C Support for roboRIO 1.0 User Guide

C Support for roboRIO provides tools for you to program the roboRIO by using non-LabVIEW programming languages, such as the C programming language.

C Support for roboRIO includes the following components:

- **C Support**—Contains header files, source files, and binary files for using the NI FPGA interface and NI-VISA interface on the roboRIO target.
- **Examples**—Contains example projects that invoke the C support to use the resources on the roboRIO target.
- **Template**—Contains a blank project configured with the required roboRIO settings. The template provides a starting point for using the C support.

System Requirements

- One of the following operating systems:
  - Windows 8.0/8.1 (32-bit and 64-bit)
  - Windows 7 (32-bit and 64-bit)
  - Windows Vista (32-bit and 64-bit)
  - Windows XP Service Pack 3 Professional
  - Windows Server 2012 R2 (64-bit)
  - Windows Server 2008 R2 (64-bit)
  - Windows Server 2003 R2 (32-bit)
- LabVIEW 2015 roboRIO Toolkit—Provides drivers and software for setting up the roboRIO target.
- Java—Required for C/C++ Development Tools for NI Linux Real-Time 2014, Eclipse Edition.
- C/C++ Development Tools for NI Linux Real-Time 2014, Eclipse Edition—Provides the integrated development environment (IDE) and compilation tools.

Installation Instructions

You must perform the following tasks before developing a roboRIO application:

- Setting up the software environment
- Configuring the roboRIO target
- Importing C Support for roboRIO to Eclipse
- Installing an FPGA bitfile on the roboRIO target

NATIONAL INSTRUMENTS

Setting up the Software Environment

1. Install the LabVIEW 2015 roboRIO Toolkit. Visit `ni.com/info` and enter the Info Code roboRIOToolkit2015 to download and install the roboRIO Toolkit.
2. Install Java. Visit the Java website http://www.java.com/getjava to download Java.
3. Install the C/C++ Development Tools for NI Linux Real-Time 2014, Eclipse Edition. Visit `ni.com/info` and enter the Info Code Eclipse2014 to download and install Eclipse.
4. Download the C Support for roboRIO 1.0. Visit `ni.com/info` and enter the Info Code roboriocsupport2015 to download the C Support for roboRIO.
5. Add the compiler path to the system environment variables.
   a. In the Windows Control Panel, select **System and Security»System»Advanced system settings** to display the **System Properties** dialog box.
   b. Click **Environment Variables** to display the **Environment Variables** dialog box.
   c. Select **PATH** in the **User variables** group box and click **Edit**. If **PATH** does not exist, click **New** to create one.
   d. Append the compiler path to **Variable value**. Delimit paths with semicolons.
      (Windows 32-bit): `C:\Program Files\National Instruments\Eclipse\14.0\arm\sysroots\i686-nilrtsdk-mingw32\usr\bin\armv7a-vfp-neon-nilrt-linux-gnueabi`
      (Windows 64-bit): `C:\Program Files (x86)\National Instruments\Eclipse\14.0\arm\sysroots\i686-nilrtsdk-mingw32\usr\bin\armv7a-vfp-neon-nilrt-linux-gnueabi`

Note The compiler paths are customized for the 2014 version of Eclipse. If you use other versions of Eclipse, update the value to use the cross-compilers directory of Eclipse.

   e. Click **OK** to close the dialog box and save changes.

Configuring the roboRIO Target

Complete the following steps to install software on the roboRIO target by using the **Getting Started with roboRIO** wizard:

1. Connect the roboRIO to the host computer using a USB cable. The **roboRIO USB Monitor** appears after the USB driver is installed.
2. Note down the IP address of the roboRIO target.
3. Click **Launch the Getting Started Wizard** and go through the wizard to install or upgrade all required software on the roboRIO target and test the roboRIO onboard devices.

After you install the software on the roboRIO target, complete the following steps to enable Secure Shell (SSH) on the roboRIO target by using the NI Web-based Configuration & Monitoring application:

1. On the host computer, open a Web browser and enter the following URL to launch NI Web-based Configuration & Monitoring: `http://<IP address>/`, where `<IP address>` is the IP address of your roboRIO target.
2. In the **Startup Settings** section, enable the **Enable Secure Shell Server (sshd)** checkbox.
3. Click **Save** at the top of the page.
4. Click **Restart** on the upper right corner of the page to restart the roboRIO target.

Importing C Support for roboRIO to Eclipse

Complete the following steps to import C Support for roboRIO to Eclipse:

1. Launch Eclipse, specify a workspace, and click **OK** to display the C/C++ perspective.
2. Select **File»Import** to display the **Import** dialog box.
3. Select **General»Existing Projects into Workspace** and click **Next** to display the **Import Projects** page.
4. Select **Select archive file**, click **Browse** and select the *C Support for roboRIO 1.0* that you download.
5. Ensure that all items are checked and click **Finish** to import C Support for roboRIO to Eclipse.

Note Projects that already exist in the workspace directory appear grayed out. Rename or delete the existing projects from the disk before you import them again.

Installing an FPGA Bitfile on the roboRIO Target

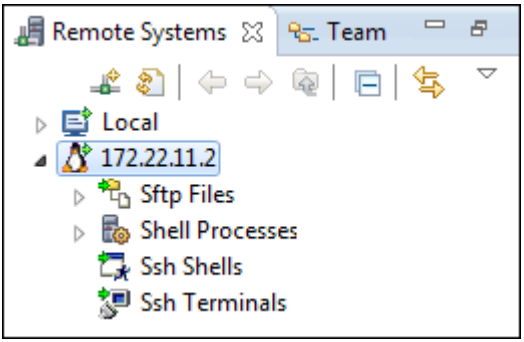
After importing C Support for roboRIO to Eclipse, establish a connection to install the FPGA bitfile on the roboRIO target.

Complete the following steps to establish a connection to the roboRIO target:

1. In Eclipse, select **Window»Open Perspective»Other** to display the **Open Perspective** dialog box.
2. Select **Remote Systems Explorer** and click **OK** to display the Remote Systems Explorer perspective.
3. Click the **Remote Systems Explore**r icon to display the **Remote Systems** pane.
4. Click the **Define a connection to remote system** icon to display the **New Connection** dialog box.
5. Select **General**»**Linux** and click **Next**.
6. Enter the IP address of your roboRIO target in the **Host name** textbox and click **Next** to display the **Files** page.
7. Enable the **ssh.files** checkbox and click **Next** to display the **Processes** page.
8. Enable the **processes.shell.linux** checkbox and click **Next** to display the **Shells** page.
9. Enable the **ssh.shells** checkbox and click **Next** to display the **Ssh Terminals** page.
10. Click **Finish**. Your new remote system now appears in the **Remote Systems** pane.

Complete the following steps to connect to the roboRIO target:

1. In the **Remote Systems** pane, right-click the target and select **Connect** from the shortcut menu to display the **Enter Password** dialog box.
2. Enter the user ID and password for the roboRIO and click **OK**. By default, the user ID is `admin` and there is no password.
3. Click **OK** in the **Info** dialog box.
4. If the **Keyboard Interactive authentication** dialog box appears, enter the same authentication as step 2 and click **OK**. A green arrow appears on the target icon when the roboRIO is connected.



Complete the following steps to install the FPGA bitfile on the roboRIO target:

1. In the **Remote Systems** pane, right-click **Sftp Files»Root** and select **New»Folder** to display the **New Folder** dialog box.
2. Enter `/var/local/natinst/bitfiles` in the **New folder name** textbox and click **Finish**. Ignore the error if the folder already exists.

3. Right-click **Sftp Files»Root»/»var»local»natinst»bitfiles** and select **Export From Project** from the shortcut menu to display the **Export** dialog box.
4. Click **C Support for roboRIO»source** to display the files in C Support for roboRIO.
5. Select the FPGA bitfile **NiFpga_RoboRioFpga10.lvbitx**.
6. Click **Finish**. Verify that the FPGA file that you select appears in the `bitfiles` folder.

Using C Support for roboRIO with Eclipse for NI Linux Real-Time

C Support for roboRIO includes examples and a template project. You can use the examples, whose names start with `roboRIO Example`, to build and deploy an example project to the roboRIO. Refer to the *Examples Overview* section of this document for more information about examples. You can use the template project, `roboRIO Template`, to build and deploy your own application.

This section introduces how to build and deploy an example project and a template project and how to create a new project.

Building and Deploying an Example Project

Complete the following steps to build and deploy an example project:

1. Launch Eclipse in the C/C++ perspective. If Eclipse is not in the C/C++ perspective, select **Window»Open Perspective»Other** to display the **Open Perspective** dialog box, select **C/C++ (default)**, and click **OK**.
2. In the **Project Explorer** pane, right-click an example and select **Build Project** from the shortcut menu to build the example.
3. Right-click the example and select **Run As»Run Configurations** to display the **Run Configurations** dialog box.
4. Expand **C/C++ Remote Application** and select the example to run.
5. Click **Search Project** to display the **Program Selection** dialog box.
6. Select the example in the **Binaries** section and click **OK**.
7. Click **Apply** and click **Run**. The example starts to run on the roboRIO target. You can find the result in the **Console** pane.
8. In the **Project Explorer** pane, right-click the example and select **Debug As»Debug Configurations** to display the **Debug Configurations** dialog box.
9. Expand **C/C++ Remote Application** and select the example to debug.
10. Click **Search Project** to display the **Program Selection** dialog box.
11. Select the example in the **Binaries** section and click **OK**.
12. Click **Apply** and click **Debug**. The example runs on the roboRIO target with a debugger. You can find the debug tools on the toolbar of Eclipse.

Note The default configuration of the project builds the debug mode for debugging. You can switch to the release mode by right-clicking the project and

selecting **Build Configurations»Set Active»2 Release** from the shortcut menu.

Building and Deploying Your First Project

Complete the following steps to build and deploy your first project by using the template project:

1. Launch Eclipse in the C/C++ perspective. If Eclipse is not in the C/C++ perspective, select **Window»Open Perspective»Other** to display the **Open Perspective** dialog box, select **C/C++ (default)**, and click **OK**.
2. In the **Project Explorer** pane, right-click **roboRIO Template** and select **Rename** from the shortcut menu to display the **Rename Resource** dialog box.
3. Specify a new name for your project and click **OK**.

Note You must specify a new name for your project. Otherwise, you cannot import the `roboRIO Template` project again.

4. Right-click your project and select **New»File** to add your source files to the project. You can also reuse the source files in example projects by copying and pasting the source files into your project.
5. Right-click the project and select **Build Project** from the shortcut menu to build the project.
6. Right-click the project and select **Run As»Run Configurations** to display the **Run Configurations** dialog box.
7. Expand **C/C++ Remote Application** and select **roboRIO Template**.
8. In the **Name** textbox, enter the new name that you specified in step 3.
9. Click **Search Project** to display the **Program Selection** dialog box.
10. Select your project in the **Binaries** section and click **OK**.
11. Click **Apply** and click **Run**. The project starts to run on the roboRIO target. You can find the result in the **Console** pane.
12. Right-click the project and select **Debug As»Debug Configurations** to display the **Debug Configurations** dialog box.
13. Expand **C/C++ Remote Application** and select your project.
14. Click **Search Project** to display the **Program Selection** dialog box.
15. Select your project in the **Binaries** section and click **OK**.
16. Click **Apply** and click **Run**. The project starts to run on the roboRIO target with a debugger. You can find the debug tools on the toolbar of Eclipse.

Note The default configuration of the project builds the debug mode for debugging. You can switch to the release mode by right-clicking the project and selecting **Build Configurations»Set Active»2 Release** from the shortcut menu.

Creating a New Project

C Support for roboRIO also includes a template project archive that you can use to create new projects for the roboRIO. The template project archive is included when you import C Support for roboRIO. Complete the following steps to create a new project:

1. Launch Eclipse in the C/C++ perspective. If Eclipse is not in the C/C++ perspective, select **Window»Open Perspective»Other** to display the **Open Perspective** dialog box, select **C/C++ (default)**, and click OK.
2. Select **File»Import** to display the **Import** dialog box.
3. Select **General»Existing Projects into Workspace** and click **Next** to display the **Import Projects** page.
4. Select **Select archive file,** navigate to `<workspace>\C Support for roboRIO\template project`, where `<workspace>` is the workspace directory that you specify in Eclipse, and select the `roboRIO Template v1.0.zip` file. The roboRIO Template now appears in the **Projects** list.
5. Click **Finish**.

Note Projects that already exist in the workspace directory appear grayed out. Rename or delete the existing projects from the disk before you import them again.

Complete the *Building and Deploying Your First Project* section of this document to use this template project with the roboRIO.

Examples Overview

NI provides the following examples for using the roboRIO. Refer to the `main.c` file in each example for more information.

Accelerometer

Demonstrates using the onboard accelerometer. This example reads the acceleration values in the three directions and prints the values to the console.

AIIRQ

Demonstrates using the analog input interrupt request (IRQ). This example registers an IRQ on analog input AI0 on connector B and creates a new thread that waits for the interrupt to occur.

AIO

Demonstrates using the analog input and output (AIO). This example reads initial values of two analog input channels from connector B and writes the sum of the read values on connector B. This example also prints the values to the console.

ButtonIRQ

Demonstrates using the button interrupt request. This example registers an IRQ on the user button of the roboRIO and creates a new thread that waits for the interrupt to occur.

DIIRQ

Demonstrates using the digital input interrupt request. This example registers an IRQ on digital input DI0 on connector B and creates a new thread that waits for the interrupt to occur.

DIO

Demonstrates using the digital input and output (DIO). This example reads initial values of two digital input channels from connector B and writes the Boolean AND of the read values on connector B. This example also prints the values to the console.

Encoder

Demonstrates using the encoder. This example reads a step and direction signal from the encoder on connector B and prints the values to the console.

I2C

Demonstrates using the I²C. This example reads the temperature from a connected TMP102 digital temperature sensor and writes the response to the console.

LED

Demonstrates using the LEDs. This example writes values to the LEDs to display green and red LEDs.

PWM

Demonstrates using pulse-width modulation (PWM). This example generates a PWM signal from PWM 0 on connector A.

Relay

Demonstrates using the relay. This example generates an ON relay signal on Relay0.

RSL

Demonstrates using the robot signal light (RSL). This example writes values to the RSL channel every three seconds. The RSL LED indicates the value changes of the RSL channel.

SPI

Demonstrates using the serial peripheral interface bus (SPI). This example writes a message to the SPI bus and then prints any returned bytes to the console.

TimerIRQ

Demonstrates using the timer interrupt request. This example registers an IRQ on software timer and creates a new thread that waits for the interrupt to occur.

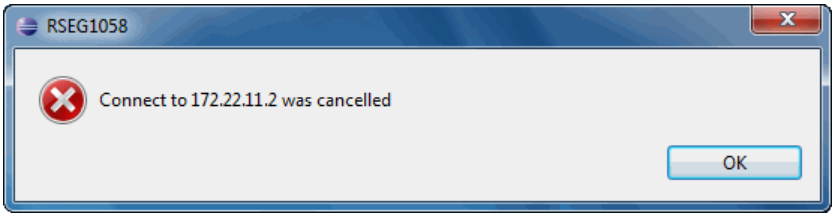
UART

Demonstrates using the universal asynchronous receiver/transmitter (UART). This example writes a character to the UART bus and then prints any returned character to the console.

Known Issues

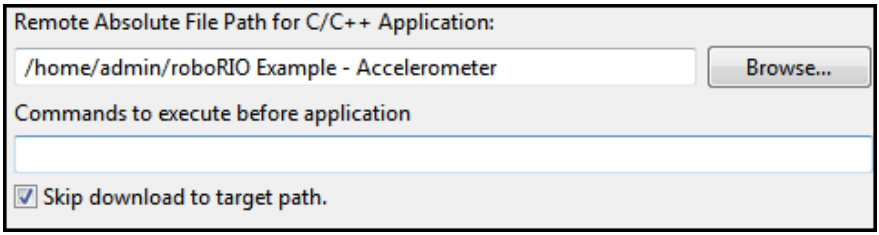
Connection Cancelled

You might find that the connection to the roboRIO target sometimes cancels when you start to run or debug your project in Eclipse.



The connection in Eclipse is not stable when you download your application to the roboRIO target. Click **OK** to dismiss the message. The connection reestablishes next time you download your application. You also can manually reestablish the connection in the Remote System Explorer perspective.

A way to minimize the problem is to enable the **Skip download to target path** checkbox in the **Run Configurations** or **Debug Configurations** dialog box. However, you must then manually transfer the built executable to the roboRIO using SFTP.



Using the roboRIO Target with LabVIEW

To use the roboRIO target with LabVIEW, you must install LabVIEW and the LabVIEW Real-Time Module and then reinstall the roboRIO Toolkit. Refer to the readme of each product for specific system requirements and supported operating systems.

Related Information

roboRIO Shipping Personality Reference—Contains information about the FPGA bitfile included with C Support for roboRIO.