMMPORIFG** ■ **PMM_SVSHIFG** ■ **PMM_SVSLIFG** ■ **PMM_PMMLPM5IFG**

Returns

Logical OR of any of the following:
- **PMM_SVSMLDLYIFG**
- **PMM_SVMLIFG**
- **PMM_SVMLVLRIFG**
- **PMM_SVSMHDLYIFG**
- **PMM_SVMHIFG**
- **PMM_SVMHVLRIFG**
- **PMM_PMMBORIFG**
- **PMM_PMMRSTIFG**
- **PMM_PMMPORIFG**
- **PMM_SVSHIFG**
- **PMM_SVSLIFG**
- **PMM_PMMLPM5IFG**
indicating the status of the masked interrupts

PMM_optimizeSvsHInLPMFullPerf()

```
void PMM_optimizeSvsHInLPMFullPerf (
            void )
```

Optimized to provide tpd = 2.5 s(1) in LPM with least power.

Modified bits of **PMMCTL0** register and bits of **SVSMLCTL** register.

Returns

None

PMM_optimizeSvsLInLPMFastWake()

```
void PMM_optimizeSvsLInLPMFastWake (
            void )
```

Optimized to provide twake-up-fast from LPM2, LPM3, and LPM4 with least power.

Modified bits of **PMMCTL0** register and bits of **SVSMLCTL** register.

Returns

None

PMM_setVCore()

```
bool PMM_setVCore (
            uint8_t level )
```

Set Vcore to expected level.

Parameters

level	level to which Vcore needs to be decreased/increased Valid values are: ■ **PMM_CORE_LEVEL_0** [Default] ■ **PMM_CORE_LEVEL_1** ■ **PMM_CORE_LEVEL_2** ■ **PMM_CORE_LEVEL_3**

Modified bits of **PMMCTL0** register, bits of **PMMIFG** register, bits of **PMMRIE** register, bits of **SVSMHCTL** register and bits of **SVSMLCTL** register.

Returns

STATUS_SUCCESS or STATUS_FAIL

References PMM_setVCoreDown(), and PMM_setVCoreUp().

PMM_setVCoreDown()

```
uint16_t PMM_setVCoreDown (
            uint8_t level )
```

Decrease Vcore by one level.

Parameters

level	level to which Vcore needs to be decreased Valid values are: ■ **PMM_CORE_LEVEL_0** [Default] ■ **PMM_CORE_LEVEL_1** ■ **PMM_CORE_LEVEL_2** ■ **PMM_CORE_LEVEL_3**

Modified bits of **PMMCTL0** register, bits of **PMMIFG** register, bits of **PMMRIE** register, bits of **SVSMHCTL** register and bits of **SVSMLCTL** register.

Returns

STATUS_SUCCESS

Referenced by PMM_setVCore().

PMM_setVCoreUp()

```
uint16_t PMM_setVCoreUp (
            uint8_t level )
```

Increase Vcore by one level.

Parameters

level	level to which Vcore needs to be increased Valid values are: ■ **PMM_CORE_LEVEL_0** [Default] ■ **PMM_CORE_LEVEL_1** ■ **PMM_CORE_LEVEL_2** ■ **PMM_CORE_LEVEL_3**

Modified bits of **PMMCTL0** register, bits of **PMMIFG** register, bits of **PMMRIE** register, bits of **SVSMHCTL** register and bits of **SVSMLCTL** register.

Returns

STATUS_SUCCESS or STATUS_FAIL

Referenced by PMM_setVCore().

27.3 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_CORE_LEVEL_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);
}
```

28 RAM Controller

28.1 Introduction

The RAMCTL provides access to the different power modes of the RAM. The RAMCTL allows the ability to reduce the leakage current while the CPU is off. The RAM can also be switched off. In retention mode, the RAM content is saved while the RAM content is lost in off mode. The RAM is partitioned in sectors, typically of 4KB (sector) size. See the device-specific data sheet for actual block allocation and size. Each sector is controlled by the RAM controller RAM Sector Off control bit (RCRSyOFF) of the RAMCTL Control 0 register (RCCTL0). The RCCTL0 register is protected with a key. Only if the correct key is written during a word write, the RCCTL0 register content can be modified. Byte write accesses or write accesses with a wrong key are ignored.

28.2 API Functions

Functions

- void RAM_setSectorOff (uint8_t sector)
  Set specified RAM sector off.
- uint8_t RAM_getSectorState (uint8_t sector)
  Get RAM sector ON/OFF status.

28.2.1 Detailed Description

The MSP430ware API that configure the RAM controller are:

RAM_setSectorOff() - Set specified RAM sector off RAM_getSectorState() - Get RAM sector ON/OFF status

28.2.2 Function Documentation

RAM_getSectorState()

```
uint8_t RAM_getSectorState (
                uint8_t sector )
```

Get RAM sector ON/OFF status.

Parameters

sector	is specified sector Mask value is the logical OR of any of the following: ■ **RAM_SECTOR0** ■ **RAM_SECTOR1** ■ **RAM_SECTOR2** ■ **RAM_SECTOR3** ■ **RAM_SECTOR4** ■ **RAM_SECTOR5** ■ **RAM_SECTOR6** ■ **RAM_SECTOR7**

Modified bits of **RCCTL0** register.

Returns

Logical OR of any of the following:
- **RAM_SECTOR0**
- **RAM_SECTOR1**
- **RAM_SECTOR2**
- **RAM_SECTOR3**
- **RAM_SECTOR4**
- **RAM_SECTOR5**
- **RAM_SECTOR6**
- **RAM_SECTOR7**
  indicating the status of the masked sectors

RAM_setSectorOff()

```
void RAM_setSectorOff (
            uint8_t sector )
```

Set specified RAM sector off.

Parameters

sector	is specified sector to be set off. Mask value is the logical OR of any of the following: ■ **RAM_SECTOR0** ■ **RAM_SECTOR1** ■ **RAM_SECTOR2** ■ **RAM_SECTOR3** ■ **RAM_SECTOR4** ■ **RAM_SECTOR5** ■ **RAM_SECTOR6** ■ **RAM_SECTOR7**

Modified bits of **RCCTL0** register.

Returns

None

28.3 Programming Example

The following example shows some RAM Controller operations using the APIs

```
    //Start timer
    Timer_A_clearTimerInterrupt(TIMER_A0_BASE);

    Timer_A_initUpModeParam param = {0};
    param.clockSource = TIMER_A_CLOCKSOURCE_ACLK;
    param.clockSourceDivider = TIMER_A_CLOCKSOURCE_DIVIDER_1;
    param.timerPeriod = 25000;
    param.timerInterruptEnable_TAIE = TIMER_A_TAIE_INTERRUPT_DISABLE;
    param.captureCompareInterruptEnable_CCR0_CCIE =
        TIMER_A_CAPTURECOMPARE_INTERRUPT_ENABLE;
    param.timerClear = TIMER_A_DO_CLEAR;
    param.startTimer = true;
    Timer_A_initUpMode(TIMER_A0_BASE, &param);

    //RAM controller sector off
    RAM_setSectorOff(RAM_SECTOR2);

    //Enter LPM0, enable interrupts
    __bis_SR_register(LPM3_bits + GIE);

    //For debugger
    __no_operation();
}

//******************************************************************************
//
//This is the Timer B0 interrupt vector service routine.
//
//******************************************************************************
#pragma vector=TIMERB0_VECTOR
__interrupt void TIMERB0_ISR (void)
{
    returnValue = RAM_getSectorState(RAM_BASE,
        RAM_SECTOR0 +
        RAM_SECTOR1 +
        RAM_SECTOR2 +
        RAM_SECTOR3);
```

```
}
```

29 Internal Reference (REF)

29.1 Introduction

The Internal Reference (REF) API provides a set of functions for using the MSP430Ware REF modules. Functions are provided to setup and enable use of the Reference voltage, enable or disable the internal temperature sensor, and view the status of the inner workings of the REF module.

The reference module (REF) is responsible for generation of all critical reference voltages that can be used by various analog peripherals in a given device. These include, but are not necessarily limited to, the ADC10_A, ADC12_A, DAC12_A, LCD_B, and COMP_B modules dependent upon the particular device. The heart of the reference system is the bandgap from which all other references are derived by unity or non-inverting gain stages. The REFGEN sub-system consists of the bandgap, the bandgap bias, and the non-inverting buffer stage which generates the three primary voltage reference available in the system, namely 1.5 V, 2.0 V, and 2.5 V. In addition, when enabled, a buffered bandgap voltage is also available.

29.2 API Functions

Functions

- void Ref_setReferenceVoltage (uint16_t baseAddress, uint8_t referenceVoltageSelect)
  Sets the reference voltage for the voltage generator.
- void Ref_disableTempSensor (uint16_t baseAddress)
  Disables the internal temperature sensor to save power consumption.
- void Ref_enableTempSensor (uint16_t baseAddress)
  Enables the internal temperature sensor.
- void Ref_enableReferenceVoltageOutput (uint16_t baseAddress)
  Outputs the reference voltage to an output pin.
- void Ref_disableReferenceVoltageOutput (uint16_t baseAddress)
  Disables the reference voltage as an output to a pin.
- void Ref_enableReferenceVoltage (uint16_t baseAddress)
  Enables the reference voltage to be used by peripherals.
- void Ref_disableReferenceVoltage (uint16_t baseAddress)
  Disables the reference voltage.
- uint16_t Ref_getBandgapMode (uint16_t baseAddress)
  Returns the bandgap mode of the Ref module.
- bool Ref_isBandgapActive (uint16_t baseAddress)
  Returns the active status of the bandgap in the Ref module.
- uint16_t Ref_isRefGenBusy (uint16_t baseAddress)
  Returns the busy status of the reference generator in the Ref module.
- bool Ref_isRefGenActive (uint16_t baseAddress)
  Returns the active status of the reference generator in the Ref module.

29.2.1 Detailed Description

The DMA API is broken into three groups of functions: those that deal with the reference voltage, those that handle the internal temperature sensor, and those that return the status of the REF module.

The reference voltage of the REF module is handled by

- Ref_setReferenceVoltage()
- Ref_enableReferenceVoltageOutput()
- Ref_disableReferenceVoltageOutput()
- Ref_enableReferenceVoltage()
- Ref_disableReferenceVoltage()

The internal temperature sensor is handled by

- Ref_disableTempSensor()
- Ref_enableTempSensor()

The status of the REF module is handled by

- Ref_getBandgapMode()
- Ref_isBandgapActive()
- Ref_isRefGenBusy()
- Ref_isRefGen()

29.2.2 Function Documentation

Ref_disableReferenceVoltage()

```
void Ref_disableReferenceVoltage (
            uint16_t baseAddress )
```

Disables the reference voltage.

This function is used to disable the generated reference voltage. Please note, if the Ref_isRefGenBusy() returns Ref_BUSY, this function will have no effect.

Parameters

baseAddress	is the base address of the REF module.

Modified bits are **REFON** of **REFCTL0** register.

Returns

None

Ref_disableReferenceVoltageOutput()

```
void Ref_disableReferenceVoltageOutput (
            uint16_t baseAddress )
```

Disables the reference voltage as an output to a pin.

This function is used to disables the reference voltage being generated to be given to an output pin. Please note, if the Ref_isRefGenBusy() returns Ref_BUSY, this function will have no effect.

Parameters

baseAddress	is the base address of the REF module.

Modified bits are **REFOUT** of **REFCTL0** register.

Returns

None

Ref_disableTempSensor()

```
void Ref_disableTempSensor (
            uint16_t baseAddress )
```

Disables the internal temperature sensor to save power consumption.

This function is used to turn off the internal temperature sensor to save on power consumption. The temperature sensor is enabled by default. Please note, that giving ADC12 module control over the Ref module, the state of the temperature sensor is dependent on the controls of the ADC12 module. Please note, if the Ref_isRefGenBusy() returns Ref_BUSY, this function will have no effect.

Parameters

baseAddress	is the base address of the REF module.

Modified bits are **REFTCOFF** of **REFCTL0** register.

Returns

None

Ref_enableReferenceVoltage()

```
void Ref_enableReferenceVoltage (
```

```
                uint16_t baseAddress )
```

Enables the reference voltage to be used by peripherals.

This function is used to enable the generated reference voltage to be used other peripherals or by an output pin, if enabled. Please note, that giving ADC12 module control over the Ref module, the state of the reference voltage is dependent on the controls of the ADC12 module. Please note, ADC10_A does not support the reference request. If the Ref_isRefGenBusy() returns Ref_BUSY, this function will have no effect.

Parameters

baseAddress	is the base address of the REF module.

Modified bits are **REFON** of **REFCTL0** register.

Returns

None

Ref_enableReferenceVoltageOutput()

```
void Ref_enableReferenceVoltageOutput (
                uint16_t baseAddress )
```

Outputs the reference voltage to an output pin.

This function is used to output the reference voltage being generated to an output pin. Please note, the output pin is device specific. Please note, that giving ADC12 module control over the Ref module, the state of the reference voltage as an output to a pin is dependent on the controls of the ADC12 module. If ADC12_A reference burst is disabled or DAC12_A is enabled, this output is available continuously. If ADC12_A reference burst is enabled, this output is available only during an ADC12_A conversion. For devices with CTSD16, Ref_enableReferenceVoltage() needs to be invoked to get VREFBG available continuously. Otherwise, VREFBG is only available externally when a module requests it. Please note, if the Ref_isRefGenBusy() returns Ref_BUSY, this function will have no effect.

Parameters

baseAddress	is the base address of the REF module.

Modified bits are **REFOUT** of **REFCTL0** register.

Returns

None

Ref_enableTempSensor()

```
void Ref_enableTempSensor (
                uint16_t baseAddress )
```

Enables the internal temperature sensor.

This function is used to turn on the internal temperature sensor to use by other peripherals. The temperature sensor is enabled by default. Please note, if the Ref_isRefGenBusy() returns Ref_BUSY, this function will have no effect.

Parameters

baseAddress	is the base address of the REF module.

Modified bits are **REFTCOFF** of **REFCTL0** register.

Returns

None

Ref_getBandgapMode()

```
uint16_t Ref_getBandgapMode (
            uint16_t baseAddress )
```

Returns the bandgap mode of the Ref module.

This function is used to return the bandgap mode of the Ref module, requested by the peripherals using the bandgap. If a peripheral requests static mode, then the bandgap mode will be static for all modules, whereas if all of the peripherals using the bandgap request sample mode, then that will be the mode returned. Sample mode allows the bandgap to be active only when necessary to save on power consumption, static mode requires the bandgap to be active until no peripherals are using it anymore.

Parameters

baseAddress	is the base address of the REF module.

Returns

One of the following:

- **REF_STATICMODE** if the bandgap is operating in static mode
- **REF_SAMPLEMODE** if the bandgap is operating in sample mode
  indicating the bandgap mode of the module

Ref_isBandgapActive()

```
bool Ref_isBandgapActive (
            uint16_t baseAddress )
```

Returns the active status of the bandgap in the Ref module.

This function is used to return the active status of the bandgap in the Ref module. If the bandgap is in use by a peripheral, then the status will be seen as active.

Parameters

baseAddress	is the base address of the REF module.

Returns

One of the following:
- **REF_ACTIVE** if active
- **REF_INACTIVE** if not active
indicating the bandgap active status of the module

Ref_isRefGenActive()

```
bool Ref_isRefGenActive (
            uint16_t baseAddress )
```

Returns the active status of the reference generator in the Ref module.

This function is used to return the active status of the reference generator in the Ref module. If the ref generator is on and ready to use, then the status will be seen as active.

Parameters

baseAddress	is the base address of the REF module.

Returns

One of the following:
- **REF_ACTIVE** if active
- **REF_INACTIVE** if not active
indicating the reference generator active status of the module

Ref_isRefGenBusy()

```
uint16_t Ref_isRefGenBusy (
            uint16_t baseAddress )
```

Returns the busy status of the reference generator in the Ref module.

This function is used to return the busy status of the reference generator in the Ref module. If the ref generator is in use by a peripheral, then the status will be seen as busy.

Parameters

baseAddress	is the base address of the REF module.

Returns

One of the following:
- **REF_NOTBUSY** if the reference generator is not being used
- **REF_BUSY** if the reference generator is being used, disallowing changes to be made to the Ref module controls
  indicating the reference generator busy status of the module

Ref_setReferenceVoltage()

```
void Ref_setReferenceVoltage (
            uint16_t baseAddress,
            uint8_t referenceVoltageSelect )
```

Sets the reference voltage for the voltage generator.

This function sets the reference voltage generated by the voltage generator to be used by other peripherals. This reference voltage will only be valid while the Ref module is in control. Please note, if the Ref_isRefGenBusy() returns Ref_BUSY, this function will have no effect.

Parameters

baseAddress	is the base address of the REF module.
referenceVoltageSelect	is the desired voltage to generate for a reference voltage. Valid values are: ■ **REF_VREF1_5V** [Default] ■ **REF_VREF2_0V** ■ **REF_VREF2_5V** Modified bits are **REFVSEL** of **REFCTL0** register.

Returns

None

29.3 Programming Example

The following example shows how to initialize and use the REF API with the ADC12_A module to use as a positive reference to the analog signal input.

```
// By default, REFMSTR=1 => REFCTL is used to configure the internal reference

// If ref generator busy, WAIT
while(Ref_refGenBusyStatus(REF_BASE));
// Select internal ref = 2.5V
Ref_setReferenceVoltage(REF_BASE,
                        REF_VREF2_5V);
// Internal Reference ON
Ref_enableReferenceVoltage(REF_BASE);

__delay_cycles(75);                    // Delay (~75us) for Ref to settle

// Initialize the ADC12_A Module
```

```
/*
 * Base address of ADC12_A Module
 * Use internal ADC12_A bit as sample/hold signal to start conversion
 * USE MODOSC 5MHZ Digital Oscillator as clock source
 * Use default clock divider of 1
 */
ADC12_A_init(ADC12_A_BASE,
           ADC12_A_SAMPLEHOLDSOURCE_SC,
           ADC12_A_CLOCKSOURCE_ADC12OSC,
           ADC12_A_CLOCKDIVIDEBY_1);
/*
 * Base address of ADC12 Module
 * For memory buffers 0-7 sample/hold for 64 clock cycles
 * For memory buffers 8-15 sample/hold for 4 clock cycles (default)
 * Disable Multiple Sampling
 */
ADC12_A_setupSamplingTimer(ADC12_A_BASE,
                         ADC12_A_CYCLEHOLD_64_CYCLES,
                         ADC12_A_CYCLEHOLD_4_CYCLES,
                         ADC12_A_MULTIPLESAMPLESENABLE);

// Configure Memory Buffer
/*
 * Base address of the ADC12 Module
 * Configure memory buffer 0
 * Map input A0 to memory buffer 0
 * Vref+ = Vref+ (INT)
 * Vref- = AVss
 */
ADC12_A_memoryConfigure(ADC12_A_BASE,
                      ADC12_A_MEMORY_0,
                      ADC12_A_INPUT_A0,
                      ADC12_A_VREFPOS_INT,
                      ADC12_A_VREFNEG_AVSS,
                      ADC12_A_NOTENDOFSEQUENCE);

while (1)
{
  // Enable/Start sampling and conversion
  /*
   * Base address of ADC12 Module
   * Start the conversion into memory buffer 0
   * Use the single-channel, single-conversion mode
   */
  ADC12_A_startConversion(ADC12_A_BASE,
                        ADC12_A_MEMORY_0,
                        ADC12_A_SINGLECHANNEL);

  // Poll for interrupt on memory buffer 0
  while(!ADC12_A_interruptStatus(ADC12_A_BASE, ADC12IFG0));

  __no_operation();                     // SET BREAKPOINT HERE
}
```

30 Real-Time Clock (RTC_A)

30.1 Introduction

The Real Time Clock (RTC_A) API provides a set of functions for using the MSP430Ware RTC_A modules. Functions are provided to calibrate the clock, initialize the RTC_A modules in calendar mode/counter mode and setup conditions for, and enable, interrupts for the RTC_A modules. If an RTC_A module is used, then counter mode may also be initialized, as well as prescale counters.

The RTC_A module provides the ability to keep track of the current time and date in calendar mode, or can be setup as a 32-bit counter (RTC_A Only).

The RTC_A module generates multiple interrupts. There are 2 interrupts that can be defined in calendar mode, and 1 interrupt in counter mode for counter overflow, as well as an interrupt for each prescaler.

30.2 API Functions

Functions

- void RTC_A_startClock (uint16_t baseAddress)
  Starts the RTC.
- void RTC_A_holdClock (uint16_t baseAddress)
  Holds the RTC.
- void RTC_A_setCalibrationFrequency (uint16_t baseAddress, uint16_t frequencySelect)
  Allows and Sets the frequency output to RTCCLK pin for calibration measurement.
- void RTC_A_setCalibrationData (uint16_t baseAddress, uint8_t offsetDirection, uint8_t offsetValue)
  Sets the specified calibration for the RTC.
- void RTC_A_initCounter (uint16_t baseAddress, uint16_t clockSelect, uint16_t counterSizeSelect)
  Initializes the settings to operate the RTC in Counter mode.
- void RTC_A_initCalendar (uint16_t baseAddress, Calendar *CalendarTime, uint16_t formatSelect)
  Initializes the settings to operate the RTC in calendar mode.
- Calendar RTC_A_getCalendarTime (uint16_t baseAddress)
  Returns the Calendar Time stored in the Calendar registers of the RTC.
- void RTC_A_configureCalendarAlarm (uint16_t baseAddress, RTC_A_configureCalendarAlarmParam *param)
  Sets and Enables the desired Calendar Alarm settings.
- void RTC_A_setCalendarEvent (uint16_t baseAddress, uint16_t eventSelect)
  Sets a single specified Calendar interrupt condition.
- uint32_t RTC_A_getCounterValue (uint16_t baseAddress)
  Returns the value of the Counter register.

- void RTC_A_setCounterValue (uint16_t baseAddress, uint32_t counterValue)
  Sets the value of the Counter register.
- void RTC_A_initCounterPrescale (uint16_t baseAddress, uint8_t prescaleSelect, uint16_t prescaleClockSelect, uint16_t prescaleDivider)
  Initializes the Prescaler for Counter mode.
- void RTC_A_holdCounterPrescale (uint16_t baseAddress, uint8_t prescaleSelect)
  Holds the selected Prescaler.
- void RTC_A_startCounterPrescale (uint16_t baseAddress, uint8_t prescaleSelect)
  Starts the selected Prescaler.
- void RTC_A_definePrescaleEvent (uint16_t baseAddress, uint8_t prescaleSelect, uint8_t prescaleEventDivider)
  Sets up an interrupt condition for the selected Prescaler.
- uint8_t RTC_A_getPrescaleValue (uint16_t baseAddress, uint8_t prescaleSelect)
  Returns the selected prescaler value.
- void RTC_A_setPrescaleValue (uint16_t baseAddress, uint8_t prescaleSelect, uint8_t prescaleCounterValue)
  Sets the selected prescaler value.
- void RTC_A_enableInterrupt (uint16_t baseAddress, uint8_t interruptMask)
  Enables selected RTC interrupt sources.
- void RTC_A_disableInterrupt (uint16_t baseAddress, uint8_t interruptMask)
  Disables selected RTC interrupt sources.
- uint8_t RTC_A_getInterruptStatus (uint16_t baseAddress, uint8_t interruptFlagMask)
  Returns the status of the selected interrupts flags.
- void RTC_A_clearInterrupt (uint16_t baseAddress, uint8_t interruptFlagMask)
  Clears selected RTC interrupt flags.

30.2.1 Detailed Description

The RTC_A API is broken into 5 groups of functions: clock settings, calender mode, counter mode, prescale counter, and interrupt condition setup/enable functions and data conversion.

The RTC_A clock settings are handled by

- RTC_A_startClock()
- RTC_A_holdClock()
- RTC_A_setCalibrationFrequency()
- RTC_A_setCalibrationData()

The RTC_A calender mode is initialized and setup by

- RTC_A_initCalender()
- RTC_A_getCalenderTime()

The RTC_A counter mode is initialized and setup by

- RTC_A_initCounter()
- RTC_A_getCounterValue()
- RTC_A_setCounterValue()
- RTC_A_initCounterPrescale()
- RTC_A_holdCounterPrescale()

- RTC_A_startCounterPrescale()

The RTC_A prescale counter is handled by

- RTC_A_getPrescaleValue()
- RTC_A_setPrescaleValue()

The RTC_A interrupts are handled by

- RTC_A_configureCalendarAlarm()
- RTC_A_setCalenderEvent()
- RTC_A_definePrescaleEvent()
- RTC_A_enableInterrupt()
- RTC_A_disableInterrupt()
- RTC_A_getInterruptStatus()
- RTC_A_clearInterrupt()

30.2.2 Function Documentation

RTC_A_clearInterrupt()

```
void RTC_A_clearInterrupt (
            uint16_t baseAddress,
            uint8_t interruptFlagMask )
```

Clears selected RTC interrupt flags.

This function clears the RTC interrupt flag is cleared, so that it no longer asserts.

Parameters

baseAddress	is the base address of the RTC_A module.
interruptFlagMask	is a bit mask of the interrupt flags to be cleared. Mask value is the logical OR of any of the following: - **RTC_A_TIME_EVENT_INTERRUPT** - asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met. - **RTC_A_CLOCK_ALARM_INTERRUPT** - asserts when alarm condition in Calendar mode is met. - **RTC_A_CLOCK_READ_READY_INTERRUPT** - asserts when Calendar registers are settled. - **RTC_A_PRESCALE_TIMER0_INTERRUPT** - asserts when Prescaler 0 event condition is met. - **RTC_A_PRESCALE_TIMER1_INTERRUPT** - asserts when Prescaler 1 event condition is met.

Returns

None

RTC_A_configureCalendarAlarm()

```
void RTC_A_configureCalendarAlarm (
            uint16_t baseAddress,
            RTC_A_configureCalendarAlarmParam * param )
```

Sets and Enables the desired Calendar Alarm settings.

This function sets a Calendar interrupt condition to assert the RTCAIFG interrupt flag. The condition is a logical and of all of the parameters. For example if the minutes and hours alarm is set, then the interrupt will only assert when the minutes AND the hours change to the specified setting. Use the RTC_A_ALARM_OFF for any alarm settings that should not be apart of the alarm condition.

Parameters

baseAddress	is the base address of the RTC_A module.
param	is the pointer to struct for calendar alarm configuration.

Returns

None

References RTC_A_configureCalendarAlarmParam::dayOfMonthAlarm, RTC_A_configureCalendarAlarmParam::dayOfWeekAlarm, RTC_A_configureCalendarAlarmParam::hoursAlarm, and RTC_A_configureCalendarAlarmParam::minutesAlarm.

RTC_A_definePrescaleEvent()

```
void RTC_A_definePrescaleEvent (
            uint16_t baseAddress,
            uint8_t prescaleSelect,
            uint8_t prescaleEventDivider )
```

Sets up an interrupt condition for the selected Prescaler.

This function sets the condition for an interrupt to assert based on the individual prescalers.

Parameters

baseAddress	is the base address of the RTC_A module.
prescaleSelect	is the prescaler to define an interrupt for. Valid values are: ■ **RTC_A_PRESCALE_0** ■ **RTC_A_PRESCALE_1**

Parameters

prescaleEventDivider	is a divider to specify when an interrupt can occur based on the clock source of the selected prescaler. (Does not affect timer of the selected prescaler). Valid values are: ■ **RTC_A_PSEVENTDIVIDER_2** [Default] ■ **RTC_A_PSEVENTDIVIDER_4** ■ **RTC_A_PSEVENTDIVIDER_8** ■ **RTC_A_PSEVENTDIVIDER_16** ■ **RTC_A_PSEVENTDIVIDER_32** ■ **RTC_A_PSEVENTDIVIDER_64** ■ **RTC_A_PSEVENTDIVIDER_128** ■ **RTC_A_PSEVENTDIVIDER_256** Modified bits are **RTxIP** of **RTCPSxCTL** register.

Returns

None

RTC_A_disableInterrupt()

```
void RTC_A_disableInterrupt (
            uint16_t baseAddress,
            uint8_t interruptMask )
```

Disables selected RTC interrupt sources.

This function disables the selected RTC interrupt source. 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 RTC_A module.
interruptMask	is a bit mask of the interrupts to disable. Mask value is the logical OR of any of the following: ■ **RTC_A_TIME_EVENT_INTERRUPT** - asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met. ■ **RTC_A_CLOCK_ALARM_INTERRUPT** - asserts when alarm condition in Calendar mode is met. ■ **RTC_A_CLOCK_READ_READY_INTERRUPT** - asserts when Calendar registers are settled. ■ **RTC_A_PRESCALE_TIMER0_INTERRUPT** - asserts when Prescaler 0 event condition is met. ■ **RTC_A_PRESCALE_TIMER1_INTERRUPT** - asserts when Prescaler 1 event condition is met.

Returns

None

RTC_A_enableInterrupt()

```
void RTC_A_enableInterrupt (
            uint16_t baseAddress,
            uint8_t interruptMask )
```

Enables selected RTC interrupt sources.

This function enables the selected RTC interrupt source. 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 RTC_A module.
interruptMask	is a bit mask of the interrupts to enable. Mask value is the logical OR of any of the following: ■ **RTC_A_TIME_EVENT_INTERRUPT** - asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met. ■ **RTC_A_CLOCK_ALARM_INTERRUPT** - asserts when alarm condition in Calendar mode is met. ■ **RTC_A_CLOCK_READ_READY_INTERRUPT** - asserts when Calendar registers are settled. ■ **RTC_A_PRESCALE_TIMER0_INTERRUPT** - asserts when Prescaler 0 event condition is met. ■ **RTC_A_PRESCALE_TIMER1_INTERRUPT** - asserts when Prescaler 1 event condition is met.

Returns

None

RTC_A_getCalendarTime()

```
Calendar RTC_A_getCalendarTime (
            uint16_t baseAddress )
```

Returns the Calendar Time stored in the Calendar registers of the RTC.

This function returns the current Calendar time in the form of a Calendar structure. The RTCRDY polling is used in this function to prevent reading invalid time.

Parameters

baseAddress	is the base address of the RTC_A module.

Returns

A Calendar structure containing the current time.

References Calendar::DayOfMonth, Calendar::DayOfWeek, Calendar::Hours, Calendar::Minutes, Calendar::Month, Calendar::Seconds, and Calendar::Year.

RTC_A_getCounterValue()

```
uint32_t RTC_A_getCounterValue (
            uint16_t baseAddress )
```

Returns the value of the Counter register.

This function returns the value of the counter register for the RTC_A module. It will return the 32-bit value no matter the size set during initialization. The RTC should be held before trying to use this function.

Parameters

baseAddress	is the base address of the RTC_A module.

Returns

The raw value of the full 32-bit Counter Register.

RTC_A_getInterruptStatus()

```
uint8_t RTC_A_getInterruptStatus (
            uint16_t baseAddress,
            uint8_t interruptFlagMask )
```

Returns the status of the selected interrupts flags.

This function returns the status of the interrupt flag for the selected channel.

Parameters

baseAddress	is the base address of the RTC_A module.

Parameters

interruptFlagMask	is a bit mask of the interrupt flags to return the status of. Mask value is the logical OR of any of the following: ■ **RTC_A_TIME_EVENT_INTERRUPT** - asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met. ■ **RTC_A_CLOCK_ALARM_INTERRUPT** - asserts when alarm condition in Calendar mode is met. ■ **RTC_A_CLOCK_READ_READY_INTERRUPT** - asserts when Calendar registers are settled. ■ **RTC_A_PRESCALE_TIMER0_INTERRUPT** - asserts when Prescaler 0 event condition is met. ■ **RTC_A_PRESCALE_TIMER1_INTERRUPT** - asserts when Prescaler 1 event condition is met.

Returns

Logical OR of any of the following:

- **RTC_A_TIME_EVENT_INTERRUPT** asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met.
- **RTC_A_CLOCK_ALARM_INTERRUPT** asserts when alarm condition in Calendar mode is met.
- **RTC_A_CLOCK_READ_READY_INTERRUPT** asserts when Calendar registers are settled.
- **RTC_A_PRESCALE_TIMER0_INTERRUPT** asserts when Prescaler 0 event condition is met.
- **RTC_A_PRESCALE_TIMER1_INTERRUPT** asserts when Prescaler 1 event condition is met.
  indicating the status of the masked interrupts

RTC_A_getPrescaleValue()

```
uint8_t RTC_A_getPrescaleValue (
            uint16_t baseAddress,
            uint8_t prescaleSelect )
```

Returns the selected prescaler value.

This function returns the value of the selected prescale counter register. Note that the counter value should be held by calling RTC_A_holdClock() before calling this API.

Parameters

baseAddress	is the base address of the RTC_A module.

Parameters

prescaleSelect	is the prescaler to obtain the value of. Valid values are: ■ **RTC_A_PRESCALE_0** ■ **RTC_A_PRESCALE_1**

Returns

The value of the specified prescaler count register

RTC_A_holdClock()

```
void RTC_A_holdClock (
            uint16_t baseAddress )
```

Holds the RTC.

This function sets the RTC main hold bit to disable RTC functionality.

Parameters

baseAddress	is the base address of the RTC_A module.

Returns

None

RTC_A_holdCounterPrescale()

```
void RTC_A_holdCounterPrescale (
            uint16_t baseAddress,
            uint8_t prescaleSelect )
```

Holds the selected Prescaler.

This function holds the prescale counter from continuing. This will only work in counter mode, in Calendar mode, the RTC_A_holdClock() must be used. In counter mode, if using both prescalers in conjunction with the main RTC counter, then stopping RT0PS will stop RT1PS, but stopping RT1PS will not stop RT0PS.

Parameters

baseAddress	is the base address of the RTC_A module.
prescaleSelect	is the prescaler to hold. Valid values are: ■ **RTC_A_PRESCALE_0** ■ **RTC_A_PRESCALE_1**

Returns

None

RTC_A_initCalendar()

```
void RTC_A_initCalendar (
            uint16_t baseAddress,
            Calendar * CalendarTime,
            uint16_t formatSelect )
```

Initializes the settings to operate the RTC in calendar mode.

This function initializes the Calendar mode of the RTC module. To prevent potential erroneous alarm conditions from occurring, the alarm should be disabled by clearing the RTCAIE, RTCAIFG and AE bits with APIs: RTC_A_disableInterrupt(), RTC_A_clearInterrupt() and RTC_A_configureCalendarAlarm() before calendar initialization.

Parameters

baseAddress	is the base address of the RTC_A module.
CalendarTime	is the pointer to the structure containing the values for the Calendar to be initialized to. Valid values should be of type pointer to Calendar and should contain the following members and corresponding values: **Seconds** between 0-59 **Minutes** between 0-59 **Hours** between 0-23 **DayOfWeek** between 0-6 **DayOfMonth** between 1-31 **Month** between 1-12 **Year** between 0-4095 **NOTE:** Values beyond the ones specified may result in erratic behavior.
formatSelect	is the format for the Calendar registers to use. Valid values are: ■ **RTC_A_FORMAT_BINARY** [Default] ■ **RTC_A_FORMAT_BCD** Modified bits are **RTCBCD** of **RTCCTL1** register.

Returns

None

References Calendar::DayOfMonth, Calendar::DayOfWeek, Calendar::Hours, Calendar::Minutes, Calendar::Month, Calendar::Seconds, and Calendar::Year.

RTC_A_initCounter()

```
void RTC_A_initCounter (
            uint16_t baseAddress,
            uint16_t clockSelect,
            uint16_t counterSizeSelect )
```

Initializes the settings to operate the RTC in Counter mode.

This function initializes the Counter mode of the RTC_A. Setting the clock source and counter size will allow an interrupt from the RTCTEVIFG once an overflow to the counter register occurs.

Parameters

baseAddress	is the base address of the RTC_A module.
clockSelect	is the selected clock for the counter mode to use. Valid values are: ■ **RTC_A_CLOCKSELECT_ACLK** [Default] ■ **RTC_A_CLOCKSELECT_SMCLK** ■ **RTC_A_CLOCKSELECT_RT1PS** - use Prescaler 1 as source to RTC Modified bits are **RTCSSEL** of **RTCCTL1** register.
counterSizeSelect	is the size of the counter. Valid values are: ■ **RTC_A_COUNTERSIZE_8BIT** [Default] ■ **RTC_A_COUNTERSIZE_16BIT** ■ **RTC_A_COUNTERSIZE_24BIT** ■ **RTC_A_COUNTERSIZE_32BIT** Modified bits are **RTCTEV** of **RTCCTL1** register.

Returns

None

RTC_A_initCounterPrescale()

```
void RTC_A_initCounterPrescale (
            uint16_t baseAddress,
            uint8_t prescaleSelect,
            uint16_t prescaleClockSelect,
            uint16_t prescaleDivider )
```

Initializes the Prescaler for Counter mode.

This function initializes the selected prescaler for the counter mode in the RTC_A module. If the RTC is initialized in Calendar mode, then these are automatically initialized. The Prescalers can be used to divide a clock source additionally before it gets to the main RTC clock.

Parameters

baseAddress	is the base address of the RTC_A module.
prescaleSelect	is the prescaler to initialize. Valid values are: ■ **RTC_A_PRESCALE_0** ■ **RTC_A_PRESCALE_1**

Parameters

prescaleClockSelect	is the clock to drive the selected prescaler. Valid values are: ■ **RTC_A_PSCLOCKSELECT_ACLK** ■ **RTC_A_PSCLOCKSELECT_SMCLK** ■ **RTC_A_PSCLOCKSELECT_RT0PS** - use Prescaler 0 as source to Prescaler 1 (May only be used if prescaleSelect is RTC_A_PRESCALE_1) Modified bits are **RTxSSEL** of **RTCPSxCTL** register.
prescaleDivider	is the divider for the selected clock source. Valid values are: ■ **RTC_A_PSDIVIDER_2** [Default] ■ **RTC_A_PSDIVIDER_4** ■ **RTC_A_PSDIVIDER_8** ■ **RTC_A_PSDIVIDER_16** ■ **RTC_A_PSDIVIDER_32** ■ **RTC_A_PSDIVIDER_64** ■ **RTC_A_PSDIVIDER_128** ■ **RTC_A_PSDIVIDER_256** Modified bits are **RTxPSDIV** of **RTCPSxCTL** register.

Returns

None

RTC_A_setCalendarEvent()

```
void RTC_A_setCalendarEvent (
            uint16_t baseAddress,
            uint16_t eventSelect )
```

Sets a single specified Calendar interrupt condition.

This function sets a specified event to assert the RTCTEVIFG interrupt. This interrupt is independent from the Calendar alarm interrupt.

Parameters

baseAddress	is the base address of the RTC_A module.

Parameters

eventSelect	is the condition selected. Valid values are: ■ **RTC_A_CALENDAREVENT_MINUTECHANGE** - assert interrupt on every minute ■ **RTC_A_CALENDAREVENT_HOURCHANGE** - assert interrupt on every hour ■ **RTC_A_CALENDAREVENT_NOON** - assert interrupt when hour is 12 ■ **RTC_A_CALENDAREVENT_MIDNIGHT** - assert interrupt when hour is 0 Modified bits are **RTCTEV** of **RTCCTL** register.

Returns

None

RTC_A_setCalibrationData()

```
void RTC_A_setCalibrationData (
            uint16_t baseAddress,
            uint8_t offsetDirection,
            uint8_t offsetValue )
```

Sets the specified calibration for the RTC.

This function sets the calibration offset to make the RTC as accurate as possible. The offsetDirection can be either +4-ppm or -2-ppm, and the offsetValue should be from 1-63 and is multiplied by the direction setting (i.e. +4-ppm $*$ 8 (offsetValue) = +32-ppm). Please note, when measuring the frequency after setting the calibration, you will only see a change on the 1Hz frequency.

Parameters

baseAddress	is the base address of the RTC_A module.
offsetDirection	is the direction that the calibration offset will go. Valid values are: ■ **RTC_A_CALIBRATION_DOWN2PPM** - calibrate at steps of -2 ■ **RTC_A_CALIBRATION_UP4PPM** - calibrate at steps of +4 Modified bits are **RTCCALS** of **RTCCTL2** register.
offsetValue	is the value that the offset will be a factor of; a valid value is any integer from 1-63. Modified bits are **RTCCAL** of **RTCCTL2** register.

Returns

None

RTC_A_setCalibrationFrequency()

```
void RTC_A_setCalibrationFrequency (
            uint16_t baseAddress,
            uint16_t frequencySelect )
```

Allows and Sets the frequency output to RTCCLK pin for calibration measurement.

This function sets a frequency to measure at the RTCCLK output pin. After testing the set frequency, the calibration could be set accordingly.

Parameters

baseAddress	is the base address of the RTC_A module.
frequencySelect	is the frequency output to RTCCLK. Valid values are: ■ **RTC_A_CALIBRATIONFREQ_OFF** [Default] - turn off calibration output ■ **RTC_A_CALIBRATIONFREQ_512HZ** - output signal at 512Hz for calibration ■ **RTC_A_CALIBRATIONFREQ_256HZ** - output signal at 256Hz for calibration ■ **RTC_A_CALIBRATIONFREQ_1HZ** - output signal at 1Hz for calibration Modified bits are **RTCCALF** of **RTCCTL3** register.

Returns

None

RTC_A_setCounterValue()

```
void RTC_A_setCounterValue (
            uint16_t baseAddress,
            uint32_t counterValue )
```

Sets the value of the Counter register.

This function sets the counter register of the RTC_A module.

Parameters

baseAddress	is the base address of the RTC_A module.
counterValue	is the value to set the Counter register to; a valid value may be any 32-bit integer.

Returns

None

RTC_A_setPrescaleValue()

```
void RTC_A_setPrescaleValue (
            uint16_t baseAddress,
            uint8_t prescaleSelect,
            uint8_t prescaleCounterValue )
```

Sets the selected prescaler value.

This function sets the prescale counter value. Before setting the prescale counter, it should be held by calling RTC_A_holdClock().

Parameters

baseAddress	is the base address of the RTC_A module.
prescaleSelect	is the prescaler to set the value for. Valid values are: ■ **RTC_A_PRESCALE_0** ■ **RTC_A_PRESCALE_1**
prescaleCounterValue	is the specified value to set the prescaler to. Valid values are any integer between 0-255 Modified bits are **RTxPS** of **RTxPS** register.

Returns

None

RTC_A_startClock()

```
void RTC_A_startClock (
            uint16_t baseAddress )
```

Starts the RTC.

This function clears the RTC main hold bit to allow the RTC to function.

Parameters

baseAddress	is the base address of the RTC_A module.

Returns

None

RTC_A_startCounterPrescale()

```
void RTC_A_startCounterPrescale (
              uint16_t baseAddress,
              uint8_t prescaleSelect )
```

Starts the selected Prescaler.

This function starts the selected prescale counter. This function will only work if the RTC is in counter mode.

Parameters

baseAddress	is the base address of the RTC_A module.
prescaleSelect	is the prescaler to start. Valid values are: ■ **RTC_A_PRESCALE_0** ■ **RTC_A_PRESCALE_1**

Returns

None

30.3 Programming Example

The following example shows how to initialize and use the RTC API to setup Calender Mode with the current time and various interrupts.

```
//Initialize calendar struct
Calendar currentTime;
currentTime.Seconds    = 0x00;
currentTime.Minutes    = 0x26;
currentTime.Hours      = 0x13;
currentTime.DayOfWeek  = 0x03;
currentTime.DayOfMonth = 0x20;
currentTime.Month      = 0x07;
currentTime.Year       = 0x2011;

//Initialize alarm struct
RTC_A_configureCalendarAlarmParam alarmParam;
alarmParam.minutesAlarm = 0x00;
alarmParam.hoursAlarm = 0x17;
alarmParam.dayOfWeekAlarm = RTC_A_ALARMCONDITION_OFF;
alarmParam.dayOfMonthAlarm = 0x05;

//Initialize Calendar Mode of RTC_A
/*
 * Base Address of the RTC_A
 * Pass in current time, initialized above
 * Use BCD as Calendar Register Format
 */
RTC_A_initCalendar(RTC_A_BASE,
    &currentTime,
    RTC_A_FORMAT_BCD);
```

```
//Setup Calendar Alarm for 5:00pm on the 5th day of the month.
//Note: Does not specify day of the week.
RTC_C_configureCalendarAlarm(RTC_A_BASE, &alarmParam);

//Specify an interrupt to assert every minute
RTC_A_setCalendarEvent(RTC_A_BASE,
    RTC_A_CALENDAREVENT_MINUTECHANGE);

//Enable interrupt for RTC_A Ready Status, which asserts when the RTC_A
//Calendar registers are ready to read.
//Also, enable interrupts for the Calendar alarm and Calendar event.
RTC_A_enableInterrupt(RTC_A_BASE,
    RTC_A_CLOCK_READ_READY_INTERRUPT +
    RTC_A_TIME_EVENT_INTERRUPT +
    RTC_A_CLOCK_ALARM_INTERRUPT);

//Start RTC_A Clock
RTC_A_startClock(RTC_A_BASE);

//Enter LPM3 mode with interrupts enabled
__bis_SR_register(LPM3_bits + GIE);
__no_operation();
```

31 Real-Time Clock (RTC_B)

31.1 Introduction

The Real Time Clock (RTC_B) API provides a set of functions for using the MSP430Ware RTC_B modules. Functions are provided to calibrate the clock, initialize the RTC modules in calendar mode, and setup conditions for, and enable, interrupts for the RTC modules. If an RTC_B module is used, then prescale counters are also initialized.

The RTC_B module provides the ability to keep track of the current time and date in calendar mode.

The RTC_B module generates multiple interrupts. There are 2 interrupts that can be defined in calendar mode, and 1 interrupt for user-configured event, as well as an interrupt for each prescaler.

31.2 API Functions

Functions

- void RTC_B_startClock (uint16_t baseAddress)
  Starts the RTC.
- void RTC_B_holdClock (uint16_t baseAddress)
  Holds the RTC.
- void RTC_B_setCalibrationFrequency (uint16_t baseAddress, uint16_t frequencySelect)
  Allows and Sets the frequency output to RTCCLK pin for calibration measurement.
- void RTC_B_setCalibrationData (uint16_t baseAddress, uint8_t offsetDirection, uint8_t offsetValue)
  Sets the specified calibration for the RTC.
- void RTC_B_initCalendar (uint16_t baseAddress, Calendar *CalendarTime, uint16_t formatSelect)
  Initializes the settings to operate the RTC in calendar mode.
- Calendar RTC_B_getCalendarTime (uint16_t baseAddress)
  Returns the Calendar Time stored in the Calendar registers of the RTC.
- void RTC_B_configureCalendarAlarm (uint16_t baseAddress, RTC_B_configureCalendarAlarmParam *param)
  Sets and Enables the desired Calendar Alarm settings.
- void RTC_B_setCalendarEvent (uint16_t baseAddress, uint16_t eventSelect)
  Sets a single specified Calendar interrupt condition.
- void RTC_B_definePrescaleEvent (uint16_t baseAddress, uint8_t prescaleSelect, uint8_t prescaleEventDivider)
  Sets up an interrupt condition for the selected Prescaler.
- uint8_t RTC_B_getPrescaleValue (uint16_t baseAddress, uint8_t prescaleSelect)
  Returns the selected prescaler value.

- void RTC_B_setPrescaleValue (uint16_t baseAddress, uint8_t prescaleSelect, uint8_t prescaleCounterValue)
  Sets the selected prescaler value.
- void RTC_B_enableInterrupt (uint16_t baseAddress, uint8_t interruptMask)
  Enables selected RTC interrupt sources.
- void RTC_B_disableInterrupt (uint16_t baseAddress, uint8_t interruptMask)
  Disables selected RTC interrupt sources.
- uint8_t RTC_B_getInterruptStatus (uint16_t baseAddress, uint8_t interruptFlagMask)
  Returns the status of the selected interrupts flags.
- void RTC_B_clearInterrupt (uint16_t baseAddress, uint8_t interruptFlagMask)
  Clears selected RTC interrupt flags.
- uint16_t RTC_B_convertBCDToBinary (uint16_t baseAddress, uint16_t valueToConvert)
  Convert the given BCD value to binary format.
- uint16_t RTC_B_convertBinaryToBCD (uint16_t baseAddress, uint16_t valueToConvert)
  Convert the given binary value to BCD format.

31.2.1 Detailed Description

The RTC_B API is broken into 5 groups of functions: clock settings, calender mode, prescale counter, interrupt condition setup/enable functions and data conversion.

The RTC_B clock settings are handled by

- RTC_B_startClock()
- RTC_B_holdClock()
- RTC_B_setCalibrationFrequency()
- RTC_B_setCalibrationData()

The RTC_B calender mode is initialized and handled by

- RTC_B_initCalendar()
- RTC_B_configureCalendarAlarm()
- RTC_B_getCalendarTime()

The RTC_B prescale counter is handled by

- RTC_B_getPrescaleValue()
- RTC_B_setPrescaleValue()

The RTC_B interrupts are handled by

- RTC_B_definePrescaleEvent()
- RTC_B_setCalendarEvent()
- RTC_B_enableInterrupt()
- RTC_B_disableInterrupt()
- RTC_B_getInterruptStatus()
- RTC_B_clearInterrupt()

The RTC_B conversions are handled by

- RTC_B_convertBCDToBinary()
- RTC_B_convertBinaryToBCD()

31.2.2 Function Documentation

RTC_B_clearInterrupt()

```
void RTC_B_clearInterrupt (
            uint16_t baseAddress,
            uint8_t interruptFlagMask )
```

Clears selected RTC interrupt flags.

This function clears the RTC interrupt flag is cleared, so that it no longer asserts.

Parameters

baseAddress	is the base address of the RTC_B module.
interruptFlagMask	is a bit mask of the interrupt flags to be cleared. Mask value is the logical OR of any of the following: ■ **RTC_B_TIME_EVENT_INTERRUPT** - asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met. ■ **RTC_B_CLOCK_ALARM_INTERRUPT** - asserts when alarm condition in Calendar mode is met. ■ **RTC_B_CLOCK_READ_READY_INTERRUPT** - asserts when Calendar registers are settled. ■ **RTC_B_PRESCALE_TIMER0_INTERRUPT** - asserts when Prescaler 0 event condition is met. ■ **RTC_B_PRESCALE_TIMER1_INTERRUPT** - asserts when Prescaler 1 event condition is met. ■ **RTC_B_OSCILLATOR_FAULT_INTERRUPT** - asserts if there is a problem with the 32kHz oscillator, while the RTC is running.

Returns

None

RTC_B_configureCalendarAlarm()

```
void RTC_B_configureCalendarAlarm (
            uint16_t baseAddress,
            RTC_B_configureCalendarAlarmParam * param )
```

Sets and Enables the desired Calendar Alarm settings.

This function sets a Calendar interrupt condition to assert the RTCAIFG interrupt flag. The condition is a logical and of all of the parameters. For example if the minutes and hours alarm is set, then the interrupt will only assert when the minutes AND the hours change to the specified setting. Use the RTC_B_ALARM_OFF for any alarm settings that should not be apart of the alarm condition.

Parameters

baseAddress	is the base address of the RTC_B module.
param	is the pointer to struct for calendar alarm configuration.

Returns

None

References RTC_B_configureCalendarAlarmParam::dayOfMonthAlarm, RTC_B_configureCalendarAlarmParam::dayOfWeekAlarm, RTC_B_configureCalendarAlarmParam::hoursAlarm, and RTC_B_configureCalendarAlarmParam::minutesAlarm.

RTC_B_convertBCDToBinary()

```
uint16_t RTC_B_convertBCDToBinary (
            uint16_t baseAddress,
            uint16_t valueToConvert )
```

Convert the given BCD value to binary format.

This function converts BCD values to binary format. This API uses the hardware registers to perform the conversion rather than a software method.

Parameters

baseAddress	is the base address of the RTC_B module.
valueToConvert	is the raw value in BCD format to convert to Binary. Modified bits are **BCD2BIN** of **BCD2BIN** register.

Returns

The binary version of the input parameter

RTC_B_convertBinaryToBCD()

```
uint16_t RTC_B_convertBinaryToBCD (
            uint16_t baseAddress,
            uint16_t valueToConvert )
```

Convert the given binary value to BCD format.

This function converts binary values to BCD format. This API uses the hardware registers to perform the conversion rather than a software method.

Parameters

baseAddress	is the base address of the RTC_B module.
valueToConvert	is the raw value in Binary format to convert to BCD. Modified bits are **BIN2BCD** of **BIN2BCD** register.

Returns

The BCD version of the valueToConvert parameter

RTC_B_definePrescaleEvent()

```
void RTC_B_definePrescaleEvent (
            uint16_t baseAddress,
            uint8_t prescaleSelect,
            uint8_t prescaleEventDivider )
```

Sets up an interrupt condition for the selected Prescaler.

This function sets the condition for an interrupt to assert based on the individual prescalers.

Parameters

baseAddress	is the base address of the RTC_B module.
prescaleSelect	is the prescaler to define an interrupt for. Valid values are: ■ **RTC_B_PRESCALE_0** ■ **RTC_B_PRESCALE_1**
prescaleEventDivider	is a divider to specify when an interrupt can occur based on the clock source of the selected prescaler. (Does not affect timer of the selected prescaler). Valid values are: ■ **RTC_B_PSEVENTDIVIDER_2** [Default] ■ **RTC_B_PSEVENTDIVIDER_4** ■ **RTC_B_PSEVENTDIVIDER_8** ■ **RTC_B_PSEVENTDIVIDER_16** ■ **RTC_B_PSEVENTDIVIDER_32** ■ **RTC_B_PSEVENTDIVIDER_64** ■ **RTC_B_PSEVENTDIVIDER_128** ■ **RTC_B_PSEVENTDIVIDER_256** Modified bits are **RTxIP** of **RTCPSxCTL** register.

Returns

None

RTC_B_disableInterrupt()

```
void RTC_B_disableInterrupt (
            uint16_t baseAddress,
            uint8_t interruptMask )
```

Disables selected RTC interrupt sources.

This function disables the selected RTC interrupt source. 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 RTC_B module.
interruptMask	is a bit mask of the interrupts to disable. Mask value is the logical OR of any of the following: ■ **RTC_B_TIME_EVENT_INTERRUPT** - asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met. ■ **RTC_B_CLOCK_ALARM_INTERRUPT** - asserts when alarm condition in Calendar mode is met. ■ **RTC_B_CLOCK_READ_READY_INTERRUPT** - asserts when Calendar registers are settled. ■ **RTC_B_PRESCALE_TIMER0_INTERRUPT** - asserts when Prescaler 0 event condition is met. ■ **RTC_B_PRESCALE_TIMER1_INTERRUPT** - asserts when Prescaler 1 event condition is met. ■ **RTC_B_OSCILLATOR_FAULT_INTERRUPT** - asserts if there is a problem with the 32kHz oscillator, while the RTC is running.

Returns

None

RTC_B_enableInterrupt()

```
void RTC_B_enableInterrupt (
            uint16_t baseAddress,
            uint8_t interruptMask )
```

Enables selected RTC interrupt sources.

This function enables the selected RTC interrupt source. 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 RTC_B module.

Parameters

interruptMask	is a bit mask of the interrupts to enable. Mask value is the logical OR of any of the following: ■ **RTC_B_TIME_EVENT_INTERRUPT** - asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met. ■ **RTC_B_CLOCK_ALARM_INTERRUPT** - asserts when alarm condition in Calendar mode is met. ■ **RTC_B_CLOCK_READ_READY_INTERRUPT** - asserts when Calendar registers are settled. ■ **RTC_B_PRESCALE_TIMER0_INTERRUPT** - asserts when Prescaler 0 event condition is met. ■ **RTC_B_PRESCALE_TIMER1_INTERRUPT** - asserts when Prescaler 1 event condition is met. ■ **RTC_B_OSCILLATOR_FAULT_INTERRUPT** - asserts if there is a problem with the 32kHz oscillator, while the RTC is running.

Returns

None

RTC_B_getCalendarTime()

```
Calendar RTC_B_getCalendarTime (
            uint16_t baseAddress )
```

Returns the Calendar Time stored in the Calendar registers of the RTC.

This function returns the current Calendar time in the form of a Calendar structure. The RTCRDY polling is used in this function to prevent reading invalid time.

Parameters

baseAddress	is the base address of the RTC_B module.

Returns

A Calendar structure containing the current time.

References Calendar::DayOfMonth, Calendar::DayOfWeek, Calendar::Hours, Calendar::Minutes, Calendar::Month, Calendar::Seconds, and Calendar::Year.

RTC_B_getInterruptStatus()

```
uint8_t RTC_B_getInterruptStatus (
            uint16_t baseAddress,
```

```
uint8_t interruptFlagMask )
```

Returns the status of the selected interrupts flags.

This function returns the status of the interrupt flag for the selected channel.

Parameters

baseAddress	is the base address of the RTC_B module.
interruptFlagMask	is a bit mask of the interrupt flags to return the status of. Mask value is the logical OR of any of the following: ■ **RTC_B_TIME_EVENT_INTERRUPT** - asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met. ■ **RTC_B_CLOCK_ALARM_INTERRUPT** - asserts when alarm condition in Calendar mode is met. ■ **RTC_B_CLOCK_READ_READY_INTERRUPT** - asserts when Calendar registers are settled. ■ **RTC_B_PRESCALE_TIMER0_INTERRUPT** - asserts when Prescaler 0 event condition is met. ■ **RTC_B_PRESCALE_TIMER1_INTERRUPT** - asserts when Prescaler 1 event condition is met. ■ **RTC_B_OSCILLATOR_FAULT_INTERRUPT** - asserts if there is a problem with the 32kHz oscillator, while the RTC is running.

Returns

Logical OR of any of the following:

- **RTC_B_TIME_EVENT_INTERRUPT** asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met.
- **RTC_B_CLOCK_ALARM_INTERRUPT** asserts when alarm condition in Calendar mode is met.
- **RTC_B_CLOCK_READ_READY_INTERRUPT** asserts when Calendar registers are settled.
- **RTC_B_PRESCALE_TIMER0_INTERRUPT** asserts when Prescaler 0 event condition is met.
- **RTC_B_PRESCALE_TIMER1_INTERRUPT** asserts when Prescaler 1 event condition is met.
- **RTC_B_OSCILLATOR_FAULT_INTERRUPT** asserts if there is a problem with the 32kHz oscillator, while the RTC is running.
  indicating the status of the masked interrupts

RTC_B_getPrescaleValue()

```
uint8_t RTC_B_getPrescaleValue (
        uint16_t baseAddress,
        uint8_t prescaleSelect )
```

Returns the selected prescaler value.

This function returns the value of the selected prescale counter register. Note that the counter value should be held by calling RTC_B_holdClock() before calling this API.

Parameters

baseAddress	is the base address of the RTC_B module.
prescaleSelect	is the prescaler to obtain the value of. Valid values are: ■ **RTC_B_PRESCALE_0** ■ **RTC_B_PRESCALE_1**

Returns

The value of the specified prescaler count register

RTC_B_holdClock()

```
void RTC_B_holdClock (
            uint16_t baseAddress )
```

Holds the RTC.

This function sets the RTC main hold bit to disable RTC functionality.

Parameters

baseAddress	is the base address of the RTC_B module.

Returns

None

RTC_B_initCalendar()

```
void RTC_B_initCalendar (
            uint16_t baseAddress,
            Calendar * CalendarTime,
            uint16_t formatSelect )
```

Initializes the settings to operate the RTC in calendar mode.

This function initializes the Calendar mode of the RTC module. To prevent potential erroneous alarm conditions from occurring, the alarm should be disabled by clearing the RTCAIE, RTCAIFG and AE bits with APIs: RTC_B_disableInterrupt(), RTC_B_clearInterrupt() and RTC_B_configureCalendarAlarm() before calendar initialization.

Parameters

baseAddress	is the base address of the RTC_B module.

Parameters

CalendarTime	is the pointer to the structure containing the values for the Calendar to be initialized to. Valid values should be of type pointer to Calendar and should contain the following members and corresponding values: **Seconds** between 0-59 **Minutes** between 0-59 **Hours** between 0-23 **DayOfWeek** between 0-6 **DayOfMonth** between 1-31 **Month** between 1-12 **Year** between 0-4095 **NOTE:** Values beyond the ones specified may result in erratic behavior.
formatSelect	is the format for the Calendar registers to use. Valid values are: ■ **RTC_B_FORMAT_BINARY** [Default] ■ **RTC_B_FORMAT_BCD** Modified bits are **RTCBCD** of **RTCCTL1** register.

Returns

None

References Calendar::DayOfMonth, Calendar::DayOfWeek, Calendar::Hours, Calendar::Minutes, Calendar::Month, Calendar::Seconds, and Calendar::Year.

RTC_B_setCalendarEvent()

```
void RTC_B_setCalendarEvent (
            uint16_t baseAddress,
            uint16_t eventSelect )
```

Sets a single specified Calendar interrupt condition.

This function sets a specified event to assert the RTCTEVIFG interrupt. This interrupt is independent from the Calendar alarm interrupt.

Parameters

baseAddress	is the base address of the RTC_B module.
eventSelect	is the condition selected. Valid values are: ■ **RTC_B_CALENDAREVENT_MINUTECHANGE** - assert interrupt on every minute ■ **RTC_B_CALENDAREVENT_HOURCHANGE** - assert interrupt on every hour ■ **RTC_B_CALENDAREVENT_NOON** - assert interrupt when hour is 12 ■ **RTC_B_CALENDAREVENT_MIDNIGHT** - assert interrupt when hour is 0 Modified bits are **RTCTEV** of **RTCCTL** register.

Returns

None

RTC_B_setCalibrationData()

```
void RTC_B_setCalibrationData (
            uint16_t baseAddress,
            uint8_t offsetDirection,
            uint8_t offsetValue )
```

Sets the specified calibration for the RTC.

This function sets the calibration offset to make the RTC as accurate as possible. The offsetDirection can be either +4-ppm or -2-ppm, and the offsetValue should be from 1-63 and is multiplied by the direction setting (i.e. +4-ppm ∗ 8 (offsetValue) = +32-ppm). Please note, when measuring the frequency after setting the calibration, you will only see a change on the 1Hz frequency.

Parameters

baseAddress	is the base address of the RTC_B module.
offsetDirection	is the direction that the calibration offset will go. Valid values are: ■ **RTC_B_CALIBRATION_DOWN2PPM** - calibrate at steps of -2 ■ **RTC_B_CALIBRATION_UP4PPM** - calibrate at steps of +4 Modified bits are **RTCCALS** of **RTCCTL2** register.
offsetValue	is the value that the offset will be a factor of; a valid value is any integer from 1-63. Modified bits are **RTCCAL** of **RTCCTL2** register.

Returns

None

RTC_B_setCalibrationFrequency()

```
void RTC_B_setCalibrationFrequency (
            uint16_t baseAddress,
            uint16_t frequencySelect )
```

Allows and Sets the frequency output to RTCCLK pin for calibration measurement.

This function sets a frequency to measure at the RTCCLK output pin. After testing the set frequency, the calibration could be set accordingly.

Parameters

baseAddress	is the base address of the RTC_B module.

Parameters

frequencySelect	is the frequency output to RTCCLK. Valid values are: ■ **RTC_B_CALIBRATIONFREQ_OFF** [Default] - turn off calibration output ■ **RTC_B_CALIBRATIONFREQ_512HZ** - output signal at 512Hz for calibration ■ **RTC_B_CALIBRATIONFREQ_256HZ** - output signal at 256Hz for calibration ■ **RTC_B_CALIBRATIONFREQ_1HZ** - output signal at 1Hz for calibration Modified bits are **RTCCALF** of **RTCCTL3** register.

Returns

None

RTC_B_setPrescaleValue()

```
void RTC_B_setPrescaleValue (
            uint16_t baseAddress,
            uint8_t prescaleSelect,
            uint8_t prescaleCounterValue )
```

Sets the selected prescaler value.

This function sets the prescale counter value. Before setting the prescale counter, it should be held by calling RTC_B_holdClock().

Parameters

baseAddress	is the base address of the RTC_B module.
prescaleSelect	is the prescaler to set the value for. Valid values are: ■ **RTC_B_PRESCALE_0** ■ **RTC_B_PRESCALE_1**
prescaleCounterValue	is the specified value to set the prescaler to. Valid values are any integer between 0-255 Modified bits are **RTxPS** of **RTxPS** register.

Returns

None

RTC_B_startClock()

```
void RTC_B_startClock (
```

uint16_t *baseAddress*)

Starts the RTC.

This function clears the RTC main hold bit to allow the RTC to function.

Parameters

baseAddress	is the base address of the RTC_B module.

Returns

None

31.3 Programming Example

The following example shows how to initialize and use the RTC API to setup Calender Mode with the current time and various interrupts.

```
//Initialize calendar struct
Calendar currentTime;
currentTime.Seconds    = 0x00;
currentTime.Minutes    = 0x26;
currentTime.Hours      = 0x13;
currentTime.DayOfWeek  = 0x03;
currentTime.DayOfMonth = 0x20;
currentTime.Month      = 0x07;
currentTime.Year       = 0x2011;

//Initialize alarm struct
RTC_B_configureCalendarAlarmParam alarmParam;
alarmParam.minutesAlarm = 0x00;
alarmParam.hoursAlarm = 0x17;
alarmParam.dayOfWeekAlarm = RTC_B_ALARMCONDITION_OFF;
alarmParam.dayOfMonthAlarm = 0x05;

//Initialize Calendar Mode of RTC_B
/*
 * Base Address of the RTC_B
 * Pass in current time, initialized above
 * Use BCD as Calendar Register Format
 */
RTC_B_initCalendar(RTC_B_BASE,
    &currentTime,
    RTC_B_FORMAT_BCD);

//Setup Calendar Alarm for 5:00pm on the 5th day of the month.
//Note: Does not specify day of the week.
RTC_B_setCalendarAlarm(RTC_B_BASE, &alarmParam);

//Specify an interrupt to assert every minute
RTC_B_setCalendarEvent(RTC_B_BASE,
    RTC_B_CALENDAREVENT_MINUTECHANGE);

//Enable interrupt for RTC_B Ready Status, which asserts when the RTC_B
//Calendar registers are ready to read.
//Also, enable interrupts for the Calendar alarm and Calendar event.
RTC_B_enableInterrupt(RTC_B_BASE,
    RTC_B_CLOCK_READ_READY_INTERRUPT +
    RTC_B_TIME_EVENT_INTERRUPT +
    RTC_B_CLOCK_ALARM_INTERRUPT);

//Start RTC_B Clock
RTC_B_startClock(RTC_B_BASE);

//Enter LPM3 mode with interrupts enabled
```

```
    __bis_SR_register(LPM3_bits + GIE);
    __no_operation();
```

32 Real-Time Clock (RTC_C)

32.1 Introduction

The Real Time Clock (RTC_C) API provides a set of functions for using the MSP430Ware RTC_C modules. Functions are provided to calibrate the clock, initialize the RTC_C modules in Calendar mode, and setup conditions for, and enable, interrupts for the RTC_C modules.

The RTC_C module provides the ability to keep track of the current time and date in calendar mode. The counter mode (device-dependent) provides a 32-bit counter.

The RTC_C module generates multiple interrupts. There are 2 interrupts that can be defined in calendar mode, and 1 interrupt in counter mode for counter overflow, as well as an interrupt for each prescaler.

If the device header file defines the baseaddress as RTC_C_BASE, pass in RTC_C_BASE as the baseaddress parameter.If the device header file defines the baseaddress as RTC_CE_BASE, pass in RTC_CE_BASE as the baseaddress parameter.

32.2 API Functions

Functions

- void RTC_C_startClock (uint16_t baseAddress)
  Starts the RTC.
- void RTC_C_holdClock (uint16_t baseAddress)
  Holds the RTC.
- void RTC_C_setCalibrationFrequency (uint16_t baseAddress, uint16_t frequencySelect)
  Allows and Sets the frequency output to RTCCLK pin for calibration measurement.
- void RTC_C_setCalibrationData (uint16_t baseAddress, uint8_t offsetDirection, uint8_t offsetValue)
  Sets the specified calibration for the RTC.
- void RTC_C_initCounter (uint16_t baseAddress, uint16_t clockSelect, uint16_t counterSizeSelect)
  Initializes the settings to operate the RTC in Counter mode.
- bool RTC_C_setTemperatureCompensation (uint16_t baseAddress, uint16_t offsetDirection, uint8_t offsetValue)
  Sets the specified temperature compensation for the RTC.
- void RTC_C_initCalendar (uint16_t baseAddress, Calendar *CalendarTime, uint16_t formatSelect)
  Initializes the settings to operate the RTC in calendar mode.
- Calendar RTC_C_getCalendarTime (uint16_t baseAddress)
  Returns the Calendar Time stored in the Calendar registers of the RTC.
- void RTC_C_configureCalendarAlarm (uint16_t baseAddress, RTC_C_configureCalendarAlarmParam *param)

Sets and Enables the desired Calendar Alarm settings.
- void RTC_C_setCalendarEvent (uint16_t baseAddress, uint16_t eventSelect)
  Sets a single specified Calendar interrupt condition.
- uint32_t RTC_C_getCounterValue (uint16_t baseAddress)
  Returns the value of the Counter register.
- void RTC_C_setCounterValue (uint16_t baseAddress, uint32_t counterValue)
  Sets the value of the Counter register.
- void RTC_C_initCounterPrescale (uint16_t baseAddress, uint8_t prescaleSelect, uint16_t prescaleClockSelect, uint16_t prescaleDivider)
  Initializes the Prescaler for Counter mode.
- void RTC_C_holdCounterPrescale (uint16_t baseAddress, uint8_t prescaleSelect)
  Holds the selected Prescaler.
- void RTC_C_startCounterPrescale (uint16_t baseAddress, uint8_t prescaleSelect)
  Starts the selected Prescaler.
- void RTC_C_definePrescaleEvent (uint16_t baseAddress, uint8_t prescaleSelect, uint8_t prescaleEventDivider)
  Sets up an interrupt condition for the selected Prescaler.
- uint8_t RTC_C_getPrescaleValue (uint16_t baseAddress, uint8_t prescaleSelect)
  Returns the selected prescaler value.
- void RTC_C_setPrescaleValue (uint16_t baseAddress, uint8_t prescaleSelect, uint8_t prescaleCounterValue)
  Sets the selected Prescaler value.
- void RTC_C_enableInterrupt (uint16_t baseAddress, uint8_t interruptMask)
  Enables selected RTC interrupt sources.
- void RTC_C_disableInterrupt (uint16_t baseAddress, uint8_t interruptMask)
  Disables selected RTC interrupt sources.
- uint8_t RTC_C_getInterruptStatus (uint16_t baseAddress, uint8_t interruptFlagMask)
  Returns the status of the selected interrupts flags.
- void RTC_C_clearInterrupt (uint16_t baseAddress, uint8_t interruptFlagMask)
  Clears selected RTC interrupt flags.
- uint16_t RTC_C_convertBCDToBinary (uint16_t baseAddress, uint16_t valueToConvert)
  Convert the given BCD value to binary format.
- uint16_t RTC_C_convertBinaryToBCD (uint16_t baseAddress, uint16_t valueToConvert)
  Convert the given binary value to BCD format.

32.2.1 Detailed Description

The RTC_C API is broken into 6 groups of functions: clock settings, calender mode, counter mode, prescale counter, interrupt condition setup/enable functions and data conversion.

The RTC_C clock settings are handled by

- RTC_C_startClock()
- RTC_C_holdClock()
- RTC_C_setCalibrationFrequency()
- RTC_C_setCalibrationData()
- RTC_C_setTemperatureCompensation()

The RTC_C calender mode is initialized and setup by

- RTC_C_initCalendar()

- RTC_C_getCalenderTime()

The RTC_C counter mode is initialized and handled by

- RTC_C_initCounter()
- RTC_C_setCounterValue()
- RTC_C_getCounterValue()
- RTC_C_initCounterPrescale()
- RTC_C_holdCounterPrescale()
- RTC_C_startCounterPrescale()

The RTC_C prescale counter is handled by

- RTC_C_getPrescaleValue()
- RTC_C_setPrescaleValue()

The RTC_C interrupts are handled by

- RTC_C_configureCalendarAlarm()
- RTC_C_setCalenderEvent()
- RTC_C_definePrescaleEvent()
- RTC_C_enableInterrupt()
- RTC_C_disableInterrupt()
- RTC_C_getInterruptStatus()
- RTC_C_clearInterrupt()

The RTC_C data conversion is handled by

- RTC_C_convertBCDToBinary()
- RTC_C_convertBinaryToBCD()

32.2.2 Function Documentation

RTC_C_clearInterrupt()

```
void RTC_C_clearInterrupt (
            uint16_t baseAddress,
            uint8_t interruptFlagMask )
```

Clears selected RTC interrupt flags.

This function clears the RTC interrupt flag is cleared, so that it no longer asserts.

Parameters

baseAddress	is the base address of the RTC_C module.

Parameters

interruptFlagMask	is a bit mask of the interrupt flags to be cleared. Mask value is the logical OR of any of the following: ■ **RTC_C_TIME_EVENT_INTERRUPT** - asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met. ■ **RTC_C_CLOCK_ALARM_INTERRUPT** - asserts when alarm condition in Calendar mode is met. ■ **RTC_C_CLOCK_READ_READY_INTERRUPT** - asserts when Calendar registers are settled. ■ **RTC_C_PRESCALE_TIMER0_INTERRUPT** - asserts when Prescaler 0 event condition is met. ■ **RTC_C_PRESCALE_TIMER1_INTERRUPT** - asserts when Prescaler 1 event condition is met. ■ **RTC_C_OSCILLATOR_FAULT_INTERRUPT** - asserts if there is a problem with the 32kHz oscillator, while the RTC is running.

Returns

None

RTC_C_configureCalendarAlarm()

```
void RTC_C_configureCalendarAlarm (
            uint16_t baseAddress,
            RTC_C_configureCalendarAlarmParam * param )
```

Sets and Enables the desired Calendar Alarm settings.

This function sets a Calendar interrupt condition to assert the RTCAIFG interrupt flag. The condition is a logical and of all of the parameters. For example if the minutes and hours alarm is set, then the interrupt will only assert when the minutes AND the hours change to the specified setting. Use the RTC_C_ALARM_OFF for any alarm settings that should not be apart of the alarm condition.

Parameters

baseAddress	is the base address of the RTC_C module.
param	is the pointer to struct for calendar alarm configuration.

Returns

None

References RTC_C_configureCalendarAlarmParam::dayOfMonthAlarm, RTC_C_configureCalendarAlarmParam::dayOfWeekAlarm, RTC_C_configureCalendarAlarmParam::hoursAlarm, and RTC_C_configureCalendarAlarmParam::minutesAlarm.

RTC_C_convertBCDToBinary()

```
uint16_t RTC_C_convertBCDToBinary (
            uint16_t baseAddress,
            uint16_t valueToConvert )
```

Convert the given BCD value to binary format.

This function converts BCD values to binary format. This API uses the hardware registers to perform the conversion rather than a software method.

Parameters

baseAddress	is the base address of the RTC_C module.
valueToConvert	is the raw value in BCD format to convert to Binary. Modified bits are **BCD2BIN** of **BCD2BIN** register.

Returns

The binary version of the input parameter

RTC_C_convertBinaryToBCD()

```
uint16_t RTC_C_convertBinaryToBCD (
            uint16_t baseAddress,
            uint16_t valueToConvert )
```

Convert the given binary value to BCD format.

This function converts binary values to BCD format. This API uses the hardware registers to perform the conversion rather than a software method.

Parameters

baseAddress	is the base address of the RTC_C module.
valueToConvert	is the raw value in Binary format to convert to BCD. Modified bits are **BIN2BCD** of **BIN2BCD** register.

Returns

The BCD version of the valueToConvert parameter

RTC_C_definePrescaleEvent()

```
void RTC_C_definePrescaleEvent (
            uint16_t baseAddress,
            uint8_t prescaleSelect,
            uint8_t prescaleEventDivider )
```

Sets up an interrupt condition for the selected Prescaler.

This function sets the condition for an interrupt to assert based on the individual prescalers.

Parameters

baseAddress	is the base address of the RTC_C module.
prescaleSelect	is the prescaler to define an interrupt for. Valid values are: ■ **RTC_C_PRESCALE_0** ■ **RTC_C_PRESCALE_1**
prescaleEventDivider	is a divider to specify when an interrupt can occur based on the clock source of the selected prescaler. (Does not affect timer of the selected prescaler). Valid values are: ■ **RTC_C_PSEVENTDIVIDER_2** [Default] ■ **RTC_C_PSEVENTDIVIDER_4** ■ **RTC_C_PSEVENTDIVIDER_8** ■ **RTC_C_PSEVENTDIVIDER_16** ■ **RTC_C_PSEVENTDIVIDER_32** ■ **RTC_C_PSEVENTDIVIDER_64** ■ **RTC_C_PSEVENTDIVIDER_128** ■ **RTC_C_PSEVENTDIVIDER_256** Modified bits are **RTxIP** of **RTCPSxCTL** register.

Returns

None

RTC_C_disableInterrupt()

```
void RTC_C_disableInterrupt (
            uint16_t baseAddress,
            uint8_t interruptMask )
```

Disables selected RTC interrupt sources.

This function disables the selected RTC interrupt source. 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 RTC_C module.

Parameters

interruptMask	is a bit mask of the interrupts to disable. Mask value is the logical OR of any of the following: ■ **RTC_C_TIME_EVENT_INTERRUPT** - asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met. ■ **RTC_C_CLOCK_ALARM_INTERRUPT** - asserts when alarm condition in Calendar mode is met. ■ **RTC_C_CLOCK_READ_READY_INTERRUPT** - asserts when Calendar registers are settled. ■ **RTC_C_PRESCALE_TIMER0_INTERRUPT** - asserts when Prescaler 0 event condition is met. ■ **RTC_C_PRESCALE_TIMER1_INTERRUPT** - asserts when Prescaler 1 event condition is met. ■ **RTC_C_OSCILLATOR_FAULT_INTERRUPT** - asserts if there is a problem with the 32kHz oscillator, while the RTC is running.

Returns

None

RTC_C_enableInterrupt()

```
void RTC_C_enableInterrupt (
            uint16_t baseAddress,
            uint8_t interruptMask )
```

Enables selected RTC interrupt sources.

This function enables the selected RTC interrupt source. 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 RTC_C module.

Parameters

interruptMask	is a bit mask of the interrupts to enable. Mask value is the logical OR of any of the following: ■ **RTC_C_TIME_EVENT_INTERRUPT** - asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met. ■ **RTC_C_CLOCK_ALARM_INTERRUPT** - asserts when alarm condition in Calendar mode is met. ■ **RTC_C_CLOCK_READ_READY_INTERRUPT** - asserts when Calendar registers are settled. ■ **RTC_C_PRESCALE_TIMER0_INTERRUPT** - asserts when Prescaler 0 event condition is met. ■ **RTC_C_PRESCALE_TIMER1_INTERRUPT** - asserts when Prescaler 1 event condition is met. ■ **RTC_C_OSCILLATOR_FAULT_INTERRUPT** - asserts if there is a problem with the 32kHz oscillator, while the RTC is running.

Returns

None

RTC_C_getCalendarTime()

```
Calendar RTC_C_getCalendarTime (
            uint16_t baseAddress )
```

Returns the Calendar Time stored in the Calendar registers of the RTC.

This function returns the current Calendar time in the form of a Calendar structure. The RTCRDY polling is used in this function to prevent reading invalid time.

Parameters

baseAddress	is the base address of the RTC_C module.

Returns

A Calendar structure containing the current time.

References Calendar::DayOfMonth, Calendar::DayOfWeek, Calendar::Hours, Calendar::Minutes, Calendar::Month, Calendar::Seconds, and Calendar::Year.

RTC_C_getCounterValue()

```
uint32_t RTC_C_getCounterValue (
            uint16_t baseAddress )
```

Returns the value of the Counter register.

This function returns the value of the counter register for the RTC_C module. It will return the 32-bit value no matter the size set during initialization. The RTC should be held before trying to use this function.

Parameters

baseAddress	is the base address of the RTC_C module.

Returns

The raw value of the full 32-bit Counter Register.

RTC_C_getInterruptStatus()

```
uint8_t RTC_C_getInterruptStatus (
            uint16_t baseAddress,
            uint8_t interruptFlagMask )
```

Returns the status of the selected interrupts flags.

This function returns the status of the interrupt flag for the selected channel.

Parameters

baseAddress	is the base address of the RTC_C module.
interruptFlagMask	is a bit mask of the interrupt flags to return the status of. Mask value is the logical OR of any of the following: ■ **RTC_C_TIME_EVENT_INTERRUPT** - asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met. ■ **RTC_C_CLOCK_ALARM_INTERRUPT** - asserts when alarm condition in Calendar mode is met. ■ **RTC_C_CLOCK_READ_READY_INTERRUPT** - asserts when Calendar registers are settled. ■ **RTC_C_PRESCALE_TIMER0_INTERRUPT** - asserts when Prescaler 0 event condition is met. ■ **RTC_C_PRESCALE_TIMER1_INTERRUPT** - asserts when Prescaler 1 event condition is met. ■ **RTC_C_OSCILLATOR_FAULT_INTERRUPT** - asserts if there is a problem with the 32kHz oscillator, while the RTC is running.

Returns

Logical OR of any of the following:

- **RTC_C_TIME_EVENT_INTERRUPT** asserts when counter overflows in counter mode or when Calendar event condition defined by defineCalendarEvent() is met.

- **RTC_C_CLOCK_ALARM_INTERRUPT** asserts when alarm condition in Calendar mode is met.
- **RTC_C_CLOCK_READ_READY_INTERRUPT** asserts when Calendar registers are settled.
- **RTC_C_PRESCALE_TIMER0_INTERRUPT** asserts when Prescaler 0 event condition is met.
- **RTC_C_PRESCALE_TIMER1_INTERRUPT** asserts when Prescaler 1 event condition is met.
- **RTC_C_OSCILLATOR_FAULT_INTERRUPT** asserts if there is a problem with the 32kHz oscillator, while the RTC is running.
  indicating the status of the masked interrupts

RTC_C_getPrescaleValue()

```
uint8_t RTC_C_getPrescaleValue (
            uint16_t baseAddress,
            uint8_t prescaleSelect )
```

Returns the selected prescaler value.

This function returns the value of the selected prescale counter register. Note that the counter value should be held by calling RTC_C_holdClock() before calling this API.

Parameters

baseAddress	is the base address of the RTC_C module.
prescaleSelect	is the prescaler to obtain the value of. Valid values are: ■ **RTC_C_PRESCALE_0** ■ **RTC_C_PRESCALE_1**

Returns

The value of the specified prescaler count register

RTC_C_holdClock()

```
void RTC_C_holdClock (
            uint16_t baseAddress )
```

Holds the RTC.

This function sets the RTC main hold bit to disable RTC functionality.

Parameters

baseAddress	is the base address of the RTC_C module.

Returns

None

RTC_C_holdCounterPrescale()

```
void RTC_C_holdCounterPrescale (
            uint16_t baseAddress,
            uint8_t prescaleSelect )
```

Holds the selected Prescaler.

This function holds the prescale counter from continuing. This will only work in counter mode, in Calendar mode, the RTC_C_holdClock() must be used. In counter mode, if using both prescalers in conjunction with the main RTC counter, then stopping RT0PS will stop RT1PS, but stopping RT1PS will not stop RT0PS.

Parameters

baseAddress	is the base address of the RTC_C module.
prescaleSelect	is the prescaler to hold. Valid values are: ▪ **RTC_C_PRESCALE_0** ▪ **RTC_C_PRESCALE_1**

Returns

None

RTC_C_initCalendar()

```
void RTC_C_initCalendar (
            uint16_t baseAddress,
            Calendar * CalendarTime,
            uint16_t formatSelect )
```

Initializes the settings to operate the RTC in calendar mode.

This function initializes the Calendar mode of the RTC module. To prevent potential erroneous alarm conditions from occurring, the alarm should be disabled by clearing the RTCAIE, RTCAIFG and AE bits with APIs: RTC_C_disableInterrupt(), RTC_C_clearInterrupt() and RTC_C_configureCalendarAlarm() before calendar initialization.

Parameters

baseAddress	is the base address of the RTC_C module.

Parameters

CalendarTime	is the pointer to the structure containing the values for the Calendar to be initialized to. Valid values should be of type pointer to Calendar and should contain the following members and corresponding values: **Seconds** between 0-59 **Minutes** between 0-59 **Hours** between 0-23 **DayOfWeek** between 0-6 **DayOfMonth** between 1-31 **Month** between 1-12 **Year** between 0-4095 **NOTE:** Values beyond the ones specified may result in erratic behavior.
formatSelect	is the format for the Calendar registers to use. Valid values are: ■ **RTC_C_FORMAT_BINARY** [Default] ■ **RTC_C_FORMAT_BCD** Modified bits are **RTCBCD** of **RTCCTL1** register.

Returns

None

References Calendar::DayOfMonth, Calendar::DayOfWeek, Calendar::Hours, Calendar::Minutes, Calendar::Month, Calendar::Seconds, and Calendar::Year.

RTC_C_initCounter()

```
void RTC_C_initCounter (
            uint16_t baseAddress,
            uint16_t clockSelect,
            uint16_t counterSizeSelect )
```

Initializes the settings to operate the RTC in Counter mode.

This function initializes the Counter mode of the RTC_C. Setting the clock source and counter size will allow an interrupt from the RTCTEVIFG once an overflow to the counter register occurs.

Parameters

baseAddress	is the base address of the RTC_C module.
clockSelect	is the selected clock for the counter mode to use. Valid values are: ■ **RTC_C_CLOCKSELECT_32KHZ_OSC** ■ **RTC_C_CLOCKSELECT_RT1PS** Modified bits are **RTCSSEL** of **RTCCTL1** register.

Parameters

counterSizeSelect	is the size of the counter. Valid values are: ■ **RTC_C_COUNTERSIZE_8BIT** [Default] ■ **RTC_C_COUNTERSIZE_16BIT** ■ **RTC_C_COUNTERSIZE_24BIT** ■ **RTC_C_COUNTERSIZE_32BIT** Modified bits are **RTCTEV** of **RTCCTL1** register.

Returns

None

RTC_C_initCounterPrescale()

```
void RTC_C_initCounterPrescale (
            uint16_t baseAddress,
            uint8_t prescaleSelect,
            uint16_t prescaleClockSelect,
            uint16_t prescaleDivider )
```

Initializes the Prescaler for Counter mode.

This function initializes the selected prescaler for the counter mode in the RTC_C module. If the RTC is initialized in Calendar mode, then these are automatically initialized. The Prescalers can be used to divide a clock source additionally before it gets to the main RTC clock.

Parameters

baseAddress	is the base address of the RTC_C module.
prescaleSelect	is the prescaler to initialize. Valid values are: ■ **RTC_C_PRESCALE_0** ■ **RTC_C_PRESCALE_1**
prescaleClockSelect	is the clock to drive the selected prescaler. Valid values are: ■ **RTC_C_PSCLOCKSELECT_ACLK** ■ **RTC_C_PSCLOCKSELECT_SMCLK** ■ **RTC_C_PSCLOCKSELECT_RT0PS** - use Prescaler 0 as source to Prescaler 1 (May only be used if prescaleSelect is RTC_C_PRESCALE_1) Modified bits are **RTxSSEL** of **RTCPSxCTL** register.

Parameters

prescaleDivider	is the divider for the selected clock source. Valid values are: ■ **RTC_C_PSDIVIDER_2** [Default] ■ **RTC_C_PSDIVIDER_4** ■ **RTC_C_PSDIVIDER_8** ■ **RTC_C_PSDIVIDER_16** ■ **RTC_C_PSDIVIDER_32** ■ **RTC_C_PSDIVIDER_64** ■ **RTC_C_PSDIVIDER_128** ■ **RTC_C_PSDIVIDER_256** Modified bits are **RTxPSDIV** of **RTCPSxCTL** register.

Returns

None

RTC_C_setCalendarEvent()

```
void RTC_C_setCalendarEvent (
            uint16_t baseAddress,
            uint16_t eventSelect )
```

Sets a single specified Calendar interrupt condition.

This function sets a specified event to assert the RTCTEVIFG interrupt. This interrupt is independent from the Calendar alarm interrupt.

Parameters

baseAddress	is the base address of the RTC_C module.
eventSelect	is the condition selected. Valid values are: ■ **RTC_C_CALENDAREVENT_MINUTECHANGE** - assert interrupt on every minute ■ **RTC_C_CALENDAREVENT_HOURCHANGE** - assert interrupt on every hour ■ **RTC_C_CALENDAREVENT_NOON** - assert interrupt when hour is 12 ■ **RTC_C_CALENDAREVENT_MIDNIGHT** - assert interrupt when hour is 0 Modified bits are **RTCTEV** of **RTCCTL** register.

Returns

None

RTC_C_setCalibrationData()

```
void RTC_C_setCalibrationData (
            uint16_t baseAddress,
            uint8_t offsetDirection,
            uint8_t offsetValue )
```

Sets the specified calibration for the RTC.

This function sets the calibration offset to make the RTC as accurate as possible. The offsetDirection can be either +1-ppm or -1-ppm, and the offsetValue should be from 1-240 and is multiplied by the direction setting (i.e. +1-ppm $*$ 8 (offsetValue) = +8-ppm).

Parameters

baseAddress	is the base address of the RTC_C module.
offsetDirection	is the direction that the calibration offset will go. Valid values are: ■ **RTC_C_CALIBRATION_DOWN1PPM** - calibrate at steps of -1 ■ **RTC_C_CALIBRATION_UP1PPM** - calibrate at steps of +1 Modified bits are **RTC0CALS** of **RTC0CAL** register.
offsetValue	is the value that the offset will be a factor of; a valid value is any integer from 1-240. Modified bits are **RTC0CALx** of **RTC0CAL** register.

Returns

None

RTC_C_setCalibrationFrequency()

```
void RTC_C_setCalibrationFrequency (
            uint16_t baseAddress,
            uint16_t frequencySelect )
```

Allows and Sets the frequency output to RTCCLK pin for calibration measurement.

This function sets a frequency to measure at the RTCCLK output pin. After testing the set frequency, the calibration could be set accordingly.

Parameters

baseAddress	is the base address of the RTC_C module.

Parameters

frequencySelect	is the frequency output to RTCCLK. Valid values are: ■ **RTC_C_CALIBRATIONFREQ_OFF** [Default] - turn off calibration output ■ **RTC_C_CALIBRATIONFREQ_512HZ** - output signal at 512Hz for calibration ■ **RTC_C_CALIBRATIONFREQ_256HZ** - output signal at 256Hz for calibration ■ **RTC_C_CALIBRATIONFREQ_1HZ** - output signal at 1Hz for calibration Modified bits are **RTCCALF** of **RTCCTL3** register.

Returns

None

RTC_C_setCounterValue()

```
void RTC_C_setCounterValue (
            uint16_t baseAddress,
            uint32_t counterValue )
```

Sets the value of the Counter register.

This function sets the counter register of the RTC_C module.

Parameters

baseAddress	is the base address of the RTC_C module.
counterValue	is the value to set the Counter register to; a valid value may be any 32-bit integer.

Returns

None

RTC_C_setPrescaleValue()

```
void RTC_C_setPrescaleValue (
            uint16_t baseAddress,
            uint8_t prescaleSelect,
            uint8_t prescaleCounterValue )
```

Sets the selected Prescaler value.

This function sets the prescale counter value. Before setting the prescale counter, it should be held by calling RTC_C_holdClock().

Parameters

baseAddress	is the base address of the RTC_C module.
prescaleSelect	is the prescaler to set the value for. Valid values are: ■ **RTC_C_PRESCALE_0** ■ **RTC_C_PRESCALE_1**
prescaleCounterValue	is the specified value to set the prescaler to. Valid values are any integer between 0-255 Modified bits are **RTxPS** of **RTxPS** register.

Returns

None

RTC_C_setTemperatureCompensation()

```
bool RTC_C_setTemperatureCompensation (
            uint16_t baseAddress,
            uint16_t offsetDirection,
            uint8_t offsetValue )
```

Sets the specified temperature compensation for the RTC.

This function sets the calibration offset to make the RTC as accurate as possible. The offsetDirection can be either +1-ppm or -1-ppm, and the offsetValue should be from 1-240 and is multiplied by the direction setting (i.e. +1-ppm $*$ 8 (offsetValue) = +8-ppm).

Parameters

baseAddress	is the base address of the RTC_C module.
offsetDirection	is the direction that the calibration offset wil go Valid values are: ■ **RTC_C_COMPENSATION_DOWN1PPM** ■ **RTC_C_COMPENSATION_UP1PPM** Modified bits are **RTCTCMPS** of **RTCTCMP** register.
offsetValue	is the value that the offset will be a factor of; a valid value is any integer from 1-240. Modified bits are **RTCTCMPx** of **RTCTCMP** register.

Returns

STATUS_SUCCESS or STATUS_FAILURE of setting the temperature compensation

RTC_C_startClock()

```
void RTC_C_startClock (
            uint16_t baseAddress )
```

Starts the RTC.

This function clears the RTC main hold bit to allow the RTC to function.

Parameters

baseAddress	is the base address of the RTC_C module.

Returns

None

RTC_C_startCounterPrescale()

```
void RTC_C_startCounterPrescale (
            uint16_t baseAddress,
            uint8_t prescaleSelect )
```

Starts the selected Prescaler.

This function starts the selected prescale counter. This function will only work if the RTC is in counter mode.

Parameters

baseAddress	is the base address of the RTC_C module.
prescaleSelect	is the prescaler to start. Valid values are: ■ **RTC_C_PRESCALE_0** ■ **RTC_C_PRESCALE_1**

Returns

None

32.3 Programming Example

The following example shows how to initialize and use the RTC_C API to setup Calender Mode with the current time and various interrupts.

```
//Initialize calendar struct
Calendar currentTime;
currentTime.Seconds    = 0x00;
currentTime.Minutes    = 0x26;
currentTime.Hours      = 0x13;
currentTime.DayOfWeek  = 0x03;
currentTime.DayOfMonth = 0x20;
currentTime.Month      = 0x07;
currentTime.Year       = 0x2011;

//Initialize alarm struct
RTC_C_configureCalendarAlarmParam alarmParam;
alarmParam.minutesAlarm = 0x00;
```

```
alarmParam.hoursAlarm = 0x17;
alarmParam.dayOfWeekAlarm = RTC_C_ALARMCONDITION_OFF;
alarmParam.dayOfMonthAlarm = 0x05;

//Initialize Calendar Mode of RTC_C
/*
 * Base Address of the RTC_C_A
 * Pass in current time, initialized above
 * Use BCD as Calendar Register Format
 */
RTC_C_initCalendar(RTC_C_BASE,
    &currentTime,
    RTC_C_FORMAT_BCD);

//Setup Calendar Alarm for 5:00pm on the 5th day of the month.
//Note: Does not specify day of the week.
RTC_C_setCalendarAlarm(RTC_C_BASE, &alarmParam);

//Specify an interrupt to assert every minute
RTC_C_setCalendarEvent(RTC_C_BASE,
    RTC_C_CALENDAREVENT_MINUTECHANGE);

//Enable interrupt for RTC_C Ready Status, which asserts when the RTC_C
//Calendar registers are ready to read.
//Also, enable interrupts for the Calendar alarm and Calendar event.
RTC_C_enableInterrupt(RTC_C_BASE,
    RTC_C_CLOCK_READ_READY_INTERRUPT +
    RTC_C_TIME_EVENT_INTERRUPT +
    RTC_C_CLOCK_ALARM_INTERRUPT);

//Start RTC_C Clock
RTC_C_startClock(RTC_C_BASE);

//Enter LPM3 mode with interrupts enabled
__bis_SR_register(LPM3_bits + GIE);
__no_operation();
```

33 24-Bit Sigma Delta Converter (SD24_B)

33.1 Introduction

The SD24_B module consists of up to eight 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 1024. 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_B 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 415 = 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.

33.2 API Functions

Functions

- void SD24_B_init (uint16_t baseAddress, SD24_B_initParam ∗param)
  Initializes the SD24_B Module.
- void SD24_B_initConverter (uint16_t baseAddress, SD24_B_initConverterParam ∗param)
  Configure SD24_B converter.
- void SD24_B_initConverterAdvanced (uint16_t baseAddress, SD24_B_initConverterAdvancedParam ∗param)
  Configure SD24_B converter - Advanced Configure.
- void SD24_B_setConverterDataFormat (uint16_t baseAddress, uint8_t converter, uint8_t dataFormat)
  Set SD24_B converter data format.
- void SD24_B_startGroupConversion (uint16_t baseAddress, uint8_t group)
  Start Conversion Group.
- void SD24_B_stopGroupConversion (uint16_t baseAddress, uint8_t group)
  Stop Conversion Group.
- void SD24_B_startConverterConversion (uint16_t baseAddress, uint8_t converter)
  Start Conversion for Converter.

- void SD24_B_stopConverterConversion (uint16_t baseAddress, uint8_t converter)
  Stop Conversion for Converter.
- void SD24_B_configureDMATrigger (uint16_t baseAddress, uint16_t interruptFlag)
  Configures the converter that triggers a DMA transfer.
- void SD24_B_setInterruptDelay (uint16_t baseAddress, uint8_t converter, uint8_t sampleDelay)
  Configures the delay for an interrupt to trigger.
- void SD24_B_setConversionDelay (uint16_t baseAddress, uint8_t converter, uint16_t cycleDelay)
  Configures the delay for the conversion start.
- void SD24_B_setOversampling (uint16_t baseAddress, uint8_t converter, uint16_t oversampleRatio)
  Configures the oversampling ratio for a converter.
- void SD24_B_setGain (uint16_t baseAddress, uint8_t converter, uint8_t gain)
  Configures the gain for the converter.
- uint32_t SD24_B_getResults (uint16_t baseAddress, uint8_t converter)
  Returns the results for a converter.
- uint16_t SD24_B_getHighWordResults (uint16_t baseAddress, uint8_t converter)
  Returns the high word results for a converter.
- void SD24_B_enableInterrupt (uint16_t baseAddress, uint8_t converter, uint16_t mask)
  Enables interrupts for the SD24_B Module.
- void SD24_B_disableInterrupt (uint16_t baseAddress, uint8_t converter, uint16_t mask)
  Disables interrupts for the SD24_B Module.
- void SD24_B_clearInterrupt (uint16_t baseAddress, uint8_t converter, uint16_t mask)
  Clears interrupts for the SD24_B Module.
- uint16_t SD24_B_getInterruptStatus (uint16_t baseAddress, uint8_t converter, uint16_t mask)
  Returns the interrupt status for the SD24_B Module.

33.2.1 Detailed Description

The SD24_B 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_B.

The SD24_B initialization and conversion functions are

- SD24_B_init()
- SD24_B_configureConverter()
- SD24_B_configureConverterAdvanced()
- SD24_B_startGroupConversion()
- SD24_B_stopGroupConversion()
- SD24_B_stopConverterConversion()
- SD24_B_startConverterConversion()
- SD24_B_configureDMATrigger()
- SD24_B_getResults()
- SD24_B_getHighWordResults()

The SD24_B interrupts are handled by

- SD24_B_enableInterrupt()

- SD24_B_disableInterrupt()
- SD24_B_clearInterrupt()
- SD24_B_getInterruptStatus()

Auxiliary features of the SD24_B are handled by

- SD24_B_setConverterDataFormat()
- SD24_B_setInterruptDelay()
- SD24_B_setOversampling()
- SD24_B_setGain()

33.2.2 Function Documentation

SD24_B_clearInterrupt()

```
void SD24_B_clearInterrupt (
            uint16_t baseAddress,
            uint8_t converter,
            uint16_t mask )
```

Clears interrupts for the SD24_B Module.

This function clears interrupt flags for the SD24_B module.

Parameters

baseAddress	is the base address of the SD24_B module.
converter	is the selected converter. Valid values are: ■ **SD24_B_CONVERTER_0** ■ **SD24_B_CONVERTER_1** ■ **SD24_B_CONVERTER_2** ■ **SD24_B_CONVERTER_3** ■ **SD24_B_CONVERTER_4** ■ **SD24_B_CONVERTER_5** ■ **SD24_B_CONVERTER_6** ■ **SD24_B_CONVERTER_7**
mask	is the bit mask of the converter interrupt sources to clear. Mask value is the logical OR of any of the following: ■ **SD24_B_CONVERTER_INTERRUPT** ■ **SD24_B_CONVERTER_OVERFLOW_INTERRUPT** Modified bits are **SD24OVIFGx** of **SD24BIFG** register.

Returns

None

SD24_B_configureDMATrigger()

```
void SD24_B_configureDMATrigger (
            uint16_t baseAddress,
            uint16_t interruptFlag )
```

Configures the converter that triggers a DMA transfer.

This function chooses which interrupt will trigger a DMA transfer.

Parameters

baseAddress	is the base address of the SD24_B module.
interruptFlag	selects the converter interrupt that triggers a DMA transfer. Valid values are: ■ **SD24_B_DMA_TRIGGER_IFG0** ■ **SD24_B_DMA_TRIGGER_IFG1** ■ **SD24_B_DMA_TRIGGER_IFG2** ■ **SD24_B_DMA_TRIGGER_IFG3** ■ **SD24_B_DMA_TRIGGER_IFG4** ■ **SD24_B_DMA_TRIGGER_IFG5** ■ **SD24_B_DMA_TRIGGER_IFG6** ■ **SD24_B_DMA_TRIGGER_IFG7** ■ **SD24_B_DMA_TRIGGER_TRGIFG** Modified bits are **SD24DMAx** of **SD24BCTL1** register.

Returns

None

SD24_B_disableInterrupt()

```
void SD24_B_disableInterrupt (
            uint16_t baseAddress,
            uint8_t converter,
            uint16_t mask )
```

Disables interrupts for the SD24_B Module.

This function disables interrupts for the SD24_B module.

Parameters

baseAddress	is the base address of the SD24_B module.

Parameters

converter	is the selected converter. Valid values are: ■ **SD24_B_CONVERTER_0** ■ **SD24_B_CONVERTER_1** ■ **SD24_B_CONVERTER_2** ■ **SD24_B_CONVERTER_3** ■ **SD24_B_CONVERTER_4** ■ **SD24_B_CONVERTER_5** ■ **SD24_B_CONVERTER_6** ■ **SD24_B_CONVERTER_7**
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_B_CONVERTER_INTERRUPT** ■ **SD24_B_CONVERTER_OVERFLOW_INTERRUPT** Modified bits are **SD24OVIEx** of **SD24BIE** register.

Modified bits of **SD24BIE** register.

Returns

None

SD24_B_enableInterrupt()

```
void SD24_B_enableInterrupt (
             uint16_t baseAddress,
             uint8_t converter,
             uint16_t mask )
```

Enables interrupts for the SD24_B Module.

This function enables interrupts for the SD24_B module. Does not clear interrupt flags.

Parameters

baseAddress	is the base address of the SD24_B module.

Parameters

converter	is the selected converter. Valid values are: ■ **SD24_B_CONVERTER_0** ■ **SD24_B_CONVERTER_1** ■ **SD24_B_CONVERTER_2** ■ **SD24_B_CONVERTER_3** ■ **SD24_B_CONVERTER_4** ■ **SD24_B_CONVERTER_5** ■ **SD24_B_CONVERTER_6** ■ **SD24_B_CONVERTER_7**
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_B_CONVERTER_INTERRUPT** ■ **SD24_B_CONVERTER_OVERFLOW_INTERRUPT** Modified bits are **SD24OVIEx** of **SD24BIE** register.

Returns

None

SD24_B_getHighWordResults()

```
uint16_t SD24_B_getHighWordResults (
            uint16_t baseAddress,
            uint8_t converter )
```

Returns the high word results for a converter.

This function gets the results from the SD24MEMHx register and returns it.

Parameters

baseAddress	is the base address of the SD24_B module.
converter	selects the converter who's results will be returned Valid values are: ■ **SD24_B_CONVERTER_0** ■ **SD24_B_CONVERTER_1** ■ **SD24_B_CONVERTER_2** ■ **SD24_B_CONVERTER_3** ■ **SD24_B_CONVERTER_4** ■ **SD24_B_CONVERTER_5** ■ **SD24_B_CONVERTER_6** ■ **SD24_B_CONVERTER_7**

Returns

Result of conversion

SD24_B_getInterruptStatus()

```
uint16_t SD24_B_getInterruptStatus (
            uint16_t baseAddress,
            uint8_t converter,
            uint16_t mask )
```

Returns the interrupt status for the SD24_B Module.

This function returns interrupt flag statuses for the SD24_B module.

Parameters

baseAddress	is the base address of the SD24_B module.
converter	is the selected converter. Valid values are: ■ **SD24_B_CONVERTER_0** ■ **SD24_B_CONVERTER_1** ■ **SD24_B_CONVERTER_2** ■ **SD24_B_CONVERTER_3** ■ **SD24_B_CONVERTER_4** ■ **SD24_B_CONVERTER_5** ■ **SD24_B_CONVERTER_6** ■ **SD24_B_CONVERTER_7**
mask	is the bit mask of the converter interrupt sources to return. Mask value is the logical OR of any of the following: ■ **SD24_B_CONVERTER_INTERRUPT** ■ **SD24_B_CONVERTER_OVERFLOW_INTERRUPT**

Returns

Logical OR of any of the following:
- **SD24_B_CONVERTER_INTERRUPT**
- **SD24_B_CONVERTER_OVERFLOW_INTERRUPT**
  indicating the status of the masked interrupts

SD24_B_getResults()

```
uint32_t SD24_B_getResults (
            uint16_t baseAddress,
            uint8_t converter )
```

Returns the results for a converter.

This function gets the results from the SD24BMEMLx and SD24MEMHx registers and concatenates them to form a long. The actual result is a maximum 24 bits.

Parameters

baseAddress	is the base address of the SD24_B module.
converter	selects the converter who's results will be returned Valid values are: ■ **SD24_B_CONVERTER_0** ■ **SD24_B_CONVERTER_1** ■ **SD24_B_CONVERTER_2** ■ **SD24_B_CONVERTER_3** ■ **SD24_B_CONVERTER_4** ■ **SD24_B_CONVERTER_5** ■ **SD24_B_CONVERTER_6** ■ **SD24_B_CONVERTER_7**

Returns

Result of conversion

SD24_B_init()

```
void SD24_B_init (
            uint16_t baseAddress,
            SD24_B_initParam * param )
```

Initializes the SD24_B Module.

This function initializes the SD24_B module sigma-delta analog-to-digital conversions. Specifically the function sets up the clock source for the SD24_B core to use for conversions. Upon completion of the initialization the SD24_B interrupt registers will be reset and the given parameters will be set. The converter configuration settings are independent of this function. The values you choose for the clock divider and predivider are used to determine the effective clock frequency. The formula used is: f_sd24 = f_clk /(divider ∗ predivider)

Parameters

baseAddress	is the base address of the SD24_B module.
param	is the pointer to struct for initialization.

Returns

None

References SD24_B_initParam::clockDivider, SD24_B_initParam::clockPreDivider, SD24_B_initParam::clockSourceSelect, and SD24_B_initParam::referenceSelect.

SD24_B_initConverter()

```
void SD24_B_initConverter (
            uint16_t baseAddress,
            SD24_B_initConverterParam * param )
```

Configure SD24_B converter.

This function initializes a converter of the SD24_B module. Upon completion the converter will be ready for a conversion and can be started with the SD24_B_startGroupConversion() or SD24_B_startConverterConversion() depending on the startSelect parameter. Additional configuration such as data format can be configured in SD24_B_setConverterDataFormat().

Parameters

baseAddress	is the base address of the SD24_B module.
param	is the pointer to struct for converter configuration.

Returns

None

References SD24_B_initConverterParam::alignment, SD24_B_initConverterParam::conversionMode, SD24_B_initConverterParam::converter, and SD24_B_initConverterParam::startSelect.

SD24_B_initConverterAdvanced()

```
void SD24_B_initConverterAdvanced (
            uint16_t baseAddress,
            SD24_B_initConverterAdvancedParam * param )
```

Configure SD24_B converter - Advanced Configure.

This function initializes a converter of the SD24_B module. Upon completion the converter will be ready for a conversion and can be started with the SD24_B_startGroupConversion() or SD24_B_startConverterConversion() depending on the startSelect parameter.

Parameters

baseAddress	is the base address of the SD24_B module.
param	is the pointer to struct for converter advanced configuration.

Returns

None

References SD24_B_initConverterAdvancedParam::alignment, SD24_B_initConverterAdvancedParam::conversionMode, SD24_B_initConverterAdvancedParam::converter, SD24_B_initConverterAdvancedParam::dataFormat, SD24_B_initConverterAdvancedParam::gain,

SD24_B_initConverterAdvancedParam::oversampleRatio,
SD24_B_initConverterAdvancedParam::sampleDelay, and
SD24_B_initConverterAdvancedParam::startSelect.

SD24_B_setConversionDelay()

```
void SD24_B_setConversionDelay (
            uint16_t baseAddress,
            uint8_t converter,
            uint16_t cycleDelay )
```

Configures the delay for the conversion start.

This function configures the delay for the specified converter start. Please note the delay should be written before conversion or after corresponding conversion is completed. If no delay at start of conversion is desired, a previously written non-zero value must be changed to zero before starting the conversion.

Parameters

baseAddress	is the base address of the SD24_B module.
converter	selects the converter that will be delayed Valid values are: ■ **SD24_B_CONVERTER_0** ■ **SD24_B_CONVERTER_1** ■ **SD24_B_CONVERTER_2** ■ **SD24_B_CONVERTER_3** ■ **SD24_B_CONVERTER_4** ■ **SD24_B_CONVERTER_5** ■ **SD24_B_CONVERTER_6** ■ **SD24_B_CONVERTER_7**
cycleDelay	is the clock cycles to delay ranging from 0 to 1023. Modified bits are **SD24PREx** of **SD24BPREx** register.

Returns

None

SD24_B_setConverterDataFormat()

```
void SD24_B_setConverterDataFormat (
            uint16_t baseAddress,
            uint8_t converter,
            uint8_t dataFormat )
```

Set SD24_B 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_B module.
converter	selects the converter that will be configured. Check datasheet for available converters on device. Valid values are: ■ **SD24_B_CONVERTER_0** ■ **SD24_B_CONVERTER_1** ■ **SD24_B_CONVERTER_2** ■ **SD24_B_CONVERTER_3** ■ **SD24_B_CONVERTER_4** ■ **SD24_B_CONVERTER_5** ■ **SD24_B_CONVERTER_6** ■ **SD24_B_CONVERTER_7**
dataFormat	selects how the data format of the results Valid values are: ■ **SD24_B_DATA_FORMAT_BINARY** [Default] ■ **SD24_B_DATA_FORMAT_2COMPLEMENT** Modified bits are **SD24DFx** of **SD24BCCTLx** register.

Returns

None

SD24_B_setGain()

```
void SD24_B_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_B module.

Parameters

converter	selects the converter that will be configured Valid values are: ■ **SD24_B_CONVERTER_0** ■ **SD24_B_CONVERTER_1** ■ **SD24_B_CONVERTER_2** ■ **SD24_B_CONVERTER_3** ■ **SD24_B_CONVERTER_4** ■ **SD24_B_CONVERTER_5** ■ **SD24_B_CONVERTER_6** ■ **SD24_B_CONVERTER_7**
gain	selects the gain for the converter Valid values are: ■ **SD24_B_GAIN_1** [Default] ■ **SD24_B_GAIN_2** ■ **SD24_B_GAIN_4** ■ **SD24_B_GAIN_8** ■ **SD24_B_GAIN_16** ■ **SD24_B_GAIN_32** ■ **SD24_B_GAIN_64** ■ **SD24_B_GAIN_128** Modified bits are **SD24GAINx** of **SD24BINCTLx** register.

Returns

None

SD24_B_setInterruptDelay()

```
void SD24_B_setInterruptDelay (
            uint16_t baseAddress,
            uint8_t converter,
            uint8_t sampleDelay )
```

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_B module.

Parameters

converter	selects the converter that will be stopped Valid values are: ■ **SD24_B_CONVERTER_0** ■ **SD24_B_CONVERTER_1** ■ **SD24_B_CONVERTER_2** ■ **SD24_B_CONVERTER_3** ■ **SD24_B_CONVERTER_4** ■ **SD24_B_CONVERTER_5** ■ **SD24_B_CONVERTER_6** ■ **SD24_B_CONVERTER_7**
sampleDelay	selects the delay for the interrupt Valid values are: ■ **SD24_B_FOURTH_SAMPLE_INTERRUPT** [Default] ■ **SD24_B_THIRD_SAMPLE_INTERRUPT** ■ **SD24_B_SECOND_SAMPLE_INTERRUPT** ■ **SD24_B_FIRST_SAMPLE_INTERRUPT** Modified bits are **SD24INTDLYx** of **SD24INCTLx** register.

Returns

None

SD24_B_setOversampling()

```
void SD24_B_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_B module.

Parameters

converter	selects the converter that will be configured Valid values are: ■ **SD24_B_CONVERTER_0** ■ **SD24_B_CONVERTER_1** ■ **SD24_B_CONVERTER_2** ■ **SD24_B_CONVERTER_3** ■ **SD24_B_CONVERTER_4** ■ **SD24_B_CONVERTER_5** ■ **SD24_B_CONVERTER_6** ■ **SD24_B_CONVERTER_7**
oversampleRatio	selects oversampling ratio for the converter Valid values are: ■ **SD24_B_OVERSAMPLE_32** ■ **SD24_B_OVERSAMPLE_64** ■ **SD24_B_OVERSAMPLE_128** ■ **SD24_B_OVERSAMPLE_256** ■ **SD24_B_OVERSAMPLE_512** ■ **SD24_B_OVERSAMPLE_1024** Modified bits are **SD24OSRx** of **SD24BOSRx** register.

Returns

None

SD24_B_startConverterConversion()

```
void SD24_B_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_B module.

Parameters

converter	selects the converter that will be started Valid values are: ■ **SD24_B_CONVERTER_0** ■ **SD24_B_CONVERTER_1** ■ **SD24_B_CONVERTER_2** ■ **SD24_B_CONVERTER_3** ■ **SD24_B_CONVERTER_4** ■ **SD24_B_CONVERTER_5** ■ **SD24_B_CONVERTER_6** ■ **SD24_B_CONVERTER_7** Modified bits are **SD24SC** of **SD24BCCTLx** register.

Returns

None

SD24_B_startGroupConversion()

```
void SD24_B_startGroupConversion (
            uint16_t baseAddress,
            uint8_t group )
```

Start Conversion Group.

This function starts all the converters that are associated with a group. To set a converter to a group use the SD24_B_configureConverter() function.

Parameters

baseAddress	is the base address of the SD24_B module.
group	selects the group that will be started Valid values are: ■ **SD24_B_GROUP0** ■ **SD24_B_GROUP1** ■ **SD24_B_GROUP2** ■ **SD24_B_GROUP3** Modified bits are **SD24DGRPxSC** of **SD24BCTL1** register.

Returns

None

SD24_B_stopConverterConversion()

```
void SD24_B_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_B module.
converter	selects the converter that will be stopped Valid values are: ■ **SD24_B_CONVERTER_0** ■ **SD24_B_CONVERTER_1** ■ **SD24_B_CONVERTER_2** ■ **SD24_B_CONVERTER_3** ■ **SD24_B_CONVERTER_4** ■ **SD24_B_CONVERTER_5** ■ **SD24_B_CONVERTER_6** ■ **SD24_B_CONVERTER_7** Modified bits are **SD24SC** of **SD24BCCTLx** register.

Returns

None

SD24_B_stopGroupConversion()

```
void SD24_B_stopGroupConversion (
            uint16_t baseAddress,
            uint8_t group )
```

Stop Conversion Group.

This function stops all the converters that are associated with a group. To set a converter to a group use the SD24_B_configureConverter() function.

Parameters

baseAddress	is the base address of the SD24_B module.

Parameters

group	selects the group that will be stopped Valid values are: ■ **SD24_B_GROUP0** ■ **SD24_B_GROUP1** ■ **SD24_B_GROUP2** ■ **SD24_B_GROUP3** Modified bits are **SD24DGRPxSC** of **SD24BCTL1** register.

Returns

None

33.3 Programming Example

The following example shows how to initialize and use the SD24_B API to start a single channel, single conversion.

```
unsigned long results;

SD24_B_initParam initParam = {0};
initParam.clockSourceSelect = SD24_B_CLOCKSOURCE_SMCLK; // Select SMCLK as SD24_B clock
      source
initParam.clockPreDivider = SD24_B_PRECLOCKDIVIDER_1;
initParam.clockDivider = SD24_B_CLOCKDIVIDER_1;
initParam.referenceSelect = SD24_B_REF_INTERNAL; // Select internal REF
SD24_B_init(SD24_BASE, &initParam);

SD24_B_configureConverter(SD24_BASE,
       SD24_B_CONVERTER_2,
       SD24_B_ALIGN_RIGHT,
       SD24_B_CONVERSION_SELECT_SD24SC,
       SD24_B_SINGLE_MODE);

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

while (1)
{
    SD24_B_startConverterConversion(SD24_BASE,
        SD24_B_CONVERTER_2);                              // Set bit to start conversion

    // Poll interrupt flag for channel 2
    while( SD24_B_getInterruptStatus(SD24_BASE,
            SD24_B_CONVERTER_2
            SD24_CONVERTER_INTERRUPT) == 0 );

    results = SD24_B_getResults(SD24_BASE,
        SD24_B_CONVERTER_2);                         // Save CH2 results (clears IFG)

    __no_operation();                      // SET BREAKPOINT HERE
}
```

34 SFR Module

34.1 Introduction

The Special Function Registers API provides a set of functions for using the MSP430Ware SFR module. Functions are provided to enable and disable interrupts and control the ∼RST/NMI pin

The SFR module can enable interrupts to be generated from other peripherals of the device.

34.2 API Functions

Functions

- void SFR_enableInterrupt (uint8_t interruptMask)
  Enables selected SFR interrupt sources.
- void SFR_disableInterrupt (uint8_t interruptMask)
  Disables selected SFR interrupt sources.
- uint8_t SFR_getInterruptStatus (uint8_t interruptFlagMask)
  Returns the status of the selected SFR interrupt flags.
- void SFR_clearInterrupt (uint8_t interruptFlagMask)
  Clears the selected SFR interrupt flags.
- void SFR_setResetPinPullResistor (uint16_t pullResistorSetup)
  Sets the pull-up/down resistor on the ∼RST/NMI pin.
- void SFR_setNMIEdge (uint16_t edgeDirection)
  Sets the edge direction that will assert an NMI from a signal on the ∼RST/NMI pin if NMI function is active.
- void SFR_setResetNMIPinFunction (uint8_t resetPinFunction)
  Sets the function of the ∼RST/NMI pin.

34.2.1 Detailed Description

The SFR API is broken into 2 groups: the SFR interrupts and the SFR ∼RST/NMI pin control

The SFR interrupts are handled by

- SFR_enableInterrupt()
- SFR_disableInterrupt()
- SFR_getInterruptStatus()
- SFR_clearInterrupt()

The SFR ∼RST/NMI pin is controlled by

- SFR_setResetPinPullResistor()
- SFR_setNMIEdge()
- SFR_setResetNMIPinFunction()

34.2.2 Function Documentation

SFR_clearInterrupt()

```
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 should be cleared Mask value is the logical OR of any of the following: ■ **SFR_JTAG_OUTBOX_INTERRUPT** - JTAG outbox interrupt enable ■ **SFR_JTAG_INBOX_INTERRUPT** - JTAG inbox interrupt enable ■ **SFR_NMI_PIN_INTERRUPT** - NMI pin interrupt enable, if NMI function is chosen ■ **SFR_VACANT_MEMORY_ACCESS_INTERRUPT** - Vacant memory access interrupt enable ■ **SFR_OSCILLATOR_FAULT_INTERRUPT** - Oscillator fault interrupt enable ■ **SFR_WATCHDOG_INTERVAL_TIMER_INTERRUPT** - Watchdog interval timer interrupt enable ■ **SFR_FLASH_CONTROLLER_ACCESS_VIOLATION_INTERRUPT** - Flash controller access violation interrupt enable

Returns

None

SFR_disableInterrupt()

```
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. Mask value is the logical OR of any of the following: ■ **SFR_JTAG_OUTBOX_INTERRUPT** - JTAG outbox interrupt enable ■ **SFR_JTAG_INBOX_INTERRUPT** - JTAG inbox interrupt enable ■ **SFR_NMI_PIN_INTERRUPT** - NMI pin interrupt enable, if NMI function is chosen ■ **SFR_VACANT_MEMORY_ACCESS_INTERRUPT** - Vacant memory access interrupt enable ■ **SFR_OSCILLATOR_FAULT_INTERRUPT** - Oscillator fault interrupt enable ■ **SFR_WATCHDOG_INTERVAL_TIMER_INTERRUPT** - Watchdog interval timer interrupt enable ■ **SFR_FLASH_CONTROLLER_ACCESS_VIOLATION_INTERRUPT** - Flash controller access violation interrupt enable

Returns

None

SFR_enableInterrupt()

```
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.

Parameters

interruptMask	is the bit mask of interrupts that will be enabled. Mask value is the logical OR of any of the following: ■ **SFR_JTAG_OUTBOX_INTERRUPT** - JTAG outbox interrupt enable ■ **SFR_JTAG_INBOX_INTERRUPT** - JTAG inbox interrupt enable ■ **SFR_NMI_PIN_INTERRUPT** - NMI pin interrupt enable, if NMI function is chosen ■ **SFR_VACANT_MEMORY_ACCESS_INTERRUPT** - Vacant memory access interrupt enable ■ **SFR_OSCILLATOR_FAULT_INTERRUPT** - Oscillator fault interrupt enable ■ **SFR_WATCHDOG_INTERVAL_TIMER_INTERRUPT** - Watchdog interval timer interrupt enable ■ **SFR_FLASH_CONTROLLER_ACCESS_VIOLATION_INTERRUPT** - Flash controller access violation interrupt enable

Returns

None

SFR_getInterruptStatus()

```
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. Mask value is the logical OR of any of the following: ■ **SFR_JTAG_OUTBOX_INTERRUPT** - JTAG outbox interrupt enable ■ **SFR_JTAG_INBOX_INTERRUPT** - JTAG inbox interrupt enable ■ **SFR_NMI_PIN_INTERRUPT** - NMI pin interrupt enable, if NMI function is chosen ■ **SFR_VACANT_MEMORY_ACCESS_INTERRUPT** - Vacant memory access interrupt enable ■ **SFR_OSCILLATOR_FAULT_INTERRUPT** - Oscillator fault interrupt enable ■ **SFR_WATCHDOG_INTERVAL_TIMER_INTERRUPT** - Watchdog interval timer interrupt enable ■ **SFR_FLASH_CONTROLLER_ACCESS_VIOLATION_INTERRUPT** - Flash controller access violation interrupt enable

Returns

Logical OR of any of the following:

- **SFR_JTAG_OUTBOX_INTERRUPT** JTAG outbox interrupt enable
- **SFR_JTAG_INBOX_INTERRUPT** JTAG inbox interrupt enable
- **SFR_NMI_PIN_INTERRUPT** NMI pin interrupt enable, if NMI function is chosen
- **SFR_VACANT_MEMORY_ACCESS_INTERRUPT** Vacant memory access interrupt enable
- **SFR_OSCILLATOR_FAULT_INTERRUPT** Oscillator fault interrupt enable
- **SFR_WATCHDOG_INTERVAL_TIMER_INTERRUPT** Watchdog interval timer interrupt enable
- **SFR_FLASH_CONTROLLER_ACCESS_VIOLATION_INTERRUPT** Flash controller access violation interrupt enable
  indicating the status of the masked interrupts

SFR_setNMIEdge()

```
void SFR_setNMIEdge (
            uint16_t edgeDirection )
```

Sets the edge direction that will assert an NMI from a signal on the ∼RST/NMI pin if NMI function is active.

This function sets the edge direction that will assert an NMI from a signal on the ∼RST/NMI pin if the NMI function is active. To activate the NMI function of the ∼RST/NMI use the SFR_setResetNMIPinFunction() passing SFR_RESETPINFUNC_NMI into the resetPinFunction parameter.

Parameters

edgeDirection	is the direction that the signal on the ∼RST/NMI pin should go to signal an interrupt, if enabled. Valid values are: ■ **SFR_NMI_RISINGEDGE** [Default] ■ **SFR_NMI_FALLINGEDGE** Modified bits are **SYSNMIIES** of **SFRRPCR** register.

Returns

None

SFR_setResetNMIPinFunction()

```
void SFR_setResetNMIPinFunction (
            uint8_t resetPinFunction )
```

Sets the function of the ∼RST/NMI pin.

This function sets the functionality of the ∼RST/NMI pin, whether in reset mode which will assert a reset if a low signal is observed on that pin, or an NMI which will assert an interrupt from an edge of the signal dependent on the setting of the edgeDirection parameter in SFR_setNMIEdge().

Parameters

resetPinFunction	is the function that the ∼RST/NMI pin should take on. Valid values are: ■ **SFR_RESETPINFUNC_RESET** [Default] ■ **SFR_RESETPINFUNC_NMI** Modified bits are **SYSNMI** of **SFRRPCR** register.

Returns

None

SFR_setResetPinPullResistor()

```
void SFR_setResetPinPullResistor (
            uint16_t pullResistorSetup )
```

Sets the pull-up/down resistor on the ∼RST/NMI pin.

This function sets the pull-up/down resistors on the ∼RST/NMI pin to the settings from the pullResistorSetup parameter.

Parameters

pullResistorSetup	is the selection of how the pull-up/down resistor on the ∼RST/NMI pin should be setup or disabled. Valid values are: ■ **SFR_RESISTORDISABLE** ■ **SFR_RESISTORENABLE_PULLUP** [Default] ■ **SFR_RESISTORENABLE_PULLDOWN** Modified bits are **SYSRSTUP** of **SFRRPCR** register.

Returns

None

34.3 Programming Example

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

```
do
  {

    // Clear SFR Fault Flag
    SFR_clearInterrupt(SFR_BASE,
                       OFIFG);

    // Test oscillator fault flag
  }while (SFR_getInterruptStatus(SFR_BASE,OFIFG));
```

35 System Control Module

35.1 Introduction

The System Control (SYS) API provides a set of functions for using the MSP430Ware SYS module. Functions are provided to control various SYS controls, setup the BSL, and control the JTAG Mailbox.

35.2 API Functions

Functions

- void SysCtl_enableDedicatedJTAGPins (void)
  Sets the JTAG pins to be exclusively for JTAG until a BOR occurs.
- uint8_t SysCtl_getBSLEntryIndication (void)
  Returns the indication of a BSL entry sequence from the Spy-Bi-Wire.
- void SysCtl_enablePMMAccessProtect (void)
  Enables PMM Access Protection.
- void SysCtl_enableRAMBasedInterruptVectors (void)
  Enables RAM-based Interrupt Vectors.
- void SysCtl_disableRAMBasedInterruptVectors (void)
  Disables RAM-based Interrupt Vectors.
- void SysCtl_enableBSLProtect (void)
  Enables BSL memory protection.
- void SysCtl_disableBSLProtect (void)
  Disables BSL memory protection.
- void SysCtl_enableBSLMemory (void)
  Enables BSL memory.
- void SysCtl_disableBSLMemory (void)
  Disables BSL memory.
- void SysCtl_setRAMAssignedToBSL (uint8_t BSLRAMAssignment)
  Sets RAM assignment to BSL area.
- void SysCtl_setBSLSize (uint8_t BSLSizeSelect)
  Sets the size of the BSL in Flash.
- void SysCtl_initJTAGMailbox (uint8_t mailboxSizeSelect, uint8_t autoClearInboxFlagSelect)
  Initializes JTAG Mailbox with selected properties.
- uint8_t SysCtl_getJTAGMailboxFlagStatus (uint8_t mailboxFlagMask)
  Returns the status of the selected JTAG Mailbox flags.
- void SysCtl_clearJTAGMailboxFlagStatus (uint8_t mailboxFlagMask)
  Clears the status of the selected JTAG Mailbox flags.
- uint16_t SysCtl_getJTAGInboxMessage16Bit (uint8_t inboxSelect)
  Returns the contents of the selected JTAG Inbox in a 16 bit format.
- uint32_t SysCtl_getJTAGInboxMessage32Bit (void)

Returns the contents of JTAG Inboxes in a 32 bit format.

- void SysCtl_setJTAGOutgoingMessage16Bit (uint8_t outboxSelect, uint16_t outgoingMessage)
  Sets a 16 bit outgoing message in to the selected JTAG Outbox.
- void SysCtl_setJTAGOutgoingMessage32Bit (uint32_t outgoingMessage)
  Sets a 32 bit message in to both JTAG Outboxes.

35.2.1 Detailed Description

The SYS API is broken into 3 groups: the various SYS controls, the BSL controls, and the JTAG mailbox controls.

The various SYS controls are handled by

- SysCtl_enableDedicatedJTAGPins()
- SysCtl_getBSLEntryIndication()
- SysCtl_enablePMMAccessProtect()
- SysCtl_enableRAMBasedInterruptVectors()
- SysCtl_disableRAMBasedInterruptVectors()

The BSL controls are handled by

- SysCtl_enableBSLProtect()
- SysCtl_disableBSLProtect()
- SysCtl_disableBSLMemory()
- SysCtl_enableBSLMemory()
- SysCtl_setRAMAssignedToBSL()
- SysCtl_setBSLSize()

The JTAG Mailbox controls are handled by

- SysCtl_initJTAGMailbox()
- SysCtl_getJTAGMailboxFlagStatus()
- SysCtl_getJTAGInboxMessage16Bit()
- SysCtl_getJTAGInboxMessage32Bit()
- SysCtl_setJTAGOutgoingMessage16Bit()
- SysCtl_setJTAGOutgoingMessage32Bit()
- SysCtl_clearJTAGMailboxFlagStatus()

35.2.2 Function Documentation

SysCtl_clearJTAGMailboxFlagStatus()

```
void SysCtl_clearJTAGMailboxFlagStatus (
            uint8_t mailboxFlagMask )
```

Clears the status of the selected JTAG Mailbox flags.

This function clears the selected JTAG Mailbox flags.

Parameters

mailboxFlagMask	is the bit mask of JTAG mailbox flags that the status of should be cleared. Mask value is the logical OR of any of the following: ■ **SYSCTL_JTAGOUTBOX_FLAG0** - flag for JTAG outbox 0 ■ **SYSCTL_JTAGOUTBOX_FLAG1** - flag for JTAG outbox 1 ■ **SYSCTL_JTAGINBOX_FLAG0** - flag for JTAG inbox 0 ■ **SYSCTL_JTAGINBOX_FLAG1** - flag for JTAG inbox 1

Returns

None

SysCtl_disableBSLMemory()

```
void SysCtl_disableBSLMemory (
            void  )
```

Disables BSL memory.

This function disables BSL memory, which makes BSL memory act like vacant memory.

Returns

None

SysCtl_disableBSLProtect()

```
void SysCtl_disableBSLProtect (
            void  )
```

Disables BSL memory protection.

This function disables protection on the BSL memory.

Returns

None

SysCtl_disableRAMBasedInterruptVectors()

```
void SysCtl_disableRAMBasedInterruptVectors (
            void  )
```

Disables RAM-based Interrupt Vectors.

This function disables the interrupt vectors from being generated at the top of the RAM.

Returns

None

SysCtl_enableBSLMemory()

```
void SysCtl_enableBSLMemory (
            void )
```

Enables BSL memory.

This function enables BSL memory, which allows BSL memory to be addressed

Returns

None

SysCtl_enableBSLProtect()

```
void SysCtl_enableBSLProtect (
            void )
```

Enables BSL memory protection.

This function enables protection on the BSL memory, which prevents any reading, programming, or erasing of the BSL memory.

Returns

None

SysCtl_enableDedicatedJTAGPins()

```
void SysCtl_enableDedicatedJTAGPins (
            void )
```

Sets the JTAG pins to be exclusively for JTAG until a BOR occurs.

This function sets the JTAG pins to be exclusively used for the JTAG, and not to be shared with the GPIO pins. This setting can only be cleared when a BOR occurs.

Returns

None

SysCtl_enablePMMAccessProtect()

```
void SysCtl_enablePMMAccessProtect (
            void )
```

Enables PMM Access Protection.

This function enables the PMM Access Protection, which will lock any changes on the PMM control registers until a BOR occurs.

Returns

None

SysCtl_enableRAMBasedInterruptVectors()

```
void SysCtl_enableRAMBasedInterruptVectors (
            void )
```

Enables RAM-based Interrupt Vectors.

This function enables RAM-base Interrupt Vectors, which means that interrupt vectors are generated with the end address at the top of RAM, instead of the top of the lower 64kB of flash.

Returns

None

SysCtl_getBSLEntryIndication()

```
uint8_t SysCtl_getBSLEntryIndication (
            void )
```

Returns the indication of a BSL entry sequence from the Spy-Bi-Wire.

This function returns the indication of a BSL entry sequence from the Spy- Bi-Wire.

Returns

One of the following:

- **SYSCTL_BSLENTRY_INDICATED**
- **SYSCTL_BSLENTRY_NOTINDICATED**
  indicating if a BSL entry sequence was detected

SysCtl_getJTAGInboxMessage16Bit()

```
uint16_t SysCtl_getJTAGInboxMessage16Bit (
            uint8_t inboxSelect )
```

Returns the contents of the selected JTAG Inbox in a 16 bit format.

This function returns the message contents of the selected JTAG inbox. If the auto clear settings for the Inbox flags were set, then using this function will automatically clear the corresponding JTAG inbox flag.

Parameters

inboxSelect	is the chosen JTAG inbox that the contents of should be returned Valid values are: ■ **SYSCTL_JTAGINBOX_0** - return contents of JTAG inbox 0 ■ **SYSCTL_JTAGINBOX_1** - return contents of JTAG inbox 1

Returns

The contents of the selected JTAG inbox in a 16 bit format.

SysCtl_getJTAGInboxMessage32Bit()

```
uint32_t SysCtl_getJTAGInboxMessage32Bit (
            void )
```

Returns the contents of JTAG Inboxes in a 32 bit format.

This function returns the message contents of both JTAG inboxes in a 32 bit format. This function should be used if 32-bit messaging has been set in the SYS_initJTAGMailbox() function. If the auto clear settings for the Inbox flags were set, then using this function will automatically clear both JTAG inbox flags.

Returns

The contents of both JTAG messages in a 32 bit format.

SysCtl_getJTAGMailboxFlagStatus()

```
uint8_t SysCtl_getJTAGMailboxFlagStatus (
            uint8_t mailboxFlagMask )
```

Returns the status of the selected JTAG Mailbox flags.

This function will return the status of the selected JTAG Mailbox flags in bit mask format matching that passed into the mailboxFlagMask parameter.

Parameters

mailboxFlagMask	is the bit mask of JTAG mailbox flags that the status of should be returned. Mask value is the logical OR of any of the following: ■ **SYSCTL_JTAGOUTBOX_FLAG0** - flag for JTAG outbox 0 ■ **SYSCTL_JTAGOUTBOX_FLAG1** - flag for JTAG outbox 1 ■ **SYSCTL_JTAGINBOX_FLAG0** - flag for JTAG inbox 0 ■ **SYSCTL_JTAGINBOX_FLAG1** - flag for JTAG inbox 1

Returns

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

SysCtl_initJTAGMailbox()

```
void SysCtl_initJTAGMailbox (
            uint8_t mailboxSizeSelect,
            uint8_t autoClearInboxFlagSelect )
```

Initializes JTAG Mailbox with selected properties.

This function sets the specified settings for the JTAG Mailbox system. The settings that can be set are the size of the JTAG messages, and the auto- clearing of the inbox flags. If the inbox flags are set to auto-clear, then the inbox flags will be cleared upon reading of the inbox message buffer, otherwise they will have to be reset by software using the SYS_clearJTAGMailboxFlagStatus() function.

Parameters

mailboxSizeSelect	is the size of the JTAG Mailboxes, whether 16- or 32-bits. Valid values are: ■ **SYSCTL_JTAGMBSIZE_16BIT** [Default] - the JTAG messages will take up only one JTAG mailbox (i. e. an outgoing message will take up only 1 outbox of the JTAG mailboxes) ■ **SYSCTL_JTAGMBSIZE_32BIT** - the JTAG messages will be contained within both JTAG mailboxes (i. e. an outgoing message will take up both Outboxes of the JTAG mailboxes) Modified bits are **JMBMODE** of **SYSJMBC** register.
autoClearInboxFlagSelect	decides how the JTAG inbox flags should be cleared, whether automatically after the corresponding outbox has been written to, or manually by software. Valid values are: ■ **SYSCTL_JTAGINBOX0AUTO_JTAGINBOX1AUTO** [Default] - both JTAG inbox flags will be reset automatically when the corresponding inbox is read from. ■ **SYSCTL_JTAGINBOX0AUTO_JTAGINBOX1SW** - only JTAG inbox 0 flag is reset automatically, while JTAG inbox 1 is reset with the ■ **SYSCTL_JTAGINBOX0SW_JTAGINBOX1AUTO** - only JTAG inbox 1 flag is reset automatically, while JTAG inbox 0 is reset with the ■ **SYSCTL_JTAGINBOX0SW_JTAGINBOX1SW** - both JTAG inbox flags will need to be reset manually by the Modified bits are **JMBCLR0OFF** and **JMBCLR1OFF** of **SYSJMBC** register.

Returns

None

SysCtl_setBSLSize()

```
void SysCtl_setBSLSize (
            uint8_t BSLSizeSelect )
```

Sets the size of the BSL in Flash.

This function sets the size of the BSL in Flash memory.

Parameters

BSLSizeSelect	is the amount of segments the BSL should take. Valid values are: ■ **SYSCTL_BSLSIZE_SEG3** ■ **SYSCTL_BSLSIZE_SEGS23** ■ **SYSCTL_BSLSIZE_SEGS123** ■ **SYSCTL_BSLSIZE_SEGS1234** [Default] Modified bits are **SYSBSLSIZE** of **SYSBSLC** register.

Returns

None

SysCtl_setJTAGOutgoingMessage16Bit()

```
void SysCtl_setJTAGOutgoingMessage16Bit (
            uint8_t outboxSelect,
            uint16_t outgoingMessage )
```

Sets a 16 bit outgoing message in to the selected JTAG Outbox.

This function sets the outgoing message in the selected JTAG outbox. The corresponding JTAG outbox flag is cleared after this function, and set after the JTAG has read the message.

Parameters

outboxSelect	is the chosen JTAG outbox that the message should be set it. Valid values are: ■ **SYSCTL_JTAGOUTBOX_0** - set the contents of JTAG outbox 0 ■ **SYSCTL_JTAGOUTBOX_1** - set the contents of JTAG outbox 1
outgoingMessage	is the message to send to the JTAG. Modified bits are **MSGHI** and **MSGLO** of **SYSJMBOx** register.

Returns

None

SysCtl_setJTAGOutgoingMessage32Bit()

```
void SysCtl_setJTAGOutgoingMessage32Bit (
            uint32_t outgoingMessage )
```

Sets a 32 bit message in to both JTAG Outboxes.

This function sets the 32-bit outgoing message in both JTAG outboxes. The JTAG outbox flags are cleared after this function, and set after the JTAG has read the message.

Parameters

outgoingMessage	is the message to send to the JTAG. Modified bits are **MSGHI** and **MSGLO** of **SYSJMBOx** register.

Returns

None

SysCtl_setRAMAssignedToBSL()

```
void SysCtl_setRAMAssignedToBSL (
            uint8_t BSLRAMAssignment )
```

Sets RAM assignment to BSL area.

This function allows RAM to be assigned to BSL, based on the selection of the BSLRAMAssignment parameter.

Parameters

BSLRAMAssignment	is the selection of if the BSL should be placed in RAM or not. Valid values are: ■ **SYSCTL_BSLRAMASSIGN_NORAM** [Default] ■ **SYSCTL_BSLRAMASSIGN_LOWEST16BYTES** Modified bits are **SYSBSLR** of **SYSBSLC** register.

Returns

None

35.3 Programming Example

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

```
SysCtl_enableBSLProtect();
```

36 Timer Event Control (TEC)

36.1 Introduction

Timer Event Control (TEC) module is the interface between Timer modules and the external events. This chapter describes the TEC Module.

TEC is a module that connects different Timer modules to each other and routes the external signals to the Timer modules. TEC contains the control registers to configure the routing between the Timer modules, and it also has the enable register bits and the interrupt enable and interrupt flags for external event inputs. TEC features include:

- Enabling of internal and external clear signals
- Routing of internal signals (between Timer_D instances) and external clear signals
- Support of external fault input signals
- Interrupt vector generation of external fault and clear signals.
- Generating feedback signals to the Timer capture/compare channels to affect the timer outputs

36.2 API Functions

Functions

- void TEC_initExternalClearInput (uint16_t baseAddress, uint8_t signalType, uint8_t signalHold, uint8_t polarityBit)
  Configures the Timer Event Control External Clear Input.
- void TEC_initExternalFaultInput (uint16_t baseAddress, TEC_initExternalFaultInputParam ∗param)
  Configures the Timer Event Control External Fault Input.
- void TEC_enableExternalFaultInput (uint16_t baseAddress, uint8_t channelEventBlock)
  Enable the Timer Event Control External fault input.
- void TEC_disableExternalFaultInput (uint16_t baseAddress, uint8_t channelEventBlock)
  Disable the Timer Event Control External fault input.
- void TEC_enableExternalClearInput (uint16_t baseAddress)
  Enable the Timer Event Control External Clear Input.
- void TEC_disableExternalClearInput (uint16_t baseAddress)
  Disable the Timer Event Control External Clear Input.
- void TEC_enableAuxiliaryClearSignal (uint16_t baseAddress)
  Enable the Timer Event Control Auxiliary Clear Signal.
- void TEC_disableAuxiliaryClearSignal (uint16_t baseAddress)
  Disable the Timer Event Control Auxiliary Clear Signal.
- void TEC_clearInterrupt (uint16_t baseAddress, uint8_t mask)

Clears the Timer Event Control Interrupt flag.
- uint8_t TEC_getInterruptStatus (uint16_t baseAddress, uint8_t mask)
  Gets the current Timer Event Control interrupt status.
- void TEC_enableInterrupt (uint16_t baseAddress, uint8_t mask)
  Enables individual Timer Event Control interrupt sources.
- void TEC_disableInterrupt (uint16_t baseAddress, uint8_t mask)
  Disables individual Timer Event Control interrupt sources.
- uint8_t TEC_getExternalFaultStatus (uint16_t baseAddress, uint8_t mask)
  Gets the current Timer Event Control External Fault Status.
- void TEC_clearExternalFaultStatus (uint16_t baseAddress, uint8_t mask)
  Clears the Timer Event Control External Fault Status.
- uint8_t TEC_getExternalClearStatus (uint16_t baseAddress)
  Gets the current Timer Event Control External Clear Status.
- void TEC_clearExternalClearStatus (uint16_t baseAddress)
  Clears the Timer Event Control External Clear Status.

36.2.1 Detailed Description

The tec configuration is handled by

- TEC_configureExternalClearInput()
- TEC_initExternalFaultInput()
- TEC_enableExternalFaultInput()
- TEC_disableExternalFaultInput()
- TEC_enableExternalClearInput()
- TEC_disableExternalClearInput()
- TEC_enableAuxiliaryClearSignal()
- TEC_disableAuxiliaryClearSignal()

The interrupt and status operations are handled by

- TEC_enableExternalFaultInput()
- TEC_disableExternalFaultInput()
- TEC_clearInterrupt()
- TEC_getInterruptStatus()
- TEC_enableInterrupt()
- TEC_disableInterrupt()
- TEC_getExternalFaultStatus()
- TEC_clearExternalFaultStatus()
- TEC_getExternalClearStatus()
- TEC_clearExternalClearStatus()

36.2.2 Function Documentation

TEC_clearExternalClearStatus()

```
void TEC_clearExternalClearStatus (
            uint16_t baseAddress )
```

Clears the Timer Event Control External Clear Status.

Parameters

baseAddress	is the base address of the TEC module.

Modified bits of **TECxINT** register.

Returns

None

TEC_clearExternalFaultStatus()

```
void TEC_clearExternalFaultStatus (
            uint16_t baseAddress,
            uint8_t mask )
```

Clears the Timer Event Control External Fault Status.

Parameters

baseAddress	is the base address of the TEC module.
mask	is the masked status flag be cleared Mask value is the logical OR of any of the following: ■ **TEC_CE0** ■ **TEC_CE1** ■ **TEC_CE2** ■ **TEC_CE3** - (available on TEC5 TEC7) ■ **TEC_CE4** - (available on TEC5 TEC7) ■ **TEC_CE5** - (only available on TEC7) ■ **TEC_CE6** - (only available on TEC7)

Modified bits of **TECxINT** register.

Returns

None

TEC_clearInterrupt()

```
void TEC_clearInterrupt (
            uint16_t baseAddress,
            uint8_t mask )
```

Clears the Timer Event Control Interrupt flag.

Parameters

baseAddress	is the base address of the TEC module.
mask	is the masked interrupt flag to be cleared. Mask value is the logical OR of any of the following: ■ **TEC_EXTERNAL_FAULT_INTERRUPT** - External fault interrupt flag ■ **TEC_EXTERNAL_CLEAR_INTERRUPT** - External clear interrupt flag ■ **TEC_AUXILIARY_CLEAR_INTERRUPT** - Auxiliary clear interrupt flag

Modified bits of **TECxINT** register.

Returns

None

TEC_disableAuxiliaryClearSignal()

```
void TEC_disableAuxiliaryClearSignal (
            uint16_t baseAddress )
```

Disable the Timer Event Control Auxiliary Clear Signal.

Parameters

baseAddress	is the base address of the TEC module.

Modified bits of **TECxCTL2** register.

Returns

None

TEC_disableExternalClearInput()

```
void TEC_disableExternalClearInput (
            uint16_t baseAddress )
```

Disable the Timer Event Control External Clear Input.

Parameters

baseAddress	is the base address of the TEC module.

Modified bits of **TECxCTL2** register.

Returns

None

TEC_disableExternalFaultInput()

```
void TEC_disableExternalFaultInput (
            uint16_t baseAddress,
            uint8_t channelEventBlock )
```

Disable the Timer Event Control External fault input.

Parameters

baseAddress	is the base address of the TEC module.
channelEventBlock	selects the channel event block Valid values are: ■ **TEC_CE0** ■ **TEC_CE1** ■ **TEC_CE2** ■ **TEC_CE3** - (available on TEC5 TEC7) ■ **TEC_CE4** - (available on TEC5 TEC7) ■ **TEC_CE5** - (only available on TEC7) ■ **TEC_CE6** - (only available on TEC7)

Modified bits of **TECxCTL0** register.

Returns

None

TEC_disableInterrupt()

```
void TEC_disableInterrupt (
            uint16_t baseAddress,
            uint8_t mask )
```

Disables individual Timer Event Control interrupt sources.

Disables the indicated Timer Event Control 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 TEC module.
mask	is the bit mask of the interrupt sources to be disabled. Mask value is the logical OR of any of the following: ■ **TEC_EXTERNAL_FAULT_INTERRUPT** - External fault interrupt flag ■ **TEC_EXTERNAL_CLEAR_INTERRUPT** - External clear interrupt flag ■ **TEC_AUXILIARY_CLEAR_INTERRUPT** - Auxiliary clear interrupt flag

Modified bits of **TECxINT** register.

Returns

None

TEC_enableAuxiliaryClearSignal()

```
void TEC_enableAuxiliaryClearSignal (
            uint16_t baseAddress )
```

Enable the Timer Event Control Auxiliary Clear Signal.

Parameters

baseAddress	is the base address of the TEC module.

Modified bits of **TECxCTL2** register.

Returns

None

TEC_enableExternalClearInput()

```
void TEC_enableExternalClearInput (
            uint16_t baseAddress )
```

Enable the Timer Event Control External Clear Input.

Parameters

baseAddress	is the base address of the TEC module.

Modified bits of **TECxCTL2** register.

Returns

None

TEC_enableExternalFaultInput()

```
void TEC_enableExternalFaultInput (
            uint16_t baseAddress,
            uint8_t channelEventBlock )
```

Enable the Timer Event Control External fault input.

Parameters

baseAddress	is the base address of the TEC module.
channelEventBlock	selects the channel event block Valid values are: ■ **TEC_CE0** ■ **TEC_CE1** ■ **TEC_CE2** ■ **TEC_CE3** - (available on TEC5 TEC7) ■ **TEC_CE4** - (available on TEC5 TEC7) ■ **TEC_CE5** - (only available on TEC7) ■ **TEC_CE6** - (only available on TEC7)

Modified bits of **TECxCTL0** register.

Returns

None

TEC_enableInterrupt()

```
void TEC_enableInterrupt (
            uint16_t baseAddress,
            uint8_t mask )
```

Enables individual Timer Event Control interrupt sources.

Enables the indicated Timer Event Control 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 TEC module.

Parameters

mask	is the bit mask of the interrupt sources to be enabled. Mask value is the logical OR of any of the following: ■ **TEC_EXTERNAL_FAULT_INTERRUPT** - External fault interrupt flag ■ **TEC_EXTERNAL_CLEAR_INTERRUPT** - External clear interrupt flag ■ **TEC_AUXILIARY_CLEAR_INTERRUPT** - Auxiliary clear interrupt flag

Modified bits of **TECxINT** register.

Returns

None

TEC_getExternalClearStatus()

```
uint8_t TEC_getExternalClearStatus (
            uint16_t baseAddress )
```

Gets the current Timer Event Control External Clear Status.

Parameters

baseAddress	is the base address of the TEC module.

Returns

One of the following:

- **TEC_EXTERNAL_CLEAR_DETECTED**
- **TEC_EXTERNAL_CLEAR_NOT_DETECTED**
  indicating the status of the external clear

TEC_getExternalFaultStatus()

```
uint8_t TEC_getExternalFaultStatus (
            uint16_t baseAddress,
            uint8_t mask )
```

Gets the current Timer Event Control External Fault Status.

This returns the Timer Event Control fault status for the module.

Parameters

baseAddress	is the base address of the TEC module.

Parameters

mask	is the masked interrupt flag status to be returned. Mask value is the logical OR of any of the following: ■ **TEC_CE0** ■ **TEC_CE1** ■ **TEC_CE2** ■ **TEC_CE3** - (available on TEC5 TEC7) ■ **TEC_CE4** - (available on TEC5 TEC7) ■ **TEC_CE5** - (only available on TEC7) ■ **TEC_CE6** - (only available on TEC7)

Returns

Logical OR of any of the following:

- **TEC_CE0**
- **TEC_CE1**
- **TEC_CE2**
- **TEC_CE3** (available on TEC5 TEC7)
- **TEC_CE4** (available on TEC5 TEC7)
- **TEC_CE5** (only available on TEC7)
- **TEC_CE6** (only available on TEC7)
  indicating the external fault status of the masked channel event blocks

TEC_getInterruptStatus()

```
uint8_t TEC_getInterruptStatus (
            uint16_t baseAddress,
            uint8_t mask )
```

Gets the current Timer Event Control interrupt status.

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

Parameters

baseAddress	is the base address of the TEC module.
mask	is the masked interrupt flag status to be returned. Mask value is the logical OR of any of the following: ■ **TEC_EXTERNAL_FAULT_INTERRUPT** - External fault interrupt flag ■ **TEC_EXTERNAL_CLEAR_INTERRUPT** - External clear interrupt flag ■ **TEC_AUXILIARY_CLEAR_INTERRUPT** - Auxiliary clear interrupt flag

Returns

Logical OR of any of the following:
- **TEC_EXTERNAL_FAULT_INTERRUPT** External fault interrupt flag
- **TEC_EXTERNAL_CLEAR_INTERRUPT** External clear interrupt flag
- **TEC_AUXILIARY_CLEAR_INTERRUPT** Auxiliary clear interrupt flag
  indicating the status of the masked interrupts

TEC_initExternalClearInput()

```
void TEC_initExternalClearInput (
            uint16_t baseAddress,
            uint8_t signalType,
            uint8_t signalHold,
            uint8_t polarityBit )
```

Configures the Timer Event Control External Clear Input.

Parameters

baseAddress	is the base address of the TEC module.
signalType	is the selected signal type Valid values are: ■ **TEC_EXTERNAL_CLEAR_SIGNALTYPE_EDGE_SENSITIVE** [Default] ■ **TEC_EXTERNAL_CLEAR_SIGNALTYPE_LEVEL_SENSITIVE**
signalHold	is the selected signal hold Valid values are: ■ **TEC_EXTERNAL_CLEAR_SIGNAL_NOT_HELD** [Default] ■ **TEC_EXTERNAL_CLEAR_SIGNAL_HELD**
polarityBit	is the selected signal type Valid values are: ■ **TEC_EXTERNAL_CLEAR_POLARITY_FALLING_EDGE_OR_LOW_↩ LEVEL** [Default] ■ **TEC_EXTERNAL_CLEAR_POLARITY_RISING_EDGE_OR_HIGH_LE↩ VEL**

Modified bits of **TECxCTL2** register.

Returns

None

TEC_initExternalFaultInput()

```
void TEC_initExternalFaultInput (
            uint16_t baseAddress,
            TEC_initExternalFaultInputParam * param )
```

Configures the Timer Event Control External Fault Input.

Parameters

baseAddress	is the base address of the TEC module.
param	is the pointer to struct for external fault input initialization.

Modified bits of **TECxCTL2** register.

Returns

None

References TEC_initExternalFaultInputParam::polarityBit, TEC_initExternalFaultInputParam::selectedExternalFault, TEC_initExternalFaultInputParam::signalHold, and TEC_initExternalFaultInputParam::signalType.

36.3 Programming Example

The following example shows how to use the TEC API.

```
{
  TIMER_D_startCounter(TIMER_D1_BASE,
    TIMERD_UP_MODE);

  // Configure TD1 TEC External Clear
  // Need to physically connect P2.0/TD0.2 to P2.7/TEC1CLR
  GPIO_setAsPeripheralModuleFunctionInputPin(
    GPIO_PORT_P2,
    GPIO_PIN7
    );

  // High Level trigger, ext clear enable
  TEC_configureExternalClearInput(TEC1_BASE,
                                  TEC_EXTERNAL_CLEAR_SIGNALTYPE_LEVEL_SENSITIVE,
                                  TEC_EXTERNAL_CLEAR_SIGNAL_NOT_HELD,
                                  TEC_EXTERNAL_CLEAR_POLARITY_RISING_EDGE_OR_HIGH_LEVEL
                                  );
  TEC_enableExternalClearInput(TEC1_BASE);

}
```

37 16-Bit Timer_A (TIMER_A)

37.1 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.

37.2 API Functions

Functions

- void Timer_A_startCounter (uint16_t baseAddress, uint16_t timerMode)
  Starts Timer_A counter.
- void Timer_A_initContinuousMode (uint16_t baseAddress, Timer_A_initContinuousModeParam *param)
  Configures Timer_A in continuous mode.
- void Timer_A_initUpMode (uint16_t baseAddress, Timer_A_initUpModeParam *param)
  Configures Timer_A in up mode.
- void Timer_A_initUpDownMode (uint16_t baseAddress, Timer_A_initUpDownModeParam *param)
  Configures Timer_A in up down mode.
- void Timer_A_initCaptureMode (uint16_t baseAddress, Timer_A_initCaptureModeParam *param)
  Initializes Capture Mode.
- void Timer_A_initCompareMode (uint16_t baseAddress, Timer_A_initCompareModeParam *param)
  Initializes Compare Mode.
- void Timer_A_enableInterrupt (uint16_t baseAddress)
  Enable timer interrupt.
- void Timer_A_disableInterrupt (uint16_t baseAddress)
  Disable timer interrupt.
- uint32_t Timer_A_getInterruptStatus (uint16_t baseAddress)
  Get timer interrupt status.
- void Timer_A_enableCaptureCompareInterrupt (uint16_t baseAddress, uint16_t captureCompareRegister)
  Enable capture compare interrupt.
- void Timer_A_disableCaptureCompareInterrupt (uint16_t baseAddress, uint16_t captureCompareRegister)
  Disable capture compare interrupt.
- uint32_t Timer_A_getCaptureCompareInterruptStatus (uint16_t baseAddress, uint16_t captureCompareRegister, uint16_t mask)
  Return capture compare interrupt status.
- void Timer_A_clear (uint16_t baseAddress)
  Reset/Clear the timer clock divider, count direction, count.
- uint8_t Timer_A_getSynchronizedCaptureCompareInput (uint16_t baseAddress, uint16_t captureCompareRegister, uint16_t synchronized)
  Get synchronized capturecompare input.
- uint8_t Timer_A_getOutputForOutputModeOutBitValue (uint16_t baseAddress, uint16_t captureCompareRegister)
  Get output bit for output mode.
- uint16_t Timer_A_getCaptureCompareCount (uint16_t baseAddress, uint16_t captureCompareRegister)
  Get current capturecompare count.
- void Timer_A_setOutputForOutputModeOutBitValue (uint16_t baseAddress, uint16_t captureCompareRegister, uint8_t outputModeOutBitValue)
  Set output bit for output mode.
- void Timer_A_outputPWM (uint16_t baseAddress, Timer_A_outputPWMParam *param)
  Generate a PWM with timer running in up mode.
- void Timer_A_stop (uint16_t baseAddress)

Stops the timer.
- void Timer_A_setCompareValue (uint16_t baseAddress, uint16_t compareRegister, uint16_t compareValue)
  Sets the value of the capture-compare register.
- void Timer_A_setOutputMode (uint16_t baseAddress, uint16_t compareRegister, uint16_t compareOutputMode)
  Sets the output mode.
- void Timer_A_clearTimerInterrupt (uint16_t baseAddress)
  Clears the Timer TAIFG interrupt flag.
- void Timer_A_clearCaptureCompareInterrupt (uint16_t baseAddress, uint16_t captureCompareRegister)
  Clears the capture-compare interrupt flag.
- uint16_t Timer_A_getCounterValue (uint16_t baseAddress)
  Reads the current timer count value.

37.2.1 Detailed Description

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_initUpMode()
- Timer_A_initUpDownMode()
- Timer_A_initContinuousMode()
- Timer_A_initCaptureMode()
- Timer_A_initCompareMode()
- Timer_A_clear()
- Timer_A_stop()

TIMER_A outputs are handled by

- Timer_A_getSynchronizedCaptureCompareInput()
- Timer_A_getOutputForOutputModeOutBitValue()
- Timer_A_setOutputForOutputModeOutBitValue()
- Timer_A_outputPWM()
- 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_clearCaptureCompareInterrupt()
- Timer_A_clearTimerInterrupt()

37.2.2 Function Documentation

Timer_A_clear()

```
void Timer_A_clear (
            uint16_t baseAddress )
```

Reset/Clear the timer clock divider, count direction, count.

Parameters

baseAddress	is the base address of the TIMER_A module.

Modified bits of **TAxCTL** register.

Returns

None

References Timer_A_getSynchronizedCaptureCompareInput().

Timer_A_clearCaptureCompareInterrupt()

```
void Timer_A_clearCaptureCompareInterrupt (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Clears the capture-compare interrupt flag.

Parameters

baseAddress	is the base address of the TIMER_A module.
captureCompareRegister	selects the Capture-compare register being used. Valid values are: ■ **TIMER_A_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_6**

Modified bits are **CCIFG** of **TAxCCTLn** register.

Returns

None

Timer_A_clearTimerInterrupt()

```
void Timer_A_clearTimerInterrupt (
            uint16_t baseAddress )
```

Clears the Timer TAIFG interrupt flag.

Parameters

baseAddress	is the base address of the TIMER_A module.

Modified bits are **TAIFG** of **TAxCTL** register.

Returns

None

Timer_A_disableCaptureCompareInterrupt()

```
void Timer_A_disableCaptureCompareInterrupt (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Disable capture compare interrupt.

Parameters

baseAddress	is the base address of the TIMER_A module.
captureCompareRegister	is the selected capture compare register Valid values are: ■ **TIMER_A_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_6**

Modified bits of **TAxCCTLn** register.

Returns

None

Timer_A_disableInterrupt()

```
void Timer_A_disableInterrupt (
            uint16_t baseAddress )
```

Disable timer interrupt.

Parameters

baseAddress	is the base address of the TIMER_A module.

Modified bits of **TAxCTL** register.

Returns

None

Timer_A_enableCaptureCompareInterrupt()

```
void Timer_A_enableCaptureCompareInterrupt (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Enable capture compare interrupt.

Does not clear interrupt flags

Parameters

baseAddress	is the base address of the TIMER_A module.
captureCompareRegister	is the selected capture compare register Valid values are: ■ **TIMER_A_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_6**

Modified bits of **TAxCCTLn** register.

Returns

None

Timer_A_enableInterrupt()

```
void Timer_A_enableInterrupt (
            uint16_t baseAddress )
```

Enable timer interrupt.

Does not clear interrupt flags

Parameters

baseAddress	is the base address of the TIMER_A module.

Modified bits of **TAxCTL** register.

Returns

None

Timer_A_getCaptureCompareCount()

```
uint16_t Timer_A_getCaptureCompareCount (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Get current capturecompare count.

Parameters

baseAddress	is the base address of the TIMER_A module.
captureCompareRegister	Valid values are: ■ **TIMER_A_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_6**

Returns

Current count as an uint16_t

References Timer_A_setOutputForOutputModeOutBitValue().

Referenced by Timer_A_getOutputForOutputModeOutBitValue().

Timer_A_getCaptureCompareInterruptStatus()

```
uint32_t Timer_A_getCaptureCompareInterruptStatus (
            uint16_t baseAddress,
            uint16_t captureCompareRegister,
            uint16_t mask )
```

Return capture compare interrupt status.

Parameters

baseAddress	is the base address of the TIMER_A module.
captureCompareRegister	is the selected capture compare register Valid values are: ■ **TIMER_A_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_6**
mask	is the mask for the interrupt status Mask value is the logical OR of any of the following: ■ **TIMER_A_CAPTURE_OVERFLOW** ■ **TIMER_A_CAPTURECOMPARE_INTERRUPT_FLAG**

Returns

Logical OR of any of the following:

- **TIMER_A_CAPTURE_OVERFLOW**
- **TIMER_A_CAPTURECOMPARE_INTERRUPT_FLAG**
  indicating the status of the masked interrupts

Timer_A_getCounterValue()

```
uint16_t Timer_A_getCounterValue (
            uint16_t baseAddress )
```

Reads the current timer count value.

Reads the current count value of the timer. There is a majority vote system in place to confirm an accurate value is returned. The TIMER_A_THRESHOLD #define in the corresponding header file can be modified so that the votes must be closer together for a consensus to occur.

Parameters

baseAddress	is the base address of the TIMER_A module.

Returns

Majority vote of timer count value

Timer_A_getInterruptStatus()

```
uint32_t Timer_A_getInterruptStatus (
            uint16_t baseAddress )
```

Get timer interrupt status.

Parameters

baseAddress	is the base address of the TIMER_A module.

Returns

One of the following:

- **TIMER_A_INTERRUPT_NOT_PENDING**
- **TIMER_A_INTERRUPT_PENDING**
  indicating the Timer_A interrupt status

Timer_A_getOutputForOutputModeOutBitValue()

```
uint8_t Timer_A_getOutputForOutputModeOutBitValue (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Get output bit for output mode.

Parameters

baseAddress	is the base address of the TIMER_A module.

Parameters

captureCompareRegister	Valid values are: ■ **TIMER_A_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_6**

Returns

One of the following:
- **TIMER_A_OUTPUTMODE_OUTBITVALUE_HIGH**
- **TIMER_A_OUTPUTMODE_OUTBITVALUE_LOW**

References Timer_A_getCaptureCompareCount().

Referenced by Timer_A_getSynchronizedCaptureCompareInput().

Timer_A_getSynchronizedCaptureCompareInput()

```
uint8_t Timer_A_getSynchronizedCaptureCompareInput (
            uint16_t baseAddress,
            uint16_t captureCompareRegister,
            uint16_t synchronized )
```

Get synchronized capturecompare input.

Parameters

baseAddress	is the base address of the TIMER_A module.

Parameters

captureCompareRegister	Valid values are: ■ **TIMER_A_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_6**
synchronized	Valid values are: ■ **TIMER_A_READ_SYNCHRONIZED_CAPTURECOMPAR↵ EINPUT** ■ **TIMER_A_READ_CAPTURE_COMPARE_INPUT**

Returns

One of the following:
- **TIMER_A_CAPTURECOMPARE_INPUT_HIGH**
- **TIMER_A_CAPTURECOMPARE_INPUT_LOW**

References Timer_A_getOutputForOutputModeOutBitValue().

Referenced by Timer_A_clear().

Timer_A_initCaptureMode()

```
void Timer_A_initCaptureMode (
            uint16_t baseAddress,
            Timer_A_initCaptureModeParam * param )
```

Initializes Capture Mode.

Parameters

baseAddress	is the base address of the TIMER_A module.
param	is the pointer to struct for capture mode initialization.

Modified bits of **TAxCCTLn** register.

Returns

None

References Timer_A_initCaptureModeParam::captureInputSelect,
Timer_A_initCaptureModeParam::captureInterruptEnable,
Timer_A_initCaptureModeParam::captureMode,

Timer_A_initCaptureModeParam::captureOutputMode,
Timer_A_initCaptureModeParam::captureRegister, and
Timer_A_initCaptureModeParam::synchronizeCaptureSource.

Timer_A_initCompareMode()

```
void Timer_A_initCompareMode (
            uint16_t baseAddress,
            Timer_A_initCompareModeParam * param )
```

Initializes Compare Mode.

Parameters

baseAddress	is the base address of the TIMER_A module.
param	is the pointer to struct for compare mode initialization.

Modified bits of **TAxCCRn** register and bits of **TAxCCTLn** register.

Returns

None

References Timer_A_initCompareModeParam::compareInterruptEnable,
Timer_A_initCompareModeParam::compareOutputMode,
Timer_A_initCompareModeParam::compareRegister, and
Timer_A_initCompareModeParam::compareValue.

Timer_A_initContinuousMode()

```
void Timer_A_initContinuousMode (
            uint16_t baseAddress,
            Timer_A_initContinuousModeParam * param )
```

Configures Timer_A in continuous mode.

Parameters

baseAddress	is the base address of the TIMER_A module.
param	is the pointer to struct for continuous mode initialization.

Modified bits of **TAxCTL** register.

Returns

None

References Timer_A_initContinuousModeParam::clockSource,
Timer_A_initContinuousModeParam::clockSourceDivider,
Timer_A_initContinuousModeParam::startTimer, Timer_A_initContinuousModeParam::timerClear,
and Timer_A_initContinuousModeParam::timerInterruptEnable_TAIE.

Timer_A_initUpDownMode()

```
void Timer_A_initUpDownMode (
            uint16_t baseAddress,
            Timer_A_initUpDownModeParam * param )
```

Configures Timer_A in up down mode.

Parameters

baseAddress	is the base address of the TIMER_A module.
param	is the pointer to struct for up-down mode initialization.

Modified bits of **TAxCTL** register, bits of **TAxCCTL0** register and bits of **TAxCCR0** register.

Returns

None

References Timer_A_initUpDownModeParam::captureCompareInterruptEnable_CCR0_CCIE, Timer_A_initUpDownModeParam::clockSource, Timer_A_initUpDownModeParam::clockSourceDivider, Timer_A_initUpDownModeParam::startTimer, Timer_A_initUpDownModeParam::timerClear, Timer_A_initUpDownModeParam::timerInterruptEnable_TAIE, and Timer_A_initUpDownModeParam::timerPeriod.

Timer_A_initUpMode()

```
void Timer_A_initUpMode (
            uint16_t baseAddress,
            Timer_A_initUpModeParam * param )
```

Configures Timer_A in up mode.

Parameters

baseAddress	is the base address of the TIMER_A module.
param	is the pointer to struct for up mode initialization.

Modified bits of **TAxCTL** register, bits of **TAxCCTL0** register and bits of **TAxCCR0** register.

Returns

None

References Timer_A_initUpModeParam::captureCompareInterruptEnable_CCR0_CCIE, Timer_A_initUpModeParam::clockSource, Timer_A_initUpModeParam::clockSourceDivider, Timer_A_initUpModeParam::startTimer, Timer_A_initUpModeParam::timerClear, Timer_A_initUpModeParam::timerInterruptEnable_TAIE, and Timer_A_initUpModeParam::timerPeriod.

Timer_A_outputPWM()

```
void Timer_A_outputPWM (
            uint16_t baseAddress,
            Timer_A_outputPWMParam * param )
```

Generate a PWM with timer running in up mode.

Parameters

baseAddress	is the base address of the TIMER_A module.
param	is the pointer to struct for PWM configuration.

Modified bits of **TAxCTL** register, bits of **TAxCCTL0** register, bits of **TAxCCR0** register and bits of **TAxCCTLn** register.

Returns

None

References Timer_A_outputPWMParam::clockSource, Timer_A_outputPWMParam::clockSourceDivider, Timer_A_outputPWMParam::compareOutputMode, Timer_A_outputPWMParam::compareRegister, Timer_A_outputPWMParam::dutyCycle, and Timer_A_outputPWMParam::timerPeriod.

Timer_A_setCompareValue()

```
void Timer_A_setCompareValue (
            uint16_t baseAddress,
            uint16_t compareRegister,
            uint16_t compareValue )
```

Sets the value of the capture-compare register.

Parameters

baseAddress	is the base address of the TIMER_A module.
compareRegister	selects the Capture register being used. Refer to datasheet to ensure the device has the capture compare register being used. Valid values are: ■ **TIMER_A_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_6**
compareValue	is the count to be compared with in compare mode

Modified bits of **TAxCCRn** register.

Returns

None

Timer_A_setOutputForOutputModeOutBitValue()

```
void Timer_A_setOutputForOutputModeOutBitValue (
            uint16_t baseAddress,
            uint16_t captureCompareRegister,
            uint8_t outputModeOutBitValue )
```

Set output bit for output mode.

Parameters

baseAddress	is the base address of the TIMER_A module.
captureCompareRegister	Valid values are: ■ **TIMER_A_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_6**
outputModeOutBitValue	is the value to be set for out bit Valid values are: ■ **TIMER_A_OUTPUTMODE_OUTBITVALUE_HIGH** ■ **TIMER_A_OUTPUTMODE_OUTBITVALUE_LOW**

Modified bits of **TAxCCTLn** register.

Returns

None

Referenced by Timer_A_getCaptureCompareCount().

Timer_A_setOutputMode()

```
void Timer_A_setOutputMode (
            uint16_t baseAddress,
            uint16_t compareRegister,
            uint16_t compareOutputMode )
```

Sets the output mode.

Sets the output mode for the timer even the timer is already running.

Parameters

baseAddress	is the base address of the TIMER_A module.
compareRegister	selects the compare register being used. Valid values are: ■ **TIMER_A_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_A_CAPTURECOMPARE_REGISTER_6**
compareOutputMode	specifies the output mode. Valid values are: ■ **TIMER_A_OUTPUTMODE_OUTBITVALUE** [Default] ■ **TIMER_A_OUTPUTMODE_SET** ■ **TIMER_A_OUTPUTMODE_TOGGLE_RESET** ■ **TIMER_A_OUTPUTMODE_SET_RESET** ■ **TIMER_A_OUTPUTMODE_TOGGLE** ■ **TIMER_A_OUTPUTMODE_RESET** ■ **TIMER_A_OUTPUTMODE_TOGGLE_SET** ■ **TIMER_A_OUTPUTMODE_RESET_SET**

Modified bits are **OUTMOD** of **TAxCCTLn** register.

Returns

None

Timer_A_startCounter()

```
void Timer_A_startCounter (
            uint16_t baseAddress,
            uint16_t timerMode )
```

Starts Timer_A counter.

This function assumes that the timer has been previously configured using Timer_A_initContinuousMode, Timer_A_initUpMode or Timer_A_initUpDownMode.

Parameters

baseAddress	is the base address of the TIMER_A module.

Parameters

timerMode	mode to put the timer in Valid values are: ■ **TIMER_A_STOP_MODE** ■ **TIMER_A_UP_MODE** ■ **TIMER_A_CONTINUOUS_MODE** [Default] ■ **TIMER_A_UPDOWN_MODE**

Modified bits of **TAxCTL** register.

Returns

None

Timer_A_stop()

```
void Timer_A_stop (
            uint16_t baseAddress )
```

Stops the timer.

Parameters

baseAddress	is the base address of the TIMER_A module.

Modified bits of **TAxCTL** register.

Returns

None

37.3 Programming Example

The following example shows some TIMER_A operations using the APIs

```
{   //Start TIMER_A
    Timer_A_initContinuousModeParam initContParam = {0};
    initContParam.clockSource = TIMER_A_CLOCKSOURCE_SMCLK;
    initContParam.clockSourceDivider = TIMER_A_CLOCKSOURCE_DIVIDER_1;
    initContParam.timerInterruptEnable_TAIE = TIMER_A_TAIE_INTERRUPT_DISABLE;
    initContParam.timerClear = TIMER_A_DO_CLEAR;
    initContParam.startTimer = false;
    Timer_A_initContinuousMode(TIMER_A1_BASE, &initContParam);

    //Initiaze compare mode
    Timer_A_clearCaptureCompareInterrupt(TIMER_A1_BASE,
        TIMER_A_CAPTURECOMPARE_REGISTER_0
        );

    Timer_A_initCompareModeParam initCompParam = {0};
    initCompParam.compareRegister = TIMER_A_CAPTURECOMPARE_REGISTER_0;
    initCompParam.compareInterruptEnable = TIMER_A_CAPTURECOMPARE_INTERRUPT_ENABLE;
```

```
    initCompParam.compareOutputMode = TIMER_A_OUTPUTMODE_OUTBITVALUE;
    initCompParam.compareValue = COMPARE_VALUE;
    Timer_A_initCompareMode(TIMER_A1_BASE, &initCompParam);

    Timer_A_startCounter( TIMER_A1_BASE,
            TIMER_A_CONTINUOUS_MODE
                );

    //Enter LPM0
    __bis_SR_register(LPM0_bits);

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

38 16-Bit Timer_B (TIMER_B)

38.1 Introduction

TIMER_B is a 16-bit timer/counter with multiple capture/compare registers. TIMER_B can support multiple capture/compares, PWM outputs, and interval timing. TIMER_B 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 B hardware peripheral.

TIMER_B 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_B interrupts

Differences From Timer_A Timer_B is identical to Timer_A with the following exceptions:

- The length of Timer_B is programmable to be 8, 10, 12, or 16 bits
- Timer_B TBxCCRn registers are double-buffered and can be grouped
- All Timer_B outputs can be put into a high-impedance state
- The SCCI bit function is not implemented in Timer_B

TIMER_B can operate in 3 modes

- Continuous Mode
- Up Mode
- Down Mode

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

The TIMER_B may also be used to generate PWM outputs. PWM outputs can be generated by initializing the compare mode with TIMER_B_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_B_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_B_generatePWM() or a combination of Timer_initCompare() and timer start APIs

The TIMER_B API provides a set of functions for dealing with the TIMER_B 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.

38.2 API Functions

Functions

- void Timer_B_startCounter (uint16_t baseAddress, uint16_t timerMode)
  Starts Timer_B counter.
- void Timer_B_initContinuousMode (uint16_t baseAddress, Timer_B_initContinuousModeParam ∗param)
  Configures Timer_B in continuous mode.
- void Timer_B_initUpMode (uint16_t baseAddress, Timer_B_initUpModeParam ∗param)
  Configures Timer_B in up mode.
- void Timer_B_initUpDownMode (uint16_t baseAddress, Timer_B_initUpDownModeParam ∗param)
  Configures Timer_B in up down mode.
- void Timer_B_initCaptureMode (uint16_t baseAddress, Timer_B_initCaptureModeParam ∗param)
  Initializes Capture Mode.
- void Timer_B_initCompareMode (uint16_t baseAddress, Timer_B_initCompareModeParam ∗param)
  Initializes Compare Mode.
- void Timer_B_enableInterrupt (uint16_t baseAddress)
  Enable Timer_B interrupt.
- void Timer_B_disableInterrupt (uint16_t baseAddress)
  Disable Timer_B interrupt.
- uint32_t Timer_B_getInterruptStatus (uint16_t baseAddress)
  Get Timer_B interrupt status.
- void Timer_B_enableCaptureCompareInterrupt (uint16_t baseAddress, uint16_t captureCompareRegister)
  Enable capture compare interrupt.
- void Timer_B_disableCaptureCompareInterrupt (uint16_t baseAddress, uint16_t captureCompareRegister)
  Disable capture compare interrupt.
- uint32_t Timer_B_getCaptureCompareInterruptStatus (uint16_t baseAddress, uint16_t captureCompareRegister, uint16_t mask)
  Return capture compare interrupt status.
- void Timer_B_clear (uint16_t baseAddress)
  Reset/Clear the Timer_B clock divider, count direction, count.
- uint8_t Timer_B_getSynchronizedCaptureCompareInput (uint16_t baseAddress, uint16_t captureCompareRegister, uint16_t synchronized)
  Get synchronized capturecompare input.
- uint8_t Timer_B_getOutputForOutputModeOutBitValue (uint16_t baseAddress, uint16_t captureCompareRegister)
  Get output bit for output mode.

- uint16_t Timer_B_getCaptureCompareCount (uint16_t baseAddress, uint16_t captureCompareRegister)
  Get current capturecompare count.
- void Timer_B_setOutputForOutputModeOutBitValue (uint16_t baseAddress, uint16_t captureCompareRegister, uint16_t outputModeOutBitValue)
  Set output bit for output mode.
- void Timer_B_outputPWM (uint16_t baseAddress, Timer_B_outputPWMParam *param)
  Generate a PWM with Timer_B running in up mode.
- void Timer_B_stop (uint16_t baseAddress)
  Stops the Timer_B.
- void Timer_B_setCompareValue (uint16_t baseAddress, uint16_t compareRegister, uint16_t compareValue)
  Sets the value of the capture-compare register.
- void Timer_B_clearTimerInterrupt (uint16_t baseAddress)
  Clears the Timer_B TBIFG interrupt flag.
- void Timer_B_clearCaptureCompareInterrupt (uint16_t baseAddress, uint16_t captureCompareRegister)
  Clears the capture-compare interrupt flag.
- void Timer_B_selectCounterLength (uint16_t baseAddress, uint16_t counterLength)
  Selects Timer_B counter length.
- void Timer_B_selectLatchingGroup (uint16_t baseAddress, uint16_t groupLatch)
  Selects Timer_B Latching Group.
- void Timer_B_initCompareLatchLoadEvent (uint16_t baseAddress, uint16_t compareRegister, uint16_t compareLatchLoadEvent)
  Selects Compare Latch Load Event.
- uint16_t Timer_B_getCounterValue (uint16_t baseAddress)
  Reads the current timer count value.
- void Timer_B_setOutputMode (uint16_t baseAddress, uint16_t compareRegister, uint16_t compareOutputMode)
  Sets the output mode.

38.2.1 Detailed Description

The TIMER_B 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_B configuration and initialization is handled by

- Timer_B_startCounter()
- Timer_B_initUpMode()
- Timer_B_initUpDownMode()
- Timer_B_initContinuousMode()
- Timer_B_initCapture()
- Timer_B_initCompare()
- Timer_B_clear()
- Timer_B_stop()
- Timer_B_initCompareLatchLoadEvent()
- Timer_B_selectLatchingGroup()
- Timer_B_selectCounterLength()

TIMER_B outputs are handled by

- Timer_B_getSynchronizedCaptureCompareInput()
- Timer_B_getOutputForOutputModeOutBitValue()
- Timer_B_setOutputForOutputModeOutBitValue()
- Timer_B_generatePWM()
- Timer_B_getCaptureCompareCount()
- Timer_B_setCompareValue()
- Timer_B_getCounterValue()

The interrupt handler for the TIMER_B interrupt is managed with

- Timer_B_enableInterrupt()
- Timer_B_disableInterrupt()
- Timer_B_getInterruptStatus()
- Timer_B_enableCaptureCompareInterrupt()
- Timer_B_disableCaptureCompareInterrupt()
- Timer_B_getCaptureCompareInterruptStatus()
- Timer_B_clearCaptureCompareInterrupt()
- Timer_B_clearTimerInterrupt()

38.2.2 Function Documentation

Timer_B_clear()

```
void Timer_B_clear (
            uint16_t baseAddress )
```

Reset/Clear the Timer_B clock divider, count direction, count.

Parameters

baseAddress	is the base address of the TIMER_B module.

Modified bits of **TBxCTL** register.

Returns

None

References Timer_B_getSynchronizedCaptureCompareInput().

Timer_B_clearCaptureCompareInterrupt()

```
void Timer_B_clearCaptureCompareInterrupt (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Clears the capture-compare interrupt flag.

Parameters

baseAddress	is the base address of the TIMER_B module.
captureCompareRegister	selects the capture compare register being used. Refer to datasheet to ensure the device has the capture compare register being used. Valid values are: ■ **TIMER_B_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_6**

Modified bits are **CCIFG** of **TBxCCTLn** register.

Returns

None

Timer_B_clearTimerInterrupt()

```
void Timer_B_clearTimerInterrupt (
            uint16_t baseAddress )
```

Clears the Timer_B TBIFG interrupt flag.

Parameters

baseAddress	is the base address of the TIMER_B module.

Modified bits are **TBIFG** of **TBxCTL** register.

Returns

None

Timer_B_disableCaptureCompareInterrupt()

```
void Timer_B_disableCaptureCompareInterrupt (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Disable capture compare interrupt.

Parameters

baseAddress	is the base address of the TIMER_B module.
captureCompareRegister	selects the capture compare register being used. Refer to datasheet to ensure the device has the capture compare register being used. Valid values are: ■ **TIMER_B_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_6**

Modified bits of **TBxCCTLn** register.

Returns

None

Timer_B_disableInterrupt()

```
void Timer_B_disableInterrupt (
            uint16_t baseAddress )
```

Disable Timer_B interrupt.

Parameters

baseAddress	is the base address of the TIMER_B module.

Modified bits of **TBxCTL** register.

Returns

None

Timer_B_enableCaptureCompareInterrupt()

```
void Timer_B_enableCaptureCompareInterrupt (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Enable capture compare interrupt.

Parameters

baseAddress	is the base address of the TIMER_B module.
captureCompareRegister	selects the capture compare register being used. Refer to datasheet to ensure the device has the capture compare register being used. Valid values are: ■ **TIMER_B_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_6**

Modified bits of **TBxCCTLn** register.

Returns

None

Timer_B_enableInterrupt()

```
void Timer_B_enableInterrupt (
            uint16_t baseAddress )
```

Enable Timer_B interrupt.

Enables Timer_B interrupt. Does not clear interrupt flags.

Parameters

baseAddress	is the base address of the TIMER_B module.

Modified bits of **TBxCTL** register.

Returns

None

Timer_B_getCaptureCompareCount()

```
uint16_t Timer_B_getCaptureCompareCount (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Get current capturecompare count.

Parameters

baseAddress	is the base address of the TIMER_B module.
captureCompareRegister	selects the capture compare register being used. Refer to datasheet to ensure the device has the capture compare register being used. Valid values are: ■ **TIMER_B_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_6**

Returns

Current count as uint16_t

References Timer_B_setOutputForOutputModeOutBitValue().

Referenced by Timer_B_getOutputForOutputModeOutBitValue().

Timer_B_getCaptureCompareInterruptStatus()

```
uint32_t Timer_B_getCaptureCompareInterruptStatus (
            uint16_t baseAddress,
            uint16_t captureCompareRegister,
            uint16_t mask )
```

Return capture compare interrupt status.

Parameters

baseAddress	is the base address of the TIMER_B module.
captureCompareRegister	selects the capture compare register being used. Refer to datasheet to ensure the device has the capture compare register being used. Valid values are: ■ **TIMER_B_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_6**

Parameters

mask	is the mask for the interrupt status Mask value is the logical OR of any of the following: ■ **TIMER_B_CAPTURE_OVERFLOW** ■ **TIMER_B_CAPTURECOMPARE_INTERRUPT_FLAG**

Returns

Logical OR of any of the following:

- **TIMER_B_CAPTURE_OVERFLOW**
- **TIMER_B_CAPTURECOMPARE_INTERRUPT_FLAG**
  indicating the status of the masked interrupts

Timer_B_getCounterValue()

```
uint16_t Timer_B_getCounterValue (
            uint16_t baseAddress )
```

Reads the current timer count value.

Reads the current count value of the timer. There is a majority vote system in place to confirm an accurate value is returned. The Timer_B_THRESHOLD #define in the associated header file can be modified so that the votes must be closer together for a consensus to occur.

Parameters

baseAddress	is the base address of the Timer module.

Returns

Majority vote of timer count value

Timer_B_getInterruptStatus()

```
uint32_t Timer_B_getInterruptStatus (
            uint16_t baseAddress )
```

Get Timer_B interrupt status.

Parameters

baseAddress	is the base address of the TIMER_B module.

Returns

One of the following:
- **TIMER_B_INTERRUPT_NOT_PENDING**
- **TIMER_B_INTERRUPT_PENDING**
indicating the status of the Timer_B interrupt

Timer_B_getOutputForOutputModeOutBitValue()

```
uint8_t Timer_B_getOutputForOutputModeOutBitValue (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Get output bit for output mode.

Parameters

baseAddress	is the base address of the TIMER_B module.
captureCompareRegister	selects the capture compare register being used. Refer to datasheet to ensure the device has the capture compare register being used. Valid values are: ■ **TIMER_B_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_6**

Returns

One of the following:
- **TIMER_B_OUTPUTMODE_OUTBITVALUE_HIGH**
- **TIMER_B_OUTPUTMODE_OUTBITVALUE_LOW**

References Timer_B_getCaptureCompareCount().

Referenced by Timer_B_getSynchronizedCaptureCompareInput().

Timer_B_getSynchronizedCaptureCompareInput()

```
uint8_t Timer_B_getSynchronizedCaptureCompareInput (
            uint16_t baseAddress,
            uint16_t captureCompareRegister,
            uint16_t synchronized )
```

Get synchronized capturecompare input.

Parameters

baseAddress	is the base address of the TIMER_B module.
captureCompareRegister	selects the capture compare register being used. Refer to datasheet to ensure the device has the capture compare register being used. Valid values are: ■ **TIMER_B_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_6**
synchronized	selects the type of capture compare input Valid values are: ■ **TIMER_B_READ_SYNCHRONIZED_CAPTURECOMPAR↵ EINPUT** ■ **TIMER_B_READ_CAPTURE_COMPARE_INPUT**

Returns

One of the following:

- **TIMER_B_CAPTURECOMPARE_INPUT_HIGH**
- **TIMER_B_CAPTURECOMPARE_INPUT_LOW**

References Timer_B_getOutputForOutputModeOutBitValue().

Referenced by Timer_B_clear().

Timer_B_initCaptureMode()

```
void Timer_B_initCaptureMode (
            uint16_t baseAddress,
            Timer_B_initCaptureModeParam * param )
```

Initializes Capture Mode.

Parameters

baseAddress	is the base address of the TIMER_B module.
param	is the pointer to struct for capture mode initialization.

Modified bits of **TBxCCTLn** register.

Returns

None

References Timer_B_initCaptureModeParam::captureInputSelect, Timer_B_initCaptureModeParam::captureInterruptEnable, Timer_B_initCaptureModeParam::captureMode, Timer_B_initCaptureModeParam::captureOutputMode, Timer_B_initCaptureModeParam::captureRegister, and Timer_B_initCaptureModeParam::synchronizeCaptureSource.

Timer_B_initCompareLatchLoadEvent()

```
void Timer_B_initCompareLatchLoadEvent (
            uint16_t baseAddress,
            uint16_t compareRegister,
            uint16_t compareLatchLoadEvent )
```

Selects Compare Latch Load Event.

Parameters

baseAddress	is the base address of the TIMER_B module.
compareRegister	selects the compare register being used. Refer to datasheet to ensure the device has the compare register being used. Valid values are: ■ **TIMER_B_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_6**
compareLatchLoadEvent	selects the latch load event Valid values are: ■ **TIMER_B_LATCH_ON_WRITE_TO_TBxCCRn_COMPAR↩ E_REGISTER** [Default] ■ **TIMER_B_LATCH_WHEN_COUNTER_COUNTS_TO_0_I↩ N_UP_OR_CONT_MODE** ■ **TIMER_B_LATCH_WHEN_COUNTER_COUNTS_TO_0_I↩ N_UPDOWN_MODE** ■ **TIMER_B_LATCH_WHEN_COUNTER_COUNTS_TO_CU↩ RRENT_COMPARE_LATCH_VALUE**

Modified bits are **CLLD** of **TBxCCTLn** register.

Returns

None

Timer_B_initCompareMode()

```
void Timer_B_initCompareMode (
            uint16_t baseAddress,
            Timer_B_initCompareModeParam * param )
```

Initializes Compare Mode.

Parameters

baseAddress	is the base address of the TIMER_B module.
param	is the pointer to struct for compare mode initialization.

Modified bits of **TBxCCTLn** register and bits of **TBxCCRn** register.

Returns

None

References Timer_B_initCompareModeParam::compareInterruptEnable, Timer_B_initCompareModeParam::compareOutputMode, Timer_B_initCompareModeParam::compareRegister, and Timer_B_initCompareModeParam::compareValue.

Timer_B_initContinuousMode()

```
void Timer_B_initContinuousMode (
            uint16_t baseAddress,
            Timer_B_initContinuousModeParam * param )
```

Configures Timer_B in continuous mode.

This API does not start the timer. Timer needs to be started when required using the Timer_B_startCounter API.

Parameters

baseAddress	is the base address of the TIMER_B module.
param	is the pointer to struct for continuous mode initialization.

Modified bits of **TBxCTL** register.

Returns

None

References Timer_B_initContinuousModeParam::clockSource, Timer_B_initContinuousModeParam::clockSourceDivider, Timer_B_initContinuousModeParam::startTimer, Timer_B_initContinuousModeParam::timerClear, and Timer_B_initContinuousModeParam::timerInterruptEnable_TBIE.

Timer_B_initUpDownMode()

```
void Timer_B_initUpDownMode (
            uint16_t baseAddress,
            Timer_B_initUpDownModeParam * param )
```

Configures Timer_B in up down mode.

This API does not start the timer. Timer needs to be started when required using the Timer_B_startCounter API.

Parameters

baseAddress	is the base address of the TIMER_B module.
param	is the pointer to struct for up-down mode initialization.

Modified bits of **TBxCTL** register, bits of **TBxCCTL0** register and bits of **TBxCCR0** register.

Returns

None

References Timer_B_initUpDownModeParam::captureCompareInterruptEnable_CCR0_CCIE, Timer_B_initUpDownModeParam::clockSource, Timer_B_initUpDownModeParam::clockSourceDivider, Timer_B_initUpDownModeParam::startTimer, Timer_B_initUpDownModeParam::timerClear, Timer_B_initUpDownModeParam::timerInterruptEnable_TBIE, and Timer_B_initUpDownModeParam::timerPeriod.

Timer_B_initUpMode()

```
void Timer_B_initUpMode (
            uint16_t baseAddress,
            Timer_B_initUpModeParam * param )
```

Configures Timer_B in up mode.

This API does not start the timer. Timer needs to be started when required using the Timer_B_startCounter API.

Parameters

baseAddress	is the base address of the TIMER_B module.
param	is the pointer to struct for up mode initialization.

Modified bits of **TBxCTL** register, bits of **TBxCCTL0** register and bits of **TBxCCR0** register.

Returns

None

References Timer_B_initUpModeParam::captureCompareInterruptEnable_CCR0_CCIE, Timer_B_initUpModeParam::clockSource, Timer_B_initUpModeParam::clockSourceDivider, Timer_B_initUpModeParam::startTimer, Timer_B_initUpModeParam::timerClear, Timer_B_initUpModeParam::timerInterruptEnable_TBIE, and Timer_B_initUpModeParam::timerPeriod.

Timer_B_outputPWM()

```
void Timer_B_outputPWM (
            uint16_t baseAddress,
            Timer_B_outputPWMParam * param )
```

Generate a PWM with Timer_B running in up mode.

Parameters

baseAddress	is the base address of the TIMER_B module.
param	is the pointer to struct for PWM configuration.

Modified bits of **TBxCCTLn** register, bits of **TBxCTL** register, bits of **TBxCCTL0** register and bits of **TBxCCR0** register.

Returns

None

References Timer_B_outputPWMParam::clockSource, Timer_B_outputPWMParam::clockSourceDivider, Timer_B_outputPWMParam::compareOutputMode, Timer_B_outputPWMParam::compareRegister, Timer_B_outputPWMParam::dutyCycle, and Timer_B_outputPWMParam::timerPeriod.

Timer_B_selectCounterLength()

```
void Timer_B_selectCounterLength (
            uint16_t baseAddress,
            uint16_t counterLength )
```

Selects Timer_B counter length.

Parameters

baseAddress	is the base address of the TIMER_B module.

Parameters

counterLength	selects the value of counter length. Valid values are: ■ **TIMER_B_COUNTER_16BIT** [Default] ■ **TIMER_B_COUNTER_12BIT** ■ **TIMER_B_COUNTER_10BIT** ■ **TIMER_B_COUNTER_8BIT**

Modified bits are **CNTL** of **TBxCTL** register.

Returns

None

Timer_B_selectLatchingGroup()

```
void Timer_B_selectLatchingGroup (
            uint16_t baseAddress,
            uint16_t groupLatch )
```

Selects Timer_B Latching Group.

Parameters

baseAddress	is the base address of the TIMER_B module.
groupLatch	selects the latching group. Valid values are: ■ **TIMER_B_GROUP_NONE** [Default] ■ **TIMER_B_GROUP_CL12_CL23_CL56** ■ **TIMER_B_GROUP_CL123_CL456** ■ **TIMER_B_GROUP_ALL**

Modified bits are **TBCLGRP** of **TBxCTL** register.

Returns

None

Timer_B_setCompareValue()

```
void Timer_B_setCompareValue (
            uint16_t baseAddress,
            uint16_t compareRegister,
            uint16_t compareValue )
```

Sets the value of the capture-compare register.

Parameters

baseAddress	is the base address of the TIMER_B module.
compareRegister	selects the compare register being used. Refer to datasheet to ensure the device has the compare register being used. Valid values are: ■ **TIMER_B_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_6**
compareValue	is the count to be compared with in compare mode

Modified bits of **TBxCCRn** register.

Returns

None

Timer_B_setOutputForOutputModeOutBitValue()

```
void Timer_B_setOutputForOutputModeOutBitValue (
            uint16_t baseAddress,
            uint16_t captureCompareRegister,
            uint16_t outputModeOutBitValue )
```

Set output bit for output mode.

Parameters

baseAddress	is the base address of the TIMER_B module.
captureCompareRegister	selects the capture compare register being used. Refer to datasheet to ensure the device has the capture compare register being used. Valid values are: ■ **TIMER_B_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_6**

Parameters

outputModeOutBitValue	the value to be set for out bit Valid values are: ■ **TIMER_B_OUTPUTMODE_OUTBITVALUE_HIGH** ■ **TIMER_B_OUTPUTMODE_OUTBITVALUE_LOW**

Modified bits of **TBxCCTLn** register.

Returns

None

Referenced by Timer_B_getCaptureCompareCount().

Timer_B_setOutputMode()

```
void Timer_B_setOutputMode (
            uint16_t baseAddress,
            uint16_t compareRegister,
            uint16_t compareOutputMode )
```

Sets the output mode.

Sets the output mode for the timer even the timer is already running.

Parameters

baseAddress	is the base address of the TIMER_B module.
compareRegister	selects the compare register being used. Valid values are: ■ **TIMER_B_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_B_CAPTURECOMPARE_REGISTER_6**
compareOutputMode	specifies the output mode. Valid values are: ■ **TIMER_B_OUTPUTMODE_OUTBITVALUE** [Default] ■ **TIMER_B_OUTPUTMODE_SET** ■ **TIMER_B_OUTPUTMODE_TOGGLE_RESET** ■ **TIMER_B_OUTPUTMODE_SET_RESET** ■ **TIMER_B_OUTPUTMODE_TOGGLE** ■ **TIMER_B_OUTPUTMODE_RESET** ■ **TIMER_B_OUTPUTMODE_TOGGLE_SET** ■ **TIMER_B_OUTPUTMODE_RESET_SET**

Modified bits are **OUTMOD** of **TBxCCTLn** register.

Returns

None

Timer_B_startCounter()

```
void Timer_B_startCounter (
            uint16_t baseAddress,
            uint16_t timerMode )
```

Starts Timer_B counter.

This function assumes that the timer has been previously configured using Timer_B_initContinuousMode, Timer_B_initUpMode or Timer_B_initUpDownMode.

Parameters

baseAddress	is the base address of the TIMER_B module.
timerMode	selects the mode of the timer Valid values are: ■ **TIMER_B_STOP_MODE** ■ **TIMER_B_UP_MODE** ■ **TIMER_B_CONTINUOUS_MODE** [Default] ■ **TIMER_B_UPDOWN_MODE**

Modified bits of **TBxCTL** register.

Returns

None

Timer_B_stop()

```
void Timer_B_stop (
            uint16_t baseAddress )
```

Stops the Timer_B.

Parameters

baseAddress	is the base address of the TIMER_B module.

Modified bits of **TBxCTL** register.

Returns

None

38.3 Programming Example

The following example shows some TIMER_B operations using the APIs

```
{   //Start timer in continuous mode sourced by SMCLK
    Timer_B_initContinuousModeParam initContParam = {0};
    initContParam.clockSource = TIMER_B_CLOCKSOURCE_SMCLK;
    initContParam.clockSourceDivider = TIMER_B_CLOCKSOURCE_DIVIDER_1;
    initContParam.timerInterruptEnable_TBIE = TIMER_B_TBIE_INTERRUPT_DISABLE;
    initContParam.timerClear = TIMER_B_DO_CLEAR;
    initContParam.startTimer = false;
    Timer_B_initContinuousMode(TIMER_B0_BASE, &initContParam);

     //Initiaze compare mode
    Timer_B_clearCaptureCompareInterrupt(TIMER_B0_BASE,
        TIMER_B_CAPTURECOMPARE_REGISTER_0);

    Timer_B_initCompareModeParam initCompParam = {0};
    initCompParam.compareRegister = TIMER_B_CAPTURECOMPARE_REGISTER_0;
    initCompParam.compareInterruptEnable = TIMER_B_CAPTURECOMPARE_INTERRUPT_ENABLE;
    initCompParam.compareOutputMode = TIMER_B_OUTPUTMODE_OUTBITVALUE;
    initCompParam.compareValue = COMPARE_VALUE;
    Timer_B_initCompareMode(TIMER_B0_BASE, &initCompParam);

    Timer_B_startCounter( TIMER_B0_BASE,
        TIMER_B_CONTINUOUS_MODE
        );

}
```

39 TIMER_D

39.1 Introduction

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

This peripheral API handles Timer D hardware peripheral.

TIMER_D features include:

- Asynchronous 16-bit timer/counter with four operating modes and four selectable lengths
- Selectable and configurable clock source
- Configurable capture/compare registers
- Controlling rising and falling PWM edges by combining two neighbor TDCCR registers in one compare channel output
- Configurable outputs with PWM capability
- High-resolution mode with a fine clock frequency up to 16 times the timer input clock frequency
- Double-buffered compare registers with synchronized loading
- Interrupt vector register for fast decoding of all Timer_D interrupts

Differences From Timer_B Timer_D is identical to Timer_B with the following exceptions:

- Timer_D supports high-resolution mode.
- Timer_D supports the combination of two adjacent TDCCRx registers in one capture/compare channel.
- Timer_D supports the dual capture event mode.
- Timer_D supports external fault input, external clear input, and signal. See the TEC chapter for detailed information.
- Timer_D can synchronize with a second timer instance when available. See the TEC chapter for detailed information.

Timer_D can operate in 3 modes

- Continuous Mode
- Up Mode
- Down Mode

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

The Timer_D may also be used to generate PWM outputs. PWM outputs can be generated by initializing the compare mode with Timer_D_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_D_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_D_generatePWM() or a combination of Timer_D_initCompare() and timer start APIs

The TimerD API provides a set of functions for dealing with the TimerD 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.

39.2 API Functions

Functions

- void Timer_D_startCounter (uint16_t baseAddress, uint16_t timerMode)
  Starts Timer_D counter.
- void Timer_D_initContinuousMode (uint16_t baseAddress, Timer_D_initContinuousModeParam ∗param)
  Configures timer in continuous mode.
- void Timer_D_initUpMode (uint16_t baseAddress, Timer_D_initUpModeParam ∗param)
  Configures timer in up mode.
- void Timer_D_initUpDownMode (uint16_t baseAddress, Timer_D_initUpDownModeParam ∗param)
  Configures timer in up down mode.
- void Timer_D_initCaptureMode (uint16_t baseAddress, Timer_D_initCaptureModeParam ∗param)
  Initializes Capture Mode.
- void Timer_D_initCompareMode (uint16_t baseAddress, Timer_D_initCompareModeParam ∗param)
  Initializes Compare Mode.
- void Timer_D_enableTimerInterrupt (uint16_t baseAddress)
  Enable timer interrupt.
- void Timer_D_enableHighResInterrupt (uint16_t baseAddress, uint16_t mask)
  Enable High Resolution interrupt.
- void Timer_D_disableTimerInterrupt (uint16_t baseAddress)
  Disable timer interrupt.
- void Timer_D_disableHighResInterrupt (uint16_t baseAddress, uint16_t mask)
  Disable High Resolution interrupt.
- uint32_t Timer_D_getTimerInterruptStatus (uint16_t baseAddress)
  Get timer interrupt status.
- void Timer_D_enableCaptureCompareInterrupt (uint16_t baseAddress, uint16_t captureCompareRegister)
  Enable capture compare interrupt.
- void Timer_D_disableCaptureCompareInterrupt (uint16_t baseAddress, uint16_t captureCompareRegister)

Disable capture compare interrupt.

- uint32_t Timer_D_getCaptureCompareInterruptStatus (uint16_t baseAddress, uint16_t captureCompareRegister, uint16_t mask)
  Return capture compare interrupt status.
- uint16_t Timer_D_getHighResInterruptStatus (uint16_t baseAddress, uint16_t mask)
  Returns High Resolution interrupt status.
- void Timer_D_clear (uint16_t baseAddress)
  Reset/Clear the timer clock divider, count direction, count.
- void Timer_D_clearHighResInterrupt (uint16_t baseAddress, uint16_t mask)
  Clears High Resolution interrupt status.
- uint8_t Timer_D_getSynchronizedCaptureCompareInput (uint16_t baseAddress, uint16_t captureCompareRegister, uint16_t synchronized)
  Get synchronized capturecompare input.
- uint8_t Timer_D_getOutputForOutputModeOutBitValue (uint16_t baseAddress, uint16_t captureCompareRegister)
  Get output bit for output mode.
- uint16_t Timer_D_getCaptureCompareCount (uint16_t baseAddress, uint16_t captureCompareRegister)
  Get current capturecompare count.
- uint16_t Timer_D_getCaptureCompareLatchCount (uint16_t baseAddress, uint16_t captureCompareRegister)
  Get current capture compare latch register count.
- uint8_t Timer_D_getCaptureCompareInputSignal (uint16_t baseAddress, uint16_t captureCompareRegister)
  Get current capturecompare input signal.
- void Timer_D_setOutputForOutputModeOutBitValue (uint16_t baseAddress, uint16_t captureCompareRegister, uint8_t outputModeOutBitValue)
  Set output bit for output mode.
- void Timer_D_outputPWM (uint16_t baseAddress, Timer_D_outputPWMParam ∗param)
  Generate a PWM with timer running in up mode.
- void Timer_D_stop (uint16_t baseAddress)
  Stops the timer.
- void Timer_D_setCompareValue (uint16_t baseAddress, uint16_t compareRegister, uint16_t compareValue)
  Sets the value of the capture-compare register.
- void Timer_D_clearTimerInterrupt (uint16_t baseAddress)
  Clears the Timer TDIFG interrupt flag.
- void Timer_D_clearCaptureCompareInterrupt (uint16_t baseAddress, uint16_t captureCompareRegister)
  Clears the capture-compare interrupt flag.
- uint8_t Timer_D_initHighResGeneratorInFreeRunningMode (uint16_t baseAddress, uint8_t desiredHighResFrequency)
  Configures Timer_D in free running mode.
- void Timer_D_initHighResGeneratorInRegulatedMode (uint16_t baseAddress, Timer_D_initHighResGeneratorInRegulatedModeParam ∗param)
  Configures Timer_D in Regulated mode.
- void Timer_D_combineTDCCRToOutputPWM (uint16_t baseAddress, Timer_D_combineTDCCRToOutputPWMParam ∗param)
  Combine TDCCR to get PWM.
- void Timer_D_selectLatchingGroup (uint16_t baseAddress, uint16_t groupLatch)
  Selects Timer_D Latching Group.
- void Timer_D_selectCounterLength (uint16_t baseAddress, uint16_t counterLength)
  Selects Timer_D counter length.

- void Timer_D_initCompareLatchLoadEvent (uint16_t baseAddress, uint16_t compareRegister, uint16_t compareLatchLoadEvent)
  Selects Compare Latch Load Event.
- void Timer_D_disableHighResFastWakeup (uint16_t baseAddress)
  Disable High Resolution fast wakeup.
- void Timer_D_enableHighResFastWakeup (uint16_t baseAddress)
  Enable High Resolution fast wakeup.
- void Timer_D_disableHighResClockEnhancedAccuracy (uint16_t baseAddress)
  Disable High Resolution Clock Enhanced Accuracy.
- void Timer_D_enableHighResClockEnhancedAccuracy (uint16_t baseAddress)
  Enable High Resolution Clock Enhanced Accuracy.
- void Timer_D_disableHighResGeneratorForceON (uint16_t baseAddress)
  Disable High Resolution Clock Enhanced Accuracy.
- void Timer_D_enableHighResGeneratorForceON (uint16_t baseAddress)
  Enable High Resolution Clock Enhanced Accuracy.
- void Timer_D_selectHighResCoarseClockRange (uint16_t baseAddress, uint16_t highResCoarseClockRange)
  Select High Resolution Coarse Clock Range.
- void Timer_D_selectHighResClockRange (uint16_t baseAddress, uint16_t highResClockRange)
  Select High Resolution Clock Range Selection.
- uint16_t Timer_D_getCounterValue (uint16_t baseAddress)
  Reads the current timer count value.
- void Timer_D_setOutputMode (uint16_t baseAddress, uint16_t compareRegister, uint16_t compareOutputMode)
  Sets the output mode.

39.2.1 Detailed Description

The Timer_D 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.

TimerD configuration and initialization is handled by

- Timer_D_startCounter(),
- Timer_D_initContinuousMode(),
- Timer_D_initUpMode(),
- Timer_D_initUpDownMode(),
- Timer_D_initCaptureMode(),
- Timer_D_initCompareMode(),
- Timer_D_clear(),
- Timer_D_stop(),
- Timer_D_configureHighResGeneratorInFreeRunningMode(),
- Timer_D_configureHighResGeneratorInRegulatedMode(),
- Timer_D_combineTDCCRToGeneratePWM(),
- Timer_D_selectLatchingGroup(),
- Timer_D_selectCounterLength(),
- Timer_D_initCompareLatchLoadEvent(),

- Timer_D_disableHighResFastWakeup(),
- Timer_D_enableHighResFastWakeup(),
- Timer_D_disableHighResClockEnhancedAccuracy(),
- Timer_D_enableHighResClockEnhancedAccuracy(),
- Timer_D_DisableHighResGeneratorForceON(),
- Timer_D_EnableHighResGeneratorForceON(),
- Timer_D_selectHighResCoarseClockRange(),
- Timer_D_selectHighResClockRange()

TimerD outputs are handled by

- Timer_D_getSynchronizedCaptureCompareInput(),
- Timer_D_getOutputForOutputModeOutBitValue(),
- Timer_D_setOutputForOutputModeOutBitValue(),
- Timer_D_outputPWM(),
- Timer_D_getCaptureCompareCount(),
- Timer_D_setCompareValue(),
- Timer_D_getCaptureCompareLatchCount(),
- Timer_D_getCaptureCompareInputSignal(),
- Timer_D_getCounterValue()

The interrupt handler for the TimerD interrupt is managed with

- Timer_D_enableTimerInterrupt(),
- Timer_D_disableTimerInterrupt(),
- Timer_D_getTimerInterruptStatus(),
- Timer_D_enableCaptureCompareInterrupt(),
- Timer_D_disableCaptureCompareInterrupt(),
- Timer_D_getCaptureCompareInterruptStatus(),
- Timer_D_clearCaptureCompareInterrupt()
- Timer_D_clearTimerInterrupt(),
- Timer_D_enableHighResInterrupt(),
- Timer_D_disableTimerInterrupt(),
- Timer_D_getHighResInterruptStatus(),
- Timer_D_clearHighResInterrupt()

Timer_D High Resolution handling APIs

- Timer_D_getHighResInterruptStatus(),
- Timer_D_clearHighResInterrupt(),
- Timer_D_disableHighResFastWakeup(),
- Timer_D_enableHighResFastWakeup(),
- Timer_D_disableHighResClockEnhancedAccuracy(),
- Timer_D_enableHighResClockEnhancedAccuracy(),

- Timer_D_DisableHighResGeneratorForceON(),
- Timer_D_EnableHighResGeneratorForceON(),
- Timer_D_selectHighResCoarseClockRange(),
- Timer_D_selectHighResClockRange(),
- Timer_D_configureHighResGeneratorInFreeRunningMode(),
- Timer_D_configureHighResGeneratorInRegulatedMode()

39.2.2 Function Documentation

Timer_D_clear()

```
void Timer_D_clear (
            uint16_t baseAddress )
```

Reset/Clear the timer clock divider, count direction, count.

Parameters

baseAddress	is the base address of the TIMER_D module.

Modified bits of **TDxCTL0** register.

Returns

None

Timer_D_clearCaptureCompareInterrupt()

```
void Timer_D_clearCaptureCompareInterrupt (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Clears the capture-compare interrupt flag.

Parameters

baseAddress	is the base address of the TIMER_D module.
captureCompareRegister	selects the Capture-compare register being used. Valid values are: ■ **TIMER_D_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_6**

Modified bits are **CCIFG** of **TDxCCTLn** register.

Returns

None

References Timer_D_initHighResGeneratorInFreeRunningMode().

Timer_D_clearHighResInterrupt()

```
void Timer_D_clearHighResInterrupt (
            uint16_t baseAddress,
            uint16_t mask )
```

Clears High Resolution interrupt status.

Parameters

baseAddress	is the base address of the TIMER_D module.
mask	is the mask for the interrupts to clear Mask value is the logical OR of any of the following: ■ **TIMER_D_HIGH_RES_FREQUENCY_UNLOCK** ■ **TIMER_D_HIGH_RES_FREQUENCY_LOCK** ■ **TIMER_D_HIGH_RES_FAIL_HIGH** ■ **TIMER_D_HIGH_RES_FAIL_LOW**

Modified bits of **TDxHINT** register.

Returns

None

References Timer_D_getSynchronizedCaptureCompareInput().

Timer_D_clearTimerInterrupt()

```
void Timer_D_clearTimerInterrupt (
            uint16_t baseAddress )
```

Clears the Timer TDIFG interrupt flag.

Parameters

baseAddress	is the base address of the TIMER_D module.

Modified bits are **TDIFG** of **TDxCTL0** register.

Returns

None

Timer_D_combineTDCCRToOutputPWM()

```
void Timer_D_combineTDCCRToOutputPWM (
            uint16_t baseAddress,
            Timer_D_combineTDCCRToOutputPWMParam * param )
```

Combine TDCCR to get PWM.

Parameters

baseAddress	is the base address of the TIMER_D module.
param	is the pointer to struct for PWM generation using two CCRs.

Modified bits of **TDxCCTLn** register, bits of **TDxCCR0** register, bits of **TDxCCTL0** register, bits of **TDxCTL0** register and bits of **TDxCTL1** register.

Returns

None

References Timer_D_combineTDCCRToOutputPWMParam::clockingMode, Timer_D_combineTDCCRToOutputPWMParam::clockSource, Timer_D_combineTDCCRToOutputPWMParam::clockSourceDivider, Timer_D_combineTDCCRToOutputPWMParam::combineCCRRegistersCombination, Timer_D_combineTDCCRToOutputPWMParam::compareOutputMode, Timer_D_combineTDCCRToOutputPWMParam::dutyCycle1, Timer_D_combineTDCCRToOutputPWMParam::dutyCycle2, and Timer_D_combineTDCCRToOutputPWMParam::timerPeriod.

Timer_D_disableCaptureCompareInterrupt()

```
void Timer_D_disableCaptureCompareInterrupt (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Disable capture compare interrupt.

Parameters

baseAddress	is the base address of the TIMER_D module.

Parameters

captureCompareRegister	is the selected capture compare register Valid values are: ■ **TIMER_D_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_6**

Modified bits of **TDxCCTLn** register.

Returns

None

Timer_D_disableHighResClockEnhancedAccuracy()

```
void Timer_D_disableHighResClockEnhancedAccuracy (
            uint16_t baseAddress )
```

Disable High Resolution Clock Enhanced Accuracy.

Parameters

baseAddress	is the base address of the TIMER_D module.

Modified bits are **TDHEAEN** of **TDxHCTL0** register.

Returns

None

Timer_D_disableHighResFastWakeup()

```
void Timer_D_disableHighResFastWakeup (
            uint16_t baseAddress )
```

Disable High Resolution fast wakeup.

Parameters

baseAddress	is the base address of the TIMER_D module.

Modified bits are **TDHFW** of **TDxHCTL0** register.

Returns

None

Timer_D_disableHighResGeneratorForceON()

```
void Timer_D_disableHighResGeneratorForceON (
            uint16_t baseAddress )
```

Disable High Resolution Clock Enhanced Accuracy.

High-resolution generator is on if the Timer_D counter

Parameters

baseAddress	is the base address of the TIMER_D module.

Modified bits are **TDHRON** of **TDxHCTL0** register.

Returns

None

Timer_D_disableHighResInterrupt()

```
void Timer_D_disableHighResInterrupt (
            uint16_t baseAddress,
            uint16_t mask )
```

Disable High Resolution interrupt.

Parameters

baseAddress	is the base address of the TIMER_D module.
mask	is the mask of interrupts to disable Mask value is the logical OR of any of the following: ■ **TIMER_D_HIGH_RES_FREQUENCY_UNLOCK** ■ **TIMER_D_HIGH_RES_FREQUENCY_LOCK** ■ **TIMER_D_HIGH_RES_FAIL_HIGH** ■ **TIMER_D_HIGH_RES_FAIL_LOW**

Modified bits of **TDxHINT** register.

Returns

None

Timer_D_disableTimerInterrupt()

```
void Timer_D_disableTimerInterrupt (
            uint16_t baseAddress )
```

Disable timer interrupt.

Parameters

baseAddress	is the base address of the TIMER_D module.

Modified bits of **TDxCTL0** register.

Returns

None

Timer_D_enableCaptureCompareInterrupt()

```
void Timer_D_enableCaptureCompareInterrupt (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Enable capture compare interrupt.

Parameters

baseAddress	is the base address of the TIMER_D module.
captureCompareRegister	is the selected capture compare register Valid values are: ■ **TIMER_D_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_6**

Modified bits of **TDxCCTLn** register.

Returns

None

Timer_D_enableHighResClockEnhancedAccuracy()

```
void Timer_D_enableHighResClockEnhancedAccuracy (
```

```
            uint16_t baseAddress )
```

Enable High Resolution Clock Enhanced Accuracy.

Parameters

baseAddress	is the base address of the TIMER_D module.

Modified bits are **TDHEAEN** of **TDxHCTL0** register.

Returns

None

Timer_D_enableHighResFastWakeup()

```
void Timer_D_enableHighResFastWakeup (
            uint16_t baseAddress )
```

Enable High Resolution fast wakeup.

Parameters

baseAddress	is the base address of the TIMER_D module.

Modified bits are **TDHFW** of **TDxHCTL0** register.

Returns

None

Timer_D_enableHighResGeneratorForceON()

```
void Timer_D_enableHighResGeneratorForceON (
            uint16_t baseAddress )
```

Enable High Resolution Clock Enhanced Accuracy.

High-resolution generator is on in all Timer_D MCx modes. The PMM remains in high-current mode.

Parameters

baseAddress	is the base address of the TIMER_D module.

Modified bits are **TDHRON** of **TDxHCTL0** register.

Returns

None

Timer_D_enableHighResInterrupt()

```
void Timer_D_enableHighResInterrupt (
            uint16_t baseAddress,
            uint16_t mask )
```

Enable High Resolution interrupt.

Parameters

baseAddress	is the base address of the TIMER_D module.
mask	is the mask of interrupts to enable Mask value is the logical OR of any of the following: ■ **TIMER_D_HIGH_RES_FREQUENCY_UNLOCK** ■ **TIMER_D_HIGH_RES_FREQUENCY_LOCK** ■ **TIMER_D_HIGH_RES_FAIL_HIGH** ■ **TIMER_D_HIGH_RES_FAIL_LOW**

Modified bits of **TDxHINT** register.

Returns

None

Timer_D_enableTimerInterrupt()

```
void Timer_D_enableTimerInterrupt (
            uint16_t baseAddress )
```

Enable timer interrupt.

Parameters

baseAddress	is the base address of the TIMER_D module.

Modified bits of **TDxCTL0** register.

Returns

None

Timer_D_getCaptureCompareCount()

```
uint16_t Timer_D_getCaptureCompareCount (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Get current capturecompare count.

Parameters

baseAddress	is the base address of the TIMER_D module.
captureCompareRegister	selects the Capture register being used. Valid values are: ■ **TIMER_D_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_6**

Returns

current count as uint16_t

References Timer_D_getCaptureCompareLatchCount().

Referenced by Timer_D_getOutputForOutputModeOutBitValue().

Timer_D_getCaptureCompareInputSignal()

```
uint8_t Timer_D_getCaptureCompareInputSignal (
            uint16_t baseAddress,
            uint16_t captureCompareRegister )
```

Get current capturecompare input signal.

Parameters

baseAddress	is the base address of the TIMER_D module.
captureCompareRegister	selects the Capture register being used. Valid values are: ■ **TIMER_D_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_6**

Returns

One of the following:
- **TIMER_D_CAPTURECOMPARE_INPUT**
- **0x00**
  indicating the current input signal

References Timer_D_setOutputForOutputModeOutBitValue().

Referenced by Timer_D_getCaptureCompareLatchCount().

Timer_D_getCaptureCompareInterruptStatus()

```
uint32_t Timer_D_getCaptureCompareInterruptStatus (
            uint16_t baseAddress,
            uint16_t captureCompareRegister,
            uint16_t mask )
```

Return capture compare interrupt status.

Parameters

baseAddress	is the base address of the TIMER_D module.
captureCompareRegister	is the selected capture compare register Valid values are: ■ **TIMER_D_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_6**
mask	is the mask for the interrupt status Mask value is the logical OR of any of the following: ■ **TIMER_D_CAPTURE_OVERFLOW** ■ **TIMER_D_CAPTURECOMPARE_INTERRUPT_FLAG**

Returns

Logical OR of any of the following:
- **TIMER_D_CAPTURE_OVERFLOW**
- **TIMER_D_CAPTURECOMPARE_INTERRUPT_FLAG**
  indicating the status of the masked flags

Timer_D_getCaptureCompareLatchCount()

```
uint16_t Timer_D_getCaptureCompareLatchCount (
```

```
uint16_t baseAddress,
uint16_t captureCompareRegister )
```

Get current capture compare latch register count.

Parameters

baseAddress	is the base address of the TIMER_D module.
captureCompareRegister	selects the Capture register being used. Valid values are: ■ **TIMER_D_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_6**

Returns

current count as uint16_t

References Timer_D_getCaptureCompareInputSignal().

Referenced by Timer_D_getCaptureCompareCount().

Timer_D_getCounterValue()

```
uint16_t Timer_D_getCounterValue (
            uint16_t baseAddress )
```

Reads the current timer count value.

Reads the current count value of the timer. There is a majority vote system in place to confirm an accurate value is returned. The Timer_D_THRESHOLD #define in the corresponding header file can be modified so that the votes must be closer together for a consensus to occur.

Parameters

baseAddress	is the base address of the TIMER_D module.

Returns

Majority vote of timer count value

Timer_D_getHighResInterruptStatus()

```
uint16_t Timer_D_getHighResInterruptStatus (
```

```
uint16_t baseAddress,
uint16_t mask )
```

Returns High Resolution interrupt status.

Parameters

baseAddress	is the base address of the TIMER_D module.
mask	is the mask for the interrupt status Mask value is the logical OR of any of the following: ■ **TIMER_D_HIGH_RES_FREQUENCY_UNLOCK** ■ **TIMER_D_HIGH_RES_FREQUENCY_LOCK** ■ **TIMER_D_HIGH_RES_FAIL_HIGH** ■ **TIMER_D_HIGH_RES_FAIL_LOW**

Modified bits of **TDxHINT** register.

Returns

Logical OR of any of the following:
- **TIMER_D_HIGH_RES_FREQUENCY_UNLOCK**
- **TIMER_D_HIGH_RES_FREQUENCY_LOCK**
- **TIMER_D_HIGH_RES_FAIL_HIGH**
- **TIMER_D_HIGH_RES_FAIL_LOW**
  indicating the status of the masked interrupts

Timer_D_getOutputForOutputModeOutBitValue()

```
uint8_t Timer_D_getOutputForOutputModeOutBitValue (
        uint16_t baseAddress,
        uint16_t captureCompareRegister )
```

Get output bit for output mode.

Parameters

baseAddress	is the base address of the TIMER_D module.
captureCompareRegister	selects the Capture register being used. Valid values are: ■ **TIMER_D_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_6**

Returns

One of the following:
- **TIMER_D_OUTPUTMODE_OUTBITVALUE_HIGH**
- **TIMER_D_OUTPUTMODE_OUTBITVALUE_LOW**

References Timer_D_getCaptureCompareCount().

Referenced by Timer_D_getSynchronizedCaptureCompareInput().

Timer_D_getSynchronizedCaptureCompareInput()

```
uint8_t Timer_D_getSynchronizedCaptureCompareInput (
            uint16_t baseAddress,
            uint16_t captureCompareRegister,
            uint16_t synchronized )
```

Get synchronized capturecompare input.

Parameters

baseAddress	is the base address of the TIMER_D module.
captureCompareRegister	selects the Capture register being used. Valid values are: ■ **TIMER_D_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_6**
synchronized	is to select type of capture compare input. Valid values are: ■ **TIMER_D_READ_SYNCHRONIZED_CAPTURECOMPAR↩ EINPUT** ■ **TIMER_D_READ_CAPTURE_COMPARE_INPUT**

Returns

One of the following:
- **TIMER_D_CAPTURECOMPARE_INPUT_HIGH**
- **TIMER_D_CAPTURECOMPARE_INPUT_LOW**

References Timer_D_getOutputForOutputModeOutBitValue().

Referenced by Timer_D_clearHighResInterrupt().

Timer_D_getTimerInterruptStatus()

```
uint32_t Timer_D_getTimerInterruptStatus (
```

```
uint16_t baseAddress )
```

Get timer interrupt status.

Parameters

baseAddress	is the base address of the TIMER_D module.

Returns

One of the following:
- **TIMER_D_INTERRUPT_NOT_PENDING**
- **TIMER_D_INTERRUPT_PENDING**
  indicating the timer interrupt status

Timer_D_initCaptureMode()

```
void Timer_D_initCaptureMode (
        uint16_t baseAddress,
        Timer_D_initCaptureModeParam * param )
```

Initializes Capture Mode.

Parameters

baseAddress	is the base address of the TIMER_D module.
param	is the pointer to struct for capture mode initialization.

Modified bits of **TDxCCTLn** register and bits of **TDxCTL2** register.

Returns

None

References Timer_D_initCaptureModeParam::captureInputSelect, Timer_D_initCaptureModeParam::captureInterruptEnable, Timer_D_initCaptureModeParam::captureMode, Timer_D_initCaptureModeParam::captureOutputMode, Timer_D_initCaptureModeParam::captureRegister, Timer_D_initCaptureModeParam::channelCaptureMode, and Timer_D_initCaptureModeParam::synchronizeCaptureSource.

Timer_D_initCompareLatchLoadEvent()

```
void Timer_D_initCompareLatchLoadEvent (
        uint16_t baseAddress,
        uint16_t compareRegister,
        uint16_t compareLatchLoadEvent )
```

Selects Compare Latch Load Event.

Parameters

baseAddress	is the base address of the TIMER_D module.
compareRegister	selects the compare register being used. Valid values are: ■ **TIMER_D_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_6**
compareLatchLoadEvent	selects the latch load event Valid values are: ■ **TIMER_D_LATCH_ON_WRITE_TO_TDxCCRn_COMPAR↩ E_REGISTER** [Default] ■ **TIMER_D_LATCH_WHEN_COUNTER_COUNTS_TO_0_I↩ N_UP_OR_CONT_MODE** ■ **TIMER_D_LATCH_WHEN_COUNTER_COUNTS_TO_0_I↩ N_UPDOWN_MODE** ■ **TIMER_D_LATCH_WHEN_COUNTER_COUNTS_TO_CU↩ RRENT_COMPARE_LATCH_VALUE**

Modified bits are **CLLD** of **TDxCCTLn** register.

Returns

None

Timer_D_initCompareMode()

```
void Timer_D_initCompareMode (
            uint16_t baseAddress,
            Timer_D_initCompareModeParam * param )
```

Initializes Compare Mode.

Parameters

baseAddress	is the base address of the TIMER_D module.
param	is the pointer to struct for compare mode initialization.

Modified bits of **TDxCCTLn** register and bits of **TDxCCRn** register.

Returns

None

References Timer_D_initCompareModeParam::compareInterruptEnable, Timer_D_initCompareModeParam::compareOutputMode, Timer_D_initCompareModeParam::compareRegister, and Timer_D_initCompareModeParam::compareValue.

Timer_D_initContinuousMode()

```
void Timer_D_initContinuousMode (
            uint16_t baseAddress,
            Timer_D_initContinuousModeParam * param )
```

Configures timer in continuous mode.

This API does not start the timer. Timer needs to be started when required using the Timer_D_start API.

Parameters

baseAddress	is the base address of the TIMER_D module.
param	is the pointer to struct for continuous mode initialization.

Modified bits of **TDxCTL0** register and bits of **TDxCTL1** register.

Returns

None

References Timer_D_initContinuousModeParam::clockingMode, Timer_D_initContinuousModeParam::clockSource, Timer_D_initContinuousModeParam::clockSourceDivider, Timer_D_initContinuousModeParam::timerClear, and Timer_D_initContinuousModeParam::timerInterruptEnable_TDIE.

Timer_D_initHighResGeneratorInFreeRunningMode()

```
uint8_t Timer_D_initHighResGeneratorInFreeRunningMode (
            uint16_t baseAddress,
            uint8_t desiredHighResFrequency )
```

Configures Timer_D in free running mode.

Parameters

baseAddress	is the base address of the TIMER_D module.

Parameters

desiredHighResFrequency	selects the desired High Resolution frequency used. Valid values are: ■ **TIMER_D_HIGHRES_64MHZ** ■ **TIMER_D_HIGHRES_128MHZ** ■ **TIMER_D_HIGHRES_200MHZ** ■ **TIMER_D_HIGHRES_256MHZ**

Modified bits of **TDxHCTL1** register, bits of **TDxHCTL0** register and bits of **TDxCTL1** register.

Returns

STATUS_SUCCESS or STATUS_FAIL

References TLV_getInfo().

Referenced by Timer_D_clearCaptureCompareInterrupt().

Timer_D_initHighResGeneratorInRegulatedMode()

```
void Timer_D_initHighResGeneratorInRegulatedMode (
        uint16_t baseAddress,
        Timer_D_initHighResGeneratorInRegulatedModeParam * param )
```

Configures Timer_D in Regulated mode.

Parameters

baseAddress	is the base address of the TIMER_D module.
param	is the pointer to struct for high resolution generator in regulated mode.

Modified bits of **TDxHCTL0** register, bits of **TDxCTL0** register and bits of **TDxCTL1** register.

Returns

None

References Timer_D_initHighResGeneratorInRegulatedModeParam::clockingMode, Timer_D_initHighResGeneratorInRegulatedModeParam::clockSource, Timer_D_initHighResGeneratorInRegulatedModeParam::clockSourceDivider, Timer_D_initHighResGeneratorInRegulatedModeParam::highResClockDivider, and Timer_D_initHighResGeneratorInRegulatedModeParam::highResClockMultiplyFactor.

Timer_D_initUpDownMode()

```
void Timer_D_initUpDownMode (
        uint16_t baseAddress,
        Timer_D_initUpDownModeParam * param )
```

Configures timer in up down mode.

This API does not start the timer. Timer needs to be started when required using the Timer_D_start API.

Parameters

baseAddress	is the base address of the TIMER_D module.
param	is the pointer to struct for up-down mode initialization.

Modified bits of **TDxCCR0** register, bits of **TDxCCTL0** register, bits of **TDxCTL0** register and bits of **TDxCTL1** register.

Returns

None

References Timer_D_initUpDownModeParam::captureCompareInterruptEnable_CCR0_CCIE, Timer_D_initUpDownModeParam::clockingMode, Timer_D_initUpDownModeParam::clockSource, Timer_D_initUpDownModeParam::clockSourceDivider, Timer_D_initUpDownModeParam::timerClear, Timer_D_initUpDownModeParam::timerInterruptEnable_TDIE, and Timer_D_initUpDownModeParam::timerPeriod.

Timer_D_initUpMode()

```
void Timer_D_initUpMode (
            uint16_t baseAddress,
            Timer_D_initUpModeParam * param )
```

Configures timer in up mode.

This API does not start the timer. Timer needs to be started when required using the Timer_D_start API.

Parameters

baseAddress	is the base address of the TIMER_D module.
param	is the pointer to struct for up mode initialization.

Modified bits of **TDxCCR0** register, bits of **TDxCCTL0** register, bits of **TDxCTL0** register and bits of **TDxCTL1** register.

Returns

None

References Timer_D_initUpModeParam::captureCompareInterruptEnable_CCR0_CCIE, Timer_D_initUpModeParam::clockingMode, Timer_D_initUpModeParam::clockSource, Timer_D_initUpModeParam::clockSourceDivider, Timer_D_initUpModeParam::timerClear, Timer_D_initUpModeParam::timerInterruptEnable_TDIE, and Timer_D_initUpModeParam::timerPeriod.

Timer_D_outputPWM()

```
void Timer_D_outputPWM (
            uint16_t baseAddress,
            Timer_D_outputPWMParam * param )
```

Generate a PWM with timer running in up mode.

Parameters

baseAddress	is the base address of the TIMER_D module.
param	is the pointer to struct for PWM configuration.

Modified bits of **TDxCCTLn** register, bits of **TDxCCR0** register, bits of **TDxCCTL0** register, bits of **TDxCTL0** register and bits of **TDxCTL1** register.

Returns

None

References Timer_D_outputPWMParam::clockingMode, Timer_D_outputPWMParam::clockSource, Timer_D_outputPWMParam::clockSourceDivider, Timer_D_outputPWMParam::compareOutputMode, Timer_D_outputPWMParam::compareRegister, Timer_D_outputPWMParam::dutyCycle, and Timer_D_outputPWMParam::timerPeriod.

Timer_D_selectCounterLength()

```
void Timer_D_selectCounterLength (
            uint16_t baseAddress,
            uint16_t counterLength )
```

Selects Timer_D counter length.

Parameters

baseAddress	is the base address of the TIMER_D module.
counterLength	selects the value of counter length. Valid values are: ■ **TIMER_D_COUNTER_16BIT** [Default] ■ **TIMER_D_COUNTER_12BIT** ■ **TIMER_D_COUNTER_10BIT** ■ **TIMER_D_COUNTER_8BIT**

Modified bits are **CNTL** of **TDxCTL0** register.

Returns

None

Timer_D_selectHighResClockRange()

```
void Timer_D_selectHighResClockRange (
            uint16_t baseAddress,
            uint16_t highResClockRange )
```

Select High Resolution Clock Range Selection.

Parameters

baseAddress	is the base address of the TIMER_D module.
highResClockRange	selects the High Resolution Clock Range. Refer to datasheet for frequency details Valid values are: ■ **TIMER_D_CLOCK_RANGE0** [Default] ■ **TIMER_D_CLOCK_RANGE1** ■ **TIMER_D_CLOCK_RANGE2**

Returns

None

Timer_D_selectHighResCoarseClockRange()

```
void Timer_D_selectHighResCoarseClockRange (
            uint16_t baseAddress,
            uint16_t highResCoarseClockRange )
```

Select High Resolution Coarse Clock Range.

Parameters

baseAddress	is the base address of the TIMER_D module.
highResCoarseClockRange	selects the High Resolution Coarse Clock Range Valid values are: ■ **TIMER_D_HIGHRES_BELOW_15MHz** [Default] ■ **TIMER_D_HIGHRES_ABOVE_15MHz**

Modified bits are **TDHCLKCR** of **TDxHCTL1** register.

Returns

None

Timer_D_selectLatchingGroup()

```
void Timer_D_selectLatchingGroup (
            uint16_t baseAddress,
```

```
uint16_t groupLatch )
```

Selects Timer_D Latching Group.

Parameters

baseAddress	is the base address of the TIMER_D module.
groupLatch	selects the group latch Valid values are: ■ **TIMER_D_GROUP_NONE** [Default] ■ **TIMER_D_GROUP_CL12_CL23_CL56** ■ **TIMER_D_GROUP_CL123_CL456** ■ **TIMER_D_GROUP_ALL**

Modified bits are **TDCLGRP** of **TDxCTL0** register.

Returns

None

Timer_D_setCompareValue()

```
void Timer_D_setCompareValue (
            uint16_t baseAddress,
            uint16_t compareRegister,
            uint16_t compareValue )
```

Sets the value of the capture-compare register.

Parameters

baseAddress	is the base address of the TIMER_D module.
compareRegister	selects the Capture register being used. Valid values are: ■ **TIMER_D_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_6**
compareValue	is the count to be compared with in compare mode

Modified bits of **TDxCCRn** register.

Returns

None

Timer_D_setOutputForOutputModeOutBitValue()

```
void Timer_D_setOutputForOutputModeOutBitValue (
            uint16_t baseAddress,
            uint16_t captureCompareRegister,
            uint8_t outputModeOutBitValue )
```

Set output bit for output mode.

Parameters

baseAddress	is the base address of the TIMER_D module.
captureCompareRegister	selects the Capture register being used. Valid values are: ■ **TIMER_D_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_6**
outputModeOutBitValue	the value to be set for out bit Valid values are: ■ **TIMER_D_OUTPUTMODE_OUTBITVALUE_HIGH** ■ **TIMER_D_OUTPUTMODE_OUTBITVALUE_LOW**

Modified bits of **TDxCCTLn** register.

Returns

None

Referenced by Timer_D_getCaptureCompareInputSignal().

Timer_D_setOutputMode()

```
void Timer_D_setOutputMode (
            uint16_t baseAddress,
            uint16_t compareRegister,
            uint16_t compareOutputMode )
```

Sets the output mode.

Sets the output mode for the timer even the timer is already running.

Parameters

baseAddress	is the base address of the TIMER_D module.
compareRegister	selects the compare register being used. Valid values are: ■ **TIMER_D_CAPTURECOMPARE_REGISTER_0** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_1** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_2** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_3** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_4** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_5** ■ **TIMER_D_CAPTURECOMPARE_REGISTER_6**
compareOutputMode	specifies the output mode. Valid values are: ■ **TIMER_D_OUTPUTMODE_OUTBITVALUE** [Default] ■ **TIMER_D_OUTPUTMODE_SET** ■ **TIMER_D_OUTPUTMODE_TOGGLE_RESET** ■ **TIMER_D_OUTPUTMODE_SET_RESET** ■ **TIMER_D_OUTPUTMODE_TOGGLE** ■ **TIMER_D_OUTPUTMODE_RESET** ■ **TIMER_D_OUTPUTMODE_TOGGLE_SET** ■ **TIMER_D_OUTPUTMODE_RESET_SET**

Modified bits are **OUTMOD** of **TDxCCTLn** register.

Returns

None

Timer_D_startCounter()

```
void Timer_D_startCounter (
            uint16_t baseAddress,
            uint16_t timerMode )
```

Starts Timer_D counter.

NOTE: This function assumes that the timer has been previously configured using Timer_D_initContinuousMode, Timer_D_initUpMode or Timer_D_initUpDownMode.

Parameters

baseAddress	is the base address of the TIMER_DA module.

Parameters

timerMode	selects the mode of the timer Valid values are: ■ **TIMER_D_STOP_MODE** ■ **TIMER_D_UP_MODE** ■ **TIMER_D_CONTINUOUS_MODE** [Default] ■ **TIMER_D_UPDOWN_MODE**

Modified bits of **TDxCTL0** register.

Returns

None

Timer_D_stop()

```
void Timer_D_stop (
            uint16_t baseAddress )
```

Stops the timer.

Parameters

baseAddress	is the base address of the TIMER_D module.

Modified bits of **TDxCTL0** register.

Returns

None

39.3 Programming Example

The following example shows some TimerD operations using the APIs

```
{   //Start TimerD
    //Start timer in continuous mode sourced by SMCLK
    Timer_D_initContinuousModeParam initContparam = {0};
    initContparam.clockSource = TIMER_D_CLOCKSOURCE_SMCLK;
    initContparam.clockSourceDivider = TIMER_D_CLOCKSOURCE_DIVIDER_1;
    initContparam.clockingMode = TIMER_D_CLOCKINGMODE_EXTERNAL_CLOCK;
    initContparam.timerInterruptEnable_TDIE = TIMER_D_TDIE_INTERRUPT_DISABLE;
    initContparam.timerClear = TIMER_D_DO_CLEAR;
    Timer_D_initContinuousMode(TIMER_D0_BASE, &initContparam);

    Timer_D_startCounter(TIMER_D0_BASE,
      TIMER_D_CONTINUOUS_MODE
          );

    //Initiaze compare mode
    Timer_D_clearCaptureCompareInterrupt(TIMER_D0_BASE,
          TIMER_D_CAPTURECOMPARE_REGISTER_0);
```

```
    Timer_D_initCompareModeParam initCompParam = {0};
    initCompParam.compareRegister = TIMER_D_CAPTURECOMPARE_REGISTER_0;
    initCompParam.compareInterruptEnable = TIMER_D_CAPTURECOMPARE_INTERRUPT_ENABLE;
    initCompParam.compareOutputMode = TIMER_D_OUTPUTMODE_OUTBITVALUE;
    initCompParam.compareValue = 50000;
    Timer_D_initCompareMode(TIMER_D0_BASE, &initCompParam);

    //Enter LPM0
    __bis_SR_register(LPM0_bits);

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

40 Tag Length Value

40.1 Introduction

The TLV structure is a table stored in flash memory that contains device-specific information. This table is read-only and is write-protected. 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 Device Descriptors section), and an explanation on its functionality is available in the MSP430x5xx/MSP430x6xx Family User's Guide

40.2 API Functions

Functions

- void TLV_getInfo (uint8_t tag, uint8_t instance, uint8_t ∗length, uint16_t ∗∗data_address)
  Gets TLV Info.
- uint16_t TLV_getDeviceType ()
  Retrieves the unique device ID from the TLV structure.
- uint16_t TLV_getMemory (uint8_t instance)
  Gets memory information.
- uint16_t TLV_getPeripheral (uint8_t tag, uint8_t instance)
  Gets peripheral information from the TLV.
- uint8_t TLV_getInterrupt (uint8_t tag)
  Get interrupt information from the TLV.

40.2.1 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_getDeviceType() This function retrieves the unique device ID from the TLV structure.
- TLV_getMemory() The returned value is zero if the end of the memory list is reached.
- TLV_getPeripheral() The returned value is zero if the specified tag value (peripheral) is not available in the device.
- TLV_getInterrupt() The returned value is zero is the specified interrupt vector is not defined.

40.2.2 Function Documentation

TLV_getDeviceType()

```
uint16_t TLV_getDeviceType (
            void )
```

Retrieves the unique device ID from the TLV structure.

Returns

The device ID is returned as type uint16_t.

TLV_getInfo()

```
void TLV_getInfo (
            uint8_t tag,
            uint8_t instance,
            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. Some examples of TLV tags are Peripheral Descriptor, Interrupts, Info Block and Die Record. This function retrieves the value of a tag and the length of the tag.

Parameters

tag	represents the tag for which the information needs to be retrieved. Valid values are: ■ **TLV_TAG_LDTAG** ■ **TLV_TAG_PDTAG** ■ **TLV_TAG_Reserved3** ■ **TLV_TAG_Reserved4** ■ **TLV_TAG_BLANK** ■ **TLV_TAG_Reserved6** ■ **TLV_TAG_Reserved7** ■ **TLV_TAG_TAGEND** ■ **TLV_TAG_TAGEXT** ■ **TLV_TAG_TIMER_D_CAL** ■ **TLV_DEVICE_ID_0** ■ **TLV_DEVICE_ID_1** ■ **TLV_TAG_DIERECORD** ■ **TLV_TAG_ADCCAL** ■ **TLV_TAG_ADC12CAL** ■ **TLV_TAG_ADC10CAL** ■ **TLV_TAG_REFCAL** ■ **TLV_TAG_CTSD16CAL**
instance	In some cases a specific tag may have more than one instance. For example there may be multiple instances of timer calibration data present under a single Timer Cal tag. This variable specifies the instance for which information is to be retrieved (0, 1, etc.). When only one instance exists; 0 is passed.
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. If the specified tag is not found then the pointer is null 0.
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. If the specified tag is not found then the pointer is null 0.

Returns

None

Referenced by Timer_D_initHighResGeneratorInFreeRunningMode(), TLV_getInterrupt(), TLV_getMemory(), and TLV_getPeripheral().

TLV_getInterrupt()

```
uint8_t TLV_getInterrupt (
```

```
uint8_t tag )
```

Get interrupt information from the TLV.

This function is used to retrieve information on available interrupt vectors. It allows the user to check if a specific interrupt vector is defined in a given device.

Parameters

tag	represents the tag for the interrupt vector. Interrupt vector tags number from 0 to N depending on the number of available interrupts. Refer to the device datasheet for a list of available interrupts.

Returns

The returned value is zero is the specified interrupt vector is not defined.

References TLV_getInfo(), and TLV_getMemory().

TLV_getMemory()

```
uint16_t TLV_getMemory (
            uint8_t instance )
```

Gets memory information.

The Peripheral Descriptor tag is split into two portions a list of the available flash memory blocks followed by a list of available peripherals. This function is used to parse through the first portion and calculate the total flash memory available in a device. The typical usage is to call the TLV_getMemory which returns a non-zero value until the entire memory list has been parsed. When a zero is returned, it indicates that all the memory blocks have been counted and the next address holds the beginning of the device peripheral list.

Parameters

instance	In some cases a specific tag may have more than one instance. This variable specifies the instance for which information is to be retrieved (0, 1 etc). When only one instance exists; 0 is passed.

Returns

The returned value is zero if the end of the memory list is reached.

References TLV_getInfo().

Referenced by TLV_getInterrupt(), and TLV_getPeripheral().

TLV_getPeripheral()

```
uint16_t TLV_getPeripheral (
            uint8_t tag,
            uint8_t instance )
```

Gets peripheral information from the TLV.

he Peripheral Descriptor tag is split into two portions a list of the available flash memory blocks followed by a list of available peripherals. This function is used to parse through the second portion and can be used to check if a specific peripheral is present in a device. The function calls TLV_getPeripheral() recursively until the end of the memory list and consequently the beginning of the peripheral list is reached. $<$

Parameters

Parameters

tag	represents represents the tag for a specific peripheral for which the information needs to be retrieved. In the header file tlv. h specific peripheral tags are pre-defined, for example USCIA_B and TA0 are defined as TLV_PID_USCI_AB and TLV_PID_TA2 respectively. Valid values are: ■ **TLV_PID_NO_MODULE** - No Module ■ **TLV_PID_PORTMAPPING** - Port Mapping ■ **TLV_PID_MSP430CPUXV2** - MSP430CPUXV2 ■ **TLV_PID_JTAG** - JTAG ■ **TLV_PID_SBW** - SBW ■ **TLV_PID_EEM_XS** - EEM X-Small ■ **TLV_PID_EEM_S** - EEM Small ■ **TLV_PID_EEM_M** - EEM Medium ■ **TLV_PID_EEM_L** - EEM Large ■ **TLV_PID_PMM** - PMM ■ **TLV_PID_PMM_FR** - PMM FRAM ■ **TLV_PID_FCTL** - Flash ■ **TLV_PID_CRC16** - CRC16 ■ **TLV_PID_CRC16_RB** - CRC16 Reverse ■ **TLV_PID_WDT_A** - WDT_A ■ **TLV_PID_SFR** - SFR ■ **TLV_PID_SYS** - SYS ■ **TLV_PID_RAMCTL** - RAMCTL ■ **TLV_PID_DMA_1** - DMA 1 ■ **TLV_PID_DMA_3** - DMA 3 ■ **TLV_PID_UCS** - UCS ■ **TLV_PID_DMA_6** - DMA 6 ■ **TLV_PID_DMA_2** - DMA 2 ■ **TLV_PID_PORT1_2** - Port 1 + 2 / A ■ **TLV_PID_PORT3_4** - Port 3 + 4 / B ■ **TLV_PID_PORT5_6** - Port 5 + 6 / C ■ **TLV_PID_PORT7_8** - Port 7 + 8 / D ■ **TLV_PID_PORT9_10** - Port 9 + 10 / E ■ **TLV_PID_PORT11_12** - Port 11 + 12 / F ■ **TLV_PID_PORTU** - Port U ■ **TLV_PID_PORTJ** - Port J ■ **TLV_PID_TA2** - Timer A2 ■ **TLV_PID_TA3** - Timer A1 ■ **TLV_PID_TA5** - Timer A5 ■ **TLV_PID_TA7** - Timer A7 ■ **TLV_PID_TB3** - Timer B3 ■ **TLV_PID_TB5** - Timer B5 ■ **TLV_PID_TB7** - Timer B7 ■ **TLV_PID_RTC** - RTC

Parameters

instance	In some cases a specific tag may have more than one instance. For example a device may have more than a single USCI module, each of which is defined by an instance number 0, 1, 2, etc. When only one instance exists; 0 is passed.

Returns

The returned value is zero if the specified tag value (peripheral) is not available in the device.

References TLV_getInfo(), and TLV_getMemory().

40.3 Programming Example

The following example shows some tlv operations using the APIs

```
struct s_TLV_Die_Record * pDIEREC;
unsigned char bDieRecord_bytes;

TLV_getInfo(TLV_TAG_DIERECORD,
            0,
            &bDieRecord_bytes,
            (unsigned int **)&pDIEREC
            );
```

41 Unified Clock System (UCS)

41.1 Introduction

The UCS is based on five available clock sources (VLO, REFO, XT1, XT2, and DCO) providing signals to three system clocks (MCLK, SMCLK, ACLK). Different low power modes are achieved by turning off the MCLK, SMCLK, ACLK, and integrated LDO.

- VLO - Internal very-low-power low-frequency oscillator. 10 kHz (0.5%/C, 4%/V)
- REFO - Reference oscillator. 32 kHz (1%, 3% over full temp range)
- XT1 (LFXT1, HFXT1) - Ultra-low-power oscillator, compatible with low-frequency 32768-Hz watch crystals and with standard XT1 (LFXT1, HFXT1) crystals, resonators, or external clock sources in the 4-MHz to 32-MHz range, including digital inputs. Most commonly used as 32-kHz watch crystal oscillator.
- XT2 - Optional high-frequency oscillator that can be used with standard crystals, resonators, or external clock sources in the 4-MHz to 32-MHz range, including digital inputs.
- DCO - Internal digitally-controlled oscillator (DCO) that can be stabilized by a frequency lock loop (FLL) that sets the DCO to a specified multiple of a reference frequency.

System Clocks and Functionality on the MSP430 MCLK Master Clock Services the CPU. Commonly sourced by DCO. Is available in Active mode only SMCLK Subsystem Master Clock Services 'fast' system peripherals. Commonly sourced by DCO. Is available in Active mode, LPM0 and LPM1 ACLK Auxiliary Clock Services 'slow' system peripherals. Commonly used for 32-kHz signal.Is available in Active mode, LPM0 to LPM3

System clocks of the MSP430x5xx generation are automatically enabled, regardless of the LPM mode of operation, if they are required for the proper operation of the peripheral module that they source. This additional flexibility of the UCS, along with improved fail-safe logic, provides a robust clocking scheme for all applications.

Fail-Safe logic The UCS fail-safe logic plays an important part in providing a robust clocking scheme for MSP430x5xx and MSP430x6xx applications. This feature hinges on the ability to detect an oscillator fault for the XT1 in both low- and high-frequency modes (XT1LFOFFG and XT1HFOFFG respectively), the high-frequency XT2 (XT2OFFG), and the DCO (DCOFFG). These flags are set and latched when the respective oscillator is enabled but not operating properly; therefore, they must be explicitly cleared in software

The oscillator fault flags on previous MSP430 generations are not latched and are asserted only as long as the failing condition exists. Therefore, an important difference between the families is that the fail-safe behavior in a 5xx-based MSP430 remains active until both the OFIFG and the respective fault flag are cleared in software.

This fail-safe behavior is implemented at the oscillator level, at the system clock level and, consequently, at the module level. Some notable highlights of this behavior are described below. For the full description of fail-safe behavior and conditions, see the MSP430x5xx/MSP430x6xx Family User's Guide (SLAU208).

- Low-frequency crystal oscillator 1 (LFXT1) The low-frequency (32768 Hz) crystal oscillator is the default reference clock to the FLL. An asserted XT1LFOFFG switches the FLL reference from the failing LFXT1 to the internal 32-kHz REFO. This can influence the DCO accuracy, because the FLL crystal ppm specification is typically tighter than the REFO accuracy over temperature and voltage of 3%.
- System Clocks (ACLK, SMCLK, MCLK) A fault on the oscillator that is sourcing a system clock switches the source from the failing oscillator to the DCO oscillator (DCOCLKDIV). This is true for all clock sources except the LFXT1. As previously described, a fault on the LFXT1 switches the source to the REFO. Since ACLK is the active clock in LPM3 there is a notable difference in the LPM3 current consumption when the REFO is the clock source ($\sim$3 uA active) versus the LFXT1 ($\sim$300 nA active).
- Modules (WDT_A) In watchdog mode, when SMCLK or ACLK fails, the clock source defaults to the VLOCLK.

41.2 API Functions

Macros

- #define **CC430_DEVICE**
- #define **NOT_CC430_DEVICE**

Functions

- void UCS_setExternalClockSource (uint32_t XT1CLK_frequency, uint32_t XT2CLK_frequency)
  Sets the external clock source.
- void UCS_initClockSignal (uint8_t selectedClockSignal, uint16_t clockSource, uint16_t clockSourceDivider)
  Initializes a clock signal.
- void UCS_turnOnLFXT1 (uint16_t xt1drive, uint8_t xcap)
  Initializes the XT1 crystal oscillator in low frequency mode.
- void UCS_turnOnHFXT1 (uint16_t xt1drive)
  Initializes the XT1 crystal oscillator in high frequency mode.
- void UCS_bypassXT1 (uint8_t highOrLowFrequency)
  Bypass the XT1 crystal oscillator.
- bool UCS_turnOnLFXT1WithTimeout (uint16_t xt1drive, uint8_t xcap, uint16_t timeout)
  Initializes the XT1 crystal oscillator in low frequency mode with timeout.
- bool UCS_turnOnHFXT1WithTimeout (uint16_t xt1drive, uint16_t timeout)
  Initializes the XT1 crystal oscillator in high frequency mode with timeout.
- bool UCS_bypassXT1WithTimeout (uint8_t highOrLowFrequency, uint16_t timeout)
  Bypasses the XT1 crystal oscillator with time out.
- void UCS_turnOffXT1 (void)
  Stops the XT1 oscillator using the XT1OFF bit.
- void UCS_turnOnXT2 (uint16_t xt2drive)
  Initializes the XT2 crystal oscillator.
- void UCS_bypassXT2 (void)
  Bypasses the XT2 crystal oscillator.
- bool UCS_turnOnXT2WithTimeout (uint16_t xt2drive, uint16_t timeout)

Initializes the XT2 crystal oscillator with timeout.
- bool UCS_bypassXT2WithTimeout (uint16_t timeout)
  Bypasses the XT2 crystal oscillator with timeout.
- void UCS_turnOffXT2 (void)
  Stops the XT2 oscillator using the XT2OFF bit.
- void UCS_initFLLSettle (uint16_t fsystem, uint16_t ratio)
  Initializes the DCO to operate a frequency that is a multiple of the reference frequency into the FLL.
- void UCS_initFLL (uint16_t fsystem, uint16_t ratio)
  Initializes the DCO to operate a frequency that is a multiple of the reference frequency into the FLL.
- void UCS_enableClockRequest (uint8_t selectClock)
  Enables conditional module requests.
- void UCS_disableClockRequest (uint8_t selectClock)
  Disables conditional module requests.
- uint8_t UCS_getFaultFlagStatus (uint8_t mask)
  Gets the current UCS fault flag status.
- void UCS_clearFaultFlag (uint8_t mask)
  Clears the current UCS fault flag status for the masked bit.
- void UCS_turnOffSMCLK (void)
  Turns off SMCLK using the SMCLKOFF bit.
- void UCS_turnOnSMCLK (void)
  Turns ON SMCLK using the SMCLKOFF bit.
- uint32_t UCS_getACLK (void)
  Get the current ACLK frequency.
- uint32_t UCS_getSMCLK (void)
  Get the current SMCLK frequency.
- uint32_t UCS_getMCLK (void)
  Get the current MCLK frequency.
- uint16_t UCS_clearAllOscFlagsWithTimeout (uint16_t timeout)
  Clears all the Oscillator Flags.

41.2.1 Detailed Description

The UCS API is broken into three groups of functions: those that deal with clock configuration and control

General UCS configuration and initialization is handled by

- UCS_initClockSignal(),
- UCS_initFLLSettle(),
- UCS_enableClockRequest(),
- UCS_disableClockRequest(),
- UCS_turnOffSMCLK(),
- UCS_turnOnSMCLK()

External crystal specific configuration and initialization is handled by

- UCS_setExternalClockSource(),
- UCS_turnOnLFXT1(),
- UCS_turnOnHFXT1(),
- UCS_bypassXT1(),

- UCS_turnOnLFXT1WithTimeout(),
- UCS_turnOnHFXT1WithTimeout(),
- UCS_bypassXT1WithTimeout(),
- UCS_turnOffXT1(),
- UCS_turnOnXT2(),
- UCS_turnOffXT2(),
- UCS_bypassXT2(),
- UCS_turnOnXT2WithTimeout(),
- UCS_bypassXT2WithTimeout()
- UCS_clearAllOscFlagsWithTimeout()

UCS_setExternalClockSource must be called if an external crystal XT1 or XT2 is used and the user intends to call UCS_getMCLK, UCS_getSMCLK or UCS_getACLK APIs. If not, it is not necessary to invoke this API.

Failure to invoke UCS_initClockSignal() sets the clock signals to the default modes ACLK default mode - UCS_XT1CLK_SELECT SMCLK default mode - UCS_DCOCLKDIV_SELECT MCLK default mode - UCS_DCOCLKDIV_SELECT

Also fail-safe mode behavior takes effect when a selected mode fails.

The status and configuration query are done by

- UCS_getFaultFlagStatus(),
- UCS_clearFaultFlag(),
- UCS_getACLK(),
- UCS_getSMCLK(),
- UCS_getMCLK()

41.2.2 Macro Definition Documentation

CC430_DEVICE

```
#define CC430_DEVICE
```

Value:

```
(defined (__CC430F5133__) || defined(__CC430F5135__) || defined(__CC430F5137__) || \
        defined(__CC430F6125__) || defined(__CC430F6126__) || defined(__CC430F6127__) || \
        defined(__CC430F6135__) || defined(__CC430F6137__) || defined(__CC430F5123__) || \
        defined(__CC430F5125__) || defined(__CC430F5143__) || defined(__CC430F5145__) || \
        defined(__CC430F5147__) || defined(__CC430F6143__) || defined(__CC430F6145__) || \
        defined(__CC430F6147__))
```

NOT_CC430_DEVICE

```
#define NOT_CC430_DEVICE
```

Value:

```
(!defined (__CC430F5133__) && !defined(__CC430F5135__) && !defined(__CC430F5137__) && \
        !defined(__CC430F6125__) && !defined(__CC430F6126__) &&  !defined(__CC430F6127__) && \
         !defined(__CC430F6135__) &&  !defined(__CC430F6137__) &&  !defined(__CC430F5123__) && \
         !defined(__CC430F5125__) &&  !defined(__CC430F5143__) &&  !defined(__CC430F5145__) && \
         !defined(__CC430F5147__) &&  !defined(__CC430F6143__) &&  !defined(__CC430F6145__) && \
         !defined(__CC430F6147__))
```

41.2.3 Function Documentation

UCS_bypassXT1()

```
void UCS_bypassXT1 (
            uint8_t highOrLowFrequency )
```

Bypass the XT1 crystal oscillator.

Bypasses the XT1 crystal oscillator. Loops until all oscillator fault flags are cleared, with no timeout.

Parameters

highOrLowFrequency	selects high frequency or low frequency mode for XT1. Valid values are: ■ **UCS_XT1_HIGH_FREQUENCY** ■ **UCS_XT1_LOW_FREQUENCY** [Default]

Modified bits of **UCSCTL7** register, bits of **UCSCTL6** register and bits of **SFRIFG** register.

Returns

None

UCS_bypassXT1WithTimeout()

```
bool UCS_bypassXT1WithTimeout (
            uint8_t highOrLowFrequency,
            uint16_t timeout )
```

Bypasses the XT1 crystal oscillator with time out.

Bypasses the XT1 crystal oscillator with time out. Loops until all oscillator fault flags are cleared or until a timeout counter is decremented and equals to zero.

Parameters

highOrLowFrequency	selects high frequency or low frequency mode for XT1. Valid values are: ■ **UCS_XT1_HIGH_FREQUENCY** ■ **UCS_XT1_LOW_FREQUENCY** [Default]
timeout	is the count value that gets decremented every time the loop that clears oscillator fault flags gets executed.

Modified bits of **UCSCTL7** register, bits of **UCSCTL6** register and bits of **SFRIFG** register.

Returns

STATUS_SUCCESS or STATUS_FAIL

UCS_bypassXT2()

```
void UCS_bypassXT2 (
            void )
```

Bypasses the XT2 crystal oscillator.

Bypasses the XT2 crystal oscillator, which supports crystal frequencies between 4 MHz and 32 MHz. Loops until all oscillator fault flags are cleared, with no timeout.

Modified bits of **UCSCTL7** register, bits of **UCSCTL6** register and bits of **SFRIFG** register.

Returns

None

UCS_bypassXT2WithTimeout()

```
bool UCS_bypassXT2WithTimeout (
            uint16_t timeout )
```

Bypasses the XT2 crystal oscillator with timeout.

Bypasses the XT2 crystal oscillator, which supports crystal frequencies between 4 MHz and 32 MHz. Loops until all oscillator fault flags are cleared or until a timeout counter is decremented and equals to zero.

Parameters

timeout	is the count value that gets decremented every time the loop that clears oscillator fault flags gets executed.

Modified bits of **UCSCTL7** register, bits of **UCSCTL6** register and bits of **SFRIFG** register.

Returns

STATUS_SUCCESS or STATUS_FAIL

UCS_clearAllOscFlagsWithTimeout()

```
uint16_t UCS_clearAllOscFlagsWithTimeout (
            uint16_t timeout )
```

Clears all the Oscillator Flags.

Parameters

timeout	is the count value that gets decremented every time the loop that clears oscillator fault flags gets executed.

Returns

Logical OR of any of the following:
- **UCS_XT2OFFG** XT2 oscillator fault flag
- **UCS_XT1HFOFFG** XT1 oscillator fault flag (HF mode)
- **UCS_XT1LFOFFG** XT1 oscillator fault flag (LF mode)
- **UCS_DCOFFG** DCO fault flag
indicating the status of the oscillator fault flags

UCS_clearFaultFlag()

```
void UCS_clearFaultFlag (
            uint8_t mask )
```

Clears the current UCS fault flag status for the masked bit.

Parameters

mask	is the masked interrupt flag status to be returned. mask parameter can be any one of the following Valid values are: ■ **UCS_XT2OFFG** - XT2 oscillator fault flag ■ **UCS_XT1HFOFFG** - XT1 oscillator fault flag (HF mode) ■ **UCS_XT1LFOFFG** - XT1 oscillator fault flag (LF mode) ■ **UCS_DCOFFG** - DCO fault flag

Modified bits of **UCSCTL7** register.

Returns

None

UCS_disableClockRequest()

```
void UCS_disableClockRequest (
            uint8_t selectClock )
```

Disables conditional module requests.

Parameters

selectClock	selects specific request disable Valid values are: ■ **UCS_ACLK** ■ **UCS_SMCLK** ■ **UCS_MCLK** ■ **UCS_MODOSC**

Modified bits of **UCSCTL8** register.

Returns

None

UCS_enableClockRequest()

```
void UCS_enableClockRequest (
            uint8_t selectClock )
```

Enables conditional module requests.

Parameters

selectClock	selects specific request enables Valid values are: ■ **UCS_ACLK** ■ **UCS_SMCLK** ■ **UCS_MCLK** ■ **UCS_MODOSC**

Modified bits of **UCSCTL8** register.

Returns

None

UCS_getACLK()

```
uint32_t UCS_getACLK (
            void )
```

Get the current ACLK frequency.

Get the current ACLK frequency. The user of this API must ensure that UCS_setExternalClockSource API was invoked before in case XT1 or XT2 is being used.

Returns

Current ACLK frequency in Hz

UCS_getFaultFlagStatus()

```
uint8_t UCS_getFaultFlagStatus (
            uint8_t mask )
```

Gets the current UCS fault flag status.

Parameters

mask	is the masked interrupt flag status to be returned. Mask parameter can be either any of the following selection. Valid values are: ■ **UCS_XT2OFFG** - XT2 oscillator fault flag ■ **UCS_XT1HFOFFG** - XT1 oscillator fault flag (HF mode) ■ **UCS_XT1LFOFFG** - XT1 oscillator fault flag (LF mode) ■ **UCS_DCOFFG** - DCO fault flag

UCS_getMCLK()

```
uint32_t UCS_getMCLK (
            void )
```

Get the current MCLK frequency.

Get the current MCLK frequency. The user of this API must ensure that UCS_setExternalClockSource API was invoked before in case XT1 or XT2 is being used.

Returns

Current MCLK frequency in Hz

UCS_getSMCLK()

```
uint32_t UCS_getSMCLK (
            void )
```

Get the current SMCLK frequency.

Get the current SMCLK frequency. The user of this API must ensure that UCS_setExternalClockSource API was invoked before in case XT1 or XT2 is being used.

Returns

Current SMCLK frequency in Hz

UCS_initClockSignal()

```
void UCS_initClockSignal (
            uint8_t selectedClockSignal,
            uint16_t clockSource,
            uint16_t clockSourceDivider )
```

Initializes a clock signal.

This function initializes each of the clock signals. The user must ensure that this function is called for each clock signal. If not, the default state is assumed for the particular clock signal. Refer MSP430Ware documentation for UCS module or Device Family User's Guide for details of default clock signal states.

Parameters

selectedClockSignal	selected clock signal Valid values are: ■ **UCS_ACLK** ■ **UCS_MCLK** ■ **UCS_SMCLK** ■ **UCS_FLLREF**
clockSource	is clock source for the selectedClockSignal Valid values are: ■ **UCS_XT1CLK_SELECT** ■ **UCS_VLOCLK_SELECT** ■ **UCS_REFOCLK_SELECT** ■ **UCS_DCOCLK_SELECT** ■ **UCS_DCOCLKDIV_SELECT** ■ **UCS_XT2CLK_SELECT**
clockSourceDivider	selected the clock divider to calculate clocksignal from clock source. Valid values are: ■ **UCS_CLOCK_DIVIDER_1** [Default] ■ **UCS_CLOCK_DIVIDER_2** ■ **UCS_CLOCK_DIVIDER_4** ■ **UCS_CLOCK_DIVIDER_8** ■ **UCS_CLOCK_DIVIDER_12** - [Valid only for UCS_FLLREF] ■ **UCS_CLOCK_DIVIDER_16** ■ **UCS_CLOCK_DIVIDER_32** - [Not valid for UCS_FLLREF]

Modified bits of **UCSCTL5** register, bits of **UCSCTL4** register and bits of **UCSCTL3** register.

Returns

None

UCS_initFLL()

```
void UCS_initFLL (
            uint16_t fsystem,
            uint16_t ratio )
```

Initializes the DCO to operate a frequency that is a multiple of the reference frequency into the FLL.

Initializes the DCO to operate a frequency that is a multiple of the reference frequency into the FLL. Loops until all oscillator fault flags are cleared, with no timeout. If the frequency is greater than 16 MHz, the function sets the MCLK and SMCLK source to the undivided DCO frequency. Otherwise, the function sets the MCLK and SMCLK source to the DCOCLKDIV frequency. The function PMM_setVCore() is required to call first if the target frequency is beyond current Vcore supported frequency range.

Parameters

fsystem	is the target frequency for MCLK in kHz
ratio	is the ratio x/y, where x = fsystem and y = FLL reference frequency.

Modified bits of **UCSCTL0** register, bits of **UCSCTL4** register, bits of **UCSCTL7** register, bits of **UCSCTL1** register, bits of **SFRIFG1** register and bits of **UCSCTL2** register.

Returns

None

Referenced by UCS_initFLLSettle().

UCS_initFLLSettle()

```
void UCS_initFLLSettle (
            uint16_t fsystem,
            uint16_t ratio )
```

Initializes the DCO to operate a frequency that is a multiple of the reference frequency into the FLL.

Initializes the DCO to operate a frequency that is a multiple of the reference frequency into the FLL. Loops until all oscillator fault flags are cleared, with a timeout. If the frequency is greater than 16 MHz, the function sets the MCLK and SMCLK source to the undivided DCO frequency. Otherwise, the function sets the MCLK and SMCLK source to the DCOCLKDIV frequency. This function executes a software delay that is proportional in length to the ratio of the target FLL frequency and the FLL reference. The function PMM_setVCore() is required to call first if the target frequency is beyond current Vcore supported frequency range.

Parameters

fsystem	is the target frequency for MCLK in kHz
ratio	is the ratio x/y, where x = fsystem and y = FLL reference frequency.

Modified bits of **UCSCTL0** register, bits of **UCSCTL4** register, bits of **UCSCTL7** register, bits of **UCSCTL1** register, bits of **SFRIFG1** register and bits of **UCSCTL2** register.

Returns

None

References UCS_initFLL().

UCS_setExternalClockSource()

```
void UCS_setExternalClockSource (
            uint32_t XT1CLK_frequency,
            uint32_t XT2CLK_frequency )
```

Sets the external clock source.

This function sets the external clock sources XT1 and XT2 crystal oscillator frequency values. This function must be called if an external crystal XT1 or XT2 is used and the user intends to call UCS_getMCLK, UCS_getSMCLK or UCS_getACLK APIs. If not, it is not necessary to invoke this API.

Parameters

XT1CLK_frequency	is the XT1 crystal frequencies in Hz
XT2CLK_frequency	is the XT2 crystal frequencies in Hz

Returns

None

UCS_turnOffSMCLK()

```
void UCS_turnOffSMCLK (
            void )
```

Turns off SMCLK using the SMCLKOFF bit.

Modified bits of **UCSCTL6** register.

Returns

None

UCS_turnOffXT1()

```
void UCS_turnOffXT1 (
            void )
```

Stops the XT1 oscillator using the XT1OFF bit.

Returns

None

UCS_turnOffXT2()

```
void UCS_turnOffXT2 (
            void )
```

Stops the XT2 oscillator using the XT2OFF bit.

Modified bits of **UCSCTL6** register.

Returns

None

UCS_turnOnHFXT1()

```
void UCS_turnOnHFXT1 (
            uint16_t xt1drive )
```

Initializes the XT1 crystal oscillator in high frequency mode.

Initializes the XT1 crystal oscillator in high frequency mode. Loops until all oscillator fault flags are cleared, with no timeout. See the device- specific data sheet for appropriate drive settings.

Parameters

xt1drive	is the target drive strength for the XT1 crystal oscillator. Valid values are: ■ **UCS_XT1_DRIVE_0** ■ **UCS_XT1_DRIVE_1** ■ **UCS_XT1_DRIVE_2** ■ **UCS_XT1_DRIVE_3** [Default]

Modified bits of **UCSCTL7** register, bits of **UCSCTL6** register and bits of **SFRIFG** register.

Returns

None

UCS_turnOnHFXT1WithTimeout()

```
bool UCS_turnOnHFXT1WithTimeout (
            uint16_t xt1drive,
            uint16_t timeout )
```

Initializes the XT1 crystal oscillator in high frequency mode with timeout.

Initializes the XT1 crystal oscillator in high frequency mode with timeout. Loops until all oscillator fault flags are cleared or until a timeout counter is decremented and equals to zero. See the device-specific data sheet for appropriate drive settings.

Parameters

xt1drive	is the target drive strength for the XT1 crystal oscillator. Valid values are: ■ **UCS_XT1_DRIVE_0** ■ **UCS_XT1_DRIVE_1** ■ **UCS_XT1_DRIVE_2** ■ **UCS_XT1_DRIVE_3** [Default]
timeout	is the count value that gets decremented every time the loop that clears oscillator fault flags gets executed.

Modified bits of **UCSCTL7** register, bits of **UCSCTL6** register and bits of **SFRIFG** register.

Returns

STATUS_SUCCESS or STATUS_FAIL

UCS_turnOnLFXT1()

```
void UCS_turnOnLFXT1 (
            uint16_t xt1drive,
            uint8_t xcap )
```

Initializes the XT1 crystal oscillator in low frequency mode.

Initializes the XT1 crystal oscillator in low frequency mode. Loops until all oscillator fault flags are cleared, with no timeout. See the device- specific data sheet for appropriate drive settings.

Parameters

xt1drive	is the target drive strength for the XT1 crystal oscillator. Valid values are: ■ **UCS_XT1_DRIVE_0** ■ **UCS_XT1_DRIVE_1** ■ **UCS_XT1_DRIVE_2** ■ **UCS_XT1_DRIVE_3** [Default] Modified bits are **XT1DRIVE** of **UCSCTL6** register.
xcap	is the selected capacitor value. This parameter selects the capacitors applied to the LF crystal (XT1) or resonator in the LF mode. The effective capacitance (seen by the crystal) is Ceff. (CXIN ■ 2 pF)/2. It is assumed that CXIN = CXOUT and that a parasitic capacitance of 2 pF is added by the package and the printed circuit board. For details about the typical internal and the effective capacitors, refer to the device-specific data sheet. Valid values are: ■ **UCS_XCAP_0** ■ **UCS_XCAP_1** ■ **UCS_XCAP_2** ■ **UCS_XCAP_3** [Default]

Modified bits are **XCAP** of **UCSCTL6** register.

Returns

None

UCS_turnOnLFXT1WithTimeout()

```
bool UCS_turnOnLFXT1WithTimeout (
            uint16_t xt1drive,
            uint8_t xcap,
            uint16_t timeout )
```

Initializes the XT1 crystal oscillator in low frequency mode with timeout.

Initializes the XT1 crystal oscillator in low frequency mode with timeout. Loops until all oscillator fault flags are cleared or until a timeout counter is decremented and equals to zero. See the device-specific datasheet for appropriate drive settings.

Parameters

xt1drive	is the target drive strength for the XT1 crystal oscillator. Valid values are: ■ **UCS_XT1_DRIVE_0** ■ **UCS_XT1_DRIVE_1** ■ **UCS_XT1_DRIVE_2** ■ **UCS_XT1_DRIVE_3** [Default]

Parameters

xcap	is the selected capacitor value. This parameter selects the capacitors applied to the LF crystal (XT1) or resonator in the LF mode. The effective capacitance (seen by the crystal) is Ceff. (CXIN ■ 2 pF)/2. It is assumed that CXIN = CXOUT and that a parasitic capacitance of 2 pF is added by the package and the printed circuit board. For details about the typical internal and the effective capacitors, refer to the device-specific data sheet. Valid values are: ■ **UCS_XCAP_0** ■ **UCS_XCAP_1** ■ **UCS_XCAP_2** ■ **UCS_XCAP_3** [Default]
timeout	is the count value that gets decremented every time the loop that clears oscillator fault flags gets executed.

Modified bits of **UCSCTL7** register, bits of **UCSCTL6** register and bits of **SFRIFG** register.

Returns

STATUS_SUCCESS or STATUS_FAIL

UCS_turnOnSMCLK()

```
void UCS_turnOnSMCLK (
            void )
```

Turns ON SMCLK using the SMCLKOFF bit.

Modified bits of **UCSCTL6** register.

Returns

None

UCS_turnOnXT2()

```
void UCS_turnOnXT2 (
            uint16_t xt2drive )
```

Initializes the XT2 crystal oscillator.

Initializes the XT2 crystal oscillator, which supports crystal frequencies between 4 MHz and 32 MHz, depending on the selected drive strength. Loops until all oscillator fault flags are cleared, with no timeout. See the device-specific data sheet for appropriate drive settings.

Parameters

xt2drive	is the target drive strength for the XT2 crystal oscillator. Valid values are: ■ **UCS_XT2_DRIVE_4MHZ_8MHZ** ■ **UCS_XT2_DRIVE_8MHZ_16MHZ** ■ **UCS_XT2_DRIVE_16MHZ_24MHZ** ■ **UCS_XT2_DRIVE_24MHZ_32MHZ** [Default]

Modified bits of **UCSCTL7** register, bits of **UCSCTL6** register and bits of **SFRIFG** register.

Returns

None

UCS_turnOnXT2WithTimeout()

```
bool UCS_turnOnXT2WithTimeout (
            uint16_t xt2drive,
            uint16_t timeout )
```

Initializes the XT2 crystal oscillator with timeout.

Initializes the XT2 crystal oscillator, which supports crystal frequencies between 4 MHz and 32 MHz, depending on the selected drive strength. Loops until all oscillator fault flags are cleared or until a timeout counter is decremented and equals to zero. See the device-specific data sheet for appropriate drive settings.

Parameters

xt2drive	is the target drive strength for the XT2 crystal oscillator. Valid values are: ■ **UCS_XT2_DRIVE_4MHZ_8MHZ** ■ **UCS_XT2_DRIVE_8MHZ_16MHZ** ■ **UCS_XT2_DRIVE_16MHZ_24MHZ** ■ **UCS_XT2_DRIVE_24MHZ_32MHZ** [Default]
timeout	is the count value that gets decremented every time the loop that clears oscillator fault flags gets executed.

Modified bits of **UCSCTL7** register, bits of **UCSCTL6** register and bits of **SFRIFG** register.

Returns

STATUS_SUCCESS or STATUS_FAIL

41.3 Programming Example

The following example shows some UCS operations using the APIs

```
// Set DCO FLL reference = REFO
  UCS_initClockSignal(UCS_BASE,
                      UCS_FLLREF,
                      UCS_REFOCLK_SELECT,
                      UCS_CLOCK_DIVIDER_1
                     );
  // Set ACLK = REFO
 UCS_initClockSignal(UCS_BASE,
                     UCS_ACLK,
                     UCS_REFOCLK_SELECT,
                     UCS_CLOCK_DIVIDER_1
                    );

  // Set Ratio and Desired MCLK Frequency and initialize DCO
  UCS_initFLLSettle(UCS_BASE,
                    UCS_MCLK_DESIRED_FREQUENCY_IN_KHZ,
                    UCS_MCLK_FLLREF_RATIO
                   );

  //Verify if the Clock settings are as expected
  clockValue = UCS_getSMCLK();

  while(1);
```

42 USCI Universal Asynchronous Receiver/Transmitter (USCI_A_UART)

42.1 Introduction

The MSP430Ware library for USCI_A_UART mode 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

The modes of operations supported by the USCI_A_UART and the library include

- USCI_A_UART mode
- Idle-line multiprocessor mode
- Address-bit multiprocessor mode
- USCI_A_UART mode with automatic baud-rate detection

In USCI_A_UART mode, the USCI 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 USCI. The transmit and receive functions use the same baud-rate frequency.

42.2 API Functions

Functions

- bool USCI_A_UART_init (uint16_t baseAddress, USCI_A_UART_initParam *param)
  Advanced initialization routine for the UART block. The values to be written into the clockPrescalar, firstModReg, secondModReg and overSampling parameters should be pre-computed and passed into the initialization function.
- void USCI_A_UART_transmitData (uint16_t baseAddress, uint8_t transmitData)
  Transmits a byte from the UART Module.
- uint8_t USCI_A_UART_receiveData (uint16_t baseAddress)

Receives a byte that has been sent to the UART Module.
- void USCI_A_UART_enableInterrupt (uint16_t baseAddress, uint8_t mask)
  Enables individual UART interrupt sources.
- void USCI_A_UART_disableInterrupt (uint16_t baseAddress, uint8_t mask)
  Disables individual UART interrupt sources.
- uint8_t USCI_A_UART_getInterruptStatus (uint16_t baseAddress, uint8_t mask)
  Gets the current UART interrupt status.
- void USCI_A_UART_clearInterrupt (uint16_t baseAddress, uint8_t mask)
  Clears UART interrupt sources.
- void USCI_A_UART_enable (uint16_t baseAddress)
  Enables the UART block.
- void USCI_A_UART_disable (uint16_t baseAddress)
  Disables the UART block.
- uint8_t USCI_A_UART_queryStatusFlags (uint16_t baseAddress, uint8_t mask)
  Gets the current UART status flags.
- void USCI_A_UART_setDormant (uint16_t baseAddress)
  Sets the UART module in dormant mode.
- void USCI_A_UART_resetDormant (uint16_t baseAddress)
  Re-enables UART module from dormant mode.
- void USCI_A_UART_transmitAddress (uint16_t baseAddress, uint8_t transmitAddress)
  Transmits the next byte to be transmitted marked as address depending on selected multiprocessor mode.
- void USCI_A_UART_transmitBreak (uint16_t baseAddress)
  Transmit break.
- uint32_t USCI_A_UART_getReceiveBufferAddressForDMA (uint16_t baseAddress)
  Returns the address of the RX Buffer of the UART for the DMA module.
- uint32_t USCI_A_UART_getTransmitBufferAddressForDMA (uint16_t baseAddress)
  Returns the address of the TX Buffer of the UART for the DMA module.

42.2.1 Detailed Description

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

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

Configuration and control of the USCI_A_UART are handled by the

- USCI_A_UART_init()
- USCI_A_UART_enable()
- USCI_A_UART_disable()
- USCI_A_UART_setDormant()
- USCI_A_UART_resetDormant()

Sending and receiving data via the USCI_A_UART is handled by the

- USCI_A_UART_transmitData()
- USCI_A_UART_receiveData()
- USCI_A_UART_transmitAddress()
- USCI_A_UART_transmitBreak()

Managing the USCI_A_UART interrupts and status are handled by the

- USCI_A_UART_enableInterrupt()
- USCI_A_UART_disableInterrupt()
- USCI_A_UART_getInterruptStatus()
- USCI_A_UART_clearInterrupt()
- USCI_A_UART_queryStatusFlags()

DMA related

- USCI_A_UART_getReceiveBufferAddressForDMA()
- USCI_A_UART_getTransmitBufferAddressForDMA()

42.2.2 Function Documentation

USCI_A_UART_clearInterrupt()

```
void USCI_A_UART_clearInterrupt (
            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 USCI_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: ■ **USCI_A_UART_RECEIVE_INTERRUPT_FLAG** - Receive interrupt flag ■ **USCI_A_UART_TRANSMIT_INTERRUPT_FLAG** - Transmit interrupt flag

Modified bits of **UCAxIFG** register.

Returns

None

USCI_A_UART_disable()

```
void USCI_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 USCI_A_UART module.

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

Returns

None

USCI_A_UART_disableInterrupt()

```
void USCI_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 USCI_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: ■ **USCI_A_UART_RECEIVE_INTERRUPT** - Receive interrupt ■ **USCI_A_UART_TRANSMIT_INTERRUPT** - Transmit interrupt ■ **USCI_A_UART_RECEIVE_ERRONEOUSCHAR_INTERRUPT** - Receive erroneous-character interrupt enable ■ **USCI_A_UART_BREAKCHAR_INTERRUPT** - Receive break character interrupt enable

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

Returns

None

USCI_A_UART_enable()

```
void USCI_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 USCI_A_UART module.

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

Returns

None

USCI_A_UART_enableInterrupt()

```
void USCI_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 USCI_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: ■ **USCI_A_UART_RECEIVE_INTERRUPT** - Receive interrupt ■ **USCI_A_UART_TRANSMIT_INTERRUPT** - Transmit interrupt ■ **USCI_A_UART_RECEIVE_ERRONEOUSCHAR_INTERRUPT** - Receive erroneous-character interrupt enable ■ **USCI_A_UART_BREAKCHAR_INTERRUPT** - Receive break character interrupt enable

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

Returns

None

USCI_A_UART_getInterruptStatus()

```
uint8_t USCI_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 USCI_A_UART module.
mask	is the masked interrupt flag status to be returned. Mask value is the logical OR of any of the following: ■ **USCI_A_UART_RECEIVE_INTERRUPT_FLAG** - Receive interrupt flag ■ **USCI_A_UART_TRANSMIT_INTERRUPT_FLAG** - Transmit interrupt flag

Modified bits of **UCAxIFG** register.

Returns

Logical OR of any of the following:

- **USCI_A_UART_RECEIVE_INTERRUPT_FLAG** Receive interrupt flag
- **USCI_A_UART_TRANSMIT_INTERRUPT_FLAG** Transmit interrupt flag indicating the status of the masked flags

USCI_A_UART_getReceiveBufferAddressForDMA()

```
uint32_t USCI_A_UART_getReceiveBufferAddressForDMA (
            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 USCI_A_UART module.

Returns

Address of RX Buffer

USCI_A_UART_getTransmitBufferAddressForDMA()

```
uint32_t USCI_A_UART_getTransmitBufferAddressForDMA (
            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 USCI_A_UART module.

Returns

Address of TX Buffer

USCI_A_UART_init()

```
bool USCI_A_UART_init (
            uint16_t baseAddress,
            USCI_A_UART_initParam * param )
```

Advanced initialization routine for the UART block. The values to be written into the clockPrescalar, 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 USCI_A_UART_enable(). To calculate values for clockPrescalar, firstModReg, secondModReg and overSampling please use the link below.

`http://software-dl.ti.com/msp430/msp430_public_sw/mcu/msp430/MSP430↩ BaudRateConverter/index.html`

Parameters

baseAddress	is the base address of the USCI_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

References USCI_A_UART_initParam::clockPrescalar, USCI_A_UART_initParam::firstModReg, USCI_A_UART_initParam::msborLsbFirst, USCI_A_UART_initParam::numberofStopBits, USCI_A_UART_initParam::overSampling, USCI_A_UART_initParam::parity, USCI_A_UART_initParam::secondModReg, USCI_A_UART_initParam::selectClockSource, and USCI_A_UART_initParam::uartMode.

USCI_A_UART_queryStatusFlags()

```
uint8_t USCI_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 USCI_A_UART module.
mask	is the masked interrupt flag status to be returned. Mask value is the logical OR of any of the following: ■ **USCI_A_UART_LISTEN_ENABLE** ■ **USCI_A_UART_FRAMING_ERROR** ■ **USCI_A_UART_OVERRUN_ERROR** ■ **USCI_A_UART_PARITY_ERROR** ■ **USCI_A_UART_BREAK_DETECT** ■ **USCI_A_UART_RECEIVE_ERROR** ■ **USCI_A_UART_ADDRESS_RECEIVED** ■ **USCI_A_UART_IDLELINE** ■ **USCI_A_UART_BUSY**

Modified bits of **UCAxSTAT** register.

Returns

Logical OR of any of the following:

- **USCI_A_UART_LISTEN_ENABLE**
- **USCI_A_UART_FRAMING_ERROR**
- **USCI_A_UART_OVERRUN_ERROR**
- **USCI_A_UART_PARITY_ERROR**
- **USCI_A_UART_BREAK_DETECT**
- **USCI_A_UART_RECEIVE_ERROR**
- **USCI_A_UART_ADDRESS_RECEIVED**
- **USCI_A_UART_IDLELINE**

- **USCI_A_UART_BUSY**
  indicating the status of the masked interrupt flags

USCI_A_UART_receiveData()

```
uint8_t USCI_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 USCI_A_UART module.

Modified bits of **UCAxRXBUF** register.

Returns

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

USCI_A_UART_resetDormant()

```
void USCI_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 USCI_A_UART module.

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

Returns

None

USCI_A_UART_setDormant()

```
void USCI_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 USCI_A_UART module.

Modified bits of **UCAxCTL1** register.

Returns

None

USCI_A_UART_transmitAddress()

```
void USCI_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 USCI_A_UART module.
transmitAddress	is the next byte to be transmitted

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

Returns

None

USCI_A_UART_transmitBreak()

```
void USCI_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, USCI_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 USCI_A_UART module.

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

Returns

None

USCI_A_UART_transmitData()

```
void USCI_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 USCI_A_UART module.
transmitData	data to be transmitted from the UART module

Modified bits of **UCAxTXBUF** register.

Returns

None

42.3 Programming Example

The following example shows how to use the USCI_A_UART API to initialize the USCI_A_UART, transmit characters, and receive characters.

```
if ( STATUS_FAIL == USCI_A_UART_init (USCI_A0_BASE,
                                 USCI_A_UART_CLOCKSOURCE_SMCLK,
                                 UCS_getSMCLK(UCS_BASE),
                                 BAUD_RATE,
                                 USCI_A_UART_NO_PARITY,
                                 USCI_A_UART_LSB_FIRST,
                                 USCI_A_UART_ONE_STOP_BIT,
                                 USCI_A_UART_MODE,
                                 USCI_A_UART_OVERSAMPLING_BAUDRATE_GENERATION ))
  {
        return;
  }

  //Enable USCI_A_UART module for operation
  USCI_A_UART_enable (USCI_A0_BASE);

  //Enable Receive Interrupt
  USCI_A_UART_enableInterrupt (USCI_A0_BASE,
                      UCRXIE);

  //Transmit data
  USCI_A_UART_transmitData(USCI_A0_BASE,
                  transmitData++
                    );

  // Enter LPM3, interrupts enabled
  __bis_SR_register(LPM3_bits + GIE);
  __no_operation();
}
```

```
//******************************************************************************
//
// This is the USCI_A0 interrupt vector service routine.
//
//******************************************************************************
#pragma vector=USCI_A0_VECTOR
__interrupt void USCI_A0_ISR(void)
{
  switch(__even_in_range(UCA0IV,4))
  {
    // Vector 2 - RXIFG
     case 2:
        // Echo back RXed character, confirm TX buffer is ready first

        // USCI_A0 TX buffer ready?
        while (!USCI_A_UART_interruptStatus(USCI_A0_BASE,
                                     UCTXIFG)
               );

        //Receive echoed data
        receivedData = USCI_A_UART_receiveData(USCI_A0_BASE);

        //Transmit next data
        USCI_A_UART_transmitData(USCI_A0_BASE,
                          transmitData++
                            );

        break;
     default: break;
  }
}
```

43 USCI Synchronous Peripheral Interface (USCI_A_SPI)

43.1 Introduction

The Serial Peripheral Interface Bus or USCI_A_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 3-wire USCI_A_SPI communication

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

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

43.2 API Functions

Functions

- bool USCI_A_SPI_initMaster (uint16_t baseAddress, USCI_A_SPI_initMasterParam ∗param)
  Initializes the SPI Master block.
- void USCI_A_SPI_changeMasterClock (uint16_t baseAddress, USCI_A_SPI_changeMasterClockParam ∗param)
  Initializes the SPI Master clock.At the end of this function call, SPI module is left enabled.
- bool USCI_A_SPI_initSlave (uint16_t baseAddress, uint8_t msbFirst, uint8_t clockPhase, uint8_t clockPolarity)
  Initializes the SPI Slave block.
- void USCI_A_SPI_changeClockPhasePolarity (uint16_t baseAddress, uint8_t clockPhase, uint8_t clockPolarity)
  Changes the SPI clock phase and polarity.At the end of this function call, SPI module is left enabled.
- void USCI_A_SPI_transmitData (uint16_t baseAddress, uint8_t transmitData)
  Transmits a byte from the SPI Module.
- uint8_t USCI_A_SPI_receiveData (uint16_t baseAddress)
  Receives a byte that has been sent to the SPI Module.
- void USCI_A_SPI_enableInterrupt (uint16_t baseAddress, uint8_t mask)
  Enables individual SPI interrupt sources.
- void USCI_A_SPI_disableInterrupt (uint16_t baseAddress, uint8_t mask)
  Disables individual SPI interrupt sources.
- uint8_t USCI_A_SPI_getInterruptStatus (uint16_t baseAddress, uint8_t mask)
  Gets the current SPI interrupt status.
- void USCI_A_SPI_clearInterrupt (uint16_t baseAddress, uint8_t mask)
  Clears the selected SPI interrupt status flag.

- void USCI_A_SPI_enable (uint16_t baseAddress)
  Enables the SPI block.
- void USCI_A_SPI_disable (uint16_t baseAddress)
  Disables the SPI block.
- uint32_t USCI_A_SPI_getReceiveBufferAddressForDMA (uint16_t baseAddress)
  Returns the address of the RX Buffer of the SPI for the DMA module.
- uint32_t USCI_A_SPI_getTransmitBufferAddressForDMA (uint16_t baseAddress)
  Returns the address of the TX Buffer of the SPI for the DMA module.
- uint8_t USCI_A_SPI_isBusy (uint16_t baseAddress)
  Indicates whether or not the SPI bus is busy.

43.2.1 Detailed Description

To use the module as a master, the user must call USCI_A_SPI_initMaster() to configure the USCI_A_SPI Master. This is followed by enabling the USCI_A_SPI module using USCI_A_SPI_enable(). The interrupts are then enabled (if needed). **It** is recommended to enable the USCI_A_SPI module before enabling the interrupts. A data transmit is then initiated using USCI_A_SPI_transmitData() and then when the receive flag is set, the received data is read using USCI_A_SPI_receiveData() and this indicates that an RX/TX operation is complete.

To use the module as a slave, initialization is done using USCI_A_SPI_initSlave() and this is followed by enabling the module using USCI_A_SPI_enable(). Following this, the interrupts may be enabled as needed. When the receive flag is set, data is first transmitted using USCI_A_SPI_transmitData() and this is followed by a data reception by USCI_A_SPI_receiveData()

The USCI_A_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 USCI_A_SPI module are managed by

- USCI_A_SPI_initMaster()
- USCI_A_SPI_initSlave()
- USCI_A_SPI_disable()
- USCI_A_SPI_enable()
- USCI_A_SPI_masterChangeClock()
- USCI_A_SPI_isBusy()

Data handling is done by

- USCI_A_SPI_transmitData()
- USCI_A_SPI_receiveData()

Interrupts from the USCI_A_SPI module are managed using

- USCI_A_SPI_disableInterrupt()
- USCI_A_SPI_enableInterrupt()
- USCI_A_SPI_getInterruptStatus()
- USCI_A_SPI_clearInterrupt()

DMA related

- USCI_A_SPI_getReceiveBufferAddressForDMA()
- USCI_A_SPI_getTransmitBufferAddressForDMA()

43.2.2 Function Documentation

USCI_A_SPI_changeClockPhasePolarity()

```
void USCI_A_SPI_changeClockPhasePolarity (
            uint16_t baseAddress,
            uint8_t clockPhase,
            uint8_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 I2C Master module.
clockPhase	is clock phase select. Valid values are: ■ **USCI_A_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON↩_NEXT** [Default] ■ **USCI_A_SPI_PHASE_DATA_CAPTURED_ONFIRST_CHANGED_ON↩_NEXT**
clockPolarity	Valid values are: ■ **USCI_A_SPI_CLOCKPOLARITY_INACTIVITY_HIGH** ■ **USCI_A_SPI_CLOCKPOLARITY_INACTIVITY_LOW** [Default]

Modified bits are **UCCKPL** and **UCCKPH** of **UCAxCTL0** register.

Returns

None

USCI_A_SPI_changeMasterClock()

```
void USCI_A_SPI_changeMasterClock (
            uint16_t baseAddress,
            USCI_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 I2C Master module.
param	is the pointer to struct for master clock setting.

Modified bits of **UCAxBRW** register.

Returns

None

References USCI_A_SPI_changeMasterClockParam::clockSourceFrequency, and USCI_A_SPI_changeMasterClockParam::desiredSpiClock.

USCI_A_SPI_clearInterrupt()

```
void USCI_A_SPI_clearInterrupt (
            uint16_t baseAddress,
            uint8_t mask )
```

Clears the selected SPI interrupt status flag.

Parameters

baseAddress	is the base address of the SPI module.
mask	is the masked interrupt flag to be cleared. Mask value is the logical OR of any of the following: ■ **USCI_A_SPI_TRANSMIT_INTERRUPT** ■ **USCI_A_SPI_RECEIVE_INTERRUPT**

Modified bits of **UCAxIFG** register.

Returns

None

USCI_A_SPI_disable()

```
void USCI_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 USCI SPI module.

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

Returns

None

USCI_A_SPI_disableInterrupt()

```
void USCI_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 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: ■ **USCI_A_SPI_TRANSMIT_INTERRUPT** ■ **USCI_A_SPI_RECEIVE_INTERRUPT**

Modified bits of **UCAxIE** register.

Returns

None

USCI_A_SPI_enable()

```
void USCI_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 USCI SPI module.

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

Returns

None

USCI_A_SPI_enableInterrupt()

```
void USCI_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 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: ■ **USCI_A_SPI_TRANSMIT_INTERRUPT** ■ **USCI_A_SPI_RECEIVE_INTERRUPT**

Modified bits of **UCAxIE** register.

Returns

None

USCI_A_SPI_getInterruptStatus()

```
uint8_t USCI_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 SPI module.
mask	is the masked interrupt flag status to be returned. Mask value is the logical OR of any of the following: ■ **USCI_A_SPI_TRANSMIT_INTERRUPT** ■ **USCI_A_SPI_RECEIVE_INTERRUPT**

Returns

The current interrupt status as the mask of the set flags Return Logical OR of any of the following:

- **USCI_A_SPI_TRANSMIT_INTERRUPT**
- **USCI_A_SPI_RECEIVE_INTERRUPT**
  indicating the status of the masked interrupts

USCI_A_SPI_getReceiveBufferAddressForDMA()

```
uint32_t USCI_A_SPI_getReceiveBufferAddressForDMA (
```

```
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 SPI module.

Returns

the address of the RX Buffer

USCI_A_SPI_getTransmitBufferAddressForDMA()

```
uint32_t USCI_A_SPI_getTransmitBufferAddressForDMA (
            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 SPI module.

Returns

the address of the TX Buffer

USCI_A_SPI_initMaster()

```
bool USCI_A_SPI_initMaster (
            uint16_t baseAddress,
            USCI_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 USCI_A_SPI_enable()

Parameters

baseAddress	is the base address of the I2C Master module.
param	is the pointer to struct for master initialization.

Modified bits are **UCCKPH**, **UCCKPL**, **UC7BIT** and **UCMSB** of **UCAxCTL0** register; bits **UCSSELx** and **UCSWRST** of **UCAxCTL1** register.

Returns

STATUS_SUCCESS

References USCI_A_SPI_initMasterParam::clockPhase, USCI_A_SPI_initMasterParam::clockPolarity, USCI_A_SPI_initMasterParam::clockSourceFrequency, USCI_A_SPI_initMasterParam::desiredSpiClock, USCI_A_SPI_initMasterParam::msbFirst, and USCI_A_SPI_initMasterParam::selectClockSource.

USCI_A_SPI_initSlave()

```
bool USCI_A_SPI_initSlave (
            uint16_t baseAddress,
            uint8_t msbFirst,
            uint8_t clockPhase,
            uint8_t clockPolarity )
```

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 USCI_A_SPI_enable()

Parameters

baseAddress	is the base address of the SPI Slave module.
msbFirst	controls the direction of the receive and transmit shift register. Valid values are: ■ **USCI_A_SPI_MSB_FIRST** ■ **USCI_A_SPI_LSB_FIRST** [Default]
clockPhase	is clock phase select. Valid values are: ■ **USCI_A_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON↩_NEXT** [Default] ■ **USCI_A_SPI_PHASE_DATA_CAPTURED_ONFIRST_CHANGED_ON↩_NEXT**
clockPolarity	Valid values are: ■ **USCI_A_SPI_CLOCKPOLARITY_INACTIVITY_HIGH** ■ **USCI_A_SPI_CLOCKPOLARITY_INACTIVITY_LOW** [Default]

Modified bits are **UCMSB**, **UCMST**, **UC7BIT**, **UCCKPL**, **UCCKPH** and **UCMODE** of **UCAxCTL0** register; bits **UCSWRST** of **UCAxCTL1** register.

Returns

STATUS_SUCCESS

USCI_A_SPI_isBusy()

```
uint8_t USCI_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 SPI module.

Returns

USCI_A_SPI_BUSY if the SPI module transmitting or receiving is busy; otherwise, returns USCI_A_SPI_NOT_BUSY. Return one of the following:

- **USCI_A_SPI_BUSY**
- **USCI_A_SPI_NOT_BUSY**
  indicating if the USCI_A_SPI is busy

USCI_A_SPI_receiveData()

```
uint8_t USCI_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 SPI module.

Returns

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

USCI_A_SPI_transmitData()

```
void USCI_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 SPI module.
transmitData	data to be transmitted from the SPI module

Returns

None

43.3 Programming Example

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

```
  //Initialize Master
    USCI_B_SPI_initMasterParam param = {0};
    param.selectClockSource = USCI_B_SPI_CLOCKSOURCE_SMCLK;
    param.clockSourceFrequency = UCS_getSMCLK();
    param.desiredSpiClock = SPICLK;
    param.msbFirst = USCI_B_SPI_MSB_FIRST;
    param.clockPhase = USCI_B_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON_NEXT;
    param.clockPolarity = USCI_B_SPI_CLOCKPOLARITY_INACTIVITY_HIGH;
    returnValue =  USCI_B_SPI_initMaster(USCI_B0_BASE, &param);

    if (STATUS_FAIL == returnValue){
        return;
    }

      //Enable USCI_A_SPI module
      USCI_A_SPI_enable(USCI_A0_BASE);

      //Enable Receive interrupt
      USCI_A_SPI_enableInterrupt(USCI_A0_BASE, UCRXIE);

      //Configure port pins to reset slave

      // Wait for slave to initialize
      __delay_cycles(100);

      // Initialize data values
      transmitData = 0x00;

      // USCI_A0 TX buffer ready?
      while (!USCI_A_SPI_interruptStatus(USCI_A0_BASE, UCTXIFG));

      //Transmit Data to slave
      USCI_A_SPI_transmitData(USCI_A0_BASE, transmitData);

      // CPU off, enable interrupts
      __bis_SR_register(LPM0_bits + GIE);
}

//******************************************************************************
//
// This is the USCI_B0 interrupt vector service routine.
//
//******************************************************************************
#pragma vector=USCI_A0_VECTOR
__interrupt void USCI_A0_ISR(void)
{
  switch(__even_in_range(UCA0IV,4))
  {
    // Vector 2 - RXIFG
    case 2:
```

```
        // USCI_A0 TX buffer ready?
        while (!USCI_A_SPI_interruptStatus(USCI_A0_BASE, UCTXIFG));

        receiveData = USCI_A_SPI_receiveData(USCI_A0_BASE);

        // Increment data
        transmitData++;

        // Send next value
        USCI_A_SPI_transmitData(USCI_A0_BASE, transmitData);

        //Delay between transmissions for slave to process information
        __delay_cycles(40);

        break;
         default: break;
    }
}
```

44 USCI Synchronous Peripheral Interface (USCI_B_SPI)

44.1 Introduction

The Serial Peripheral Interface Bus or USCI_B_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 3-wire USCI_B_SPI communication

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

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

44.2 API Functions

Functions

- bool USCI_B_SPI_initMaster (uint16_t baseAddress, USCI_B_SPI_initMasterParam *param)
  Initializes the SPI Master block.
- void USCI_B_SPI_changeMasterClock (uint16_t baseAddress, USCI_B_SPI_changeMasterClockParam *param)
  Initializes the SPI Master clock.At the end of this function call, SPI module is left enabled.
- bool USCI_B_SPI_initSlave (uint16_t baseAddress, uint8_t msbFirst, uint8_t clockPhase, uint8_t clockPolarity)
  Initializes the SPI Slave block.
- void USCI_B_SPI_changeClockPhasePolarity (uint16_t baseAddress, uint8_t clockPhase, uint8_t clockPolarity)
  Changes the SPI clock phase and polarity.At the end of this function call, SPI module is left enabled.
- void USCI_B_SPI_transmitData (uint16_t baseAddress, uint8_t transmitData)
  Transmits a byte from the SPI Module.
- uint8_t USCI_B_SPI_receiveData (uint16_t baseAddress)
  Receives a byte that has been sent to the SPI Module.
- void USCI_B_SPI_enableInterrupt (uint16_t baseAddress, uint8_t mask)
  Enables individual SPI interrupt sources.
- void USCI_B_SPI_disableInterrupt (uint16_t baseAddress, uint8_t mask)
  Disables individual SPI interrupt sources.
- uint8_t USCI_B_SPI_getInterruptStatus (uint16_t baseAddress, uint8_t mask)
  Gets the current SPI interrupt status.
- void USCI_B_SPI_clearInterrupt (uint16_t baseAddress, uint8_t mask)
  Clears the selected SPI interrupt status flag.

- void USCI_B_SPI_enable (uint16_t baseAddress)
  Enables the SPI block.
- void USCI_B_SPI_disable (uint16_t baseAddress)
  Disables the SPI block.
- uint32_t USCI_B_SPI_getReceiveBufferAddressForDMA (uint16_t baseAddress)
  Returns the address of the RX Buffer of the SPI for the DMA module.
- uint32_t USCI_B_SPI_getTransmitBufferAddressForDMA (uint16_t baseAddress)
  Returns the address of the TX Buffer of the SPI for the DMA module.
- uint8_t USCI_B_SPI_isBusy (uint16_t baseAddress)
  Indicates whether or not the SPI bus is busy.

44.2.1 Detailed Description

To use the module as a master, the user must call USCI_B_SPI_initMaster() to configure the USCI_B_SPI Master. This is followed by enabling the USCI_B_SPI module using USCI_B_SPI_enable(). The interrupts are then enabled (if needed). **It** is recommended to enable the USCI_B_SPI module before enabling the interrupts. A data transmit is then initiated using USCI_B_SPI_transmitData() and then when the receive flag is set, the received data is read using USCI_B_SPI_receiveData() and this indicates that an RX/TX operation is complete.

To use the module as a slave, initialization is done using USCI_B_SPI_initSlave() and this is followed by enabling the module using USCI_B_SPI_enable(). Following this, the interrupts may be enabled as needed. When the receive flag is set, data is first transmitted using USCI_B_SPI_transmitData() and this is followed by a data reception by USCI_B_SPI_receiveData()

The USCI_B_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 USCI_B_SPI module are managed by

- USCI_B_SPI_initMaster()
- USCI_B_SPI_initSlave()
- USCI_B_SPI_disable()
- USCI_B_SPI_enable()
- USCI_B_SPI_masterChangeClock()
- USCI_B_SPI_isBusy()

Data handling is done by

- USCI_B_SPI_transmitData()
- USCI_B_SPI_receiveData()

Interrupts from the USCI_B_SPI module are managed using

- USCI_B_SPI_disableInterrupt()
- USCI_B_SPI_enableInterrupt()
- USCI_B_SPI_getInterruptStatus()
- USCI_B_SPI_clearInterrupt()

DMA related

- USCI_B_SPI_getReceiveBufferAddressForDMA()
- USCI_B_SPI_getTransmitBufferAddressForDMA()

44.2.2 Function Documentation

USCI_B_SPI_changeClockPhasePolarity()

```
void USCI_B_SPI_changeClockPhasePolarity (
            uint16_t baseAddress,
            uint8_t clockPhase,
            uint8_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 I2C Master module.
clockPhase	is clock phase select. Valid values are: ■ **USCI_B_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON_NEXT** [Default] ■ **USCI_B_SPI_PHASE_DATA_CAPTURED_ONFIRST_CHANGED_ON_NEXT**
clockPolarity	Valid values are: ■ **USCI_B_SPI_CLOCKPOLARITY_INACTIVITY_HIGH** ■ **USCI_B_SPI_CLOCKPOLARITY_INACTIVITY_LOW** [Default]

Modified bits are **UCCKPL** and **UCCKPH** of **UCAxCTL0** register.

Returns

None

USCI_B_SPI_changeMasterClock()

```
void USCI_B_SPI_changeMasterClock (
            uint16_t baseAddress,
            USCI_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 I2C Master module.
param	is the pointer to struct for master clock setting.

Modified bits of **UCAxBRW** register.

Returns

None

References USCI_B_SPI_changeMasterClockParam::clockSourceFrequency, and USCI_B_SPI_changeMasterClockParam::desiredSpiClock.

USCI_B_SPI_clearInterrupt()

```
void USCI_B_SPI_clearInterrupt (
            uint16_t baseAddress,
            uint8_t mask )
```

Clears the selected SPI interrupt status flag.

Parameters

baseAddress	is the base address of the SPI module.
mask	is the masked interrupt flag to be cleared. Valid values are: ■ **USCI_B_SPI_TRANSMIT_INTERRUPT** ■ **USCI_B_SPI_RECEIVE_INTERRUPT**

Modified bits of **UCBxIFG** register.

Returns

None

USCI_B_SPI_disable()

```
void USCI_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 USCI SPI module.

Modified bits are **UCSWRST** of **UCBxCTL1** register.

Returns

None

USCI_B_SPI_disableInterrupt()

```
void USCI_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 SPI module.
mask	is the bit mask of the interrupt sources to be disabled. Valid values are: ■ **USCI_B_SPI_TRANSMIT_INTERRUPT** ■ **USCI_B_SPI_RECEIVE_INTERRUPT**

Modified bits of **UCBxIE** register.

Returns

None

USCI_B_SPI_enable()

```
void USCI_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 USCI SPI module.

Modified bits are **UCSWRST** of **UCBxCTL1** register.

Returns

None

USCI_B_SPI_enableInterrupt()

```
void USCI_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 SPI module.**
mask	**is the bit mask of the interrupt sources to be enabled. Valid values are:** ■ **USCI_B_SPI_TRANSMIT_INTERRUPT** ■ **USCI_B_SPI_RECEIVE_INTERRUPT**

Modified bits of UCBxIE register.

Returns

None

USCI_B_SPI_getInterruptStatus()

```
uint8_t USCI_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 SPI module.
mask	is the masked interrupt flag status to be returned. Valid values are: ■ **USCI_B_SPI_TRANSMIT_INTERRUPT** ■ **USCI_B_SPI_RECEIVE_INTERRUPT**

Returns

The current interrupt status as the mask of the set flags Return Logical OR of any of the following:

- **USCI_B_SPI_TRANSMIT_INTERRUPT**
- **USCI_B_SPI_RECEIVE_INTERRUPT**

indicating the status of the masked interrupts

USCI_B_SPI_getReceiveBufferAddressForDMA()

```
uint32_t USCI_B_SPI_getReceiveBufferAddressForDMA (
            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 SPI module.

Returns

The address of the SPI RX buffer

USCI_B_SPI_getTransmitBufferAddressForDMA()

```
uint32_t USCI_B_SPI_getTransmitBufferAddressForDMA (
            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 SPI module.

Returns

The address of the SPI TX buffer

USCI_B_SPI_initMaster()

```
bool USCI_B_SPI_initMaster (
            uint16_t baseAddress,
            USCI_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 USCI_B_SPI_enable()

Parameters

baseAddress	is the base address of the I2C Master module.
param	is the pointer to struct for master initialization.

Modified bits are **UCSSELx** and **UCSWRST** of **UCBxCTL1** register; bits **UCCKPH**, **UCCKPL**, **UC7BIT** and **UCMSB** of **UCBxCTL0** register.

Returns

STATUS_SUCCESS

References USCI_B_SPI_initMasterParam::clockPhase, USCI_B_SPI_initMasterParam::clockPolarity, USCI_B_SPI_initMasterParam::clockSourceFrequency, USCI_B_SPI_initMasterParam::desiredSpiClock, USCI_B_SPI_initMasterParam::msbFirst, and USCI_B_SPI_initMasterParam::selectClockSource.

USCI_B_SPI_initSlave()

```
bool USCI_B_SPI_initSlave (
            uint16_t baseAddress,
            uint8_t msbFirst,
            uint8_t clockPhase,
            uint8_t clockPolarity )
```

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 USCI_B_SPI_enable()

Parameters

baseAddress	is the base address of the SPI Slave module.
msbFirst	controls the direction of the receive and transmit shift register. Valid values are: ■ **USCI_B_SPI_MSB_FIRST** ■ **USCI_B_SPI_LSB_FIRST** [Default]
clockPhase	is clock phase select. Valid values are: ■ **USCI_B_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON↩_NEXT** [Default] ■ **USCI_B_SPI_PHASE_DATA_CAPTURED_ONFIRST_CHANGED_ON↩_NEXT**
clockPolarity	Valid values are: ■ **USCI_B_SPI_CLOCKPOLARITY_INACTIVITY_HIGH** ■ **USCI_B_SPI_CLOCKPOLARITY_INACTIVITY_LOW** [Default]

Modified bits are **UCSWRST** of **UCBxCTL1** register; bits **UCMSB**, **UCMST**, **UC7BIT**, **UCCKPL**, **UCCKPH** and **UCMODE** of **UCBxCTL0** register.

Returns

STATUS_SUCCESS

USCI_B_SPI_isBusy()

```
uint8_t USCI_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 SPI module.

Returns

USCI_B_SPI_BUSY if the SPI module transmitting or receiving is busy; otherwise, returns USCI_B_SPI_NOT_BUSY. Return one of the following:

- **USCI_B_SPI_BUSY**
- **USCI_B_SPI_NOT_BUSY**
  indicating if the USCI_B_SPI is busy

USCI_B_SPI_receiveData()

```
uint8_t USCI_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 SPI module.

Returns

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

USCI_B_SPI_transmitData()

```
void USCI_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 SPI module.
transmitData	data to be transmitted from the SPI module

Returns

None

44.3 Programming Example

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

```
  //Initialize Master
    USCI_B_SPI_initMasterParam param = {0};
    param.selectClockSource = USCI_B_SPI_CLOCKSOURCE_SMCLK;
    param.clockSourceFrequency = UCS_getSMCLK();
    param.desiredSpiClock = SPICLK;
    param.msbFirst = USCI_B_SPI_MSB_FIRST;
    param.clockPhase = USCI_B_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON_NEXT;
    param.clockPolarity = USCI_B_SPI_CLOCKPOLARITY_INACTIVITY_HIGH;
    returnValue =  USCI_B_SPI_initMaster(USCI_B0_BASE, &param);

    if (STATUS_FAIL == returnValue){
        return;
    }

      //Enable USCI_B_SPI module
      USCI_B_SPI_enable(USCI_A0_BASE);

      //Enable Receive interrupt
      USCI_B_SPI_enableInterrupt(USCI_A0_BASE, UCRXIE);

      //Configure port pins to reset slave

      // Wait for slave to initialize
      __delay_cycles(100);

      // Initialize data values
      transmitData = 0x00;

      // USCI_A0 TX buffer ready?
      while (!USCI_B_SPI_interruptStatus(USCI_A0_BASE, UCTXIFG));

      //Transmit Data to slave
      USCI_B_SPI_transmitData(USCI_A0_BASE, transmitData);

      // CPU off, enable interrupts
      __bis_SR_register(LPM0_bits + GIE);
}

//******************************************************************************
//
// This is the USCI_B0 interrupt vector service routine.
//
//******************************************************************************
#pragma vector=USCI_B0_VECTOR
__interrupt void USCI_B0_ISR(void)
{
  switch(__even_in_range(UCA0IV,4))
  {
    // Vector 2 - RXIFG
    case 2:
```

```
        // USCI_A0 TX buffer ready?
        while (!USCI_B_SPI_interruptStatus(USCI_A0_BASE, UCTXIFG));

        receiveData = USCI_B_SPI_receiveData(USCI_A0_BASE);

        // Increment data
        transmitData++;

        // Send next value
        USCI_B_SPI_transmitData(USCI_A0_BASE, transmitData);

        //Delay between transmissions for slave to process information
        __delay_cycles(40);

        break;
         default: break;
      }
    }
```

45 USCI Inter-Integrated Circuit (USCI_B_I2C)

45.1 Introduction

The Inter-Integrated Circuit (USCI_B_I2C) API provides a set of functions for using the MSP430Ware USCI_B_I2C modules. Functions are provided to initialize the USCI_B_I2C modules, to send and receive data, obtain status, and to manage interrupts for the USCI_B_I2C modules.

The USCI_B_I2C module provide the ability to communicate to other IC devices over an USCI_B_I2C bus. The USCI_B_I2C bus is specified to support devices that can both transmit and receive (write and read) data. Also, devices on the USCI_B_I2C bus can be designated as either a master or a slave. The MSP430Ware USCI_B_I2C modules support both sending and receiving data as either a master or a slave, and also support the simultaneous operation as both a master and a slave. Finally, the MSP430Ware USCI_B_I2C modules can operate at two speeds: Standard (100 kb/s) and Fast (400 kb/s).

USCI_B_I2C module can generate interrupts. The USCI_B_I2C module configured as a master will generate interrupts when a transmit or receive operation is completed (or aborted due to an error). The USCI_B_I2C module configured as a slave will generate interrupts when data has been sent or requested by a master.

45.2 Master Operations

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

- **USCI_B_I2C_initMaster()**
- **USCI_B_I2C_setSlaveAddress()**
- **USCI_B_I2C_setMode()**
- **USCI_B_I2C_enable()**
- **USCI_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 USCI_B_I2C module and configure it as a master with a call to USCI_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 USCI_B_I2C_setSlaveAddress. Then the mode of operation (transmit or receive) is chosen using USCI_B_I2C_setMode. The USCI_B_I2C module may now be enabled using USCI_B_I2C_enable. It is recommended to enable the USCI_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. APIs that include a time-out can be used to avoid being stuck in an infinite loop if the device is stuck waiting for an IFG flag to be set.

Master Single Byte Transmission

- USCI_B_I2C_masterSendSingleByte()

Master Multiple Byte Transmission

- USCI_B_I2C_masterSendMultiByteStart()
- USCI_B_I2C_masterSendMultiByteNext()
- USCI_B_I2C_masterSendMultiByteFinish()
- USCI_B_I2C_masterSendMultiByteStop()

Master Single Byte Reception

- USCI_B_I2C_masterReceiveSingleStart()
- USCI_B_I2C_masterReceiveSingle()

Master Multiple Byte Reception

- USCI_B_I2C_masterReceiveMultiByteStart()
- USCI_B_I2C_masterReceiveMultiByteNext()
- USCI_B_I2C_masterReceiveMultiByteFinish()
- USCI_B_I2C_masterReceiveMultiByteStop()

Master Single Byte Transmission with Time-out

- USCI_B_I2C_masterSendSingleByteWithTimeout()

Master Multiple Byte Transmission with Time-out

- USCI_B_I2C_masterSendMultiByteStartWithTimeout()
- USCI_B_I2C_masterSendMultiByteNextWithTimeout()
- USCI_B_I2C_masterReceiveMultiByteFinishWithTimeout()
- USCI_B_I2C_masterSendMultiByteStopWithTimeout()

Master Single Byte Reception with Time-out
USCI_B_I2C_masterReceiveSingleStartWithTimeout()

For the interrupt-driven transaction, the user must register an interrupt handler for the USCI_B_I2C devices and enable the USCI_B_I2C interrupt.

45.3 Slave Operations

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

- **USCI_B_I2C_initSlave()**
- **USCI_B_I2C_setMode()**
- **USCI_B_I2C_enable()**

- **USCI_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 USCI_B_I2C_initSlave to initialize the slave module in USCI_B_I2C mode and set the slave address. This is followed by a call to set the mode of operation (transmit or receive).The USCI_B_I2C module may now be enabled using USCI_B_I2C_enable() It is recommended to enable the USCI_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.

Slave Transmission API

- USCI_B_I2C_slavePutData()

Slave Reception API

- USCI_B_I2C_slaveGetData()

For the interrupt-driven transaction, the user must register an interrupt handler for the USCI_B_I2C devices and enable the USCI_B_I2C interrupt.

45.4 API Functions

Functions

- void USCI_B_I2C_initMaster (uint16_t baseAddress, USCI_B_I2C_initMasterParam *param)
  Initializes the I2C Master block.
- void USCI_B_I2C_initSlave (uint16_t baseAddress, uint8_t slaveAddress)
  Initializes the I2C Slave block.
- void USCI_B_I2C_enable (uint16_t baseAddress)
  Enables the I2C block.
- void USCI_B_I2C_disable (uint16_t baseAddress)
  Disables the I2C block.
- void USCI_B_I2C_setSlaveAddress (uint16_t baseAddress, uint8_t slaveAddress)
  Sets the address that the I2C Master will place on the bus.
- void USCI_B_I2C_setMode (uint16_t baseAddress, uint8_t mode)
  Sets the mode of the I2C device.
- void USCI_B_I2C_slavePutData (uint16_t baseAddress, uint8_t transmitData)
  Transmits a byte from the I2C Module.
- uint8_t USCI_B_I2C_slaveGetData (uint16_t baseAddress)
  Receives a byte that has been sent to the I2C Module.
- uint8_t USCI_B_I2C_isBusBusy (uint16_t baseAddress)
  Indicates whether or not the I2C bus is busy.
- uint8_t USCI_B_I2C_isBusy (uint16_t baseAddress)
  DEPRECATED - Function may be removed in future release. Indicates whether or not the I2C module is busy.
- uint8_t USCI_B_I2C_masterIsStopSent (uint16_t baseAddress)
  Indicates whether STOP got sent.
- uint8_t USCI_B_I2C_masterIsStartSent (uint16_t baseAddress)
  Indicates whether START got sent.

- void USCI_B_I2C_masterSendStart (uint16_t baseAddress)
  This function is used by the Master module to initiate START.
- void USCI_B_I2C_enableInterrupt (uint16_t baseAddress, uint8_t mask)
  Enables individual I2C interrupt sources.
- void USCI_B_I2C_disableInterrupt (uint16_t baseAddress, uint8_t mask)
  Disables individual I2C interrupt sources.
- void USCI_B_I2C_clearInterrupt (uint16_t baseAddress, uint8_t mask)
  Clears I2C interrupt sources.
- uint8_t USCI_B_I2C_getInterruptStatus (uint16_t baseAddress, uint8_t mask)
  Gets the current I2C interrupt status.
- void USCI_B_I2C_masterSendSingleByte (uint16_t baseAddress, uint8_t txData)
  Does single byte transmission from Master to Slave.
- bool USCI_B_I2C_masterSendSingleByteWithTimeout (uint16_t baseAddress, uint8_t txData, uint32_t timeout)
  Does single byte transmission from Master to Slave with timeout.
- void USCI_B_I2C_masterSendMultiByteStart (uint16_t baseAddress, uint8_t txData)
  Starts multi-byte transmission from Master to Slave.
- bool USCI_B_I2C_masterSendMultiByteStartWithTimeout (uint16_t baseAddress, uint8_t txData, uint32_t timeout)
  Starts multi-byte transmission from Master to Slave with timeout.
- void USCI_B_I2C_masterSendMultiByteNext (uint16_t baseAddress, uint8_t txData)
  Continues multi-byte transmission from Master to Slave.
- bool USCI_B_I2C_masterSendMultiByteNextWithTimeout (uint16_t baseAddress, uint8_t txData, uint32_t timeout)
  Continues multi-byte transmission from Master to Slave with timeout.
- void USCI_B_I2C_masterSendMultiByteFinish (uint16_t baseAddress, uint8_t txData)
  Finishes multi-byte transmission from Master to Slave.
- bool USCI_B_I2C_masterSendMultiByteFinishWithTimeout (uint16_t baseAddress, uint8_t txData, uint32_t timeout)
  Finishes multi-byte transmission from Master to Slave with timeout.
- void USCI_B_I2C_masterSendMultiByteStop (uint16_t baseAddress)
  Send STOP byte at the end of a multi-byte transmission from Master to Slave.
- bool USCI_B_I2C_masterSendMultiByteStopWithTimeout (uint16_t baseAddress, uint32_t timeout)
  Send STOP byte at the end of a multi-byte transmission from Master to Slave with timeout.
- void USCI_B_I2C_masterReceiveMultiByteStart (uint16_t baseAddress)
  Starts multi-byte reception at the Master end.
- uint8_t USCI_B_I2C_masterReceiveMultiByteNext (uint16_t baseAddress)
  Starts multi-byte reception at the Master end one byte at a time.
- uint8_t USCI_B_I2C_masterReceiveMultiByteFinish (uint16_t baseAddress)
  Finishes multi-byte reception at the Master end.
- bool USCI_B_I2C_masterReceiveMultiByteFinishWithTimeout (uint16_t baseAddress, uint8_t ∗rxData, uint32_t timeout)
  Finishes multi-byte reception at the Master end with timeout.
- void USCI_B_I2C_masterReceiveMultiByteStop (uint16_t baseAddress)
  Sends the STOP at the end of a multi-byte reception at the Master end.
- void USCI_B_I2C_masterReceiveSingleStart (uint16_t baseAddress)
  Initiates a single byte Reception at the Master End.
- bool USCI_B_I2C_masterReceiveSingleStartWithTimeout (uint16_t baseAddress, uint32_t timeout)
  Initiates a single byte Reception at the Master End with timeout.
- uint8_t USCI_B_I2C_masterReceiveSingle (uint16_t baseAddress)
  Receives a byte that has been sent to the I2C Master Module.

- uint32_t USCI_B_I2C_getReceiveBufferAddressForDMA (uint16_t baseAddress)
  Returns the address of the RX Buffer of the I2C for the DMA module.
- uint32_t USCI_B_I2C_getTransmitBufferAddressForDMA (uint16_t baseAddress)
  Returns the address of the TX Buffer of the I2C for the DMA module.

45.4.1 Detailed Description

The USCI_B_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 USCI_B_I2C master and slave interrupts and status are handled by

- USCI_B_I2C_enableInterrupt()
- USCI_B_I2C_disableInterrupt()
- USCI_B_I2C_clearInterrupt()
- USCI_B_I2C_getInterruptStatus()
- USCI_B_I2C_masterIsStopSent()
- USCI_B_I2C_masterIsStartSent()

Status and initialization functions for the USCI_B_I2C modules are

- USCI_B_I2C_initMaster()
- USCI_B_I2C_enable()
- USCI_B_I2C_disable()
- USCI_B_I2C_isBusBusy()
- USCI_B_I2C_isBusy()
- USCI_B_I2C_initSlave()
- USCI_B_I2C_interruptStatus()
- USCI_B_I2C_setSlaveAddress()
- USCI_B_I2C_setMode()

Sending and receiving data from the USCI_B_I2C slave module is handled by

- USCI_B_I2C_slavePutData()
- USCI_B_I2C_slaveGetData()

Sending and receiving data from the USCI_B_I2C slave module is handled by

- USCI_B_I2C_masterSendSingleByte()
- USCI_B_I2C_masterSendMultiByteStart()
- USCI_B_I2C_masterSendMultiByteNext()
- USCI_B_I2C_masterSendMultiByteFinish()
- USCI_B_I2C_masterSendMultiByteStop()
- USCI_B_I2C_masterReceiveMultiByteStart()
- USCI_B_I2C_masterReceiveMultiByteNext()
- USCI_B_I2C_masterReceiveMultiByteFinish()

- USCI_B_I2C_masterReceiveMultiByteStop()
- USCI_B_I2C_masterReceiveSingleStart()
- USCI_B_I2C_masterReceiveSingle()
- USCI_B_I2C_getReceiveBufferAddressForDMA()
- USCI_B_I2C_getTransmitBufferAddressForDMA()

DMA related

- USCI_B_I2C_getReceiveBufferAddressForDMA()
- USCI_B_I2C_getTransmitBufferAddressForDMA()

45.4.2 Function Documentation

USCI_B_I2C_clearInterrupt()

```
void USCI_B_I2C_clearInterrupt (
            uint16_t baseAddress,
            uint8_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 Slave module.
mask	is a bit mask of the interrupt sources to be cleared. Mask value is the logical OR of any of the following: ■ **USCI_B_I2C_STOP_INTERRUPT** - STOP condition interrupt ■ **USCI_B_I2C_START_INTERRUPT** - START condition interrupt ■ **USCI_B_I2C_RECEIVE_INTERRUPT** - Receive interrupt ■ **USCI_B_I2C_TRANSMIT_INTERRUPT** - Transmit interrupt ■ **USCI_B_I2C_NAK_INTERRUPT** - Not-acknowledge interrupt ■ **USCI_B_I2C_ARBITRATIONLOST_INTERRUPT** - Arbitration lost interrupt

Modified bits of **UCBxIFG** register.

Returns

None

USCI_B_I2C_disable()

```
void USCI_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 **UCBxCTL1** register.

Returns

None

USCI_B_I2C_disableInterrupt()

```
void USCI_B_I2C_disableInterrupt (
            uint16_t baseAddress,
            uint8_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: ■ **USCI_B_I2C_STOP_INTERRUPT** - STOP condition interrupt ■ **USCI_B_I2C_START_INTERRUPT** - START condition interrupt ■ **USCI_B_I2C_RECEIVE_INTERRUPT** - Receive interrupt ■ **USCI_B_I2C_TRANSMIT_INTERRUPT** - Transmit interrupt ■ **USCI_B_I2C_NAK_INTERRUPT** - Not-acknowledge interrupt ■ **USCI_B_I2C_ARBITRATIONLOST_INTERRUPT** - Arbitration lost interrupt

Modified bits of **UCBxIE** register.

Returns

None

USCI_B_I2C_enable()

```
void USCI_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 **UCBxCTL1** register.

Returns

None

USCI_B_I2C_enableInterrupt()

```
void USCI_B_I2C_enableInterrupt (
            uint16_t baseAddress,
            uint8_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. Does not clear interrupt flags.

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: ▪ **USCI_B_I2C_STOP_INTERRUPT** - STOP condition interrupt ▪ **USCI_B_I2C_START_INTERRUPT** - START condition interrupt ▪ **USCI_B_I2C_RECEIVE_INTERRUPT** - Receive interrupt ▪ **USCI_B_I2C_TRANSMIT_INTERRUPT** - Transmit interrupt ▪ **USCI_B_I2C_NAK_INTERRUPT** - Not-acknowledge interrupt ▪ **USCI_B_I2C_ARBITRATIONLOST_INTERRUPT** - Arbitration lost interrupt

Modified bits of **UCBxIE** register.

Returns

None

USCI_B_I2C_getInterruptStatus()

```
uint8_t USCI_B_I2C_getInterruptStatus (
            uint16_t baseAddress,
            uint8_t mask )
```

Gets the current I2C interrupt status.

This returns the interrupt status for the I2C module based on which flag is passed. mask parameter can be logic OR of any of the following selection.

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: ■ **USCI_B_I2C_STOP_INTERRUPT** - STOP condition interrupt ■ **USCI_B_I2C_START_INTERRUPT** - START condition interrupt ■ **USCI_B_I2C_RECEIVE_INTERRUPT** - Receive interrupt ■ **USCI_B_I2C_TRANSMIT_INTERRUPT** - Transmit interrupt ■ **USCI_B_I2C_NAK_INTERRUPT** - Not-acknowledge interrupt ■ **USCI_B_I2C_ARBITRATIONLOST_INTERRUPT** - Arbitration lost interrupt

Returns

the masked status of the interrupt flag Return Logical OR of any of the following:

- **USCI_B_I2C_STOP_INTERRUPT** STOP condition interrupt
- **USCI_B_I2C_START_INTERRUPT** START condition interrupt
- **USCI_B_I2C_RECEIVE_INTERRUPT** Receive interrupt
- **USCI_B_I2C_TRANSMIT_INTERRUPT** Transmit interrupt
- **USCI_B_I2C_NAK_INTERRUPT** Not-acknowledge interrupt
- **USCI_B_I2C_ARBITRATIONLOST_INTERRUPT** Arbitration lost interrupt indicating the status of the masked interrupts

USCI_B_I2C_getReceiveBufferAddressForDMA()

```
uint32_t USCI_B_I2C_getReceiveBufferAddressForDMA (
            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 RX Buffer

USCI_B_I2C_getTransmitBufferAddressForDMA()

```
uint32_t USCI_B_I2C_getTransmitBufferAddressForDMA (
            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 TX Buffer

USCI_B_I2C_initMaster()

```
void USCI_B_I2C_initMaster (
            uint16_t baseAddress,
            USCI_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 USCI_B_I2C_enable is invoked. If the parameter *dataRate* is USCI_B_I2C_SET_DATA_RATE_400KBPS, then the master block will be set up to transfer data at 400 kbps; otherwise, it will be set up to transfer data at 100 kbps.

Parameters

baseAddress	is the base address of the I2C Master module.
param	is the pointe to struct for master initialization.

Modified bits are **UCBxBR0** of **UCBxBR1** register; bits **UCSSELx** and **UCSWRST** of **UCBxCTL1** register; bits **UCMST**, **UCMODE_3** and **UCSYNC** of **UCBxCTL0** register.

Returns

None

References USCI_B_I2C_initMasterParam::dataRate, USCI_B_I2C_initMasterParam::i2cClk, and USCI_B_I2C_initMasterParam::selectClockSource.

USCI_B_I2C_initSlave()

```
void USCI_B_I2C_initSlave (
            uint16_t baseAddress,
            uint8_t slaveAddress )
```

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 USCI_B_I2C_enable is invoked.

Parameters

baseAddress	is the base address of the I2C Slave module.
slaveAddress	7-bit slave address

Modified bits of **UCBxI2COA** register; bits **UCSWRST** of **UCBxCTL1** register; bits **UCMODE_3** and **UCSYNC** of **UCBxCTL0** register.

Returns

None

USCI_B_I2C_isBusBusy()

```
uint8_t USCI_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

Returns USCI_B_I2C_BUS_BUSY if the I2C Master is busy; otherwise, returns USCI_B_I2C_BUS_NOT_BUSY. Return one of the following:

- **USCI_B_I2C_BUS_BUSY**
- **USCI_B_I2C_BUS_NOT_BUSY**
  indicating if the USCI_B_I2C is busy

USCI_B_I2C_isBusy()

```
uint8_t USCI_B_I2C_isBusy (
            uint16_t baseAddress )
```

DEPRECATED - Function may be removed in future release. Indicates whether or not the I2C module is busy.

This function returns an indication of whether or not the I2C module is busy transmitting or receiving data. This function checks if the Transmit or receive flag is set.

Parameters

baseAddress	is the base address of the I2C module.

Returns

Returns USCI_B_I2C_BUS_BUSY if the I2C module is busy; otherwise, returns USCI_B_I2C_BUS_NOT_BUSY. Return one of the following:
- **USCI_B_I2C_BUS_BUSY**
- **USCI_B_I2C_BUS_NOT_BUSY**
  indicating if the USCI_B_I2C is busy

USCI_B_I2C_masterIsStartSent()

```
uint8_t USCI_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 module.

Returns

Returns USCI_B_I2C_START_SEND_COMPLETE if the I2C Master finished sending START; otherwise, returns USCI_B_I2C_SENDING_START. Return one of the following:
- **USCI_B_I2C_SENDING_START**
- **USCI_B_I2C_START_SEND_COMPLETE**

USCI_B_I2C_masterIsStopSent()

```
uint8_t USCI_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 module.

Returns

Returns USCI_B_I2C_STOP_SEND_COMPLETE if the I2C Master finished sending STOP; otherwise, returns USCI_B_I2C_SENDING_STOP. Return one of the following:

- **USCI_B_I2C_SENDING_STOP**
- **USCI_B_I2C_STOP_SEND_COMPLETE**

USCI_B_I2C_masterReceiveMultiByteFinish()

```
uint8_t USCI_B_I2C_masterReceiveMultiByteFinish (
            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 does the following: - 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 **UCBxCTL1** register.

Returns

Received byte at Master end.

USCI_B_I2C_masterReceiveMultiByteFinishWithTimeout()

```
bool USCI_B_I2C_masterReceiveMultiByteFinishWithTimeout (
            uint16_t baseAddress,
            uint8_t * rxData,
            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 does the following: - Receives the current byte and initiates the STOP from Master to Slave

Parameters

baseAddress	is the base address of the I2C Master module.

Parameters

rxData	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 **UCBxCTL1** register.

Returns

STATUS_SUCCESS or STATUS_FAILURE of the transmission process.

USCI_B_I2C_masterReceiveMultiByteNext()

```
uint8_t USCI_B_I2C_masterReceiveMultiByteNext (
            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.

USCI_B_I2C_masterReceiveMultiByteStart()

```
void USCI_B_I2C_masterReceiveMultiByteStart (
            uint16_t baseAddress )
```

Starts multi-byte reception at the Master end.

This function is used by the Master module initiate reception of a single byte. This function does the following: - Sends START

Parameters

baseAddress	is the base address of the I2C Master module.

Modified bits are **UCTXSTT** of **UCBxCTL1** register.

Returns

None

USCI_B_I2C_masterReceiveMultiByteStop()

```
void USCI_B_I2C_masterReceiveMultiByteStop (
            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 **UCBxCTL1** register.

Returns

None

USCI_B_I2C_masterReceiveSingle()

```
uint8_t USCI_B_I2C_masterReceiveSingle (
            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 module.

Returns

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

USCI_B_I2C_masterReceiveSingleStart()

```
void USCI_B_I2C_masterReceiveSingleStart (
            uint16_t baseAddress )
```

Initiates a single byte Reception at the Master End.

This function sends a START and STOP immediately to indicate Single byte reception

Parameters

baseAddress	is the base address of the I2C Master module.

Modified bits are **GIE** of **SR** register; bits **UCTXSTT** and **UCTXSTP** of **UCBxCTL1** register.

Returns

None

USCI_B_I2C_masterReceiveSingleStartWithTimeout()

```
bool USCI_B_I2C_masterReceiveSingleStartWithTimeout (
            uint16_t baseAddress,
            uint32_t timeout )
```

Initiates a single byte Reception at the Master End with timeout.

This function sends a START and STOP immediately to indicate Single byte reception

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 **GIE** of **SR** register; bits **UCTXSTT** and **UCTXSTP** of **UCBxCTL1** register.

Returns

STATUS_SUCCESS or STATUS_FAILURE of the transmission process.

USCI_B_I2C_masterSendMultiByteFinish()

```
void USCI_B_I2C_masterSendMultiByteFinish (
            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 does the following: - Transmits the last data byte of a multi-byte transmission to the Slave; - Sends 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 **UCBxCTL1** register.

Returns

None

USCI_B_I2C_masterSendMultiByteFinishWithTimeout()

```
bool USCI_B_I2C_masterSendMultiByteFinishWithTimeout (
            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 does the following: - Transmits the last data byte of a multi-byte transmission to the Slave; - Sends 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 **UCBxCTL1** register.

Returns

STATUS_SUCCESS or STATUS_FAILURE of the transmission process.

USCI_B_I2C_masterSendMultiByteNext()

```
void USCI_B_I2C_masterSendMultiByteNext (
            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 does the following: -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

USCI_B_I2C_masterSendMultiByteNextWithTimeout()

```
bool USCI_B_I2C_masterSendMultiByteNextWithTimeout (
            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 does the following: -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.

USCI_B_I2C_masterSendMultiByteStart()

```
void USCI_B_I2C_masterSendMultiByteStart (
            uint16_t baseAddress,
            uint8_t txData )
```

Starts multi-byte transmission from Master to Slave.

This function is used by the Master module to send a single byte. This function does the following: - Sends START; - Transmits the first data byte of a multi-byte transmission to the Slave

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 **UCBxIFG** register, bits of **UCBxCTL1** register and bits of **UCBxIE** register.

Returns

None

USCI_B_I2C_masterSendMultiByteStartWithTimeout()

```
bool USCI_B_I2C_masterSendMultiByteStartWithTimeout (
            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 send a single byte. This function does the following: - Sends START; - Transmits the first data byte of a multi-byte transmission to the Slave

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

Returns

STATUS_SUCCESS or STATUS_FAILURE of the transmission process.

USCI_B_I2C_masterSendMultiByteStop()

```
void USCI_B_I2C_masterSendMultiByteStop (
            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 does the following: - Sends a STOP after current transmission is complete

Parameters

baseAddress	is the base address of the I2C Master module.

Modified bits are **UCTXSTP** of **UCBxCTL1** register.

Returns

None

USCI_B_I2C_masterSendMultiByteStopWithTimeout()

```
bool USCI_B_I2C_masterSendMultiByteStopWithTimeout (
            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 does the following: - 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 **UCBxCTL1** register.

Returns

STATUS_SUCCESS or STATUS_FAILURE of the transmission process.

USCI_B_I2C_masterSendSingleByte()

```
void USCI_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 does the following: - Sends START; - Transmits the byte to the Slave; - Sends 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 **UCBxIFG** register, bits of **UCBxCTL1** register and bits of **UCBxIE** register.

Returns

None

USCI_B_I2C_masterSendSingleByteWithTimeout()

```
bool USCI_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 does the following: - Sends START; - Transmits the byte to the Slave; - Sends 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 **UCBxIFG** register, bits of **UCBxCTL1** register and bits of **UCBxIE** register.

Returns

STATUS_SUCCESS or STATUS_FAILURE of the transmission process.

USCI_B_I2C_masterSendStart()

```
void USCI_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 STOP

Parameters

baseAddress	is the base address of the I2C Master module.

Returns

None

USCI_B_I2C_setMode()

```
void USCI_B_I2C_setMode (
            uint16_t baseAddress,
            uint8_t mode )
```

Sets the mode of the I2C device.

When the receive parameter is set to USCI_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 I2C Master module.
mode	indicates whether module is in transmit/receive mode Valid values are: ■ **USCI_B_I2C_TRANSMIT_MODE** ■ **USCI_B_I2C_RECEIVE_MODE** [Default]

Returns

None

USCI_B_I2C_setSlaveAddress()

```
void USCI_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 I2C Master module.
slaveAddress	7-bit slave address

Modified bits of **UCBxI2CSA** register; bits **UCSWRST** of **UCBxCTL1** register.

Returns

None

USCI_B_I2C_slaveGetData()

```
uint8_t USCI_B_I2C_slaveGetData (
            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 module.

Returns

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

USCI_B_I2C_slavePutData()

```
void USCI_B_I2C_slavePutData (
            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 Modified bit is UCBxTXBUF register

Parameters

baseAddress	is the base address of the I2C module.
transmitData	data to be transmitted from the I2C module

Modified bits of **UCBxTXBUF** register.

Returns

None

45.5 Programming Example

The following example shows how to use the USCI_B_I2C API to send data as a master.

```
  // Initialize Master
USCI_B_I2C_initMasterParam param = {0};
param.selectClockSource = USCI_B_I2C_CLOCKSOURCE_SMCLK;
param.i2cClk = UCS_getSMCLK();
param.dataRate = USCI_B_I2C_SET_DATA_RATE_400KBPS;
USCI_B_I2C_initMaster(USCI_B0_BASE, &param);


// Specify slave address
USCI_B_I2C_setSlaveAddress(USCI_B0_BASE, SLAVE_ADDRESS);

// Set in transmit mode
USCI_B_I2C_setMode(USCI_B0_BASE, USCI_B_I2C_TRANSMIT_MODE);

//Enable USCI_B_I2C Module to start operations
USCI_B_I2C_enable(USCI_B0_BASE);

while (1)
{
  // Send single byte data.
  USCI_B_I2C_masterSendSingleByte(USCI_B0_BASE, transmitData);

  // Delay until transmission completes
  while(USCI_B_I2C_busBusy(USCI_B0_BASE));

  // Increment transmit data counter
  transmitData++;
}
```

46 WatchDog Timer (WDT_A)

46.1 Introduction

The Watchdog Timer (WDT_A) API provides a set of functions for using the MSP430Ware WDT_A modules. 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_A module can generate only 1 kind of interrupt in timer interval mode. If in watchdog mode, then the WDT_A module will assert a reset once the timer has finished.

46.2 API Functions

Functions

- void WDT_A_hold (uint16_t baseAddress)
  Holds the Watchdog Timer.
- void WDT_A_start (uint16_t baseAddress)
  Starts the Watchdog Timer.
- void WDT_A_resetTimer (uint16_t baseAddress)
  Resets the timer counter of the Watchdog Timer.
- void WDT_A_initWatchdogTimer (uint16_t baseAddress, uint8_t clockSelect, uint8_t clockDivider)
  Sets the clock source for the Watchdog Timer in watchdog mode.
- void WDT_A_initIntervalTimer (uint16_t baseAddress, uint8_t clockSelect, uint8_t clockDivider)
  Sets the clock source for the Watchdog Timer in timer interval mode.

46.2.1 Detailed Description

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

- WDT_A_hold()
- WDT_A_start()
- WDT_A_clearCounter()
- WDT_A_initWatchdogTimer()
- WDT_A_initIntervalTimer()

46.2.2 Function Documentation

WDT_A_hold()

```
void WDT_A_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_A module.

Returns

None

WDT_A_initIntervalTimer()

```
void WDT_A_initIntervalTimer (
            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_A module.
clockSelect	is the clock source that the watchdog timer will use. Valid values are: ■ **WDT_A_CLOCKSOURCE_SMCLK** [Default] ■ **WDT_A_CLOCKSOURCE_ACLK** ■ **WDT_A_CLOCKSOURCE_VLOCLK** ■ **WDT_A_CLOCKSOURCE_XCLK** Modified bits are **WDTSSEL** of **WDTCTL** register.

Parameters

clockDivider	is the divider of the clock source, in turn setting the watchdog timer interval. Valid values are: ■ **WDT_A_CLOCKDIVIDER_2G** ■ **WDT_A_CLOCKDIVIDER_128M** ■ **WDT_A_CLOCKDIVIDER_8192K** ■ **WDT_A_CLOCKDIVIDER_512K** ■ **WDT_A_CLOCKDIVIDER_32K** [Default] ■ **WDT_A_CLOCKDIVIDER_8192** ■ **WDT_A_CLOCKDIVIDER_512** ■ **WDT_A_CLOCKDIVIDER_64** Modified bits are **WDTIS** and **WDTHOLD** of **WDTCTL** register.

Returns

None

WDT_A_initWatchdogTimer()

```
void WDT_A_initWatchdogTimer (
            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_A_resetTimer() before the timer runs out.

Parameters

baseAddress	is the base address of the WDT_A module.
clockSelect	is the clock source that the watchdog timer will use. Valid values are: ■ **WDT_A_CLOCKSOURCE_SMCLK** [Default] ■ **WDT_A_CLOCKSOURCE_ACLK** ■ **WDT_A_CLOCKSOURCE_VLOCLK** ■ **WDT_A_CLOCKSOURCE_XCLK** Modified bits are **WDTSSEL** of **WDTCTL** register.

Parameters

clockDivider	is the divider of the clock source, in turn setting the watchdog timer interval. Valid values are: ■ **WDT_A_CLOCKDIVIDER_2G** ■ **WDT_A_CLOCKDIVIDER_128M** ■ **WDT_A_CLOCKDIVIDER_8192K** ■ **WDT_A_CLOCKDIVIDER_512K** ■ **WDT_A_CLOCKDIVIDER_32K** [Default] ■ **WDT_A_CLOCKDIVIDER_8192** ■ **WDT_A_CLOCKDIVIDER_512** ■ **WDT_A_CLOCKDIVIDER_64** Modified bits are **WDTIS** and **WDTHOLD** of **WDTCTL** register.

Returns

None

WDT_A_resetTimer()

```
void WDT_A_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_A module.

Returns

None

WDT_A_start()

```
void WDT_A_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_A module.

Returns

None

46.3 Programming Example

The following example shows how to initialize and use the WDT_A API to interrupt about every 32 ms, toggling the LED in the ISR.

```
//Initialize WDT_A module in timer interval mode,
  //with SMCLK as source at an interval of 32 ms.
  WDT_A_initIntervalTimer(WDT_A_BASE,
      WDT_A_CLOCKSOURCE_SMCLK,
      WDT_A_CLOCKDIVIDER_32K);

  //Enable Watchdog Interrupt
  SFR_enableInterrupt(SFR_WATCHDOG_INTERVAL_TIMER_INTERRUPT);

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

  //Enter LPM0, enable interrupts
  __bis_SR_register(LPM0_bits + GIE);
  //For debugger
  __no_operation();
```

47 Data Structure Documentation

47.1 Data Structures

Here are the data structures with brief descriptions:

47.2 Timer_D_initCompareModeParam Struct Reference

Used in the Timer_D_initCompareMode() function as the param parameter.

```
#include <timer_d.h>
```

Data Fields

- uint16_t compareRegister
- uint16_t compareInterruptEnable
- uint16_t compareOutputMode
- uint16_t compareValue
  Is the count to be compared with in compare mode.

47.2.1 Detailed Description

Used in the Timer_D_initCompareMode() function as the param parameter.

47.2.2 Field Documentation

compareInterruptEnable

```
uint16_t Timer_D_initCompareModeParam::compareInterruptEnable
```

Is to enable or disable timer captureComapre interrupt.
Valid values are:

- **TIMER_D_CAPTURECOMPARE_INTERRUPT_ENABLE**
- **TIMER_D_CAPTURECOMPARE_INTERRUPT_DISABLE** [Default]

Referenced by Timer_D_initCompareMode().

compareOutputMode

```
uint16_t Timer_D_initCompareModeParam::compareOutputMode
```

Specifies the output mode.
Valid values are:

- **TIMER_D_OUTPUTMODE_OUTBITVALUE** [Default]
- **TIMER_D_OUTPUTMODE_SET**
- **TIMER_D_OUTPUTMODE_TOGGLE_RESET**
- **TIMER_D_OUTPUTMODE_SET_RESET**
- **TIMER_D_OUTPUTMODE_TOGGLE**
- **TIMER_D_OUTPUTMODE_RESET**
- **TIMER_D_OUTPUTMODE_TOGGLE_SET**
- **TIMER_D_OUTPUTMODE_RESET_SET**

Referenced by Timer_D_initCompareMode().

compareRegister

`uint16_t Timer_D_initCompareModeParam::compareRegister`

Selects the Capture register being used.
Valid values are:

- **TIMER_D_CAPTURECOMPARE_REGISTER_0**
- **TIMER_D_CAPTURECOMPARE_REGISTER_1**
- **TIMER_D_CAPTURECOMPARE_REGISTER_2**
- **TIMER_D_CAPTURECOMPARE_REGISTER_3**
- **TIMER_D_CAPTURECOMPARE_REGISTER_4**
- **TIMER_D_CAPTURECOMPARE_REGISTER_5**
- **TIMER_D_CAPTURECOMPARE_REGISTER_6**

Referenced by Timer_D_initCompareMode().

The documentation for this struct was generated from the following file:

- timer_d.h

47.3 Timer_B_initContinuousModeParam Struct Reference

Used in the Timer_B_initContinuousMode() function as the param parameter.

`#include <timer_b.h>`

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t timerInterruptEnable_TBIE
- uint16_t timerClear
- bool startTimer
  Whether to start the timer immediately.

47.3.1 Detailed Description

Used in the Timer_B_initContinuousMode() function as the param parameter.

47.3.2 Field Documentation

clockSource

`uint16_t Timer_B_initContinuousModeParam::clockSource`

Selects the clock source
Valid values are:

- **TIMER_B_CLOCKSOURCE_EXTERNAL_TXCLK** [Default]
- **TIMER_B_CLOCKSOURCE_ACLK**
- **TIMER_B_CLOCKSOURCE_SMCLK**
- **TIMER_B_CLOCKSOURCE_INVERTED_EXTERNAL_TXCLK**

Referenced by Timer_B_initContinuousMode().

clockSourceDivider

`uint16_t Timer_B_initContinuousModeParam::clockSourceDivider`

Is the divider for Clock source.
Valid values are:

- **TIMER_B_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_B_CLOCKSOURCE_DIVIDER_2**
- **TIMER_B_CLOCKSOURCE_DIVIDER_3**
- **TIMER_B_CLOCKSOURCE_DIVIDER_4**
- **TIMER_B_CLOCKSOURCE_DIVIDER_5**
- **TIMER_B_CLOCKSOURCE_DIVIDER_6**
- **TIMER_B_CLOCKSOURCE_DIVIDER_7**
- **TIMER_B_CLOCKSOURCE_DIVIDER_8**
- **TIMER_B_CLOCKSOURCE_DIVIDER_10**
- **TIMER_B_CLOCKSOURCE_DIVIDER_12**
- **TIMER_B_CLOCKSOURCE_DIVIDER_14**
- **TIMER_B_CLOCKSOURCE_DIVIDER_16**
- **TIMER_B_CLOCKSOURCE_DIVIDER_20**
- **TIMER_B_CLOCKSOURCE_DIVIDER_24**
- **TIMER_B_CLOCKSOURCE_DIVIDER_28**
- **TIMER_B_CLOCKSOURCE_DIVIDER_32**
- **TIMER_B_CLOCKSOURCE_DIVIDER_40**
- **TIMER_B_CLOCKSOURCE_DIVIDER_48**

- **TIMER_B_CLOCKSOURCE_DIVIDER_56**
- **TIMER_B_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_B_initContinuousMode().

timerClear

`uint16_t Timer_B_initContinuousModeParam::timerClear`

Decides if Timer_B clock divider, count direction, count need to be reset.
Valid values are:

- **TIMER_B_DO_CLEAR**
- **TIMER_B_SKIP_CLEAR** [Default]

Referenced by Timer_B_initContinuousMode().

timerInterruptEnable_TBIE

`uint16_t Timer_B_initContinuousModeParam::timerInterruptEnable_TBIE`

Is to enable or disable Timer_B interrupt
Valid values are:

- **TIMER_B_TBIE_INTERRUPT_ENABLE**
- **TIMER_B_TBIE_INTERRUPT_DISABLE** [Default]

Referenced by Timer_B_initContinuousMode().

The documentation for this struct was generated from the following file:

- timer_b.h

47.4 Timer_D_outputPWMParam Struct Reference

Used in the Timer_D_outputPWM() function as the param parameter.

`#include <timer_d.h>`

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t clockingMode
- uint16_t timerPeriod

  Is the specified timer period.
- uint16_t compareRegister
- uint16_t compareOutputMode
- uint16_t dutyCycle

  Specifies the dutycycle for the generated waveform.

47.4.1 Detailed Description

Used in the Timer_D_outputPWM() function as the param parameter.

47.4.2 Field Documentation

clockingMode

`uint16_t Timer_D_outputPWMParam::clockingMode`

Is the selected clock mode register values.
Valid values are:

- **TIMER_D_CLOCKINGMODE_EXTERNAL_CLOCK** [Default]
- **TIMER_D_CLOCKINGMODE_HIRES_LOCAL_CLOCK**
- **TIMER_D_CLOCKINGMODE_AUXILIARY_CLK**

Referenced by Timer_D_outputPWM().

clockSource

`uint16_t Timer_D_outputPWMParam::clockSource`

Selects Clock source.
Valid values are:

- **TIMER_D_CLOCKSOURCE_EXTERNAL_TDCLK** [Default]
- **TIMER_D_CLOCKSOURCE_ACLK**
- **TIMER_D_CLOCKSOURCE_SMCLK**
- **TIMER_D_CLOCKSOURCE_INVERTED_EXTERNAL_TDCLK**

Referenced by Timer_D_outputPWM().

clockSourceDivider

`uint16_t Timer_D_outputPWMParam::clockSourceDivider`

Is the divider for clock source.
Valid values are:

- **TIMER_D_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_D_CLOCKSOURCE_DIVIDER_2**
- **TIMER_D_CLOCKSOURCE_DIVIDER_3**
- **TIMER_D_CLOCKSOURCE_DIVIDER_4**
- **TIMER_D_CLOCKSOURCE_DIVIDER_5**
- **TIMER_D_CLOCKSOURCE_DIVIDER_6**
- **TIMER_D_CLOCKSOURCE_DIVIDER_7**

- **TIMER_D_CLOCKSOURCE_DIVIDER_8**
- **TIMER_D_CLOCKSOURCE_DIVIDER_10**
- **TIMER_D_CLOCKSOURCE_DIVIDER_12**
- **TIMER_D_CLOCKSOURCE_DIVIDER_14**
- **TIMER_D_CLOCKSOURCE_DIVIDER_16**
- **TIMER_D_CLOCKSOURCE_DIVIDER_20**
- **TIMER_D_CLOCKSOURCE_DIVIDER_24**
- **TIMER_D_CLOCKSOURCE_DIVIDER_28**
- **TIMER_D_CLOCKSOURCE_DIVIDER_32**
- **TIMER_D_CLOCKSOURCE_DIVIDER_40**
- **TIMER_D_CLOCKSOURCE_DIVIDER_48**
- **TIMER_D_CLOCKSOURCE_DIVIDER_56**
- **TIMER_D_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_D_outputPWM().

compareOutputMode

`uint16_t Timer_D_outputPWMParam::compareOutputMode`

Specifies the output mode.
Valid values are:

- **TIMER_D_OUTPUTMODE_OUTBITVALUE** [Default]
- **TIMER_D_OUTPUTMODE_SET**
- **TIMER_D_OUTPUTMODE_TOGGLE_RESET**
- **TIMER_D_OUTPUTMODE_SET_RESET**
- **TIMER_D_OUTPUTMODE_TOGGLE**
- **TIMER_D_OUTPUTMODE_RESET**
- **TIMER_D_OUTPUTMODE_TOGGLE_SET**
- **TIMER_D_OUTPUTMODE_RESET_SET**

Referenced by Timer_D_outputPWM().

compareRegister

`uint16_t Timer_D_outputPWMParam::compareRegister`

Selects the compare register being used.
Valid values are:

- **TIMER_D_CAPTURECOMPARE_REGISTER_0**
- **TIMER_D_CAPTURECOMPARE_REGISTER_1**
- **TIMER_D_CAPTURECOMPARE_REGISTER_2**
- **TIMER_D_CAPTURECOMPARE_REGISTER_3**

- **TIMER_D_CAPTURECOMPARE_REGISTER_4**
- **TIMER_D_CAPTURECOMPARE_REGISTER_5**
- **TIMER_D_CAPTURECOMPARE_REGISTER_6**

Referenced by Timer_D_outputPWM().

The documentation for this struct was generated from the following file:

- timer_d.h

47.5 SD24_B_initParam Struct Reference

Used in the SD24_B_init() function as the param parameter.

`#include <sd24_b.h>`

Data Fields

- uint16_t clockSourceSelect
- uint16_t clockPreDivider
- uint16_t clockDivider
- uint16_t referenceSelect

47.5.1 Detailed Description

Used in the SD24_B_init() function as the param parameter.

47.5.2 Field Documentation

clockDivider

`uint16_t SD24_B_initParam::clockDivider`

Selects the amount that the clock will be divided.
Valid values are:

- **SD24_B_CLOCKDIVIDER_1** [Default]
- **SD24_B_CLOCKDIVIDER_2**
- **SD24_B_CLOCKDIVIDER_3**
- **SD24_B_CLOCKDIVIDER_4**
- **SD24_B_CLOCKDIVIDER_5**
- **SD24_B_CLOCKDIVIDER_6**
- **SD24_B_CLOCKDIVIDER_7**
- **SD24_B_CLOCKDIVIDER_8**
- **SD24_B_CLOCKDIVIDER_9**

- **SD24_B_CLOCKDIVIDER_10**
- **SD24_B_CLOCKDIVIDER_11**
- **SD24_B_CLOCKDIVIDER_12**
- **SD24_B_CLOCKDIVIDER_13**
- **SD24_B_CLOCKDIVIDER_14**
- **SD24_B_CLOCKDIVIDER_15**
- **SD24_B_CLOCKDIVIDER_16**
- **SD24_B_CLOCKDIVIDER_17**
- **SD24_B_CLOCKDIVIDER_18**
- **SD24_B_CLOCKDIVIDER_19**
- **SD24_B_CLOCKDIVIDER_20**
- **SD24_B_CLOCKDIVIDER_21**
- **SD24_B_CLOCKDIVIDER_22**
- **SD24_B_CLOCKDIVIDER_23**
- **SD24_B_CLOCKDIVIDER_24**
- **SD24_B_CLOCKDIVIDER_25**
- **SD24_B_CLOCKDIVIDER_26**
- **SD24_B_CLOCKDIVIDER_27**
- **SD24_B_CLOCKDIVIDER_28**
- **SD24_B_CLOCKDIVIDER_29**
- **SD24_B_CLOCKDIVIDER_30**
- **SD24_B_CLOCKDIVIDER_31**
- **SD24_B_CLOCKDIVIDER_32**

Referenced by SD24_B_init().

clockPreDivider

`uint16_t SD24_B_initParam::clockPreDivider`

Selects the amount that the clock will be predivided
Valid values are:

- **SD24_B_PRECLOCKDIVIDER_1** [Default]
- **SD24_B_PRECLOCKDIVIDER_2**
- **SD24_B_PRECLOCKDIVIDER_4**
- **SD24_B_PRECLOCKDIVIDER_8**
- **SD24_B_PRECLOCKDIVIDER_16**
- **SD24_B_PRECLOCKDIVIDER_32**
- **SD24_B_PRECLOCKDIVIDER_64**
- **SD24_B_PRECLOCKDIVIDER_128**

Referenced by SD24_B_init().

clockSourceSelect

`uint16_t SD24_B_initParam::clockSourceSelect`

Selects the clock that will be used as the SD24_B core
Valid values are:

- **SD24_B_CLOCKSOURCE_MCLK** [Default]
- **SD24_B_CLOCKSOURCE_SMCLK**
- **SD24_B_CLOCKSOURCE_ACLK**
- **SD24_B_CLOCKSOURCE_SD24CLK**

Referenced by SD24_B_init().

referenceSelect

`uint16_t SD24_B_initParam::referenceSelect`

Selects the reference source for the SD24_B core
Valid values are:

- **SD24_B_REF_EXTERNAL** [Default]
- **SD24_B_REF_INTERNAL**

Referenced by SD24_B_init().

The documentation for this struct was generated from the following file:

- sd24_b.h

47.6 USCI_B_SPI_changeMasterClockParam Struct Reference

Used in the USCI_B_SPI_changeMasterClock() function as the param parameter.

```
#include <usci_b_spi.h>
```

Data Fields

- uint32_t clockSourceFrequency
  Is the frequency of the selected clock source.
- uint32_t desiredSpiClock
  Is the desired clock rate for SPI communication.

47.6.1 Detailed Description

Used in the USCI_B_SPI_changeMasterClock() function as the param parameter.

The documentation for this struct was generated from the following file:

- usci_b_spi.h

47.7 Timer_A_initUpModeParam Struct Reference

Used in the Timer_A_initUpMode() function as the param parameter.

```
#include <timer_a.h>
```

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t timerPeriod
- uint16_t timerInterruptEnable_TAIE
- uint16_t captureCompareInterruptEnable_CCR0_CCIE
- uint16_t timerClear
- bool startTimer

  Whether to start the timer immediately.

47.7.1 Detailed Description

Used in the Timer_A_initUpMode() function as the param parameter.

47.7.2 Field Documentation

captureCompareInterruptEnable_CCR0_CCIE

```
uint16_t Timer_A_initUpModeParam::captureCompareInterruptEnable_CCR0_CCIE
```

Is to enable or disable Timer_A CCR0 captureComapre interrupt.
Valid values are:

- **TIMER_A_CCIE_CCR0_INTERRUPT_ENABLE**
- **TIMER_A_CCIE_CCR0_INTERRUPT_DISABLE** [Default]

Referenced by Timer_A_initUpMode().

clockSource

```
uint16_t Timer_A_initUpModeParam::clockSource
```

Selects Clock source.
Valid values are:

- **TIMER_A_CLOCKSOURCE_EXTERNAL_TXCLK** [Default]

- **TIMER_A_CLOCKSOURCE_ACLK**
- **TIMER_A_CLOCKSOURCE_SMCLK**
- **TIMER_A_CLOCKSOURCE_INVERTED_EXTERNAL_TXCLK**

Referenced by Timer_A_initUpMode().

clockSourceDivider

`uint16_t Timer_A_initUpModeParam::clockSourceDivider`

Is the desired divider for the clock source
Valid values are:

- **TIMER_A_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_A_CLOCKSOURCE_DIVIDER_2**
- **TIMER_A_CLOCKSOURCE_DIVIDER_3**
- **TIMER_A_CLOCKSOURCE_DIVIDER_4**
- **TIMER_A_CLOCKSOURCE_DIVIDER_5**
- **TIMER_A_CLOCKSOURCE_DIVIDER_6**
- **TIMER_A_CLOCKSOURCE_DIVIDER_7**
- **TIMER_A_CLOCKSOURCE_DIVIDER_8**
- **TIMER_A_CLOCKSOURCE_DIVIDER_10**
- **TIMER_A_CLOCKSOURCE_DIVIDER_12**
- **TIMER_A_CLOCKSOURCE_DIVIDER_14**
- **TIMER_A_CLOCKSOURCE_DIVIDER_16**
- **TIMER_A_CLOCKSOURCE_DIVIDER_20**
- **TIMER_A_CLOCKSOURCE_DIVIDER_24**
- **TIMER_A_CLOCKSOURCE_DIVIDER_28**
- **TIMER_A_CLOCKSOURCE_DIVIDER_32**
- **TIMER_A_CLOCKSOURCE_DIVIDER_40**
- **TIMER_A_CLOCKSOURCE_DIVIDER_48**
- **TIMER_A_CLOCKSOURCE_DIVIDER_56**
- **TIMER_A_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_A_initUpMode().

timerClear

`uint16_t Timer_A_initUpModeParam::timerClear`

Decides if Timer_A clock divider, count direction, count need to be reset.
Valid values are:

- **TIMER_A_DO_CLEAR**
- **TIMER_A_SKIP_CLEAR** [Default]

Referenced by Timer_A_initUpMode().

timerInterruptEnable_TAIE

```
uint16_t Timer_A_initUpModeParam::timerInterruptEnable_TAIE
```

Is to enable or disable Timer_A interrupt
Valid values are:

- **TIMER_A_TAIE_INTERRUPT_ENABLE**
- **TIMER_A_TAIE_INTERRUPT_DISABLE** [Default]

Referenced by Timer_A_initUpMode().

timerPeriod

```
uint16_t Timer_A_initUpModeParam::timerPeriod
```

Is the specified Timer_A period. This is the value that gets written into the CCR0. Limited to 16 bits[uint16_t]

Referenced by Timer_A_initUpMode().

The documentation for this struct was generated from the following file:

- timer_a.h

47.8 USCI_B_I2C_initMasterParam Struct Reference

Used in the USCI_B_I2C_initMaster() function as the param parameter.

```
#include <usci_b_i2c.h>
```

Data Fields

- uint8_t selectClockSource
- uint32_t i2cClk
  Is the rate of the clock supplied to the I2C module.
- uint32_t dataRate

47.8.1 Detailed Description

Used in the USCI_B_I2C_initMaster() function as the param parameter.

47.8.2 Field Documentation

dataRate

```
uint32_t USCI_B_I2C_initMasterParam::dataRate
```

Set up for selecting data transfer rate.
Valid values are:

- **USCI_B_I2C_SET_DATA_RATE_400KBPS**
- **USCI_B_I2C_SET_DATA_RATE_100KBPS**

Referenced by USCI_B_I2C_initMaster().

selectClockSource

```
uint8_t USCI_B_I2C_initMasterParam::selectClockSource
```

Is the clocksource.
Valid values are:

- **USCI_B_I2C_CLOCKSOURCE_ACLK**
- **USCI_B_I2C_CLOCKSOURCE_SMCLK**

Referenced by USCI_B_I2C_initMaster().

The documentation for this struct was generated from the following file:

- usci_b_i2c.h

47.9 EUSCI_B_SPI_initSlaveParam Struct Reference

Used in the EUSCI_B_SPI_initSlave() function as the param parameter.

```
#include <eusci_b_spi.h>
```

Data Fields

- uint16_t msbFirst
- uint16_t clockPhase
- uint16_t clockPolarity
- uint16_t spiMode

47.9.1 Detailed Description

Used in the EUSCI_B_SPI_initSlave() function as the param parameter.

47.9.2 Field Documentation

clockPhase

```
uint16_t EUSCI_B_SPI_initSlaveParam::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**

Referenced by EUSCI_B_SPI_initSlave().

clockPolarity

`uint16_t EUSCI_B_SPI_initSlaveParam::clockPolarity`

Is clock polarity select
Valid values are:

- **EUSCI_B_SPI_CLOCKPOLARITY_INACTIVITY_HIGH**
- **EUSCI_B_SPI_CLOCKPOLARITY_INACTIVITY_LOW** [Default]

Referenced by EUSCI_B_SPI_initSlave().

msbFirst

`uint16_t EUSCI_B_SPI_initSlaveParam::msbFirst`

Controls the direction of the receive and transmit shift register.
Valid values are:

- **EUSCI_B_SPI_MSB_FIRST**
- **EUSCI_B_SPI_LSB_FIRST** [Default]

Referenced by EUSCI_B_SPI_initSlave().

spiMode

`uint16_t EUSCI_B_SPI_initSlaveParam::spiMode`

Is SPI mode select
Valid values are:

- **EUSCI_B_SPI_3PIN**
- **EUSCI_B_SPI_4PIN_UCxSTE_ACTIVE_HIGH**
- **EUSCI_B_SPI_4PIN_UCxSTE_ACTIVE_LOW**

Referenced by EUSCI_B_SPI_initSlave().

The documentation for this struct was generated from the following file:

- eusci_b_spi.h

47.10 Timer_A_initCompareModeParam Struct Reference

Used in the Timer_A_initCompareMode() function as the param parameter.

```
#include <timer_a.h>
```

Data Fields

- uint16_t compareRegister
- uint16_t compareInterruptEnable
- uint16_t compareOutputMode
- uint16_t compareValue

  Is the count to be compared with in compare mode.

47.10.1 Detailed Description

Used in the Timer_A_initCompareMode() function as the param parameter.

47.10.2 Field Documentation

compareInterruptEnable

```
uint16_t Timer_A_initCompareModeParam::compareInterruptEnable
```

Is to enable or disable timer captureComapre interrupt.
Valid values are:

- **TIMER_A_CAPTURECOMPARE_INTERRUPT_DISABLE** [Default]
- **TIMER_A_CAPTURECOMPARE_INTERRUPT_ENABLE**

Referenced by Timer_A_initCompareMode().

compareOutputMode

```
uint16_t Timer_A_initCompareModeParam::compareOutputMode
```

Specifies the output mode.
Valid values are:

- **TIMER_A_OUTPUTMODE_OUTBITVALUE** [Default]
- **TIMER_A_OUTPUTMODE_SET**
- **TIMER_A_OUTPUTMODE_TOGGLE_RESET**
- **TIMER_A_OUTPUTMODE_SET_RESET**
- **TIMER_A_OUTPUTMODE_TOGGLE**
- **TIMER_A_OUTPUTMODE_RESET**
- **TIMER_A_OUTPUTMODE_TOGGLE_SET**

- **TIMER_A_OUTPUTMODE_RESET_SET**

Referenced by Timer_A_initCompareMode().

compareRegister

`uint16_t Timer_A_initCompareModeParam::compareRegister`

Selects the Capture register being used. Refer to datasheet to ensure the device has the capture compare register being used.
Valid values are:

- **TIMER_A_CAPTURECOMPARE_REGISTER_0**
- **TIMER_A_CAPTURECOMPARE_REGISTER_1**
- **TIMER_A_CAPTURECOMPARE_REGISTER_2**
- **TIMER_A_CAPTURECOMPARE_REGISTER_3**
- **TIMER_A_CAPTURECOMPARE_REGISTER_4**
- **TIMER_A_CAPTURECOMPARE_REGISTER_5**
- **TIMER_A_CAPTURECOMPARE_REGISTER_6**

Referenced by Timer_A_initCompareMode().

The documentation for this struct was generated from the following file:

- timer_a.h

47.11 EUSCI_B_SPI_changeMasterClockParam Struct Reference

Used in the EUSCI_B_SPI_changeMasterClock() function as the param parameter.

`#include <eusci_b_spi.h>`

Data Fields

- uint32_t clockSourceFrequency
  Is the frequency of the selected clock source in Hz.
- uint32_t desiredSpiClock
  Is the desired clock rate in Hz for SPI communication.

47.11.1 Detailed Description

Used in the EUSCI_B_SPI_changeMasterClock() function as the param parameter.

The documentation for this struct was generated from the following file:

- eusci_b_spi.h

47.12 Timer_B_initUpDownModeParam Struct Reference

Used in the Timer_B_initUpDownMode() function as the param parameter.

```
#include <timer_b.h>
```

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t timerPeriod

  Is the specified Timer_B period.
- uint16_t timerInterruptEnable_TBIE
- uint16_t captureCompareInterruptEnable_CCR0_CCIE
- uint16_t timerClear
- bool startTimer

  Whether to start the timer immediately.

47.12.1 Detailed Description

Used in the Timer_B_initUpDownMode() function as the param parameter.

47.12.2 Field Documentation

captureCompareInterruptEnable_CCR0_CCIE

```
uint16_t Timer_B_initUpDownModeParam::captureCompareInterruptEnable_CCR0_CCIE
```

Is to enable or disable Timer_B CCR0 capture compare interrupt.
Valid values are:

- **TIMER_B_CCIE_CCR0_INTERRUPT_ENABLE**
- **TIMER_B_CCIE_CCR0_INTERRUPT_DISABLE** [Default]

Referenced by Timer_B_initUpDownMode().

clockSource

```
uint16_t Timer_B_initUpDownModeParam::clockSource
```

Selects the clock source
Valid values are:

- **TIMER_B_CLOCKSOURCE_EXTERNAL_TXCLK** [Default]
- **TIMER_B_CLOCKSOURCE_ACLK**
- **TIMER_B_CLOCKSOURCE_SMCLK**
- **TIMER_B_CLOCKSOURCE_INVERTED_EXTERNAL_TXCLK**

Referenced by Timer_B_initUpDownMode().

clockSourceDivider

`uint16_t Timer_B_initUpDownModeParam::clockSourceDivider`

Is the divider for Clock source.
Valid values are:

- **TIMER_B_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_B_CLOCKSOURCE_DIVIDER_2**
- **TIMER_B_CLOCKSOURCE_DIVIDER_3**
- **TIMER_B_CLOCKSOURCE_DIVIDER_4**
- **TIMER_B_CLOCKSOURCE_DIVIDER_5**
- **TIMER_B_CLOCKSOURCE_DIVIDER_6**
- **TIMER_B_CLOCKSOURCE_DIVIDER_7**
- **TIMER_B_CLOCKSOURCE_DIVIDER_8**
- **TIMER_B_CLOCKSOURCE_DIVIDER_10**
- **TIMER_B_CLOCKSOURCE_DIVIDER_12**
- **TIMER_B_CLOCKSOURCE_DIVIDER_14**
- **TIMER_B_CLOCKSOURCE_DIVIDER_16**
- **TIMER_B_CLOCKSOURCE_DIVIDER_20**
- **TIMER_B_CLOCKSOURCE_DIVIDER_24**
- **TIMER_B_CLOCKSOURCE_DIVIDER_28**
- **TIMER_B_CLOCKSOURCE_DIVIDER_32**
- **TIMER_B_CLOCKSOURCE_DIVIDER_40**
- **TIMER_B_CLOCKSOURCE_DIVIDER_48**
- **TIMER_B_CLOCKSOURCE_DIVIDER_56**
- **TIMER_B_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_B_initUpDownMode().

timerClear

`uint16_t Timer_B_initUpDownModeParam::timerClear`

Decides if Timer_B clock divider, count direction, count need to be reset.
Valid values are:

- **TIMER_B_DO_CLEAR**
- **TIMER_B_SKIP_CLEAR** [Default]

Referenced by Timer_B_initUpDownMode().

timerInterruptEnable_TBIE

`uint16_t Timer_B_initUpDownModeParam::timerInterruptEnable_TBIE`

Is to enable or disable Timer_B interrupt
Valid values are:

- **TIMER_B_TBIE_INTERRUPT_ENABLE**
- **TIMER_B_TBIE_INTERRUPT_DISABLE** [Default]

Referenced by Timer_B_initUpDownMode().

The documentation for this struct was generated from the following file:

- timer_b.h

47.13 Timer_D_initUpModeParam Struct Reference

Used in the Timer_D_initUpMode() function as the param parameter.

```
#include <timer_d.h>
```

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t clockingMode
- uint16_t timerPeriod
- uint16_t timerInterruptEnable_TDIE
- uint16_t captureCompareInterruptEnable_CCR0_CCIE
- uint16_t timerClear

47.13.1 Detailed Description

Used in the Timer_D_initUpMode() function as the param parameter.

47.13.2 Field Documentation

captureCompareInterruptEnable_CCR0_CCIE

`uint16_t Timer_D_initUpModeParam::captureCompareInterruptEnable_CCR0_CCIE`

Is to enable or disable timer CCR0 captureComapre interrupt.
Valid values are:

- **TIMER_D_CCIE_CCR0_INTERRUPT_ENABLE**
- **TIMER_D_CCIE_CCR0_INTERRUPT_DISABLE** [Default]

Referenced by Timer_D_initUpMode().

clockingMode

`uint16_t Timer_D_initUpModeParam::clockingMode`

Is the selected clock mode register values.
Valid values are:

- **TIMER_D_CLOCKINGMODE_EXTERNAL_CLOCK** [Default]
- **TIMER_D_CLOCKINGMODE_HIRES_LOCAL_CLOCK**
- **TIMER_D_CLOCKINGMODE_AUXILIARY_CLK**

Referenced by Timer_D_initUpMode().

clockSource

`uint16_t Timer_D_initUpModeParam::clockSource`

Selects Clock source.
Valid values are:

- **TIMER_D_CLOCKSOURCE_EXTERNAL_TDCLK** [Default]
- **TIMER_D_CLOCKSOURCE_ACLK**
- **TIMER_D_CLOCKSOURCE_SMCLK**
- **TIMER_D_CLOCKSOURCE_INVERTED_EXTERNAL_TDCLK**

Referenced by Timer_D_initUpMode().

clockSourceDivider

`uint16_t Timer_D_initUpModeParam::clockSourceDivider`

Is the divider for clock source.
Valid values are:

- **TIMER_D_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_D_CLOCKSOURCE_DIVIDER_2**
- **TIMER_D_CLOCKSOURCE_DIVIDER_3**
- **TIMER_D_CLOCKSOURCE_DIVIDER_4**
- **TIMER_D_CLOCKSOURCE_DIVIDER_5**
- **TIMER_D_CLOCKSOURCE_DIVIDER_6**
- **TIMER_D_CLOCKSOURCE_DIVIDER_7**
- **TIMER_D_CLOCKSOURCE_DIVIDER_8**
- **TIMER_D_CLOCKSOURCE_DIVIDER_10**
- **TIMER_D_CLOCKSOURCE_DIVIDER_12**
- **TIMER_D_CLOCKSOURCE_DIVIDER_14**
- **TIMER_D_CLOCKSOURCE_DIVIDER_16**
- **TIMER_D_CLOCKSOURCE_DIVIDER_20**

- **TIMER_D_CLOCKSOURCE_DIVIDER_24**
- **TIMER_D_CLOCKSOURCE_DIVIDER_28**
- **TIMER_D_CLOCKSOURCE_DIVIDER_32**
- **TIMER_D_CLOCKSOURCE_DIVIDER_40**
- **TIMER_D_CLOCKSOURCE_DIVIDER_48**
- **TIMER_D_CLOCKSOURCE_DIVIDER_56**
- **TIMER_D_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_D_initUpMode().

timerClear

`uint16_t Timer_D_initUpModeParam::timerClear`

Decides if timer clock divider, count direction, count need to be reset.
Valid values are:

- **TIMER_D_DO_CLEAR**
- **TIMER_D_SKIP_CLEAR** [Default]

Referenced by Timer_D_initUpMode().

timerInterruptEnable_TDIE

`uint16_t Timer_D_initUpModeParam::timerInterruptEnable_TDIE`

Is to enable or disable timer interrupt
Valid values are:

- **TIMER_D_TDIE_INTERRUPT_ENABLE**
- **TIMER_D_TDIE_INTERRUPT_DISABLE** [Default]

Referenced by Timer_D_initUpMode().

timerPeriod

`uint16_t Timer_D_initUpModeParam::timerPeriod`

Is the specified timer period. This is the value that gets written into the CCR0. Limited to 16 bits [uint16_t]

Referenced by Timer_D_initUpMode().

The documentation for this struct was generated from the following file:

- timer_d.h

47.14 Timer_A_initContinuousModeParam Struct Reference

Used in the Timer_A_initContinuousMode() function as the param parameter.

```
#include <timer_a.h>
```

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t timerInterruptEnable_TAIE
- uint16_t timerClear
- bool startTimer

    Whether to start the timer immediately.

47.14.1 Detailed Description

Used in the Timer_A_initContinuousMode() function as the param parameter.

47.14.2 Field Documentation

clockSource

```
uint16_t Timer_A_initContinuousModeParam::clockSource
```

Selects Clock source.
Valid values are:

- **TIMER_A_CLOCKSOURCE_EXTERNAL_TXCLK** [Default]
- **TIMER_A_CLOCKSOURCE_ACLK**
- **TIMER_A_CLOCKSOURCE_SMCLK**
- **TIMER_A_CLOCKSOURCE_INVERTED_EXTERNAL_TXCLK**

Referenced by Timer_A_initContinuousMode().

clockSourceDivider

```
uint16_t Timer_A_initContinuousModeParam::clockSourceDivider
```

Is the desired divider for the clock source
Valid values are:

- **TIMER_A_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_A_CLOCKSOURCE_DIVIDER_2**
- **TIMER_A_CLOCKSOURCE_DIVIDER_3**

- **TIMER_A_CLOCKSOURCE_DIVIDER_4**
- **TIMER_A_CLOCKSOURCE_DIVIDER_5**
- **TIMER_A_CLOCKSOURCE_DIVIDER_6**
- **TIMER_A_CLOCKSOURCE_DIVIDER_7**
- **TIMER_A_CLOCKSOURCE_DIVIDER_8**
- **TIMER_A_CLOCKSOURCE_DIVIDER_10**
- **TIMER_A_CLOCKSOURCE_DIVIDER_12**
- **TIMER_A_CLOCKSOURCE_DIVIDER_14**
- **TIMER_A_CLOCKSOURCE_DIVIDER_16**
- **TIMER_A_CLOCKSOURCE_DIVIDER_20**
- **TIMER_A_CLOCKSOURCE_DIVIDER_24**
- **TIMER_A_CLOCKSOURCE_DIVIDER_28**
- **TIMER_A_CLOCKSOURCE_DIVIDER_32**
- **TIMER_A_CLOCKSOURCE_DIVIDER_40**
- **TIMER_A_CLOCKSOURCE_DIVIDER_48**
- **TIMER_A_CLOCKSOURCE_DIVIDER_56**
- **TIMER_A_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_A_initContinuousMode().

timerClear

`uint16_t Timer_A_initContinuousModeParam::timerClear`

Decides if Timer_A clock divider, count direction, count need to be reset.
Valid values are:

- **TIMER_A_DO_CLEAR**
- **TIMER_A_SKIP_CLEAR** [Default]

Referenced by Timer_A_initContinuousMode().

timerInterruptEnable_TAIE

`uint16_t Timer_A_initContinuousModeParam::timerInterruptEnable_TAIE`

Is to enable or disable Timer_A interrupt
Valid values are:

- **TIMER_A_TAIE_INTERRUPT_ENABLE**
- **TIMER_A_TAIE_INTERRUPT_DISABLE** [Default]

Referenced by Timer_A_initContinuousMode().

The documentation for this struct was generated from the following file:

- timer_a.h

47.15 EUSCI_B_I2C_initSlaveParam Struct Reference

Used in the EUSCI_B_I2C_initSlave() function as the param parameter.

`#include <eusci_b_i2c.h>`

Data Fields

- uint8_t slaveAddress
  7-bit slave address
- uint8_t slaveAddressOffset
- uint32_t slaveOwnAddressEnable

47.15.1 Detailed Description

Used in the EUSCI_B_I2C_initSlave() function as the param parameter.

47.15.2 Field Documentation

slaveAddressOffset

`uint8_t EUSCI_B_I2C_initSlaveParam::slaveAddressOffset`

Own address Offset referred to- 'x' value of UCBxI2COAx.
Valid values are:

- **EUSCI_B_I2C_OWN_ADDRESS_OFFSET0**
- **EUSCI_B_I2C_OWN_ADDRESS_OFFSET1**
- **EUSCI_B_I2C_OWN_ADDRESS_OFFSET2**
- **EUSCI_B_I2C_OWN_ADDRESS_OFFSET3**

Referenced by EUSCI_B_I2C_initSlave().

slaveOwnAddressEnable

`uint32_t EUSCI_B_I2C_initSlaveParam::slaveOwnAddressEnable`

Selects if the specified address is enabled or disabled.
Valid values are:

- **EUSCI_B_I2C_OWN_ADDRESS_DISABLE**
- **EUSCI_B_I2C_OWN_ADDRESS_ENABLE**

Referenced by EUSCI_B_I2C_initSlave().

The documentation for this struct was generated from the following file:

- eusci_b_i2c.h

47.16 Comp_B_configureReferenceVoltageParam Struct Reference

Used in the Comp_B_configureReferenceVoltage() function as the param parameter.

```
#include <comp_b.h>
```

Data Fields

- uint16_t supplyVoltageReferenceBase
- uint16_t lowerLimitSupplyVoltageFractionOf32
- uint16_t upperLimitSupplyVoltageFractionOf32
- uint16_t referenceAccuracy

47.16.1 Detailed Description

Used in the Comp_B_configureReferenceVoltage() function as the param parameter.

47.16.2 Field Documentation

lowerLimitSupplyVoltageFractionOf32

```
uint16_t Comp_B_configureReferenceVoltageParam::lowerLimitSupplyVoltageFractionOf32
```

Is the numerator of the equation to generate the reference voltage for the lower limit reference voltage.

Referenced by Comp_B_configureReferenceVoltage().

referenceAccuracy

```
uint16_t Comp_B_configureReferenceVoltageParam::referenceAccuracy
```

is the reference accuracy setting of the Comp_B. Clocked is for low power/low accuracy.
Valid values are:

- **COMP_B_ACCURACY_STATIC**
- **COMP_B_ACCURACY_CLOCKED**

Referenced by Comp_B_configureReferenceVoltage().

supplyVoltageReferenceBase

```
uint16_t Comp_B_configureReferenceVoltageParam::supplyVoltageReferenceBase
```

Decides the source and max amount of Voltage that can be used as a reference.
Valid values are:

- **COMP_B_VREFBASE_VCC**
- **COMP_B_VREFBASE1_5V**
- **COMP_B_VREFBASE2_0V**
- **COMP_B_VREFBASE2_5V**

Referenced by Comp_B_configureReferenceVoltage().

upperLimitSupplyVoltageFractionOf32

`uint16_t Comp_B_configureReferenceVoltageParam::upperLimitSupplyVoltageFractionOf32`

Is the numerator of the equation to generate the reference voltage for the upper limit reference voltage.

Referenced by Comp_B_configureReferenceVoltage().

The documentation for this struct was generated from the following file:

- comp_b.h

47.17 Timer_A_initCaptureModeParam Struct Reference

Used in the Timer_A_initCaptureMode() function as the param parameter.

`#include <timer_a.h>`

Data Fields

- uint16_t captureRegister
- uint16_t captureMode
- uint16_t captureInputSelect
- uint16_t synchronizeCaptureSource
- uint16_t captureInterruptEnable
- uint16_t captureOutputMode

47.17.1 Detailed Description

Used in the Timer_A_initCaptureMode() function as the param parameter.

47.17.2 Field Documentation

captureInputSelect

`uint16_t Timer_A_initCaptureModeParam::captureInputSelect`

Decides the Input Select
Valid values are:

- **TIMER_A_CAPTURE_INPUTSELECT_CCIxA**
- **TIMER_A_CAPTURE_INPUTSELECT_CCIxB**
- **TIMER_A_CAPTURE_INPUTSELECT_GND**
- **TIMER_A_CAPTURE_INPUTSELECT_Vcc**

Referenced by Timer_A_initCaptureMode().

captureInterruptEnable

`uint16_t Timer_A_initCaptureModeParam::captureInterruptEnable`

Is to enable or disable timer captureComapre interrupt.
Valid values are:

- **TIMER_A_CAPTURECOMPARE_INTERRUPT_DISABLE** [Default]
- **TIMER_A_CAPTURECOMPARE_INTERRUPT_ENABLE**

Referenced by Timer_A_initCaptureMode().

captureMode

`uint16_t Timer_A_initCaptureModeParam::captureMode`

Is the capture mode selected.
Valid values are:

- **TIMER_A_CAPTUREMODE_NO_CAPTURE** [Default]
- **TIMER_A_CAPTUREMODE_RISING_EDGE**
- **TIMER_A_CAPTUREMODE_FALLING_EDGE**
- **TIMER_A_CAPTUREMODE_RISING_AND_FALLING_EDGE**

Referenced by Timer_A_initCaptureMode().

captureOutputMode

`uint16_t Timer_A_initCaptureModeParam::captureOutputMode`

Specifies the output mode.
Valid values are:

- **TIMER_A_OUTPUTMODE_OUTBITVALUE** [Default]
- **TIMER_A_OUTPUTMODE_SET**
- **TIMER_A_OUTPUTMODE_TOGGLE_RESET**
- **TIMER_A_OUTPUTMODE_SET_RESET**
- **TIMER_A_OUTPUTMODE_TOGGLE**
- **TIMER_A_OUTPUTMODE_RESET**
- **TIMER_A_OUTPUTMODE_TOGGLE_SET**
- **TIMER_A_OUTPUTMODE_RESET_SET**

Referenced by Timer_A_initCaptureMode().

captureRegister

`uint16_t Timer_A_initCaptureModeParam::captureRegister`

Selects the Capture register being used. Refer to datasheet to ensure the device has the capture compare register being used.
Valid values are:

- **TIMER_A_CAPTURECOMPARE_REGISTER_0**
- **TIMER_A_CAPTURECOMPARE_REGISTER_1**
- **TIMER_A_CAPTURECOMPARE_REGISTER_2**
- **TIMER_A_CAPTURECOMPARE_REGISTER_3**
- **TIMER_A_CAPTURECOMPARE_REGISTER_4**
- **TIMER_A_CAPTURECOMPARE_REGISTER_5**
- **TIMER_A_CAPTURECOMPARE_REGISTER_6**

Referenced by Timer_A_initCaptureMode().

synchronizeCaptureSource

`uint16_t Timer_A_initCaptureModeParam::synchronizeCaptureSource`

Decides if capture source should be synchronized with timer clock
Valid values are:

- **TIMER_A_CAPTURE_ASYNCHRONOUS** [Default]
- **TIMER_A_CAPTURE_SYNCHRONOUS**

Referenced by Timer_A_initCaptureMode().

The documentation for this struct was generated from the following file:

- timer_a.h

47.18 USCI_A_UART_initParam Struct Reference

Used in the USCI_A_UART_init() function as the param parameter.

`#include <usci_a_uart.h>`

Data Fields

- uint8_t selectClockSource
- uint16_t clockPrescalar
  Is the value to be written into UCBRx bits.
- uint8_t firstModReg
- uint8_t secondModReg
- uint8_t parity
- uint8_t msborLsbFirst

- uint8_t numberofStopBits
- uint8_t uartMode
- uint8_t overSampling

47.18.1 Detailed Description

Used in the USCI_A_UART_init() function as the param parameter.

47.18.2 Field Documentation

firstModReg

`uint8_t USCI_A_UART_initParam::firstModReg`

Is First modulation stage register setting. This value is a pre- calculated value which can be obtained from the Device Users Guide. This value is written into UCBRFx bits of UCAxMCTLW.

Referenced by USCI_A_UART_init().

msborLsbFirst

`uint8_t USCI_A_UART_initParam::msborLsbFirst`

Controls direction of receive and transmit shift register.
Valid values are:

- **USCI_A_UART_MSB_FIRST**
- **USCI_A_UART_LSB_FIRST** [Default]

Referenced by USCI_A_UART_init().

numberofStopBits

`uint8_t USCI_A_UART_initParam::numberofStopBits`

Indicates one/two STOP bits
Valid values are:

- **USCI_A_UART_ONE_STOP_BIT** [Default]
- **USCI_A_UART_TWO_STOP_BITS**

Referenced by USCI_A_UART_init().

overSampling

`uint8_t USCI_A_UART_initParam::overSampling`

Indicates low frequency or oversampling baud generation
Valid values are:

- **USCI_A_UART_OVERSAMPLING_BAUDRATE_GENERATION**
- **USCI_A_UART_LOW_FREQUENCY_BAUDRATE_GENERATION**

Referenced by USCI_A_UART_init().

parity

`uint8_t USCI_A_UART_initParam::parity`

Is the desired parity.
Valid values are:

- **USCI_A_UART_NO_PARITY** [Default]
- **USCI_A_UART_ODD_PARITY**
- **USCI_A_UART_EVEN_PARITY**

Referenced by USCI_A_UART_init().

secondModReg

`uint8_t USCI_A_UART_initParam::secondModReg`

Is Second modulation stage register setting. This value is a pre- calculated value which can be obtained from the Device Users Guide. This value is written into UCBRSx bits of UCAxMCTLW.

Referenced by USCI_A_UART_init().

selectClockSource

`uint8_t USCI_A_UART_initParam::selectClockSource`

Selects Clock source.
Valid values are:

- **USCI_A_UART_CLOCKSOURCE_SMCLK**
- **USCI_A_UART_CLOCKSOURCE_ACLK**

Referenced by USCI_A_UART_init().

uartMode

`uint8_t USCI_A_UART_initParam::uartMode`

Selects the mode of operation
Valid values are:

- **USCI_A_UART_MODE** [Default]
- **USCI_A_UART_IDLE_LINE_MULTI_PROCESSOR_MODE**
- **USCI_A_UART_ADDRESS_BIT_MULTI_PROCESSOR_MODE**

- **USCI_A_UART_AUTOMATIC_BAUDRATE_DETECTION_MODE**

Referenced by USCI_A_UART_init().

The documentation for this struct was generated from the following file:

- usci_a_uart.h

47.19 RTC_C_configureCalendarAlarmParam Struct Reference

Used in the RTC_C_configureCalendarAlarm() function as the param parameter.

```
#include <rtc_c.h>
```

Data Fields

- uint8_t minutesAlarm
- uint8_t hoursAlarm
- uint8_t dayOfWeekAlarm
- uint8_t dayOfMonthAlarm

47.19.1 Detailed Description

Used in the RTC_C_configureCalendarAlarm() function as the param parameter.

47.19.2 Field Documentation

dayOfMonthAlarm

```
uint8_t RTC_C_configureCalendarAlarmParam::dayOfMonthAlarm
```

Is the alarm condition for the day of the month.
Valid values are:

- **RTC_C_ALARMCONDITION_OFF** [Default]

Referenced by RTC_C_configureCalendarAlarm().

dayOfWeekAlarm

```
uint8_t RTC_C_configureCalendarAlarmParam::dayOfWeekAlarm
```

Is the alarm condition for the day of week.
Valid values are:

- **RTC_C_ALARMCONDITION_OFF** [Default]

Referenced by RTC_C_configureCalendarAlarm().

hoursAlarm

`uint8_t RTC_C_configureCalendarAlarmParam::hoursAlarm`

Is the alarm condition for the hours.
Valid values are:

- **RTC_C_ALARMCONDITION_OFF** [Default]

Referenced by RTC_C_configureCalendarAlarm().

minutesAlarm

`uint8_t RTC_C_configureCalendarAlarmParam::minutesAlarm`

Is the alarm condition for the minutes.
Valid values are:

- **RTC_C_ALARMCONDITION_OFF** [Default]

Referenced by RTC_C_configureCalendarAlarm().

The documentation for this struct was generated from the following file:

- rtc_c.h

47.20 USCI_A_SPI_initMasterParam Struct Reference

Used in the USCI_A_SPI_initMaster() function as the param parameter.

`#include <usci_a_spi.h>`

Data Fields

- uint8_t selectClockSource
- uint32_t clockSourceFrequency
  Is the frequency of the selected clock source.
- uint32_t desiredSpiClock
  Is the desired clock rate for SPI communication.
- uint8_t msbFirst
- uint8_t clockPhase
- uint8_t clockPolarity

47.20.1 Detailed Description

Used in the USCI_A_SPI_initMaster() function as the param parameter.

47.20.2 Field Documentation

clockPhase

`uint8_t USCI_A_SPI_initMasterParam::clockPhase`

Is clock phase select.
Valid values are:

- **USCI_A_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON_NEXT** [Default]
- **USCI_A_SPI_PHASE_DATA_CAPTURED_ONFIRST_CHANGED_ON_NEXT**

Referenced by USCI_A_SPI_initMaster().

clockPolarity

`uint8_t USCI_A_SPI_initMasterParam::clockPolarity`

Valid values are:

- **USCI_A_SPI_CLOCKPOLARITY_INACTIVITY_HIGH**
- **USCI_A_SPI_CLOCKPOLARITY_INACTIVITY_LOW** [Default]

Referenced by USCI_A_SPI_initMaster().

msbFirst

`uint8_t USCI_A_SPI_initMasterParam::msbFirst`

Controls the direction of the receive and transmit shift register.
Valid values are:

- **USCI_A_SPI_MSB_FIRST**
- **USCI_A_SPI_LSB_FIRST** [Default]

Referenced by USCI_A_SPI_initMaster().

selectClockSource

`uint8_t USCI_A_SPI_initMasterParam::selectClockSource`

Selects Clock source.
Valid values are:

- **USCI_A_SPI_CLOCKSOURCE_ACLK**
- **USCI_A_SPI_CLOCKSOURCE_SMCLK**

Referenced by USCI_A_SPI_initMaster().

The documentation for this struct was generated from the following file:

- usci_a_spi.h

47.21 USCI_B_SPI_initMasterParam Struct Reference

Used in the USCI_B_SPI_initMaster() function as the param parameter.

`#include <usci_b_spi.h>`

Data Fields

- uint8_t selectClockSource
- uint32_t clockSourceFrequency
  Is the frequency of the selected clock source.
- uint32_t desiredSpiClock
  Is the desired clock rate for SPI communication.
- uint8_t msbFirst
- uint8_t clockPhase
- uint8_t clockPolarity

47.21.1 Detailed Description

Used in the USCI_B_SPI_initMaster() function as the param parameter.

47.21.2 Field Documentation

clockPhase

`uint8_t USCI_B_SPI_initMasterParam::clockPhase`

Is clock phase select.
Valid values are:

- **USCI_B_SPI_PHASE_DATA_CHANGED_ONFIRST_CAPTURED_ON_NEXT** [Default]
- **USCI_B_SPI_PHASE_DATA_CAPTURED_ONFIRST_CHANGED_ON_NEXT**

Referenced by USCI_B_SPI_initMaster().

clockPolarity

`uint8_t USCI_B_SPI_initMasterParam::clockPolarity`

Valid values are:

- **USCI_B_SPI_CLOCKPOLARITY_INACTIVITY_HIGH**
- **USCI_B_SPI_CLOCKPOLARITY_INACTIVITY_LOW** [Default]

Referenced by USCI_B_SPI_initMaster().

msbFirst

`uint8_t USCI_B_SPI_initMasterParam::msbFirst`

Controls the direction of the receive and transmit shift register.
Valid values are:

- **USCI_B_SPI_MSB_FIRST**
- **USCI_B_SPI_LSB_FIRST** [Default]

Referenced by USCI_B_SPI_initMaster().

selectClockSource

`uint8_t USCI_B_SPI_initMasterParam::selectClockSource`

Selects Clock source.
Valid values are:

- **USCI_B_SPI_CLOCKSOURCE_ACLK**
- **USCI_B_SPI_CLOCKSOURCE_SMCLK**

Referenced by USCI_B_SPI_initMaster().

The documentation for this struct was generated from the following file:

- usci_b_spi.h

47.22 TEC_initExternalFaultInputParam Struct Reference

Used in the TEC_initExternalFaultInput() function as the param parameter.

`#include <tec.h>`

Data Fields

- uint8_t selectedExternalFault
- uint16_t signalType
- uint8_t signalHold
- uint8_t polarityBit

47.22.1 Detailed Description

Used in the TEC_initExternalFaultInput() function as the param parameter.

47.22.2 Field Documentation

polarityBit

`uint8_t TEC_initExternalFaultInputParam::polarityBit`

Is the selected signal type
Valid values are:

- **TEC_EXTERNAL_FAULT_POLARITY_FALLING_EDGE_OR_LOW_LEVEL** [Default]
- **TEC_EXTERNAL_FAULT_POLARITY_RISING_EDGE_OR_HIGH_LEVEL**

Referenced by TEC_initExternalFaultInput().

selectedExternalFault

`uint8_t TEC_initExternalFaultInputParam::selectedExternalFault`

Is the selected external fault
Valid values are:

- **TEC_EXTERNAL_FAULT_0**
- **TEC_EXTERNAL_FAULT_1**
- **TEC_EXTERNAL_FAULT_2**
- **TEC_EXTERNAL_FAULT_3**
- **TEC_EXTERNAL_FAULT_4**
- **TEC_EXTERNAL_FAULT_5**
- **TEC_EXTERNAL_FAULT_6**

Referenced by TEC_initExternalFaultInput().

signalHold

`uint8_t TEC_initExternalFaultInputParam::signalHold`

Is the selected signal hold
Valid values are:

- **TEC_EXTERNAL_FAULT_SIGNAL_NOT_HELD** [Default]
- **TEC_EXTERNAL_FAULT_SIGNAL_HELD**

Referenced by TEC_initExternalFaultInput().

signalType

`uint16_t TEC_initExternalFaultInputParam::signalType`

Is the selected signal type
Valid values are:

- **TEC_EXTERNAL_FAULT_SIGNALTYPE_EDGE_SENSITIVE** [Default]
- **TEC_EXTERNAL_FAULT_SIGNALTYPE_LEVEL_SENSITIVE**

Referenced by TEC_initExternalFaultInput().

The documentation for this struct was generated from the following file:

- tec.h

47.23 USCI_A_SPI_changeMasterClockParam Struct Reference

Used in the USCI_A_SPI_changeMasterClock() function as the param parameter.

`#include <usci_a_spi.h>`

Data Fields

- uint32_t clockSourceFrequency
  Is the frequency of the selected clock source.
- uint32_t desiredSpiClock
  Is the desired clock rate for SPI communication.

47.23.1 Detailed Description

Used in the USCI_A_SPI_changeMasterClock() function as the param parameter.

The documentation for this struct was generated from the following file:

- usci_a_spi.h

47.24 SD24_B_initConverterParam Struct Reference

Used in the SD24_B_initConverter() function as the param parameter.

`#include <sd24_b.h>`

Data Fields

- uint8_t converter
- uint8_t alignment
- uint8_t startSelect
- uint8_t conversionMode

47.24.1 Detailed Description

Used in the SD24_B_initConverter() function as the param parameter.

47.24.2 Field Documentation

alignment

`uint8_t SD24_B_initConverterParam::alignment`

Selects how the data will be aligned in result
Valid values are:

- **SD24_B_ALIGN_RIGHT** [Default]
- **SD24_B_ALIGN_LEFT**

Referenced by SD24_B_initConverter().

conversionMode

`uint8_t SD24_B_initConverterParam::conversionMode`

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

- **SD24_B_CONTINUOUS_MODE** [Default]
- **SD24_B_SINGLE_MODE**

Referenced by SD24_B_initConverter().

converter

`uint8_t SD24_B_initConverterParam::converter`

Selects the converter that will be configured. Check datasheet for available converters on device.
Valid values are:

- **SD24_B_CONVERTER_0**
- **SD24_B_CONVERTER_1**
- **SD24_B_CONVERTER_2**
- **SD24_B_CONVERTER_3**
- **SD24_B_CONVERTER_4**
- **SD24_B_CONVERTER_5**
- **SD24_B_CONVERTER_6**
- **SD24_B_CONVERTER_7**

Referenced by SD24_B_initConverter().

startSelect

```
uint8_t SD24_B_initConverterParam::startSelect
```

Selects what will trigger the start of the converter
Valid values are:

- **SD24_B_CONVERSION_SELECT_SD24SC** [Default]
- **SD24_B_CONVERSION_SELECT_EXT1**
- **SD24_B_CONVERSION_SELECT_EXT2**
- **SD24_B_CONVERSION_SELECT_EXT3**
- **SD24_B_CONVERSION_SELECT_GROUP0**
- **SD24_B_CONVERSION_SELECT_GROUP1**
- **SD24_B_CONVERSION_SELECT_GROUP2**
- **SD24_B_CONVERSION_SELECT_GROUP3**

Referenced by SD24_B_initConverter().

The documentation for this struct was generated from the following file:

- sd24_b.h

47.25 EUSCI_A_UART_initParam Struct Reference

Used in the EUSCI_A_UART_init() function as the param parameter.

```
#include <eusci_a_uart.h>
```

Data Fields

- uint8_t selectClockSource
- uint16_t clockPrescalar
  Is the value to be written into UCBRx bits.
- uint8_t firstModReg
- uint8_t secondModReg
- uint8_t parity
- uint16_t msborLsbFirst
- uint16_t numberofStopBits
- uint16_t uartMode
- uint8_t overSampling

47.25.1 Detailed Description

Used in the EUSCI_A_UART_init() function as the param parameter.

47.25.2 Field Documentation

firstModReg

`uint8_t EUSCI_A_UART_initParam::firstModReg`

Is First modulation stage register setting. This value is a pre- calculated value which can be obtained from the Device Users Guide. This value is written into UCBRFx bits of UCAxMCTLW.

Referenced by EUSCI_A_UART_init().

msborLsbFirst

`uint16_t EUSCI_A_UART_initParam::msborLsbFirst`

Controls direction of receive and transmit shift register.
Valid values are:

- **EUSCI_A_UART_MSB_FIRST**
- **EUSCI_A_UART_LSB_FIRST** [Default]

Referenced by EUSCI_A_UART_init().

numberofStopBits

`uint16_t EUSCI_A_UART_initParam::numberofStopBits`

Indicates one/two STOP bits
Valid values are:

- **EUSCI_A_UART_ONE_STOP_BIT** [Default]
- **EUSCI_A_UART_TWO_STOP_BITS**

Referenced by EUSCI_A_UART_init().

overSampling

`uint8_t EUSCI_A_UART_initParam::overSampling`

Indicates low frequency or oversampling baud generation
Valid values are:

- **EUSCI_A_UART_OVERSAMPLING_BAUDRATE_GENERATION**
- **EUSCI_A_UART_LOW_FREQUENCY_BAUDRATE_GENERATION**

Referenced by EUSCI_A_UART_init().

parity

`uint8_t EUSCI_A_UART_initParam::parity`

Is the desired parity.
Valid values are:

- **EUSCI_A_UART_NO_PARITY** [Default]
- **EUSCI_A_UART_ODD_PARITY**
- **EUSCI_A_UART_EVEN_PARITY**

Referenced by EUSCI_A_UART_init().

secondModReg

`uint8_t EUSCI_A_UART_initParam::secondModReg`

Is Second modulation stage register setting. This value is a pre- calculated value which can be obtained from the Device Users Guide. This value is written into UCBRSx bits of UCAxMCTLW.

Referenced by EUSCI_A_UART_init().

selectClockSource

`uint8_t EUSCI_A_UART_initParam::selectClockSource`

Selects Clock source. Refer to device specific datasheet for available options.
Valid values are:

- **EUSCI_A_UART_CLOCKSOURCE_SMCLK**
- **EUSCI_A_UART_CLOCKSOURCE_ACLK**

Referenced by EUSCI_A_UART_init().

uartMode

`uint16_t EUSCI_A_UART_initParam::uartMode`

Selects the mode of operation
Valid values are:

- **EUSCI_A_UART_MODE** [Default]
- **EUSCI_A_UART_IDLE_LINE_MULTI_PROCESSOR_MODE**
- **EUSCI_A_UART_ADDRESS_BIT_MULTI_PROCESSOR_MODE**
- **EUSCI_A_UART_AUTOMATIC_BAUDRATE_DETECTION_MODE**

Referenced by EUSCI_A_UART_init().

The documentation for this struct was generated from the following file:

- eusci_a_uart.h

47.26 Timer_B_outputPWMParam Struct Reference

Used in the Timer_B_outputPWM() function as the param parameter.

```
#include <timer_b.h>
```

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t timerPeriod

  Selects the desired Timer_B period.
- uint16_t compareRegister
- uint16_t compareOutputMode
- uint16_t dutyCycle

  Specifies the dutycycle for the generated waveform.

47.26.1 Detailed Description

Used in the Timer_B_outputPWM() function as the param parameter.

47.26.2 Field Documentation

clockSource

```
uint16_t Timer_B_outputPWMParam::clockSource
```

Selects the clock source
Valid values are:

- **TIMER_B_CLOCKSOURCE_EXTERNAL_TXCLK** [Default]
- **TIMER_B_CLOCKSOURCE_ACLK**
- **TIMER_B_CLOCKSOURCE_SMCLK**
- **TIMER_B_CLOCKSOURCE_INVERTED_EXTERNAL_TXCLK**

Referenced by Timer_B_outputPWM().

clockSourceDivider

```
uint16_t Timer_B_outputPWMParam::clockSourceDivider
```

Is the divider for Clock source.
Valid values are:

- **TIMER_B_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_B_CLOCKSOURCE_DIVIDER_2**
- **TIMER_B_CLOCKSOURCE_DIVIDER_3**

- **TIMER_B_CLOCKSOURCE_DIVIDER_4**
- **TIMER_B_CLOCKSOURCE_DIVIDER_5**
- **TIMER_B_CLOCKSOURCE_DIVIDER_6**
- **TIMER_B_CLOCKSOURCE_DIVIDER_7**
- **TIMER_B_CLOCKSOURCE_DIVIDER_8**
- **TIMER_B_CLOCKSOURCE_DIVIDER_10**
- **TIMER_B_CLOCKSOURCE_DIVIDER_12**
- **TIMER_B_CLOCKSOURCE_DIVIDER_14**
- **TIMER_B_CLOCKSOURCE_DIVIDER_16**
- **TIMER_B_CLOCKSOURCE_DIVIDER_20**
- **TIMER_B_CLOCKSOURCE_DIVIDER_24**
- **TIMER_B_CLOCKSOURCE_DIVIDER_28**
- **TIMER_B_CLOCKSOURCE_DIVIDER_32**
- **TIMER_B_CLOCKSOURCE_DIVIDER_40**
- **TIMER_B_CLOCKSOURCE_DIVIDER_48**
- **TIMER_B_CLOCKSOURCE_DIVIDER_56**
- **TIMER_B_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_B_outputPWM().

compareOutputMode

`uint16_t Timer_B_outputPWMParam::compareOutputMode`

Specifies the output mode.
Valid values are:

- **TIMER_B_OUTPUTMODE_OUTBITVALUE** [Default]
- **TIMER_B_OUTPUTMODE_SET**
- **TIMER_B_OUTPUTMODE_TOGGLE_RESET**
- **TIMER_B_OUTPUTMODE_SET_RESET**
- **TIMER_B_OUTPUTMODE_TOGGLE**
- **TIMER_B_OUTPUTMODE_RESET**
- **TIMER_B_OUTPUTMODE_TOGGLE_SET**
- **TIMER_B_OUTPUTMODE_RESET_SET**

Referenced by Timer_B_outputPWM().

compareRegister

`uint16_t Timer_B_outputPWMParam::compareRegister`

Selects the compare register being used. Refer to datasheet to ensure the device has the compare register being used.
Valid values are:

- **TIMER_B_CAPTURECOMPARE_REGISTER_0**
- **TIMER_B_CAPTURECOMPARE_REGISTER_1**
- **TIMER_B_CAPTURECOMPARE_REGISTER_2**
- **TIMER_B_CAPTURECOMPARE_REGISTER_3**
- **TIMER_B_CAPTURECOMPARE_REGISTER_4**
- **TIMER_B_CAPTURECOMPARE_REGISTER_5**
- **TIMER_B_CAPTURECOMPARE_REGISTER_6**

Referenced by Timer_B_outputPWM().

The documentation for this struct was generated from the following file:

- timer_b.h

47.27 EUSCI_B_I2C_initMasterParam Struct Reference

Used in the EUSCI_B_I2C_initMaster() function as the param parameter.

```
#include <eusci_b_i2c.h>
```

Data Fields

- uint8_t selectClockSource
- uint32_t i2cClk
- uint32_t dataRate
- uint8_t byteCounterThreshold
  Sets threshold for automatic STOP or UCSTPIFG.
- uint8_t autoSTOPGeneration

47.27.1 Detailed Description

Used in the EUSCI_B_I2C_initMaster() function as the param parameter.

47.27.2 Field Documentation

autoSTOPGeneration

```
uint8_t EUSCI_B_I2C_initMasterParam::autoSTOPGeneration
```

Sets up the STOP condition generation.
Valid values are:

- **EUSCI_B_I2C_NO_AUTO_STOP**
- **EUSCI_B_I2C_SET_BYTECOUNT_THRESHOLD_FLAG**
- **EUSCI_B_I2C_SEND_STOP_AUTOMATICALLY_ON_BYTECOUNT_THRESHOLD**

Referenced by EUSCI_B_I2C_initMaster().

dataRate

`uint32_t EUSCI_B_I2C_initMasterParam::dataRate`

Setup for selecting data transfer rate.
Valid values are:

- **EUSCI_B_I2C_SET_DATA_RATE_400KBPS**
- **EUSCI_B_I2C_SET_DATA_RATE_100KBPS**

Referenced by EUSCI_B_I2C_initMaster().

i2cClk

`uint32_t EUSCI_B_I2C_initMasterParam::i2cClk`

Is the rate of the clock supplied to the I2C module (the frequency in Hz of the clock source specified in selectClockSource).

Referenced by EUSCI_B_I2C_initMaster().

selectClockSource

`uint8_t EUSCI_B_I2C_initMasterParam::selectClockSource`

Selects the clocksource. Refer to device specific datasheet for available options.
Valid values are:

- **EUSCI_B_I2C_CLOCKSOURCE_ACLK**
- **EUSCI_B_I2C_CLOCKSOURCE_SMCLK**

Referenced by EUSCI_B_I2C_initMaster().

The documentation for this struct was generated from the following file:

- eusci_b_i2c.h

47.28 EUSCI_A_SPI_changeMasterClockParam Struct Reference

Used in the EUSCI_A_SPI_changeMasterClock() function as the param parameter.

`#include <eusci_a_spi.h>`

Data Fields

- uint32_t clockSourceFrequency
  Is the frequency of the selected clock source in Hz.
- uint32_t desiredSpiClock
  Is the desired clock rate in Hz for SPI communication.

47.28.1 Detailed Description

Used in the EUSCI_A_SPI_changeMasterClock() function as the param parameter.

The documentation for this struct was generated from the following file:

- eusci_a_spi.h

47.29 Timer_B_initUpModeParam Struct Reference

Used in the Timer_B_initUpMode() function as the param parameter.

```
#include <timer_b.h>
```

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t timerPeriod
- uint16_t timerInterruptEnable_TBIE
- uint16_t captureCompareInterruptEnable_CCR0_CCIE
- uint16_t timerClear
- bool startTimer

  Whether to start the timer immediately.

47.29.1 Detailed Description

Used in the Timer_B_initUpMode() function as the param parameter.

47.29.2 Field Documentation

captureCompareInterruptEnable_CCR0_CCIE

```
uint16_t Timer_B_initUpModeParam::captureCompareInterruptEnable_CCR0_CCIE
```

Is to enable or disable Timer_B CCR0 capture compare interrupt.
Valid values are:

- **TIMER_B_CCIE_CCR0_INTERRUPT_ENABLE**
- **TIMER_B_CCIE_CCR0_INTERRUPT_DISABLE** [Default]

Referenced by Timer_B_initUpMode().

clockSource

```
uint16_t Timer_B_initUpModeParam::clockSource
```

Selects the clock source
Valid values are:

- **TIMER_B_CLOCKSOURCE_EXTERNAL_TXCLK** [Default]
- **TIMER_B_CLOCKSOURCE_ACLK**
- **TIMER_B_CLOCKSOURCE_SMCLK**
- **TIMER_B_CLOCKSOURCE_INVERTED_EXTERNAL_TXCLK**

Referenced by Timer_B_initUpMode().

clockSourceDivider

`uint16_t Timer_B_initUpModeParam::clockSourceDivider`

Is the divider for Clock source.
Valid values are:

- **TIMER_B_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_B_CLOCKSOURCE_DIVIDER_2**
- **TIMER_B_CLOCKSOURCE_DIVIDER_3**
- **TIMER_B_CLOCKSOURCE_DIVIDER_4**
- **TIMER_B_CLOCKSOURCE_DIVIDER_5**
- **TIMER_B_CLOCKSOURCE_DIVIDER_6**
- **TIMER_B_CLOCKSOURCE_DIVIDER_7**
- **TIMER_B_CLOCKSOURCE_DIVIDER_8**
- **TIMER_B_CLOCKSOURCE_DIVIDER_10**
- **TIMER_B_CLOCKSOURCE_DIVIDER_12**
- **TIMER_B_CLOCKSOURCE_DIVIDER_14**
- **TIMER_B_CLOCKSOURCE_DIVIDER_16**
- **TIMER_B_CLOCKSOURCE_DIVIDER_20**
- **TIMER_B_CLOCKSOURCE_DIVIDER_24**
- **TIMER_B_CLOCKSOURCE_DIVIDER_28**
- **TIMER_B_CLOCKSOURCE_DIVIDER_32**
- **TIMER_B_CLOCKSOURCE_DIVIDER_40**
- **TIMER_B_CLOCKSOURCE_DIVIDER_48**
- **TIMER_B_CLOCKSOURCE_DIVIDER_56**
- **TIMER_B_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_B_initUpMode().

timerClear

`uint16_t Timer_B_initUpModeParam::timerClear`

Decides if Timer_B clock divider, count direction, count need to be reset.
Valid values are:

- **TIMER_B_DO_CLEAR**
- **TIMER_B_SKIP_CLEAR** [Default]

Referenced by Timer_B_initUpMode().

timerInterruptEnable_TBIE

`uint16_t Timer_B_initUpModeParam::timerInterruptEnable_TBIE`

Is to enable or disable Timer_B interrupt
Valid values are:

- **TIMER_B_TBIE_INTERRUPT_ENABLE**
- **TIMER_B_TBIE_INTERRUPT_DISABLE** [Default]

Referenced by Timer_B_initUpMode().

timerPeriod

`uint16_t Timer_B_initUpModeParam::timerPeriod`

Is the specified Timer_B period. This is the value that gets written into the CCR0. Limited to 16 bits[uint16_t]

Referenced by Timer_B_initUpMode().

The documentation for this struct was generated from the following file:

- timer_b.h

47.30 Timer_B_initCompareModeParam Struct Reference

Used in the Timer_B_initCompareMode() function as the param parameter.

`#include <timer_b.h>`

Data Fields

- uint16_t compareRegister
- uint16_t compareInterruptEnable
- uint16_t compareOutputMode
- uint16_t compareValue
  Is the count to be compared with in compare mode.

47.30.1 Detailed Description

Used in the Timer_B_initCompareMode() function as the param parameter.

47.30.2 Field Documentation

compareInterruptEnable

```
uint16_t Timer_B_initCompareModeParam::compareInterruptEnable
```

Is to enable or disable Timer_B capture compare interrupt.
Valid values are:

- **TIMER_B_CAPTURECOMPARE_INTERRUPT_DISABLE** [Default]
- **TIMER_B_CAPTURECOMPARE_INTERRUPT_ENABLE**

Referenced by Timer_B_initCompareMode().

compareOutputMode

```
uint16_t Timer_B_initCompareModeParam::compareOutputMode
```

Specifies the output mode.
Valid values are:

- **TIMER_B_OUTPUTMODE_OUTBITVALUE** [Default]
- **TIMER_B_OUTPUTMODE_SET**
- **TIMER_B_OUTPUTMODE_TOGGLE_RESET**
- **TIMER_B_OUTPUTMODE_SET_RESET**
- **TIMER_B_OUTPUTMODE_TOGGLE**
- **TIMER_B_OUTPUTMODE_RESET**
- **TIMER_B_OUTPUTMODE_TOGGLE_SET**
- **TIMER_B_OUTPUTMODE_RESET_SET**

Referenced by Timer_B_initCompareMode().

compareRegister

```
uint16_t Timer_B_initCompareModeParam::compareRegister
```

Selects the compare register being used. Refer to datasheet to ensure the device has the compare register being used.
Valid values are:

- **TIMER_B_CAPTURECOMPARE_REGISTER_0**
- **TIMER_B_CAPTURECOMPARE_REGISTER_1**
- **TIMER_B_CAPTURECOMPARE_REGISTER_2**

- **TIMER_B_CAPTURECOMPARE_REGISTER_3**
- **TIMER_B_CAPTURECOMPARE_REGISTER_4**
- **TIMER_B_CAPTURECOMPARE_REGISTER_5**
- **TIMER_B_CAPTURECOMPARE_REGISTER_6**

Referenced by Timer_B_initCompareMode().

The documentation for this struct was generated from the following file:

- timer_b.h

47.31 EUSCI_A_SPI_initMasterParam Struct Reference

Used in the EUSCI_A_SPI_initMaster() function as the param parameter.

```
#include <eusci_a_spi.h>
```

Data Fields

- uint8_t selectClockSource
- uint32_t clockSourceFrequency
  Is the frequency of the selected clock source in Hz.
- uint32_t desiredSpiClock
  Is the desired clock rate in Hz for SPI communication.
- uint16_t msbFirst
- uint16_t clockPhase
- uint16_t clockPolarity
- uint16_t spiMode

47.31.1 Detailed Description

Used in the EUSCI_A_SPI_initMaster() function as the param parameter.

47.31.2 Field Documentation

clockPhase

```
uint16_t EUSCI_A_SPI_initMasterParam::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**

Referenced by EUSCI_A_SPI_initMaster().

clockPolarity

`uint16_t EUSCI_A_SPI_initMasterParam::clockPolarity`

Is clock polarity select
Valid values are:

- **EUSCI_A_SPI_CLOCKPOLARITY_INACTIVITY_HIGH**
- **EUSCI_A_SPI_CLOCKPOLARITY_INACTIVITY_LOW** [Default]

Referenced by EUSCI_A_SPI_initMaster().

msbFirst

`uint16_t EUSCI_A_SPI_initMasterParam::msbFirst`

Controls the direction of the receive and transmit shift register.
Valid values are:

- **EUSCI_A_SPI_MSB_FIRST**
- **EUSCI_A_SPI_LSB_FIRST** [Default]

Referenced by EUSCI_A_SPI_initMaster().

selectClockSource

`uint8_t EUSCI_A_SPI_initMasterParam::selectClockSource`

Selects Clock source. Refer to device specific datasheet for available options.
Valid values are:

- **EUSCI_A_SPI_CLOCKSOURCE_ACLK**
- **EUSCI_A_SPI_CLOCKSOURCE_SMCLK**

Referenced by EUSCI_A_SPI_initMaster().

spiMode

`uint16_t EUSCI_A_SPI_initMasterParam::spiMode`

Is SPI mode select
Valid values are:

- **EUSCI_A_SPI_3PIN**
- **EUSCI_A_SPI_4PIN_UCxSTE_ACTIVE_HIGH**
- **EUSCI_A_SPI_4PIN_UCxSTE_ACTIVE_LOW**

Referenced by EUSCI_A_SPI_initMaster().

The documentation for this struct was generated from the following file:

- eusci_a_spi.h

47.32 DAC12_A_initParam Struct Reference

Used in the DAC12_A_init() function as the param parameter.

```
#include <dac12_a.h>
```

Data Fields

- uint8_t submoduleSelect
- uint16_t outputSelect
- uint16_t positiveReferenceVoltage
- uint16_t outputVoltageMultiplier
- uint8_t amplifierSetting
- uint16_t conversionTriggerSelect

47.32.1 Detailed Description

Used in the DAC12_A_init() function as the param parameter.

47.32.2 Field Documentation

amplifierSetting

```
uint8_t DAC12_A_initParam::amplifierSetting
```

Is the setting of the settling speed and current of the Vref+ and the Vout buffer.
Valid values are:

- **DAC12_A_AMP_OFF_PINOUTHIGHZ** [Default] - Initialize the DAC12_A Module with settings, but do not turn it on.
- **DAC12_A_AMP_OFF_PINOUTLOW** - Initialize the DAC12_A Module with settings, and allow it to take control of the selected output pin to pull it low (Note: this takes control away port mapping module).
- **DAC12_A_AMP_LOWIN_LOWOUT** - Select a slow settling speed and current for Vref+ input buffer and for Vout output buffer.
- **DAC12_A_AMP_LOWIN_MEDOUT** - Select a slow settling speed and current for Vref+ input buffer and a medium settling speed and current for Vout output buffer.
- **DAC12_A_AMP_LOWIN_HIGHOUT** - Select a slow settling speed and current for Vref+ input buffer and a high settling speed and current for Vout output buffer.
- **DAC12_A_AMP_MEDIN_MEDOUT** - Select a medium settling speed and current for Vref+ input buffer and for Vout output buffer.
- **DAC12_A_AMP_MEDIN_HIGHOUT** - Select a medium settling speed and current for Vref+ input buffer and a high settling speed and current for Vout output buffer.
- **DAC12_A_AMP_HIGHIN_HIGHOUT** - Select a high settling speed and current for Vref+ input buffer and for Vout output buffer.

Referenced by DAC12_A_init().

conversionTriggerSelect

`uint16_t DAC12_A_initParam::conversionTriggerSelect`

Selects the trigger that will start a conversion.
Valid values are:

- **DAC12_A_TRIGGER_ENCBYPASS** [Default] - Automatically converts data as soon as it is written into the data buffer. (Note: Do not use this selection if grouping DAC's).
- **DAC12_A_TRIGGER_ENC** - Requires a call to enableConversions() to allow a conversion, but starts a conversion as soon as data is written to the data buffer (Note: with DAC12_A module's grouped, data has to be set in BOTH DAC12_A data buffers to start a conversion).
- **DAC12_A_TRIGGER_TA** - Requires a call to enableConversions() to allow a conversion, and a rising edge of Timer_A's Out1 (TA1) to start a conversion.
- **DAC12_A_TRIGGER_TB** - Requires a call to enableConversions() to allow a conversion, and a rising edge of Timer_B's Out2 (TB2) to start a conversion.

Referenced by DAC12_A_init().

outputSelect

`uint16_t DAC12_A_initParam::outputSelect`

Selects the output pin that the selected DAC12_A module will output to.
Valid values are:

- **DAC12_A_OUTPUT_1** [Default]
- **DAC12_A_OUTPUT_2**

Referenced by DAC12_A_init().

outputVoltageMultiplier

`uint16_t DAC12_A_initParam::outputVoltageMultiplier`

Is the multiplier of the Vout voltage.
Valid values are:

- **DAC12_A_VREFx1** [Default]
- **DAC12_A_VREFx2**
- **DAC12_A_VREFx3**

Referenced by DAC12_A_init().

positiveReferenceVoltage

`uint16_t DAC12_A_initParam::positiveReferenceVoltage`

Is the upper limit voltage that the data can be converted in to.
Valid values are:

- **DAC12_A_VREF_INT** [Default]
- **DAC12_A_VREF_AVCC**
- **DAC12_A_VREF_EXT** - For devices with CTSD16, use Ref module Ref_enableReferenceVoltageOutput/Ref__disableReferenceVoltageOutput to select VeREF(external reference signal) or VREFBG(internally generated reference signal)

Referenced by DAC12_A_init().

submoduleSelect

`uint8_t DAC12_A_initParam::submoduleSelect`

Decides which DAC12_A sub-module to configure.
Valid values are:

- **DAC12_A_SUBMODULE_0**
- **DAC12_A_SUBMODULE_1**

Referenced by DAC12_A_init().

The documentation for this struct was generated from the following file:

- dac12_a.h

47.33 Timer_D_initCaptureModeParam Struct Reference

Used in the Timer_D_initCaptureMode() function as the param parameter.

`#include <timer_d.h>`

Data Fields

- uint16_t captureRegister
- uint16_t captureMode
- uint16_t captureInputSelect
- uint16_t synchronizeCaptureSource
- uint16_t captureInterruptEnable
- uint16_t captureOutputMode
- uint8_t channelCaptureMode

47.33.1 Detailed Description

Used in the Timer_D_initCaptureMode() function as the param parameter.

47.33.2 Field Documentation

captureInputSelect

`uint16_t Timer_D_initCaptureModeParam::captureInputSelect`

Decides the Input Select
Valid values are:

- **TIMER_D_CAPTURE_INPUTSELECT_CCIxA** [Default]
- **TIMER_D_CAPTURE_INPUTSELECT_CCIxB**
- **TIMER_D_CAPTURE_INPUTSELECT_GND**
- **TIMER_D_CAPTURE_INPUTSELECT_Vcc**

Referenced by Timer_D_initCaptureMode().

captureInterruptEnable

`uint16_t Timer_D_initCaptureModeParam::captureInterruptEnable`

Is to enable or disabel capture interrupt
Valid values are:

- **TIMER_D_CAPTURE_INTERRUPT_ENABLE**
- **TIMER_D_CAPTURE_INTERRUPT_DISABLE** [Default]

Referenced by Timer_D_initCaptureMode().

captureMode

`uint16_t Timer_D_initCaptureModeParam::captureMode`

Is the capture mode selected.
Valid values are:

- **TIMER_D_CAPTUREMODE_NO_CAPTURE** [Default]
- **TIMER_D_CAPTUREMODE_RISING_EDGE**
- **TIMER_D_CAPTUREMODE_FALLING_EDGE**
- **TIMER_D_CAPTUREMODE_RISING_AND_FALLING_EDGE**

Referenced by Timer_D_initCaptureMode().

captureOutputMode

`uint16_t Timer_D_initCaptureModeParam::captureOutputMode`

Specifies the output mode.
Valid values are:

- **TIMER_D_OUTPUTMODE_OUTBITVALUE** [Default]

- **TIMER_D_OUTPUTMODE_SET**
- **TIMER_D_OUTPUTMODE_TOGGLE_RESET**
- **TIMER_D_OUTPUTMODE_SET_RESET**
- **TIMER_D_OUTPUTMODE_TOGGLE**
- **TIMER_D_OUTPUTMODE_RESET**
- **TIMER_D_OUTPUTMODE_TOGGLE_SET**
- **TIMER_D_OUTPUTMODE_RESET_SET**

Referenced by Timer_D_initCaptureMode().

captureRegister

`uint16_t Timer_D_initCaptureModeParam::captureRegister`

Selects the Capture register being used. Refer to datasheet to ensure the device has the capture compare register being used
Valid values are:

- **TIMER_D_CAPTURECOMPARE_REGISTER_0**
- **TIMER_D_CAPTURECOMPARE_REGISTER_1**
- **TIMER_D_CAPTURECOMPARE_REGISTER_2**
- **TIMER_D_CAPTURECOMPARE_REGISTER_3**
- **TIMER_D_CAPTURECOMPARE_REGISTER_4**
- **TIMER_D_CAPTURECOMPARE_REGISTER_5**
- **TIMER_D_CAPTURECOMPARE_REGISTER_6**

Referenced by Timer_D_initCaptureMode().

channelCaptureMode

`uint8_t Timer_D_initCaptureModeParam::channelCaptureMode`

Specifies single/dual capture mode.
Valid values are:

- **TIMER_D_SINGLE_CAPTURE_MODE** - value],
- **TIMER_D_DUAL_CAPTURE_MODE**

Referenced by Timer_D_initCaptureMode().

synchronizeCaptureSource

`uint16_t Timer_D_initCaptureModeParam::synchronizeCaptureSource`

Decides if capture source should be synchronized with timer clock
Valid values are:

- **TIMER_D_CAPTURE_ASYNCHRONOUS** [Default]

- **TIMER_D_CAPTURE_SYNCHRONOUS**

Referenced by Timer_D_initCaptureMode().

The documentation for this struct was generated from the following file:

- timer_d.h

47.34 Timer_B_initCaptureModeParam Struct Reference

Used in the Timer_B_initCaptureMode() function as the param parameter.

```
#include <timer_b.h>
```

Data Fields

- uint16_t captureRegister
- uint16_t captureMode
- uint16_t captureInputSelect
- uint16_t synchronizeCaptureSource
- uint16_t captureInterruptEnable
- uint16_t captureOutputMode

47.34.1 Detailed Description

Used in the Timer_B_initCaptureMode() function as the param parameter.

47.34.2 Field Documentation

captureInputSelect

```
uint16_t Timer_B_initCaptureModeParam::captureInputSelect
```

Decides the Input Select
Valid values are:

- **TIMER_B_CAPTURE_INPUTSELECT_CCIxA** [Default]
- **TIMER_B_CAPTURE_INPUTSELECT_CCIxB**
- **TIMER_B_CAPTURE_INPUTSELECT_GND**
- **TIMER_B_CAPTURE_INPUTSELECT_Vcc**

Referenced by Timer_B_initCaptureMode().

captureInterruptEnable

`uint16_t Timer_B_initCaptureModeParam::captureInterruptEnable`

Is to enable or disable Timer_B capture compare interrupt.
Valid values are:

- **TIMER_B_CAPTURECOMPARE_INTERRUPT_DISABLE** [Default]
- **TIMER_B_CAPTURECOMPARE_INTERRUPT_ENABLE**

Referenced by Timer_B_initCaptureMode().

captureMode

`uint16_t Timer_B_initCaptureModeParam::captureMode`

Is the capture mode selected.
Valid values are:

- **TIMER_B_CAPTUREMODE_NO_CAPTURE** [Default]
- **TIMER_B_CAPTUREMODE_RISING_EDGE**
- **TIMER_B_CAPTUREMODE_FALLING_EDGE**
- **TIMER_B_CAPTUREMODE_RISING_AND_FALLING_EDGE**

Referenced by Timer_B_initCaptureMode().

captureOutputMode

`uint16_t Timer_B_initCaptureModeParam::captureOutputMode`

Specifies the output mode.
Valid values are:

- **TIMER_B_OUTPUTMODE_OUTBITVALUE** [Default]
- **TIMER_B_OUTPUTMODE_SET**
- **TIMER_B_OUTPUTMODE_TOGGLE_RESET**
- **TIMER_B_OUTPUTMODE_SET_RESET**
- **TIMER_B_OUTPUTMODE_TOGGLE**
- **TIMER_B_OUTPUTMODE_RESET**
- **TIMER_B_OUTPUTMODE_TOGGLE_SET**
- **TIMER_B_OUTPUTMODE_RESET_SET**

Referenced by Timer_B_initCaptureMode().

captureRegister

`uint16_t Timer_B_initCaptureModeParam::captureRegister`

Selects the capture register being used. Refer to datasheet to ensure the device has the capture register being used.
Valid values are:

- **TIMER_B_CAPTURECOMPARE_REGISTER_0**
- **TIMER_B_CAPTURECOMPARE_REGISTER_1**
- **TIMER_B_CAPTURECOMPARE_REGISTER_2**
- **TIMER_B_CAPTURECOMPARE_REGISTER_3**
- **TIMER_B_CAPTURECOMPARE_REGISTER_4**
- **TIMER_B_CAPTURECOMPARE_REGISTER_5**
- **TIMER_B_CAPTURECOMPARE_REGISTER_6**

Referenced by Timer_B_initCaptureMode().

synchronizeCaptureSource

`uint16_t Timer_B_initCaptureModeParam::synchronizeCaptureSource`

Decides if capture source should be synchronized with Timer_B clock
Valid values are:

- **TIMER_B_CAPTURE_ASYNCHRONOUS** [Default]
- **TIMER_B_CAPTURE_SYNCHRONOUS**

Referenced by Timer_B_initCaptureMode().

The documentation for this struct was generated from the following file:

- timer_b.h

47.35 EUSCI_B_SPI_initMasterParam Struct Reference

Used in the EUSCI_B_SPI_initMaster() function as the param parameter.

`#include <eusci_b_spi.h>`

Data Fields

- uint8_t selectClockSource
- uint32_t clockSourceFrequency
  Is the frequency of the selected clock source in Hz.
- uint32_t desiredSpiClock
  Is the desired clock rate in Hz for SPI communication.
- uint16_t msbFirst
- uint16_t clockPhase
- uint16_t clockPolarity
- uint16_t spiMode

47.35.1 Detailed Description

Used in the EUSCI_B_SPI_initMaster() function as the param parameter.

47.35.2 Field Documentation

clockPhase

`uint16_t EUSCI_B_SPI_initMasterParam::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**

Referenced by EUSCI_B_SPI_initMaster().

clockPolarity

`uint16_t EUSCI_B_SPI_initMasterParam::clockPolarity`

Is clock polarity select
Valid values are:

- **EUSCI_B_SPI_CLOCKPOLARITY_INACTIVITY_HIGH**
- **EUSCI_B_SPI_CLOCKPOLARITY_INACTIVITY_LOW** [Default]

Referenced by EUSCI_B_SPI_initMaster().

msbFirst

`uint16_t EUSCI_B_SPI_initMasterParam::msbFirst`

Controls the direction of the receive and transmit shift register.
Valid values are:

- **EUSCI_B_SPI_MSB_FIRST**
- **EUSCI_B_SPI_LSB_FIRST** [Default]

Referenced by EUSCI_B_SPI_initMaster().

selectClockSource

`uint8_t EUSCI_B_SPI_initMasterParam::selectClockSource`

Selects Clock source. Refer to device specific datasheet for available options.
Valid values are:

- **EUSCI_B_SPI_CLOCKSOURCE_ACLK**
- **EUSCI_B_SPI_CLOCKSOURCE_SMCLK**

Referenced by EUSCI_B_SPI_initMaster().

spiMode

```
uint16_t EUSCI_B_SPI_initMasterParam::spiMode
```

Is SPI mode select
Valid values are:

- **EUSCI_B_SPI_3PIN**
- **EUSCI_B_SPI_4PIN_UCxSTE_ACTIVE_HIGH**
- **EUSCI_B_SPI_4PIN_UCxSTE_ACTIVE_LOW**

Referenced by EUSCI_B_SPI_initMaster().

The documentation for this struct was generated from the following file:

- eusci_b_spi.h

47.36 SD24_B_initConverterAdvancedParam Struct Reference

Used in the SD24_B_initConverterAdvanced() function as the param parameter.

```
#include <sd24_b.h>
```

Data Fields

- uint8_t converter
- uint8_t alignment
- uint8_t startSelect
- uint8_t conversionMode
- uint8_t dataFormat
- uint8_t sampleDelay
- uint16_t oversampleRatio
- uint8_t gain

47.36.1 Detailed Description

Used in the SD24_B_initConverterAdvanced() function as the param parameter.

47.36.2 Field Documentation

alignment

`uint8_t SD24_B_initConverterAdvancedParam::alignment`

Selects how the data will be aligned in result
Valid values are:

- **SD24_B_ALIGN_RIGHT** [Default]
- **SD24_B_ALIGN_LEFT**

Referenced by SD24_B_initConverterAdvanced().

conversionMode

`uint8_t SD24_B_initConverterAdvancedParam::conversionMode`

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

- **SD24_B_CONTINUOUS_MODE** [Default]
- **SD24_B_SINGLE_MODE**

Referenced by SD24_B_initConverterAdvanced().

converter

`uint8_t SD24_B_initConverterAdvancedParam::converter`

Selects the converter that will be configured. Check datasheet for available converters on device.
Valid values are:

- **SD24_B_CONVERTER_0**
- **SD24_B_CONVERTER_1**
- **SD24_B_CONVERTER_2**
- **SD24_B_CONVERTER_3**
- **SD24_B_CONVERTER_4**
- **SD24_B_CONVERTER_5**
- **SD24_B_CONVERTER_6**
- **SD24_B_CONVERTER_7**

Referenced by SD24_B_initConverterAdvanced().

dataFormat

`uint8_t SD24_B_initConverterAdvancedParam::dataFormat`

Selects how the data format of the results
Valid values are:

- **SD24_B_DATA_FORMAT_BINARY** [Default]
- **SD24_B_DATA_FORMAT_2COMPLEMENT**

Referenced by SD24_B_initConverterAdvanced().

gain

`uint8_t SD24_B_initConverterAdvancedParam::gain`

Selects the gain for the converter
Valid values are:

- **SD24_B_GAIN_1** [Default]
- **SD24_B_GAIN_2**
- **SD24_B_GAIN_4**
- **SD24_B_GAIN_8**
- **SD24_B_GAIN_16**
- **SD24_B_GAIN_32**
- **SD24_B_GAIN_64**
- **SD24_B_GAIN_128**

Referenced by SD24_B_initConverterAdvanced().

oversampleRatio

`uint16_t SD24_B_initConverterAdvancedParam::oversampleRatio`

Selects oversampling ratio for the converter
Valid values are:

- **SD24_B_OVERSAMPLE_32**
- **SD24_B_OVERSAMPLE_64**
- **SD24_B_OVERSAMPLE_128**
- **SD24_B_OVERSAMPLE_256**
- **SD24_B_OVERSAMPLE_512**
- **SD24_B_OVERSAMPLE_1024**

Referenced by SD24_B_initConverterAdvanced().

sampleDelay

`uint8_t SD24_B_initConverterAdvancedParam::sampleDelay`

Selects the delay for the interrupt
Valid values are:

- **SD24_B_FOURTH_SAMPLE_INTERRUPT** [Default]

- **SD24_B_THIRD_SAMPLE_INTERRUPT**
- **SD24_B_SECOND_SAMPLE_INTERRUPT**
- **SD24_B_FIRST_SAMPLE_INTERRUPT**

Referenced by SD24_B_initConverterAdvanced().

startSelect

`uint8_t SD24_B_initConverterAdvancedParam::startSelect`

Selects what will trigger the start of the converter
Valid values are:

- **SD24_B_CONVERSION_SELECT_SD24SC** [Default]
- **SD24_B_CONVERSION_SELECT_EXT1**
- **SD24_B_CONVERSION_SELECT_EXT2**
- **SD24_B_CONVERSION_SELECT_EXT3**
- **SD24_B_CONVERSION_SELECT_GROUP0**
- **SD24_B_CONVERSION_SELECT_GROUP1**
- **SD24_B_CONVERSION_SELECT_GROUP2**
- **SD24_B_CONVERSION_SELECT_GROUP3**

Referenced by SD24_B_initConverterAdvanced().

The documentation for this struct was generated from the following file:

- sd24_b.h

47.37 Timer_D_combineTDCCRToOutputPWMParam Struct Reference

Used in the Timer_D_combineTDCCRToOutputPWM() function as the param parameter.

`#include <timer_d.h>`

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t clockingMode
- uint16_t timerPeriod
  Is the specified timer period.
- uint16_t combineCCRRegistersCombination
- uint16_t compareOutputMode
- uint16_t dutyCycle1
  Specifies the dutycycle for the generated waveform.
- uint16_t dutyCycle2
  Specifies the dutycycle for the generated waveform.

47.37.1 Detailed Description

Used in the Timer_D_combineTDCCRToOutputPWM() function as the param parameter.

47.37.2 Field Documentation

clockingMode

`uint16_t Timer_D_combineTDCCRToOutputPWMParam::clockingMode`

Is the selected clock mode register values.
Valid values are:

- **TIMER_D_CLOCKINGMODE_EXTERNAL_CLOCK** [Default]
- **TIMER_D_CLOCKINGMODE_HIRES_LOCAL_CLOCK**
- **TIMER_D_CLOCKINGMODE_AUXILIARY_CLK**

Referenced by Timer_D_combineTDCCRToOutputPWM().

clockSource

`uint16_t Timer_D_combineTDCCRToOutputPWMParam::clockSource`

Selects Clock source.
Valid values are:

- **TIMER_D_CLOCKSOURCE_EXTERNAL_TDCLK** [Default]
- **TIMER_D_CLOCKSOURCE_ACLK**
- **TIMER_D_CLOCKSOURCE_SMCLK**
- **TIMER_D_CLOCKSOURCE_INVERTED_EXTERNAL_TDCLK**

Referenced by Timer_D_combineTDCCRToOutputPWM().

clockSourceDivider

`uint16_t Timer_D_combineTDCCRToOutputPWMParam::clockSourceDivider`

Is the divider for clock source.
Valid values are:

- **TIMER_D_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_D_CLOCKSOURCE_DIVIDER_2**
- **TIMER_D_CLOCKSOURCE_DIVIDER_3**
- **TIMER_D_CLOCKSOURCE_DIVIDER_4**
- **TIMER_D_CLOCKSOURCE_DIVIDER_5**
- **TIMER_D_CLOCKSOURCE_DIVIDER_6**
- **TIMER_D_CLOCKSOURCE_DIVIDER_7**

- **TIMER_D_CLOCKSOURCE_DIVIDER_8**
- **TIMER_D_CLOCKSOURCE_DIVIDER_10**
- **TIMER_D_CLOCKSOURCE_DIVIDER_12**
- **TIMER_D_CLOCKSOURCE_DIVIDER_14**
- **TIMER_D_CLOCKSOURCE_DIVIDER_16**
- **TIMER_D_CLOCKSOURCE_DIVIDER_20**
- **TIMER_D_CLOCKSOURCE_DIVIDER_24**
- **TIMER_D_CLOCKSOURCE_DIVIDER_28**
- **TIMER_D_CLOCKSOURCE_DIVIDER_32**
- **TIMER_D_CLOCKSOURCE_DIVIDER_40**
- **TIMER_D_CLOCKSOURCE_DIVIDER_48**
- **TIMER_D_CLOCKSOURCE_DIVIDER_56**
- **TIMER_D_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_D_combineTDCCRToOutputPWM().

combineCCRRegistersCombination

`uint16_t Timer_D_combineTDCCRToOutputPWMParam::combineCCRRegistersCombination`

Selects desired CCR registers to combine
Valid values are:

- **TIMER_D_COMBINE_CCR1_CCR2**
- **TIMER_D_COMBINE_CCR3_CCR4** - (available on Timer_D5, Timer_D7)
- **TIMER_D_COMBINE_CCR5_CCR6** - (available only on Timer_D7)

Referenced by Timer_D_combineTDCCRToOutputPWM().

compareOutputMode

`uint16_t Timer_D_combineTDCCRToOutputPWMParam::compareOutputMode`

Specifies the output mode.
Valid values are:

- **TIMER_D_OUTPUTMODE_OUTBITVALUE** [Default]
- **TIMER_D_OUTPUTMODE_SET**
- **TIMER_D_OUTPUTMODE_TOGGLE_RESET**
- **TIMER_D_OUTPUTMODE_SET_RESET**
- **TIMER_D_OUTPUTMODE_TOGGLE**
- **TIMER_D_OUTPUTMODE_RESET**
- **TIMER_D_OUTPUTMODE_TOGGLE_SET**
- **TIMER_D_OUTPUTMODE_RESET_SET**

Referenced by Timer_D_combineTDCCRToOutputPWM().

The documentation for this struct was generated from the following file:

- timer_d.h

47.38 Timer_D_initContinuousModeParam Struct Reference

Used in the Timer_D_initContinuousMode() function as the param parameter.

```
#include <timer_d.h>
```

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t clockingMode
- uint16_t timerInterruptEnable_TDIE
- uint16_t timerClear

47.38.1 Detailed Description

Used in the Timer_D_initContinuousMode() function as the param parameter.

47.38.2 Field Documentation

clockingMode

```
uint16_t Timer_D_initContinuousModeParam::clockingMode
```

Is the selected clock mode register values.
Valid values are:

- **TIMER_D_CLOCKINGMODE_EXTERNAL_CLOCK** [Default]
- **TIMER_D_CLOCKINGMODE_HIRES_LOCAL_CLOCK**
- **TIMER_D_CLOCKINGMODE_AUXILIARY_CLK**

Referenced by Timer_D_initContinuousMode().

clockSource

```
uint16_t Timer_D_initContinuousModeParam::clockSource
```

Selects Clock source.
Valid values are:

- **TIMER_D_CLOCKSOURCE_EXTERNAL_TDCLK** [Default]
- **TIMER_D_CLOCKSOURCE_ACLK**
- **TIMER_D_CLOCKSOURCE_SMCLK**
- **TIMER_D_CLOCKSOURCE_INVERTED_EXTERNAL_TDCLK**

Referenced by Timer_D_initContinuousMode().

clockSourceDivider

`uint16_t Timer_D_initContinuousModeParam::clockSourceDivider`

Is the divider for clock source.
Valid values are:

- **TIMER_D_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_D_CLOCKSOURCE_DIVIDER_2**
- **TIMER_D_CLOCKSOURCE_DIVIDER_3**
- **TIMER_D_CLOCKSOURCE_DIVIDER_4**
- **TIMER_D_CLOCKSOURCE_DIVIDER_5**
- **TIMER_D_CLOCKSOURCE_DIVIDER_6**
- **TIMER_D_CLOCKSOURCE_DIVIDER_7**
- **TIMER_D_CLOCKSOURCE_DIVIDER_8**
- **TIMER_D_CLOCKSOURCE_DIVIDER_10**
- **TIMER_D_CLOCKSOURCE_DIVIDER_12**
- **TIMER_D_CLOCKSOURCE_DIVIDER_14**
- **TIMER_D_CLOCKSOURCE_DIVIDER_16**
- **TIMER_D_CLOCKSOURCE_DIVIDER_20**
- **TIMER_D_CLOCKSOURCE_DIVIDER_24**
- **TIMER_D_CLOCKSOURCE_DIVIDER_28**
- **TIMER_D_CLOCKSOURCE_DIVIDER_32**
- **TIMER_D_CLOCKSOURCE_DIVIDER_40**
- **TIMER_D_CLOCKSOURCE_DIVIDER_48**
- **TIMER_D_CLOCKSOURCE_DIVIDER_56**
- **TIMER_D_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_D_initContinuousMode().

timerClear

`uint16_t Timer_D_initContinuousModeParam::timerClear`

Decides if timer clock divider, count direction, count need to be reset.
Valid values are:

- **TIMER_D_DO_CLEAR**
- **TIMER_D_SKIP_CLEAR** [Default]

Referenced by Timer_D_initContinuousMode().

timerInterruptEnable_TDIE

`uint16_t Timer_D_initContinuousModeParam::timerInterruptEnable_TDIE`

Is to enable or disable timer interrupt
Valid values are:

- **TIMER_D_TDIE_INTERRUPT_ENABLE**
- **TIMER_D_TDIE_INTERRUPT_DISABLE** [Default]

Referenced by Timer_D_initContinuousMode().

The documentation for this struct was generated from the following file:

- timer_d.h

47.39 DMA_initParam Struct Reference

Used in the DMA_init() function as the param parameter.

`#include <dma.h>`

Data Fields

- uint8_t channelSelect
- uint16_t transferModeSelect
- uint16_t transferSize
- uint8_t triggerSourceSelect
- uint8_t transferUnitSelect
- uint8_t triggerTypeSelect

47.39.1 Detailed Description

Used in the DMA_init() function as the param parameter.

47.39.2 Field Documentation

channelSelect

`uint8_t DMA_initParam::channelSelect`

Is the specified channel to initialize.
Valid values are:

- **DMA_CHANNEL_0**
- **DMA_CHANNEL_1**
- **DMA_CHANNEL_2**

- **DMA_CHANNEL_3**
- **DMA_CHANNEL_4**
- **DMA_CHANNEL_5**
- **DMA_CHANNEL_6**
- **DMA_CHANNEL_7**

Referenced by DMA_init().

transferModeSelect

`uint16_t DMA_initParam::transferModeSelect`

Is the transfer mode of the selected channel.
Valid values are:

- **DMA_TRANSFER_SINGLE** [Default] - Single transfer, transfers disabled after transferAmount of transfers.
- **DMA_TRANSFER_BLOCK** - Multiple transfers of transferAmount, transfers disabled once finished.
- **DMA_TRANSFER_BURSTBLOCK** - Multiple transfers of transferAmount interleaved with CPU activity, transfers disabled once finished.
- **DMA_TRANSFER_REPEATED_SINGLE** - Repeated single transfer by trigger.
- **DMA_TRANSFER_REPEATED_BLOCK** - Multiple transfers of transferAmount by trigger.
- **DMA_TRANSFER_REPEATED_BURSTBLOCK** - Multiple transfers of transferAmount by trigger interleaved with CPU activity.

Referenced by DMA_init().

transferSize

`uint16_t DMA_initParam::transferSize`

Is the amount of transfers to complete in a block transfer mode, as well as how many transfers to complete before the interrupt flag is set. Valid value is between 1-65535, if 0, no transfers will occur.

Referenced by DMA_init().

transferUnitSelect

`uint8_t DMA_initParam::transferUnitSelect`

Is the specified size of transfers.
Valid values are:

- **DMA_SIZE_SRCWORD_DSTWORD** [Default]
- **DMA_SIZE_SRCBYTE_DSTWORD**
- **DMA_SIZE_SRCWORD_DSTBYTE**

- **DMA_SIZE_SRCBYTE_DSTBYTE**

Referenced by DMA_init().

triggerSourceSelect

`uint8_t DMA_initParam::triggerSourceSelect`

Is the source that will trigger the start of each transfer, note that the sources are device specific. Valid values are:

- **DMA_TRIGGERSOURCE_0** [Default]
- **DMA_TRIGGERSOURCE_1**
- **DMA_TRIGGERSOURCE_2**
- **DMA_TRIGGERSOURCE_3**
- **DMA_TRIGGERSOURCE_4**
- **DMA_TRIGGERSOURCE_5**
- **DMA_TRIGGERSOURCE_6**
- **DMA_TRIGGERSOURCE_7**
- **DMA_TRIGGERSOURCE_8**
- **DMA_TRIGGERSOURCE_9**
- **DMA_TRIGGERSOURCE_10**
- **DMA_TRIGGERSOURCE_11**
- **DMA_TRIGGERSOURCE_12**
- **DMA_TRIGGERSOURCE_13**
- **DMA_TRIGGERSOURCE_14**
- **DMA_TRIGGERSOURCE_15**
- **DMA_TRIGGERSOURCE_16**
- **DMA_TRIGGERSOURCE_17**
- **DMA_TRIGGERSOURCE_18**
- **DMA_TRIGGERSOURCE_19**
- **DMA_TRIGGERSOURCE_20**
- **DMA_TRIGGERSOURCE_21**
- **DMA_TRIGGERSOURCE_22**
- **DMA_TRIGGERSOURCE_23**
- **DMA_TRIGGERSOURCE_24**
- **DMA_TRIGGERSOURCE_25**
- **DMA_TRIGGERSOURCE_26**
- **DMA_TRIGGERSOURCE_27**
- **DMA_TRIGGERSOURCE_28**
- **DMA_TRIGGERSOURCE_29**
- **DMA_TRIGGERSOURCE_30**
- **DMA_TRIGGERSOURCE_31**

Referenced by DMA_init().

triggerTypeSelect

```
uint8_t DMA_initParam::triggerTypeSelect
```

Is the type of trigger that the trigger signal needs to be to start a transfer.
Valid values are:

- **DMA_TRIGGER_RISINGEDGE** [Default]
- **DMA_TRIGGER_HIGH** - A trigger would be a high signal from the trigger source, to be held high through the length of the transfer(s).

Referenced by DMA_init().

The documentation for this struct was generated from the following file:

- dma.h

47.40 ADC12_A_configureMemoryParam Struct Reference

Used in the ADC12_A_configureMemory() function as the param parameter.

```
#include <adc12_a.h>
```

Data Fields

- uint8_t memoryBufferControlIndex
- uint8_t inputSourceSelect
- uint8_t positiveRefVoltageSourceSelect
- uint8_t negativeRefVoltageSourceSelect
- uint8_t endOfSequence

47.40.1 Detailed Description

Used in the ADC12_A_configureMemory() function as the param parameter.

47.40.2 Field Documentation

endOfSequence

```
uint8_t ADC12_A_configureMemoryParam::endOfSequence
```

Indicates that the specified memory buffer will be the end of the sequence if a sequenced conversion mode is selected
Valid values are:

- **ADC12_A_NOTENDOFSEQUENCE** [Default] - The specified memory buffer will NOT be the end of the sequence OR a sequenced conversion mode is not selected.

- **ADC12_A_ENDOFSEQUENCE** - The specified memory buffer will be the end of the sequence.

Referenced by ADC12_A_configureMemory().

inputSourceSelect

`uint8_t ADC12_A_configureMemoryParam::inputSourceSelect`

Is the input that will store the converted data into the specified memory buffer.
Valid values are:

- **ADC12_A_INPUT_A0** [Default]
- **ADC12_A_INPUT_A1**
- **ADC12_A_INPUT_A2**
- **ADC12_A_INPUT_A3**
- **ADC12_A_INPUT_A4**
- **ADC12_A_INPUT_A5**
- **ADC12_A_INPUT_A6**
- **ADC12_A_INPUT_A7**
- **ADC12_A_INPUT_A8**
- **ADC12_A_INPUT_A9**
- **ADC12_A_INPUT_TEMPSENSOR**
- **ADC12_A_INPUT_BATTERYMONITOR**
- **ADC12_A_INPUT_A12**
- **ADC12_A_INPUT_A13**
- **ADC12_A_INPUT_A14**
- **ADC12_A_INPUT_A15**

Referenced by ADC12_A_configureMemory().

memoryBufferControlIndex

`uint8_t ADC12_A_configureMemoryParam::memoryBufferControlIndex`

Is the selected memory buffer to set the configuration for.
Valid values are:

- **ADC12_A_MEMORY_0** [Default]
- **ADC12_A_MEMORY_1**
- **ADC12_A_MEMORY_2**
- **ADC12_A_MEMORY_3**
- **ADC12_A_MEMORY_4**
- **ADC12_A_MEMORY_5**
- **ADC12_A_MEMORY_6**

- **ADC12_A_MEMORY_7**
- **ADC12_A_MEMORY_8**
- **ADC12_A_MEMORY_9**
- **ADC12_A_MEMORY_10**
- **ADC12_A_MEMORY_11**
- **ADC12_A_MEMORY_12**
- **ADC12_A_MEMORY_13**
- **ADC12_A_MEMORY_14**
- **ADC12_A_MEMORY_15**

Referenced by ADC12_A_configureMemory().

negativeRefVoltageSourceSelect

`uint8_t ADC12_A_configureMemoryParam::negativeRefVoltageSourceSelect`

Is the reference voltage source to set as the lower limit for the conversion stored in the specified memory.
Valid values are:

- **ADC12_A_VREFNEG_AVSS** [Default]
- **ADC12_A_VREFNEG_EXT**

Referenced by ADC12_A_configureMemory().

positiveRefVoltageSourceSelect

`uint8_t ADC12_A_configureMemoryParam::positiveRefVoltageSourceSelect`

Is the reference voltage source to set as the upper limit for the conversion stored in the specified memory.
Valid values are:

- **ADC12_A_VREFPOS_AVCC** [Default]
- **ADC12_A_VREFPOS_EXT**
- **ADC12_A_VREFPOS_INT**

Referenced by ADC12_A_configureMemory().

The documentation for this struct was generated from the following file:

- adc12_a.h

47.41 Timer_D_initHighResGeneratorInRegulatedMode↩ Param Struct Reference

Used in the Timer_D_initHighResGeneratorInRegulatedMode() function as the param parameter.

```
#include <timer_d.h>
```

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t clockingMode
- uint8_t highResClockMultiplyFactor
- uint8_t highResClockDivider

47.41.1 Detailed Description

Used in the Timer_D_initHighResGeneratorInRegulatedMode() function as the param parameter.

47.41.2 Field Documentation

clockingMode

```
uint16_t Timer_D_initHighResGeneratorInRegulatedModeParam::clockingMode
```

Is the selected clock mode register values.
Valid values are:

- **TIMER_D_CLOCKINGMODE_EXTERNAL_CLOCK** [Default]
- **TIMER_D_CLOCKINGMODE_HIRES_LOCAL_CLOCK**
- **TIMER_D_CLOCKINGMODE_AUXILIARY_CLK**

Referenced by Timer_D_initHighResGeneratorInRegulatedMode().

clockSource

```
uint16_t Timer_D_initHighResGeneratorInRegulatedModeParam::clockSource
```

Selects Clock source.
Valid values are:

- **TIMER_D_CLOCKSOURCE_EXTERNAL_TDCLK** [Default]
- **TIMER_D_CLOCKSOURCE_ACLK**
- **TIMER_D_CLOCKSOURCE_SMCLK**

- **TIMER_D_CLOCKSOURCE_INVERTED_EXTERNAL_TDCLK**

Referenced by Timer_D_initHighResGeneratorInRegulatedMode().

clockSourceDivider

`uint16_t Timer_D_initHighResGeneratorInRegulatedModeParam::clockSourceDivider`

Is the divider for clock source.
Valid values are:

- **TIMER_D_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_D_CLOCKSOURCE_DIVIDER_2**
- **TIMER_D_CLOCKSOURCE_DIVIDER_3**
- **TIMER_D_CLOCKSOURCE_DIVIDER_4**
- **TIMER_D_CLOCKSOURCE_DIVIDER_5**
- **TIMER_D_CLOCKSOURCE_DIVIDER_6**
- **TIMER_D_CLOCKSOURCE_DIVIDER_7**
- **TIMER_D_CLOCKSOURCE_DIVIDER_8**
- **TIMER_D_CLOCKSOURCE_DIVIDER_10**
- **TIMER_D_CLOCKSOURCE_DIVIDER_12**
- **TIMER_D_CLOCKSOURCE_DIVIDER_14**
- **TIMER_D_CLOCKSOURCE_DIVIDER_16**
- **TIMER_D_CLOCKSOURCE_DIVIDER_20**
- **TIMER_D_CLOCKSOURCE_DIVIDER_24**
- **TIMER_D_CLOCKSOURCE_DIVIDER_28**
- **TIMER_D_CLOCKSOURCE_DIVIDER_32**
- **TIMER_D_CLOCKSOURCE_DIVIDER_40**
- **TIMER_D_CLOCKSOURCE_DIVIDER_48**
- **TIMER_D_CLOCKSOURCE_DIVIDER_56**
- **TIMER_D_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_D_initHighResGeneratorInRegulatedMode().

highResClockDivider

`uint8_t Timer_D_initHighResGeneratorInRegulatedModeParam::highResClockDivider`

Selects the high resolution divider.
Valid values are:

- **TIMER_D_HIGHRES_CLK_DIVIDER_1**
- **TIMER_D_HIGHRES_CLK_DIVIDER_2**
- **TIMER_D_HIGHRES_CLK_DIVIDER_4**
- **TIMER_D_HIGHRES_CLK_DIVIDER_8**

Referenced by Timer_D_initHighResGeneratorInRegulatedMode().

highResClockMultiplyFactor

`uint8_t Timer_D_initHighResGeneratorInRegulatedModeParam::highResClockMultiplyFactor`

Selects the high resolution multiply factor.
Valid values are:

- **TIMER_D_HIGHRES_CLK_MULTIPLY_FACTOR_8x**
- **TIMER_D_HIGHRES_CLK_MULTIPLY_FACTOR_16x**

Referenced by Timer_D_initHighResGeneratorInRegulatedMode().

The documentation for this struct was generated from the following file:

- timer_d.h

47.42 Calendar Struct Reference

Used in the RTC_A_initCalendar() function as the CalendarTime parameter.

`#include <rtc_a.h>`

Data Fields

- uint8_t Seconds
  Seconds of minute between 0-59.
- uint8_t Minutes
  Minutes of hour between 0-59.
- uint8_t Hours
  Hour of day between 0-23.
- uint8_t DayOfWeek
  Day of week between 0-6.
- uint8_t DayOfMonth
  Day of month between 1-31.
- uint8_t Month
  Month between 1-12.
- uint16_t Year
  Year between 0-4095.

47.42.1 Detailed Description

Used in the RTC_A_initCalendar() function as the CalendarTime parameter.

Used in the RTC_C_initCalendar() function as the CalendarTime parameter.

Used in the RTC_B_initCalendar() function as the CalendarTime parameter.

The documentation for this struct was generated from the following files:

- rtc_a.h
- rtc_b.h
- rtc_c.h

47.43 Timer_A_initUpDownModeParam Struct Reference

Used in the Timer_A_initUpDownMode() function as the param parameter.

```
#include <timer_a.h>
```

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t timerPeriod

  Is the specified Timer_A period.
- uint16_t timerInterruptEnable_TAIE
- uint16_t captureCompareInterruptEnable_CCR0_CCIE
- uint16_t timerClear
- bool startTimer

  Whether to start the timer immediately.

47.43.1 Detailed Description

Used in the Timer_A_initUpDownMode() function as the param parameter.

47.43.2 Field Documentation

captureCompareInterruptEnable_CCR0_CCIE

```
uint16_t Timer_A_initUpDownModeParam::captureCompareInterruptEnable_CCR0_CCIE
```

Is to enable or disable Timer_A CCR0 captureComapre interrupt.
Valid values are:

- **TIMER_A_CCIE_CCR0_INTERRUPT_ENABLE**
- **TIMER_A_CCIE_CCR0_INTERRUPT_DISABLE** [Default]

Referenced by Timer_A_initUpDownMode().

clockSource

```
uint16_t Timer_A_initUpDownModeParam::clockSource
```

Selects Clock source.
Valid values are:

- **TIMER_A_CLOCKSOURCE_EXTERNAL_TXCLK** [Default]
- **TIMER_A_CLOCKSOURCE_ACLK**
- **TIMER_A_CLOCKSOURCE_SMCLK**
- **TIMER_A_CLOCKSOURCE_INVERTED_EXTERNAL_TXCLK**

Referenced by Timer_A_initUpDownMode().

clockSourceDivider

`uint16_t Timer_A_initUpDownModeParam::clockSourceDivider`

Is the desired divider for the clock source
Valid values are:

- **TIMER_A_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_A_CLOCKSOURCE_DIVIDER_2**
- **TIMER_A_CLOCKSOURCE_DIVIDER_3**
- **TIMER_A_CLOCKSOURCE_DIVIDER_4**
- **TIMER_A_CLOCKSOURCE_DIVIDER_5**
- **TIMER_A_CLOCKSOURCE_DIVIDER_6**
- **TIMER_A_CLOCKSOURCE_DIVIDER_7**
- **TIMER_A_CLOCKSOURCE_DIVIDER_8**
- **TIMER_A_CLOCKSOURCE_DIVIDER_10**
- **TIMER_A_CLOCKSOURCE_DIVIDER_12**
- **TIMER_A_CLOCKSOURCE_DIVIDER_14**
- **TIMER_A_CLOCKSOURCE_DIVIDER_16**
- **TIMER_A_CLOCKSOURCE_DIVIDER_20**
- **TIMER_A_CLOCKSOURCE_DIVIDER_24**
- **TIMER_A_CLOCKSOURCE_DIVIDER_28**
- **TIMER_A_CLOCKSOURCE_DIVIDER_32**
- **TIMER_A_CLOCKSOURCE_DIVIDER_40**
- **TIMER_A_CLOCKSOURCE_DIVIDER_48**
- **TIMER_A_CLOCKSOURCE_DIVIDER_56**
- **TIMER_A_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_A_initUpDownMode().

timerClear

`uint16_t Timer_A_initUpDownModeParam::timerClear`

Decides if Timer_A clock divider, count direction, count need to be reset.
Valid values are:

- **TIMER_A_DO_CLEAR**
- **TIMER_A_SKIP_CLEAR** [Default]

Referenced by Timer_A_initUpDownMode().

timerInterruptEnable_TAIE

`uint16_t Timer_A_initUpDownModeParam::timerInterruptEnable_TAIE`

Is to enable or disable Timer_A interrupt
Valid values are:

- **TIMER_A_TAIE_INTERRUPT_ENABLE**
- **TIMER_A_TAIE_INTERRUPT_DISABLE** [Default]

Referenced by Timer_A_initUpDownMode().

The documentation for this struct was generated from the following file:

- timer_a.h

47.44 Comp_B_initParam Struct Reference

Used in the Comp_B_init() function as the param parameter.

`#include <comp_b.h>`

Data Fields

- uint8_t positiveTerminalInput
- uint8_t negativeTerminalInput
- uint16_t powerModeSelect
- uint8_t outputFilterEnableAndDelayLevel
- uint16_t invertedOutputPolarity

47.44.1 Detailed Description

Used in the Comp_B_init() function as the param parameter.

47.44.2 Field Documentation

invertedOutputPolarity

`uint16_t Comp_B_initParam::invertedOutputPolarity`

Controls if the output will be inverted or not
Valid values are:

- **COMP_B_NORMALOUTPUTPOLARITY** [Default]
- **COMP_B_INVERTEDOUTPUTPOLARITY**

Referenced by Comp_B_init().

negativeTerminalInput

```
uint8_t Comp_B_initParam::negativeTerminalInput
```

Selects the input to the negative terminal.
Valid values are:

- **COMP_B_INPUT0** [Default]
- **COMP_B_INPUT1**
- **COMP_B_INPUT2**
- **COMP_B_INPUT3**
- **COMP_B_INPUT4**
- **COMP_B_INPUT5**
- **COMP_B_INPUT6**
- **COMP_B_INPUT7**
- **COMP_B_INPUT8**
- **COMP_B_INPUT9**
- **COMP_B_INPUT10**
- **COMP_B_INPUT11**
- **COMP_B_INPUT12**
- **COMP_B_INPUT13**
- **COMP_B_INPUT14**
- **COMP_B_INPUT15**
- **COMP_B_VREF**

Referenced by Comp_B_init().

outputFilterEnableAndDelayLevel

```
uint8_t Comp_B_initParam::outputFilterEnableAndDelayLevel
```

Controls the output filter delay state, which is either off or enabled with a specified delay level. This parameter is device specific and delay levels should be found in the device's datasheet.
Valid values are:

- **COMP_B_FILTEROUTPUT_OFF** [Default]
- **COMP_B_FILTEROUTPUT_DLYLVL1**
- **COMP_B_FILTEROUTPUT_DLYLVL2**
- **COMP_B_FILTEROUTPUT_DLYLVL3**
- **COMP_B_FILTEROUTPUT_DLYLVL4**

Referenced by Comp_B_init().

positiveTerminalInput

`uint8_t Comp_B_initParam::positiveTerminalInput`

Selects the input to the positive terminal.
Valid values are:

- **COMP_B_INPUT0** [Default]
- **COMP_B_INPUT1**
- **COMP_B_INPUT2**
- **COMP_B_INPUT3**
- **COMP_B_INPUT4**
- **COMP_B_INPUT5**
- **COMP_B_INPUT6**
- **COMP_B_INPUT7**
- **COMP_B_INPUT8**
- **COMP_B_INPUT9**
- **COMP_B_INPUT10**
- **COMP_B_INPUT11**
- **COMP_B_INPUT12**
- **COMP_B_INPUT13**
- **COMP_B_INPUT14**
- **COMP_B_INPUT15**
- **COMP_B_VREF**

Referenced by Comp_B_init().

powerModeSelect

`uint16_t Comp_B_initParam::powerModeSelect`

Selects the power mode at which the Comp_B module will operate at.
Valid values are:

- **COMP_B_POWERMODE_HIGHSPEED** [Default]
- **COMP_B_POWERMODE_NORMALMODE**
- **COMP_B_POWERMODE_ULTRALOWPOWER**

Referenced by Comp_B_init().

The documentation for this struct was generated from the following file:

- comp_b.h

47.45 RTC_A_configureCalendarAlarmParam Struct Reference

Used in the RTC_A_configureCalendarAlarm() function as the param parameter.

`#include <rtc_a.h>`

Data Fields

- uint8_t minutesAlarm
- uint8_t hoursAlarm
- uint8_t dayOfWeekAlarm
- uint8_t dayOfMonthAlarm

47.45.1 Detailed Description

Used in the RTC_A_configureCalendarAlarm() function as the param parameter.

47.45.2 Field Documentation

dayOfMonthAlarm

`uint8_t RTC_A_configureCalendarAlarmParam::dayOfMonthAlarm`

Is the alarm condition for the day of the month.
Valid values are:

- **RTC_A_ALARMCONDITION_OFF** [Default]

Referenced by RTC_A_configureCalendarAlarm().

dayOfWeekAlarm

`uint8_t RTC_A_configureCalendarAlarmParam::dayOfWeekAlarm`

Is the alarm condition for the day of week.
Valid values are:

- **RTC_A_ALARMCONDITION_OFF** [Default]

Referenced by RTC_A_configureCalendarAlarm().

hoursAlarm

`uint8_t RTC_A_configureCalendarAlarmParam::hoursAlarm`

Is the alarm condition for the hours.
Valid values are:

- **RTC_A_ALARMCONDITION_OFF** [Default]

Referenced by RTC_A_configureCalendarAlarm().

minutesAlarm

`uint8_t RTC_A_configureCalendarAlarmParam::minutesAlarm`

Is the alarm condition for the minutes.
Valid values are:

- **RTC_A_ALARMCONDITION_OFF** [Default]

Referenced by RTC_A_configureCalendarAlarm().

The documentation for this struct was generated from the following file:

- rtc_a.h

47.46 EUSCI_A_SPI_initSlaveParam Struct Reference

Used in the EUSCI_A_SPI_initSlave() function as the param parameter.

`#include <eusci_a_spi.h>`

Data Fields

- uint16_t msbFirst
- uint16_t clockPhase
- uint16_t clockPolarity
- uint16_t spiMode

47.46.1 Detailed Description

Used in the EUSCI_A_SPI_initSlave() function as the param parameter.

47.46.2 Field Documentation

clockPhase

`uint16_t EUSCI_A_SPI_initSlaveParam::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**

Referenced by EUSCI_A_SPI_initSlave().

clockPolarity

`uint16_t EUSCI_A_SPI_initSlaveParam::clockPolarity`

Is clock polarity select
Valid values are:

- **EUSCI_A_SPI_CLOCKPOLARITY_INACTIVITY_HIGH**
- **EUSCI_A_SPI_CLOCKPOLARITY_INACTIVITY_LOW** [Default]

Referenced by EUSCI_A_SPI_initSlave().

msbFirst

`uint16_t EUSCI_A_SPI_initSlaveParam::msbFirst`

Controls the direction of the receive and transmit shift register.
Valid values are:

- **EUSCI_A_SPI_MSB_FIRST**
- **EUSCI_A_SPI_LSB_FIRST** [Default]

Referenced by EUSCI_A_SPI_initSlave().

spiMode

`uint16_t EUSCI_A_SPI_initSlaveParam::spiMode`

Is SPI mode select
Valid values are:

- **EUSCI_A_SPI_3PIN**
- **EUSCI_A_SPI_4PIN_UCxSTE_ACTIVE_HIGH**
- **EUSCI_A_SPI_4PIN_UCxSTE_ACTIVE_LOW**

Referenced by EUSCI_A_SPI_initSlave().

The documentation for this struct was generated from the following file:

- eusci_a_spi.h

47.47 Timer_D_initUpDownModeParam Struct Reference

Used in the Timer_D_initUpDownMode() function as the param parameter.

```
#include <timer_d.h>
```

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t clockingMode
- uint16_t timerPeriod

    Is the specified timer period.
- uint16_t timerInterruptEnable_TDIE
- uint16_t captureCompareInterruptEnable_CCR0_CCIE
- uint16_t timerClear

47.47.1 Detailed Description

Used in the Timer_D_initUpDownMode() function as the param parameter.

47.47.2 Field Documentation

captureCompareInterruptEnable_CCR0_CCIE

```
uint16_t Timer_D_initUpDownModeParam::captureCompareInterruptEnable_CCR0_CCIE
```

Is to enable or disable timer CCR0 captureComapre interrupt.
Valid values are:

- **TIMER_D_CCIE_CCR0_INTERRUPT_ENABLE**
- **TIMER_D_CCIE_CCR0_INTERRUPT_DISABLE** [Default]

Referenced by Timer_D_initUpDownMode().

clockingMode

```
uint16_t Timer_D_initUpDownModeParam::clockingMode
```

Is the selected clock mode register values.
Valid values are:

- **TIMER_D_CLOCKINGMODE_EXTERNAL_CLOCK** [Default]
- **TIMER_D_CLOCKINGMODE_HIRES_LOCAL_CLOCK**
- **TIMER_D_CLOCKINGMODE_AUXILIARY_CLK**

Referenced by Timer_D_initUpDownMode().

clockSource

`uint16_t Timer_D_initUpDownModeParam::clockSource`

Selects Clock source.
Valid values are:

- **TIMER_D_CLOCKSOURCE_EXTERNAL_TDCLK** [Default]
- **TIMER_D_CLOCKSOURCE_ACLK**
- **TIMER_D_CLOCKSOURCE_SMCLK**
- **TIMER_D_CLOCKSOURCE_INVERTED_EXTERNAL_TDCLK**

Referenced by Timer_D_initUpDownMode().

clockSourceDivider

`uint16_t Timer_D_initUpDownModeParam::clockSourceDivider`

Is the divider for clock source.
Valid values are:

- **TIMER_D_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_D_CLOCKSOURCE_DIVIDER_2**
- **TIMER_D_CLOCKSOURCE_DIVIDER_3**
- **TIMER_D_CLOCKSOURCE_DIVIDER_4**
- **TIMER_D_CLOCKSOURCE_DIVIDER_5**
- **TIMER_D_CLOCKSOURCE_DIVIDER_6**
- **TIMER_D_CLOCKSOURCE_DIVIDER_7**
- **TIMER_D_CLOCKSOURCE_DIVIDER_8**
- **TIMER_D_CLOCKSOURCE_DIVIDER_10**
- **TIMER_D_CLOCKSOURCE_DIVIDER_12**
- **TIMER_D_CLOCKSOURCE_DIVIDER_14**
- **TIMER_D_CLOCKSOURCE_DIVIDER_16**
- **TIMER_D_CLOCKSOURCE_DIVIDER_20**
- **TIMER_D_CLOCKSOURCE_DIVIDER_24**
- **TIMER_D_CLOCKSOURCE_DIVIDER_28**
- **TIMER_D_CLOCKSOURCE_DIVIDER_32**
- **TIMER_D_CLOCKSOURCE_DIVIDER_40**
- **TIMER_D_CLOCKSOURCE_DIVIDER_48**
- **TIMER_D_CLOCKSOURCE_DIVIDER_56**
- **TIMER_D_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_D_initUpDownMode().

timerClear

`uint16_t Timer_D_initUpDownModeParam::timerClear`

Decides if timer clock divider, count direction, count need to be reset.
Valid values are:

- **TIMER_D_DO_CLEAR**
- **TIMER_D_SKIP_CLEAR** [Default]

Referenced by Timer_D_initUpDownMode().

timerInterruptEnable_TDIE

`uint16_t Timer_D_initUpDownModeParam::timerInterruptEnable_TDIE`

Is to enable or disable timer interrupt
Valid values are:

- **TIMER_D_TDIE_INTERRUPT_ENABLE**
- **TIMER_D_TDIE_INTERRUPT_DISABLE** [Default]

Referenced by Timer_D_initUpDownMode().

The documentation for this struct was generated from the following file:

- timer_d.h

47.48 PMAP_initPortsParam Struct Reference

Used in the PMAP_initPorts() function as the param parameter.

`#include <pmap.h>`

Data Fields

- const uint8_t ∗ portMapping
  Is the pointer to init Data.
- uint8_t ∗ PxMAPy
  Is the pointer start of first PMAP to initialize.
- uint8_t numberOfPorts
  Is the number of Ports to initialize.
- uint8_t portMapReconfigure

47.48.1 Detailed Description

Used in the PMAP_initPorts() function as the param parameter.

47.48.2 Field Documentation

portMapReconfigure

```
uint8_t PMAP_initPortsParam::portMapReconfigure
```

Is used to enable/disable reconfiguration
Valid values are:

- **PMAP_ENABLE_RECONFIGURATION**
- **PMAP_DISABLE_RECONFIGURATION** [Default]

Referenced by PMAP_initPorts().

The documentation for this struct was generated from the following file:

- pmap.h

47.49 RTC_B_configureCalendarAlarmParam Struct Reference

Used in the RTC_B_configureCalendarAlarm() function as the param parameter.

```
#include <rtc_b.h>
```

Data Fields

- uint8_t minutesAlarm
- uint8_t hoursAlarm
- uint8_t dayOfWeekAlarm
- uint8_t dayOfMonthAlarm

47.49.1 Detailed Description

Used in the RTC_B_configureCalendarAlarm() function as the param parameter.

47.49.2 Field Documentation

dayOfMonthAlarm

```
uint8_t RTC_B_configureCalendarAlarmParam::dayOfMonthAlarm
```

Is the alarm condition for the day of the month.
Valid values are:

- **RTC_B_ALARMCONDITION_OFF** [Default]

Referenced by RTC_B_configureCalendarAlarm().

dayOfWeekAlarm

`uint8_t RTC_B_configureCalendarAlarmParam::dayOfWeekAlarm`

Is the alarm condition for the day of week.
Valid values are:

- **RTC_B_ALARMCONDITION_OFF** [Default]

Referenced by RTC_B_configureCalendarAlarm().

hoursAlarm

`uint8_t RTC_B_configureCalendarAlarmParam::hoursAlarm`

Is the alarm condition for the hours.
Valid values are:

- **RTC_B_ALARMCONDITION_OFF** [Default]

Referenced by RTC_B_configureCalendarAlarm().

minutesAlarm

`uint8_t RTC_B_configureCalendarAlarmParam::minutesAlarm`

Is the alarm condition for the minutes.
Valid values are:

- **RTC_B_ALARMCONDITION_OFF** [Default]

Referenced by RTC_B_configureCalendarAlarm().

The documentation for this struct was generated from the following file:

- rtc_b.h

47.50 Timer_A_outputPWMParam Struct Reference

Used in the Timer_A_outputPWM() function as the param parameter.

`#include <timer_a.h>`

Data Fields

- uint16_t clockSource
- uint16_t clockSourceDivider
- uint16_t timerPeriod
  Selects the desired timer period.
- uint16_t compareRegister

- uint16_t compareOutputMode
- uint16_t dutyCycle

  Specifies the dutycycle for the generated waveform.

47.50.1 Detailed Description

Used in the Timer_A_outputPWM() function as the param parameter.

47.50.2 Field Documentation

clockSource

`uint16_t Timer_A_outputPWMParam::clockSource`

Selects Clock source.
Valid values are:

- **TIMER_A_CLOCKSOURCE_EXTERNAL_TXCLK** [Default]
- **TIMER_A_CLOCKSOURCE_ACLK**
- **TIMER_A_CLOCKSOURCE_SMCLK**
- **TIMER_A_CLOCKSOURCE_INVERTED_EXTERNAL_TXCLK**

Referenced by Timer_A_outputPWM().

clockSourceDivider

`uint16_t Timer_A_outputPWMParam::clockSourceDivider`

Is the desired divider for the clock source
Valid values are:

- **TIMER_A_CLOCKSOURCE_DIVIDER_1** [Default]
- **TIMER_A_CLOCKSOURCE_DIVIDER_2**
- **TIMER_A_CLOCKSOURCE_DIVIDER_3**
- **TIMER_A_CLOCKSOURCE_DIVIDER_4**
- **TIMER_A_CLOCKSOURCE_DIVIDER_5**
- **TIMER_A_CLOCKSOURCE_DIVIDER_6**
- **TIMER_A_CLOCKSOURCE_DIVIDER_7**
- **TIMER_A_CLOCKSOURCE_DIVIDER_8**
- **TIMER_A_CLOCKSOURCE_DIVIDER_10**
- **TIMER_A_CLOCKSOURCE_DIVIDER_12**
- **TIMER_A_CLOCKSOURCE_DIVIDER_14**
- **TIMER_A_CLOCKSOURCE_DIVIDER_16**
- **TIMER_A_CLOCKSOURCE_DIVIDER_20**

- **TIMER_A_CLOCKSOURCE_DIVIDER_24**
- **TIMER_A_CLOCKSOURCE_DIVIDER_28**
- **TIMER_A_CLOCKSOURCE_DIVIDER_32**
- **TIMER_A_CLOCKSOURCE_DIVIDER_40**
- **TIMER_A_CLOCKSOURCE_DIVIDER_48**
- **TIMER_A_CLOCKSOURCE_DIVIDER_56**
- **TIMER_A_CLOCKSOURCE_DIVIDER_64**

Referenced by Timer_A_outputPWM().

compareOutputMode

`uint16_t Timer_A_outputPWMParam::compareOutputMode`

Specifies the output mode.
Valid values are:

- **TIMER_A_OUTPUTMODE_OUTBITVALUE** [Default]
- **TIMER_A_OUTPUTMODE_SET**
- **TIMER_A_OUTPUTMODE_TOGGLE_RESET**
- **TIMER_A_OUTPUTMODE_SET_RESET**
- **TIMER_A_OUTPUTMODE_TOGGLE**
- **TIMER_A_OUTPUTMODE_RESET**
- **TIMER_A_OUTPUTMODE_TOGGLE_SET**
- **TIMER_A_OUTPUTMODE_RESET_SET**

Referenced by Timer_A_outputPWM().

compareRegister

`uint16_t Timer_A_outputPWMParam::compareRegister`

Selects the compare register being used. Refer to datasheet to ensure the device has the capture compare register being used.
Valid values are:

- **TIMER_A_CAPTURECOMPARE_REGISTER_0**
- **TIMER_A_CAPTURECOMPARE_REGISTER_1**
- **TIMER_A_CAPTURECOMPARE_REGISTER_2**
- **TIMER_A_CAPTURECOMPARE_REGISTER_3**
- **TIMER_A_CAPTURECOMPARE_REGISTER_4**
- **TIMER_A_CAPTURECOMPARE_REGISTER_5**
- **TIMER_A_CAPTURECOMPARE_REGISTER_6**

Referenced by Timer_A_outputPWM().

The documentation for this struct was generated from the following file:

- timer_a.h

IMPORTANT NOTICE