

## ***C2833x/C2823x C/C++ Header Files and Peripheral Examples Quick Start***

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## Device Support:

This software package supports 2833x and 2823x devices. This includes the following: TMS320F28335, TMS320F28334, TMS320F28332, TMS320F28235, TMS320F28234, and TMS320F28232.

Throughout this document, TMS320F28335, TMS320F28334, TMS320F28332, TMS320F28235, TMS320F28234, and TMS320F28232 are abbreviated as F28335, F28334, F28332, F28235, F28234, and F28232 respectively.

## 1 Introduction:

The C2833x/C2823x C/C++ peripheral header files and example projects facilitate writing in C/C++ Code for the Texas Instruments TMS320x2833x DSPs. The code can be used as a learning tool or as the basis for a development platform depending on the current needs of the user.

- Learning Tool:

This download includes several example Code Composer Studio<sup>TM†</sup> projects for a '2833x/'2823x development platform. One such platform is the eZdsp<sup>TM††</sup> F28335 USB from Spectrum Digital Inc. ([www.spectrumdigital.com](http://www.spectrumdigital.com)). Another such platform is the "Delfino" F28335 Control Card from Texas Instruments ([www.ti.com/f28xkits](http://www.ti.com/f28xkits))

These examples demonstrate the steps required to initialize the device and utilize the on-chip peripherals. The provided examples can be copied and modified giving the user a platform to quickly experiment with different peripheral configurations.

These projects can also be migrated to other devices by simply changing the memory allocation in the linker command file.

- Development Platform:

The peripheral header files can easily be incorporated into a new or existing project to provide a platform for accessing the on-chip peripherals using C or C++ code. In addition, the user can pick and choose functions from the provided code samples as needed and discard the rest.

To get started this document provides the following information:

- Overview of the bit-field structure approach used in the C2833x/C2823x C/C++ peripheral header files.
- Overview of the included peripheral example projects.
- Steps for integrating the peripheral header files into a new or existing project.
- Troubleshooting tips and frequently asked questions.

<sup>†</sup> Code Composer Studio is a trademark of Texas Instruments ([www.ti.com](http://www.ti.com)).

<sup>††</sup> eZdsp is a trademark of Spectrum Digital Inc ([www.spectrumdigital.com](http://www.spectrumdigital.com)).

Trademarks are the property of their respective owners.

- Migration tips for users moving from the DSP281x and DSP280x header files to the DSP2833x/2823x header files.

Finally, this document does not provide a tutorial on writing C code, using Code Composer Studio, or the C28x Compiler and Assembler. It is assumed that the reader already has a 28335 hardware platform setup and connected to a host with Code Composer Studio installed. The user should have a basic understanding of how to use Code Composer Studio to download code through JTAG and perform basic debug operations.

## **1.1 Revision History**

### **Version 1.32 – controlSUITE update**

- ☐ This update makes numerous improvements to the Code Composer Studio 4 projects.
- ☐ A detailed revision history can be found in Section 9.

### **Version 1.31**

- ☐ This version makes a minor update to remove Tool="DspBiosBuilder" from all PJT files to ease migration of CCSv3.3 to CCSv4 projects on the Microcontroller-only (code-size limited) version of CCSv4. A detailed revision history can be found in Section 9.

### **Version 1.30**

- ☐ This version includes minor corrections and comment fixes to the header files and examples, and also adds separate example folders, DSP2833x\_examples\_ccsv4, and DSP2823x\_ccsv4, with examples supported by the Eclipse-based Code Composer Studio v4. A detailed revision history can be found in Section 9.

### **Version 1.20**

- ☐ This version includes minor corrections and typo fixes to the header files and examples, and adds the DSP28x\_Project.h file, found in the /common/include/ directory, which allows easy porting of project files and examples between device header files. Support has also been added for access to dual-mapped EPWM registers. A detailed revision history can be found in Section 9.

### **Version 1.10**

- ☐ This version includes minor corrections to the header and common files, and adds support for F2823x non-floating point unit examples. These examples use the same common and header files as the F2833x examples. A detailed revision history can be found in Section 9.

### **Version 1.03**

- ☐ This version includes minor additions to the header and common files, including an upgraded revision to the SFO library V5. A detailed revision history can be found in Section 9.

### **Version 1.02**

- ❑ This version includes minor additions to the gel files and updates to the source/example files. A detailed revision history can be found in Section 9.

### Version 1.01

- ❑ This version fixes some typos and minor errors in the DSP2833x header files and examples. A detailed revision history can be found in Section 9.

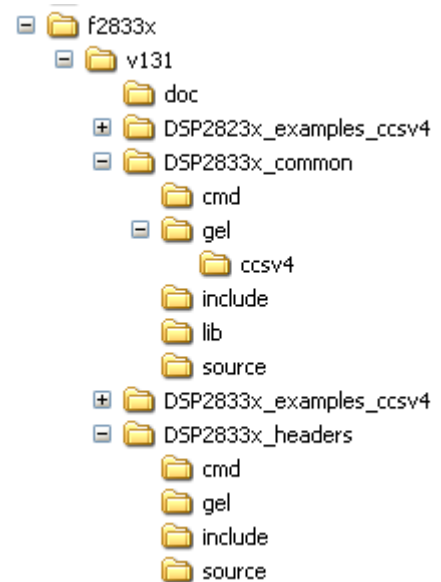
### Version 1

- ❑ This version is the first release of the DSP2833x header files and examples.

## 1.2 Where Files are Located (Directory Structure)

As installed, the *C2833x/C2823x C/C++ Header Files and Peripheral Examples* is partitioned into a well-defined directory structure.

Table 1 describes the contents of the main directories used by DSP2833x/2823x header files and peripheral examples:



**Table 1. DSP2833x Main Directory Structure**

Directory	Description
<base>	Base install directory. For the rest of this document <base> will be omitted from the directory names.
<base>\doc	Documentation including the revision history from the previous release.
<base>\DSP2833x_headers	Files required to incorporate the peripheral header files into a project. The header files use the bit-field structure approach described in Section 2. Integrating the header files into a new or existing project is described in Section 4.
<base>\DSP2833x_common	Common source files shared across example projects to illustrate how to perform tasks using header file approach. Use of these files is optional, but may be useful in new projects. A list of these files is in Section 7.
<base>\DSP2833x_examples_ccsv4	Example Code Composer Studio v4 projects compiled with floating point unit <i>enabled</i> . An overview of the examples is given in Section 3.
<base>\DSP2823x_examples_ccsv4	Example Code Composer Studio projects compiled with floating point unit <i>disabled</i> . An overview of the examples is given in Section 3.

Under the *DSP2833x\_headers* and *DSP2833x\_common* directories the source files are further broken down into sub-directories each indicating the type of file. Table 2 lists the sub-directories and describes the types of files found within each:

**Table 2. DSP2833x Sub-Directory Structure**

Sub-Directory	Description
DSP2833x_headers\cmd	Linker command files that allocate the bit-field structures described in Section 2.
DSP2833x_headers\source	Source files required to incorporate the header files into a new or existing project.
DSP2833x_headers\include	Header files for each of the on-chip peripherals.
DSP2833x_common\cmd	Example memory command files that allocate memory on the devices.
DSP2833x_common\include	Common .h files that are used by the peripheral examples.
DSP2833x_common\source	Common .c files that are used by the peripheral examples.
DSP2833x_common\lib	Common library (.lib) files that are used by the peripheral examples.
DSP2833x_common\gel\ccsv4	Code Composer Studio v4.x GEL files for each device. These are optional.

## 2 Understanding The Peripheral Bit-Field Structure Approach

The following application note includes useful information regarding the bit-field peripheral structure approach used by the header files and examples.

This method is compared to traditional #define macros and topics of code efficiency and special case registers are also addressed. The information in this application note is important to understand the impact using bit fields can have on your application code.

***Programming TMS320x28xx and 28xxx Peripherals in C/C++ (SPRAA85)***

### 3 Peripheral Example Projects

This section describes how to get started with and configure the peripheral examples included in the C2833x/C2823x Header Files and Peripheral Examples software package.

**NOTE:**

Because the '2833x devices are floating-point devices, the '2833x peripheral examples are configured for floating-point by default. Therefore, C2000 CodeGenTools V5.x, which includes fpu32 floating-point support, is required to build and run these examples.

Because the '2823x devices are fixed-point devices, the '2823x peripheral examples are configured for non-floating-point by default.

#### 3.1 Getting Started

To get started, follow these steps to load the 32-bit CPU-Timer example. Other examples are set-up in a similar manner.

1. **Have a hardware platform, such as the eZdsp F28335 USB or a F28335 Experimenter's Kit, connected to a host with Code Composer Studio installed.**

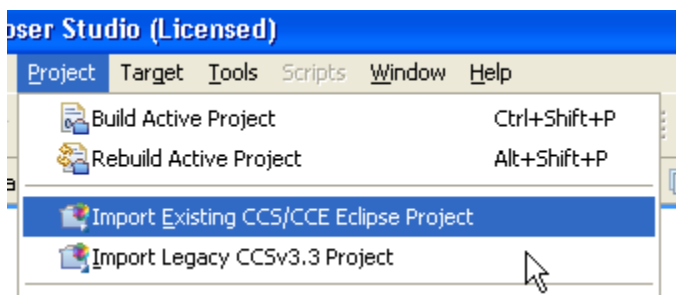
NOTE: As supplied, the '2833x and '2823x example projects are built for the '28335/'28235 device. If you are using another 2833x or 2823x device, the memory definition in the linker command file (.cmd) will need to be changed and the project rebuilt.

2. **Open the example project.**

Each example has its own project directory which is "imported"/opened in Code Composer Studio v4.

To open the 'CPU-Timer example project directory, follow the following steps:

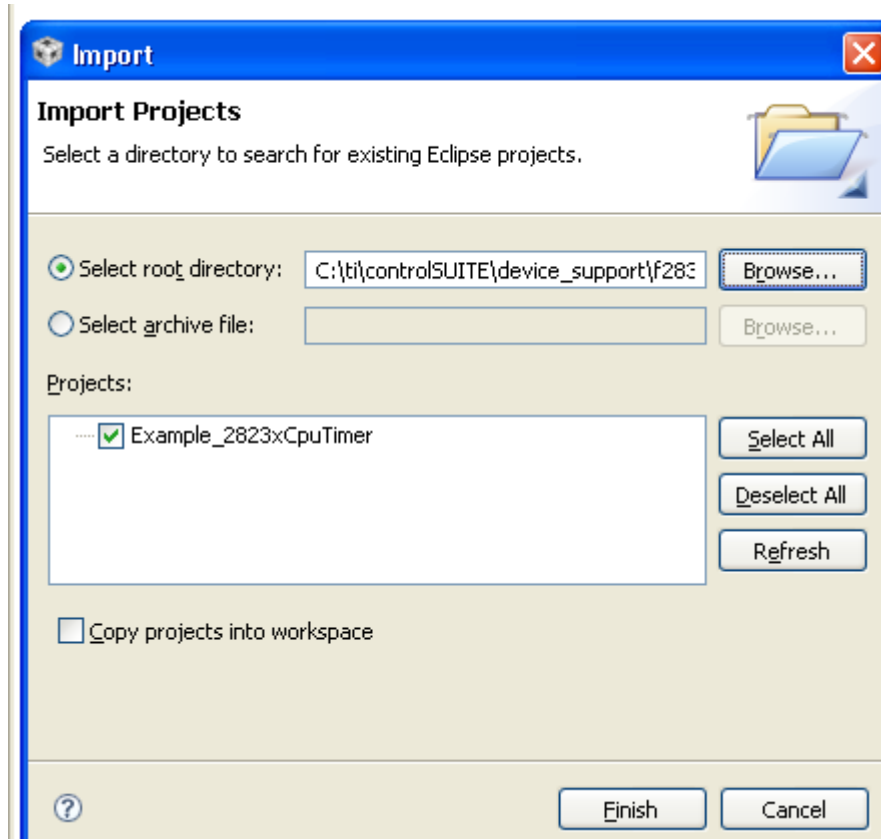
- a. In Code Composer Studio v 4.x: Project->Import Existing CCS/CCE Eclipse Project.



- b. Next to "Select Root Directory", browse to the CPU Timer example directory:  
 For 2833x: *DSP2833x\_examples\_ccsv4\cpu\_timer*  
 For 2823x: *DSP2823x\_examples\_ccsv4\cpu\_timer*

*Note: These two projects are identical except the 2833x version includes the --float\_support=fpu32 compiler option.*

**Note:** Do **NOT** check the box to copy projects into the workspace. The projects will **NOT** work properly if this box is checked.



- c. Select the *Finish* button.

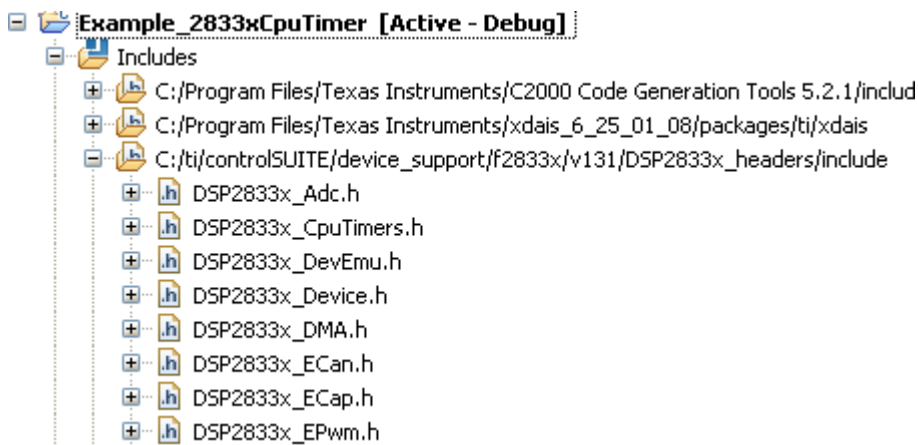
This will import/open the project in the CCStudio v4 C/C++ Perspective project window.

### 3. Edit DSP28\_Device.h

In the project window,

Expand *Example\_2833xCpuTimer->Includes*

Under includes, Expand <install directory base>/DSP2833x\_headers/include/



Edit the DSP2833x\_Device.h file and make sure the appropriate device is selected. By default the 28335 is selected. For '2823x devices, the '2833x counterpart is selected. For instance, if using F28235, DSP28\_28335 is selected as the TARGET.

```

/*****
* DSP2833x_headers\include\DSP2833x_Device.h
*****/

#define    TARGET    1
//-----
// User To Select Target Device:

#define    DSP28_28335    TARGET
#define    DSP28_28334    0
#define    DSP28_28332    0

```

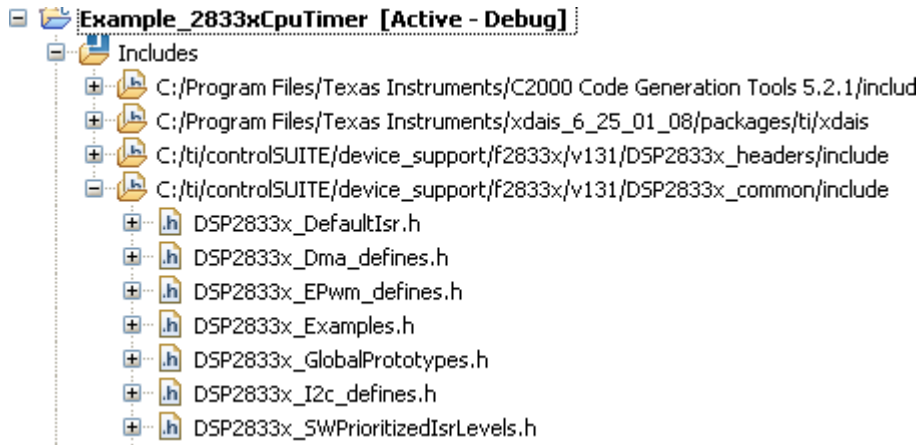


#### 4. Edit DSP2833x\_Examples.h

In the project window,

Expand *Example\_2833xCpuTimer->Includes->*

Then expand: *<install directory base base>/DSP2833x\_common/include/*



Edit DSP2833x\_Examples.h and specify the clock rate, the PLL control register value (PLLCR and DIVSEL). These values will be used by the examples to initialize the PLLCR register and DIVSEL bits.

The default values will result in a 150Mhz SYSCLKOUT frequency.

```

/*****
* DSP2833x_common\include\DSP2833x_Examples.h
*****/
/*-----
Specify the PLL control register (PLLCR) and divide select (DIVSEL) value.
-----*/
// #define DSP28_DIVSEL    0    // Enable /4 for SYSCLKOUT(default at reset)
// #define DSP28_DIVSEL    1    // Disable /4 for SYSCLKOUT
#define DSP28_DIVSEL      2    // Enable /2 for SYSCLKOUT
// #define DSP28_DIVSEL    3    // Enable /1 for SYSCLKOUT

#define DSP28_PLLCR      10
// #define DSP28_PLLCR     9
// #define DSP28_PLLCR     8
// #define DSP28_PLLCR     7
// #define DSP28_PLLCR     6
// #define DSP28_PLLCR     5
// #define DSP28_PLLCR     4
// #define DSP28_PLLCR     3
// #define DSP28_PLLCR     2
// #define DSP28_PLLCR     1
// #define DSP28_PLLCR     0    // (Default at reset) PLL is bypassed in this mode
//-----

```

In DSP2833x\_Examples.h, also specify the SYSCLKOUT rate. This value is used to scale a delay loop used by the examples. The default value is for a 150 Mhz SYSCLKOUT. If you have a 100 MHz device you will need to adjust these settings accordingly.

```

/*****
* DSP2833x_common\include\DSP2833x_Examples.h
*****/
.....
#define CPU_RATE      6.667L    // for a 150MHz CPU clock speed (SYSCLKOUT)
// #define CPU_RATE      7.143L    // for a 140MHz CPU clock speed (SYSCLKOUT)
// #define CPU_RATE      8.333L    // for a 120MHz CPU clock speed (SYSCLKOUT)
.....

```

In DSP2833x\_Examples.h also specify the maximum SYSCLKOUT frequency (150MHz or 100MHz) by setting it to 1 and the other to 0. This value is used by those examples with timing dependent code (i.e. baud rates or other timing parameters) to determine whether 150MHz code or 100MHz code should be run.

The default value is for 150Mhz SYSCLKOUT. If you have a 100MHz device you will need to adjust these settings accordingly. If you intend to run examples which use these definitions at a different frequency, then the timing parameters in those examples must be directly modified accordingly regardless of the setting here.

```

/*****
* DSP2833x_common\include\DSP2833x_Examples.h
*****/
.....
#define CPU_FRQ_100MHZ    0        // 100 MHz CPU Freq - 1 for 100 MHz devices
#define CPU_FRQ_150MHZ    1        // 150 Mhz CPU Freq - default, 1 for 150 MHz devices

//-----

```

## 5. Review the comments at the top of the main source file: Example\_2833xCpuTimer.c.

A brief description of the example and any assumptions that are made and any external hardware requirements are listed in the comments at the top of the main source file of each example. In some cases you may be required to make external connections for the example to work properly.

## 6. Perform any hardware setup required by the example.

Perform any hardware setup indicated by the comments in the main source. The CPU-Timer example only requires that the hardware be setup for “Boot to SARAM” mode. Other examples may require additional hardware configuration such as connecting pins together or pulling a pin high or low.

The following table shows a listing of the boot mode pin settings for your reference. Refer to the documentation for your hardware platform for information on configuring the boot mode pins. For more information on the ‘2833x/’2823x boot modes refer to the device specific *Boot ROM Reference Guide*.

**Table 3. 2833x/2823x Boot Mode Settings**

GPIO87 XA15 PU	GPIO86 XA14 PU	GPIO85 XA13 PU	GPIO84 XA12 PU	Mode
1	1	1	1	Boot to flash 0x33FFF6
1	1	1	0	Call SCI-A boot loader
1	1	0	1	Call SPI-A boot loader
1	1	0	0	Call I2C boot loader
1	0	1	1	Call eCAN-A boot loader
1	0	1	0	Call McBSP-A boot loader
1	0	0	1	Boot to XINTF x16 0x100000
1	0	0	0	Boot to XINTF x32 0x100000
0	1	1	1	Boot to OTP 0x380400
0	1	1	0	Call parallel GPIO boot loader
0	1	0	1	Call parallel XINTF boot loader
0	1	0	0	Boot to M0 SARAM 0x000000
0	0	1	1	Branch to check boot mode
0	0	1	0	Boot to flash, bypass ADC cal
0	0	0	1	Boot to SARAM, bypass ADC cal
0	0	0	0	Boot to SCI-A, bypass ADC cal

## 7. Build and Load the code

Once any hardware configuration has been completed, in Code Composer Studio v4, go to *Target->Debug Active Project*.

This will open the “Debug Perspective” in CCSv4, build the project, load the .out file into the 28x device, reset the part, and execute code to the start of the main function. By default, in Code Composer Studio v4, every time *Debug Active Project* is selected, the code is automatically built and the .out file loaded into the 28x device.

## 8. Run the example, add variables to the watch window or examine the memory contents.

At the top of the code in the comments section, there should be a list of “Watch variables”. To add these to the watch window, highlight them and right-click. Then select *Add Watch expression*. Now variables of interest are added to the watch window.

## 9. Experiment, modify, re-build the example.

If you wish to modify the examples it is suggested that you make a copy of the entire header file packet to modify or at least create a backup of the original files first. New examples provided by TI will assume that the base files are as supplied.

Sections 3.2 and 0 describe the structure and flow of the examples in more detail.

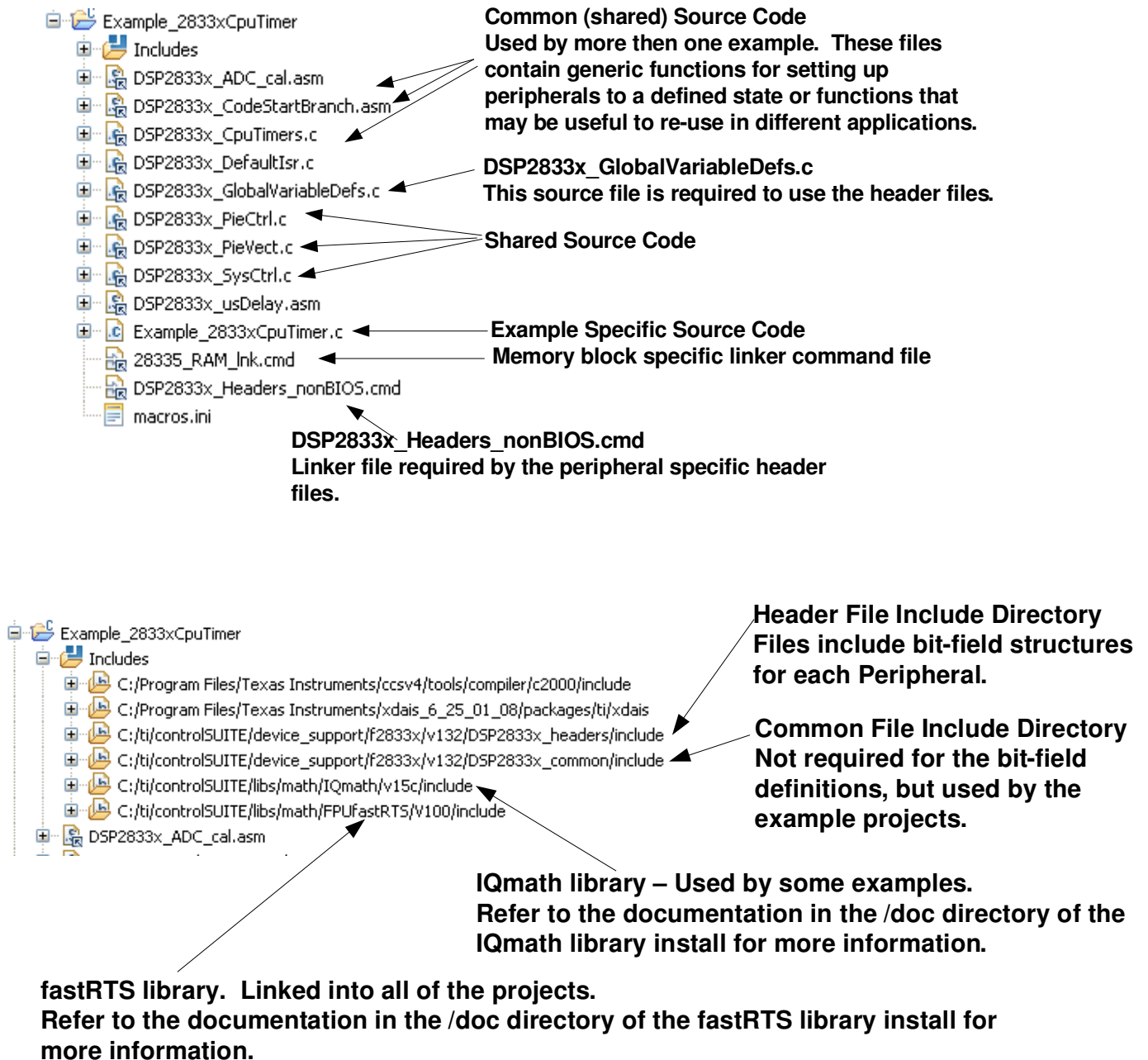
## 10. When done, delete the project from the Code Composer Studio v4 workspace.

Go to *View->C/C++ Projects* to open up your project view. To remove/delete the project from the workspace, right click on the project’s name and select *delete*. **Make sure the *Do not delete contents* button is selected**, then select *Yes*. This does not delete the project itself. It merely removes the project from the workspace until you wish to open/import it again.

The examples use the header files in the *DSP2833x\_headers* directory and shared source in the *DSP2833x\_common* directory. Only example files specific to a particular example are located within in the example directory.

**Note: Most of the example code included uses the .bit field structures to access registers. This is done to help the user learn how to use the peripheral and device. Using the bit fields has the advantage of yielding code that is easier to read and modify. This method will result in a slight code overhead when compared to using the .all method. In addition, the example projects have the compiler optimizer turned off. The user can change the compiler settings to turn on the optimizer if desired.**

## 3.2 Example Program Structure



Each of the example programs has a very similar structure. This structure includes unique source code, shared source code, header files and linker command files.

#### NOTE:

The '2823x example programs use the same source and include files as the '2833x example programs. The only difference between the '2823x examples and the '2833x examples is that '2823x programs are compiled for fixed-point, and '2833x programs are compiled for floating-point.

```

/*****
* DSP2833x_examples\cpu_timer\Example_2833xCpuTimer.c
*****/

#include "DSP28x_Project.h"           // Device Headerfile and Examples Include File

```

- **DSP28x\_Project.h**

This header file includes DSP2833x\_Device.h and DSP2833x\_Examples.h. Because the name is device-generic, example/custom projects can be easily ported between different device header files. With this file included in the example source files, only the example/custom project (.pj) file and DSP28x\_Project.h file would need to be modified when porting source code between different devices. This file is found in the *<base>\DSP2833x\_common\include* directory.

- **DSP2833x\_Device.h**

This header file is required to use the header files. This file includes all of the required peripheral specific header files and includes device specific macros and typedef statements. This file is found in the *<base>\DSP2833x\_headers\include* directory.

- **DSP2833x\_Examples.h**

This header file defines parameters that are used by the example code. This file is not required to use just the DSP2833x peripheral header files but is required by some of the common source files. This file is found in the *<base>\DSP2833x\_common\include* directory.

### 3.2.1 Source Code

Each of the example projects consists of source code that is unique to the example as well as source code that is common or shared across examples.

- **DSP2833x\_GlobalVariableDefs.c**

Any project that uses the DSP2833x peripheral header files must include this source file. In this file are the declarations for the peripheral register structure variables and data section assignments. This file is found in the *<base>\DSP2833x\_headers\source* directory.

- **Example specific source code:**

Files that are specific to a particular example have the prefix Example\_2833x (or Example\_2823x) in their filename. For example Example\_2833xCpuTimer.c is specific to the CPU Timer example and not used for any other example. Example specific files are located in the `<base>\DSP2833x_examples\<example>` directory for '2833x devices and in the `<base>\DSP2823x_examples\<example>` directory for '2823x devices.

- **Common source code:**

The remaining source files are shared across the examples. These files contain common functions for peripherals or useful utility functions that may be re-used. Shared source files are located in the `DSP2833x_common\source` directory. Users may choose to incorporate none, some, or the entire shared source into their own new or existing projects.

### 3.2.2 Linker Command Files

Each example uses two linker command files. These files specify the memory where the linker will place code and data sections. One linker file is used for assigning compiler generated sections to the memory blocks on the device while the other is used to assign the data sections of the peripheral register structures used by the DSP2833x peripheral header files.

- **Memory block linker allocation:**

The linker files shown in Table 4 are used to assign sections to memory blocks on the device. These linker files are located in the `<base>\DSP2833x_common\cmd` directory. Each example will use one of the following files depending on the memory used by the example.

**Table 4. Included Memory Linker Command Files**

Memory Linker Command File Examples	Location	Description
28335_RAM_Ink.cmd	DSP2833x_common\cmd	28335/28235 memory linker command file. Includes all of the internal SARAM blocks on a 28335/28235 device. "RAM" linker files do not include flash or OTP blocks.
28334_RAM_Ink.cmd	DSP2833x_common\cmd	28335/28235 SARAM memory linker command file.
28332_RAM_Ink.cmd	DSP2833x_common\cmd	28334/28234 SARAM memory linker command file.
F28335.cmd	DSP2833x_common\cmd	F28335/F28235 memory linker command file. Includes all Flash, OTP and CSM password protected memory locations.
F28334.cmd	DSP2833x_common\cmd	F28334/F28234 memory linker command file.
F28332.cmd	DSP2833x_common\cmd	F28332/F28232 memory linker command file.

- **Header file structure data section allocation:**

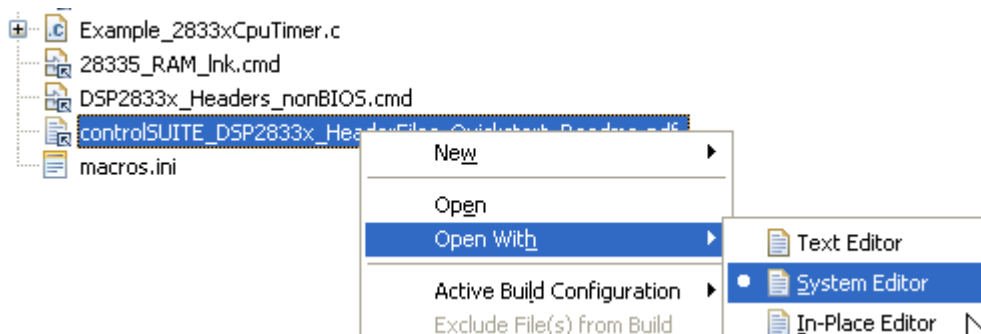
Any project that uses the header file peripheral structures must include a linker command file that assigns the peripheral register structure data sections to the proper memory location. These files are described in Table 5.

**Table 5. DSP2833x Peripheral Header Linker Command File**

Header File Linker Command File	Location	Description
DSP2833x_Headers_BIOS.cmd	DSP2833x_headers\cmd	Linker .cmd file to assign the header file variables in a BIOS project. This file must be included in any BIOS project that uses the header files. Refer to section 4.2.
DSP2833x_Headers_nonBIOS.cmd	DSP2833x_headers\cmd	Linker .cmd file to assign the header file variables in a non-BIOS project. This file must be included in any non-BIOS project that uses the header files. Refer to section 4.2.

### 3.2.3 Documentation

This document is linked into each project so it can easily be opened through the project view. To do this, right click on the document, select “open with” and “system editor”.





## Example Program Flow

All of the example programs follow a similar recommended flow for setting up a 2833x/2823x device. Figure 1 outlines this basic flow:

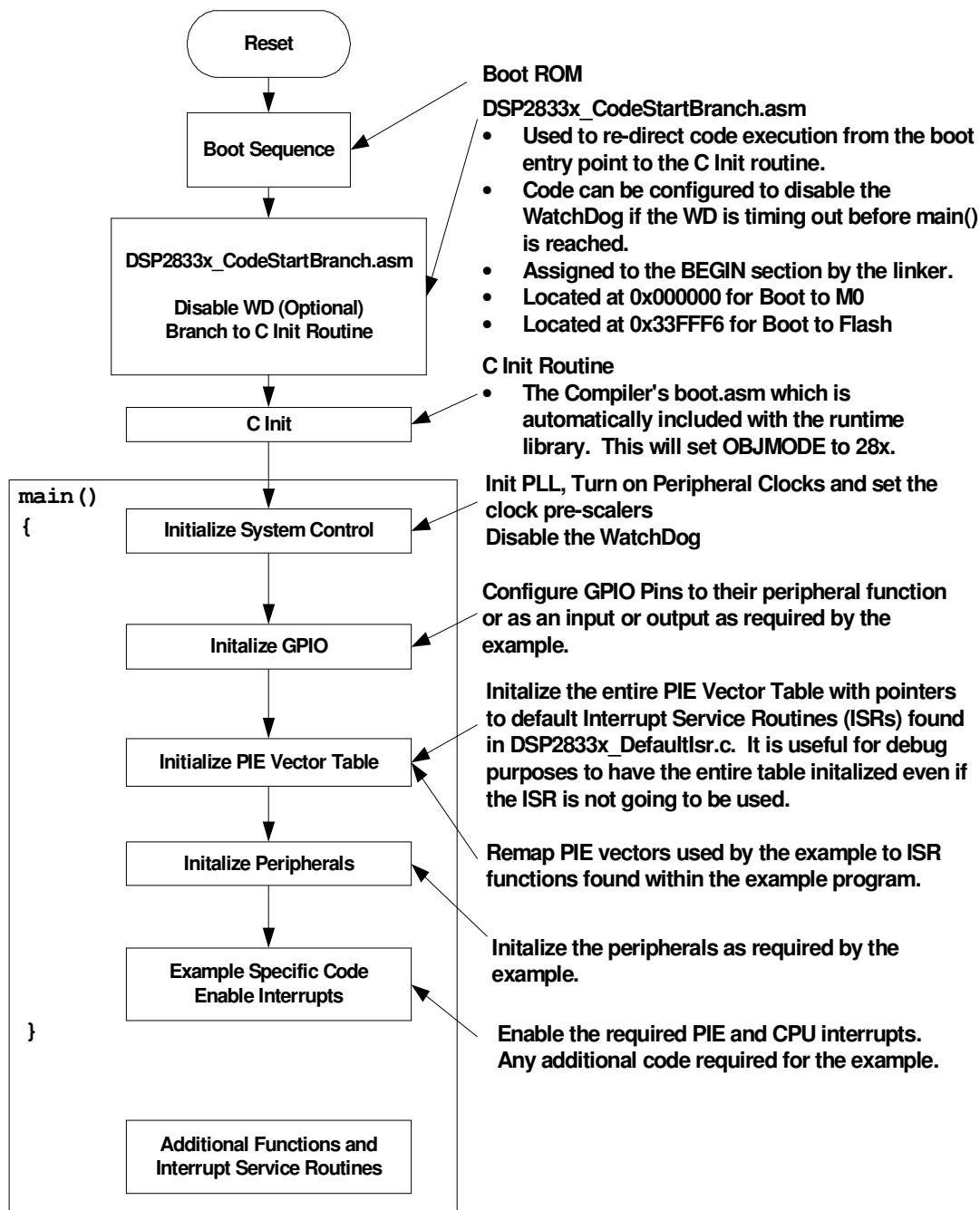


Figure 1. Flow for Example Programs

### 3.3 Included Examples:

**Table 6. Included Examples**

Example	Description
adc_dma	ADC example with ADC interfaced to DMA. ChannelA0-A3 are converted 10 times.
adc_seq_ovd_tests	ADC test using the sequencer override feature.
adc_seqmode_test	ADC Seq Mode Test. Channel A0 is converted forever and logged in a buffer
adc_soc	ADC example to convert two channels: ADCINA3 and ADCINA2. Interrupts are enabled and PWM1 is configured to generate a periodic ADC SOC on SEQ1.
cpu_timer	Configures CPU Timer0 and increments a count each time the ISR is serviced.
dma_ram_to_ram	Example of RAM to RAM data block transfer using the DMA.
dma_xintf_to_ram	Example of XINTF to RAM data block transfer using the DMA.
ecan_a_to_b_xmit	Transmit from eCANa to eCANb
ecan_back2back	eCAN self-test mode example. Transmits eCAN data back-to-back at high speed without stopping.
ecap_apwm	This example sets up the alternate eCAP pins in the APWM mode
ecap_capture_pwm	Captures the edges of a ePWM signal.
epwm_deadband	Example deadband generation via ePWM3
epwm_dma	DMA triggered by SOC from ePWMs. This example also demonstrates ePWM registers re-mapped to DMA-accessible register space.
epwm_timer_interrupts	Starts ePWM1-ePWM6 timers. Every period an interrupt is taken for each ePWM.
epwm_trip_zone	Uses the trip zone signals to set the ePWM signals to a particular state.
epwm_up_aq	Generate a PWM waveform using an up count time base ePWM1-ePWM3 are used.
epwm_updown_aq	Generate a PWM waveform using an up/down time base. ePWM- ePWM3 are used.
eqep_freqcal	Frequency cal using eQEP1 Note: The controlSUITE version of this example uses the IQmath library from its controlSUITE install location. Change the .macros file to change this location if desired.
eqep_pos_speed	Pos/speed calculation using eQEP1 Note: The controlSUITE version of this example uses the IQmath library from its controlSUITE install location. Change the .macros file to change this location if desired.
external_interrupt	Configures GPIO0 as XINT1 and GPIO1 as XINT2. The interrupts are fired by toggling GPIO30 and GPIO31 which are connected to XINT1 (GPIO0) and XINT2 (GPIO1) externally by the user.
flash	ePWM timer interrupt project moved from SARAM to Flash. Includes steps that were used to convert the project from SARAM to Flash. Some interrupt service routines are copied from FLASH to SARAM for faster execution.
fpu	Two projects illustrating the difference between code compiled with floating-point hardware (FPU) and fixed-point hardware (using software to simulate floating-point). <i>Note: This example is not included in the DSP2823x_examples directory because DSP2823x devices do not have an FPU.</i>
gpio_setup	Three examples of different pinout configurations.
gpio_toggle	Toggles all of the I/O pins using different methods – DATA, SET/CLEAR and TOGGLE registers. The pins can be observed using an oscilloscope.
hrpwm	Sets up ePWM1-ePWM4 and controls the edge of output A using the HRPWM extension. Both rising edge and falling edge are controlled.

### Included Examples Continued...

hrpwm_sfo	Use TI's MEP Scale Factor Optimizer (SFO) library to change the HRPWM. This version of the SFO library supports HRPWM on ePWM channels 1-4 only.
hrpwm_sfo_v5	Use TI's MEP Scale Factor Optimizer (SFO) library version 5 to change the HRPWM. This version of the SFO library supports HRPWM on up to 16 ePWM channels (if available)
hrpwm_slider	This is the same as the hrpwm example except the control of CMPAHR is now controlled by the user via a slider bar. The included .gel file sets up the slider.
i2c_eeprom	Communicate with the EEPROM on the eZdsp F28335 USB platform via I2C
lpm_haltwake	Puts device into low power halt mode. GPIO0 is configured to wake the device from halt when an external high-low-high pulse is applied to it.
lpm_idlewake	Puts device into low power idle mode. GPIO0 is configured as XINT1 pin. When an XINT1 interrupt occurs due to a falling edge on GPIO0, the device is woken from idle.
lpm_standbywake	Puts device into low power standby mode. GPIO0 is configured to wake the device from halt when an external high-low-high pulse is applied to it.
mcbbsp_loopback	McBSP-A example that uses the peripheral's loop-back testmode to send data.
mcbbsp_loopback_dma	McBSP-A example that uses the peripheral's loop-back testmode with the DMA to send and receive data.
mcbbsp_loopback_interrupts	McBSP-A example that uses the peripheral's loop-back testmode to send data. Interrupts are used in this example.
mcbbsp_spi_loopback	McBSP-A example that configures the peripheral for SPI mode and uses the loop-back testmode to send data.
sci_autobaud	Externally connect SCI-A to SCI-B and send data between the two peripherals. Baud lock is performed using the autobaud feature of the SCI. This test is repeated for different baud rates.
sci_echoback	SCI-A example that can be used to echoback to a terminal program such as hyperterminal. A transceiver and a connection to a PC is required.
scia_loopback	SCI-A example that uses the peripheral's loop-back test mode to send data.
scia_loopback_interrupts	SCI-A example that uses the peripheral's loop-back test mode to send data. Both interrupts and FIFOs are used in this example.
spi_loopback	SPI-A example that uses the peripherals loop-back test mode to send data.
spi_loopback_interrupts	SPI-A example that uses the peripherals loop-back test mode to send data. Both interrupts and FIFOs are used in this example.
sw_prioritized_interrupts	The standard hardware prioritization of interrupts can be used for most applications. This example shows a method for software to re-prioritize interrupts if required.
timed_led_blink	This example blinks GPIO32 (LED on the eZdsp) at a rate of 1 Hz using CPU Timer 0.
watchdog	Illustrates feeding the dog and re-directing the watchdog to an interrupt.
xintf_run_from	This example shows how to run from XINTF zone 7 and configure the XINTF memory interface on the F28335 eZdsp.

### 3.4 Executing the Examples From Flash

Most of the DSP2833x/2823x examples execute from SARAM in “boot to SARAM” mode. One example, *DSP2833x\_examples\Flash* (or *DSP2823x\_examples\Flash*), executes from flash memory in “boot to flash” mode. This example is the PWM timer interrupt example with the following changes made to execute out of flash:

**1. Change the linker command file to link the code to flash.**

Remove 28335\_RAM\_Ink.cmd from the project and add one of the flash based linker files (ex: F28335.cmd, F28334.cmd, or F28332.cmd). These files are located in the *<base>DSP2833x\_common\cmd\* directory.

**2. Add the *DSP2833x\_common\source\DSP2833x\_CSMPasswords.asm* to the project.**

This file contains the passwords that will be programmed into the Code Security Module (CSM) password locations. Leaving the passwords set to 0xFFFF during development is recommended as the device can easily be unlocked. For more information on the CSM refer to the appropriate *System Control and Interrupts Reference Guide*.

**3. Modify the source code to copy all functions that must be executed out of SARAM from their load address in flash to their run address in SARAM.**

In particular, the flash wait state initialization routine must be executed out of SARAM. In the DSP2833x/2823x examples, functions that are to be executed from SARAM have been assigned to the ramfuncs section by compiler CODE\_SECTION #pragma statements as shown in the example below.

```

/*****
* DSP2833x_common\source\DSP2833x_SysCtrl.c
*****/

#pragma CODE_SECTION(InitFlash, "ramfuncs");

```

The ramfuncs section is then assigned to a load address in flash and a run address in SARAM by the memory linker command file as shown below:

```

/*****
* DSP2833x_common\include\F28335.cmd
*****/
SECTIONS
{
    ramfuncs      : LOAD = FLASHD,
                  RUN  = RAML0,
                  LOAD_START(_RamfuncsLoadStart),
                  LOAD_END(_RamfuncsLoadEnd),
                  RUN_START(_RamfuncsRunStart),
                  PAGE = 0
}

```

The linker will assign symbols as specified above to specific addresses as follows:

Address	Symbol
Load start address	RamfuncsLoadStart
Load end address	RamfuncsLoadEnd
Run start address	RamfuncsRunStart

These symbols can then be used to copy the functions from the Flash to SARAM using the included example MemCopy routine or the C library standard memcpy() function.

To perform this copy from flash to SARAM using the included example MemCopy function:

- Add the file *DSP2833x\_common\source\DSP2833x\_MemCopy.c* to the project.
- Add the following function prototype to the example source code. This is done for you in the *DSP2833x\_Examples.h* file.

```

/*****
* DSP2833x_common\include\DSP2833x_Examples.h
*****/

MemCopy(&RamfuncsLoadStart, &RamfuncsLoadEnd, &RamfuncsRunStart);

```

- Add the following variable declaration to your source code to tell the compiler that these variables exist. The linker command file will assign the address of each of these variables as specified in the linker command file as shown in step 3. For the DSP2833x/2823x example code this has already been done in *DSP2833x\_Examples.h*.

```

/*****
* DSP2833x_common\include\DSP2833x_GlobalPrototypes.h
*****/

extern Uint16 RamfuncsLoadStart;
extern Uint16 RamfuncsLoadEnd;
extern Uint16 RamfuncsRunStart;

```

- Modify the code to call the example MemCopy function for each section that needs to be copied from flash to SARAM.

```

/*****
* DSP2833x_examples\Flash source file
*****/

MemCopy(&RamfuncsLoadStart, &RamfuncsLoadEnd, &RamfuncsRunStart);

```

#### 4. Modify the code to call the flash initialization routine:

This function will initialize the wait states for the flash and enable the Flash Pipeline mode.

```

/*****
* DSP2833x peripheral example .c file
*****/

InitFlash();

```

#### 5. Set the required jumpers for “boot to Flash” mode.

The required jumper settings for each boot mode are shown in Table 7.

**Table 7. 2833x/2823x Boot Mode Settings**

<b>GPIO87 XA15 PU</b>	<b>GPIO86 XA14 PU</b>	<b>GPIO85 XA13 PU</b>	<b>GPIO84 XA12 PU</b>	<b>Mode</b>
1	1	1	1	<b>Boot to flash 0x33FFF6</b>
1	1	1	0	Call SCI-A boot loader
1	1	0	1	Call SPI-A boot loader
1	1	0	0	Call I2C boot loader
1	0	1	1	Call eCAN-A boot loader
1	0	1	0	Call McBSP-A boot loader
1	0	0	1	Boot to XINTF x16 0x100000
1	0	0	0	Boot to XINTF x32 0x100000
0	1	1	1	Boot to OTP 0x380400
0	1	1	0	Call parallel GPIO boot loader
0	1	0	1	Call parallel XINTF boot loader
0	1	0	0	Boot to M0 SARAM 0x000000
0	0	1	1	Branch to check boot mode
0	0	1	0	Boot to flash, bypass ADC cal
0	0	0	1	Boot to SARAM, bypass ADC cal
0	0	0	0	Boot to SCI-A, bypass ADC cal

Refer to the documentation for your hardware platform for information on configuring the boot mode selection pins.

For more information on the ‘2833x/2823x boot modes refer to the appropriate *Boot ROM Reference Guide*.

#### 6. Program the device with the built code.

In Code Composer Studio v4.0, when code is loaded into the device during debug, it automatically programs to flash memory.

This can also be done using SDFlash available from Spectrum Digital’s website ([www.spectrumdigital.com](http://www.spectrumdigital.com)).

**7. To debug flash code that is already programmed, load the project in CCS, select *Target->Load Symbols->Browse project and select the .out file.***

It is useful to load only symbol information when working in a debugging environment where the debugger cannot or need not load the object code, such as when the code is in ROM or already programmed in flash. This operation loads the symbol information from the specified file.

### 3.5 Converting Floating-Point Compiled Examples to Fixed-Point and Vice Versa

This section applies to '2833x devices only.

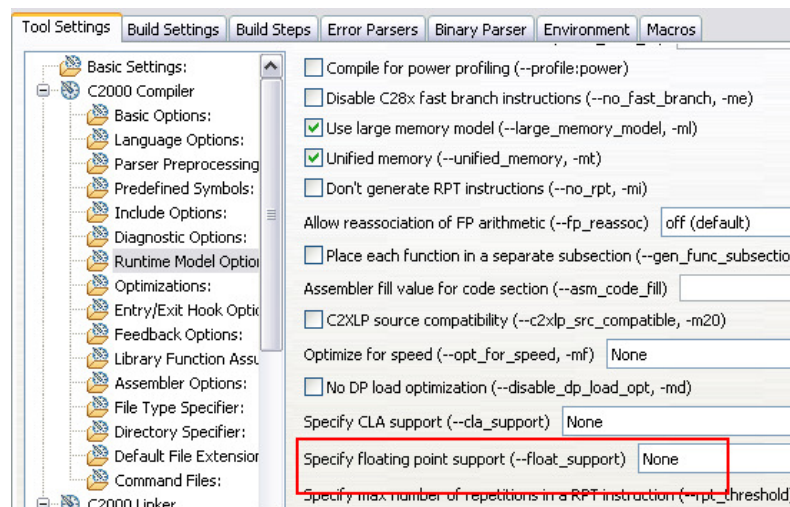
Because the '2833x is a floating-point device, all of the DSP2833x examples (unless otherwise denoted in the example description) are configured for floating-point. In some cases, it may be desirable to compile the code for fixed-point instead of floating-point.

To convert the examples so they compile for fixed-point, certain steps must be taken. The following steps are demonstrated on the example in *DSP2833x\_examples\fpu*. The directory includes two projects with identical C-code— one compiled using fixed-point instructions and the other compiled using floating-point instructions.

**1. Configure the compiler build options for fixed-point instead of floating-point.**

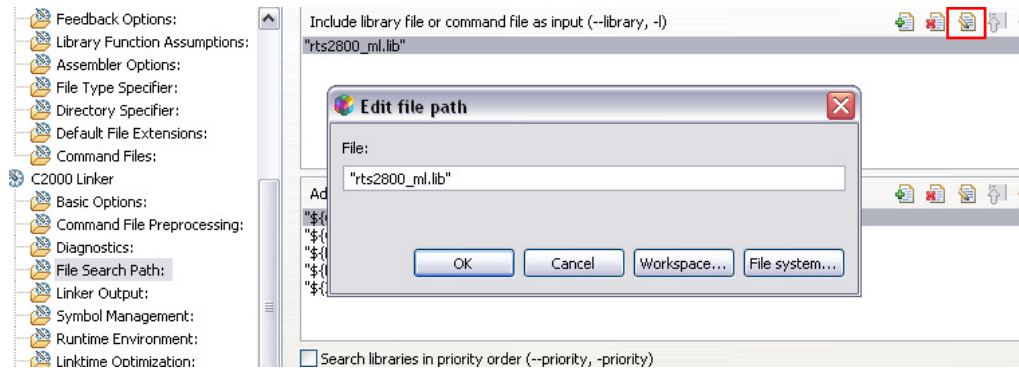
**These instructions apply to Code Composer Studio V4.x.**

- a. Go to *Project-> Properties*
- b. Select *C/C++ Build*. Then in the *Tool Settings* tab, select “*C2000 Compiler*”->*Runtime Model Options*. In the screen that appears on the right, select “*None*” from the “*Specify floating point support (--float\_support)*” pull-down menu. Then select the *Apply* button at the bottom of the window.



## 2. Use the fixed-point version of the rts2800.lib library instead of the floating-point version.

- In the *Tool Settings* tab, go to “C2000 Linker->File Search Path:”
- In the upper box on the right labeled “Include library file or command file as input (--library, -l)”, select the “Edit” icon in the top right, and change “rts2800\_fpu32.lib” (for floating-point version of the rts2800 library) to “rts2800\_ml.lib” (for fixed-point large memory model version of the library).



## 3. Replace any floating-point compiled libraries included in the project with their fixed-point equivalents.

If your project is compiled for floating-point (--float\_support=fpu32 option), then any libraries included by your project must also be compiled for floating-point. Likewise, if your project is compiled for fixed-point, the included libraries must also be compiled for fixed-point.

- In the Project window, right click on “SFO\_TI\_Build\_V5\_fpu.lib”, and select “Delete”.
- Then, right-click on the project name and select “New->File”.
- Select your project. Then at the bottom of the window, click the “Advanced>>” button.
- Check the “Link to file in the file system” checkbox.

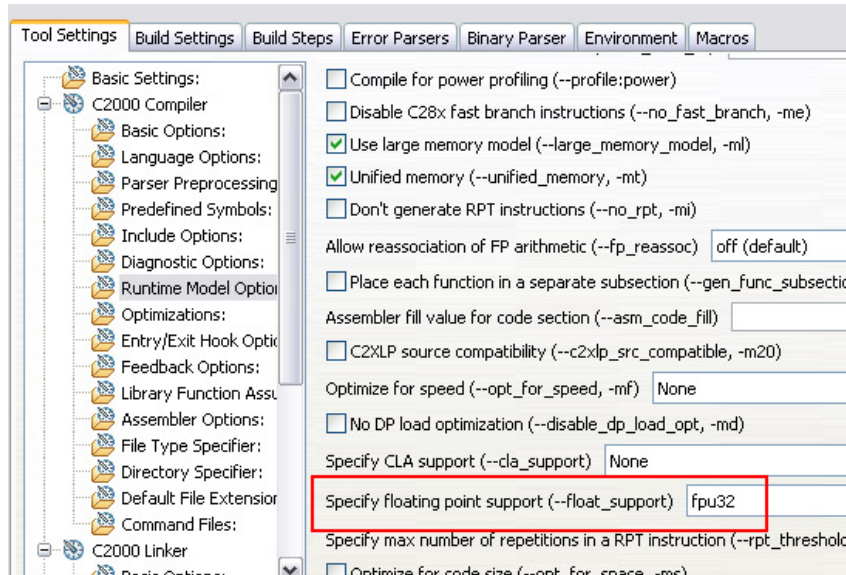


- e. Now you have 2 options for adding the floating-point version of the library to your project. Option A is the quickest way, but only works on your own computer as long as the library remains at the same location on your computer (the project will break on another computer or if you move the library to a different location on your computer). Option B takes a few more steps, but it can be used if you plan to move the project and associated files to another location on the same or different computer.
  - i. Option A: Select "*Browse...*" and navigate to where the floating-point version of your library is located, and select the library to replace the fixed-point version. (for instance, "SFO\_TI\_Build\_V5\_fpu.lib" is replaced with "SFO\_TI\_Build\_V5.lib").
  - ii. Option B: Select "*Variables...*", and select the macro pointing to the path of your header file installation direction. (i.e. select `INSTALLROOT_2833X_V130` which points to the default installation directory path for V1.30 of the 2833x header files and peripheral examples). Then select "*Extend...*", and navigate to where the fixed-point version of your library is located, and select the library to replace the floating-point version. (for instance, "SFO\_TI\_Build\_V5\_fpu.lib" is replaced with "SFO\_TI\_Build\_V5.lib").

After these 3 steps are performed, the floating-point example project has been converted to fixed-point and can be re-compiled and built for fixed-point. To convert a fixed-point example back into floating-point, the following steps must be taken:

#### **1. Configure the compiler build options for floating-point instead of fixed-point.**

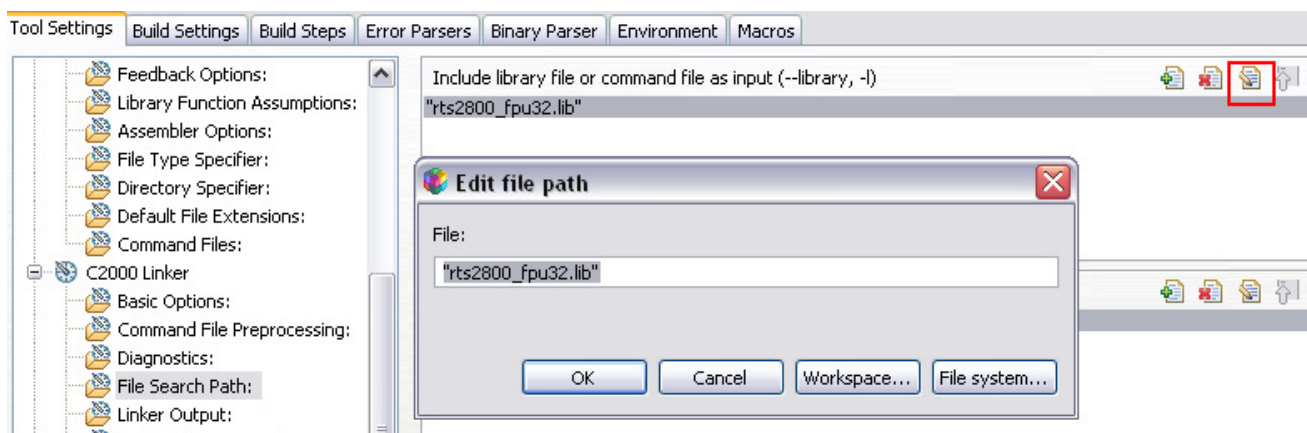
- a. Go to *Project-> Properties*.
- b. Select *C/C++ Build*
- c. On the *Tool Settings* tab, select "*C2000 Compiler*"->*Runtime Model Options*.



- d. In the screen that appears on the right, select “*fpu32*” from the “*Specify floating point support (--float\_support)*” pull-down menu.
- e. Then select the *Apply* button at the bottom of the window.

## 2. Use the floating-point version of the rts2800.lib library instead of the fixed-point version.

- a. In the *Tool Settings* tab, go to “*C2000 Linker->File Search Path:*”
- b. In the upper box on the right labeled “*Include library file or command file as input (-library, -l)*”, select the “*Edit*” icon in the top right
- c. Change “*rts2800\_ml.lib*” (for fixed-point large memory version of the rts2800 library) to “*rts2800\_fpu32.lib*” (for the floating-point version of the library).



## 3. Replace any fixed-point compiled libraries included in the project with their floating-point equivalents.

- a. In the Project window, right click on “*SFO\_TI\_Build\_V5.lib*”, and select “*Delete*”.

- b. Then, right-click on the project name and select “*New->File*”.
- c. Select your project. Then at the bottom of the window, click the “*Advanced>>*” button.
- d. Check the “*Link to file in the file system*” checkbox.
- e. Now you have 2 options for adding the floating-point version of the library to your project. Option A is the quickest way, but only works on your own computer as long as the library remains at the same location on your computer (the project will break on another computer or if you move the library to a different location on your computer). Option B takes a few more steps, but it can be used if you plan to move the project and associated files to another location on the same or different computer.
  - iii. Option A: Select “*Browse...*” and navigate to where the floating-point version of your library is located, and select the library to replace the fixed-point version. (for instance, “SFO\_TI\_Build\_V5.lib” is replaced with “SFO\_TI\_Build\_V5\_fpu.lib”).
  - iv. Option B: Select “*Variables...*”, and select the macro pointing to the path of your header file installation direction. (i.e. select `INSTALLROOT_2833X_V131` which points to the default installation directory path for V1.30 of the 2833x header files and peripheral examples). Then select “*Extend...*”, and navigate to where the floating-point version of your library is located, and select the library to replace the fixed-point version. (for instance, “SFO\_TI\_Build\_V5.lib” is replaced with “SFO\_TI\_Build\_V5\_fpu.lib”).

After these 3 steps are performed, the fixed-point example project has been converted to floating-point and can be re-compiled and built for floating-point.

## 4 Steps for Incorporating the Header Files and Sample Code

Follow these steps to incorporate the peripheral header files and sample code into your own projects. If you already have a project that uses the DSP280x or DSP281x header files then also refer to Section 6 for migration tips.

### 4.1 Before you begin

Before you include the header files and any sample code into your own project, it is recommended that you perform the following:

#### 1. Load and step through an example project.

Load and step through an example project to get familiar with the header files and sample code. This is described in Section 3.

#### 2. Create a copy of the source files you want to use.

*DSP2833x\_headers*: code required to incorporate the header files into your project  
*DSP2833x\_common*: shared source code much of which is used in the example projects.

*DSP2823x\_examples*: '2823x fixed-point compiled example projects that use the header files and shared code.

*DSP2833x\_examples*: '2833x floating-point compiled example projects that use the header files and shared code.

### 4.2 Including the DSP2833x Peripheral Header Files

Including the DSP2833x header files in your project will allow you to use the bit-field structure approach in your code to access the peripherals on the DSP. To incorporate the header files in a new or existing project, perform the following steps:

#### 1. #include "DSP2833x\_Device.h" (or #include "DSP28x\_Project.h" ) in your source files.

The DSP2833x\_Device.h include file will in-turn include all of the peripheral specific header files and required definitions to use the bit-field structure approach to access the peripherals.

```

/*****
* User's source file
*****/

#include "DSP2833x_Device.h"

```

Another option is to #include "DSP28x\_Project.h" in your source files, which in-turn includes "DSP2833x\_Device.h" and "DSP2833x\_Examples.h" (if it is not necessary to include common source files in the user project, the #include "DSP2833x\_Examples.h" line can be deleted). Due to the device-generic nature of the file name, user code is easily ported between different device header files. With this file included in the user's

source files, only the project (.pj1) file and DSP28x\_Project.h file would need to be modified when porting source code between different devices.

```

/*****
* User's source file
*****/

#include "DSP28x_Project.h"

```

## Edit DSP2833x\_Device.h and select the target you are building for:

In the below example, the file is configured to build for the '28335/'28235 device.

```

/*****
* DSP2833x_headers\include\DSP2833x_Device.h
*****/

#define TARGET 1
#define DSP28_28335 TARGET // Selects '28335/'28235
#define DSP28_28334 0 // Selects '28334/'28234
#define DSP28_28332 0 // Selects '28332/'28232... etc

```

By default, the '28335/'28235 device is selected.

## 2. Add the source file *DSP2833x\_GlobalVariableDefs.c* to the project.

This file is found in the *DSP2833x\_headers\source\* directory and includes:

- Declarations for the variables that are used to access the peripheral registers.
- Data section #pragma assignments that are used by the linker to place the variables in the proper locations in memory.

## 3. Add the appropriate DSP2833x header linker command file to the project.

As described in Section 2, when using the DSP2833x header file approach, the data sections of the peripheral register structures are assigned to the memory locations of the peripheral registers by the linker.

To perform this memory allocation in your project, one of the following linker command files located in *DSP2833x\_headers\cmd\* must be included in your project:

- For non-DSP/BIOS<sup>†</sup> projects: *DSP2833x\_Headers\_nonBIOS.cmd*
- For DSP/BIOS projects: *DSP2833x\_Headers\_BIOS.cmd*

<sup>†</sup> DSP/BIOS is a trademark of Texas Instruments

The method for adding the header linker file to the project depends on preference.

**Method #1:**

- a. Right-click on the project in the project window of the C/C++ Projects perspective.
- b. Select *Link Files to Project...*
- c. Navigate to the *DSP2833x\_headers\cmd* directory on your system and select the desired .cmd file.

**Notes:**

**The limitation with Method #1 is that the path to the command file is fixed on your PC. If you move the installation directory to another location on your PC, the project will “break” because it still expects the .cmd file to be in the original location.**

**Use Method #2 if you are using “linked variables” in your project to ensure your project/installation directory is portable across computers and different locations on the same PC.**

**For more information, see:**

[http://processors.wiki.ti.com/index.php/Portable Projects in CCSv4 for C2000](http://processors.wiki.ti.com/index.php/Portable_Projects_in_CCSv4_for_C2000)

**Method #2:**

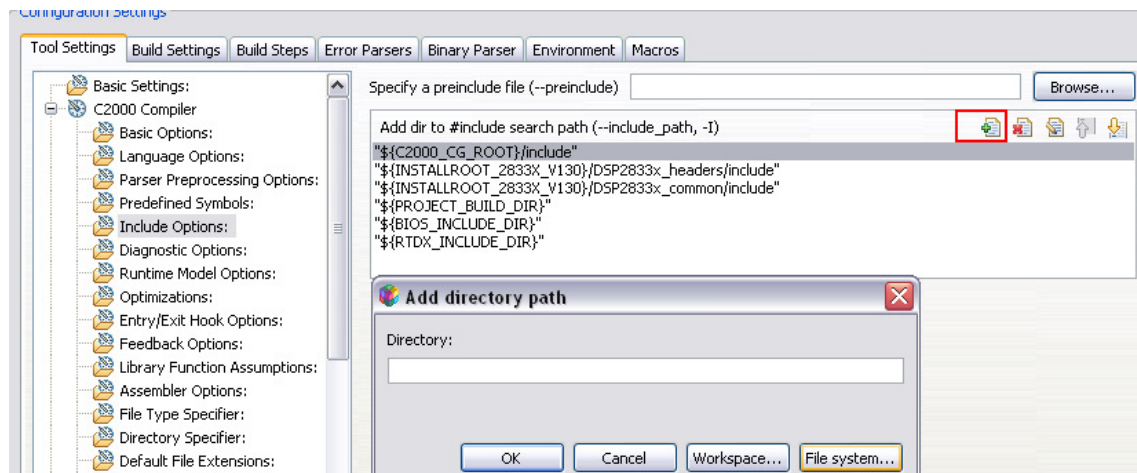
- a. Right-click on the project in the project window of the C/C++ Projects perspective.
- b. Select *New->File*.
- c. Click on the *Advanced>>* button to expand the window.
- d. Check the *Link to file in the file system* checkbox.
- e. Select the *Variables...* button. From the list, pick the linked variable (macro defined in your *macros.ini* file) associated with your installation directory. (For the 2833x header files, this is *INSTALLROOT\_2833X\_V<version #>*). For more information on linked variables and the *macros.ini* file, see:  
[http://processors.wiki.ti.com/index.php/Portable Projects in CCSv4 for C2000#Method .232 for Linking Files to Project](http://processors.wiki.ti.com/index.php/Portable_Projects_in_CCSv4_for_C2000#Method_232_for_Linking_Files_to_Project)
- f. Click on the *Extend...* button. Navigate to the desired .cmd file and select *OK*.

#### 4. Add the directory path to the DSP2833x header files to your project.

##### Code Composer Studio 4.x:

To specify the directory where the header files are located:

- Open the menu: *Project->Properties*.
- In the menu on the left, select "C/C++ Build".
- In the "Tool Settings" tab, Select "C2000 Compiler -> Include Options."
- In the "Add dir to #include search path (--include\_path, -I)" window, select the "Add" icon in the top right corner.
- Select the "File system..." button and navigate to the directory path of *DSP2833x\_headers\include* on your system.



#### 5. Additional suggested build options:

The following are additional compiler and linker options. The options can all be set via the *Project->Build Options* menu in CCStudio v3.x and the *Project->Properties* menu under *C/C++ Build* in CCStudio v4.x.

##### – **Compiler Tab:**

- ☐ **-ml**      **Select *Advanced* and check *-ml***

Build for large memory model. This setting allows data sections to reside anywhere within the 4M-memory reach of the 28x devices.

- ☐ **-pdr**      **Select *Diagnostics* and check *-pdr***

Issue non-serious warnings. The compiler uses a warning to indicate code that is valid but questionable. In many cases, these warnings issued by enabling *-pdr* can alert you to code that may cause problems later on.

##### – **Linker Tab:**

- ☐ **-w**      **Select *Advanced* and check *-w***

Warn about output sections. This option will alert you if any unassigned memory sections exist in your code. By default the linker will attempt to place any unassigned code or data section to an available memory location without alerting the user. This can cause problems, however, when the section is placed in an unexpected location.

**❑ -e            Select *Basic* and enter Code Entry Point -e**

Defines a global symbol that specifies the primary entry point for the output module. For the DSP2833x/DSP2823x examples, this is the symbol "code\_start". This symbol is defined in the DSP2833x\_common\source\DSP2833x\_CodeStartBranch.asm file. When you load the code in Code Composer Studio, the debugger will set the PC to the address of this symbol. If you do not define a entry point using the -e option, then the linker will use \_c\_int00 by default.

### 4.3 Including Common Example Code

Including the common source code in your project will allow you to leverage code that is already written for the device. To incorporate the shared source code into a new or existing project, perform the following steps:

**1. #include "DSP2833x\_Examples.h" (or "DSP28x\_Project.h") in your source files.**

The "DSP2833x\_Examples.h" include file will include common definitions and declarations used by the example code.

```

/*****
* User's source file
*****/

#include "DSP2833x_Examples.h"

```

Another option is to #include "DSP28x\_Project.h" in your source files, which in-turn includes "DSP2833x\_Device.h" and "DSP2833x\_Examples.h". Due to the device-generic nature of the file name, user code is easily ported between different device header files. With this file included in the user's source files, only the project (.pj) file and DSP28x\_Project.h file would need to be modified when porting source code between different devices.

```

/*****
* User's source file
*****/

#include "DSP28x_Project.h"

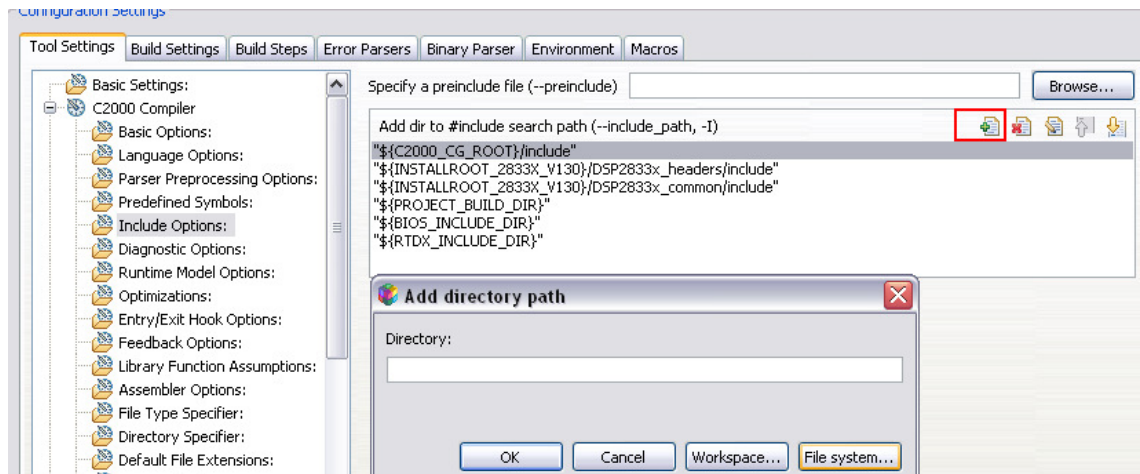
```



## 2. Add the directory path to the example include files to your project.

To specify the directory where the header files are located:

- Open the menu: *Project->Properties*.
- In the menu on the left, select "C/C++ Build".
- In the "Tool Settings" tab, Select "C2000 Compiler -> Include Options:"
- In the "Add dir to #include search path (--include\_path, -I)" window, select the "Add" icon in the top right corner.
- Select the "File system..." button and navigate to the directory path of *DSP2833x\_headers\include* on your system.



### 3. Add a linker command file to your project.

The following memory linker .cmd files are provided as examples in the *DSP2833x\_common\cmd* directory. For getting started the basic *28335\_RAM\_Ink.cmd* file is suggested and used by most of the examples.

**Table 8. Included Main Linker Command Files**

Memory Linker Command File Examples	Location	Description
28335_RAM_Ink.cmd	DSP2833x_common\cmd	28335/28235 memory linker command file. Includes all of the internal SARAM blocks on a 28335/28235 device. "RAM" linker files do not include flash or OTP blocks.
28334_RAM_Ink.cmd	DSP2833x_common\cmd	28334/28234 SARAM memory linker command file.
28332_RAM_Ink.cmd	DSP2833x_common\cmd	28332/28232 SARAM memory linker command file.
F28335.cmd	DSP2833x_common\cmd	F28335/F28235 memory linker command file. Includes all Flash, OTP and CSM password protected memory locations.
F28334.cmd	DSP2833x_common\cmd	F28334/F28234 memory linker command file.
F28332.cmd	DSP2833x_common\cmd	F28332/F28232 memory linker command file.

### 4. Set the CPU Frequency

In the *DSP2833x\_common\include\DSP2833x\_Examples.h* file specify the proper CPU frequency. Some examples are included in the file.

```

/*****
* DSP2833x_common\include\DSP2833x_Examples.h
*****/
.....
#define CPU_RATE      6.667L    // for a 150MHz CPU clock speed (SYSCLKOUT)
// #define CPU_RATE      7.143L    // for a 140MHz CPU clock speed (SYSCLKOUT)
// #define CPU_RATE      8.333L    // for a 120MHz CPU clock speed (SYSCLKOUT)
.....

```

### 5. Add desired common source files to the project.

The common source files are found in the *DSP2833x\_common\source\* directory.

### 6. Include .c files for the PIE.

Since all catalog '2833x'/2823x applications make use of the PIE interrupt block, you will want to include the PIE support .c files to help with initializing the PIE. The shell ISR functions can be used directly or you can re-map your own function into the PIE vector table provided. A list of these files can be found in section 7.2.1.

## 5 Troubleshooting Tips & Frequently Asked Questions

- **In the examples, what do “EALLOW;” and “EDIS;” do?**

EALLOW; is a macro defined in DSP2833x\_Device.h for the assembly instruction EALLOW and likewise EDIS is a macro for the EDIS instruction. That is EALLOW; is the same as embedding the assembly instruction asm(“ EALLOW”);

Several control registers on the 28x devices are protected from spurious CPU writes by the EALLOW protection mechanism. The EALLOW bit in status register 1 indicates if the protection is enabled or disabled. While protected, all CPU writes to the register are ignored and only CPU reads, JTAG reads and JTAG writes are allowed. If this bit has been set by execution of the EALLOW instruction, then the CPU is allowed to freely write to the protected registers. After modifying the registers, they can once again be protected by executing the EDIS assembly instruction to clear the EALLOW bit.

For a complete list of protected registers, refer to *TMS320x2833x, x2823x System Control and Interrupts Reference Guide* (SPRUFB0).

- **Peripheral registers read back 0x0000 and/or cannot be written to.**

There are a few things to check:

- Peripheral registers cannot be modified or unless the clock to the specific peripheral is enabled. The function InitPeripheralClocks() in the DSP2833x\_common\source directory shows an example of enabling the peripheral clocks.
- Some peripherals are not present on all 2833x family derivatives. Refer to the device datasheet for information on which peripherals are available.
- The EALLOW bit protects some registers from spurious writes by the CPU. If your program seems unable to write to a register, then check to see if it is EALLOW protected. If it is, then enable access using the EALLOW assembly instruction. *TMS320x2833x System Control and Interrupts Reference Guide* (SPRUFB0) for a complete list of EALLOW protected registers.

- **Memory blocks read back all 0x0000.**

In this case most likely the code security module is locked and thus the protected memory locations are reading back all 0x0000. Refer to *TMS320x2833x, x2823x System Control and Interrupts Reference Guide* (SPRUFB0) for information on the code security module.

- **Code cannot write to memory blocks.**

In this case most likely the code security module is locked and thus the protected memory locations are reading back all 0x0000. Code that is executing from outside of the protected cannot read or write to protected memory while the CSM is locked. Refer to the *TMS320x2833x Control and Interrupts Reference Guide* (SPRUFB0) for information on the code security module

- **A peripheral register reads back ok, but cannot be written to.**

The EALLOW bit protects some registers from spurious writes by the CPU. If your program seems unable to write to a register, then check to see if it is EALLOW protected. If it is, then enable access using the EALLOW assembly instruction. *TMS320x2833x, x2823x System Control and Interrupts Reference Guide (SPRUFB0)* for a complete list of EALLOW protected registers.

- **I re-built one of the projects to run from Flash and now it doesn't work. What could be wrong?**

Make sure all initialized sections have been moved to flash such as .econst and .switch.

If you are using SDFlash, make sure that all initialized sections, including .econst, are allocated to page 0 in the linker command file (.cmd). SDFlash will only program sections in the .out file that are allocated to page 0.

- **Why do the examples populate the PIE vector table and then re-assign some of the function pointers to other ISRs?**

The examples share a common default ISR file. This file is used to populate the PIE vector table with pointers to default interrupt service routines. Any ISR used within the example is then remapped to a function within the same source file. This is done for the following reasons:

- The entire PIE vector table is enabled, even if the ISR is not used within the example. This can be very useful for debug purposes.
- The default ISR file is left un-modified for use with other examples or your own project as you see fit.
- It illustrates how the PIE table can be updated at a later time.

- **When I build the examples, the linker outputs the following: warning: entry point other than \_c\_int00 specified. What does this mean?**

This warning is given when a symbol other than \_c\_int00 is defined as the code entry point of the project. For these examples, the symbol code\_start is the first code that is executed after exiting the boot ROM code and thus is defined as the entry point via the -e linker option. This symbol is defined in the DSP2833x\_CodeStartBranch.asm file. The entry point symbol is used by the debugger and by the hex utility. When you load the code, CCS will set the PC to the entry point symbol. By default, this is the \_c\_int00 symbol which marks the start of the C initialization routine. For the DSP2833x examples, the code\_start symbol is used instead. Refer to the source code for more information.

- **When I build many of the examples, the compiler outputs the following: remark: controlling expression is constant. What does this mean?**

Some of the examples run forever until the user stops execution by using a while(1) {} loop. The remark refers to the while loop using a constant and thus the loop will never be exited.

- **When I build some of the examples, the compiler outputs the following: warning: statement is unreachable. What does this mean?**

Some of the examples run forever until the user stops execution by using a while(1) {} loop. If there is code after this while(1) loop then it will never be reached.

- **I changed the build configuration of one of the projects from “Debug” to “Release” and now the project will not build. What could be wrong?**

When you switch to a new build configuration (*Project->Configurations*) the compiler and linker options changed for the project. The user must enter other options such as include search path and the library search path. Open the build options menu (*Project->Build Options* in CCStudio v3.x or *Project->Properties* in CCStudio v4.x under *C/C++ Build*) and enter the following information:

- Compiler Tab, Preprocessor: Include search path
- Linker Tab, Basic: Library search path
- Linker Tab, Basic: Include libraries (ie rts2800\_ml.lib)

Refer to section 4 for more details.

- **In the flash example I loaded the symbols and ran to main. I then set a breakpoint but the breakpoint is never hit. What could be wrong?**

In the Flash example, the InitFlash function and several of the ISR functions are copied out of flash into SARAM. When you set a breakpoint in one of these functions, Code Composer will insert an ESTOP0 instruction into the SARAM location. When the ESTOP0 instruction is hit, program execution is halted. CCS will then remove the ESTOP0 and replace it with the original opcode. In the case of the flash program, when one of these functions is copied from Flash into SARAM, the ESTOP0 instruction is overwritten code. This is why the breakpoint is never hit. To avoid this, set the breakpoint after the SARAM functions have been copied to SARAM.

- **The eCAN control registers require 32-bit write accesses.**

The compiler will instead make a 16-bit write accesses if it can in order to improve codesize and/or performance. This can result in unpredictable results.

One method to avoid this is to create a duplicate copy of the eCAN control registers in RAM. Use this copy as a shadow register. First copy the contents of the eCAN register you want to modify into the shadow register. Make the changes to the shadow register and then write the data back as a 32-bit value. This method is shown in the DSP2833x\_examples\ecan\_back2back example project.

## 5.1 Effects of read-modify-write instructions.

When writing any code, whether it be C or assembly, keep in mind the effects of read-modify-write instructions.

The '28x DSP will write to registers or memory locations 16 or 32-bits at a time. Any instruction that seems to write to a single bit is actually reading the register, modifying the single bit, and then writing back the results. This is referred to as a read-modify-write instruction. For most registers this operation does not pose a problem. A notable exception is:

### 5.1.1 Registers with multiple flag bits in which writing a 1 clears that flag.

For example, consider the PIEACK register. Bits within this register are cleared when writing a 1 to that bit. If more than one bit is set, performing a read-modify-write on the register may clear more bits than intended.

The below solution is incorrect. It will write a 1 to any bit set and thus clear all of them:

```

/*****
* User's source file
*****/

PieCtrl.PIEACK.bit.Ack1 = 1;    // INCORRECT! May clear more bits.

```

The correct solution is to write a mask value to the register in which only the intended bit will have a 1 written to it:

```

/*****
* User's source file
*****/

#define PIEACK_GROUP1 0x0001
.....
PieCtrl.PIEACK.all = PIEACK_GROUP1;    // CORRECT!

```

### 5.1.2 Registers with Volatile Bits.

Some registers have volatile bits that can be set by external hardware.

Consider the PIEIFRx registers. An atomic read-modify-write instruction will read the 16-bit register, modify the value and then write it back. During the modify portion of the operation a bit in the PIEIFRx register could change due to an external hardware event and thus the value may get corrupted during the write.

The rule for registers of this nature is to never modify them during runtime. Let the CPU take the interrupt and clear the IFR flag.

## 6 Migration Tips for moving from the TMS320x280x or TMS320x281x header files to the TMS320x2833x/TMS320x2823x header files

This section includes suggestions for moving a project from the 280x or 281x header files to the 2833x header files.

1. **Create a copy of your project to work with or back-up your current project.**
2. **Open the project file(s) in a text editor**

### **In Code Composer Studio v4.x:**

Open the *.project*, *.cdtbuild*, and *macros.ini* files in your example folder. Replace all instances of 280x with 2803x so that the appropriate source files and build options are used. Check the path names to make sure they point to the appropriate header file and source code directories. Also replace the header file version number for the paths and macro names as well where appropriate. For instance, if a macro name was `INSTALLROOT_280X_V170` for your 280x project using 280x header files V1.70, change this to `INSTALLROOT_2833X_V131` to migrate to the 2833x header files V1.30. If not using the default macro name for your header file version, be sure to change your macros according to your chosen macro name in the *.project*, *.cdtbuild*, and *macros.ini* files.

3. **Load the project into Code Composer Studio**

Use the Edit-> find in files dialog to find instances of `DSP280x_Device.h` and `DSP280x_Example.h` for 280x header files, or `DSP281x_Device.h` and `DSP281x_Example.h` for 281x header files. Replace these with `DSP2833x_Device.h` and `DSP2833x_Example.h` respectively.

4. **Make sure you are using the correct linker command files (.cmd) appropriate for your device and for the DSP2833x header files.**

You will have one file for the memory definitions and one file for the header file structure definitions. Using a 280x or 281x memory file can cause issues since the H0 memory block has been split, renamed, and/or moved on the 2833x/2823x devices.

## 5. Build the project.

The compiler will highlight areas that have changed. If migrating from the TMS320x280x header files, code should be mostly compatible after all instances of DSP280x are replaced with DSP2833x in all relevant files, and the above steps are taken. Additionally, several bits have been removed and/or replaced. See Table 9.

**Table 9. Summary of Register and Bit-Name Changes from DSP280x V1.41 to DSP2833x V1.01**

Peripheral	Register	Bit Name		Comment
		Old	New	
SysCtrlRegs				
	XCLK			Register removed because XCLKOUT is controlled by XINTF now.
	PLLSTS	CLKINDIV(bit 1)	DIVSEL (bits 8,7)	DIVSEL allows more values by which CLKIN can be divided.

If migrating from the TMS320x281x header files, most of these changes will fall into one of the following categories:

- Bit-name or register name corrections to align with the peripheral user guides. See Table 10 for a listing of these changes.
- Code that was written for the 281x event manager (EV) will need to be re-written for the 2833x/2823x ePWM, eCAP and eQEP peripherals.
- Code for the 281x McBSP will need to be modified for the 2833x/2823x version of the peripheral (FIFO replaced with DMA).

Code for the 281x XINTF will need to be modified for the 2833x/2823x version of the peripheral in the following ways:

- The .cmd linker file will need to be updated because zone memory locations have changed and the 2833x/2823x only has Zones 0, 6, and 7.
- Because both the boot ROM and the XINTF zones are always memory-mapped on the 2833x, there is no longer any need for the MPNMC bit in the XINTCNF2 registers. Therefore, the MPNMC bit on the 281x is now reserved on the 2833x/2823x. See Table 10.
- On the 281x, the clock to the XINTF was always enabled. On the 2833x/2823x, code must be added which will enable/disable the clock to the XINTF module in the PCLKCR3 system control register.
- Because the XINTF pins on the 2833x/2823x are now MUX'd with GPIO pins at reset, code migrating from the 281x to the 2833x/2823x will need to modify the XINTF initialization to enable the GPIO pins for XINTF mode.
- There is now an XRESET register on the 2833x/2823x which was not available on the 281x.



**Table 10. Summary of Register and Bit-Name Changes from DSP281x V1.00 to DSP2833x V1.01**

Peripheral	Register	Bit Name		Comment
		Old	New	
AdcRegs				
	ADCTRL2	EVB_SOC_SEQ2	EPWM_SOCB_SEQ2	SOC is now performed by ePWM
		EVA_SOC_SEQ1	EPWM_SOCB_SEQ1	SOC is now performed by ePWM
		EVB_SOC_SEQ	EPWM_SOCB_SEQ	SOC is now performed by ePWM
DevEmuRegs				
	DEVICEID		PARTID REVID	Split into two registers, PARTID and REVID
EcanaRegs				
	CANMDL	BYTE1	BYTE3	Order of bytes was incorrect
		BYTE3	BYTE1	
		BYTE4	BYTE0	
	CANMDH	BYTE5	BYTE7	Order of bytes was incorrect
		BYTE7	BYTE5	
		BYTE8	BYTE4	
GpioMuxRegs				
				The GPIO peripheral has been redesigned from the 281x. All of the registers have moved from 16-bit to 32-bits. The GpioMuxRegs are now the GpioCtrlRegs and the bit definitions have all changed. Please refer to <i>TMS320x2833x Control and Interrupts Reference Guide</i> for more information on the GPIO peripheral.
PieCtrlRegs				
	PIECTRL	PIECRTL	PIECTRL	Typo
SciaRegs, ScibRegs				
	SCIFFTX	TXFFILIL	TXFFIL	Typo
		TXINTCLR	TXFFINTCLR	Alignment with user's guide.
	SCIFFRX	RXFIFST	RXFFST	Typo – Also corrected in user's guide
McbspaRegs				
	MFFTX			The McBSP FIFO on the 281x has been removed and replaced by the DMA. Therefore these FIFO registers do not exist on the 2833x. Please refer to the <i>TMS320x2833x McBSP Reference Guide</i> for more information on the McBSP peripheral.
	MFFRX			
	MFFCT			
XintfRegs				
	XINTCNF2	MPNMC	Rsvd2	The MPNMC bit does not exist on the 2833x
	XTIMING1			There is no Zone 1 on the 2833x
	XTIMING2			There is no Zone 2 on the 2833x

## 7 Packet Contents:

This section lists all of the files included in the release.

### 7.1 Header File Support – DSP2833x\_headers

The DSP2833x header files are located in the `<base>\DSP2833x_headers\` directory.

#### 7.1.1 DSP2833x Header Files – Main Files

The following files must be added to any project that uses the DSP2833x header files. Refer to section 4.2 for information on incorporating the header files into a new or existing project.

**Table 11. DSP2833x Header Files – Main Files**

File	Location	Description
DSP2833x_Device.h	DSP2833x_headers\include	Main include file. Include this one file in any of your .c source files. This file in-turn includes all of the peripheral specific .h files listed below. In addition the file includes typedef statements and commonly used mask values. Refer to section 4.2.
DSP2833x_GlobalVariableDefs.c	DSP2833x_headers\source	Defines the variables that are used to access the peripheral structures and data section #pragma assignment statements. This file must be included in any project that uses the header files. Refer to section 4.2.
DSP2833x_Headers_BIOS.cmd	DSP2833x_headers\cmd	Linker .cmd file to assign the header file variables in a BIOS project. This file must be included in any BIOS project that uses the header files. Refer to section 4.2.
DSP2833x_Headers_nonBIOS.cmd	DSP2833x_headers\cmd	Linker .cmd file to assign the header file variables in a non-BIOS project. This file must be included in any non-BIOS project that uses the header files. Refer to section 4.2.

### 7.1.2 DSP2833x Header Files – Peripheral Bit-Field and Register Structure Definition Files

The following files define the bit-fields and register structures for each of the peripherals on the 2833x devices. These files are automatically included in the project by including *DSP2833x\_Device.h*. Refer to section 4.2 for more information on incorporating the header files into a new or existing project.

**Table 12. DSP2833x Header File Bit-Field & Register Structure Definition Files**

File	Location	Description
DSP2833x_Adc.h	DSP2833x_headers\include	ADC register structure and bit-field definitions.
DSP2833x_CpuTimers.h	DSP2833x_headers\include	CPU-Timer register structure and bit-field definitions.
DSP2833x_DevEmu.h	DSP2833x_headers\include	Emulation register definitions
DSP2833x_DMA.h	DSP2833x_headers\include	DMA register structures and bit-field definitions.
DSP2833x_ECan.h	DSP2833x_headers\include	eCAN register structures and bit-field definitions.
DSP2833x_ECap.h	DSP2833x_headers\include	eCAP register structures and bit-field definitions.
DSP2833x_EPwm.h	DSP2833x_headers\include	ePWM register structures and bit-field definitions.
DSP2833x_EQep.h	DSP2833x_headers\include	eQEP register structures and bit-field definitions.
DSP2833x_Gpio.h	DSP2833x_headers\include	General Purpose I/O (GPIO) register structures and bit-field definitions.
DSP2833x_I2c.h	DSP2833x_headers\include	I2C register structure and bit-field definitions.
DSP2833x_Mcbsp.h	DSP2833x_headers\include	McBSP register structure and bit-field definitions.
DSP2833x_PieCtrl.h	DSP2833x_headers\include	PIE control register structure and bit-field definitions.
DSP2833x_PieVect.h	DSP2833x_headers\include	Structure definition for the entire PIE vector table.
DSP2833x_Sci.h	DSP2833x_headers\include	SCI register structure and bit-field definitions.
DSP2833x_Spi.h	DSP2833x_headers\include	SPI register structure and bit-field definitions.
DSP2833x_SysCtrl.h	DSP2833x_headers\include	System register definitions. Includes Watchdog, PLL, CSM, Flash/OTP, Clock registers.
DSP2833x_Xintf.h	DSP2833x_headers\include	XINTF register structure and bit-field definitions.
DSP2833x_XIntrupt.h	DSP2833x_headers\include	External interrupt register structure and bit-field definitions.

### 7.1.3 Code Composer .gel Files

The following Code Composer Studio .gel files are included for use with the DSP2833x Header File peripheral register structures.

**Table 13. DSP2833x Included GEL Files**

File	Location	Description
DSP2833x_Peripheral.gel	DSP2833x_headers\gel	This is relevant for CCSv3.3 only. Provides GEL pull-down menus to load the DSP2833x data structures into the watch window. You may want to have CCS load this file automatically by adding a <code>GEL_LoadGel("&lt;base&gt;DSP2833x_headers\gel\ DSP2833x_peripheral.gel")</code> function to the standard F28335.gel that was included with CCS.
DSP2833x_DualMap_EPWM.gel	DSP2833x_headers\gel	Provides GEL pull-down menus to enable EPWM dual-map mode on device (re-maps EPWM registers to allow DMA access to EPWM registers), and loads DSP2833x dual-mapped EPWM data structures into the watch window.

### 7.1.4 Variable Names and Data Sections

This section is a summary of the variable names and data sections allocated by the DSP2833x\_headers\source\DSP2833x\_GlobalVariableDefs.c file. Note that all peripherals may not be available on a particular 2833x device. Refer to the device datasheet for the peripheral mix available on each 2833x family derivative.

**Table 14. DSP2833x Variable Names and Data Sections**

Peripheral	Starting Address	Structure Variable Name
ADC	0x007100	AdcRegs
ADC Mirrored Result Registers	0x000B00	AdcMirror
ADC Calibration Value Locations	0x380083	AdcCalVal
Code Security Module	0x000AE0	CsmRegs
Code Security Module Password Locations	0x33FFF8-0x33FFFF	CsmPwl
CPU Timer 0	0x000C00	CpuTimer0Regs
Device and Emulation Registers	0x000880	DevEmuRegs
DMA Registers	0x001000	DmaRegs
eCAN-A	0x006000	ECanaRegs
eCAN-A Mail Boxes	0x006100	ECanaMboxes
eCAN-A Local Acceptance Masks	0x006040	ECanaLAMRegs
eCAN-A Message Object Time Stamps	0x006080	ECanaMOTSRegs
eCAN-A Message Object Time-Out	0x0060C0	ECanaMOTORRegs
eCAN-B	0x006200	ECanbRegs
eCAN-B Mail Boxes	0x006300	ECanbMboxes

eCAN-B Local Acceptance Masks	0x006240	ECanbLAMRegs
<b>Peripheral</b>	<b>Starting Address</b>	<b>Structure Variable Name</b>
eCAN-B Message Object Time Stamps	0x006280	ECanbMOTSRegs
eCAN-B Message Object Time-Out	0x0062C0	ECanbMOTORegs
ePWM1	0x006800	EPwm1Regs
ePWM2	0x006840	EPwm2Regs
ePWM3	0x006880	EPwm3Regs
ePWM4	0x0068C0	EPwm4Regs
ePWM5	0x006900	EPwm5Regs
ePWM6	0x006940	EPwm6Regs
ePWM1 (dual-mapped)	0x005800	EPwm1Regs
ePWM2 (dual-mapped)	0x005840	EPwm2Regs
ePWM3 (dual-mapped)	0x005880	EPwm3Regs
ePWM4 (dual-mapped)	0x0058C0	EPwm4Regs
ePWM5 (dual-mapped)	0x005900	EPwm5Regs
ePWM6 (dual-mapped)	0x005940	EPwm6Regs
eCAP1	0x006A00	ECap1Regs
eCAP2	0x006A20	ECap2Regs
eCAP3	0x006A40	ECap3Regs
eCAP4	0x006A60	ECap4Regs
eCAP5	0x006A80	ECap5Regs
eCAP6	0x006AA0	ECap6Regs
eQEP1	0x006B00	EQep1Regs
eQEP2	0x006B40	EQep2Regs
External Interrupt Registers	0x007070,	XIntruptRegs
Flash & OTP Configuration Registers	0x000A80	FlashRegs
General Purpose I/O Data Registers	0x006fC0	GpioDataRegs
General Purpose Control Registers	0x006F80	GpioCtrlRegs
General Purpose Interrupt Registers	0x006fE0	GpioIntRegs
I2C	0x007900	I2caRegs
McBSP-A	0x005000	McbspaRegs
McBSP-B	0x005040	McbspbRegs
PIE Control	0x000CE0	PieCtrlRegs
SCI-A	0x007050	SciaRegs
SCI-B	0x007750	ScibRegs
SCI-C	0x007770	ScicRegs
SPI-A	0x007040	SpiaRegs
XINTF	0x000B20	XintfRegs

## 7.2 Common Example Code – DSP2833x\_common

### 7.2.1 Peripheral Interrupt Expansion (PIE) Block Support

In addition to the register definitions defined in DSP2833x\_PieCtrl.h, this packet provides the basic ISR structure for the PIE block. These files are:

**Table 15. Basic PIE Block Specific Support Files**

File	Location	Description
DSP2833x_DefaultIsr.c	DSP2833x_common\source	Shell interrupt service routines (ISRs) for the entire PIE vector table. You can choose to populate one of functions or re-map your own ISR to the PIE vector table. <b>Note: This file is not used for DSP/BIOS projects.</b>
DSP2833x_DefaultIsr.h	DSP2833x_common\include	Function prototype statements for the ISRs in DSP2833x_DefaultIsr.c. <b>Note: This file is not used for DSP/BIOS projects.</b>
DSP2833x_PieVect.c	DSP2833x_common\source	Creates an instance of the PIE vector table structure initialized with pointers to the ISR functions in DSP2833x_DefaultIsr.c. This instance can be copied to the PIE vector table in order to initialize it with the default ISR locations.

In addition, the following files are included for software prioritization of interrupts. These files are used in place of those above when additional software prioritization of the interrupts is required. Refer to the example and documentation in *DSP2833x\_examples\sw\_prioritized\_interrupts* for more information.

**Table 16. Software Prioritized Interrupt PIE Block Specific Support Files**

File	Location	Description
DSP2833x_SWPrioritizedDefaultIsr.c	DSP2833x_common\source	Default shell interrupt service routines (ISRs). These are shell ISRs for all of the PIE interrupts. You can choose to populate one of functions or re-map your own interrupt service routine to the PIE vector table. <b>Note: This file is not used for DSP/BIOS projects.</b>
DSP2833x_SWPrioritizedIsrLevels.h	DSP2833x_common\include	Function prototype statements for the ISRs in DSP2833x_DefaultIsr.c. <b>Note: This file is not used for DSP/BIOS projects.</b>
DSP2833x_SWPrioritizedPieVect.c	DSP2833x_common\source	Creates an instance of the PIE vector table structure initialized with pointers to the default ISR functions that are included in DSP2833x_DefaultIsr.c. This instance can be copied to the PIE vector table in order to initialize it with the default ISR locations.

## 7.2.2 Peripheral Specific Files

Several peripheral specific initialization routines and support functions are included in the peripheral .c source files in the *DSP2833x\_common\src\* directory. These files include:

**Table 17. Included Peripheral Specific Files**

File	Description
DSP2833x_GlobalPrototypes.h	Function prototypes for the peripheral specific functions included in these files.
DSP2833x_Adc.c	ADC specific functions and macros.
DSP2833x_CpuTimers.c	CPU-Timer specific functions and macros.
DSP2833x_DMA.c	DMA specific functions and macros.
DSP2833x_Dma_defines.h	#define macros that are used for the DMA examples.
DSP2833x_ECan.c	Enhanced CAN specific functions and macros.
DSP2833x_ECap.c	eCAP module specific functions and macros.
DSP2833x_EPwm.c	ePWM module specific functions and macros.
DSP2833x_EPwm_defines.h	#define macros that are used for the ePWM examples
DSP2833x_EQep.c	eQEP module specific functions and macros.
DSP2833x_Gpio.c	General-purpose IO (GPIO) specific functions and macros.
DSP2833x_I2C.c	I2C specific functions and macros.
DSP2833x_I2c_defines.h	#define macros that are used for the I2C examples
DSP2833x_Mcbsp.c	McBSP specific functions and macros.
DSP2833x_PieCtrl.c	PIE control specific functions and macros.
DSP2833x_Sci.c	SCI specific functions and macros.
DSP2833x_Spi.c	SPI specific functions and macros.
DSP2833x_SysCtrl.c	System control (watchdog, clock, PLL etc) specific functions and macros.
DSP2833x_Xintf.c	XINTF specific functions and macros.

**Note:** The specific routines are under development and may not all be available as of this release. They will be added and distributed as more examples are developed.

### 7.2.3 Utility Function Source Files

**Table 18. Included Utility Function Source Files**

File	Description
DSP2833x_ADC_cal.asm	Includes the ADC_cal function, which is pre-programmed into reserved TI OTP. This function, which copies device-specific calibration data into the ADCREFSEL and ADCOFFTRIM registers, is normally called in the boot ROM. When debugging though, if the boot ROM is bypassed, it is necessary to call this function after enabling the clocks to the ADC in order to use the ADC module.
DSP2833x_CodeStartBranch.asm	Branch to the start of code execution. This is used to re-direct code execution when booting to Flash, OTP or M0 SARAM memory. An option to disable the watchdog before the C init routine is included.
DSP2833x_DBGIER.asm	Assembly function to manipulate the DEBIER register from C.
DSP2833x_DisInt.asm	Disable interrupt and restore interrupt functions. These functions allow you to disable INTM and DBGM and then later restore their state.
DSP2833x_usDelay.asm	Assembly function to insert a delay time in microseconds. This function is cycle dependant and must be executed from zero wait-stated RAM to be accurate. Refer to <i>DSP2833x_examples\adc</i> for an example of its use.
DSP2833x_CSMPasswords.asm	Include in a project to program the code security module passwords and reserved locations.

### 7.2.4 Example Linker .cmd files

Example memory linker command files are located in the *DSP2833x\_common\cmd* directory. For getting started the basic 28335\_eZdsp\_RAM\_Ink.cmd file is suggested and used by many of the included examples.

The SARAM blocks L0, L1, L2, and L3 are mirrored on these devices. For simplicity these memory maps only include one instance of these memory blocks.

**Table 19. Included Main Linker Command Files**

Memory Linker Command File Examples	Location	Description
28335_RAM_Ink.cmd	DSP2833x_common\cmd	28335/28235 memory linker command file. Includes all of the internal SARAM blocks on a 28335/28235 device. "RAM" linker files do not include flash or OTP
28334_RAM_Ink.cmd	DSP2833x_common\cmd	28334/28234 SARAM memory linker command file.
28332_RAM_Ink.cmd	DSP2833x_common\cmd	28332/28232 SARAM memory linker command file.
F28335.cmd	DSP2833x_common\cmd	F28335/F28235 memory linker command file. Includes all Flash, OTP and CSM password protected memory locations.
F28334.cmd	DSP2833x_common\cmd	F28334/F28234 memory linker command file.
F28332.cmd	DSP2833x_common\cmd	F28332/ F28232 memory linker command file.



### 7.2.5 Example Library .lib Files

Example library files are located in the *DSP2833x\_common\lib* directory. The SFO libraries are included for use in the example projects. Please refer to *TMS320x28xx, 28xxx HRPWM Reference Guide* (SPRU924) for more information on SFO library usage and the HRPWM module.

**Table 20. Included Library Files**

Main Liner Command File Examples	Description
SFO_TI_Build.lib	Please refer to the <i>TMS320x28xx, 28xxx HRPWM Reference Guide</i> (SPRU924) for more information on the SFO library
SFO_TI_Build_fpu.lib	The floating-point equivalent of SFO_TI_Build.lib. See Section 3.5 for information about including fixed and floating point libraries.
SFO.h	SFO header file
SFO_TI_Build_V5.lib/ SFO_TI_Build_V5B.lib	Please refer to the <i>TMS320x28xx, 28xxx HRPWM Reference Guide</i> (SPRU924) for more information on the SFO V5 library. Updated versions will be marked with alphabetical characters after "V5" (i.e. SFO_TI_Build_V5B.lib)
SFO_TI_Build_V5_fpu.lib/ SFO_TI_Build_V5B_fpu.lib	The floating-point equivalent of SFO_TI_Build_V5.lib. See Section 3.5 for information about including fixed and floating point libraries. Updated versions will be marked with alphabetical characters after "V5" (i.e. SFO_TI_Build_V5B.lib)
SFO_V5.h	SFO V5 header file

**Note:** The controlSUITE version of this package does not include a local copy of the IQmath library. Instead it uses the library from its installed location within controlSUITE.

## 8 Migrating Projects from Code Composer Studio v3.x to Code Composer Studio 4.0

This document does not discuss Code Composer Studio specifics. For more information on project migration from CCStudio v3.x to CCStudio v4, visit the online C2000 Code Comoposer Studio v4 wiki at:

[http://tiexpressdsp.com/index.php/C2000\\_Getting\\_Started\\_with\\_Code\\_Composer\\_Studio\\_v4](http://tiexpressdsp.com/index.php/C2000_Getting_Started_with_Code_Composer_Studio_v4)

Or visit the online Code Composer Studio v4 wiki at:

[http://tiexpressdsp.com/index.php?title=Category:Code\\_Composer\\_Studio\\_v4](http://tiexpressdsp.com/index.php?title=Category:Code_Composer_Studio_v4)

## 9 Detailed Revision History:

### V1.31 to V1.32 – controlSUITE update

This update makes numerous improvements to the Code Composer Studio 4 projects.

- a. Updated the CCS 4 projects to fit within the controlSUITE directory structure.
- b. Added the search path to the controlSUITE install of the fastRTS and IQmath libraries to each project.
- c. Removed the local copy of the IQmath library and header file.
- d. Linked in the fastRTS library to each project. The fastRTS is linked in before the normal RTS. Refer to the fastRTS library documentation for information.
- e. Removed the “release” configuration of each project as it has not been properly setup and tested.
- f. Reviewed the compiler and linker switches and updated them as needed.
- g. Linked this document to each project so it can be easily opened. Right click on the document and select “open with” and “system editor”.
- h. Increased the delay in the GPIO Toggle example..

### Changes from V1.30 to V1.31

#### **Changes to Example Files:**

- b) **All PJT Files** - Removed the line: Tool="DspBiosBuilder" from all example PJT files for easy migration path to CCSv4 Microcontroller-only (code-size limited) version users.

### Changes from V1.20 to V1.30

#### **Changes to Header Files:**

- c) **DSP2833x\_DevEmu.h**– Removed non-existent bits from DEVICECNF register.
- d) **DSP2833x\_Headers\_BIOS.cmd**- Changed CSM\_PWL from 0x3F7FF8 to 0x33FFF8
- e) **DSP2833x\_Xintf.h**- Fixed XRESET register so that it uses XRESET bit structure instead of XBANK bi structure.

#### **Changes to Common Files:**

- f) **DSP2833x\_SysCtrl.c**– Added comment indicating DIVSEL = divide by 1 mode is valid only when PLL is bypassed.
- g) **2833x\_RAM\_Ink.cmd, F2833x.cmd** – In all common device command linker files, BOOT\_RSVD was moved from PAGE0 to PAGE1 data space.
- h) **2833x.gel**- In all device gel files, XINTF\_Enable function call was removed from OnFilePreloaded() function, but function itself remains in the gel files.

- i) **Added /DSP2833x\_common/gel/ccsv4/ directory-** Because CCSv4.0 does not support the "WatchAdd()" gel command, new device gels without any "WatchAdd()" entries have been generated for CCSv4.0. These are located in the /ccsv4/ directory.
- j) **DSP2833x\_CpuTimers.c-** Modified comments – CPUTimer 2 is reserved for use by DSP/BIOS. When using DSP/BIOS, all CPUTimer 2 code should be commented out.

#### Changes to Example Files:

- a) **Example\_2833xMcBSP\_DLB.pjt, Example\_2833xMcBSP\_DLB\_DMA.pjt, Example\_2833xMcBSP\_DLB\_int.pjt, Example\_2833xMcBSP\_SPI\_DLB.pjt-** Changed McBSP.c to Mcbbsp.c. There is no McBSP.c file in the /DSP2833x\_common/source/ directory. When migration projects from CCSv3.3 to CCSv4.0, CCSv4.0 is case-sensitive.
- b) **Example\_2833xHaltWake.c** – Updated Description comments concerning halt wakeup procedure using GPIO0.
- c) **Added DSP2833x\_examples\_ccsv4 and DSP2823x\_examples\_ccsv4 directories** - Added directories for CCSv4.x projects. The example projects in these directories are identical to those found in the normal CCSv3.x DSP2833x\_examples and DSP2823x\_examples directories with the exception that the examples now support the Code Composer Studio v4.x project folder format instead of the Code Composer Studio v3.x PJT files. The example gel files have also been removed for the CCSv4 example projects because the gel file functions used in the example gels are no longer supported.

#### Changes from V1.10 to V1.20

##### Changes to Header Files:

- a) **DSP2833x\_Spi.h-** Changed SPIPRI register bit 6 to "rsvd" to match SPI Reference Guide.
- b) **DSP2833x\_DualMap\_EPWM.gel** - added this gel file, which enables dual-mapping of EPWM registers to DMA-accessible memory (registers are re-mapped), and creates GEL pull-down menus which add re-mapped registers to watch window (applicable for '2833x/'2823x silicon Rev.A and later).
- c) **DSP2833x\_Mcbbsp.h** – In MFFINT register, changed bits 1 and 3 to "rsvd" to match McBSP Reference Guide.
- d) **DSP2833x\_DevEmu.h** – Current PARTID register moved to OTP at 0x380090. New structure called PartIdRegs with 1 register, PARTID, created (identical to register previously located at 0x882 as part of DevEmuRegs). At address 0x882 (previously PARTID register), created new register, CLASSID, with two fields – CLASSNO and PARTTYPE. CLASSNO indicates whether device is floating-point or fixed-point. PARTTYPE is identical to PARTTYPE field in PARTID register.
- e) **DSP2833x\_Dma.h** – Added comments to include EPWM SOC signals as DMA triggers.

- f) **DSP2833x\_GlobalPrototypes.c** – Added PartIdRegs entry for new register structure.
- g) **DSP2833x\_Headers\_nonBIOS.cmd, DSP2833x\_Headers\_BIOS.cmd** – Added PARTID memory location in OTP at 0x380090 (1 16-bit word) and added Section to place PartIdRegs structure in PARTID memory location.

#### Changes to Common Files:

- h) **DSP2833x\_GlobalPrototypes.h**– Added delay\_loop() prototype for function used in DSP2833x\_Mcbsp.c.
- i) **DSP280x\_I2c\_defines.h** – Fixed typo: I2C\_DEINFES changed to I2C\_DEFINES.
- j) **DSP2833x\_ECan.c** – Updated baud rate frequencies to account for CANCLK = SYSCLK/2. Removed bit configuration comments at end of file. Added disclaimer – bit timings in source file are suggested timings only. They may vary with different system settings and user environment.
- k) **DSP2833x\_Dma.c** – In DMAInitialize() function, added one NOP after HARDRESET bit is set to align with DMA reference guide requirement.
- l) **f28235.gel, f28234.gel, and f28232.gel** – Added 2823x gel files, which are identical copies of 28335.gel, 28334.gel, and 28332.gel with the exception that FPU registers are removed. Also added C28x\_Mode() function call to OnRestart(), OnReset(), and OnTargetConnect() functions so that device is always configured for C28x addressing mode when debugging.
- m) **f28335.gel, f28334.gel, and f28332.gel** – Added C28x\_Mode() function call to OnRestart(), OnReset(), and OnTargetConnect() functions so that device is always configured for C28x addressing mode when debugging.
- n) **DSP2833x\_Examples.h** – Added part #'s for 28235, 28234, and 28232, and changed part #'s for 28335, 28334, 28332 in accordance to new PARTID's for Indus Rev. A.
- o) **IQmathLib.h**– New IQmath header files to be used with V1.5 of IQmath.lib and IQmath\_fpu32.lib libraries.
- p) **IQmath.lib and IQmath\_fpu32.lib** – Added version 1.5 of IQ math libraries (fixed and floating-point compiled versions) replaces old Version 1.4.
- q) **F28335.cmd, F28334.cmd, F28332.cmd, 28335\_RAM\_Ink.cmd, 28334\_RAM\_Ink.cmd, 28332\_RAM\_Ink.cmd** – Commented out IQmathTables2 section with segment that indicates only IQNexpTable is loaded into Boot ROM (doing so eliminates linker errors if IQNexp() or IQexp() functions are not called in code).

#### Changes to Example Files:

- r) **Example\_2833xEPwm\_DMA.c, Example\_2833xEPwm\_DMA.pjt, Example\_2833xEPwm\_DMA.gel, DSP2833x\_EPWMDM\_Headers\_BIOS.cmd, DSP2833x\_EPWMDM\_Headers\_nonBIOS.cmd (and 2823x versions)** – Added new example (in epwm\_dma folder of DSP2833x\_examples and DSP2823x\_examples directories) which demonstrates dual-mapping of EPWM registers (registers re-mapped to DMA-accessible memory locations starting at 0x5800 instead of 0x6800) and DMA triggered by EPWM SOC signals.
- s) **Example\_2833xHRPWM\_slider.c (and 2823x version)**- Set EPwm1Regs.TBPRD = period - 1; so that initial duty cycle is truly 50% % (TB counter counts from 0 to period-1 for a total of “period” counts).
- t) **Example2833x\_HRPWM.c** – Set EPwm1Regs.TBPRD = period - 1; so that initial duty cycle is truly 50% (TB counter counts from 0 to period-1 for a total of “period” counts).
- u) **Example\_2833xHRPWM\_SFO\_V5.c (and 2823x version)** – Added code to enable HRPWM logic prior to calling SFO\_MepDis\_V5().
- v) **Example\_freqcal.xls (eqep\_freqcal)**– description of UPPS bit settings has been corrected.
- w) **Example\_2833xCodeRunFromXintf.c (and 2823x version)** – added #if directives for setting up CPU Timer frequency for both 150 MHz and 100 MHz options.
- x) **Example\_2833xHaltWake.c (and 2823x version)** – removed “return” statement at end of ISR and changed GPASET to GPATOGGLE for GPIO1 in ISR.
- y) **Various examples** (dma\_ram\_to\_ram, mcbbsp\_loopback, mcbbsp\_spi\_loopback, sci\_loopback, and all lpm examples)- changed “while(1) to for(;;) to eliminate compiler warnings.
- z) **Example\_2833xMcBSP\_DLB.c (and 2823x version)**– Cleaned up example to eliminate compiler warnings.
- aa) **Example\_2833xMcBSP\_DLB\_DMA.c (and 2823x version)**– Cleaned up example to eliminate compiler warnings.
- bb) **Example\_2833xCodeRunFromXintf.c (and 2823x version)**- Added CPU Timer configuration for 150 MHz SYSCLK (previously only 100 MHz SYSCLK configuration).
- cc) **Example\_2833xEqep\_freqcal.pjt and Example\_2833xEqep\_freqcal.pjt** – Modified build options to build with fpu enabled (now that fpu32-compiled IQmath\_fpu32.lib library is available).

### **Changes from V1.03 to V1.10**

#### **Changes to Header Files:**

- a) **DSP2833x\_Peripheral.gel**– Collapsed eCAN register submenus into one submenu each for eCAN-A and eCAN-B to reduce GEL submenu size (reaching Code Composer Studio limit)
- b) **DSP2833x\_Device.h**- added types for int64 and Uint64.

- c) **DSP2833x\_Headers\_BIOS.cmd** and **DSP2833x\_Headers\_nonBIOS.cmd** – Fixed comments – “DMA Rev. 0” changed to “DMA”.

#### **Changes to Common Files:**

- d) **DSP2833x\_SWPrioritizedDefaultIsr.c** and **DSP2833x\_DefaultIsr.c** – Removed references to EMPTY\_ISR(). The function is not used in any other file in header file directory structure.
- e) **f28335.gel**, **f28334.gel**, and **f28332.gel** – Collapsed several GEL submenus, removed code which adds FPU registers to watch window upon connect, modified important messages to appear only once upon file preload, and configured gel to display an error message only when ADC not properly calibrated.

#### **Changes to Example Files:**

- f) **DSP2823x\_examples** - Added DSP2823x\_examples folder with all of the same examples as DSP2833x\_examples (minus fpu) compiled with fixed-point code instead of floating-point code because DSP2823x devices do not have an FPU.
- g) **Example2833x\_SWPrioritizedDefaultIsr.c** – Removed reference to EMPTY\_ISR(). The function is not used in any other file in header file directory structure.

### **Changes from V1.02 to V1.03**

#### **Changes to Header Files:**

- a) **DSP2833x\_Headers\_Bios.cmd** – Added sections for ECAP5/ECAP6 and removed SECTIONS definition for PIE\_VECT.
- b) **DSP2833x\_Gpio.h** – Added missing QUALPRD1 field to GPBCTRL\_BITS.

#### **Changes to Common Files:**

- c) **DSP2833x\_SWPrioritizedDefaultIsr.c** – Fixed some PIEIER number typos.
- d) **SFO\_TI\_Build\_V5B.lib** and **SFO\_TI\_Build\_V5Bfpu.lib** – Because the SFO\_MepEn() function in the original version of the SFO library was restricted to MEP control on falling edge only with HRLOAD on CTR=ZRO, a new version of the V5 library, V5B, was added, which includes a SFO\_MepEn() function that supports *all* available HRPWM configurations – falling and rising edge as well as HRLOAD on CTR=ZRO and CTR=PRD.

#### **Changes to Example Files:**

- e) **Example\_2833xECanBack2Back.c**– Removed initialization code and replaced with InitECana() function from DSP2833x\_ECan.c file.
- f) **Example\_2833xHRPWM.c** – Modified configuration such that duty cycle really starts at 50% (was off by 1 count) and fixed some minor typos.

### **Changes from V1.01 to V1.02**

**Changes to Header Files:**

- a) **DSP2833x\_Spi.h** – Removed extern references to SPI-B to SPI-D (legacy from DSP280x)

**Changes to Common Files:**

- b) **DSP2833x\_Mcbsp.c** – Removed GPAQSEL bit field updates to output-only MDXA and MDXB GPIO pin configurations. Also set #define CLKGDV\_VAL to default value of 1.
- c) **F28335.gel, F28334.gel, and F28332.gel** – Added ADC\_Cal() function called in OnRestart(), OnReset(), and OnFileLoaded(), and XINTF\_enable() function called in OnPreFileLoaded().

**Changes to Example Files:**

- d) **Xintf Examples** – In init\_zone7() function, added EALLOW and EDIS because XINTF registers are now EALLOW-protected.

**Changes from V1.00 to V1.01**
**Changes to Header Files:**

- a) **DSP2833x\_Peripheral.gel** – Corrected location of External Interrupt registers.
- b) **DSP2833x\_SysCtrl.h** – Previously, Flash and OTP waitstates (PAGEWAIT, RANDWAIT, and OTPWAIT) were configured for 100 MHz SYSCLKOUT. Hooks for 150 MHz SYSCLKOUT have been added to configure them for 150 MHz SYSCLKOUT as well.
- c) **DSP2833x\_Mcbsp.h** – Removed MFFST register. It no longer applies to 2833x McBSP.

**Changes to Common Files:**

- d) **DSP2833x\_DefaultIsr.h** – Was previously incorrectly named DSP2833x\_DefaultISR.h. Naming has been fixed.
- a) **DSP2833x\_Mcbsp.c** – Removed references to MFFST register.

**Changes to Example Files:**

- b) **Example\_2833xCpuTimer.c** – Added hooks to switch between 150MHz SYSCLKOUT and 100MHz SYSCLKOUT when generating a 1 second timer interrupt.
- c) **Example\_2833xMcBSP\_DLB\_DMA.c, Example\_2833xMcBSP\_DLB\_int.c** – Removed references to MFFST register.
- d) **Example\_2833xFlash.c** – Changed toggling GPIO pin from GPIO34 to GPIO32 (GPIO32 corresponds to LED on 2833x eZdsp)

- e) **Example\_2833xLEDBlink.c** – Created new example in timed\_led\_blink/ example directory which toggles GPIO32 to turn the eZdsp on and off at a 1 Hz rate.

### **V1.00**

- ☐ This version is the first customer release of the DSP2833x header files and examples.