NI ELVIS III
Getting Started

Contents

Getting Started

The getting started guide provides step-by-step instructions on how to connect the NI ELVIS III hardware, launch the Soft Front Panels (SFPs) from Measurements Live, and develop applications on the NI ELVIS III using the NI ELVIS III Software Bundle.

If you are a...	Where to go
Student	- Getting Started with Measurements Live - Creating an NI ELVIS III Application with LabVIEW - Programming the NI ELVIS III with Python or C **Note** If your lab administrator has not set up the hardware and software for you, set up your device and the host computer first.
Lab administrator	Guide for Lab Administrators—Instructs you to set up lab devices, computers, and servers.
Professor	Act as a lab administrator or refer to Teaching with NI ELVIS III.

Setting up Your Device

This section provides step-by-step instructions on how to connect and set up the NI ELVIS III workstation.

- What You Need to Get Started
- Installing and Powering the Hardware
- Connecting the Device to Your Host Computer
- Configuring the Device

What You Need to Get Started

To set up and use the NI ELVIS III, you need the following items:

- Required hardware

  - NI ELVIS III workstation
  - AC/DC power supply
  - High-speed USB 2.0 cable
  - Computer

- Recommended items for first time users

  - BNC to BNC cable or
  - Cables and Accessories Kit (786520-01)

- Optional items and tools for further exploration

  - NI ELVIS III prototyping board
  - Components to build your circuits
  - Cabling and sensors as required for your application
  - Wire cutter
  - Wire stripper

- Software

  - NI ELVIS III Software Bundle Installer (optional)

- Documentation

  - NI ELVIS III Quick Start Guide
  - NI ELVIS III Safety, Environmental, and Regulatory Information (SERI) manual

Unpacking Your Device

The NI ELVIS III workstation and the NI ELVIS III Prototyping Board ship in antistatic packages to prevent electrostatic damage. Electrostatic discharge can damage several components on the NI ELVIS III hardware.

> ⊙ **Notice** Never touch the exposed pins of connectors.

To avoid such damage in handling the workstation and prototyping board, take the following precautions:

- Ground yourself using a grounding strap or by holding a grounded object.
- Touch the antistatic package to a metal part of the computer chassis before removing the workstation or prototyping board from the package.

Remove the hardware from the package and inspect it for loose components or any sign of damage. Contact NI if the hardware appears damaged in any way.

Store the workstation and the prototyping board in the antistatic envelopes when not in use.

Tip Go to Installing and Powering the Hardware next.

Installing and Powering the Hardware

Before you set up and use the NI ELVIS III device, ensure that you have the required items listed in the What You Need to Get Started section.

1. Ensure that the power switch at the back of the NI ELVIS III workstation is switched off.
2. Connect the power supply.
3. Connect the Wi-Fi antenna and/or relevant cables based on the following:
   a. For initial configuration and launching of the Soft Front Panels without network access or programming, start with Connecting to the Device via USB.
   b. For Ethernet connection configuration, start with Connecting to the Device via Ethernet.
   c. For wireless connection (Wi-Fi models only) configuration, start with Connecting to the Device via Wireless Network (Wi-Fi models only).

   **Note** The USB cable is also required for the initial configuration of the wireless network.
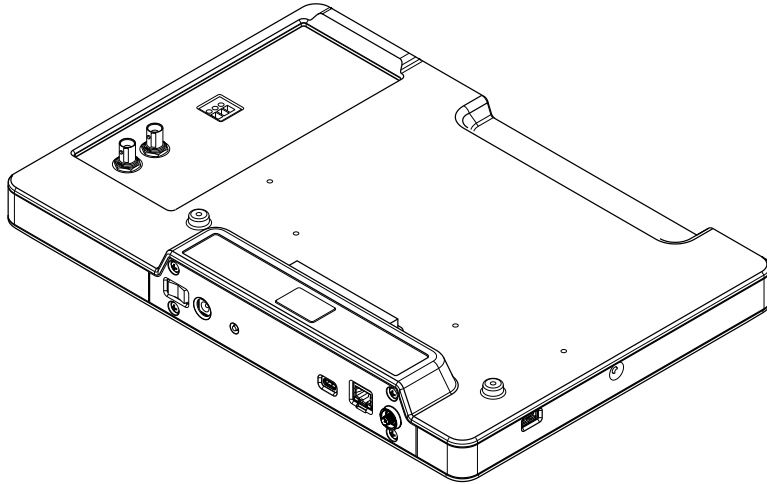
    a. Power supply cable

    b. Device USB cable (required for initial configuration)

    c. Ethernet cable (optional connection)

    d. Wi-Fi antenna (Wi-Fi models only)

4. Plug the power supply into a wall outlet and switch on the power switch at the back of the NI ELVIS III workstation.

5. Ensure that the application board power button on the workstation is turned off. The integrated LED in the power button should not be lit.

6. Install the NI ELVIS III prototyping board (or compatible application boards) as shown in the following figure:
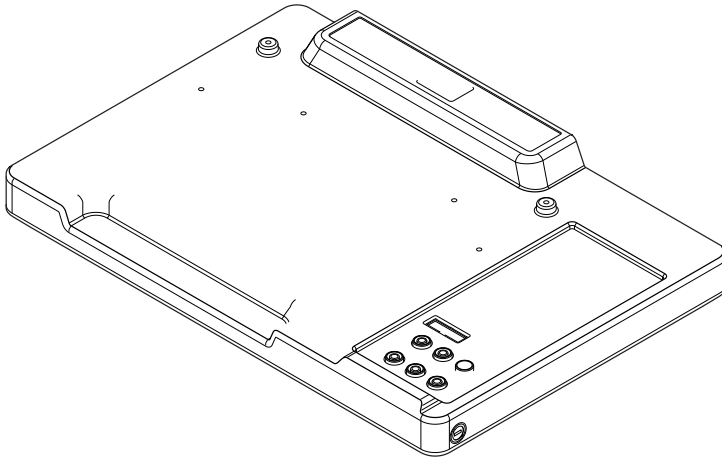
   a. Position the opening in the NI ELVIS III prototyping board over the application board mounting bracket.

   b. Slide the edge connector of the NI ELVIS III prototyping board into the receptacle on the workstation and ease it into place.

7. Secure the NI ELVIS III prototyping board to the workstation using two M4 mounting screws as shown in the following figure:
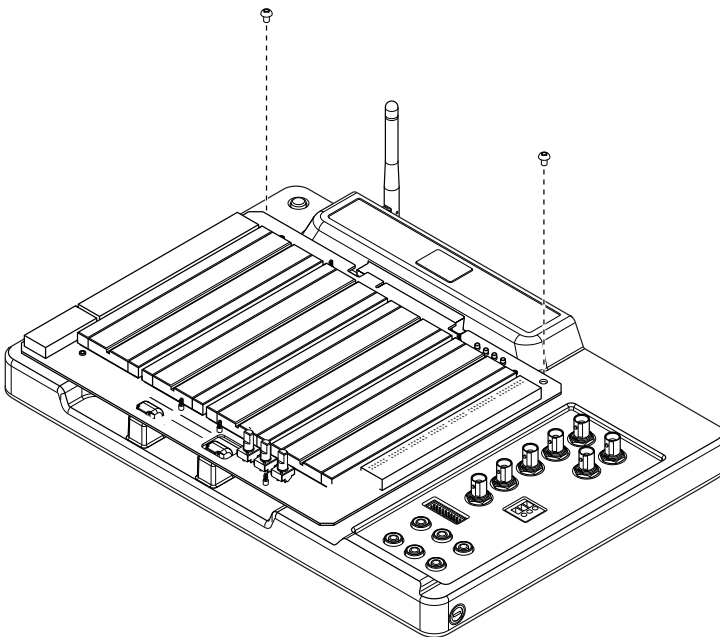
8. Power on the application board power button on the workstation. The integrated LED in the power button should be lit. The four Fixed User Power Supplies LEDs on the prototyping board should also be lit.

> (!) **Notice** When you turn on your device and connect it to the network, certain device data (serial number, device ID, MAC address, IP address, Hostname, used hardware and software versions) is transmitted in encrypted format to NI. This information will be deleted after you remove your device from the network, for example, by turning it off or switching off the Ethernet or Wi-Fi (Wi-Fi models only) functionality. The only exception is when the device is configured for infinite lease time and/or infinite grace period, in which case the serial number and device ID will be stored for this purpose only. Accessing the above data is necessary to establish the connection and transmit communication between the devices connected to the Measurements Live network and the instrument soft front panels in Measurements Live, access to which is provided with the product. NI does not store or use this data for any other purposes. Because the above information, in particular the device ID, may be available for others connected to the network, providing any personal information by setting your device ID or otherwise will be at your sole risk and responsibility. NI is not responsible for the behavior of any other device users connected to the network. If you do not want to share the above data with others in the Measurements Live network, you should not use the network functionality of your device. You can still use your device with your computer through a USB connection.

> 🔆 **Tip** Go to Connecting the Device to Your Host Computer next.

Connecting the Device to Your Host Computer

You can connect the NI ELVIS III to your host computer using one of the following methods:

- Connecting to the Device via USB
- Connecting to the Device via Ethernet

- Connecting to the Device via Wireless Network (Wi-Fi models only)

Connecting to the Device via USB

Complete the following steps to use a USB cable to connect the NI ELVIS III from the USB device port to your host computer.

1. Connect the Type-C to Type-A USB 2.0 cable to the NI ELVIS III as shown in the following figure:
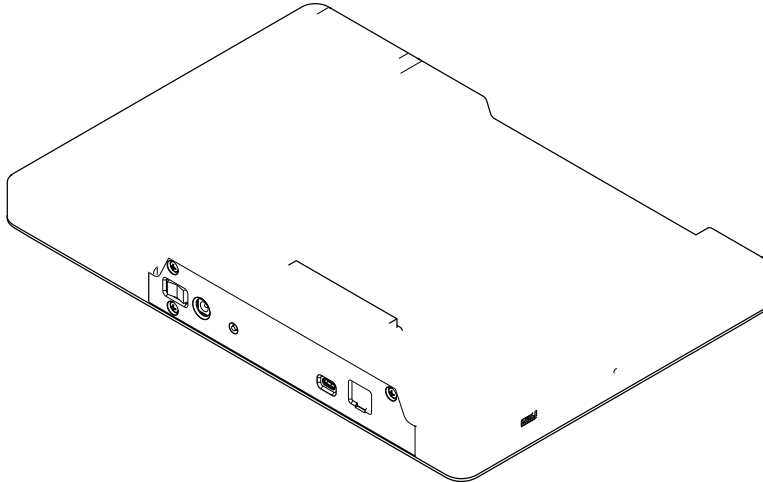
2. Connect the other end of the USB cable to the host computer.

> ⊘ **Notice** Ensure that the host computer is powered on before connecting the USB cable.

If the connection is successful, you can see the IP address of the USB connection on the OLED display of the NI ELVIS III after you install the Measurements Live Support Files. Press and hold the user programmable button (Button 0) on the left-hand side of the NI ELVIS III workstation until you turn on the display. The IP address of the USB connection appears after the ⟷ icon.

> **Note** The device does not need an ID when connected via USB. The OLED display returns **ID not available** when you connect the device via USB only.

> **Tip** Go to Setting up the Host Computer to set up the software environment.

> **Tip** Go to Configuring the Device if you need to upgrade the software on the device or set up an administrator password.

Connecting to the Device via Ethernet

Complete the following steps to use an Ethernet cable to connect the NI ELVIS III to your host computer.

1. Connect the Ethernet cable to the NI ELVIS III as shown in the following figure:
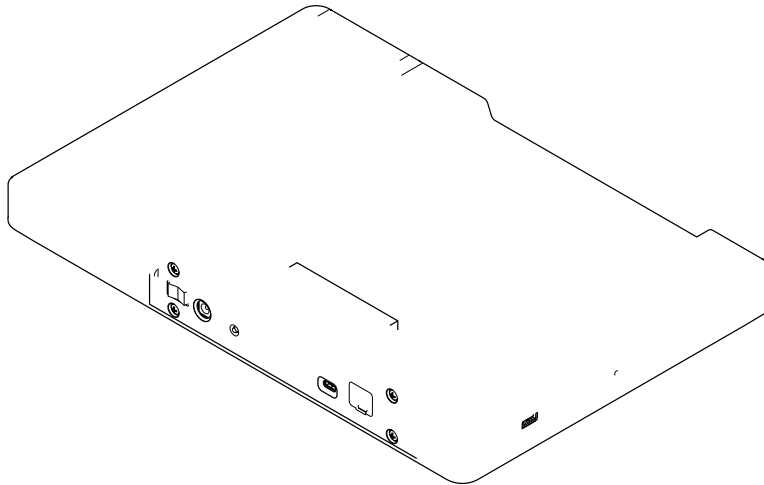
2. Ensure that the Ethernet cable is connected to a router that is set up correctly.

> **Note** Your host computer and the NI ELVIS III needs to be connected to the same subnet (local network).
>
> | Host Computer | NI ELVIS III | Local Network |
> |---|---|---|
> | | Router | |

If the connection is successful, you can see the IP address of the Ethernet connection on the OLED display of the NI ELVIS III. Press and hold the user programmable button (Button 0) on the left-hand side of the NI ELVIS III workstation until you turn on the display. The IP address of the Ethernet connection appears after the ⊹ icon.

> **Tip** Go to Setting up the Host Computer to set up the software environment.

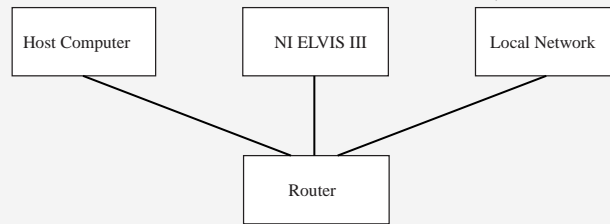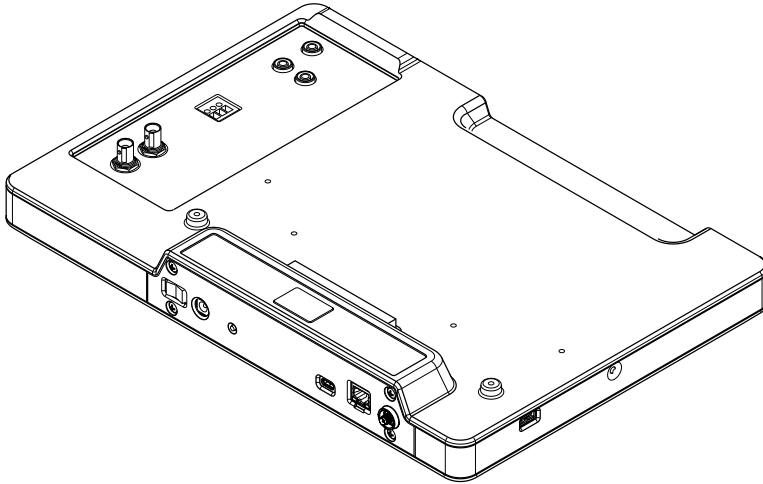> **Tip** Go to Configuring the Device if you need to upgrade the software on the device or set up an administrator password.

Connecting to the Device via Wireless Network (Wi-Fi models only)

Complete the following steps to connect the NI ELVIS III to your host computer via a wireless network.

1. Connect the Wi-Fi antenna to the NI ELVIS III as shown in the following figure:

> ✎ **Note** The USB cable is also required for the initial configuration of the wireless network.

2. Configure a wireless network on the NI ELVIS III.

Configuring a Wireless Network on the Device

> ✎ **Note** The following steps are required for initial configuration only. The NI ELVIS III automatically connects to the wireless network that it has connected to before.

1. Use a USB cable to connect the NI ELVIS III to your computer, as explained in Connecting to the Device via USB.

2. In Internet Explorer, enter http://<USB IP address>/WIF.html in the address bar to launch the **System Configuration** page. To view the IP address of the USB connection, press and hold the user programmable button (Button 0) on the left-hand side of the NI ELVIS III workstation until the OLED display on the workstation is lit. The IP address of the USB connection appears after the ⟐ icon.

> **Note**
>
> - You must use Internet Explorer to complete this step.
> - The IP address of the USB connection appears only after you install the Measurements Live Support Files.

3. Click the **Network Configuration** button on the left of the web page to display the **Network Configuration** page.

4. In the **Wireless Adapter wlan0** section, select **Connect to wireless network** from the **Wireless Mode** pull-down menu.

5. Select the country in which you are located from the **Country** pull-down menu. You must specify a country before you can select an available channel for the wireless network.

6. Select the wireless network you want to join or select **Other network** if you cannot find the wireless network from the **Wireless Network** pull-down menu.

7. Enter security settings for the wireless network that you select. You must select **Infrastructure** from the **Network Type** pull-down menu because the NI ELVIS III does not support Ad Hoc networks.

8. Select **DHCP or Link Local** from the **Configure IPv4 Address** pull-down menu. This option specifies that the NI ELVIS III automatically acquires an IP address.

9. Click **Save** to save the settings.

If the connection is successful, you can see the IP address of the wireless network connection on the OLED display of the NI ELVIS III. Press and hold the user programmable button on the left-hand side of the NI ELVIS III workstation until you turn on the display. The IP address of the wireless network connection appears after the 🛜 icon.

> 💡 **Tip** Go to Setting up the Host Computer to set up the software environment.

> 💡 **Tip** Go to Configuring the Device if you need to upgrade the software on the device or set up an administrator password.

Configuring the Device

In most cases, you do not need to configure the NI ELVIS III. The NI ELVIS III ships with the recommended software installed and necessary configurations made. You may need to configure the NI ELVIS III in cases such as upgrading the software on it or setting up an administrator password.

To configure the software on the NI ELVIS III, you will need to use Measurement & Automation Explorer (MAX).

This tutorial contains instructions on completing the most common configurations for the NI ELVIS III using MAX:

- Installing Software on the Device—This topic tells you how to upgrade the software on the NI ELVIS III or reinstall the software on the NI ELVIS III after you reformat it.
- Updating Firmware on the Device—This topic tells you how to upgrade the firmware on the NI ELVIS III.
- Securing the Device—This topic tells you how to protect your lab devices by setting administrator password and permissions.

For more information about configuring the NI ELVIS III using MAX, refer to the **LabVIEW Real-Time Target Configuration** section of the **Measurement & Automation Explorer Help** which you can launch by selecting Help » MAX Help in MAX.

> **Tip** Go to Setting up the Host Computernext.

Installing Software on the Device

The NI ELVIS III ships with the recommended software set installed on the device. You can use Measurement & Automation Explorer (MAX) to upgrade or modify the software set, or reinstall the software set after reformatting the device.

> **Note** MAX is installed automatically when you install the NI ELVIS III Software Bundle or the LabVIEW ELVIS III Toolkit.

Complete the following steps to install software on the NI ELVIS III using MAX:

1. In MAX, expand **Remote Systems** in the configuration tree and then expand your NI ELVIS III target.

2. Right-click **Software** and click **Add/Remove Software** to launch LabVIEW Real-Time Software Wizard.

   > ✎ **Note** If MAX prompts you to log in, enter admin in **User name** and leave **Password** blank if you have not set a new password. Refer to Securing the Device to learn how to set a new password for the device.

3. Select the recommended software set for the NI ELVIS III.

4. Click **Next**.

5. Ensure that LabVIEW ELVIS III Toolkitx is selected, where x matches the version of the LabVIEW ELVIS III Toolkit.

6. Click **Next** to view a summary of your selection.

7. Click **Next** to start installing the software. When the installation completes, the wizard restarts the NI ELVIS III.

8. Click **Finish** to close the wizard.

> 💡 **Tip** Go to Setting up the Host Computer to set up the software environment.

> 💡 **Tip** Go to Updating Firmware on the Device to update the firmware.

Updating Firmware on the Device

The NI ELVIS III ships with required firmware. You can use Measurement & Automation Explorer (MAX) to update the firmware.

> ✎ **Note** MAX is installed automatically when you install the NI ELVIS III Software Bundle or the LabVIEW ELVIS III Toolkit.

Complete the following steps to update firmware on the NI ELVIS III using MAX:

1. Obtain the latest firmware file by installing the latest NI ELVIS III Software Bundle.

2. In MAX, expand **Remote Systems** in the configuration tree.

3. Click the NI ELVIS III target, and click the **Update Firmware** button in the **System Settings** section.
   MAX automatically navigates to the latest firmware file for the NI ELVIS III. Firmware files for the NI ELVIS III are named ELVISIII_<version number>.cfg. For example, ELVISIII_6.0.0.cfg.

4. Click **Open**.

5. Click **Begin Update** to update the firmware.

   > **Note** If MAX prompts you to log in, enter admin in **User name** and leave **Password** blank if you have not set a new password. Refer to Securing the Device to learn how to set a new password for the device.

You can verify the version of the firmware currently installed on the NI ELVIS III in the **System Settings** section.

> **Tip** Go to Setting up the Host Computer to set up the software environment.

> **Tip** Go to Securing the Device to prevent unauthorized users from changing system configuration.

Securing the Device

If you are a Lab Administrator, you can prevent unauthorized users from changing system configuration on the NI ELVIS III by setting an administrator password and permissions in MAX.

> **Note** MAX is installed automatically when you install the NI ELVIS III Software Bundle or the LabVIEW ELVIS III Toolkit.

Setting a New Password

By default, each remote device includes a single user with the following name and password:

- **User name**: admin
- **Password**: <blank>

Complete the following steps to set a new password.

1. In MAX, expand **Remote Systems** in the configuration tree and then select your NI ELVIS III.
2. Login with the default user name and password:
   a. Click **Log In** on the toolbar.
   b. Enter admin in **User name** and leave **Password** blank.
   c. Click **OK**.
3. Click **Set Permissions** on the toolbar to launch the Security Configuration page in a browser.
4. Enter admin in **User name** and leave **Password** blank.
5. Double-click **admin** in the list of users under the **Users** tab.
6. Enter a secure password in **New Password**.
7. Re-enter your password in **Re-type New Password**.
8. Click **Save**.
9. Click **Upload Changes** to save the changes to the system.

You can now return to MAX and log in using the new password.

> ✏️ **Note** NI cannot recover lost system passwords. If you forget the password, you must contact NI and reformat the NI ELVIS III.

Removing Permissions from the Everyone Group

To secure your device, your must also remove all permissions from the **everyone** group.

1. Click **Set Permissions** on the toolbar to launch the Security Configuration page in a browser.
2. Enter your user name and password. Enter admin in **User name** and leave **Password** blank if you have not set a password.
3. Click the **Groups** tab.
4. Click the **everyone** group.
5. Select all permissions in the **This group has the following permissions** section and click **Remove** to remove all the permissions.
6. Click **Save** to save the change.

> 💡 **Tip** Go to Setting up the Host Computer next.

Setting up the Host Computer

According to the task you want to perform with the NI ELVIS III, set up the software environment on your host computer.

What you want to do	Where to go
Use the Soft Front Panels (SFPs) to control an NI ELVIS III in a web browser and do not need to program the NI ELVIS III with LabVIEW.	Zero installation! Go directly to measurementslive.ni.com.
Use the SFPs when not connecting your device to the Internet.	Installing the Support Files
Use the Logic Analyzer and Pattern Generator.	
Program the NI ELVIS III with LabVIEW.	Installing the Software Bundle

> **Tip** Go to Using the Device next.

Installing the Measurements Live Support Files

You can either download the Measurements Live Support Files from ni.com or access the offline installer stored on your NI ELVIS III USB drive.

Downloading the Online Installer

You can download and install the Measurements Live Support Files from ni.com.

Accessing the Offline Installer

Complete the following steps to access the offline installer stored on your NI ELVIS III USB drive:

1. Use a USB cable to connect the NI ELVIS III to the host computer, as illustrated in Connecting to the Device via USB.
2. On your host computer, navigate to the icon that represents the NI ELVIS III USB drive.
3. Open Start Here.html and follow the instructions on the screen to install the Measurements Live Support Files.

You can now launch the SFPs from Measurements Live.

> **Tip** Go to Launching the Soft Front Panels for using Soft Front Panels to access and control the Instrument I/O without programming.

> **Tip** Go to Installing the Software Bundle for installing necessary software to control the Instrument I/O programmatically.

Installing the NI ELVIS III Software Bundle

The NI ELVIS III Software Bundle includes the main software you need to build embedded applications for the NI ELVIS III, including LabVIEW, the LabVIEW Real-Time Module, the LabVIEW ELVIS III Toolkit, and Multisim.

Download the NI ELVIS III Software Bundle from ni.com/academic/download.

Apart from the required LabVIEW software to develop applications, you may also need to install some of the optional software based on the type of the application you want to create:

- To customize the FPGA on the NI ELVIS III, install the LabVIEW FPGA Module.
- To create applications that are controls specific, you may need to install additional NI software products, such as the LabVIEW Control Design and Simulation Module.

To verify that you have successfully set up a programming environment, you can create a simple application to control an onboard device on the NI ELVIS III.

Tip Go to Creating an Application next.

Using the Device

This section provides step-by-step instructions on how to access and control the instruments on the NI ELVIS III by using the Soft Front Panels (SFPs), and how to program the I/O on the NI ELVIS III by using the NI ELVIS III Software Bundle.

- Launching the Soft Front Panels
- Creating an Application

Launching the Soft Front Panels

You can launch the instrument Soft Front Panels (SFPs) from Measurements Live.

To open Measurements Live, go directly to measurementslive.ni.com. After you open Measurements Live, follow the onscreen instructions to connect to the NI ELVIS III and launch the desired SFP.

Note If you want to use the Logic Analyzer and Pattern Generator (Logic) or connect to the NI ELVIS III via USB, you must first install the SFPs to your host computer. Open Measurements Live from your Windows desktop or macOS Launchpad.

Using Measurements Live, you can connect to and control the NI ELVIS III anywhere and from any device that has internet connection. For example, you can open Measurements Live from your smart phone and control an NI ELVIS III in the school lab to generate a sine waveform. Note that you need a real-time device ID to establish the connection between your device and the NI ELVIS III. Lab administrators can set up a custom signaling server to allow students to get the device ID remotely.

By default, the SFPs stay in the same browser window, which allows you to view and configure all open SFPs in one place. You can change the layout of the SFPs by dragging and dropping them to the positions you want. You can also open an SFP in a separate browser window if you want to focus your work on one single SFP.

If you are using Measurements Live for the first time, read through the following sections to find answers to commonly raised questions.

How Do I Rearrange My SFPs?

You can rearrange the SFPs within the browser window to get a better layout. Click the ⬌ icon on the top left side of an SFP and drag and drop it to the position you want. Large SFPs such as the Oscilloscope are always located to the left of small SFPs such as the Variable Power Supplies (VPS). Your window size decides whether the SFPs are arranged vertically or horizontally.

How Do I Open an SFP in a Separate Window?

If you want to focus your work on one single SFP, click the ▾ icon on the top left side of the SFP and then click ⬀. The SFP pops up in a separate browser window. To restore your SFP to the original window, close the SFP and launch it again.

How Do I Save My Data?

You can export data and take screenshots for all open SFPs simultaneously by clicking the buttons on the top right side of Measurements Live. Note that you cannot export data when the SFPs are running. For SFPs opened in separate windows, you must save their data respectively.

Why Can't I Export Certain Types of Files for an SFP?

Refer to [Data Import and Export](#) for detailed information about the file types that each SFP supports.

Using the Soft Front Panels

This topic provides an example of using the Function and Arbitrary Waveform Generator (FGen/Arb) and the Oscilloscope to generate and display a waveform.

1. Connect a BNC - BNC cable between the Oscilloscope CH 1 and the Function Generator CH 1 BNC connectors on the NI ELVIS III as shown in the following diagram:
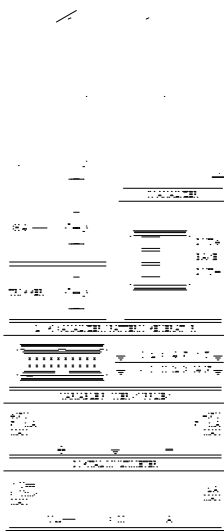
2. Select Function and Arbitrary Waveform Generator from the **Instruments** tab in Measurements Live.

3. On the FGen/Arb SFP, configure Channel 1 as follows:

Setting	Value
Channel 1	**Static**
Waveform	**Sine**
Frequency	100 Hz
Amplitude	2 Vpp

| Setting	Value
DC Offset	0 V

4. Click **Run** to start the FGen/Arb.

5. In Measurements Live, select the Oscilloscope SFP from the **Instruments** tab.

6. On the Oscilloscope SFP, configure the Oscilloscope as follows.

Setting	Value
Time/div	5 ms
Channel 1	**On**
Volts/div	1 V
Probe attenuation	1x
Coupling	**DC**
Vertical offset	0 V

7. Click **Run** to start the Oscilloscope.
   You should see a 100 Hz sine wave on the Oscilloscope display. Adjust the settings of the FGen/Arb and observe the changes of the waveform on the Oscilloscope display.

User Programmable Button

The user programmable button on the left-hand side of the NI ELVIS III workstation serves two purposes. It aids in connecting the NI ELVIS III to your host computer, and you can programmatically monitor it in a LabVIEW RT or LabVIEW FPGA application.
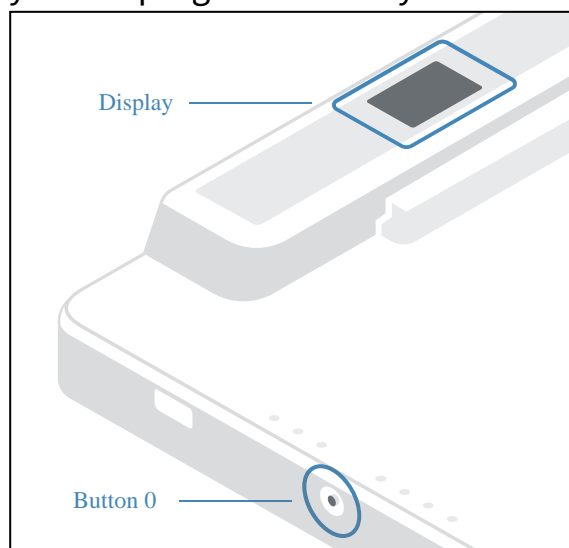
Pressing and holding the button enables the OLED display, which shows the current device ID and IP addresses for the NI ELVIS III. This functionality is always active, even if an application is programmatically monitoring the button.

You can also programmatically monitor the button in your application to trigger or control other events. You can acquire the values from the button by using the Button Express VI in an RT application or by using the FPGA I/O node in an FPGA application.

The following figure shows an example of using the Button Express VI, which is highlighted, to monitor the button and display the current state using a Boolean indicator. When you press the button, the Boolean indicator of the VI returns TRUE.
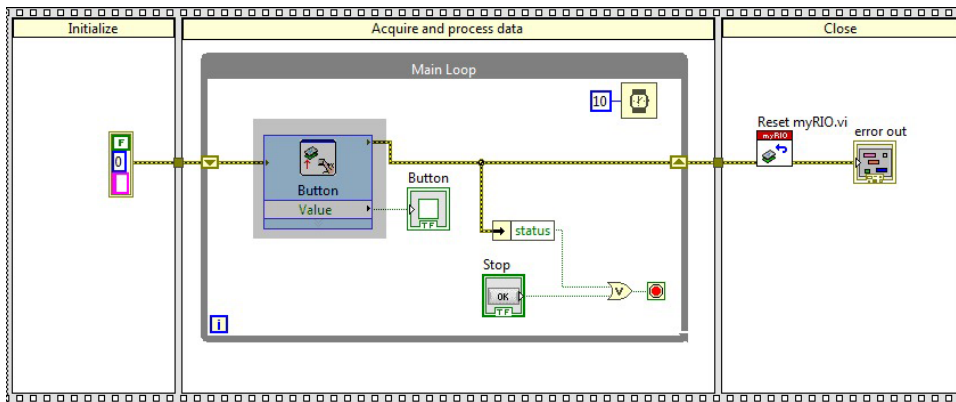
Note Take care when you press and hold the user programmable button to display the device ID and IP addresses. If a running VI is monitoring the button, it cannot differentiate between a button press intended to enable the display and a press intended to trigger an action by the application. Pressing and holding the button enables the display and triggers the programmatic action simultaneously.

Creating an NI ELVIS III Application

This tutorial explains how to create an NI ELVIS III application using the NI ELVIS III Software Bundle. It guides you through creating a project, building the block diagram, and running the application.

- Creating an Project

- <u>Programming the Control I/O</u>

> ✎ **Note** This tutorial does not require the NI ELVIS III Prototyping Board.

Creating an NI ELVIS III Project

Before programming with the NI ELVIS III, you must first create an NI ELVIS III project. With an NI ELVIS III project, you can group together all the files relevant to your application and run VIs on the NI ELVIS III.

Complete the following steps to create an NI ELVIS III project by using the NI ELVIS III Project template.

1. Click **Create New Project** in LabVIEW to display the **Create Project** dialog box.
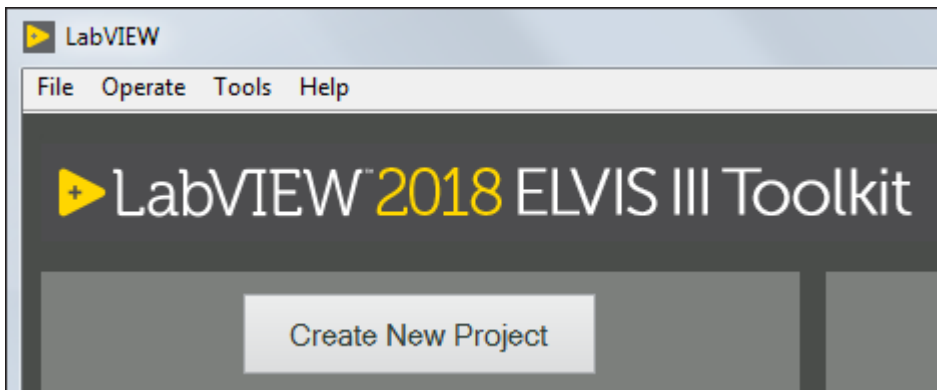
2. Select **Templates** » **NI ELVIS III** from the project category.
3. Select **NI ELVIS III Project** from the project list.
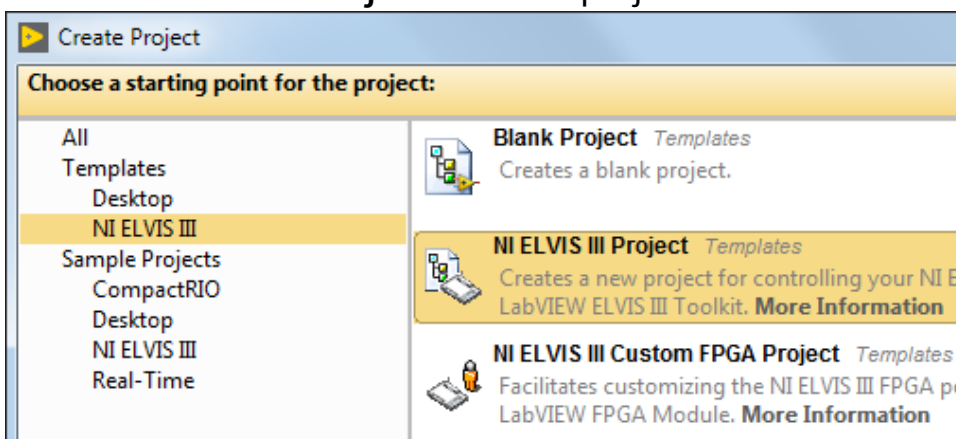
4. Click **Next** to configure details of the new project.

5. In **Project Name**, enter My First ELVIS III Application.

6. In **Project Root**, enter the path to the directory for saving the project.

7. (Optional) In **File Name Prefix**, enter a prefix that distinguishes different copies of templates you create.

8. Under **Target**, select the NI ELVIS III on which to run your application.
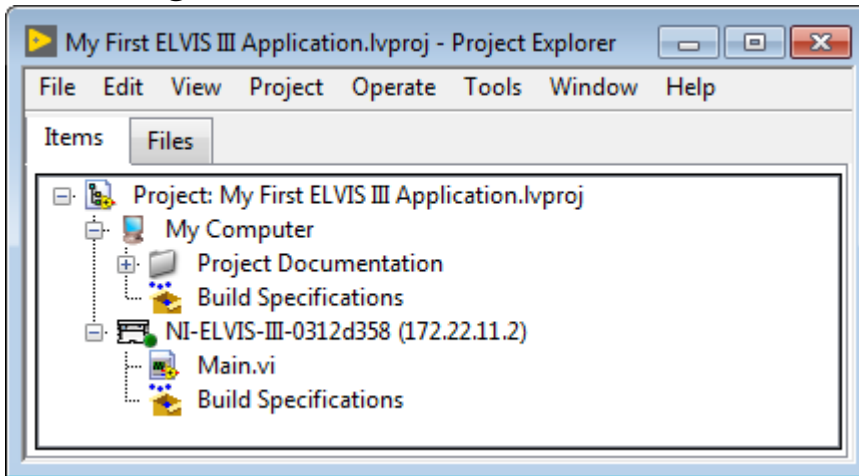
9. Click **Finish**. LabVIEW saves the project and opens the **Project Explorer** window.

10. Explore the **Project Explorer** window. For example, expand items in the project tree to find Main.vi. Refer to the Project Documentation folder for detailed information about the NI ELVIS III project.
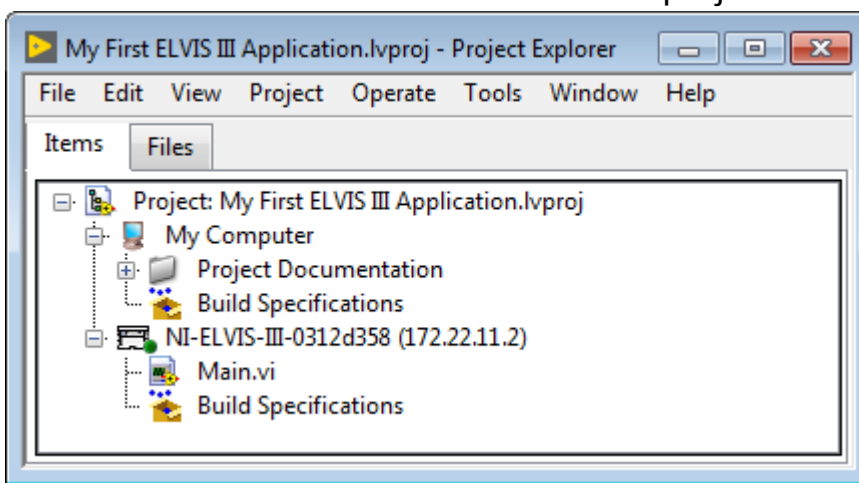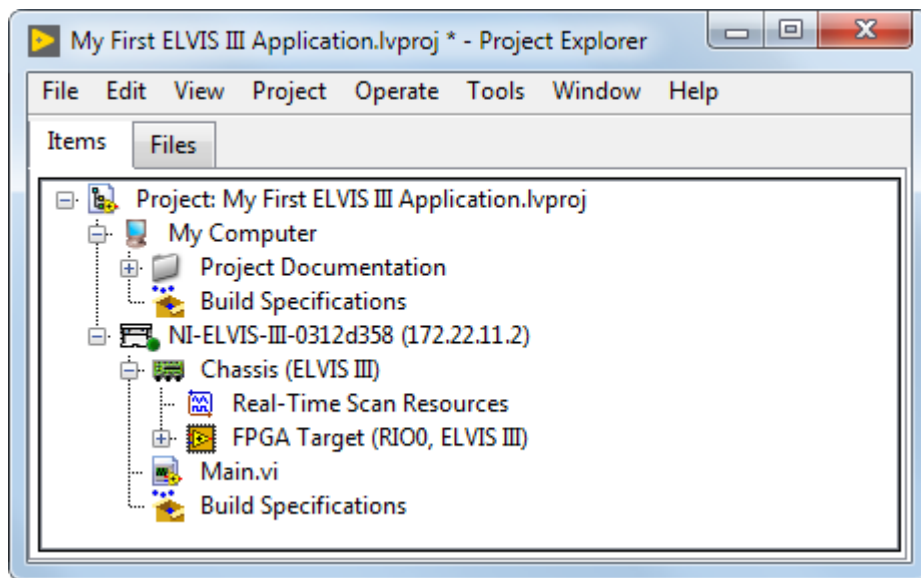
Project Explorer Window

Use the **Project Explorer** window to manage the NI ELVIS III project you have created.
You can use the Project Explorer window to complete the following tasks:

- Managing the targets, VIs, and other support files of a project from one location.

- Connecting the host computer to the targets, setting target properties, and deploying VIs to targets.

The following figure shows the Project Explorer window when you add the NI ELVIS III and its chassis to a LabVIEW project. To add a chassis, right-click the NI ELVIS III target in the Project Explorer window and select **New** » **Targets and Devices**. Locate the chassis you want to add and click **OK**.

The Project Explorer window includes the following components:

- **Project root**—Contains the host computer and the NI ELVIS III you add to the current project. To add more targets to the project, right-click the project root and select **New** » **Targets and Devices** from the shortcut menu.

- **My Computer**—Represents the local or host computer as a target in the project.

    - **Build Specifications**—Includes build configurations for source distributions and other types of builds available in LabVIEW toolkits and modules.

- **RT Target**—Represents the NI ELVIS III you add to the project. VIs and libraries that you add to the NI ELVIS III appear under the target in the Project Explorer window.

    - **FPGA Target**—Represents the FPGA target on the NI ELVIS III.

    - **Build Specifications**—Includes specifications for building source distributions, stand-alone real-time applications, and zip files.

> **Tip** Go to <u>Programming the Control I/O</u> next.

Programming the Control I/O

In this part of the tutorial, you start from a project that monitors the user programmable button on the NI ELVIS III, and extend its functionality to control the user programmable LEDs.

Before starting this part, make sure you have completed the steps to <u>create an NI ELVIS III project</u>.

1. In the Project Explorer window of your NI ELVIS III project, open the Main VI. By default, LabVIEW opens the front panel of the Main VI. The front panel is the user interface of a VI.
2. Press <Ctrl-E> to switch to the block diagram of the Main VI.
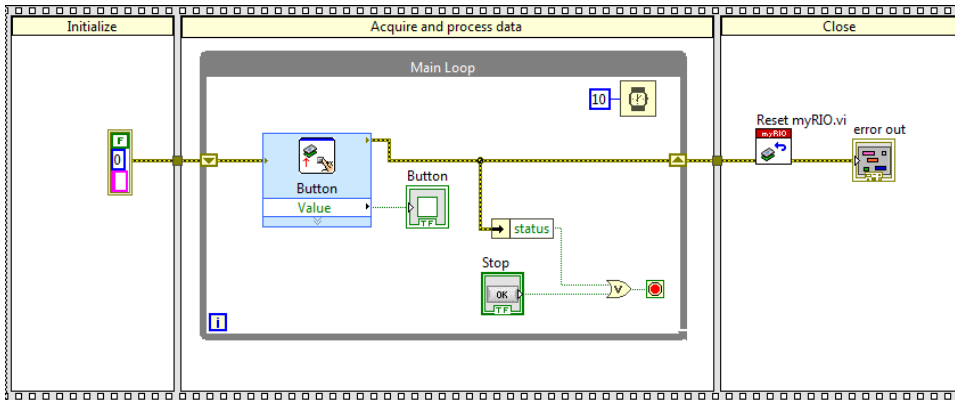
The block diagram contains the graphical code of a VI. The Main VI contains a Button Express VI which reads the Boolean value from the user programmable button and displays the changes of the Boolean values in the LED on the front panel. The Main VI uses a Flat Sequence structure that contains several subdiagrams. Refer to Structures for more information about the structure of the Main VI.

3. Select **View** » **Functions Palette** to display the Functions palette. You can also right-click on the block diagram to display the palette. Navigate to **Functions** » **Academic I/O** » **Control I/O** to locate the LED Express VI.

4. Drop the LED Express VI in the Main Loop of the Main VI by clicking the LED Express VI and then clicking on the block diagram.
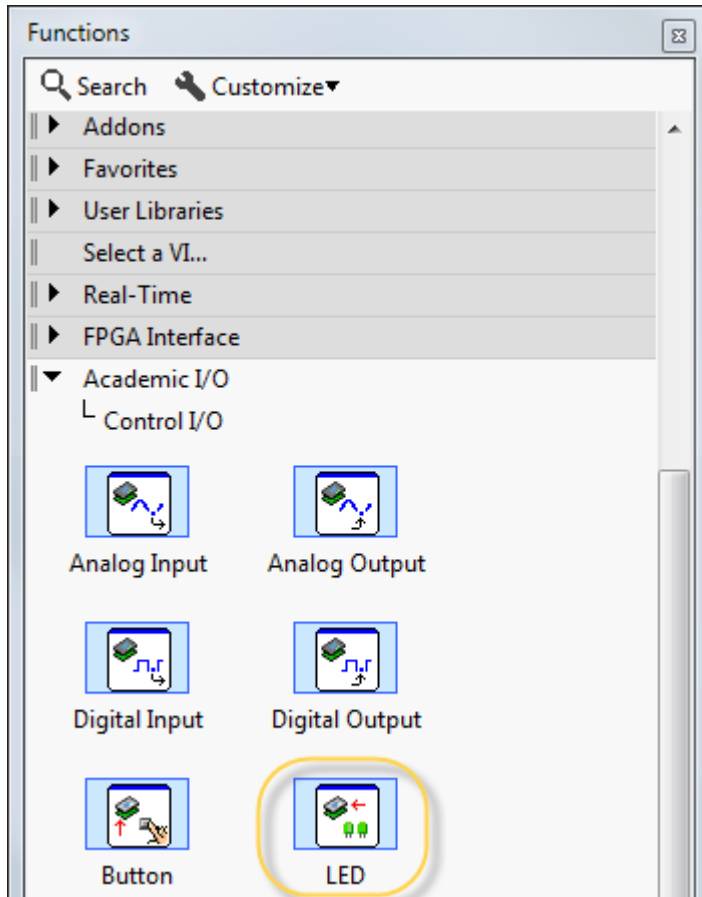
5. Double-click the LED Express VI in the Main Loop to display the configuration dialog box. In the configuration dialog box, press <Ctrl-H> to display the Context Help window. You can move the cursor over options in the configuration dialog box and learn basic information about the options from the Context Help window. Most objects in LabVIEW display context help information.

6. Select the LEDs to control and click **OK** to apply your configuration. This tutorial teaches you to control all the user programmable LEDs.
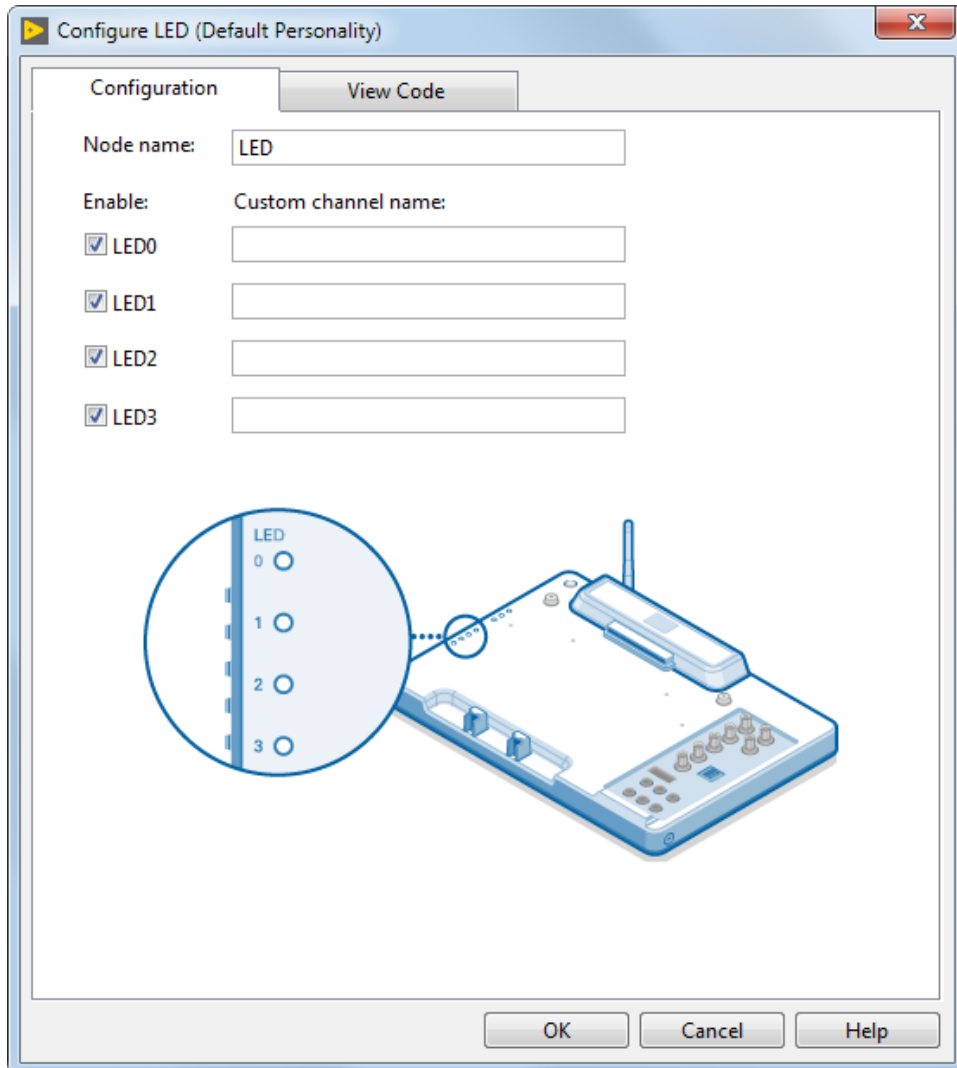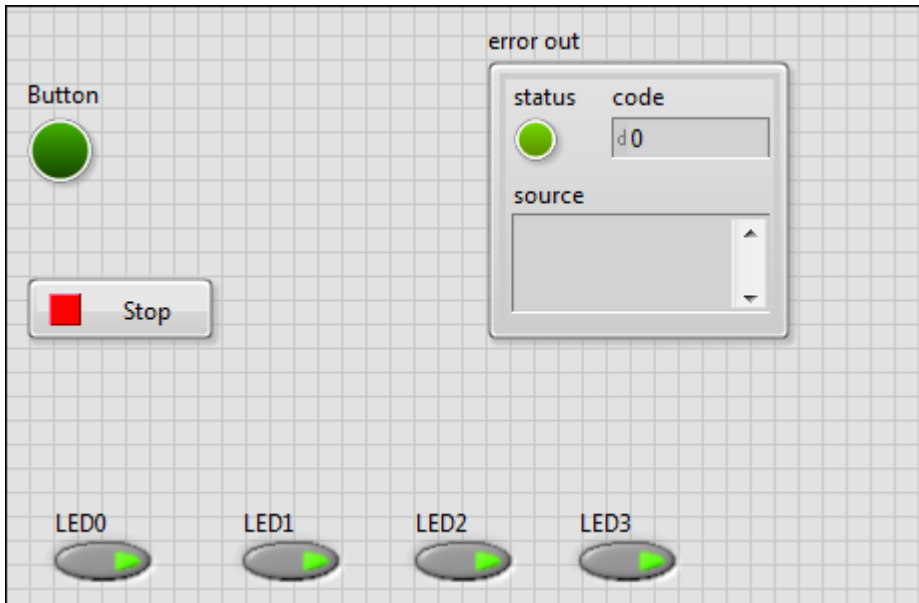
7. Right-click each input of the LED Express VI and select **Create** » **Control** to create Boolean controls for the LEDs. You can click a Boolean control on the front panel to toggle between the TRUE and FALSE states, which determines the ON and OFF states of an LED.
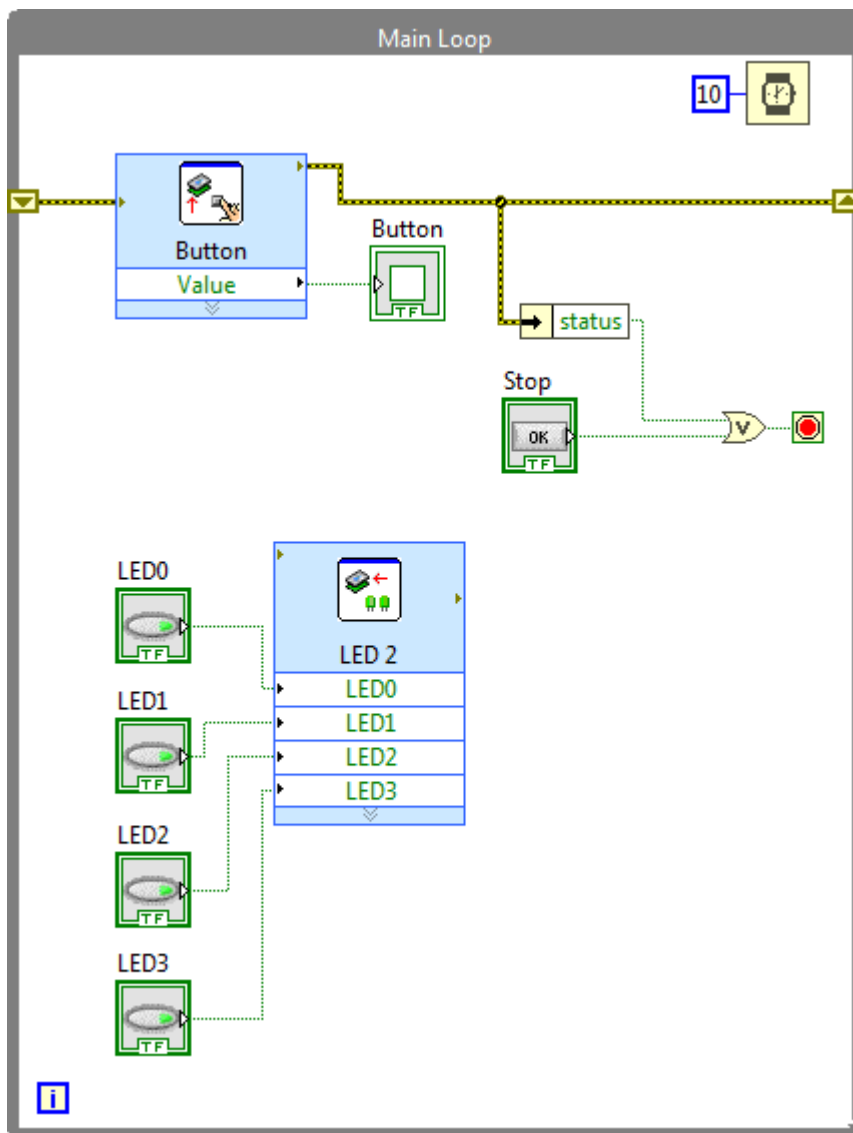
8. Press <Ctrl-E> to switch to the front panel of the Main VI. Arrange the Boolean controls from left to right.

9. Click **Run**. The Deployment Progress window appears, which shows the status of the deployment of the Main VI on the NI ELVIS III.
After the deployment is complete, you can toggle the Boolean controls and observe the state changes of the LEDs.

10. Click **Stop**.

11. Click **File** » **Save** to save the VI.
You have successfully created a VI that controls the user programmable LEDs. Before you proceed to the next step, spend some time understanding the following LabVIEW programming concepts:

- Structures
- Error Checking

Structures
Structures are graphical representations of the loops and case statements of text-based programming languages.
The block diagram of the Main VI contains a Flat Sequence structure, which contains one or more subdiagrams, or frames, that execute sequentially. You can use the Flat Sequence structure for more advanced applications that require sequential execution of subdiagrams. The Flat Sequence structure in the Main VI executes the following frames from left to right:

- **Initialize**—Initializes the **error in** cluster. You can add more code to initialize the NI ELVIS III, variables, and user interface elements, such as controls and indicators, depending on your application needs.

- **Acquire and process data**— Acquires the boolean value from the button on the NI ELVIS III and displays the value by using the Button indicator. The Main Loop repeats code until you click **Stop** or an error occurs.

- **Close**— Resets the FPGA target and all the I/O channels on the NI ELVIS III before the application exits. You can also use this frame to close user interface elements and variables.
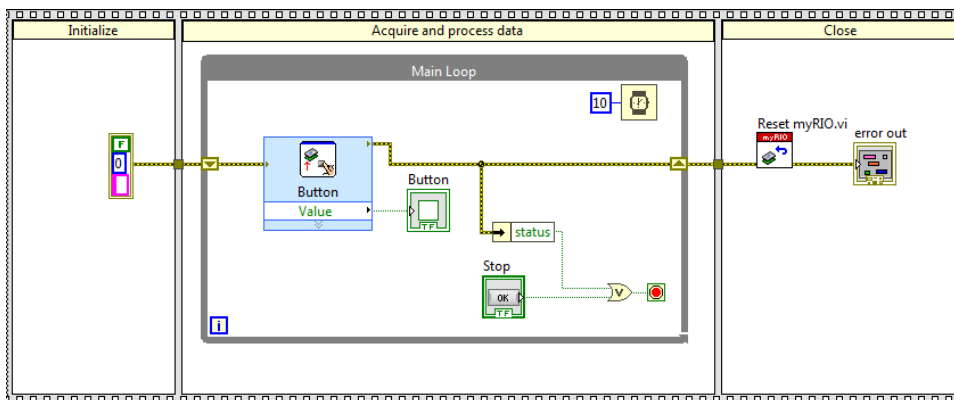
Tip Go to Error Checking next.

Error Checking
Error checking identifies why and where errors occur in your VI.
The current Main VI checks errors in the Button Express VI. If the Button Express VI returns an error, the Main VI stops.
The yellow wire that comes into and out of the Button Express VI is the error wire. The error wire passes the error cluster value, which contains three elements: status, code, and source.

- status is TRUE if an error occurred.
- code is the error or warning code.

- source specifies the origin of the error or warning and is, in most cases, the name of the node that produced the error or warning.

The Unbundle By Name function, which is highlighted in the figure, returns the status element in the error cluster. If the Button Express VI returns an error, status is TRUE, and the Boolean value is passed to the Conditional Terminal, also highlighted. When Conditional Terminal receives a TRUE value, the Main Loop stops repeating the code within its diagram, and the Main VI stops.

To ensure that the Main VI also stops when the LED Express VI returns an error, you must add code to check errors in the LED Express VI. Use the Merge Errors function to merge errors from the Button and LED Express VIs. You can access the Merge Errors function by navigating to **Functions** » **Programming** » **Dialog & User Interface** » **Merge Errors**.

The following figure shows the block diagram after you add the Merge Errors function, which is highlighted. The Main VI stops if the Button Express VI or the LED Express VI returns an error, or if you click Stop on the front panel.