Getting Started with LabVIEW

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National Instruments Corporate Headquarters

11500 North Mopac Expressway   Austin, Texas 78759-3504   USA   Tel: 512 683 0100

Worldwide Offices

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The following conventions are used in this manual:

» — The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options** directs you to pull down the **File** menu, select the **Page Setup** item, and select **Options** from the last dialog box.

💡 — This icon denotes a tip, which alerts you to advisory information.

📝 — This icon denotes a note, which alerts you to important information.

bold — Bold text denotes items that you must select or click on in the software, such as menu items and dialog box options. Bold text also denotes palette and parameter names.

italic — Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. This font also denotes text that is a placeholder for a word or value that you must supply.

`monospace` — Text in this font denotes text or characters that you should enter from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, functions, operations, variables, filenames and extensions, and code excerpts.

Platform — Text in this font denotes a specific platform and indicates that the text following it applies only to that platform.

right-click — **(Macintosh)** Press <Command>-click to perform the same action as a right-click.

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Introduction to LabVIEW

Refer to Appendix A, *System Requirements*, for more information about system configuration requirements. Refer to the *LabVIEW Release Notes* for installation instructions.

What Is LabVIEW?

LabVIEW is a graphical programming language that uses icons instead of lines of text to create applications. In contrast to text-based programming languages, where instructions determine program execution, LabVIEW uses dataflow programming, where the flow of data determines execution.

In LabVIEW, you build a user interface by using a set of tools and objects. The user interface is known as the front panel. You then add code using graphical representations of functions to control the front panel objects. The block diagram contains this code. In some ways, the block diagram resembles a flowchart.

You can purchase several add-on software toolsets for developing specialized applications. All the toolsets integrate seamlessly in LabVIEW. Refer to the National Instruments Web site at `ni.com` for more information about these toolsets.

LabVIEW is integrated fully for communication with hardware such as GPIB, VXI, PXI, RS-232, RS-485, and data acquisition control, vision, and motion control devices. LabVIEW also has built-in features for connecting your application to the Internet using the LabVIEW web server and software standards such as TCP/IP networking and ActiveX.

Using LabVIEW, you can create 32-bit compiled applications that give you the fast execution speeds needed for custom data acquisition, test, measurement, and control solutions. You also can create stand-alone executables and shared libraries, like DLLs, because LabVIEW is a true 32-bit compiler.

LabVIEW contains comprehensive libraries for data collection, analysis, presentation, and storage. LabVIEW also includes traditional program development tools. You can set breakpoints, animate program execution, and single-step through the program to make debugging and development easier.

LabVIEW also provides numerous mechanisms for connecting to external code or software through DLLs, shared libraries, ActiveX, and more. In addition, numerous add-on tools are available for a variety of application needs.

Why Should I Use LabVIEW?

LabVIEW empowers you to build your own solutions for scientific and engineering systems. LabVIEW gives you the flexibility and performance of a powerful programming language without the associated difficulty and complexity.

LabVIEW gives thousands of successful users a faster way to program instrumentation, data acquisition, and control systems. By using LabVIEW to prototype, design, test, and implement your instrument systems, you can reduce system development time and increase productivity by a factor of 4 to 10.

LabVIEW also gives you the benefits of a large installed user base, years of product feedback, and powerful add-on tools. Finally, National Instruments technical support and Developer Zone ensure successful development of your solutions.

How Does LabVIEW Work?

LabVIEW programs are called virtual instruments, or VIs, because their appearance and operation imitate physical instruments, such as oscilloscopes and multimeters. Every VI uses functions that manipulate input from the user interface or other sources and display that information or move it to other files or other computers.

A VI contains the following three components:

- **Front panel**—Serves as the user interface.
- **Block diagram**—Contains the graphical source code that defines the functionality of the VI.
- **Icon and connector pane**—Identifies the VI so that you can use the VI in another VI. A VI within another VI is called a subVI. A subVI corresponds to a subroutine in text-based programming languages.

Front Panel

The front panel is the user interface of the VI. You build the front panel with controls and indicators, which are the interactive input and output terminals of the VI, respectively. Controls are knobs, pushbuttons, dials, and other input devices. Indicators are graphs, LEDs, and other displays. Controls simulate instrument input devices and supply data to the block diagram of the VI. Indicators simulate instrument output devices and display data the block diagram acquires or generates.

Block Diagram

After you build the front panel, you add code using graphical representations of functions to control the front panel objects. The block diagram contains this graphical source code. Front panel objects appear as terminals on the block diagram.

Additionally, the block diagram contains functions and structures from built-in LabVIEW VI libraries. Wires connect each of the nodes on the block diagram, including control and indicator terminals, functions, and structures.

Palettes

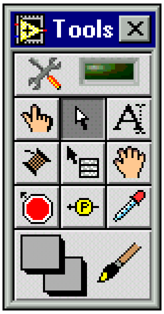
LabVIEW palettes give you the options you need to create and edit the front panel and block diagram.

Tools Palette

The **Tools** palette is available on the front panel and the block diagram. A tool is a special operating mode of the mouse cursor. When you select a tool, the cursor icon changes to the tool icon. Use the tools to operate and modify front panel and block diagram objects.

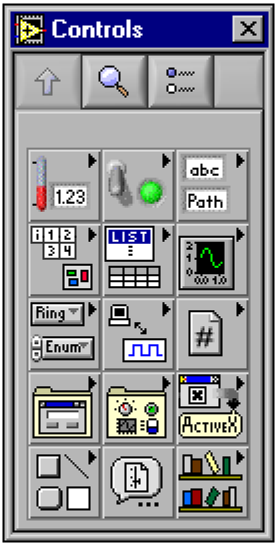
Select **Window»Show Tools Palette** to display the **Tools** palette. You can place the **Tools** palette anywhere on the screen.

If automatic tool selection is enabled and you move the cursor over objects on the front panel or block diagram, LabVIEW automatically selects the corresponding tool from the **Tools** palette.



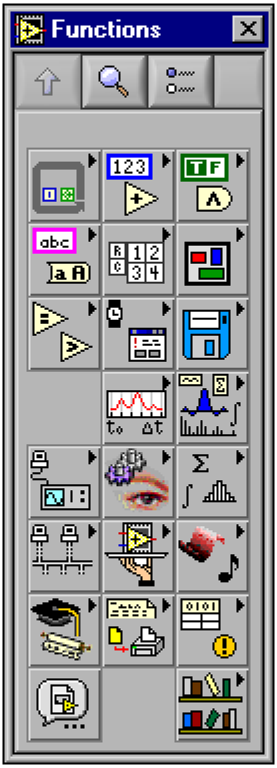
Controls Palette

The **Controls** palette is available only on the front panel. The **Controls** palette contains the controls and indicators you use to create the front panel. Select **Window»Show Controls Palette** or right-click the front panel workspace to display the **Controls** palette. You can place the **Controls** palette anywhere on the screen.



Functions Palette

The **Functions** palette is available only on the block diagram. The **Functions** palette contains the VIs and functions you use to build the block diagram. Select **Window»Show Functions Palette** or right-click the block diagram workspace to display the **Functions** palette. You can place the **Functions** palette anywhere on the screen.



Navigating the Controls and Functions Palettes

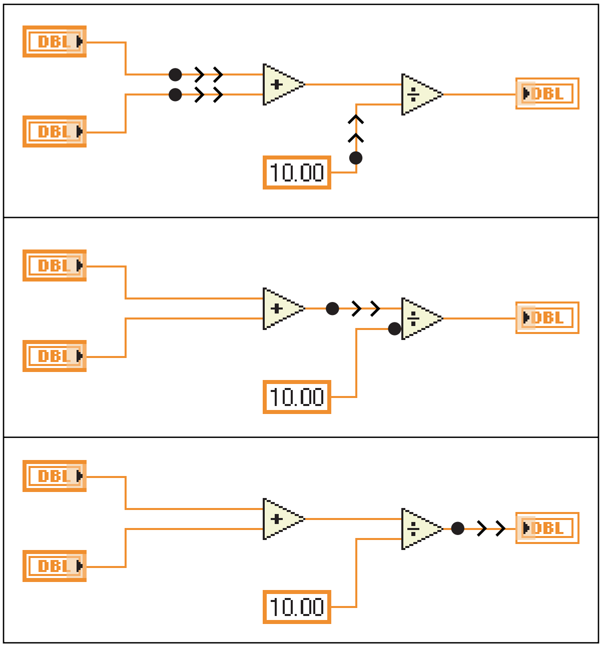
Use the navigation buttons on the **Controls** and **Functions** palettes to navigate and search for controls, VIs, and functions. When you click a subpalette icon, the entire palette changes to the subpalette you selected. You also can right-click a VI icon on the palette and select **Open VI** from the shortcut menu to open the VI.

The **Controls** and **Functions** palettes contain the following navigation buttons:

- **Up**—Takes you up one level in the palette hierarchy.
- **Search**—Changes the palette to search mode. In search mode, you can perform text-based searches to locate controls, VIs, or functions in the palettes.
- **Options**—Opens the **Function Browser Options** dialog box, from which you can configure the appearance of the palettes.

Data Flow

LabVIEW follows a dataflow model for running VIs. A block diagram node executes when all its inputs are available. When a node completes execution, it supplies data to its output terminals and passes the output data to the next node in the dataflow path.



Where Do I Start?

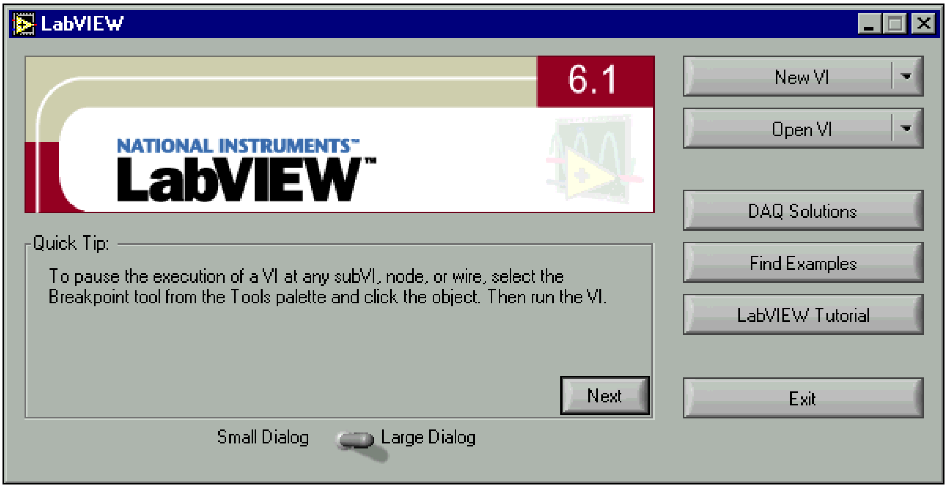
If you are new to LabVIEW, use this *Getting Started with LabVIEW* manual and the *LabVIEW Tutorial* to help you get started quickly. The *LabVIEW Tutorial* introduces you to the LabVIEW environment. This manual teaches you how to build VIs for data acquisition and instrument control and how to debug them. It also teaches you how to find example VIs.

You can complete the activities in this book in approximately 90 minutes.

LabVIEW Tutorial

Use this tutorial to learn basic LabVIEW concepts. The tutorial guides you through several activities to familiarize you with graphical programming. Access the *LabVIEW Tutorial* by selecting **Help»VI, Function, and How-To Help** or by clicking the **LabVIEW Tutorial** button in the **LabVIEW** dialog box, shown in the following illustration.

You can complete the *LabVIEW Tutorial* in approximately 15 minutes.



Quick Tip:

To pause the execution of a VI at any subVI, node, or wire, select the Breakpoint tool from the Tools palette and click the object. Then run the VI.

Either launch LabVIEW or close all open VIs if you are already running LabVIEW to access the **LabVIEW** dialog box.

After you finish the *LabVIEW Tutorial*, continue with the activities in this manual to learn how to build LabVIEW programs for instrument I/O, data acquisition, and control.

You should complete the activities in this book in the order in which they appear because subsequent activities build on the sample programs you create. Approximate completion times are given for each activity and each section within an activity.

2

Virtual Instruments

This chapter teaches you step by step how to create an application in LabVIEW. It also teaches you how to find example VIs in LabVIEW. Complete the LabVIEW tutorial before starting the activities in this chapter.

You will learn to do the following:

- Create a new program in LabVIEW. The VI you build generates data, analyzes it, then writes it to a file.
- Find and run an example VI.

Search for Example VIs

LabVIEW includes hundreds of example VIs you can use and incorporate into your own VIs. You can modify an example to fit your application, or you can copy and paste from one or more examples into your own VI.

You can complete this activity in approximately 5 minutes.

1. In the **LabVIEW** dialog box, click the **Find Examples** button to display the **Find Examples** dialog box. If you already opened a VI, select **Help»Find Examples** to display the **Find Examples** dialog box.
2. On the **Browse** tab, navigate to the **Industry Applications»Analysis** category. You also can search by keyword on the **Search** tab.
3. Double-click **Temperature System Demo** to open this example VI.
4. Click the **Run** button, shown at left, on the front panel toolbar to see how the VI runs.
5. Click the sliders, knobs, and other controls to see how they affect the data.
6. Stop the program by moving the **Acquisition** switch to the **off** position.
7. Close the example and use the **Find Examples** dialog box to browse or search for other example VIs.

Refer to the Developer Zone on the National Instruments Web site at `zone.ni.com` for additional example VIs.

Build a Virtual Instrument

This activity demonstrates how you can build a VI that plots, analyzes, and saves data.

You can complete this activity in approximately 30 minutes.

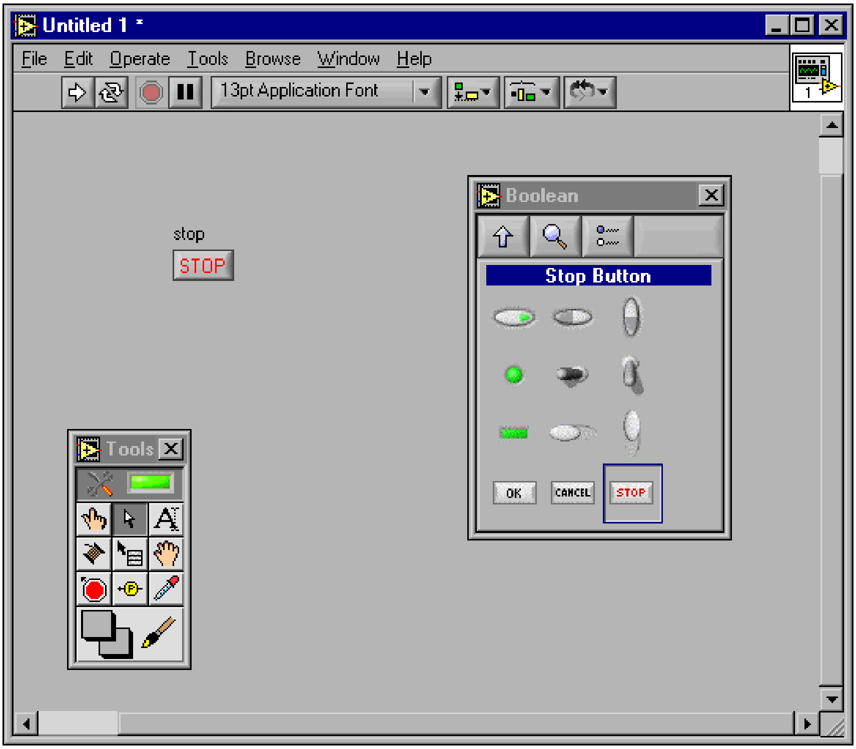
Create a User Interface

You can create a graphical user interface on the front panel using controls and indicators on the **Controls** palette.

You can complete this section in approximately 5 minutes.

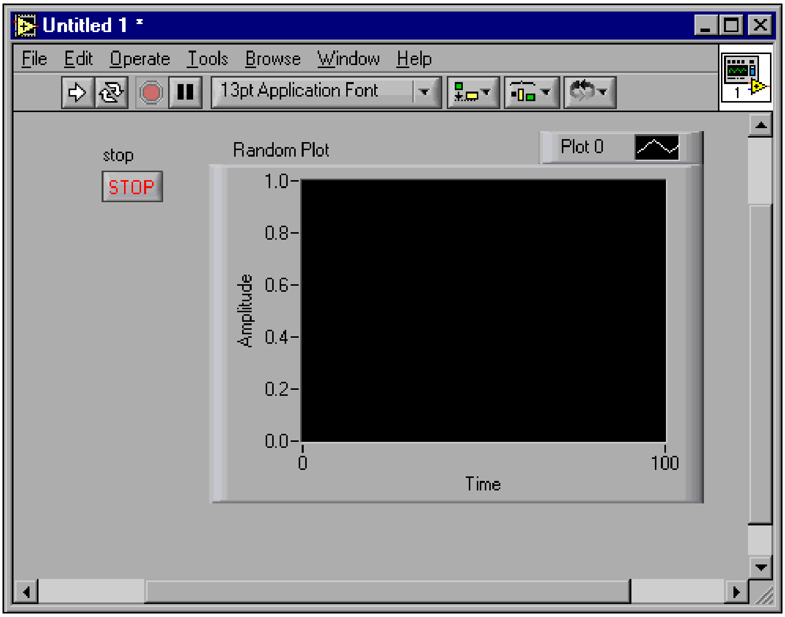
1. Create a new VI by clicking the **New VI** button in the **LabVIEW** dialog box.

   Either launch LabVIEW or close all open VIs if you are already running LabVIEW to access the **LabVIEW** dialog box.
2. Select **Window»Show Tools Palette** to display the **Tools** palette.
3. If the **Automatic Tool Selection** LED in the **Tools** palette is not lit, click the **Automatic Tool Selection** button, shown at left, to enable automatic tool selection.
4. Select **Window»Show Controls Palette** to display the **Controls** palette.
5. Select a stop button on the **Controls»Boolean** palette and place it on the front panel, as shown in the following example.



Tip You can right-click the object and select **Visible Items»Label** from the shortcut menu to hide the text label.

6. Click the **Up** button on the **Controls** palette toolbar, shown at left, to navigate back to the main **Controls** palette.
7. Select a waveform chart on the **Controls»Graph** palette and place it on the front panel. This chart plots data one point at a time.
8. When you place the chart on the front panel, LabVIEW highlights the label and selects the Labeling tool, shown at left. Type `Random Plot` and press the <Shift-Enter> keys to edit the label. To edit the label again, double-click the label to switch to the Labeling tool and highlight the text you want to edit.
9. Double-click **-10.0** on the y-axis of the chart and type `0.0` to change the scale. Double-click **10.0** on the y-axis and type `1.0` to change the scale. The front panel should appear similar to the following example.



Build the Block Diagram

So far, you have defined how the user interface will look. Now you can create the source code on the block diagram. For this VI, you generate random numbers ranging from zero to one and plot them on a chart.

You can complete this section in approximately 5 minutes.

1. Display the block diagram by selecting **Window»Show Diagram** or clicking the block diagram window. The two terminals on the block diagram correspond to the **Stop** button and the Random Plot waveform chart on the front panel.

Tip Press the <Ctrl-E> keys to switch between the front panel and block diagram.

2. Select **Window»Show Functions Palette** to show the **Functions** palette.
3. Select the Random Number (0–1) function on the **Functions» Numeric** palette and move the function close to the Random Plot terminal to draw a temporary wire between the two objects.
4. Click to place the function. LabVIEW connects the function to the terminal with a wire.

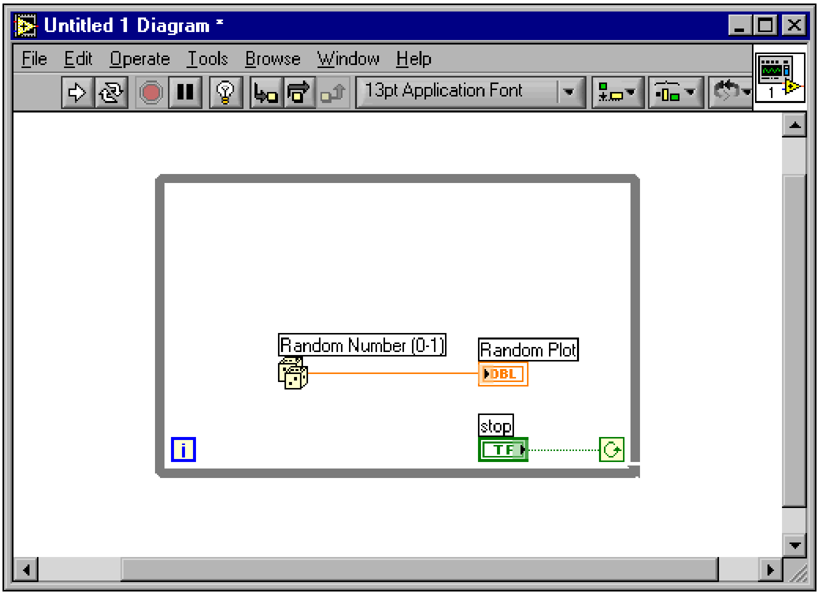
5. (Optional) Use the Positioning tool, shown at left, to rearrange or resize objects. Move the cursor over the center of an object to select the Positioning tool.

    - To move an object, click the object and release the mouse button to select the object. A moving dashed outline called a marquee highlights the object. Drag the object to move it.
    - To resize an object, move the cursor over a corner of the object to display resizing handles. Move the Positioning tool over a resizing handle to change the tool to the resizing cursor. Use the resizing cursor to drag the resizing handles until the dashed border outlines the size you want, and release the mouse button.

6. Select a While Loop on the **Functions»Structures** palette. The While Loop runs all code within its boundaries until the conditional terminal receives a TRUE or FALSE value. The default behavior is **Continue if True**, shown at left.

7. Place the mouse cursor in the position on the block diagram where you want to anchor the top left corner of the While Loop.

8. Drag the dotted rectangle diagonally to enclose the function and both terminals. The block diagram should appear similar to the following example.



Wire and Run the VI

You transfer data among block diagram objects through wires. Each wire has a single data source, but you can wire it to many VIs and functions that read the data. Wires are different colors, styles, and thicknesses, depending on their data types. A broken wire appears as a dashed black line. When you finish wiring this VI, you can run it from the front panel to see it plot data to the chart.

You can complete this section in approximately 5 minutes.

1. Complete the following steps to wire the **Stop** terminal to the While Loop conditional terminal, shown at left.

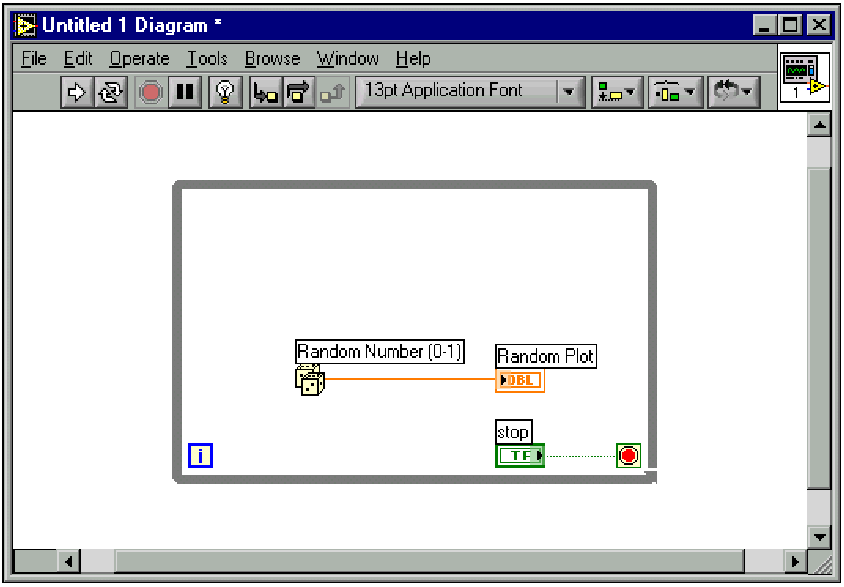
   a. Move the cursor over the arrow on the **Stop** terminal. LabVIEW selects the Wiring tool, shown at left, and the terminal blinks.

Note If the Stop terminal is highlighted by a marquee, you must deselect the terminal by clicking any open space on the block diagram before you can wire the terminal.

   b. Click the blinking terminal and move the cursor over the conditional terminal so it blinks.

   c. Click the blinking conditional terminal to draw a wire between the two objects.

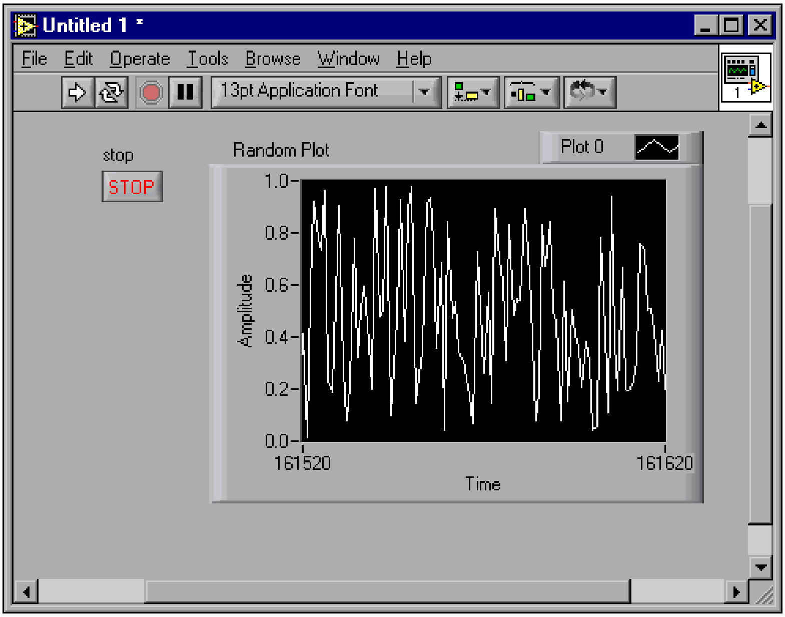
2. Because this VI uses a **Stop** button, you must change the behavior of the conditional terminal to **Stop if True**. Right-click the conditional terminal or the border of the While Loop and select **Stop if True** from the shortcut menu. The appearance of the conditional terminal changes as shown at left. The block diagram should appear similar to the following example.



3. Display the front panel by pressing the <Ctrl-E> keys.

4. Click the **Run** button, shown at left, on the toolbar to run the VI.

5. Click the **Stop** button to stop the VI. The front panel should appear similar to the following example.



Add Timing to the VI

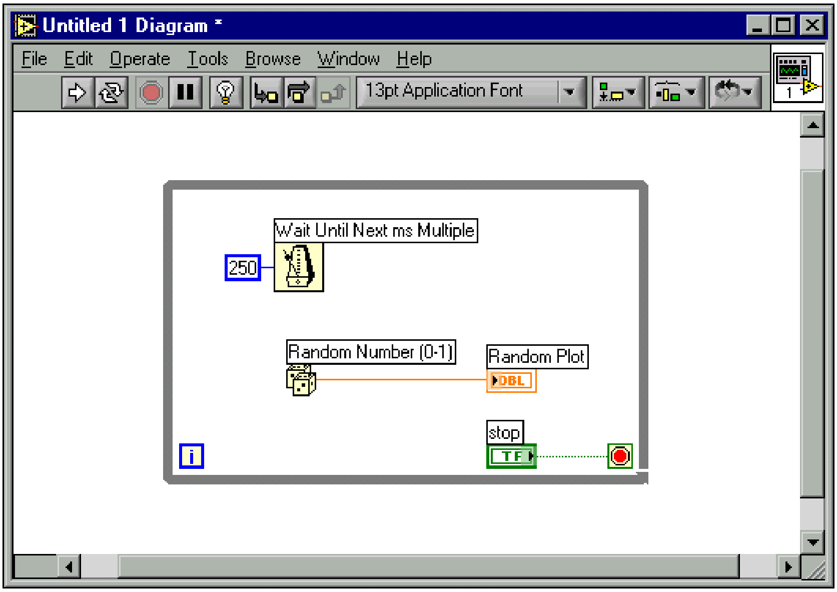
You can add a timing delay to the VI to plot the points more slowly on the waveform chart.

You can complete this section in approximately 5 minutes.

1. Display the block diagram by pressing the <Ctrl-E> keys.
2. Select the Wait Until Next ms Multiple function on the **Functions»Time & Dialog** palette and place it inside the While Loop.
3. Move the cursor over the **millisecond multiple** terminal on the left side of the Wait Until Next ms Multiple function until the terminal blinks. LabVIEW selects the Wiring tool, shown at left.
4. Right-click the terminal and select **Create»Constant** from the shortcut menu.

5. Type `250` in the **millisecond multiple** constant to create a 250 ms delay between the generation of points to plot for the chart. The block diagram should appear similar to the following example.

Tip To edit a block diagram constant value, double-click the constant.



6. On the front panel, click the **Run** button, shown at left, to run the VI and observe the delay effect.

7. Select **File»Save As** and save this VI as `Random Number Example.vi` in `labview\vi.lib\tutorial.llb`.

Add Analysis and File I/O to the VI

You can average the random data points you have collected and save the data to a spreadsheet file.

You can complete this section in approximately 15 minutes.

1. Display the block diagram of the Random Number Example VI you created. If the VI is not already open, select **File»Open** and browse to the Random Number Example VI in `labview\vi.lib\tutorial.llb`.

2. Select the Add Array Elements function and the Divide function on the **Functions»Numeric** palette and place them outside the While Loop.
3. Select the Array Size function on the **Functions»Array** palette and place it outside the While Loop.

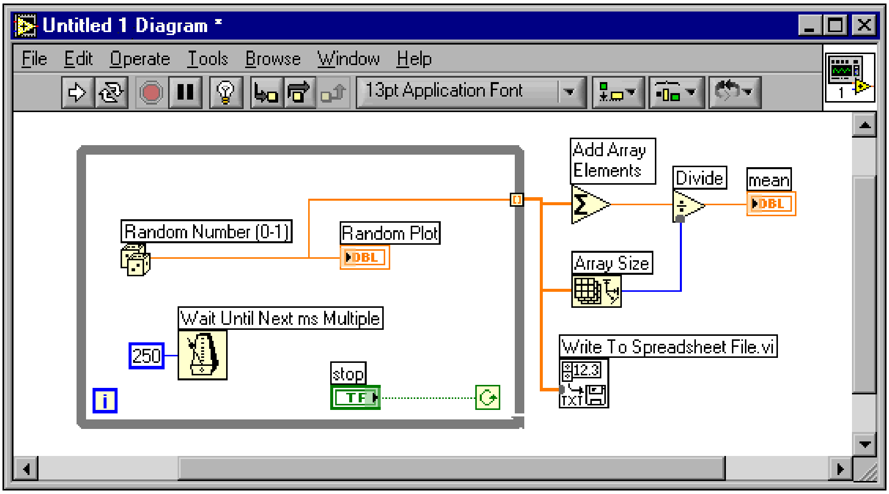
Note It is important to place the functions outside the While Loop because you want to compute the data mean only after the While Loop collects all the data.

4. Wire the **sum** terminal on the right side of the Add Array Elements function to the **x** terminal on the left side of the Divide function.
5. Wire the **size(s)** terminal on the right side of the Array Size function to the **y** terminal on the left side of the Divide function.
6. Use the Wiring tool to right-click the **x/y** terminal on the right side of the Divide function and select **Create»Indicator** from the shortcut menu to create a numeric indicator on the front panel to display the mean of the random data.
7. Select the Write To Spreadsheet File VI on the **Functions»File I/O** palette and place it outside the While Loop.
8. Complete the following steps to create a wire branch.
    a. Move the cursor over the wire connecting the Random Number (0–1) function and the **Random Plot** indicator.
    b. Press the <Ctrl> key to temporarily switch to the Wiring tool while you click the wire.
    c. Click the **Numeric Array** input terminal of the Add Array Elements function. LabVIEW draws a wire connecting the existing wire and the **Numeric Array** input. A broken wire appears to indicate that you are trying to wire terminals of different data types. You will correct the broken wire in step 11.

Tip You also can right-click the existing wire and select **Create Wire Branch** from the shortcut menu.

9. Create another wire branch from the branch you created in the previous step. Wire this new branch from the segment outside the loop to the **1D data** input of the Write to Spreadsheet File VI. You use the **1D data** input because the While Loop creates a one-dimensional row of data from the generated random numbers. The wire appears broken, but you will correct it in step 11.
10. Create another wire branch from the segment outside the loop to the **array** input of the Array Size function.

11. The orange square on the While Loop is a data exit terminal called a tunnel. Right-click the tunnel and select **Enable Indexing** from the shortcut menu to allow the While Loop to collect the data and pass it to the Add Array Elements function as a one-dimensional row of data when the loop terminates. The broken wires change to solid orange wires because the terminals are now of the same data type. The block diagram should appear similar to the following illustration.



12. Display the front panel and click the **Run** button, shown at left, to run the VI.

13. Click the **Stop** button to see the mean of the data. Because the functions that determine the mean are outside the While Loop, the VI does not display the mean until you click the **Stop** button. The **Choose file to write** dialog box prompts you for the name of the file for saving the random number data points.

14. Type `data.txt` and click the **Save** button.

15. Use any text editor to open `data.txt` and view the data.

Note You can find the solution to this activity in `LabVIEW\vi.lib\tutorial.llb\Random Number Example Solution.vi`.

3

Measurement

This chapter teaches you some basics on how to use LabVIEW to configure, communicate with, and acquire data from special purpose instruments and general purpose data acquisition (DAQ) hardware.

Refer to the National Instruments Developer Zone, at `zone.ni.com`, which offers measurement and automation resources including examples, technical presentations, instrument drivers, and tutorial information. Also, refer to the *LabVIEW Measurements Manual* for more information about how to take and analyze measurements in LabVIEW.

Instrument I/O

This section introduces you to the basic concepts on how to use LabVIEW to acquire data from instruments controlled by GPIB, VXI, RS-232, and other hardware standards. This section also shows you how to run the Demo Scope VI if you do not have instrument I/O hardware installed.

LabVIEW communicates with most instruments through instrument drivers, which are libraries of VIs that control programmable instruments. LabVIEW instrument drivers simplify instrument control and reduce test development time by eliminating the need to learn the low-level programming protocol for each instrument.

Instruments obey a set of commands to respond to remote control and requests for data. When you use LabVIEW instrument drivers, you run intuitive, high-level command VIs, such as the Read DC Voltage VI for a digital multimeter or the Configure Time Axis VI for a digital oscilloscope. The driver VI you call automatically sends the appropriate instrument-specific command strings to the instrument.

The foundation for LabVIEW drivers is the VISA (Virtual Instrument Software Architecture) VI library, a single interface library for controlling GPIB, VXI, RS-232, and other types of instruments. Drivers using VISA are scalable across instrument I/O interfaces.

Refer to Part IV, *Instrument Control in LabVIEW*, of the *LabVIEW Measurements Manual* for more information about instrument control, instrument drivers, and using VISA to communicate with instruments.

Run the Demo Scope VI

If you do not have instrument I/O hardware installed, run the Demo Scope VI. The Demo Scope VI is the demonstration equivalent of a Getting Started VI for an actual instrument driver.

You can complete this activity in approximately 5 minutes.

1. Open the Demo Scope VI instrument driver in `LabVIEW\vi.lib\tutorial.llb`.
2. Click on the **Run** button to acquire simulated data on one or two channels on the oscilloscope. Change the **Time Base** and **Volts/Division** settings to see the effects.
3. Click the **STOP** button to stop the VI.
4. View the block diagram. Notice that Initialize is called first, followed by the commands to send to the instrument in the Application Example VI. The Close VI then closes communication with the instrument. When you program with LabVIEW drivers, follow this model to initialize the instrument, then call the functions to control the instrument, and finally close the instrument for communication.

Data Acquisition

This section teaches you how to use LabVIEW with general purpose data acquisition (DAQ) hardware. If you use only stand-alone instruments and control them with GPIB, VXI, or serial standards, refer to the *Instrument I/O* section of this chapter.

Refer to Part II, *DAQ Basics*, of the *LabVIEW Measurements Manual* for more information about data acquisition in LabVIEW.

Note Data acquisition and the DAQ wizards are available on Windows and Macintosh only.

You will learn to do the following:

- Use the *DAQ Solution Wizard* to generate solutions for data acquisition applications.
  - Use the *DAQ Channel Wizard* to configure an analog input channel.
  - Generate a solution from the *Solutions Gallery*.
- Add analog input to the VI you created in Chapter 2, *Virtual Instruments*.

Note Refer to your hardware manual or the NI-DAQ Help file for data acquisition hardware installation and configuration instructions.

Use the DAQ Solution Wizard

If you are using DAQ hardware, you must configure analog input, analog output, digital input, or digital output channels. You can launch the DAQ Channel Wizard from the *DAQ Solution Wizard* to configure the channels. Then you can generate a DAQ solution from the Solutions Gallery.

On Windows, you access the DAQ Channel Wizard by selecting **Tools»Measurement & Automation Explorer** and clicking Data Neighborhood. On Macintosh you can access the DAQ Channel Wizard by selecting **Tools»Data Acquisition»DAQ Channel Wizard**. The DAQ Channel Wizard also can be accessed from the DAQ Solution Wizard.

You can complete this activity in approximately 15 minutes.

Configure Analog Input Channels

The DAQ Solution Wizard guides you through naming and configuring analog and digital channels using the DAQ Channel Wizard. The DAQ Channel Wizard helps you define the physical quantities you are measuring or generating on each DAQ hardware channel. It queries for information about the physical quantity being measured, the sensor or actuator being used, and the associated DAQ hardware.

You can complete this section in approximately 5 minutes.

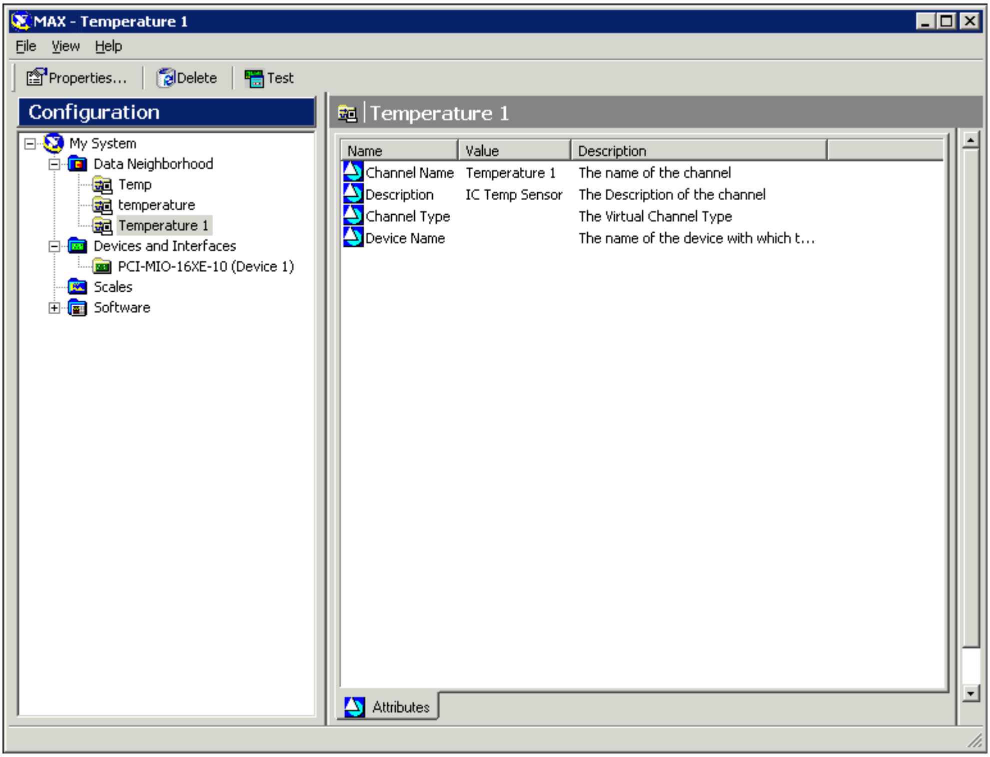
1. Click the **DAQ Solutions** button in the **LabVIEW** dialog box to launch the **DAQ Solution Wizard** and get started with analog input quickly and easily.

Either launch LabVIEW or close all open VIs if you are already running LabVIEW to access the **LabVIEW** dialog box.

2. When the **Welcome to the DAQ Solution Wizard** dialog box appears, click the **Go to DAQ Channel Wizard** button.
3. **(Windows)** Select the Data Neighborhood category from **Tools»Measurement & Automation Explorer**. Right-click Data Neighborhood and select **Create New** from the shortcut menu to configure a new channel. In the **Create New** dialog box select **Virtual Channel** and click the **Finish** button.

   (Macintosh) Select **New Channel** to configure a new channel.

   The DAQ Channel Wizard helps you configure analog and digital channels by name so you can use those names in your program. The DAQ Channel Wizard also conditions those channels so signal conditioning, such as scaling factors and cold-junction compensation, is performed transparently.
4. Select **Analog Input** as the channel type to configure and click the **Next** button. You also can configure analog output and digital input/output in the DAQ Channel Wizard.
5. Type a channel name and channel description in the appropriate text boxes. Click the **Next** button to continue.
6. Select the type of sensor. If the channel is a temperature measurement, click the check box. Click the **Next** button to continue.
7. Define the physical quantity that you are measuring. Select the units for your measurement and enter the range for the signal in the appropriate boxes. Click the **Next** button to continue.
8. Define how the sensor scales the signal from the physical units to the hardware units. Click the **Next** button to continue.
9. Select the data acquisition device and channel settings. If you have multiple DAQ hardware devices installed, choose the device that will read this signal. Click the **Finish** button to configure the analog input channel.
10. Notice that the new configuration is listed under Data Neighborhood **(Windows)**, as shown in the following illustration, or in the main DAQ Channel Wizard view **(Macintosh)**. You have finished configuring an analog input channel for your DAQ hardware. Select **File»Close** to close Measurement & Automation Explorer **(Windows)**. Select **Quit** to exit the DAQ Channel Wizard **(Macintosh)**.



Name	Value	Description
Channel Name	Temperature 1	The name of the channel
Description	IC Temp Sensor	The Description of the channel
Channel Type		The Virtual Channel Type
Device Name		The name of the device with which t...

Generate a Solution from the Solutions Gallery

After you have configured the channel, you can generate a solution from the Solutions Gallery.

You can complete this section in approximately 10 minutes.

1. When you return to the DAQ Solution Wizard, select **Use channel names specified in DAQ Channel Wizard** and click the **Next** button.
2. Select **Solutions Gallery** and click the **Next** button to open the Solutions Gallery.
3. Choose a solution to generate for the analog input channel. For this example, in the Gallery Categories list, select **Data Logging**.
4. In the Common Solutions list, select **Simple Data Logger**.
5. Click the **Next** button to continue.
6. Select the channel name you configured in the DAQ Channel Wizard as the input channel to use for the solution.

7. Click the **Open Solution** button to generate the solution.
8. Click the **Run** button to take data from the configured analog input channel and log the data to a file. A file dialog box prompts you for a file name. Type `data.txt` and click the **Save** button.
9. Click the **STOP** button in the lower-right corner of the front panel to stop the VI. Use any text editor to view `data.txt`.

Tip You can customize the front panel and block diagram of the VI solution and save your customized solutions.

10. Save any changes you want to keep and close this VI.
11. View the DAQ Solution Wizard window and click the **Back** button to browse other gallery categories and common solution VIs.
12. Click the **Cancel** button to exit the DAQ Solution Wizard.

Add Analog Input to the VI

The Random Number Example VI you created in Chapter 2, *Virtual Instruments* generates random numbers and plots them to a chart. Now you will replace the random number generator with an analog input VI to acquire data from your DAQ device, plot it on a chart, analyze it, and write it to a file.

You can complete this activity in approximately 5 minutes.

Note If you have not built the Random Number Example VI, you can find the solution VI in `LabVIEW\vi.lib\tutorial.llb\Random Number Example Solution.vi`.

1. Open the Random Number Example VI from `labview\vi.lib\tutorial.llb`.
2. View the block diagram. Right-click the Random Number function, and select **Replace»Data Acquisition»Analog Input» AI Sample Channel** to replace the Random Number function with the AI Sample Channel VI. Be sure to select the AI Sample Channel VI and not the AI Sample Channels VI. Note that the output has changed from a double-precision number to a waveform. This allows timing information to flow to the chart for display.
3. Use the Wiring tool to right-click the **channel (0)** input of the AI Sample Channel VI and select **Create Constant** from the shortcut menu to specify the name of the channel from which you will acquire data.

4. Select the name of the channel you already configured in the DAQ Channel Wizard from the pull-down menu on the constant.
5. View the front panel. Right-click the graph and select **Y Scale»AutoScale Y** from the shortcut menu.
6. Click the **Run** button to acquire and display data on the chart.
7. Click the **Stop** button to stop the VI.
8. In the file dialog box, enter a name such as `data.txt` and click the **Save** button to save the data to a spreadsheet file.
9. Save this VI as `Acquire Data.vi` in `labview\vi.lib\tutorial.llb`.

Refer to the *LabVIEW Measurements Manual* for information about multiple-point acquisition, waveform generation, digital I/O, and counter/timer applications.

4

Debugging

This chapter teaches you how to use some of the debugging techniques available in LabVIEW.

Use Execution Highlighting

Execution highlighting shows the movement of data on the block diagram from one node to another using bubbles that move along the wires.

You can complete this activity in approximately 5 minutes.

1. Open the Random Number Example VI you created earlier from `LabVIEW\vi.lib\tutorial.llb`.
2. View the block diagram and click the **Highlight Execution** button on the toolbar.
3. Run the VI from the block diagram window. The program executes in slow motion with moving bubbles to highlight the flow of execution. It also displays data as it becomes available in the VI.
4. Click the **Abort** button to stop the VI.
5. Click the **Highlight Execution** button again to turn off execution highlighting.

Single-Step with Probes

You can set breakpoints in a VI and single-step into, out of, and over sections of the block diagram. You also can insert probes to examine data values in detail during program execution. This example shows how to insert probes and single-step through a VI to monitor data while the VI runs.

You can complete this activity in approximately 5 minutes.

1. Open the Random Number Example VI you created earlier from `LabVIEW\vi.lib\tutorial.llb`.

2. Right-click the output wire of the Random Number function and select **Probe** from the shortcut menu. A small **number:** window displays the value of the data at that point.
3. Click the **Step Into** button on the toolbar, shown at left. The While Loop now flashes to indicate that the VI is running in single-step mode.
4. Click the **Step Into** button again. The Random Number function now flashes.
5. Click the **Step Over** button, shown at left, to step over the Random Number function. The Random Number function executes, so the output now appears in the probe.
6. Using **Step Into** and **Step Over** buttons, single-step a few more times through the loop to view each random number as the VI generates them.
7. Click the **Pause** button to run the VI in normal mode.
8. View the front panel and click the **Stop** button to stop the VI. Save the collected data to `data.txt`.

5

Where to Go from Here

This chapter describes how to use the *LabVIEW Help* and the additional resources available to you.

Refer to the *LabVIEW User Manual*, the *LabVIEW Measurements Manual*, or the *LabVIEW Help* for more information about LabVIEW programming.

Note If you select the Complete install option, LabVIEW installs PDF versions of all LabVIEW manuals, which you can access by selecting **Help»Search the LabVIEW Bookshelf** in LabVIEW. You must have Adobe Acrobat Reader 4.0 or later installed to view the PDFs. Refer to the Adobe Systems Incorporated Web site at `www.adobe.com` to download Acrobat Reader.

Online Help

All built-in LabVIEW VIs and functions include a complete description of the VI functionality and parameters. Access context-sensitive VI and function help by selecting **Help»Show Context Help** or pressing <Ctrl-H>.

When you place a VI on the block diagram and pass the mouse cursor over it, the VI description displays in the **Context Help** window. Click the lock button at the bottom of the **Context Help** window to lock the current contents of the window.

Access the *LabVIEW Help* file to search for particular topics by selecting **Help»VI, Function, and How-To Help**. You also can right-click any built-in VI or function on the block diagram and select **Help** from the shortcut menu.

Note **(Macintosh and UNIX)** National Instruments recommends that you use Netscape 6.0 or later to view the *LabVIEW Help*.

National Instruments' Commitment to You

LabVIEW represents a long-standing commitment by National Instruments to provide tools that simplify the development of instrumentation, data acquisition, and control systems. When you choose LabVIEW as your development environment, you join thousands of scientists and engineers who are taking advantage of the power of graphical programming.

Customer Education

For additional training, National Instruments offers interactive CDs, videos, books, and hands-on LabVIEW courses to help you master LabVIEW quickly and develop successful applications.

Alliance Program

The Alliance Program is a network of third-party developers and consultants who are experts in LabVIEW and other National Instruments products. The National Instruments *Alliance Solutions* directory lists additional libraries and utilities developed by our Alliance members to help you use LabVIEW. In addition, the *Alliance Solutions* directory lists expert LabVIEW consultants who can help you develop custom applications.

A

System Requirements

The following table lists the required system configurations for running LabVIEW on Windows, Macintosh, and UNIX platforms.

Platform	Media and System Requirements	Important Notes
All Platforms	Distributed on CD-ROM.	LabVIEW and the *LabVIEW Help* contain 16-bit color graphics. LabVIEW requires a minimum color palette setting of 256 colors. 16-bit color is recommended. The *LabVIEW Help* requires a minimum color palette setting of 256 colors with a screen resolution of 1024 × 768 pixels. 16-bit color is recommended.
All Windows Versions	Refer to the installation instructions that appear on your screen for information on the size of the LabVIEW system you are installing. LabVIEW runs on any system that supports Windows. You need a minimum of 32 MB of RAM and at least 65 MB of disk space for the typical LabVIEW installation or 300 MB for the complete LabVIEW installation.	You must have at least 32 MB of RAM. You might need more memory, depending on the size of the application you design in LabVIEW and the amount of data that your application manipulates. National Instruments recommends you have 64 MB of RAM. To use the Measurement & Automation Explorer interactive help system you must have Microsoft Internet Explorer 5.0 or later installed. The *LabVIEW Tutorial* requires a sound card, a video card capable of playing `.avi` files, and a minimum color palette setting of 256 colors with a screen resolution of 1024 × 768 pixels. 16-bit color is recommended.

Platform	Media and System Requirements	Important Notes
Windows NT	LabVIEW runs on Windows NT 4.0 Service Pack 3 or later.	To take advantage of ActiveX functionality in LabVIEW, you must have Windows NT 4.0 Service Pack 3 or later and Microsoft Internet Explorer 4.0 or later installed.
Windows ME	—	Refer to `ni.com/windowsme` for information about using LabVIEW in Windows ME.
Windows XP	—	Refer to `ni.com/info` and enter the Info Code: `winxp` for information about using LabVIEW in Windows XP.
Power Macintosh	LabVIEW requires System 7.6.1 or later. You need a minimum of 32 MB of RAM and at least 100 MB of disk space for the typical LabVIEW installation or 325 MB for the complete LabVIEW installation.	You must have at least 32 MB of RAM. You might need more memory, depending on the size of the application you design in LabVIEW and the amount of data that your application manipulates. National Instruments recommends you have 64 MB of RAM. For more accurate timing, install the Apple QuickTime extension. When you use QuickTime, timing accuracy should increase from 16.6 ms resolution to approximately 1 ms resolution. System response varies depending on background applications, other extensions, networking activity, and disk caching. The *LabVIEW Tutorial* requires a sound card, a video card capable of playing `.avi` files, and a minimum color palette setting of 256 colors with a screen resolution of 1024 × 768 pixels. 16-bit color is recommended. National Instruments recommends that you use Netscape 6.0 or later to view the *LabVIEW Help*.

Platform	Media and System Requirements	Important Notes
All UNIX Versions	LabVIEW requires an X Window System server, such as OpenWindows, CDE, or X11R6. You need a minimum of 32 MB of RAM with 32 MB of swap space storage. You need at least 65 MB of disk space for the typical LabVIEW installation or 150 MB for the complete LabVIEW installation.	You must have at least 32 MB of RAM. You might need more memory, depending on the size of the application you design in LabVIEW and the amount of data that your application manipulates. National Instruments recommends you have 64 MB of RAM. To save space, install only the VIs you plan to use. LabVIEW uses a directory for storing temporary files. Some of the temporary files are large, so keep several megabytes of disk space available for this temporary directory. The default for the temporary directory is `/tmp`. You can change the temporary directory by selecting **Tools»Options**. If LabVIEW aborts unexpectedly, it might leave files behind in the temporary directory. Remove old files occasionally to avoid depleting your disk space. LabVIEW does not require a specific graphical user interface (GUI) such as Motif or OpenLook, because LabVIEW uses `Xlib` to create its own GUI. National Instruments recommends that you use Netscape 6.0 or later to view the *LabVIEW Help*.
Sun	LabVIEW runs on SPARCstations with Solaris 2.5.1 or later.	—
Linux	LabVIEW runs on Linux for Intel *x*86 processors with kernel version 2.0.*x* or later. LabVIEW runs on most major Linux distributions, such as RedHat, Calderra, SuSE, and Debian.	Requires GNU C Library Version 2.1.3 or later (`glibc2`, also known as `libc.so.6`). RedHat Linux 5.0 or later includes the `glibc2` run-time library.

B

Technical Support Resources

Web Support

National Instruments Web support is your first stop for help in solving installation, configuration, and application problems and questions. Online problem-solving and diagnostic resources include frequently asked questions, knowledge bases, product-specific troubleshooting wizards, manuals, drivers, software updates, and more. Web support is available through the Technical Support section of `ni.com`.

NI Developer Zone

The NI Developer Zone at `ni.com/zone` is the essential resource for building measurement and automation systems. At the NI Developer Zone, you can easily access the latest example programs, system configurators, tutorials, technical news, as well as a community of developers ready to share their own techniques.

Customer Education

National Instruments provides a number of alternatives to satisfy your training needs, from self-paced tutorials, videos, and interactive CDs to instructor-led hands-on courses at locations around the world. Visit the Customer Education section of `ni.com` for online course schedules, syllabi, training centers, and class registration.

System Integration

If you have time constraints, limited in-house technical resources, or other dilemmas, you may prefer to employ consulting or system integration services. You can rely on the expertise available through our worldwide network of Alliance Program members. To find out more about our Alliance system integration solutions, visit the System Integration section of `ni.com`.

Worldwide Support

National Instruments has offices located around the world to help address your support needs. You can access our branch office Web sites from the Worldwide Offices section of `ni.com`. Branch office Web sites provide up-to-date contact information, support phone numbers, e-mail addresses, and current events.

If you have searched the technical support resources on our Web site and still cannot find the answers you need, contact your local office or National Instruments corporate. Phone numbers for our worldwide offices are listed at the front of this manual.

Glossary

B

block diagram — Pictorial description or representation of a program or algorithm. The block diagram, consists of executable icons called nodes and wires that carry data between the nodes. The block diagram is the source code for the VI. The block diagram resides in the block diagram window of the VI.

C

conditional terminal — Terminal of a While Loop that contains a Boolean value that determines if the VI performs another iteration.

connector pane — Region in the upper right corner of a front panel or block diagram window that displays the VI terminal pattern. It defines the inputs and outputs you can wire to a VI.

control — Front panel object for entering data to a VI interactively or to a subVI programmatically, such as a knob, push button, or dial.

Controls palette — Palette that contains front panel controls, indicators, and decorative objects.

D

DAQ Channel Wizard — Utility that guides you through naming and configuring DAQ analog and digital channels. Available in the Data Neighborhood of Measurement & Automation Explorer **(Windows)** or DAQ Channel Wizard **(Macintosh)**.

DAQ Solution Wizard — Utility that guides you through specifying your DAQ application, and it provides a custom DAQ solution.

data flow — Programming system that consists of executable nodes that execute only when they receive all required input data and produce output automatically when they execute. LabVIEW is a dataflow system.

E

Enable Indexing

Option that allows you to build a set of data to be released at the termination of a While Loop. With indexing disabled, a While Loop releases only the final data point generated within the loop.

execution highlighting

Debugging technique that animates VI execution to illustrate the data flow in the VI.

F

front panel

Interactive user interface of a VI. Front panel appearance imitates physical instruments, such as oscilloscopes and multimeters.

function

Built-in execution element, comparable to an operator, function, or statement in a text-based programming language.

Functions palette

Palette that contains VIs, functions, block diagram structures, and constants.

G

General Purpose Interface Bus

GPIB—synonymous with HP-IB. The standard bus used for controlling electronic instruments with a computer. Also called IEEE 488 bus because it is defined by ANSI/IEEE Standards 488-1978, 488.1-1987, and 488.2-1992.

I

icon

Graphical representation of a node on a block diagram.

IEEE 488.2

Institute of Electrical and Electronic Engineers Standard 488.2-1987, which defines the GPIB.

indicator

Front panel object that displays output, such as a graph or LED.

L

Labeling tool	Tool to create labels and enter text into text windows.
LabVIEW	Laboratory Virtual Instrument Engineering Workbench. LabVIEW is a graphical programming language that uses icons instead of lines of text to create programs.

M

MB	Megabytes of memory. 1 MB is equal to 1,024 KB.

N

node	Program execution element. Nodes are analogous to statements, operators, functions, and subroutines in text-based programming languages. On a block diagram, nodes include functions, structures, and subVIs.

O

Operating tool	Tool to enter data into controls and operate them.

P

palette	Display of icons that represent possible options.
Positioning tool	Tool to move and resize objects.
probe	Debugging feature for checking intermediate values in a VI.
PXI	PCI eXtensions for Instrumentation. A modular, computer-based instrumentation platform.

R

RS-232	Recommended Standard 232, a serial interface bus standard.
RS-485	Recommended Standard 485, a serial interface bus standard.

S

shift register	Optional mechanism in loop structures to pass the value of a variable from one iteration of a loop to a subsequent iteration. Shift registers are similar to static variables in text-based programming languages.
Solutions Gallery	Option within the DAQ Solution Wizard in which you can select from numerous categories of common DAQ applications.
structure	Program control element, such as a Sequence Structure, Case structure, For Loop, or While Loop.
subpalette	A palette contained in an icon of another palette.
subVI	VI used in the block diagram of another VI. Comparable to a subroutine.

T

terminal	Object or region on a node through which data pass.
tip strip	Small yellow text banners that identify the terminal name and make it easier to identify terminals for wiring.
Tools palette	Palette that contains tools you can use to edit and debug front panel and block diagram objects.
tunnel	Data entry or exit terminal on a structure.

V

VI	*See* virtual instrument.
virtual instrument	Program in LabVIEW that models the appearance and function of a physical instrument.
VISA	Single interface library for controlling GPIB, VXI, RS-232, and other types of instruments.
VXI	VME eXtensions for Instrumentation (bus).

W

waveform chart	Indicator that plots data points at a certain rate.
While Loop	Loop structure that repeats a section of code until a condition is met.
wire	Data path between nodes.
wire branch	Section of wire that contains all the wire segments from junction to junction, terminal to junction, or terminal to terminal if there are no junctions between.
wire junction	Point where three or more wire segments join.
wire segment	Single horizontal or vertical piece of wire.
Wiring tool	Tool to define data paths between terminals.