

Getting Started with the NI LabVIEW™ Embedded Module for ARM Microcontrollers

The LabVIEW Embedded Module for ARM Microcontrollers is a comprehensive graphical development environment for embedded design. This module seamlessly integrates the LabVIEW graphical development environment and ARM microcontrollers. You can lower development costs and achieve faster development times by using the Embedded Module for ARM Microcontrollers to program ARM targets.

This module builds on NI LabVIEW Embedded technology, which facilitates dataflow graphical programming for embedded systems and includes hundreds of analysis and signal processing functions, integrated I/O, and an interactive debugging interface. With the Embedded Module for ARM Microcontrollers, you can view live front panel updates using JTAG, serial, or TCP/IP. The Embedded Module for ARM Microcontrollers generates C code from the LabVIEW block diagram, builds that code into an application using Keil µVision, and runs the application on ARM targets.

This manual includes system requirements, installation instructions, new features, and a step-by-step tutorial that shows you how to build, run, and debug an ARM application.

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System Requirements

The Embedded Module for ARM Microcontrollers has the following system requirements:

- One of the following operating systems:
 - Windows 7 (32-bit)
 - Windows Vista (32-bit)
 - Windows XP (32-bit)

- Windows Server 2003 R2 (32-bit)



Note The Embedded Module for ARM Microcontrollers does not support Windows NT/Me/98/95/2000, Windows Server non-R2 editions, or the Windows Server 2008 R2 edition.

- RealView Microcontroller Development Kit, including Keil μ Vision4
- LabVIEW 2010 Full or Professional Development System
- Keil ULINK2 USB-JTAG adaptor

Refer to the *LabVIEW Release Notes*, available by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals** and opening `LV_Release_Notes.pdf`, for information about LabVIEW development system requirements.

Installing the Embedded Module for ARM Microcontrollers

Complete the following steps to install the Embedded Module for ARM Microcontrollers.



Note The Embedded Module for ARM Microcontrollers installer automatically installs LabVIEW if it is not already installed. The Embedded Module for ARM Microcontrollers also automatically installs the RealView Microcontroller Development Kit, which includes Keil μ Vision.

1. Log in as an administrator or as a user with administrator privileges.
2. Insert the NI LabVIEW Embedded Module for ARM Microcontrollers DVD. If the installer does not automatically begin, double-click `autorun.exe` on the DVD to begin installation.
3. Select **Install LabVIEW Embedded Module for ARM Microcontrollers**.
4. Follow the instructions on the screen for installing the Embedded Module for ARM Microcontrollers.



Note During installation, the installer automatically launches the RealView Microcontroller Development Kit installer.

5. Follow the activation instructions for the Embedded Module for ARM Microcontrollers that appear on the screen. Skip this step if you are evaluating the Embedded Module for ARM Microcontrollers. Refer to the [Evaluating the Embedded Module for ARM Microcontrollers](#) section for more information about running in evaluation mode.



Tip You also can use the NI License Manager, available by selecting **Start»All Programs»National Instruments»NI License Manager**, to activate National Instruments products. Refer to the *National Instruments License Manager Help*, available by selecting **Help»Contents** in the NI License Manager, for more information about activating NI products.

6. Restart the computer when the installer prompts you and log in as an administrator or as a user with administrator privileges.
7. Activate the Keil μ Vision License ID Code (LIC). Complete the following steps to activate the LIC. Skip this step if you are evaluating the Embedded Module for ARM Microcontrollers. Refer to the [Evaluating the Embedded Module for ARM Microcontrollers](#) section for more information about running in evaluation mode.
 - a. Launch Keil μ Vision by selecting **Start»All Programs»Keil uVision**.
 - b. Select **File»License Management** to display the **License Management** dialog box.
 - c. Click the **Help** button to open the ARM Development Tools help file.

- d. Follow the instructions for obtaining a single-user license. You need an internet connection and a product serial number (PSN) to activate the license. The PSN is an alphanumeric value located on the Certificate of Ownership or license card included with purchased products.
- e. After you add the LIC to the **License Management** dialog box, click the **Close** button to close the dialog box.
- f. Exit Keil μ Vision.

Refer to the Keil Web site at www.keil.com/license for more information about activating Keil μ Vision.

Evaluating the Embedded Module for ARM Microcontrollers

You can install and evaluate the Embedded Module for ARM Microcontrollers for 60 days. When you run the Embedded Module for ARM Microcontrollers in evaluation mode, LabVIEW includes the following limitations:



Note If you are evaluating the Embedded Module for ARM Microcontrollers with an already licensed and activated LabVIEW development system, these limitations apply only to ARM targets, VIs, and applications.

- **A 60-day time limit until the evaluation version expires**—While not activated, LabVIEW prompts you to activate the product each time you launch LabVIEW. You also receive a warning when you build a VI into an application until you activate the Keil μ Vision License ID Code (LIC). After the evaluation period for LabVIEW expires, you are no longer able to launch LabVIEW until you purchase and activate the Embedded Module for ARM Microcontrollers.
- **A KB size limit**—Any applications you create and build with LabVIEW and Keil μ Vision are limited to 128 KB.
- **An evaluation version watermark during the 60-day time limit**—All user VIs and controls contain an evaluation watermark.

Installing the MCB2300 Evaluation Board

You need the following items to use the MCB2300 evaluation board with JTAG emulation:

- MCB2300 board
- A PC with two unused USB ports: one port to supply power to the MCB2300 board and the other port to perform ULINK2 USB-JTAG downloading and debugging
- ULINK2 USB-JTAG adaptor
- Two USB serial cables, each no longer than 10 feet

Refer to the hardware documentation for required accessories such as cables and adaptors.



Caution Be careful when removing the board from the package and handling the board to avoid the discharge of static electricity, which might damage some components.

Figure 1 shows the location of some of the parts on the MCB2300 evaluation board. Refer to the hardware documentation for more information about the evaluation board.

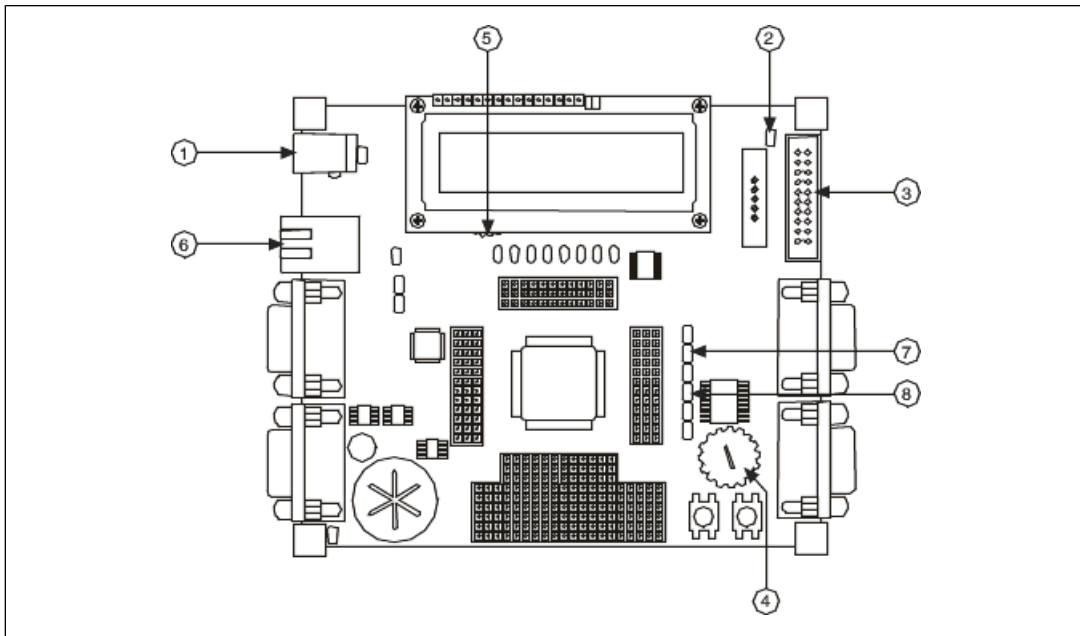


Figure 1. Locating Parts for the MCB2300 Installation

1 USB Connector	4 Potentiometer (Analog Input AD0)	7 ISP Jumper
2 Power LED	5 Contrast Control for LCD	8 RST Jumper
3 JTAG Connector	6 Ethernet Connector	

Complete the following steps to install the board. You do not have to open the computer case to install the board.

1. Verify that you have Keil μ Vision installed. μ Vision is a part of the RealView Microcontroller Development Kit. You can look for the `Keil\uvx` directory on the hard disk, where x is the μ Vision version, or select **Start>All Programs** and locate the shortcut to Keil μ Vision. Do not launch μ Vision from the shortcut if you are going to use LabVIEW. Refer to the [Installing the Embedded Module for ARM Microcontrollers](#) section for information about installing the RealView Microcontroller Development Kit.
2. Connect the ULINK2 USB-JTAG adaptor to a USB port on the host computer. If you are connecting the ULINK2 USB-JTAG adaptor to the computer for the first time, the connection activates the Windows Found New Hardware icon on Windows. A Windows message notifies you when the new device is ready for use and the hardware installation is complete.
3. Connect the ULINK2 USB-JTAG adaptor to the JTAG connector on the board.
4. Connect the USB connector on the board to a USB port on the host computer. This USB connection provides power to the board. The power LED illuminates on the board.



Note The board remembers the last program that ran because you must program the flash memory on the board to run an application. Therefore, the board begins running

the last application as soon as the board receives power. You must download a new application to change the start-up behavior of the board.

5. Verify that the RST and ISP jumpers are off if you plan to use the COM0 port. Refer to Figure 1 to locate the RST and ISP jumpers. Refer to the jumper settings configuration topic in the *MCB2300 User's Guide*, available by navigating to `Keil\ARM\Hlp` and opening `mcb2300.chm`, for information about configuring jumpers for other programming utilities, such as Flash Magic.

Installing the LM3S8962 Evaluation Board

You need the following items to use the LM3S8962 evaluation board with JTAG emulation:

- LM3S8962 evaluation board
- A PC with two unused USB ports: one port to supply power to the board and the other port to perform ULINK2 USB-JTAG downloading and debugging
- ULINK2 USB-JTAG adaptor
- Two USB serial cables, each no longer than 10 feet

Figure 2 shows the location of some of the parts on the LM3S8962 evaluation board. Refer to the hardware documentation for required accessories such as cables and adaptors.



Caution Be careful when removing the board from the package and handling the board to avoid the discharge of static electricity, which might damage some components.

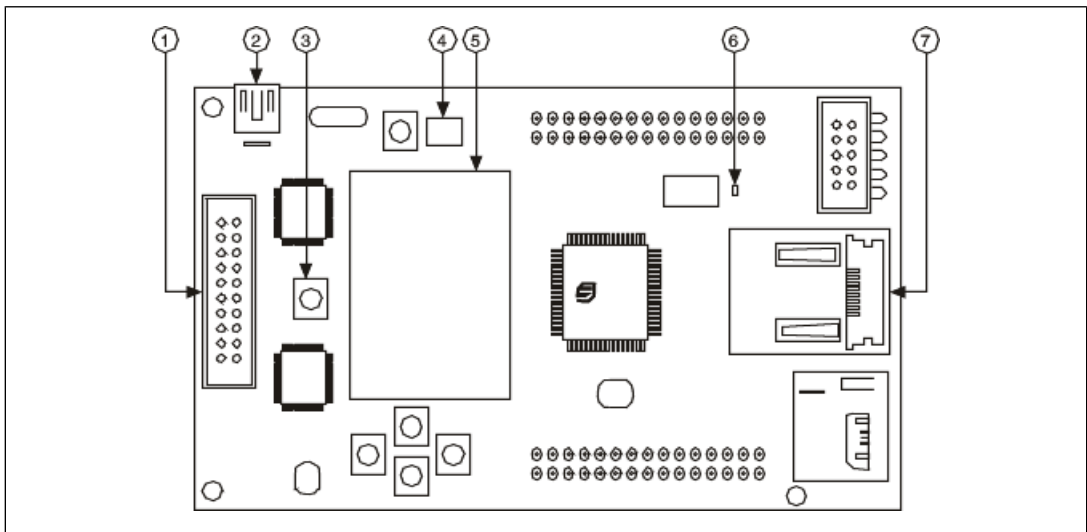


Figure 2. Locating Parts on the LM3S8962 Evaluation Board

1 JTAG Connector	4 Speaker	6 Power LED
2 USB Connector	5 Organic LED Display	7 Ethernet Connector
3 Reset Button		

Complete the following steps to install the board. You do not have to open the computer case to install the board.

1. Verify that you have Keil μ Vision installed. μ Vision is a part of the RealView Microcontroller Development Kit. You can look for the `Keil\uvx` directory on the hard disk, where x is the μ Vision version, or select **Start>All Programs** and locate the shortcut to Keil μ Vision. Do not launch μ Vision from the shortcut if you are going to use LabVIEW.

Refer to the [Installing the Embedded Module for ARM Microcontrollers](#) section for information about installing the RealView Microcontroller Development Kit.

2. Connect the ULINK2 USB-JTAG adaptor to a USB port on the host computer. If you are connecting the ULINK2 USB-JTAG adaptor to the computer for the first time, the connection activates the Windows Found New Hardware icon on Windows. A Windows message notifies you when the new device is ready for use and the hardware installation is complete.
3. Connect the ULINK2 USB-JTAG adaptor to the JTAG connector on the board.
4. Connect the USB connector on the board to a USB port on the host computer. This USB connection provides power to the board. The power LED illuminates on the board.



Note The board remembers the last program that ran because you must program the flash memory on the board to run an application. Therefore, the board begins running the last application as soon as the board receives power. You must download a new application to change the start-up behavior of the board.

5. Install the three drivers for the LM3S8962 evaluation board when the Found New Hardware Wizard prompts you.
 - a. In the Found New Hardware Wizard welcome page, select **No, not this time** so that Windows does not connect to Windows Update to search for the software.
 - b. Click the **Next** button.
 - c. Select **Install the software automatically (Recommended)**. If you did not install the Luminary Micro drivers during the software installation, you must insert the installation DVD before the wizard begins to scan the hard drive.
 - d. Click the **Next** button.
 - e. Click the **Continue Anyway** button when the Hardware Installation alert window opens.
 - f. Click the **Finish** button when Windows finishes installing the driver.
 - g. Repeat steps a through f to install the other two drivers.



Note The Luminary Micro drivers create a virtual serial port over the USB connection. If you unplug the evaluation board and then plug the evaluation board into another USB port on the host, the Luminary Micro drivers create additional virtual COM ports.

Refer to the *Stellaris LM3S8962 Evaluation Board User's Manual*, available on the Luminary Micro Software and Documentation CD included with the Stellaris LM3S8962 Evaluation Kit, for more information about the LM3S8962 evaluation board.

What's New

The LabVIEW Embedded Module for ARM Microcontrollers includes the following new features and changes:

- **StellarisWare VIs**—The Embedded Module for ARM Microcontrollers now includes the **StellarisWare VIs**, which allow you to use the Stellaris Peripheral Driver Library functions on Luminary Micro EK-LM3S8962 or LM3Sxxxx targets.
- **Expanded Interrupt Support**—You now can use the **Manage Interrupts** page of the **ARM Build Specification Properties** dialog box to enable and configure interrupts for Luminary Micro EK-LM3S8962 and LM3Sxxxx targets. The Embedded Module for ARM Microcontrollers supports the following types of interrupts: analog-to-digital converter (ADC), analog comparator, brown-out detection, general-purpose I/O (GPIO), PWM fault, PWM generator, quadrature encoder interface (QEI), timer, and watchdog.
- **Peripheral Power VIs**—The Embedded Module for ARM Microcontrollers now includes the **Peripheral Power VIs**, which you can use to enable or disable peripherals on ARM targets.
- **New Build Report**—The **Application Status** window now includes the **Build Report** page, which displays the amount of memory the application is using currently and the total unused memory available on the target.
- **C Generation Error Reporting**—The Embedded Module for ARM Microcontrollers includes improved error reporting when generating C code. The **Output** page of the **Application Status** window displays errors and warnings that occur when generating C code.
- **Heap Size Optimization**—The **Advanced Compiling Options** page of the **ARM Build Specification Properties** dialog box now includes the **Optimize heap size** option, which directs μ Vision to build the application an additional time. Building the application an additional time allows LabVIEW to calculate the remaining unused RAM on the target. LabVIEW then reserves the maximum amount of remaining RAM that the target can use to allocate memory dynamically. Heap optimization reduces the possibility that the application will run out of dynamic memory while running.
- **Data Value Reference Support**—The Embedded Module for ARM Microcontrollers now supports the Data Value Reference Read / Write Element border node, which you can use to operate on the data within the In Place Element structure and replace that data in the original memory space. The Embedded Module for ARM Microcontrollers also supports the New Data Value Reference and Delete Data Value Reference functions.
- **Additional Fixed-Point Data Type Support**—The Embedded Module for ARM Microcontrollers now supports the Fixed-Point to Integer Cast and Integer to Fixed-Point Cast functions, which you can use to interpret the bits to produce a fixed-point or integer output with the same bits. You now also can use fixed-point data types and 1D and 2D arrays of fixed-point data types for input to and output from the Inline C Node.

Tutorial for the Embedded Module for ARM Microcontrollers

Use this tutorial to learn how to build, run, and debug an ARM application. In this tutorial, you create a VI that you build into an application and run on the ARM target. You use the front panel on the host computer as a debugging interface between the host computer and the target. An LED indicator on the front panel lights when an input exceeds a threshold you define. Then, you add Elemental I/O to the VI that lights an LED on the target when the input exceeds the threshold.

Creating the LabVIEW Project

Use LabVIEW projects (.lvproj) to group together LabVIEW files and non-LabVIEW files, create build specifications for building a VI into an ARM application, and run the application on the target. You must use a project to build an ARM VI into an ARM application.

Complete the following steps to create a project with an ARM target and a blank VI.

1. Launch LabVIEW. In the **Getting Started** window, select **ARM Project** from the **Targets** pull-down menu. Click the **Go** button to launch the Create New ARM Project Wizard.
2. Select **New ARM project, blank VI** in the **Project type** pull-down menu to create the LabVIEW project with a blank VI.



Tip The **New ARM project, existing VI** imports an existing VI rather than creating a new, blank VI.

3. Click the **Next** button to display the **Select ARM target type** page.
4. Select the target from the **Target type** pull-down menu.
5. Click the **Next** button to display the **System preview** page.
6. Verify the **Create a build specification** checkbox contains a checkmark. Build specifications contain the build settings and code generation options to use when you build a VI into an application.
7. Click the **Finish** button. Because the **Create a build specification** checkbox contains a checkmark, the Create New ARM Project Wizard creates a build specification with default settings. LabVIEW prompts you to save the project and VI before the Create New ARM Project Wizard can create the build specification. The project now appears in the **Project Explorer** window.

Reviewing the Project Explorer Window

The **Project Explorer** window includes two pages, the **Items** page and the **Files** page. The **Items** page displays the project items as they exist in the project tree. The **Files** page displays the project items that have a corresponding file on disk. Project operations on the **Files** page both reflect and update the contents on disk. You can switch from one page to the other by clicking the **Items** and **Files** tabs.

Expand the ARM target in the **Project Explorer** window. The VI you created with the Create New ARM Project Wizard appears under the ARM target. LabVIEW automatically adds **Dependencies** and **Build Specifications** under the target. SubVIs appear under **Dependencies** when you add a VI that contains subVIs to a project. Build specifications you create appear under **Build Specifications**.

To see the build specification you created with the Create New ARM Project Wizard, expand the **Build Specifications** item under the ARM target in the **Project Explorer** window. **Application** is the default build specification name. You can rename the build specification by right-clicking **Application** and selecting **Rename** from the shortcut menu or by double-clicking the build specification, which opens the **Build Specification Properties** dialog box, and entering a new name in the **Build specification** name text box. Refer to the [Verifying the Build Specification](#) section for more information about the **Build Specification Properties** dialog box.

Creating the Front Panel

The front panel window usually contains the user interface for a VI. ARM applications do not include a user interface, but you can use the front panel window as a debugging interface. In this tutorial, you create a VI with an LED indicator that lights on the front panel if the input exceeds a threshold value you define.

Complete the following steps to create the front panel debugging interface.

1. Add the following controls to the front panel window:
 - Two numeric controls located on the **Numeric** palette.
 - One numeric indicator located on the **Numeric** palette.

- One round LED located on the **Boolean** palette.



Tip If you cannot find the object you want, click the **Search** button on the **Controls** palette toolbar for front panel objects or the **Functions** palette for block diagram objects. Type the name of the object for which you want to search. LabVIEW searches as you type and displays any matches in the search results text box. You also can press the <Ctrl-Space> keys or select **View»Quick Drop** to display the **Quick Drop** dialog box. Type the name of the object you want to add to the front panel or block diagram windows.

2. Rename the controls as shown in Figure 3.
 - Rename one of the numeric controls to **input**.
 - Rename the other numeric control to **threshold**.
 - Rename the numeric indicator to **output**.
 - Rename the round LED to **threshold exceeded?**.



Tip Double-click to select a single word in a label. Triple-click to select the entire label.

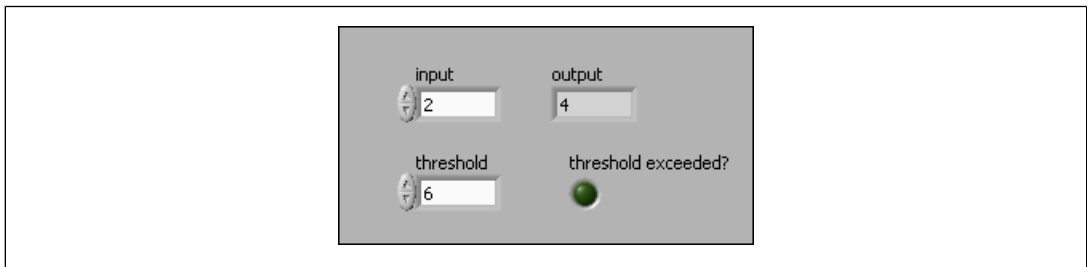


Figure 3. Changing the Labels

Creating the Block Diagram

The block diagram is the source code for a VI and contains a pictorial description or representation of an application. Wires carry data between the objects, or nodes, on the block diagram. The controls and indicators you added in the *Creating the Front Panel* section appear as terminals on the block diagram.

Complete the following steps to build the block diagram shown in Figure 4. The block diagram multiplies an input value by 2 and then lights an LED if the product is greater than the threshold value you specify.

1. Switch to the block diagram by clicking the block diagram if it is visible or selecting **Window»Show Block Diagram**.




Tip You also can switch to the block diagram by pressing the <Ctrl-E> keys.

2. Select **Help»Show Context Help** to display the **Context Help** window. The **Context Help** window displays basic information about LabVIEW objects when you move the cursor over each object.



Tip You also can press the <Ctrl-H> keys to open and close the Context Help window.

3. Place a While Loop, located on the **Structures** palette, around the controls and indicator on the block diagram. While Loops repeat the inner subdiagram until the conditional terminal, which is an input terminal, receives a particular Boolean value. Right-click the conditional terminal, , in

the lower right corner of the While Loop and select **Create Constant** from the shortcut menu. The default Boolean constant in the While Loop is FALSE.

4. Place a Multiply function, located on the **Numeric** palette, on the block diagram inside the While Loop.
5. Wire the **input** control to the **x** input of the Multiply function.
6. Right-click the **y** input of the Multiply function and select **Create»Constant** from the shortcut menu. Enter 2 to multiply the value of the **input** control by two.
7. Place a Greater? function, located on the **Comparison** palette, on the block diagram.
8. Wire the **x*y** output of the Multiply function to the **x** input of the Greater? function.
9. Wire the **threshold** control to the **y** input of the Greater? function.
10. Wire the **x > y?** output of the Greater? function to the **threshold exceeded** indicator.
11. Wire the **output** indicator to the wire connecting the Multiply function and the Greater? function.
12. Place a Wait Until Next ms Multiple function, located on the **Time, Dialog & Error** palette, inside the While Loop.
13. Right-click the **millisecond multiple** input and select **Create»Constant** from the shortcut menu. Enter 100 to wait 100 milliseconds between loop iterations.
14. Save the VI.

The block diagram should look similar to Figure 4.

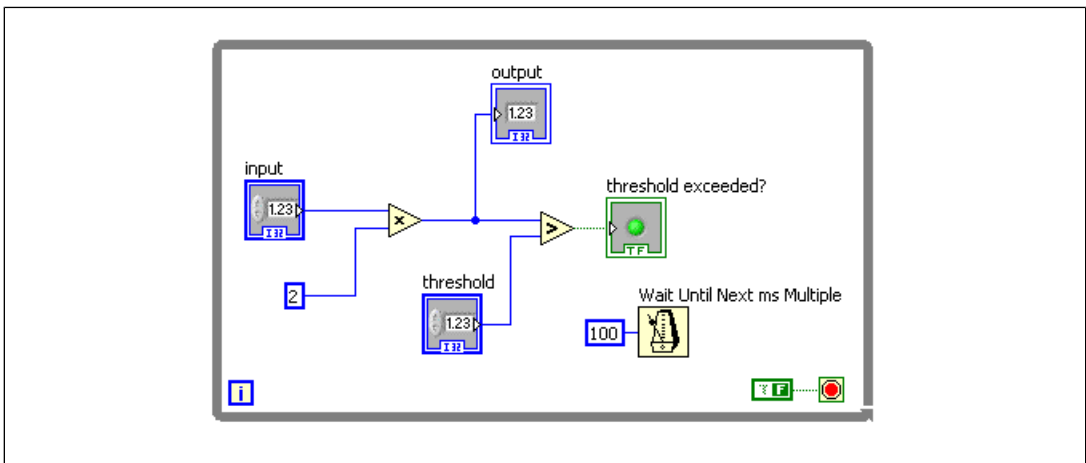


Figure 4. Creating the Block Diagram

Verifying the Build Specification

Use build specifications to specify how the Embedded Module for ARM Microcontrollers generates C code and how to build the ARM VI into an application.

You can have multiple build specifications for the same target. For example, you might want one build specification that generates debugging information and another build specification that does not generate this extra information. By default, ARM build specifications enable debugging.

Complete the following steps to verify the settings in the build specification you created with the Create New ARM Project Wizard.

1. Right-click the build specification in the **Project Explorer** window and select **Properties** from the shortcut menu to display the **Build Specification Properties** dialog box.




Tip You also can double-click the build specification to open the **Build Specification Properties** dialog box.

2. Verify that the **Enable debugging** checkbox contains a checkmark and the current debugging mode is JTAG.



Tip The current debugging mode is shown under the **Enable debugging** checkbox. You select the debugging mode on the **Advanced Debugging Options** page.

3. Verify the execution location is **Run on target using ULINK2** to run the application on the evaluation board.
4. Select the **Source Files** category and verify that the VI is in the **Top-level VI** text box. When you use the Create New ARM Project Wizard to create a project, LabVIEW automatically uses the VI the wizard creates as the top-level VI. When you create a project without using the wizard, you must manually select the top-level VI by clicking the blue right arrow button, , to move a VI from the source files list to the **Top-level VI** text box. If the ARM project contains other files, such as `.c` and `.lib` files, add these files to the **Additional files** list.
5. Click the **OK** button to close the dialog box.
6. Select **File»Save All** in the **Project Explorer** window or VI.


Building and Running the ARM Application

After you develop the ARM VI on the host computer, you build the VI into an application that runs on an ARM target. When you build an ARM application, the Embedded Module for ARM Microcontrollers generates C code from the LabVIEW block diagram using the settings you configure in the **Build Specification Properties** dialog box.



Note You must activate the Keil μ Vision License ID Code (LIC) before you can build an ARM application with LabVIEW. If the LIC is not activated, you receive a warning when you try to build the application. Refer to the *Activating the Keil μ Vision License ID Code Readme*, available by selecting **Start»All Programs»National Instruments»LabVIEW»Readme** and opening `readme_ARM_uVision_Licensing.html`, for information about activating the LIC. Refer to the [Installing the Embedded Module for ARM Microcontrollers](#) section for more information about evaluation mode.

Complete the following steps to build, download, and run an ARM application.

1. Click the **Run** button, , in the VI or right-click the build specification in the **Project Explorer** window and select **Run** from the shortcut menu to build, download, and run the application on the ARM target using the settings in the **Build Specification** dialog box. LabVIEW displays the status of the build process, which includes compiling and linking. In addition, the **Application Status** window assists in monitoring the download, connection, and execution progress of the application.



Note Click the **OK** button if a dialog box appears notifying you about an updated μ Vision template.

2. Enter a value in the **threshold** numeric control on the host computer.

- Enter different values in the **input** numeric control. In Figure 5, the **output** value on the left does not exceed the **threshold** value. If you change the **input** value so that the **output** value is greater than the **threshold** value, the **threshold exceeded?** LED lights.

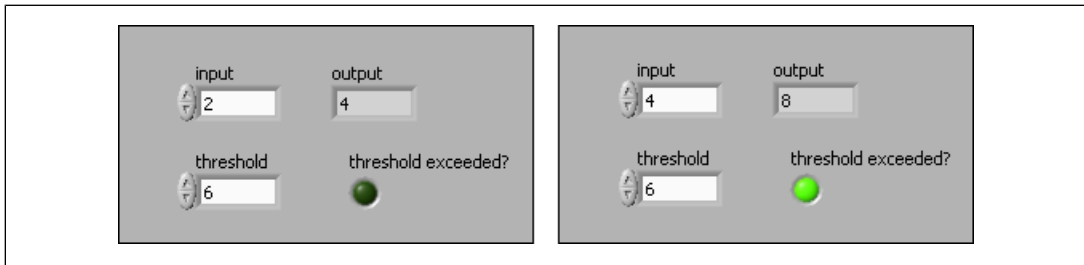



Figure 5. LED Lights when Output Exceeds Threshold




Tip LabVIEW uses default values for controls and indicators when building a ARM VI into a ARM application. To change the initial values, enter the new values in the front panel controls and then select **Edit»Make Current Values Default** to change the initial values. You must rebuild the ARM application if you change the initial values for any controls.

- Click the **Abort Execution** button, , to stop the ARM application.

Debugging with Breakpoints and Probes

Complete the following steps to debug the ARM tutorial application with breakpoints and probes.

- Switch to the block diagram if it is not visible.
- Right-click the Multiply function and select **Breakpoint»Set Breakpoint** from the shortcut menu. The breakpoint is highlighted with a red border around the function. This breakpoint specifies to pause execution just before the function executes.
- Click the **Run** button or right-click the build specification in the **Project Explorer** window and select **Debug** or **Run** from the shortcut menu. Save the VI if prompted. LabVIEW also prompts you if you need to rebuild or redownload the ARM application to the ARM target. The ARM tutorial application begins running on the ARM target. When the application reaches the breakpoint during execution, the ARM target halts all operation, the application pauses, and the **Pause** button on the host computer, , appears red and changes to a **Continue** button.
- Add probes on the wires coming into the Multiply function to see the values.
 - Click the wire coming into the **x** input.
 - Click the wire coming into the **y** input.

As shown in Figure 6, a floating **Probe Watch** window appears after you create a probe. LabVIEW numbers the probes in the **Probe Watch** window automatically and displays the same number in a glyph on the wire you click.

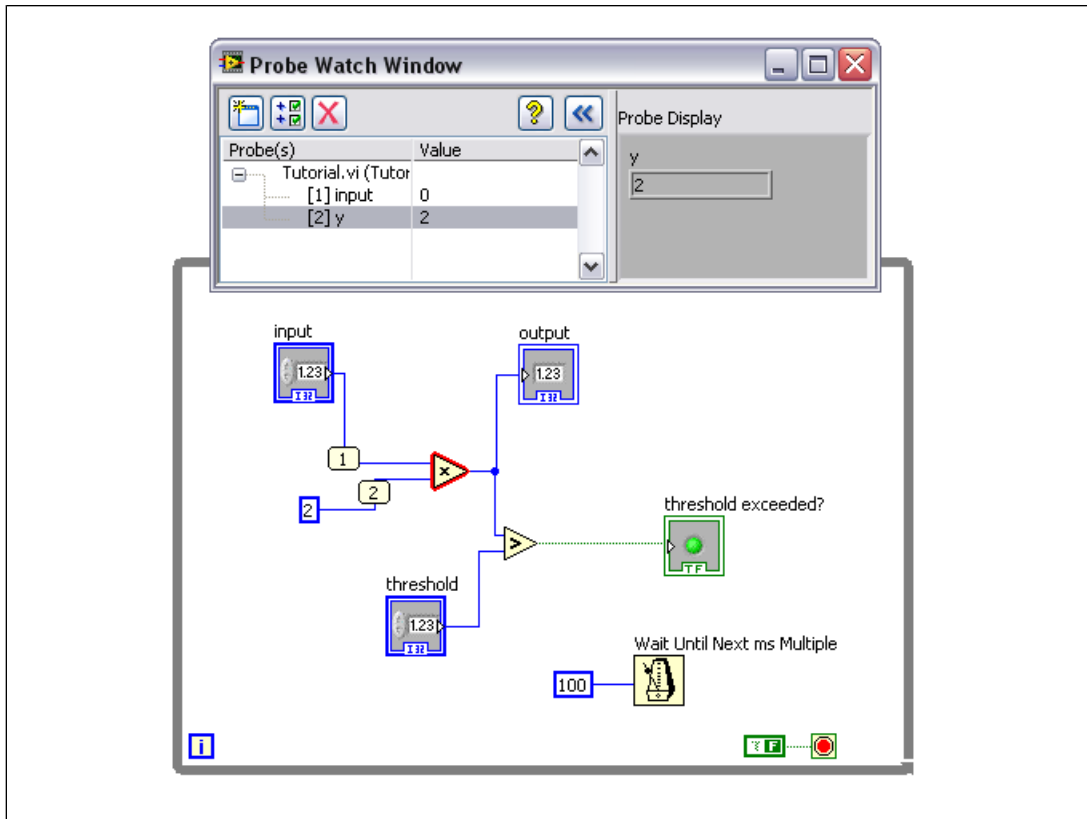




Figure 6. Creating Probes

5. Enter a different value in the **input** numeric control and click the **Continue** button, , to see the value of the first probe in the **Probe Watch** window change as the ARM application executes additional iterations of the While Loop. Repeat entering a different value in the **input** numeric control and clicking the **Continue** button a few times.
6. Click the **Step Over** button, , to execute the Multiply function and pause at the Greater? function, which blinks when it is ready to execute.
7. Continue clicking the **Step Over** button to step through the rest of the block diagram.
8. Click the **Abort Execution** button to stop the application.
9. Right-click the Multiply function and select **Breakpoint>Clear Breakpoint** from the shortcut menu to remove the breakpoint.

Using Elemental I/O

Elemental I/O resources are fixed elements of ARM targets that you use to transfer data among the different parts of the target. Each Elemental I/O resource has a specific type, such as digital, analog, or PWM. For example, you can use digital Elemental I/O resources to manipulate an LED on the ARM target. Refer to the *LabVIEW Help* for more information about using Elemental I/O with ARM targets.

The following sections describe how to use Elemental I/O to light an LED on the ARM target when the threshold is exceeded.

Adding Elemental I/O Items to the Project

You must add Elemental I/O items to the project before you can use Elemental I/O in an ARM VI. Complete the following steps to add Elemental I/O items to the project.

1. Right-click the target in the **Project Explorer** window and select **New»Elemental I/O** from the shortcut menu to display the **New Elemental I/O** dialog box.
2. Expand **Digital Output** in the **Available Resources** list.
3. **(Luminary Micro EK-LM3S8962)** Select **LED0**.
(Keil MCB2300) Hold down the <Ctrl> key and select **LED1** and **LED2**.
4. Click the **Add** button to add the selected resources to the **New Elemental I/O** list.
5. Click the **OK** button to add the Elemental I/O items to the LabVIEW project.

Many pins on ARM targets can have multiple configurations. For example, LED1 and PWM2 both use the same pin on the MCB2300 board. Therefore, you cannot use both LED1 and PWM2 in the same application. If you add LED1 and PWM2 to the project at the same time, LabVIEW indicates a conflict on the PWM2 item in the **Project Explorer** window. Similarly, LED0 and PWM1 both use the same pin on the EK-LM3S8962 board. Therefore, you cannot use both LED0 and PWM1 in the same application for an EK-LM3S8962 target.

After you add Elemental I/O items to the project, LabVIEW filters the available resources in the **New Elemental I/O** dialog box to remove resources with pin conflicts. If you right-click the MCB2300 target and select **New»Elemental I/O** the shortcut menu again, notice that PWM2 is no longer available in the **Available Resources** list because you already added LED1 to the project. If you right-click the EK-LM3S8962 target and select **New»Elemental I/O** the shortcut menu again, notice that PWM1 is no longer available in the **Available Resources** list because you already added LED0 to the project.

Using Elemental I/O on the Block Diagram

You can use Elemental I/O on the block diagram after you add Elemental I/O items to the project. Complete the following steps to use Elemental I/O on the block diagram.



Note Refer to the *Using Elemental I/O Nodes* topic in the *LabVIEW Help* for more information about using Elemental I/O Nodes.

MCB2300 Target

1. Drag LED1 from the **Project Explorer** window to the block diagram above the **threshold exceeded?** indicator.
2. Expand the Elemental I/O Node by dragging the bottom handle until you see LED1 and LED2.
3. Wire the **x > y?** output of the Greater? function to the LED1 and LED2 items in the Elemental I/O Node.
4. Right-click the wire that connects the **x > y?** output to LED2 and select **Insert»Boolean Palette»Not** from the shortcut menu to place a Not function on the wire. Using the Not function specifies that LED1 and LED2 alternate status such that when LED1 is off, LED2 is on.

EK-LM3S8962 Target

1. Drag LED0 from the **Project Explorer** window to the block diagram above the **threshold exceeded?** indicator.
2. Wire the **x > y?** output of the Greater? function to the LED0 item in the Elemental I/O Node.

Building and Running the Application with Elemental I/O



Note Before you run the application, verify that LabVIEW is downloading to the target and not to the simulator. In the **Build Specification Properties** dialog box, verify **Run on target using ULINK2** is selected.

Complete the following steps to run the ARM application and use Elemental I/O to light an LED on the target.

1. Click the **Run** button. Save the VI if prompted.
2. Click the **Yes** button when LabVIEW prompts you to rebuild the application.
3. Enter different values in the **input** numeric control until the **threshold exceeded?** indicator lights on the front panel.

(Luminary Micro EK-LM3S8962) When the **threshold exceeded?** indicator lights on the host computer, LED0 on the ARM target also lights.

(Keil MCB2300) When the **threshold exceeded?** indicator lights on the host computer, LED1 on the ARM target also lights and LED2 turns off.

4. Click the **Abort Execution** button to stop the application.

Where to Go from Here

National Instruments provides many resources to help you succeed with your NI products. Use the following related documentation as you continue exploring LabVIEW and the Embedded Module for ARM Microcontrollers

- *LabVIEW Help*, available by selecting **Help»LabVIEW Help** in LabVIEW, provides information about LabVIEW programming, step-by-step instructions for using LabVIEW, and reference information about LabVIEW VIs, functions, palettes, menus, and tools. Refer to the **Embedded Module for ARM Microcontrollers** book on the **Contents** tab of the *LabVIEW Help* for information specific to the Embedded Module for ARM Microcontrollers and applications you create. The *LabVIEW Help* uses (ARM) in the index to indicate topics specific to the Embedded Module for ARM Microcontrollers.
- Context help provides brief descriptions of VIs and functions with a link to the complete reference for a VI or function. Select **Help»Show Context Help** to open the **Context Help** window.
- Examples, available from the NI Example Finder and in the `labview\examples\lvemb\ARM` directory, can help you get started creating applications.
- The readme file, available by selecting **Start»All Programs»National Instruments»LabVIEW»Readme** and opening `readme_ARM.html`, contains known issues and last-minute information.
- *Getting Started with LabVIEW* manual, available by selecting **Start»All Programs»National Instruments»LabVIEW»LabVIEW Manuals** and opening `LV_Getting_Started.pdf`, provides information about the LabVIEW graphical programming environment and the basic LabVIEW features you use to build data acquisition and instrument control applications.
- **(Keil MCB2300)** The *MCB2300 User's Guide*, available by navigating to the `Keil\ARM\Hlp` directory and opening `mcb2300.chm`, provides information about the MCB2300 evaluation board.
- **(Luminary Micro EK-LM3S8962)** *Stellaris LM3S8962 Evaluation Board User's Manual*, available on the Luminary Micro Software and Documentation CD included with the Stellaris LM3S8962 Evaluation Kit, provides detailed information about the various parts on the LM3S8962 evaluation board.
- **(Luminary Micro EK-LM3S8962)** If you are considering moving to custom hardware, the *LM3S8962 Microcontroller Data Sheet*, available on the Luminary Micro Software and

Documentation CD included with the Stellaris LM3S8962 Evaluation Kit, provides reference information for the LM3S8962 microcontroller.

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