

Stellaris® ARM® Cortex™-M4F Training

Floating Point Unit

Section 2: Getting Started with a FPU Demo Project using EK-LM4F232



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Section 2 Objectives

1. Set up the hardware (EK-LM4F232 evaluation board).
2. Gain familiarity with EK-LM4F232 evaluation board & quick start application.
3. Install drivers for EK-LMF232 evaluation board.
4. Getting started with an FPU demo project using CCS.

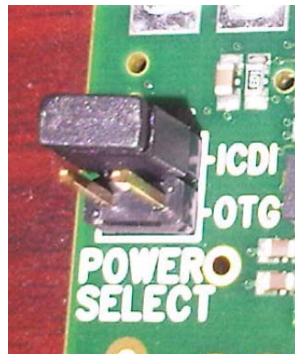
Setting Up Hardware

1. You will need:
 - a. Computer with at least one USB port
 - b. USB cable (type A-male to type B-male)
 - c. EK-LM4F232 evaluation board
2. Connect the evaluation board to the computer using the USB cable.



Connecting EK-LM4F232 to Your Computer

3. Make sure that the POWER SELECT jumper is connected at ICDI position. The board will power up and a pre-programmed quick start application will launch.



Power Select Jumper Settings

Familiarizing with Evaluation Kit

1. When the quick start application begins to execute, you will see the following on the screen.



Screen Shots from Quick Start Application

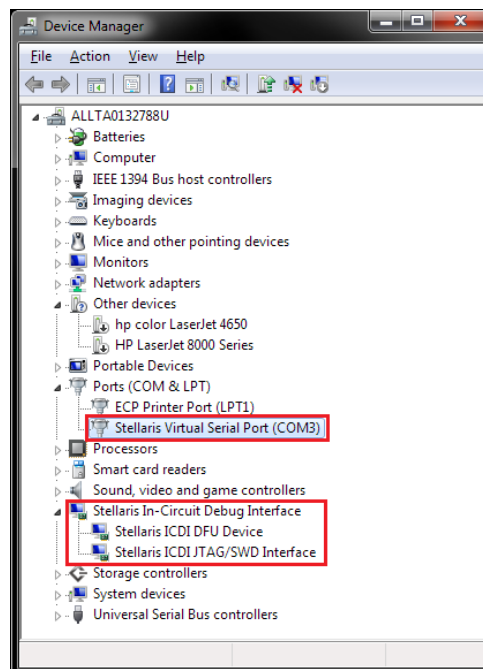
2. Press ▲, ►, ▼, ◀ and SELECT/WAKE buttons to navigate through menus.
3. For more information on EK-LM4F232, please visit www.ti.com/ek-lm4f232.

Setting Up Software & Installing Drivers

1. You should have already downloaded & installed CCS v5.x from the TI website (http://processors.wiki.ti.com/index.php/Download_CCS or www.ti.com/ccs). Please note that installing CCS can take long time depending upon the components selected. It is highly recommended that you install the software before arriving to the workshop. Please see Appendix 1 for step by step instructions on how to install CCS.
2. You should have already downloaded & installed StellarisWare from the TI website It can be downloaded from <http://www.ti.com/tool/sw-ek-lm4f232>. Just run the setup file and extract thefiles to the default path i.e. C:/StellarisWare.
3. Now we will install following drivers on your computer.
 - a. *Stellaris Virtual Serial Port*
 - b. *Stellaris ICDI/SWD Drivers*
 - c. *Stellaris DFU Drivers*

When EK-LM4F232 is connected to the computer for the first time, Windows New Hardware Found wizard will appear. The wizard will prompt you to locate and install the drivers. Upon successful installation, the drivers will be listed in Windows ® Device Manager. Please refer to Appendix 2 and 3 for step by step instruction on how to install drivers.

Before advancing to the next steps, it is important to make sure the that the computer can recognize the evaluation board and that all the required drivers are installed.

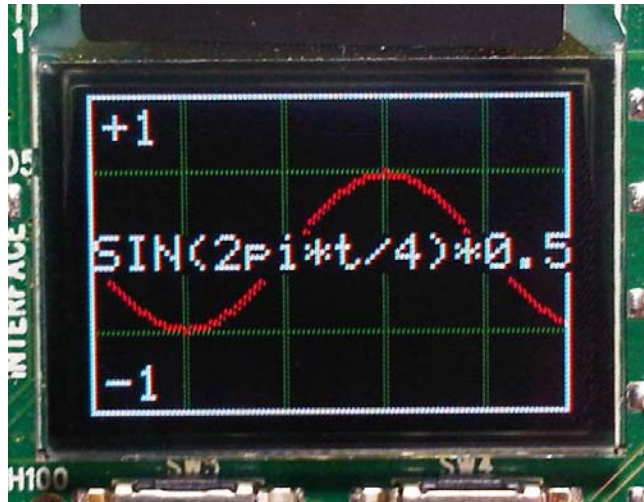


Stellaris Drivers listed in the Device Manager

Getting Started with an FPU Demo Project

In the remainder of section 2, we will take an existing project that uses FPU, build it using CCS and program it to the EK-LM4F232 evaluation board. Subsequently, in Section 3 we will work on exercises where we will modify this project to learn several advanced concepts.

In this lab, you will build, download and debug an existing FPU demo project (sine_demo) from StellarisWare to Stellaris EK-LM4F232 evaluation board. Upon successful completion of this lab, you should see the following waveform on the screen of your evaluation board.



Screen Shot: FPU Demo Project (sine_demo)

Sine_demo computes a sine wave and displays it on the screen.

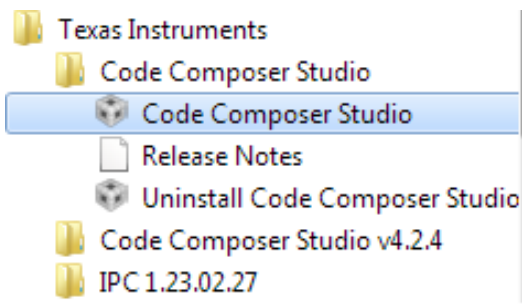
IMPORTANT: Before you move ahead with the lab, you must perform the following steps:

- 1) Assuming that you have installed StellarisWare at its default location on your computer's hard drive, browse to "C:\StellarisWare\boards\ek-lm4f232\sine_demo"
- 2) Rename the **sine_demo.c** file to **sine_demo_default.c**
- 3) Copy **sine_demo.c** provided to you with the lab (should be located in the same directory as this document) to the above directory.
- 4) The comment in the beginning of sine_demo.c must look as follows:

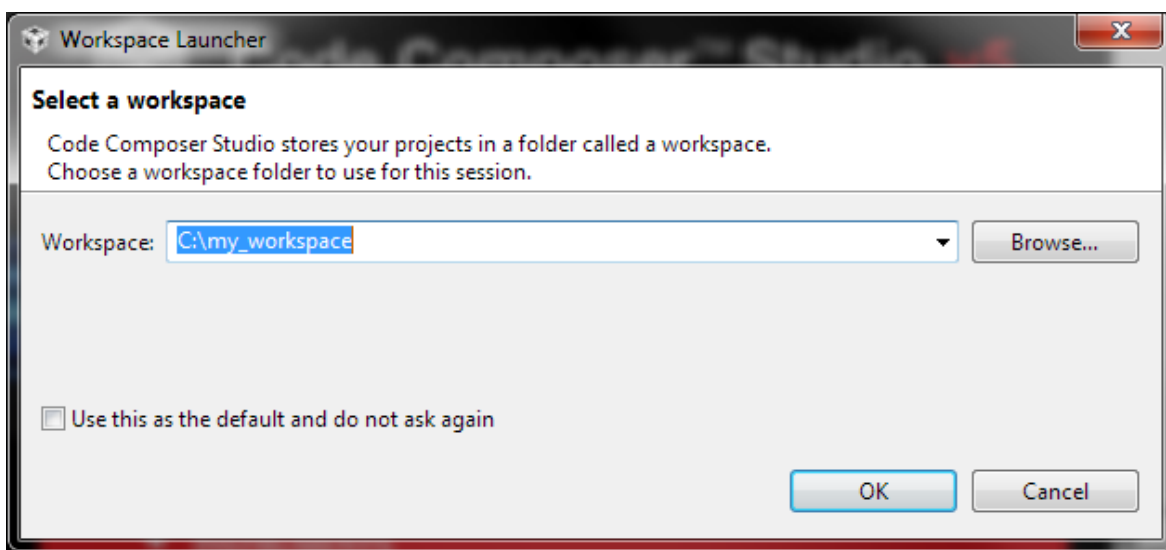
```
//*****  
*  
//  
// sine_demo.c - Stellaris LM4F FPU Lab  
//  
// Copyright (c) 2011 Texas Instruments Incorporated. All rights reserved.  
// Software License Agreement
```

Launching CCS

1. Launch CCSv5.x by going to Start > Texas Instruments > Code Composer Studio > Code Composer Studio



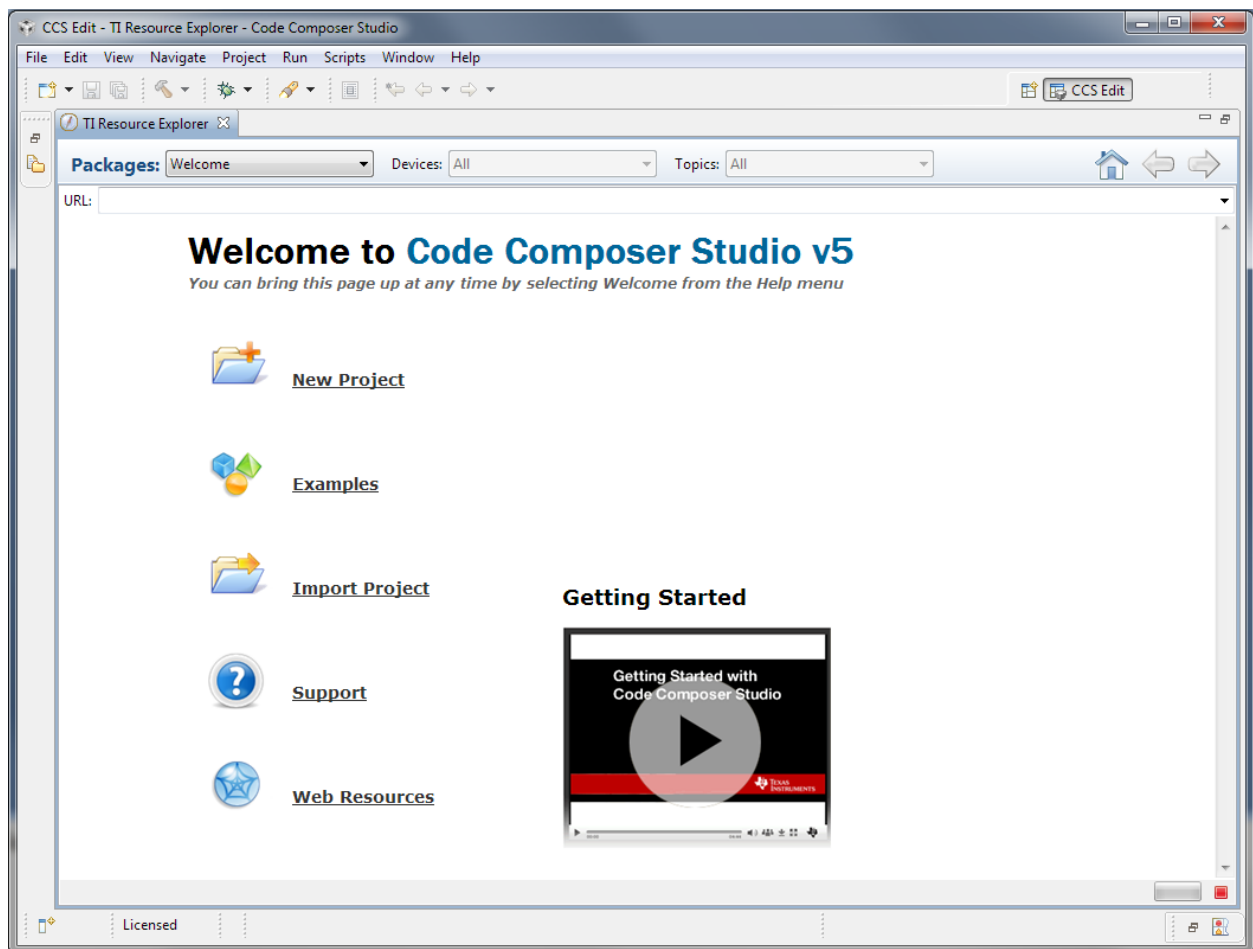
When the “Select a workspace” dialog appears, specify the location for a new workspace. Do not check the “Use this as the default and do not ask again” checkbox. Click on “OK” button.



2. The following screen will appear. CCS takes a while to launch.

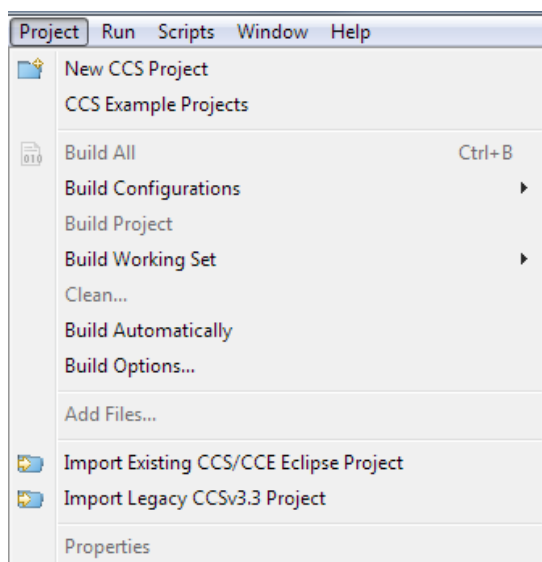


3. When the following screen appears, you can select from various options to start using CCS.

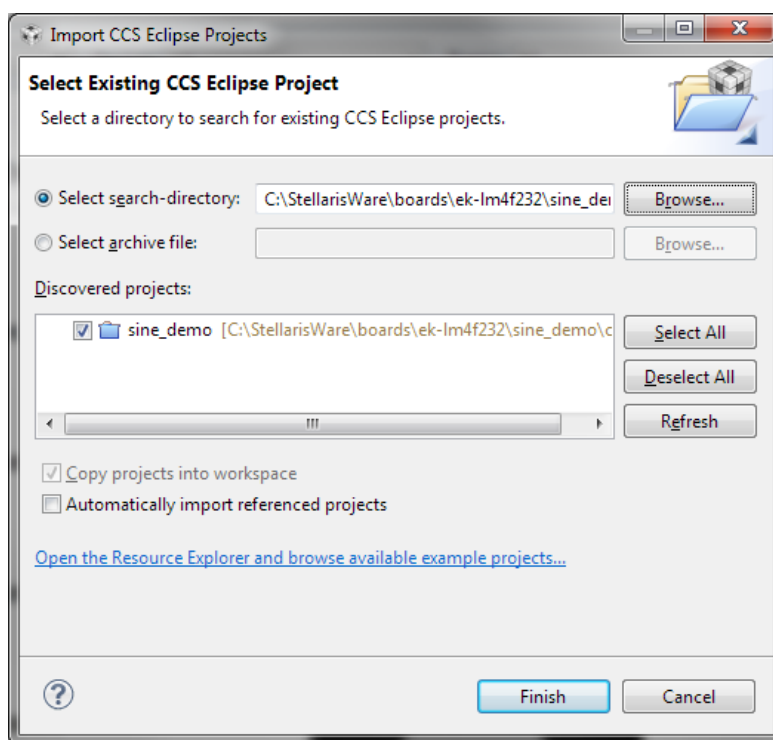


Importing a Project

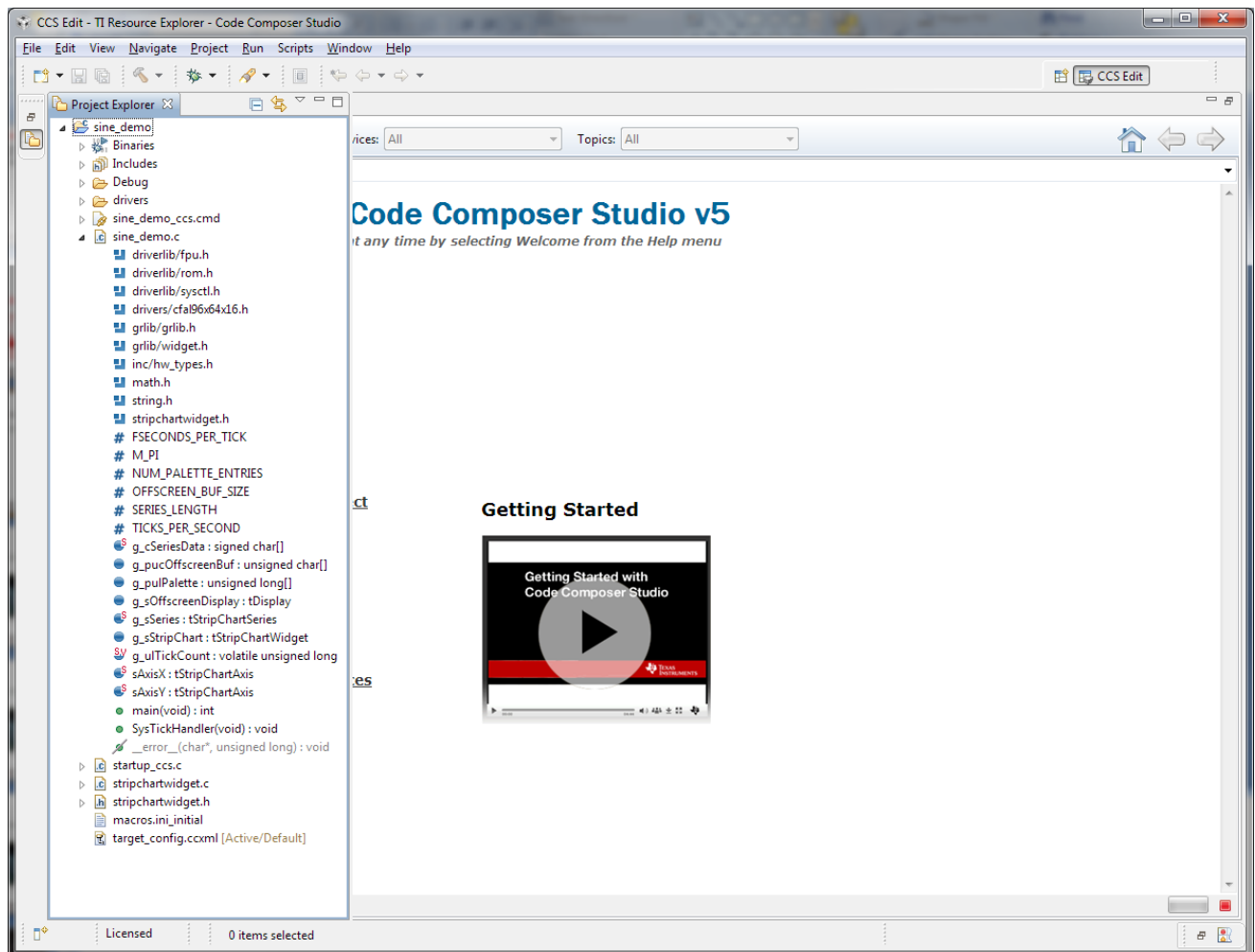
4. Click on the “Import Project” on the welcome screen to launch an existing demo project. Or, click on “Project” menu, and select “Import Existing CCS/CCE Eclipse Project” option” as shown below.



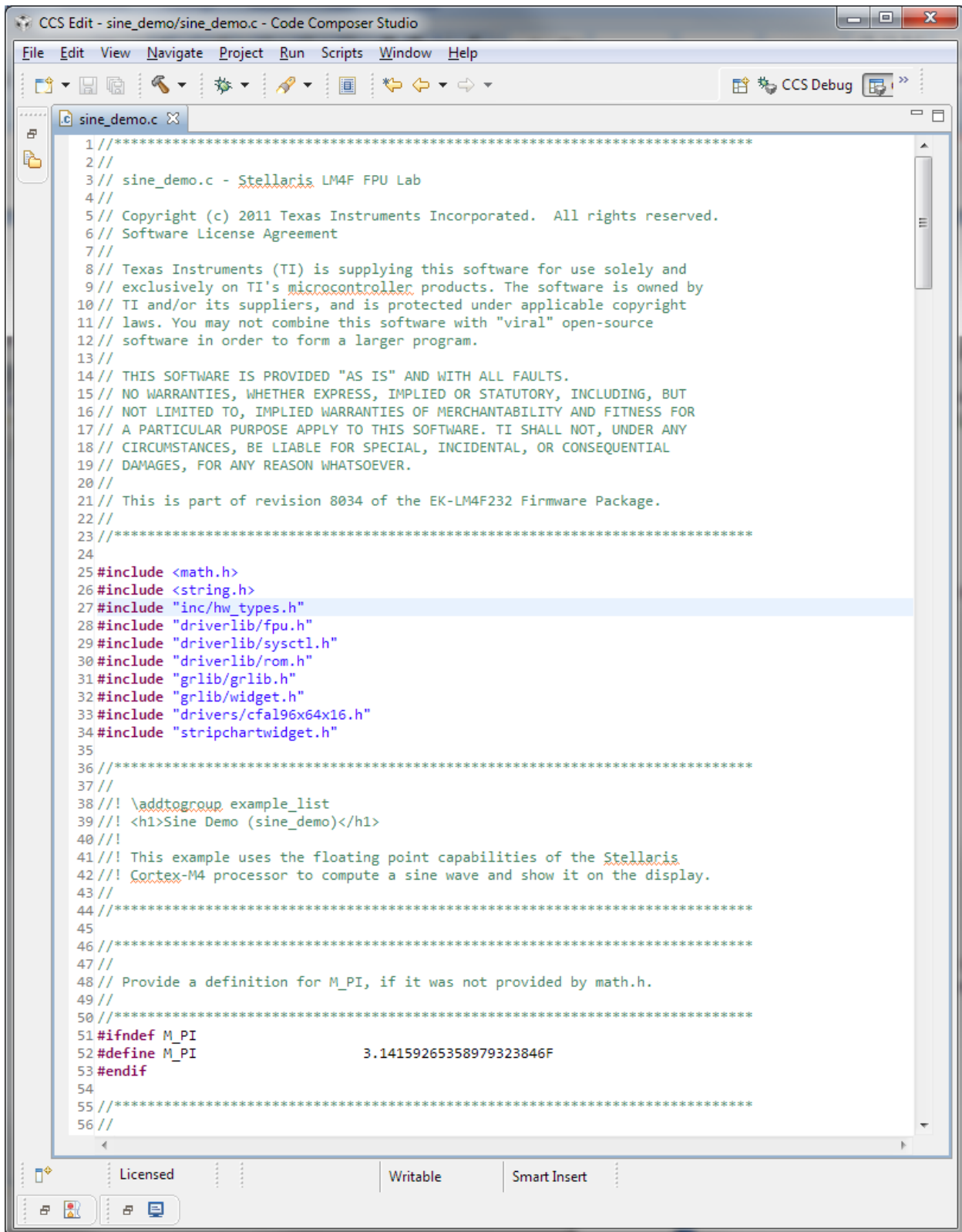
5. The “Import” dialog box appears. Browse to the directory “C:\StellarisWare\boards\ek-lm4f232\sine_demo” where “sine_demo” project is located. Subsequently, click on “Finish.”



6. The project will load in CCS as shown below.



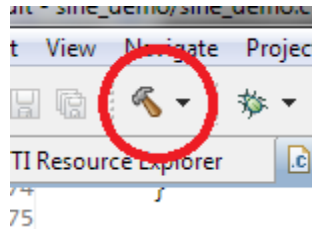
7. Double-click on “sine_demo.c” file to view the source code as shown below:



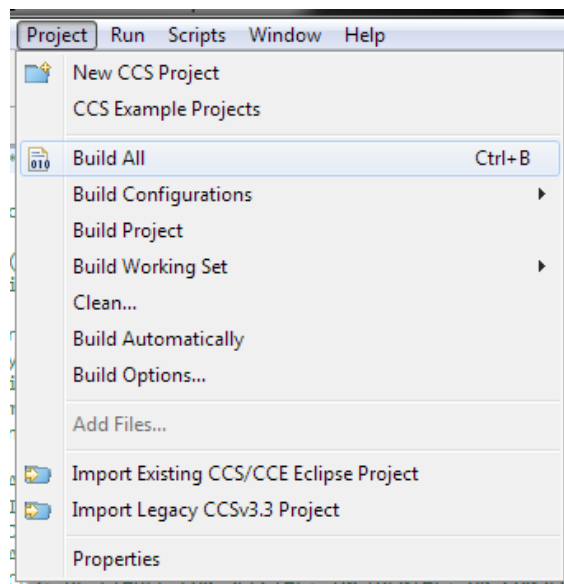
```
1 //*****
2 //
3 // sine_demo.c - Stellaris LM4F FPU Lab
4 //
5 // Copyright (c) 2011 Texas Instruments Incorporated. All rights reserved.
6 // Software License Agreement
7 //
8 // Texas Instruments (TI) is supplying this software for use solely and
9 // exclusively on TI's microcontroller products. The software is owned by
10 // TI and/or its suppliers, and is protected under applicable copyright
11 // laws. You may not combine this software with "viral" open-source
12 // software in order to form a larger program.
13 //
14 // THIS SOFTWARE IS PROVIDED "AS IS" AND WITH ALL FAULTS.
15 // NO WARRANTIES, WHETHER EXPRESS, IMPLIED OR STATUTORY, INCLUDING, BUT
16 // NOT LIMITED TO, IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR
17 // A PARTICULAR PURPOSE APPLY TO THIS SOFTWARE. TI SHALL NOT, UNDER ANY
18 // CIRCUMSTANCES, BE LIABLE FOR SPECIAL, INCIDENTAL, OR CONSEQUENTIAL
19 // DAMAGES, FOR ANY REASON WHATSOEVER.
20 //
21 // This is part of revision 8034 of the EK-LM4F232 Firmware Package.
22 //
23 //*****
24
25 #include <math.h>
26 #include <string.h>
27 #include "inc/hw_types.h"
28 #include "driverlib/fpu.h"
29 #include "driverlib/sysctl.h"
30 #include "driverlib/rom.h"
31 #include "glib/glib.h"
32 #include "glib/widget.h"
33 #include "drivers/cfal96x64x16.h"
34 #include "stripchartwidget.h"
35
36 //*****
37 //
38 /// \addtogroup example_list
39 /// <h1>Sine Demo (sine_demo)</h1>
40 ///
41 /// This example uses the floating point capabilities of the Stellaris
42 /// Cortex-M4 processor to compute a sine wave and show it on the display.
43 //
44 //*****
45
46 //*****
47 //
48 // Provide a definition for M_PI, if it was not provided by math.h.
49 //
50 //*****
51 #ifndef M_PI
52 #define M_PI 3.14159265358979323846F
53 #endif
54
55 //*****
56 //
```

Building a Project

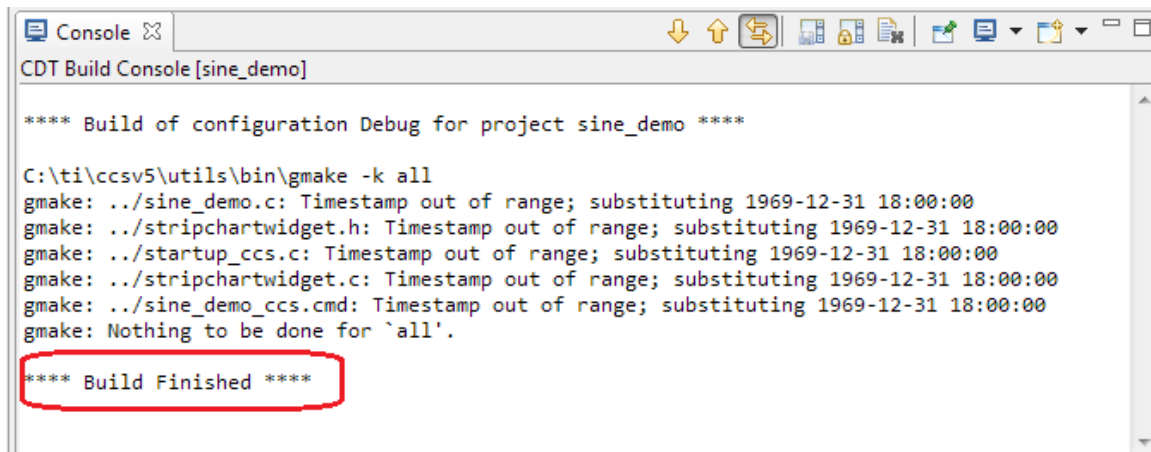
8. All the required libraries & files are already included in the project. Click on the *hammer* icon to build (compile & link) the active project.



Or, you can also build the project by selecting “Build All” from “Project” menu.

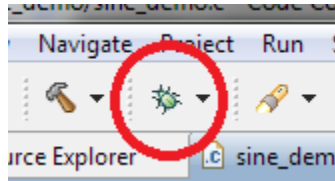


9. The project should build successfully without errors. The “Console” window will display the build results. Should any error/warnings occur, they will be displayed in the “Problems” window.

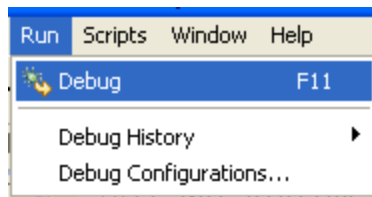


Debugging a Project

10. After the project has been successfully built, we can download the application into the flash of the microcontroller using CCS debugger. Make sure that the Stellaris evaluation board is connected to your computer and all the required drivers are installed on your computer. Click on the *bug* icon to download and debug the active project.

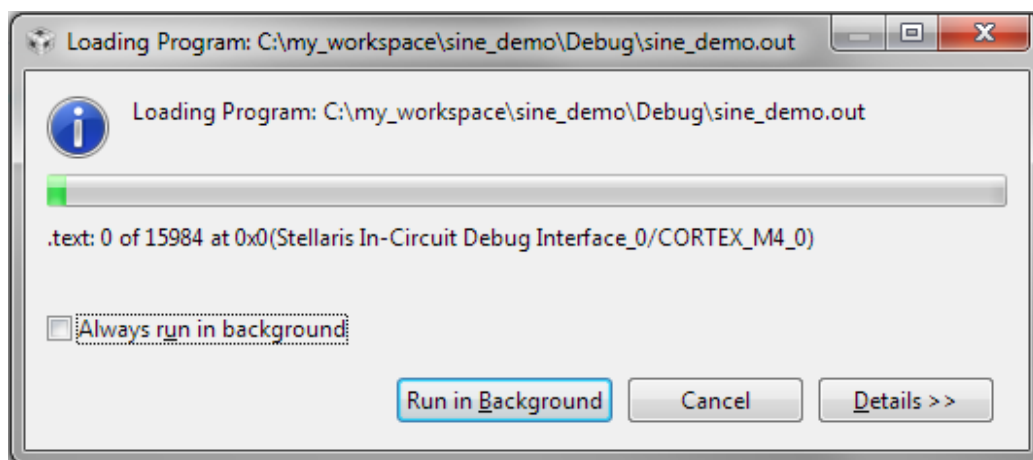


Or, you can also launch the debugger by selecting “Debug” from “Run” menu.

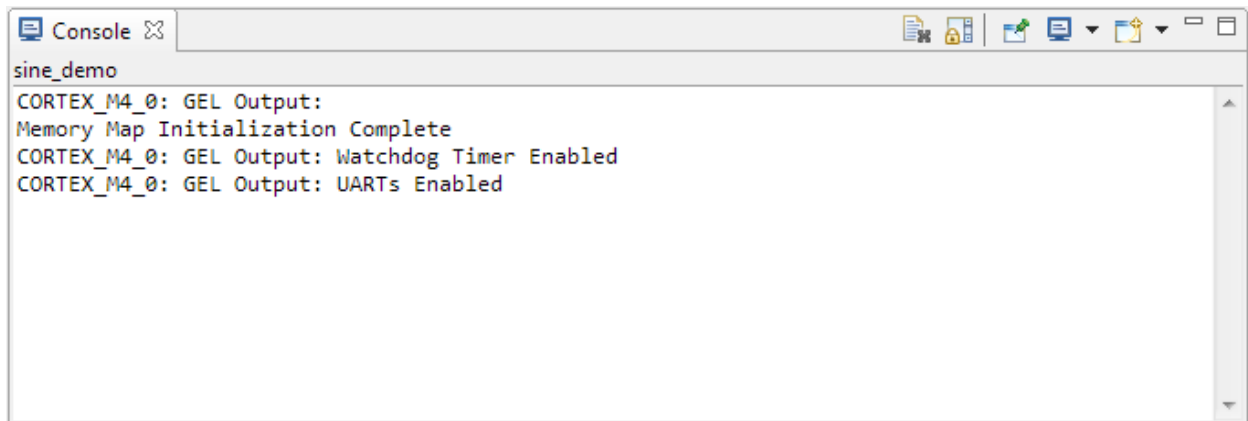


Note: As an alternative to procedure mentioned in the step above, users can also use LM Flash Programmer to program the binary file “sine_demo.bin” located in “C:\StellarisWare\boards\ek-lm4f232\sine_demo\ccs\Debug”

11. Upon clicking the “Bug” icon, the following window will appear indicating that the debugger is launching and is connecting to the board.



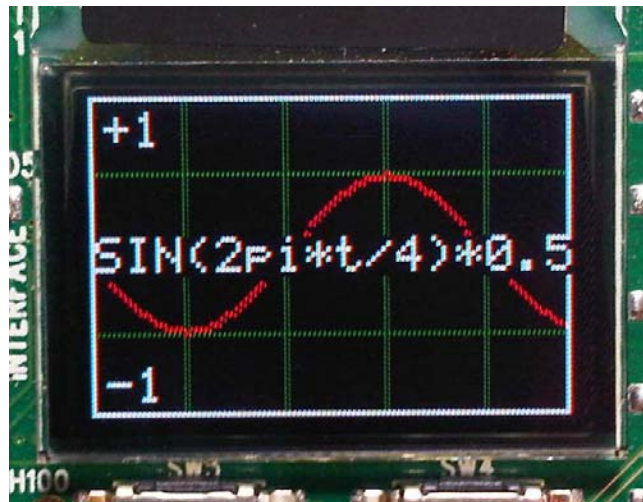
12. When the debugger is launched, the console window will show the following contents indicating that memory map has been initialized and microcontroler's flash has been programmed.



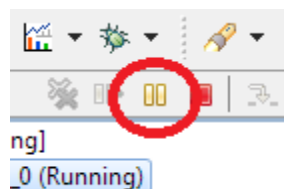
13. Press the “Resume/Run” button to start the code execution.



14. You will see the following on the screen of the Stellaris evaluation board.



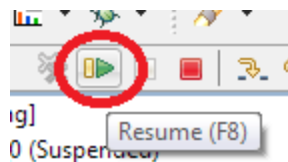
15. Press the “Suspend/ Pause” button to pause the code execution.



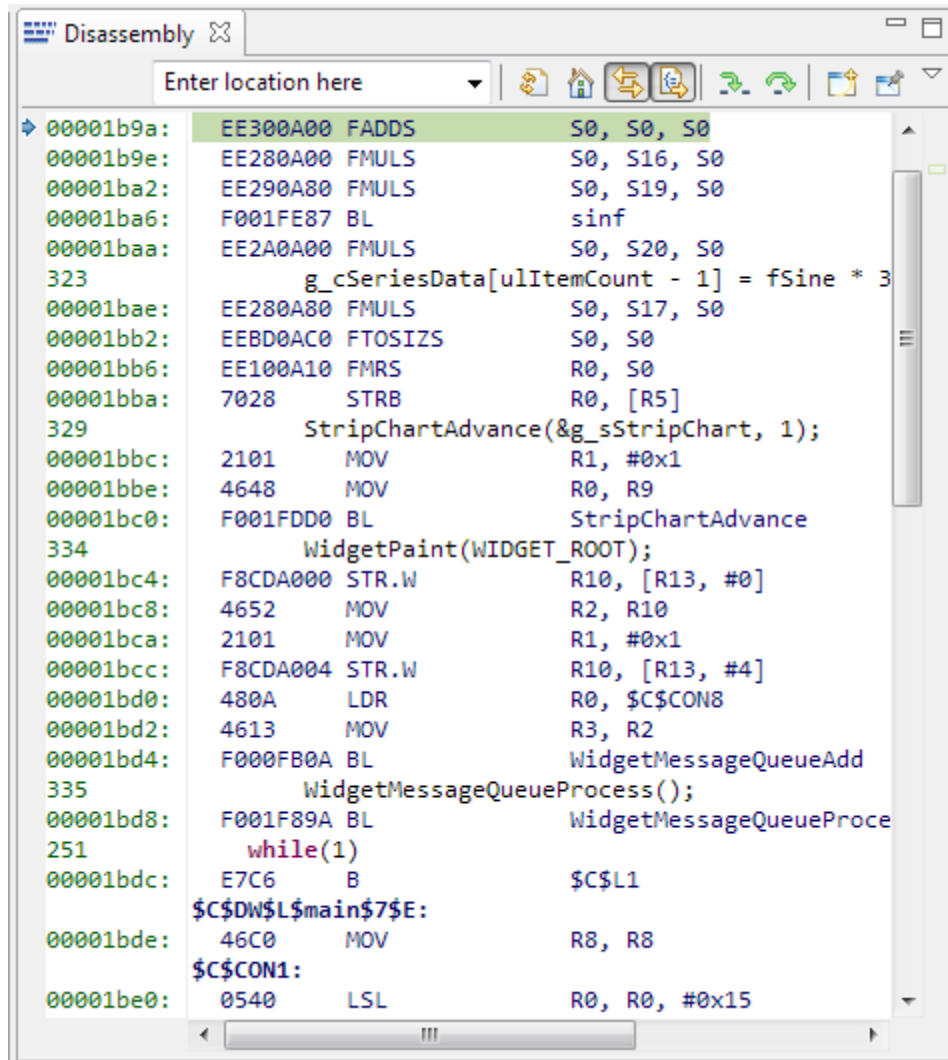
16. In the source code window (sine_demo.c), double click on the blue bar next to line with code `(fSine = sinf(fRadians)*0.5F;)` to create a breakpoint, or you can right click on the line and select Breakpoint (CCS breakpoint) > Breakpoint.


```
sine_demo.c x
314     fRadians /= 4.0F;
315
316     //
317     // Compute the sine. Multiply by 0.5 to reduce the amplitude.
318     // Section 2
319     //
320     fSine = sinf(fRadians) * 0.5F;
321
322     //
323     // Exercise 1 : Increasing the amplitude of sine wave
324     //
325     while(0)
326     {
327         fSine = sinf(fRadians) * 1/ulNumHarmonics;
328         break;
329     }
330
```

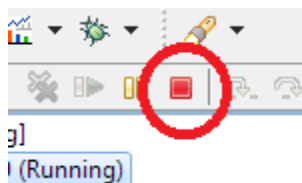
17. Click on the “Resume/Run” button, to resume the code execution.



18. Open the disassembly window and view the assembly generated by the compiler. Note the use of Cortex™ M4 Floating point instructions.



19. Press the “Terminate” button to disconnect from the device, close the debugger and switch back to CCS code development screen.



20. With this you have successfully completed section 2 of Stellaris M4F Training on Floating Point!

Source Code Explanation

The source code for this example utilizes a new StellarisWare widget called a strip chart. The strip chart will display the current value of a waveform on the right hand side and then slide the display to the left as time passes. This is similar to a strip chart as used on many devices such as an EKG or a seismograph.

The standard “math.h” implementation provides the “sinf” function which calculates the new values for the wave based on the tick counter that is being advanced by the SysTick interrupt handler.

16. With this you have successfully completed section 2 of this Stellaris® ARM® Cortex™ M4F Training on Analog Peripherals.

Appendix 1

How to Install Code Composer Studio

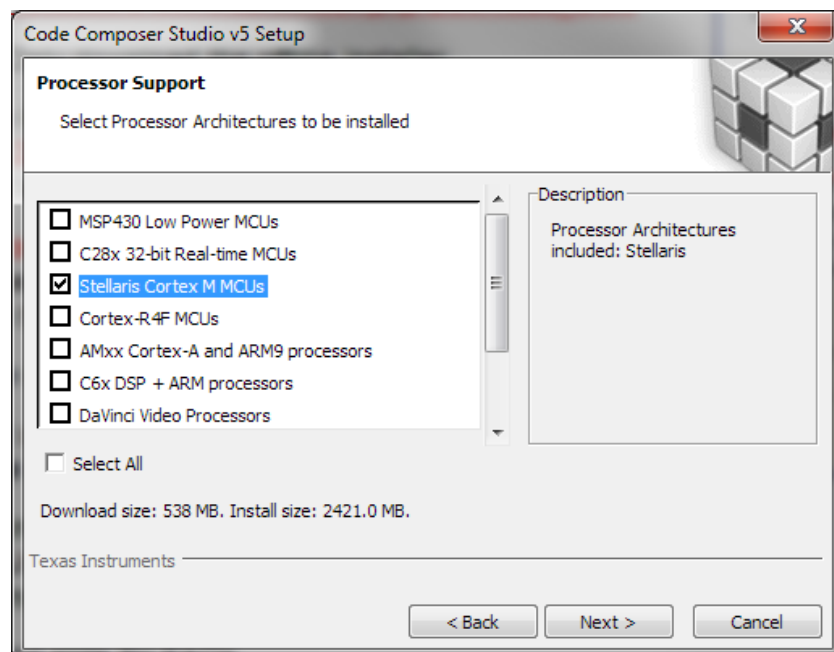
Step by Step Instructions

In order to compile and debug a demo project, you will first need to install TI Code Composer Studio in your computer.

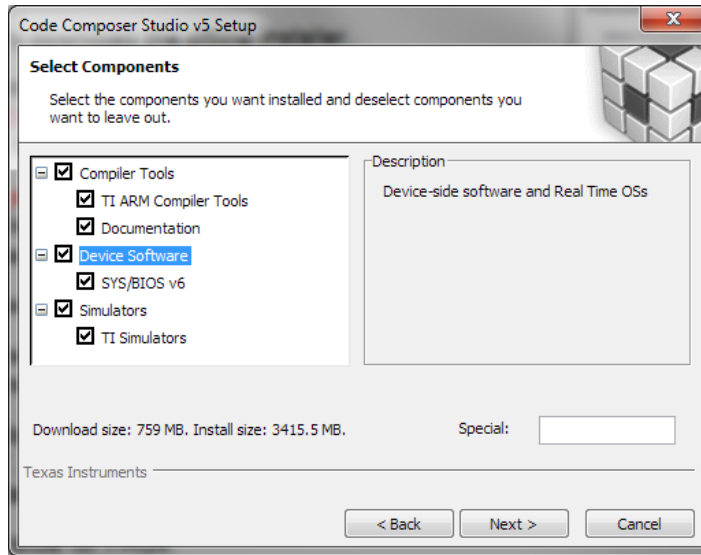
1. Download CCS v5.2.0.00069 (or the latest version) from Download CCS wiki page http://processors.wiki.ti.com/index.php/Download_CCS

Note: Only download the offline installer.

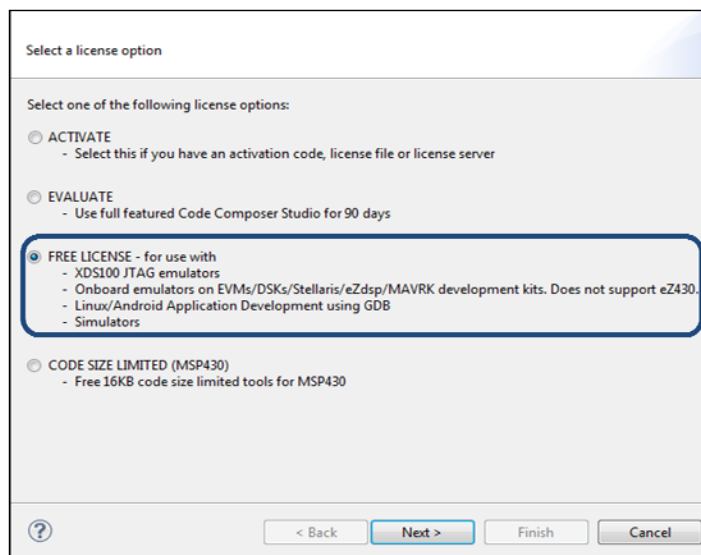
2. Before installing CCS, please unzip the CCS5.2.0.00069_win32.zip file that you've downloaded to any local directory on your computer.
3. Run `ccs_setup_5.2.0.00069.exe` located inside unzipped/extracted CCS5.2.0.00069_win32 directory to launch the CCS installer.
4. Please use the default installation path i.e. C:\ti
5. Do not check the box "Install CCS plugins into an existing Eclipse installation" when it appears.
6. In the installation wizard, you must select "Stellaris Cortex M MCUs". You may select more options if you like. Keep other installation options as default.



7. Make sure to select all the components including SYS/BIOS v6.



8. Upon installation, when the “Select a license option” window appears, if you do not have a license for CCS v5.1, please select the “FREE LICENSE” option.



9. If you are using a TI computer, you will automatically get the full license when you will connect to the TI network. Else if you need a full functionality CCS license, please contact your training coordinator.

FAQs:

Q: Do I still need to install CCS v5.x if I already have CCS v4.2?

A: Yes. CCS v5.x is required for the hands-on exercises, & it can be installed independent of CCSv4.x

Q: What if I already have CCS v5.x installed on my computer?

A: Good! Just make sure it has all the components required for Stellaris microcontrollers. Note that CCS v5.1x does not have Stellaris ICDI drivers, so you will have to download them separately from http://www.ti.com/tool/stellaris_icdi_drivers.

Q: Do I need to purchase a license to use CCS v5.x during the workshop?

A: Not if you are using CCS v5.x for EK-LM4F232 board.

Appendix 2

How to Install Drivers for EK-LM4F232

Step by Step Instructions for Windows XP

In order to debug and download the custom application in the microcontroller's Flash memory and use Virtual COM Port connectivity, you must first install the following drivers on the host computer:

- Stellaris Virtual Serial Port
- Stellaris ICDI JTAG/SWD
- Stellaris ICDI DFU

These drivers are available for download at http://www.ti.com/tool/stellaris_icdi_drivers

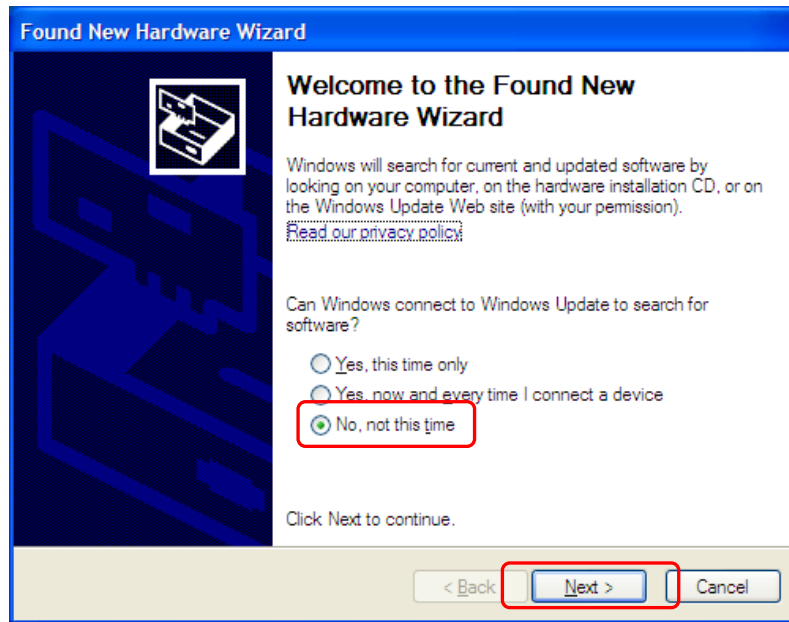
Note: This document describes the procedure to install drivers on the Windows XP operating system. There might be some variation for installing the drivers on other Windows operating systems, although the procedure should be similar.

To see which drivers are installed on the host computer, check the hardware properties using the Windows Device Manager. Do the following:

1. Right-click My Computer from the Windows Start button and select Properties from the drop-down menu.
2. In the System Properties window, click the Hardware tab.
3. Click the Device Manager button. The Device Manager window displays a list of hardware devices installed on your computer and allows you to set the properties for each device.

When the board is connected to the computer for the first time, the computer detects the onboard ICDI interface and the Stellaris® LM4F232 microcontroller. Drivers that are not yet installed display a yellow exclamation mark in the Device Manager window.

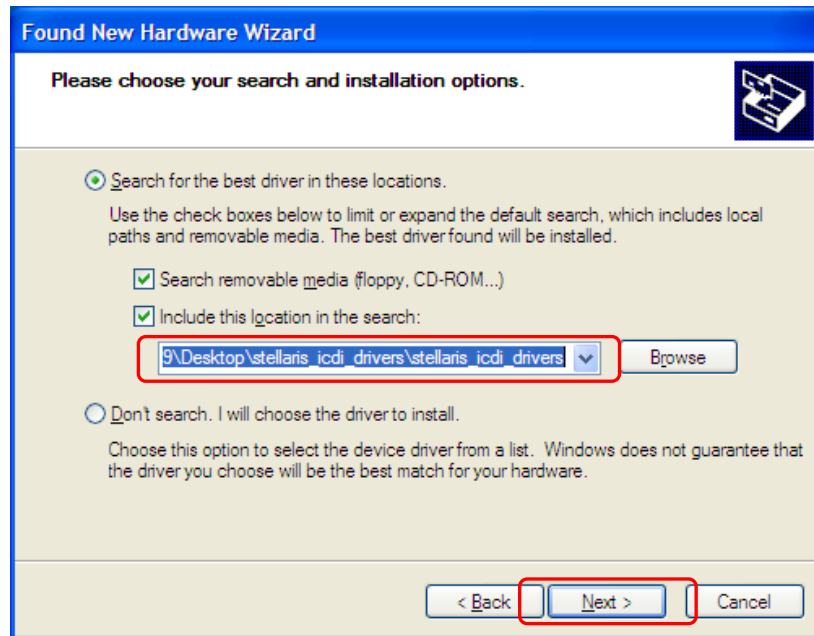
When you plug in the evaluation board for the first time, Windows starts the Found New Hardware Wizard as shown below. Select “No, not this time” and click on “Next” button to continue.



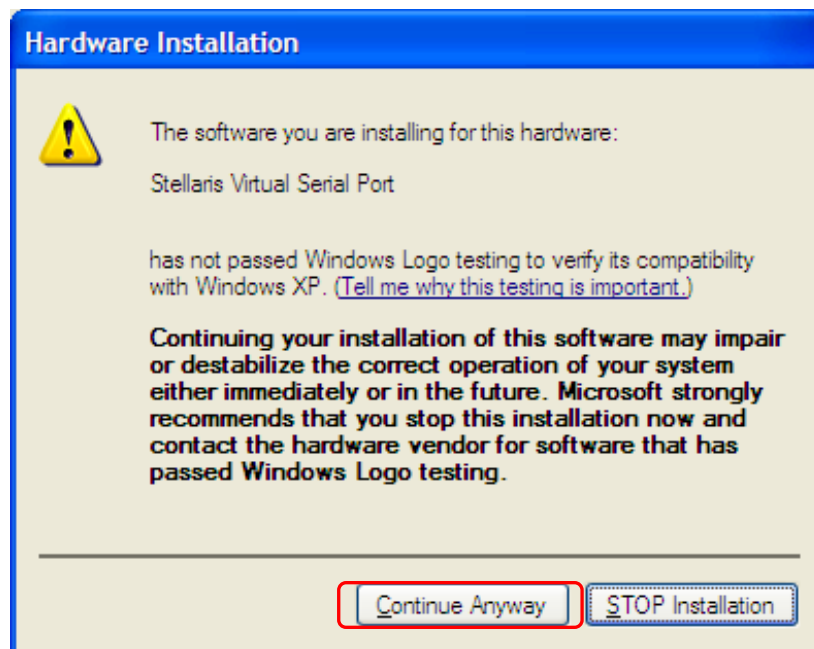
On the next screen, wizard will ask if you want to install the drivers for the Stellaris Virtual Serial Port. Select “Install from a list or specific location (Advanced)” and then click Next.



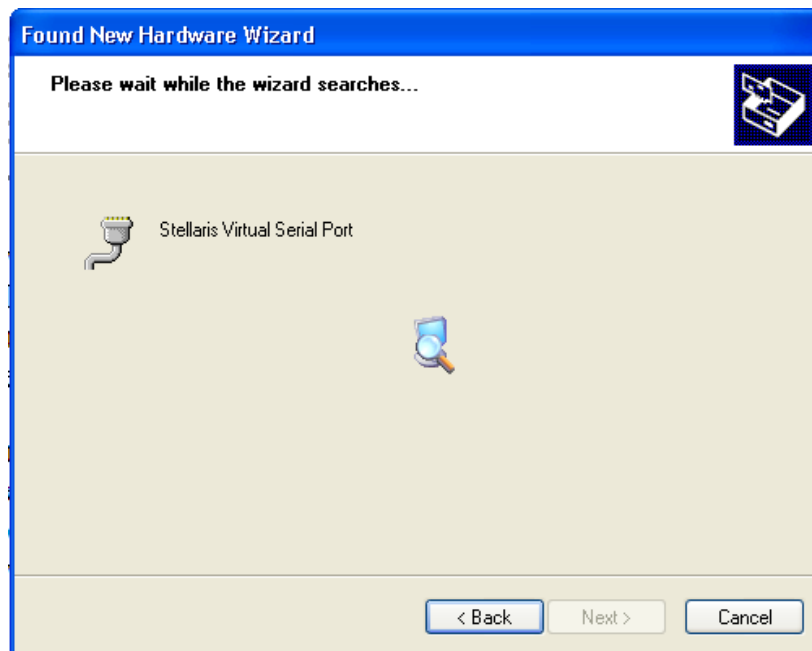
Make sure the “Documentation and Software” CD that came with the evaluation kit is in your CD-ROM drive. Or that you have extracted the drivers to a known location your computer’s hard drive. Select “Search for the best driver in these locations,” and check the “Search removable media (floppy, CD-ROM...)” option. Click Next.



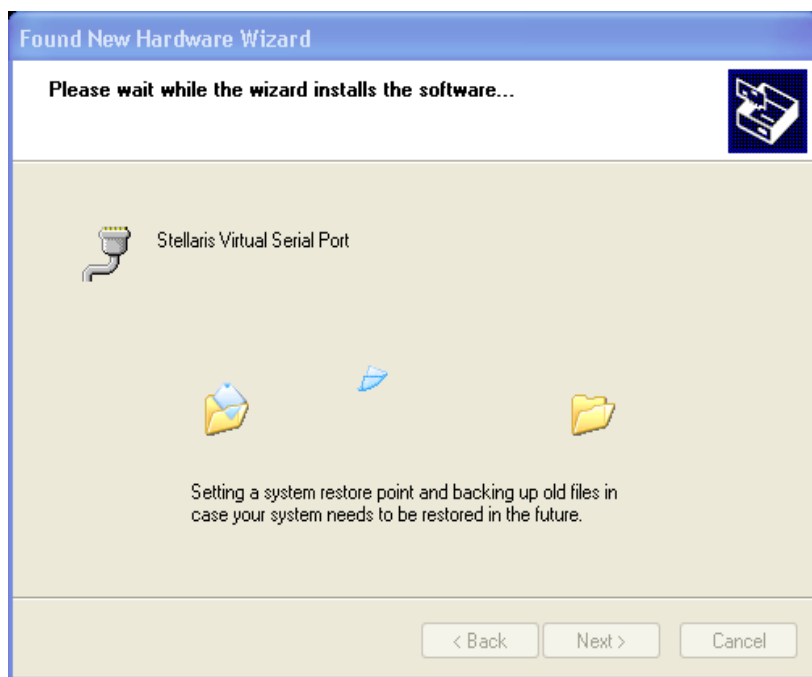
A warning may pop up during the installation process regarding the driver not being signed, click “Continue Anyway” to proceed.



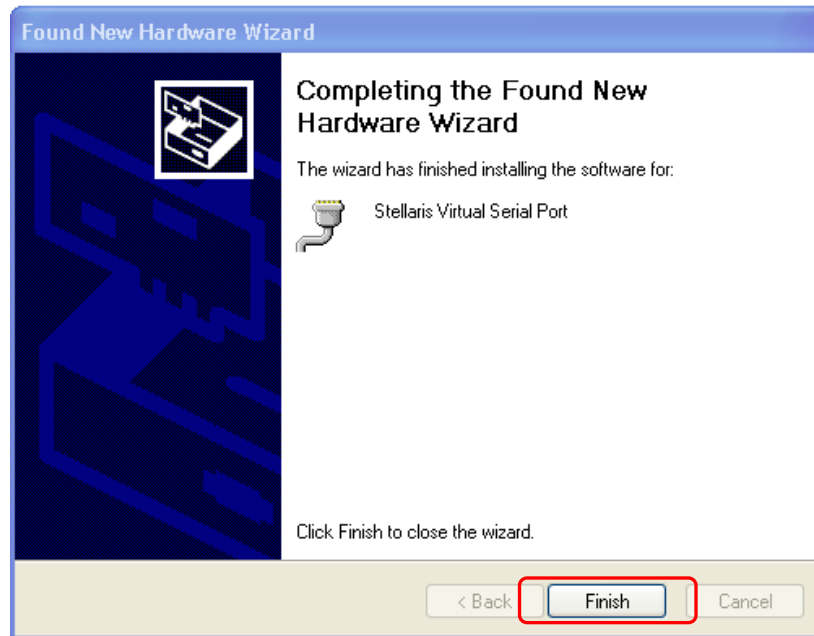
The wizard displays a “Please wait while the wizard searches...” status window. No user action is required.



The wizard then displays a “Please wait while the wizard installs the software...” status window as the software is installed.



After the installation of the Stellaris Virtual Serial Port drivers, click Finish to close the dialog box.



You have just installed the drivers for the Stellaris Virtual Serial Port.

The Found New Hardware Wizard appears again for the Stellaris ICDI JTAG/SWD Interface and then one more time for the Stellaris ICDI DFU Device drivers. Follow the same instructions to install the drivers for these two devices.

You can confirm the three device driver installations by launching the Windows Device Manager and right-clicking to select "Scan for Hardware Changes." This updates the Device Manager properties list. The Stellaris Virtual Serial Port, Stellaris ICDI JTAG/SWD Interface, and Stellaris ICDI DFU Device now appear in the list. This indicates that the drivers have been successfully installed.

These drivers provide the debugger with access to the JTAG/SWD interface, and the host PC access to the Virtual COM Port. With these drivers installed, Windows automatically detects any new Stellaris boards (with a Stellaris-based ICDI) that you connect to your computer, and installs the required drivers for you.

Appendix 3

How to Install Drivers for EK-LM4F232

Step by Step Instructions for Windows 7

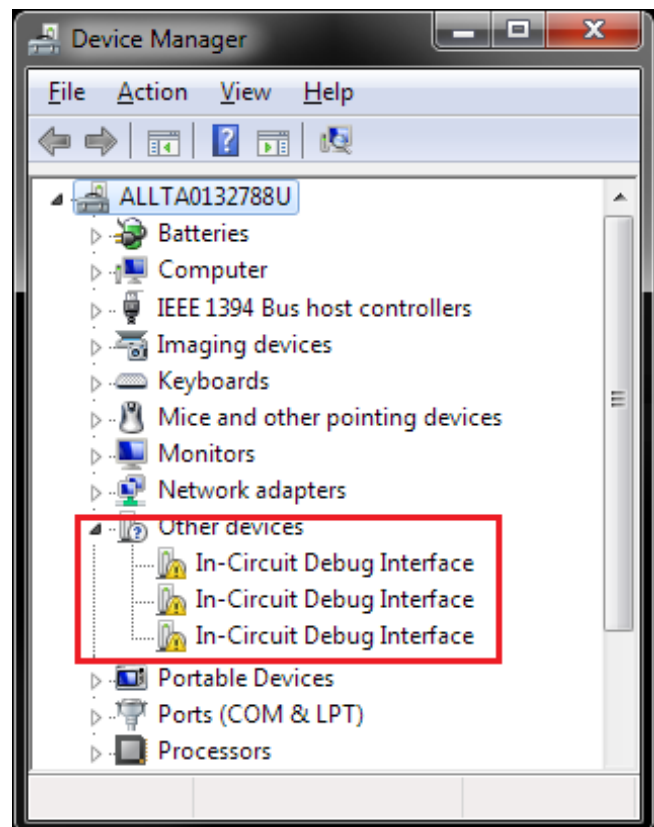
In order to debug and download the custom application in the microcontroller's Flash memory and use Virtual COM Port connectivity using Stellaris based In-Circuit Debugging Interface (ICDI), you must first install the following drivers on the host computer:

- Stellaris Virtual Serial Port
- Stellaris ICDI JTAG/SWD
- Stellaris ICDI DFU

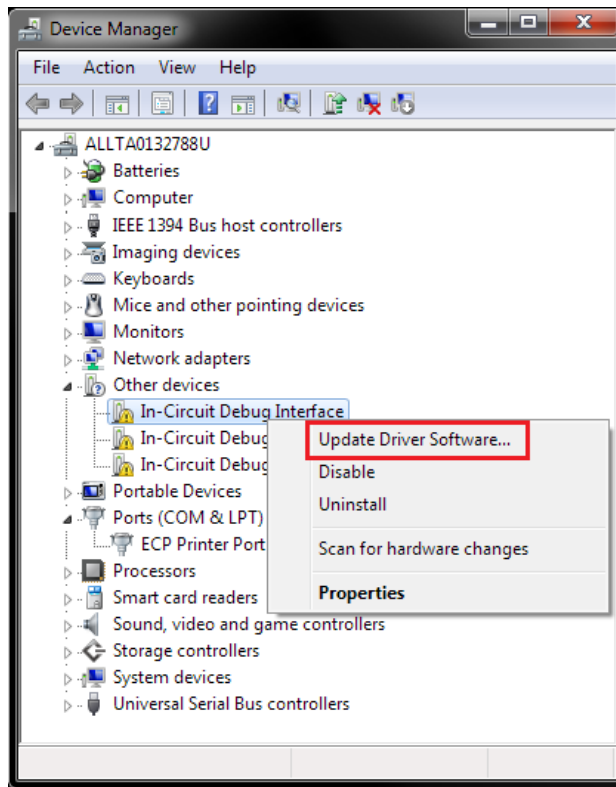
These drivers are available for download at http://www.ti.com/tool/stellaris_icdi_drivers. Download and extract the drivers to a known location on your computer before proceeding to the step by step instructions listed below.

Please note that this document describes the procedure to install drivers on the Windows 7 operating system. There might be some variation in the steps for installing the drivers on other Windows operating systems, although the overall procedure should be similar.

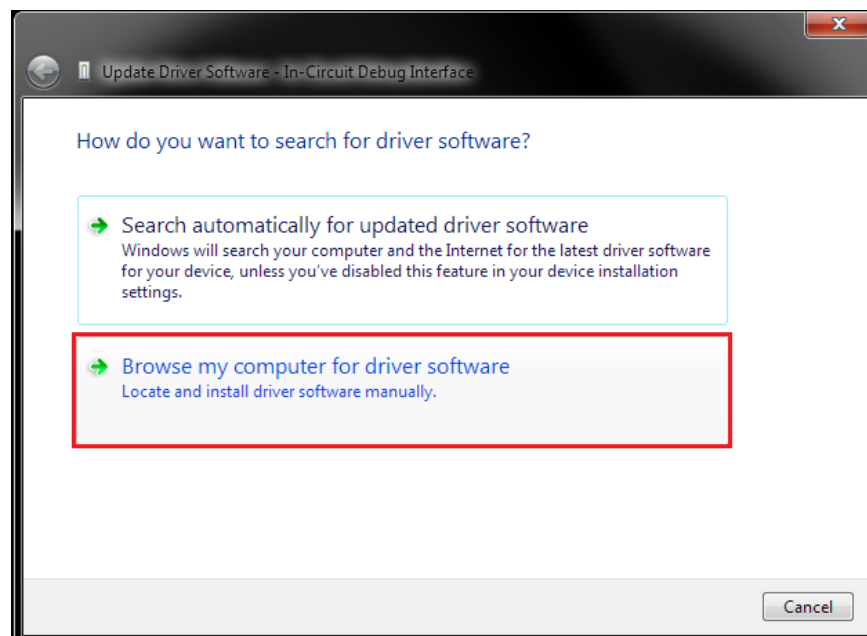
1. Right-click on My Computer from the Windows Start button and select Properties from the drop-down menu.
2. In the Control Panel column on the left of the screen, click the Device Manager button. The Device Manager window displays a list of hardware devices installed on your computer and allows you to set the properties for each device.
3. When the EK-LM4F232 board is connected to the computer for the first time, the computer detects the onboard ICDI interface and the Stellaris® LM4F232 microcontroller. Drivers that are not yet installed display a yellow exclamation mark in the Device Manager window. This is shown in the screen shot below.



To install the drivers, right click on the first “In-Circuit Debug Interface” in “Other Devices” section. Select “Update Driver Software” option.



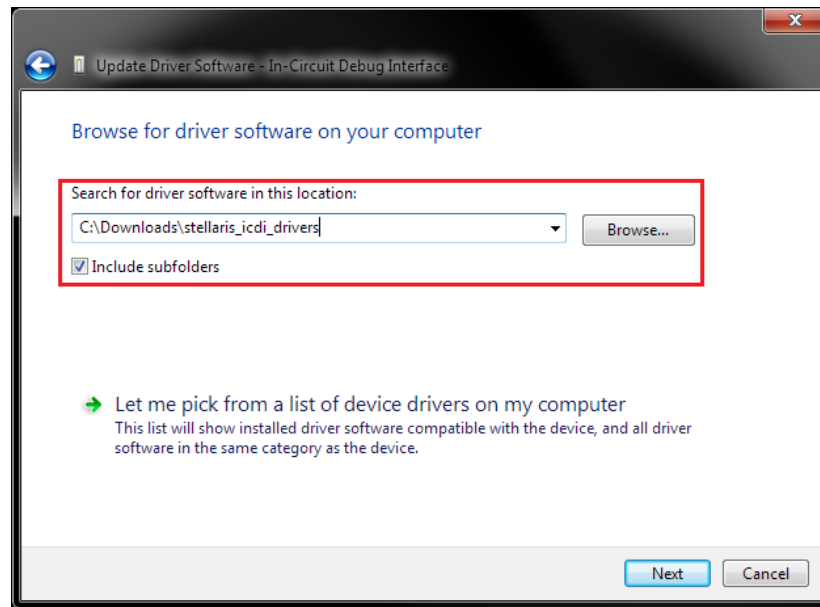
4. In the pop-up that appears next, select “Browse my computer for driver software” to point Windows to the location where drivers are located on your computer.



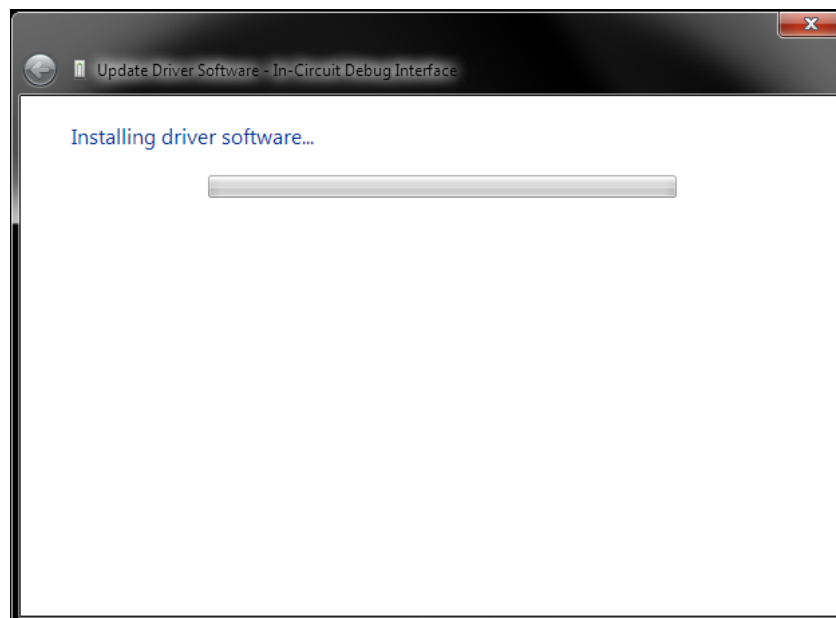
5. Click on “Browse” button, and browse to the location where the drivers are located on your computer.

If you are installing the drivers from the “Documentation and Software” CD/ DVD that came with the evaluation kit, make sure the disk is in your optical drive. Or that you have extracted the drivers to a known location your computer’s hard drive.

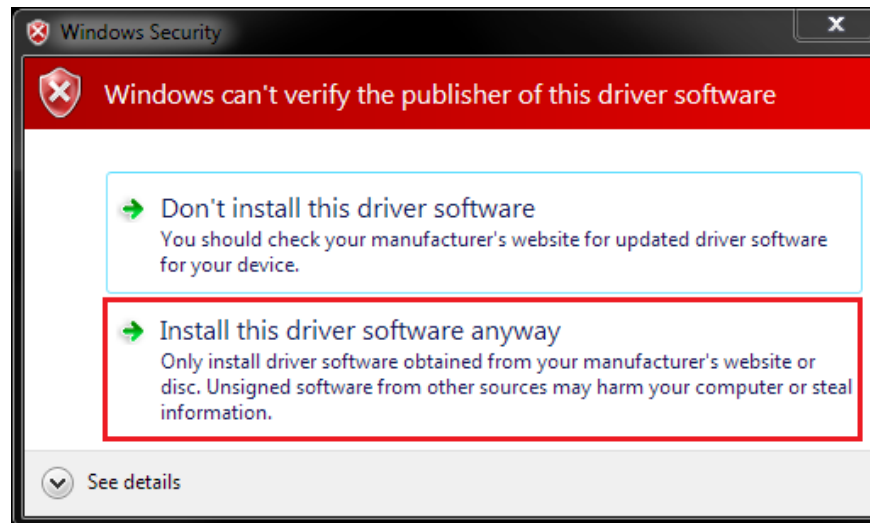
Click Next to begin the driver installation process.



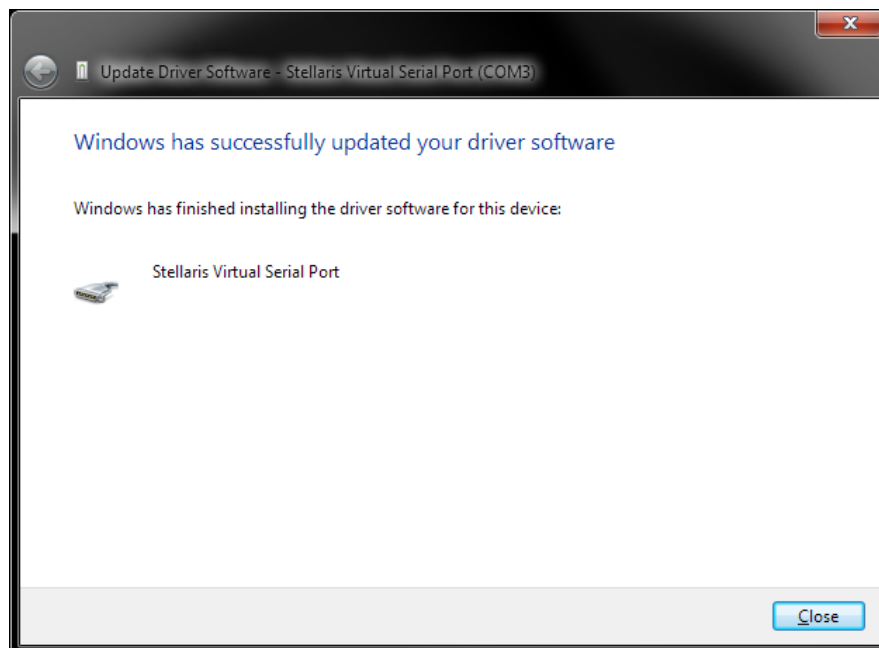
While Windows is installing the drivers, you will see the following on the screen.



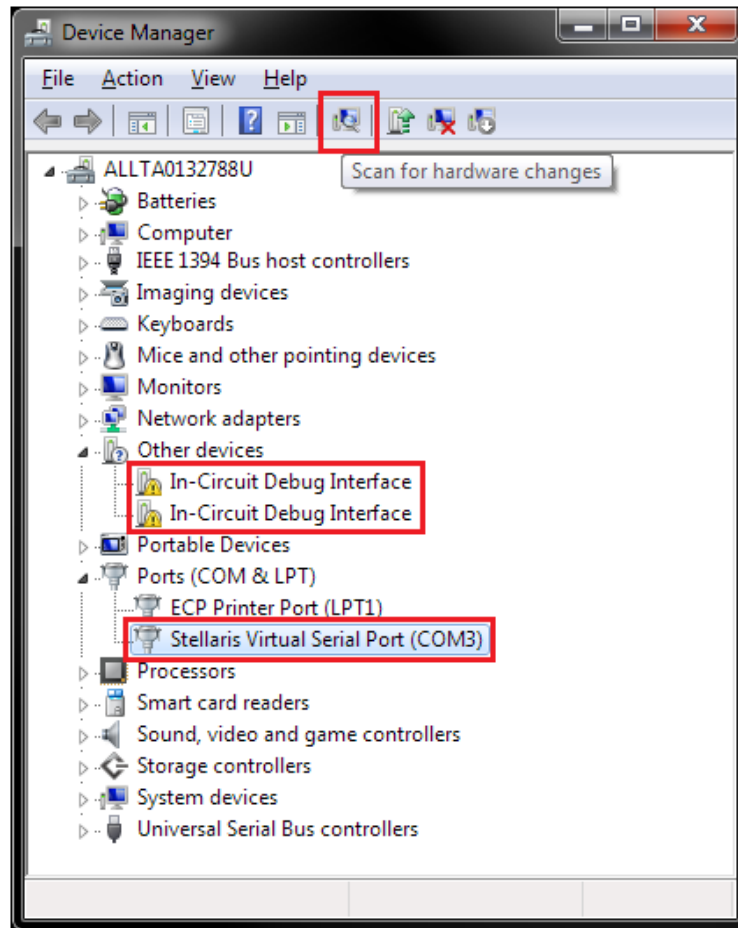
6. The “Windows Security” pop-up may appear, please select “Install this driver software anyway”



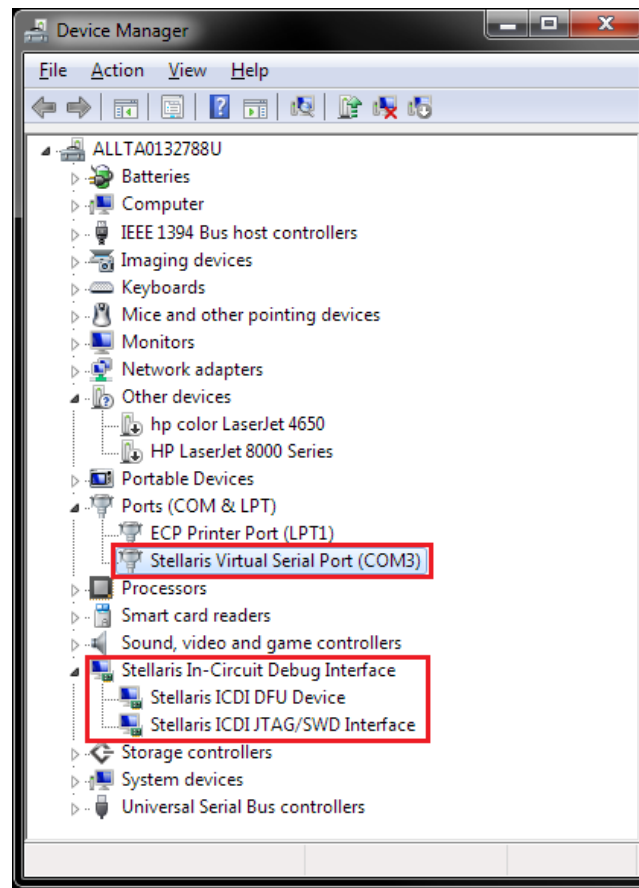
7. After drivers have been installed, you will see the following.



8. Go to Windows Device Manager, and click on “Scan for hardware changes” button. This updates the Device Manager properties list. You will see “Stellaris Virtual Serial Port” appear under “Ports (COM & LPT).” This confirms that Stellaris Virtual Serial Port driver has been successfully installed.



9. Repeat steps 4 through 8 to install (i) Stellaris ICDI DFU Device drivers and (ii) Stellaris ICDI/JTAG/SWD Interface. Upon successful installation of all the three drivers, the Device Manager window should list the following items shown in the red box.



10. These drivers provide the debugger with access to the JTAG/SWD interface, and the host PC access to the Virtual COM Port. With these drivers installed, Windows automatically detects any new Stellaris boards (with a Stellaris-based ICDI) that you connect to your computer, and installs the required drivers for you.