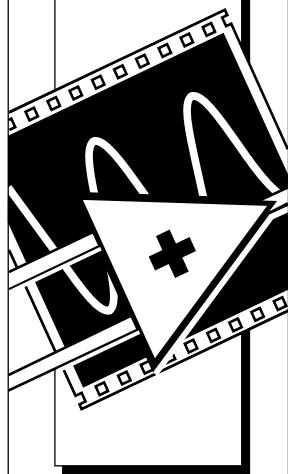


LabVIEW



LabVIEW® Evaluation Guide

May 1997 Edition
Part Number 350100C-01

Conventions Used in This Manual

The following conventions are used in this manual:

bold Bold text denotes a menu name, palette name, menu item, or dialog box button or option. Bold text also denotes a tip.

italic Italic text denotes a glossary term or a cross reference.

bold italic Bold italic text denotes a note.

monospace Text in this font denotes text or characters that you should literally enter from the keyboard. This font also is used for the proper names of disk drives, paths, directories, programs, filenames, and extensions.

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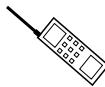


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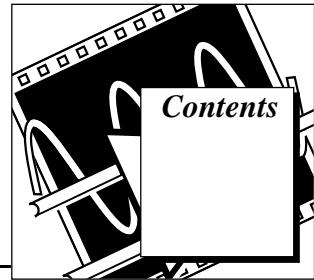


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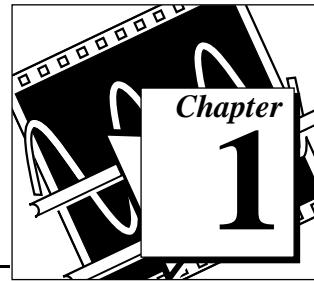
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Glossary



Introduction to LabVIEW

This chapter provides an overview of the LabVIEW development environment.

For information about system configuration requirements, or installation instructions, see the appendix, *Installation Instructions*.

What Is LabVIEW?

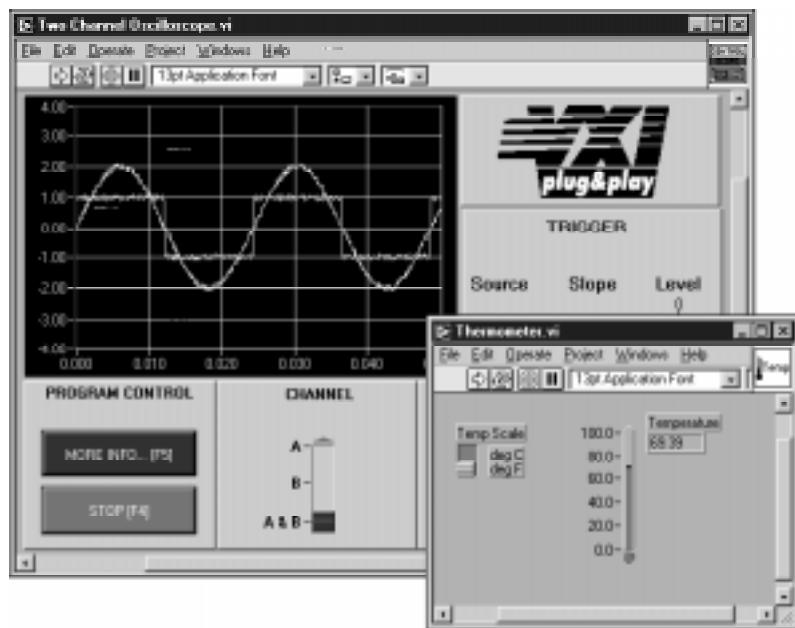
Italicized text denotes a glossary term.

LabVIEW (Laboratory Virtual Instrument Engineering Workbench) is a development environment based on the graphical programming language *G*. LabVIEW is fully integrated for communication with hardware such as *GPIB*, *VXI*, *RS-232*, *RS-485*, and plug-in data acquisition boards. LabVIEW also has built-in libraries for using software standards such as TCP/IP Networking and OLE Automation.

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

You can use LabVIEW with little programming experience. LabVIEW uses terminology, icons, and ideas familiar to technicians, scientists, and engineers, and relies on graphical symbols rather than textual language to describe programming actions.

Programs in LabVIEW for real-world applications can vary from the simple to the powerful, as illustrated in the following graphic.



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 to see how the program executes, and single-step through the program to make debugging and program development easier.

LabVIEW also provides numerous mechanisms for connecting to external code or software through DLLs, shared libraries, OLE Automation, and more. In addition, numerous add-on toolkits 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 has given thousands of successful users a faster way to program instrumentation and data acquisition 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.

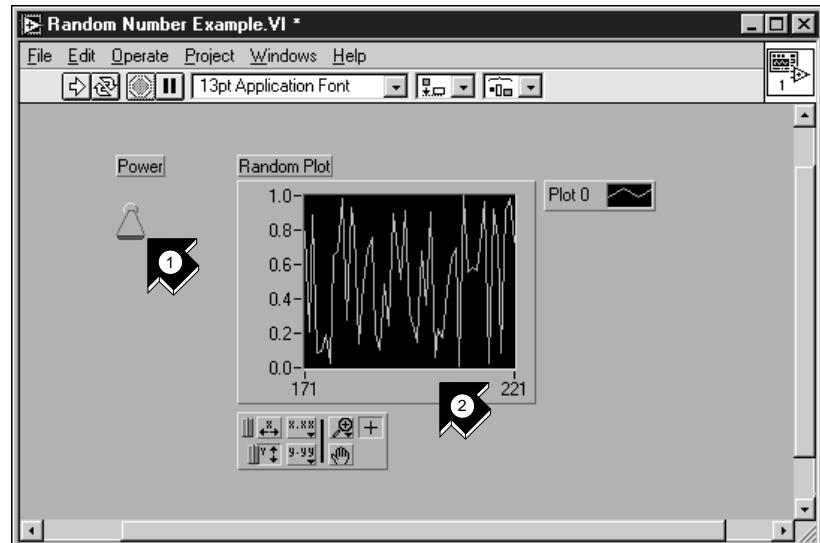
LabVIEW also gives you the benefits of a large installed user base, years of product feedback, and powerful add-on tools. Finally, National Instruments support services and user network ensure the successful development of your solutions.

How Does LabVIEW Work?

All LabVIEW programs, or *virtual instruments* (VIs), have a *front panel* and a *block diagram*. The *palettes* in LabVIEW contain the options you use to create and modify your VI. This section overviews the LabVIEW front panel, block diagram, and palettes. It also explains the *dataflow* model for program execution that LabVIEW follows.

Front Panel

The *front panel* is the graphical user interface of your LabVIEW VI. This interface collects user input and displays program output. The front panel can contain knobs, push buttons, graphs, and more.



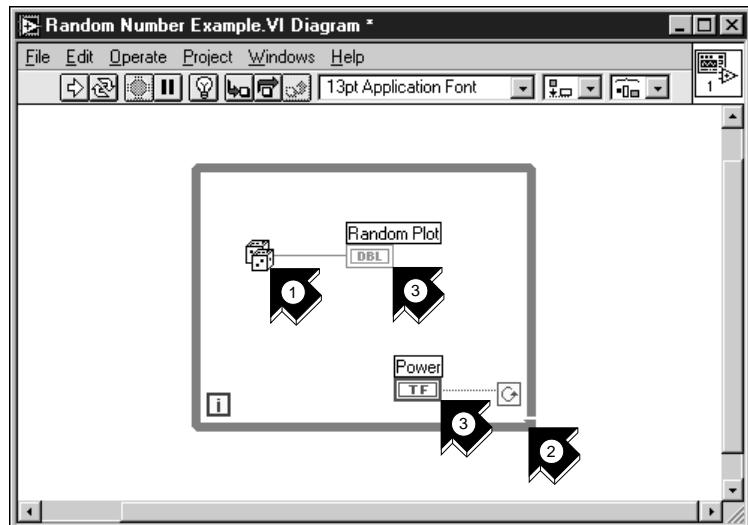
1. A *control* (input).

2. An *indicator* (output).

Block Diagram

The *block diagram* contains the graphical source code of your VI. In the block diagram, you program your VI to control and perform functions on the inputs and outputs you created on the front panel.

The block diagram can include functions and structures from the built-in LabVIEW VI libraries. It also can include terminals that are associated with controls and indicators created on the front panel.



1. A *function*.
2. A *structure*.
3. *Terminals* from the front panel.

Palettes

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

Tools Palette

You use the *Tools palette* in both the front panel and the block diagram. The Tools palette contains the tools you use to edit and debug front panel and block diagram objects.



Controls Palette

You use the *Controls palette* in the front panel. The Controls palette contains the front panel controls and indicators you use to create the user interface.



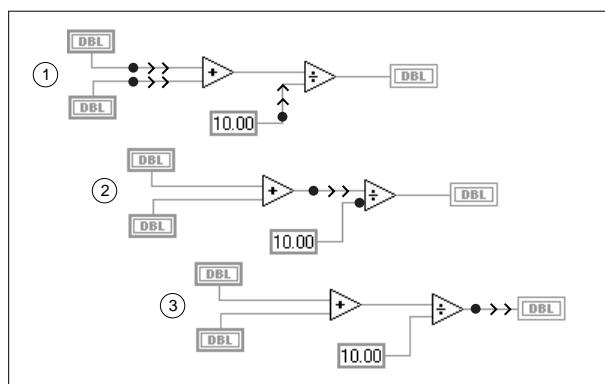
Functions Palette

You use the *Functions palette* in the block diagram. The Functions palette contains the objects you use to program your VI, such as arithmetic, instrument I/O, file I/O, and data acquisition operations.



Data Flow

LabVIEW VIs follow a dataflow model for program execution. The block diagram consists of *nodes* such as VIs, structures, and terminals from the front panel. These nodes are connected by *wires*, which define the flow of data through the program. The execution of a node occurs when all its inputs are available. When a node finishes executing, it releases all its outputs to the next node in the dataflow path.



Where Do I Start?

If you are new to LabVIEW, the LabVIEW Online Tutorial and the *LabVIEW Evaluation Guide* help you get started quickly. The LabVIEW Online Tutorial introduces you to the LabVIEW environment. The *Evaluation Guide* teaches you how to build VIs for data acquisition and instrument control and how to debug these VIs. It also teaches you how to use the Search Examples feature and the DAQ Solution Wizard.



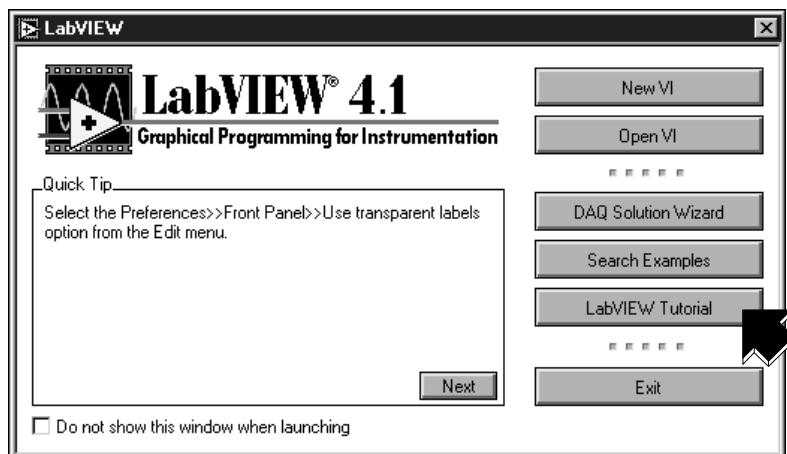
You can complete the activities in this book in approximately 90 minutes.

Online Tutorial

To learn about the LabVIEW environment, first launch the LabVIEW Online Tutorial from the LabVIEW dialog box.



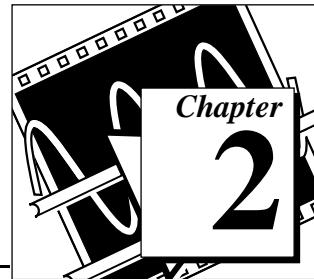
You can complete the online tutorial in approximately 15 minutes.



After you finish the Online Tutorial, continue with the activities in the *Evaluation Guide* to learn how to build LabVIEW programs for data acquisition and instrument control.

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

Virtual Instruments



This chapter teaches you step-by-step how to create an application in LabVIEW. It also guides you through the Search Examples feature to help you find examples in LabVIEW.

You will learn to do the following:

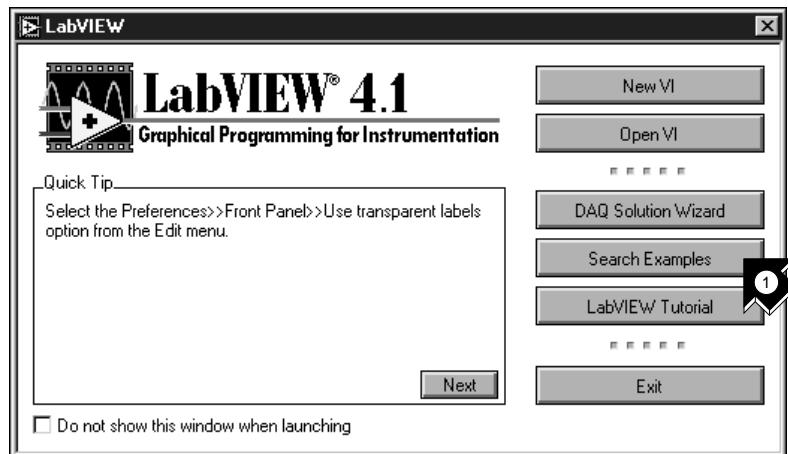
- Use the Search Examples feature to find and run an example
- Create a new program in LabVIEW
 - The VI you build generates data, analyzes it, then writes it to a file.

Search for Examples

After viewing the Online Tutorial, you are ready to run some examples in LabVIEW.



You can complete this activity in approximately 5 minutes.



1. Click **Search Examples** to see a listing of LabVIEW examples.

Search Examples

File Edit Bookmark Options Help

Contents Index Back Print

Search Examples

You can find examples related to the following subjects:

| | | |
|--|--|--|
| Fundamentals | I/O Interfaces | Communication |
| Arrays | Data Acquisition (DAQ) | OLE |
| Strings | GPIB | Dynamic Data Exchange (DDE) |
| Graphs and Charts | Serial Communication | TCP/IP |
| Structures | VXI | |
| Analysis | Instrument Driver Template VIs | |
| File I/O | | |
| Advanced | | Demonstrations |
| Locals and Globals | | Test Sequencer |
| Queues | | Instrument I/O |
| Customizing Controls and VIs | | Analysis |
| Execution Control | | Process 2 |
| Calling External Code | |  |

2. Click **Analysis** in the Demonstrations category.

Search Examples

File Edit Bookmark Options Help

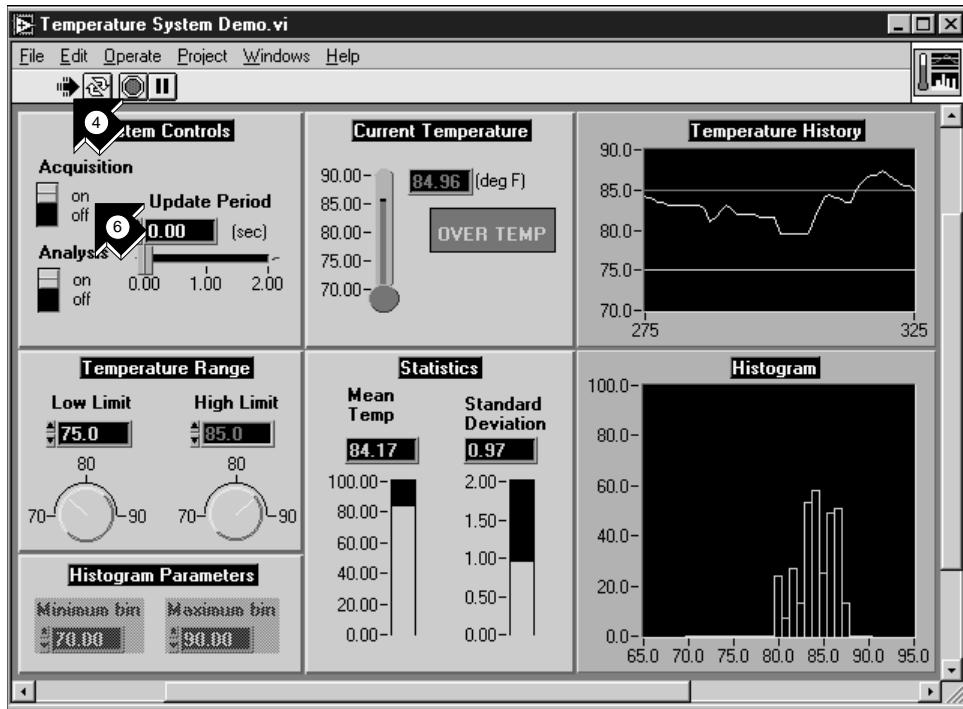
Contents Index Back Print

Analysis Demonstrations

When you click the name of the example VI, the VI will open in LabVIEW.

| | |
|---|--|
| Temperature System Demo | Demonstrates a temperature analysis application. This example reads a simulated temperature; sends an alarm if it is outside a given range; determines a statistical mean, standard deviation, and histogram of the temperature history. |
|  3 | |
| Signal Generation and Processing | Determines the result of filtering and windowing a generated signal. This example also displays the power spectrum for the generated signal. |
| | |
| Vibration Analysis | Simulates a vibration analysis example. The displacement waveform and the power spectrum are calculated and displayed in this example. |

3. Click **Temperature System Demo** to open this demonstration VI.



4. Click the **Run** button on the front panel toolbar to see the how a LabVIEW VI runs.
5. Click the sliders, knobs, and other controls to see how they affect the data.
6. Stop the program by clicking the **Acquisition** switch to the off position.

Build a Virtual Instrument

This activity demonstrates how simple it is to chart, analyze, and save data in LabVIEW.



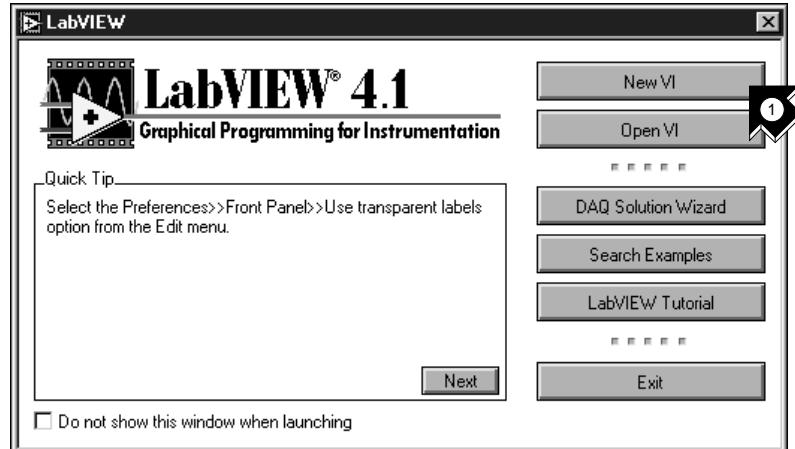
You can complete this activity in approximately 30 minutes.

Create a User Interface

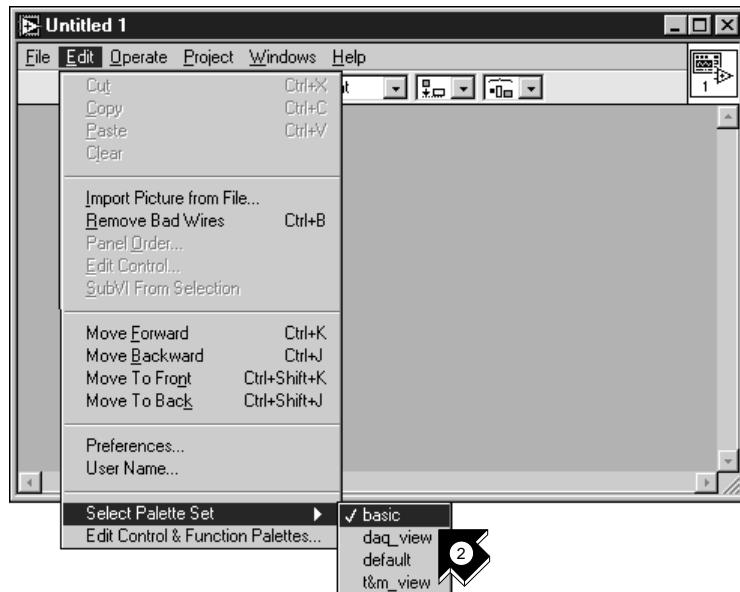
You can create a graphical user interface on the front panel using controls and indicators from the Controls palette.



You can complete this section in approximately 5 minutes.



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



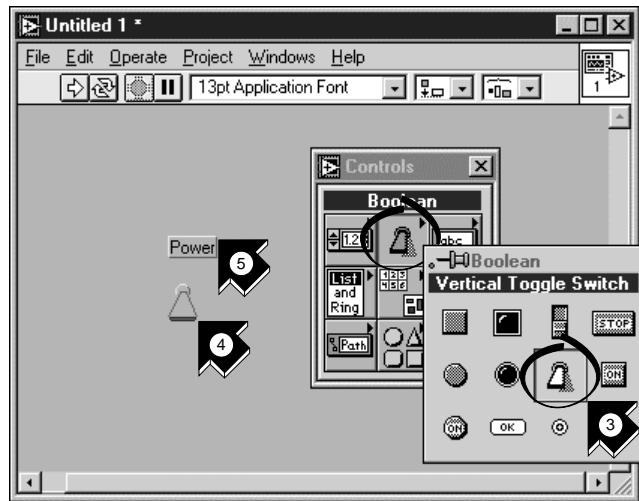
2. On the new front panel, choose **Edit»Select Palette Set»basic**.



Tips

The » symbol leads you through nested menu and palette items to a final action. The sequence Edit»Select Palette Set»basic directs you to open the Edit menu, click Select Palette Set, and finally choose basic as your palette.

The basic palette you select for this activity is a small subset of the LabVIEW libraries. You can select the default palette to view the entire functionality of LabVIEW.



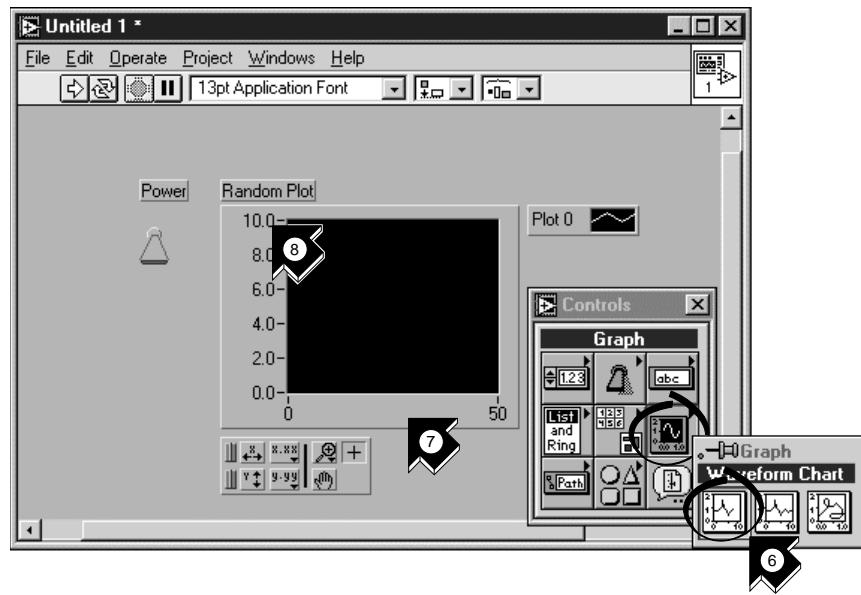
3. Select **Vertical Toggle Switch** from the **Controls»Boolean** subpalette. Select icons from the palette in the same way you select items from a menu.
4. Move your pointer into the front panel and click to place the toggle switch on the front panel.
5. Type **Power** into the label for the toggle switch. If the label disappears, choose **Show Label** from the pop-up menu on the toggle switch. To access the pop-up menu, right-click on the toggle switch (on the Macintosh, command-click on the toggle switch).



Tip To rearrange or resize objects and wires, use the Positioning tool from the Tools palette.



Positioning tool



Operating tool

6. Create a *waveform chart* by selecting **Controls»Graph»Waveform Chart**. This chart plots data one point at a time.
7. Place the chart on the front panel and label it *Random Plot*.
8. To change the scale of the waveform chart, select the *Operating tool* from the Tools palette. If the Tools palette is not visible, select **Windows»Show Tools Palette**. Double-click **10.0** on the Y axis of the Random Plot indicator and enter **1.0**.

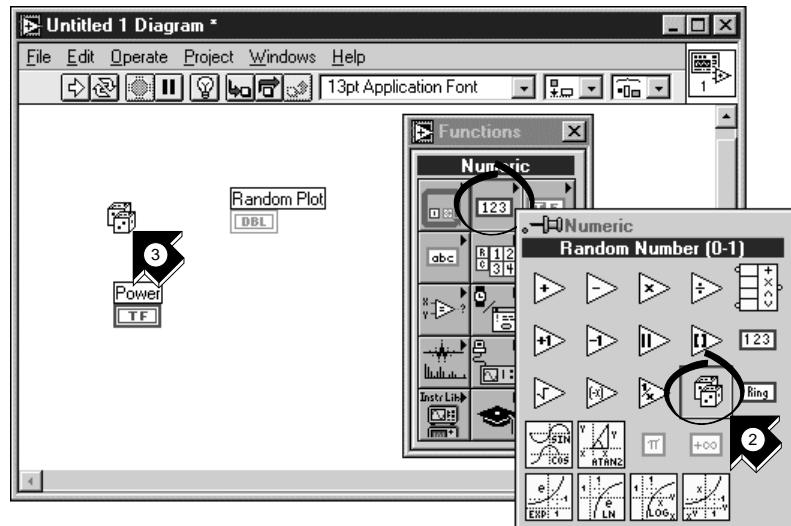
Build the Block Diagram

Now you can create the source code in the block diagram of your VI.

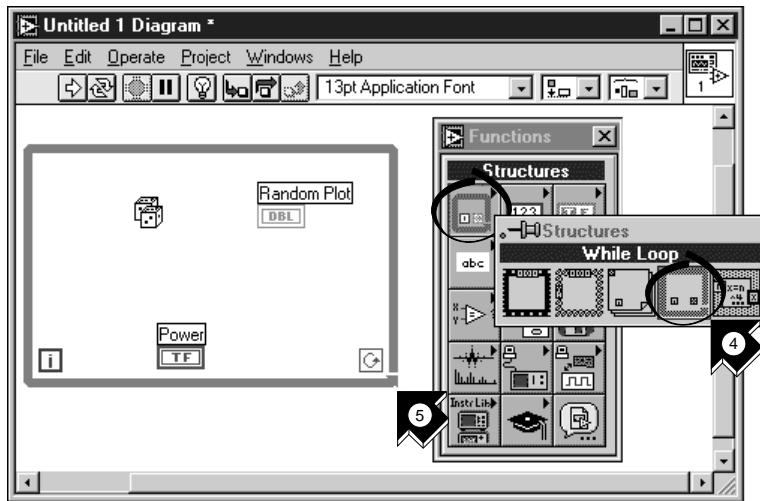


You can complete this section in approximately 5 minutes.

1. Go to the block diagram by choosing **Show Diagram** from the **Windows** menu or clicking in the block diagram window. The two terminals on the block diagram correspond to the Power toggle switch and the Random Plot waveform chart on the front panel.



2. Select **Random Number (0-1)** from the **Functions»Numeric** subpalette. If the Functions palette is not visible, select **Windows»Show Functions Palette**. For this activity, you use a random number generator to generate input data for your VI.
3. Place the Random Number function on the block diagram. This VI generates a random number ranging from zero to one.



4. Select **While Loop** from the **Functions»Structures** subpalette. The *While Loop* runs all code within its boundaries while the value on its *conditional terminal* remains TRUE. When the value changes to FALSE, the While Loop exits.
5. Place your pointer in the position on the block diagram where you want to anchor the top left corner of the loop. Drag the loop diagonally to enclose the Random Number function, the Power toggle switch, and the Random Plot chart.



Tip If your **While Loop** did not enclose all of the code, right-click on the border of the loop to access the pop-up menu (on the Macintosh, command-click on the border of the loop). Choose **Remove While Loop** from this pop-up menu. Then repeat steps four and five to re-create the loop so it encloses all the code.

Wire and Run Your VI

You need to add wiring to define the data flow in your VI. After your VI is complete, you can run it from the front panel to see the data plot to your chart.

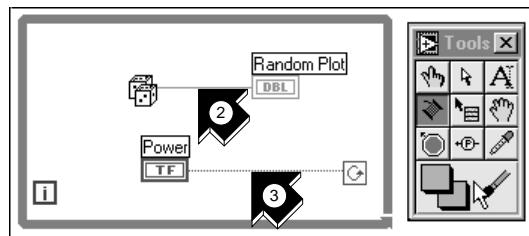


You can complete this section in approximately 5 minutes.



Wiring tool

1. Select the *Wiring tool* from the Tools palette. If the Tools palette is not visible, select **Windows»Show Tools Palette**.



2. Wire the Random Number function to the Random Plot chart terminal. To create a wire, click on the Random Number function, move to the Random Plot chart, and click again to terminate the wire.



Tips

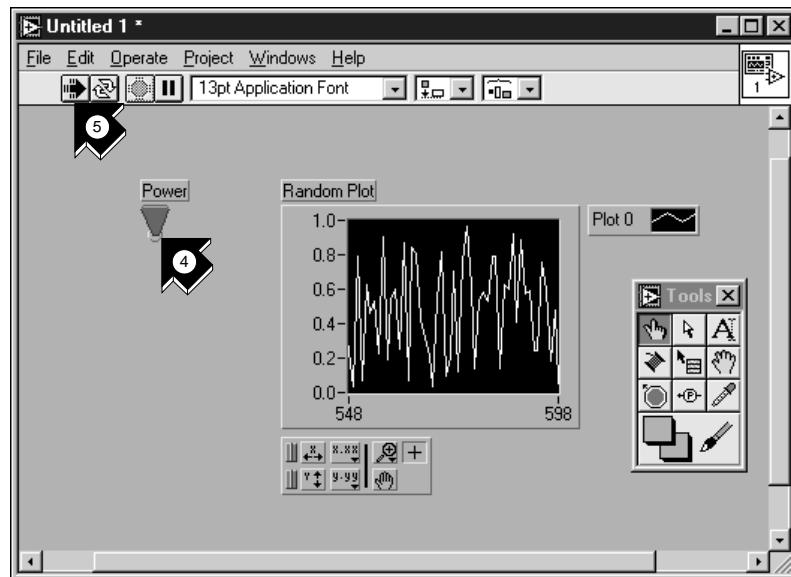
When you position the *Wiring tool* over a terminal, the terminal blinks and a tip strip appears that labels the terminal. When the correct terminal blinks, click to wire to or from that terminal.

If you see black dashed wires, select Remove Bad Wires from the Edit menu.



conditional terminal

3. Wire the Power toggle switch terminal to the conditional terminal on the While Loop.



Operating tool



Run

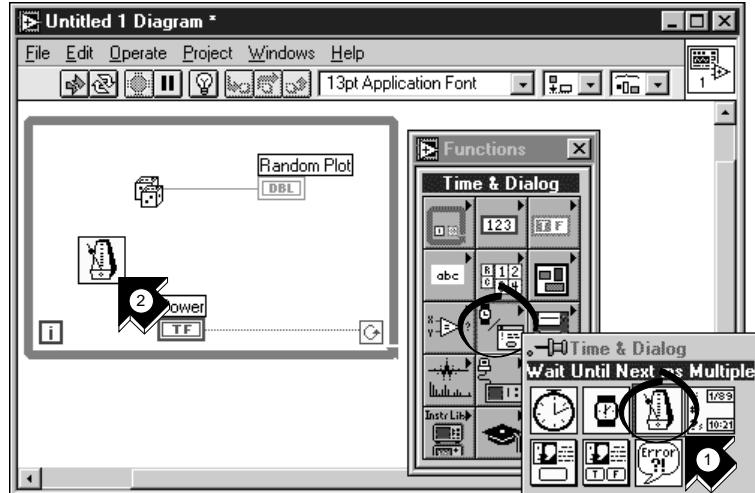
4. Go to the front panel and select the **Operating** tool. Click the Power toggle switch to turn it to the TRUE position.
5. Click the **Run** button on the toolbar to run the VI.
6. To stop running the VI, click the Power toggle switch again to turn it to the FALSE position. Because the While Loop executes only as long as its conditional terminal remains TRUE, changing the value of the toggle switch to FALSE stops the loop.

Add Timing to Your VI

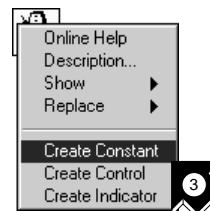
You can add a timing delay to your VI to plot the points more slowly on the waveform chart.



You can complete this section in approximately 5 minutes.



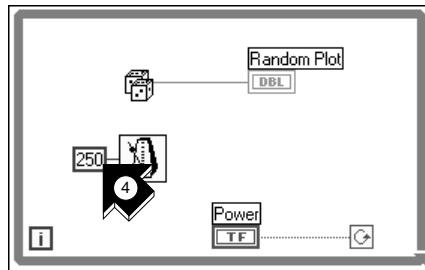
1. Go to the block diagram. Select **Wait Until Next ms Multiple** from the **Functions»Time & Dialog** subpalette.
2. Place the Wait Until Next ms Multiple function within the While Loop.



3. From the pop-up menu on the left side of the Wait Until Next ms Multiple function, choose **Create Constant**. When you access the pop-up menu of the function, make sure you position the pointer over the left side of the function. Otherwise, the constant you create is not wired to the function.



Tip To access the pop-up menu of a LabVIEW object, right-click on the object. On the Macintosh, use command-click.



Run

4. Type 250 in the millisecond multiple control to create a 250 ms delay between the generation of points to plot for the chart.
5. Go to the front panel, click the Power toggle switch to the TRUE position, and run the VI to see the delay effect. Click the Power toggle switch to the FALSE position to stop the VI. Save this program as `Random Number Example.vi` in the `LabVIEW\vi.lib\tutorial.11b` directory.



Note *Paths in this manual are denoted using backslashes (\) to separate drive names, directories, and files.*

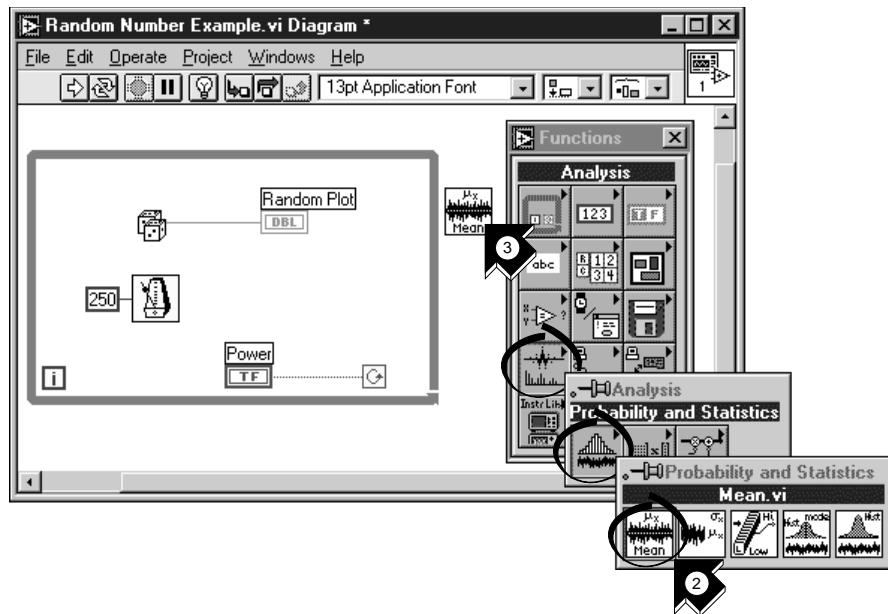
Add Analysis and File I/O to Your VI

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



You can complete this section in approximately 10 minutes.

1. Go to the block diagram window of the Random Number Example VI you created. If your VI is not open already, choose Random Number Example.vi from the LabVIEW\vi.lib\tutorial.llb directory.

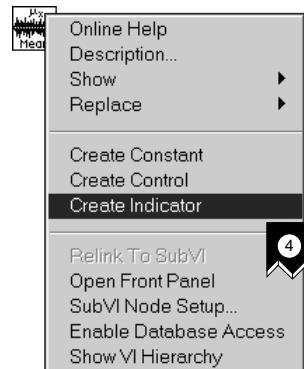


2. Select **Mean.vi** from the **Functions»Analysis»Probability and Statistics** subpalette.

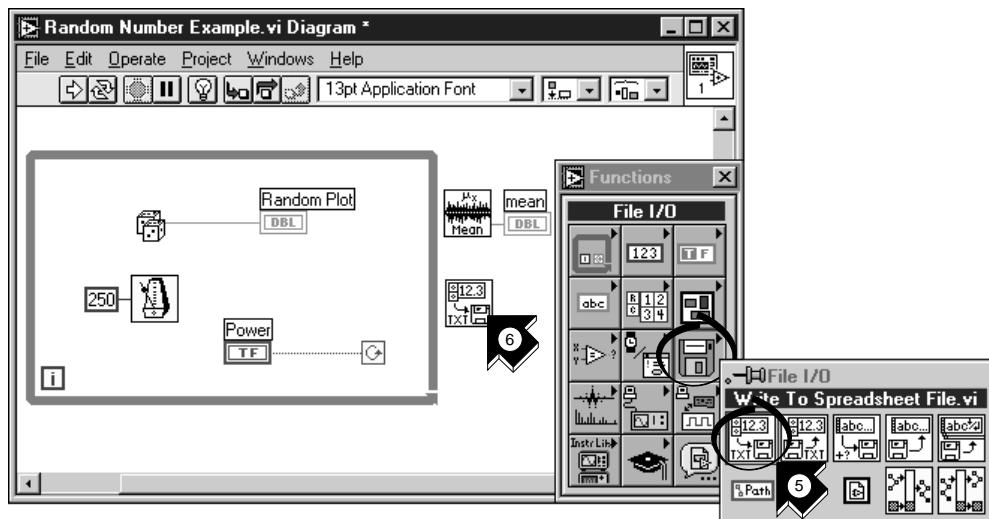


Tip If you do not see the Functions palette, select Windows»Show Functions Palette.

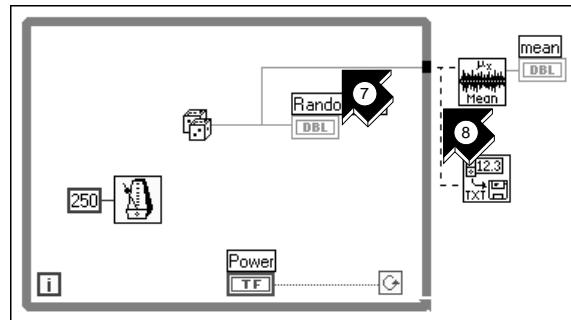
3. Place the Mean VI in the block diagram outside the While Loop.



4. From the pop-up menu on the upper-right corner of the Mean VI, choose **Create Indicator**. This creates a front panel numeric indicator to display the mean of the random data.



5. Select **Write To Spreadsheet File.vi** from the **Functions»File I/O** subpalette.
6. Place the Write To Spreadsheet File VI in the block diagram outside the While Loop.



Wiring tool

7. Using the **Wiring tool**, wire the Random Number function to the **X** input terminal of the Mean VI. Create this *wire branch* by wiring from the existing wire segment.

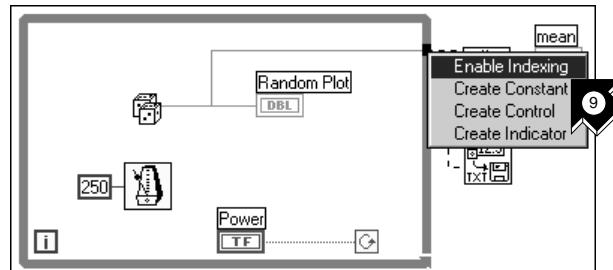


Tips

The wire segment blinks when the Wiring tool is positioned correctly to fasten a new wire from the existing segment.

The Wiring tool allows you to see *tip strip* labels for terminals on nodes in the block diagram.

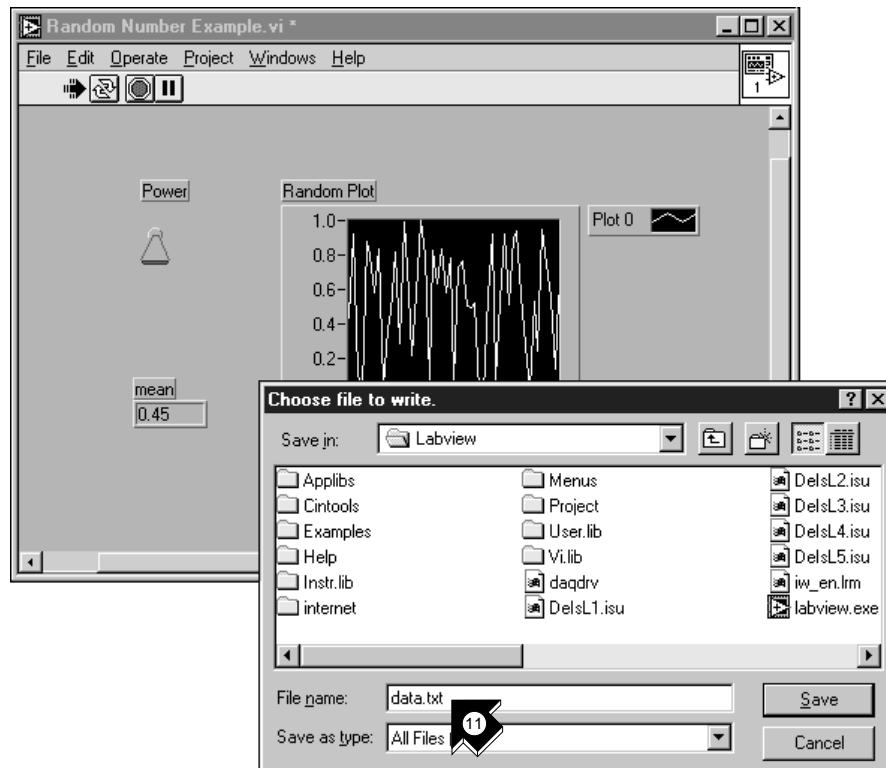
8. Create another wire branch from the branch created in the previous step. Wire this new branch to the **1D data** input of the Write to Spreadsheet File VI. You use the 1D data input because the While Loop creates a one-dimensional row of data from the generated random numbers.



9. The black *tunnel* on the While Loop is a data exit terminal on the loop. From the pop-up menu on the black tunnel, choose **Enable Indexing**. The dashed wires change to solid orange wires. *Enable Indexing* allows the While Loop to collect the data and pass it to the Mean VI as a data set when the loop terminates.



10. Go to the front panel. Using the **Operating** tool, click the Power toggle switch to the TRUE position and run the VI.



11. When you turn off the power, you see the mean of your data and a file dialog box that prompts you for the name of the random number file. Type `data.txt` and click **Save**.



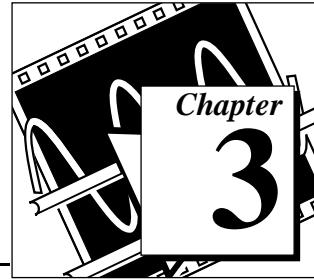
Tip **The mean does not appear until the data is collected when the power is turned off.**



12. 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.*

Data Acquisition



This chapter teaches you how to use LabVIEW to acquire data from data acquisition hardware. If you only use standalone instruments and control them with GPIB, VXI, or serial standards, see Chapter 4, *Instrumentation*.

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 your 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 online Help file for data acquisition hardware installation and configuration instructions.*

Use the DAQ Solution Wizard

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



Note *The DAQ Solution Wizard currently is available on Windows platforms only.*



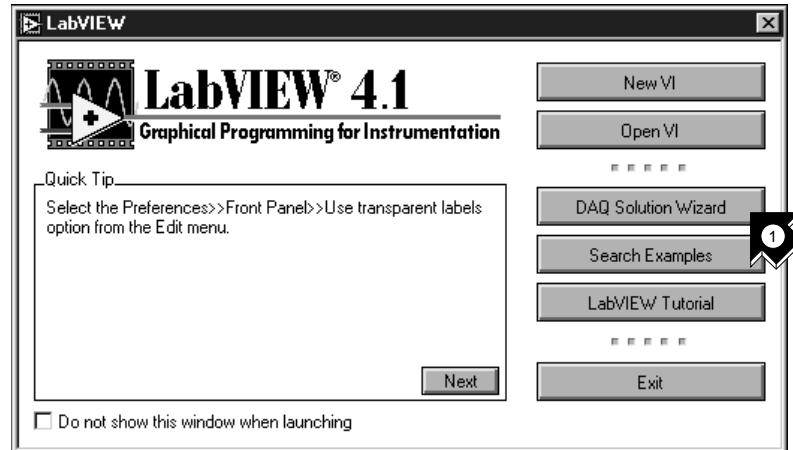
You can complete this activity in approximately 15 minutes.

Configure Your Analog Input Channel

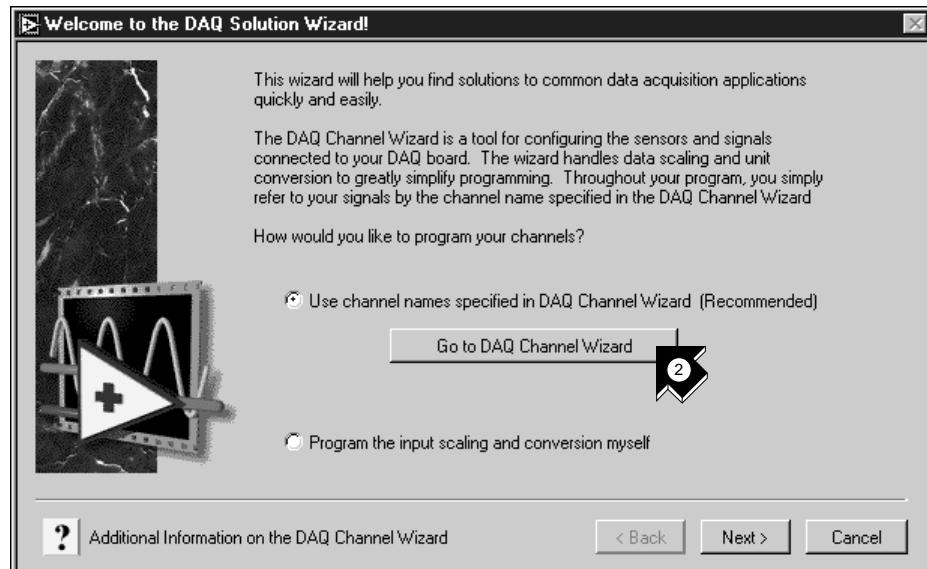
The DAQ Solution Wizard guides you through naming and configuring your analog input channels.



You can complete this section in approximately 5 minutes.



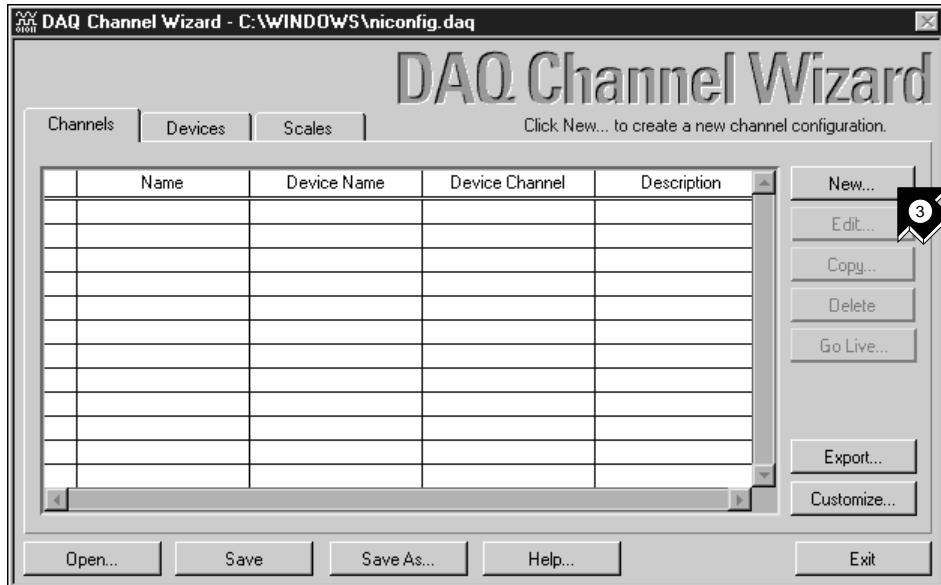
1. To get started with analog input quickly and easily, select **DAQ Solution Wizard** in the LabVIEW dialog box. To access the LabVIEW dialog box, either launch LabVIEW or close all open VIs if you already are running LabVIEW.



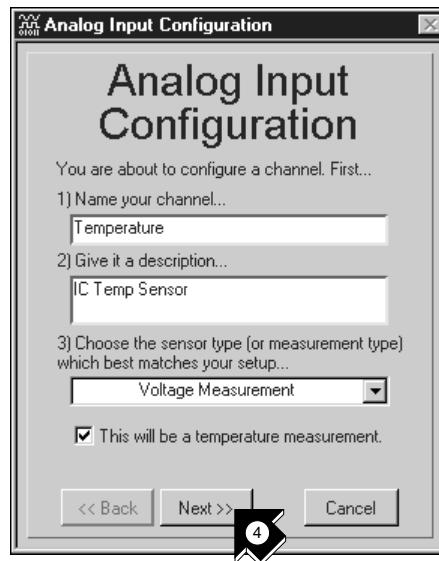
2. When the Welcome to the DAQ Solution Wizard! dialog box opens, click **Go to DAQ Channel Wizard**.



Note If you are using the evaluation version of LabVIEW and you do not have hardware, the DAQ Channel Wizard will be disabled. However, you will see a list of channels that you can use to generate solutions.



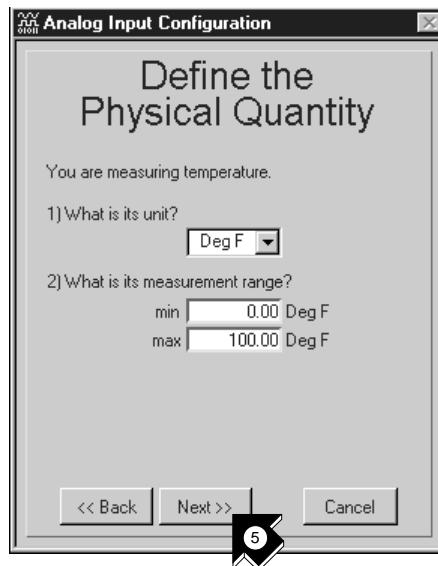
3. Click **New...** in the DAQ Channel Wizard dialog box to configure a new channel. The DAQ Channel Wizard helps you configure analog input channels by name so you can use those names in your program. The DAQ Channel Wizard also conditions those channels so that signal conditioning such as scaling factors and cold-junction compensation are performed transparently to you.



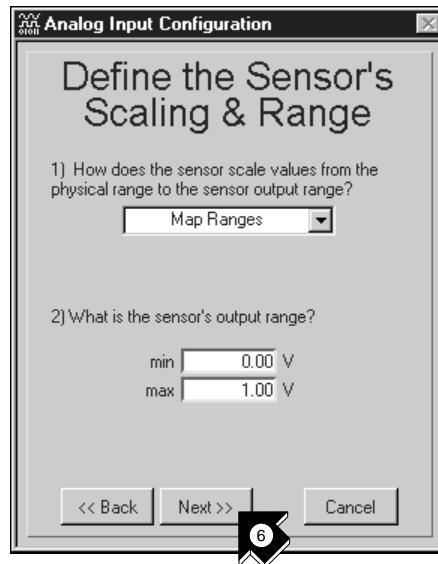
4. Type your channel name and description in the appropriate text boxes. You can select the type of sensor in the drop-down list box. Select the checkbox to mark the channel as a temperature measurement. Click **Next>>** to continue.



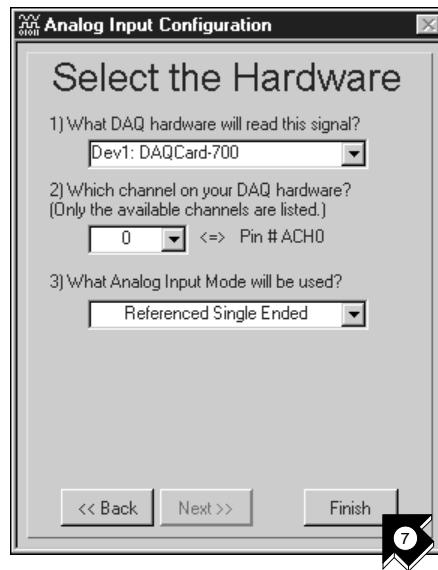
Tip If you are not taking a temperature reading, use parameters in the DAQ Channel Wizard appropriate for your measurement.



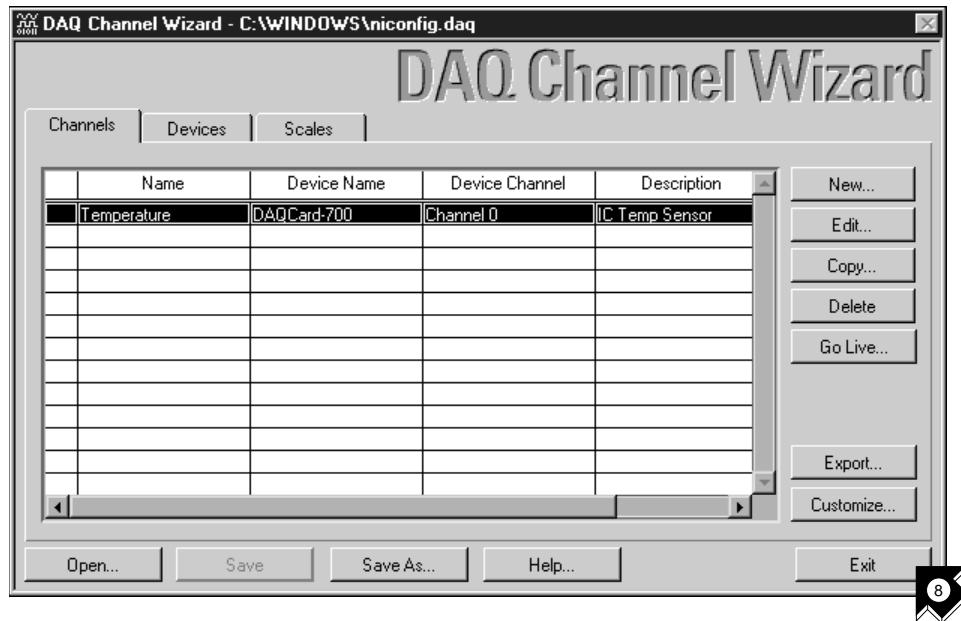
5. Define the physical quantity that you are measuring. Select the units and enter the range in the appropriate boxes. Click **Next>>** to continue.



6. Define the scaling and range of the sensor. Click **Next>>** to continue.



7. Select your data acquisition hardware settings. If you have multiple DAQ hardware devices installed, choose the device that will read this signal. Click **Finish** to configure your analog input channel.



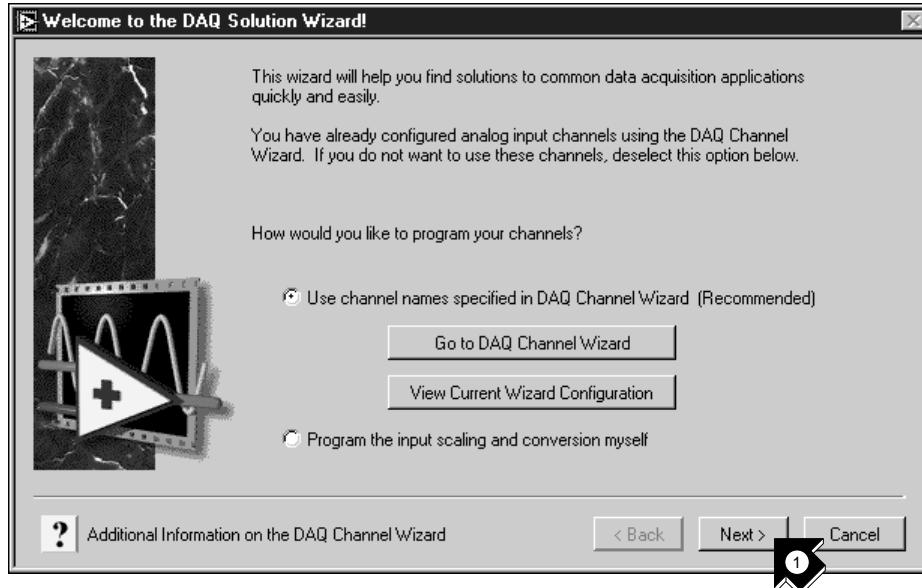
8. Notice that your new configuration appears in the table. You have finished configuring an analog input channel named Temperature for your DAQ hardware. This channel measures temperature from zero to 100 degrees Fahrenheit, mapped from the zero to one volt range of the sensor. Click **Exit** and save changes.

Generate a Solution from the Solutions Gallery

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



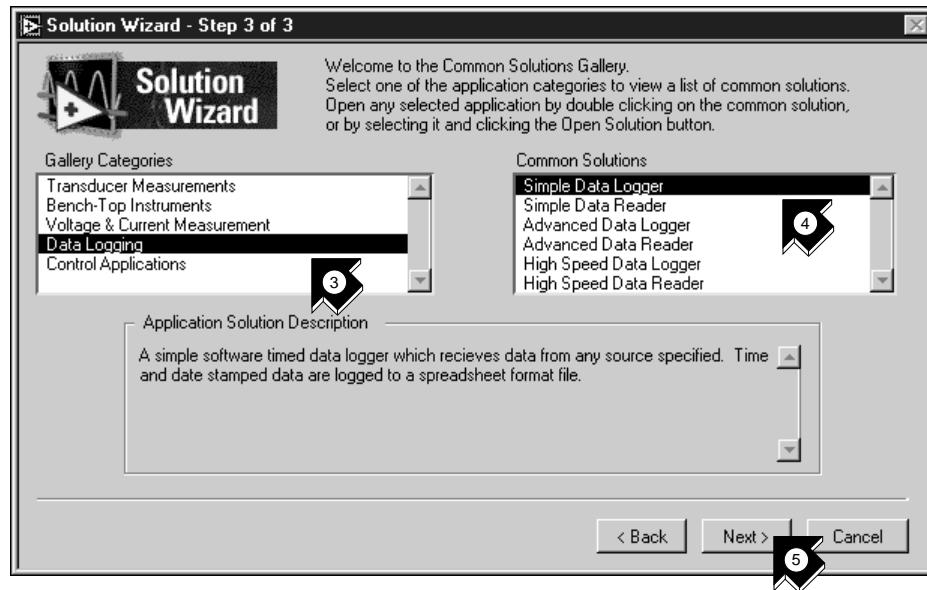
You can complete this section in approximately 10 minutes.



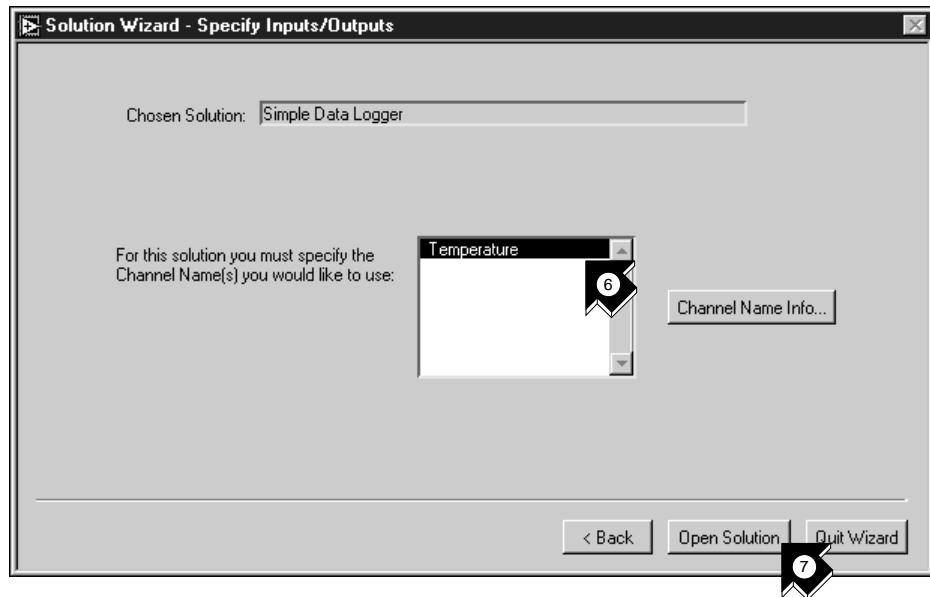
1. Click **Next >** when you return to the DAQ Solution Wizard.



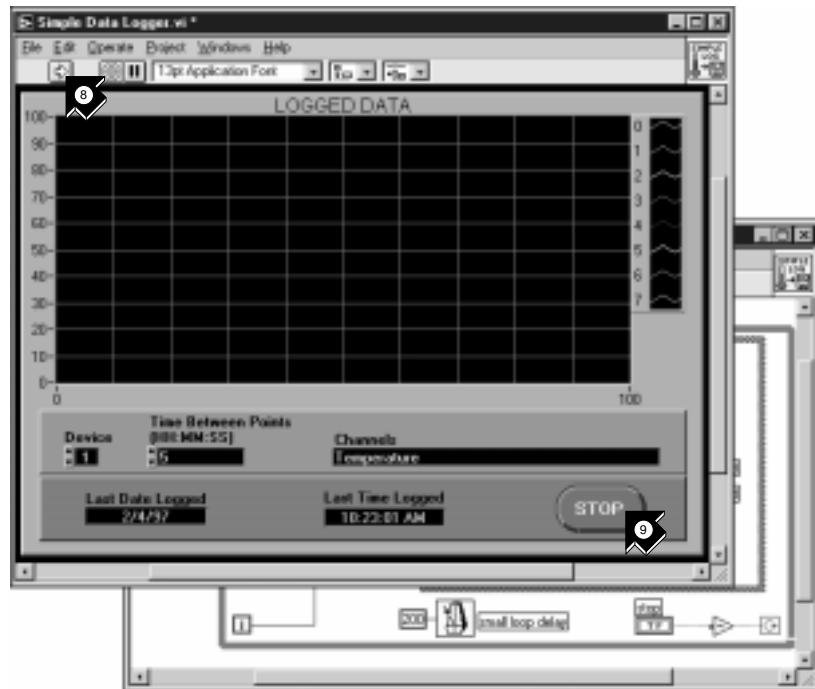
2. Click **Next >** in the DAQ Solution Wizard to open the Solutions Gallery.



3. Choose a solution to generate for your analog input channel. For this example, select **Data Logging** in the Gallery Categories list.
4. Select **Simple Data Logger** in the Common Solutions list.
5. Click **Next >** to continue.



6. Select **Temperature** as the input channel to use for the solution.
7. Click **Open Solution** to generate the solution.



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



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

10. Close this VI and save any changes you want to keep.
11. Go to the DAQ Solution Wizard window and click < **Back** to browse other gallery categories and common solution VIs.
12. Click **Quit Wizard** to exit.

Add Analog Input to Your VI

You have created a Random Number Example VI that generates random numbers and plots them to a strip chart. Now you can replace the random number generator with an analog input VI to acquire data from your DAQ board, plot it to a strip chart, analyze it, and write it to a file.

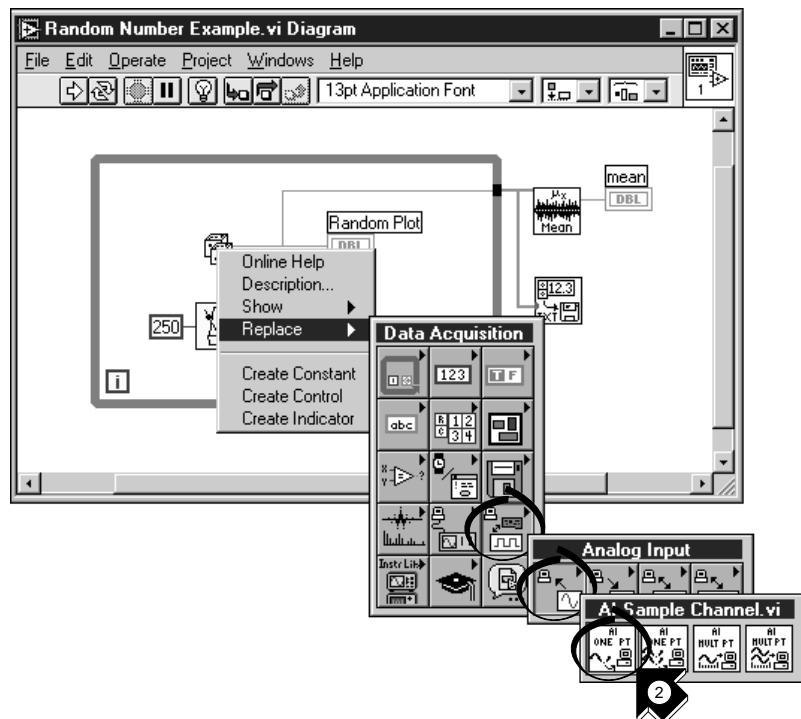


You can complete this activity in approximately 5 minutes.



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 the LabVIEW\vi.lib\tutorial.llb directory.



2. Go to the block diagram. From the pop-up menu on the Random Number function, choose **Replace»Data Acquisition»Analog Input»AI Sample Channel.vi**.

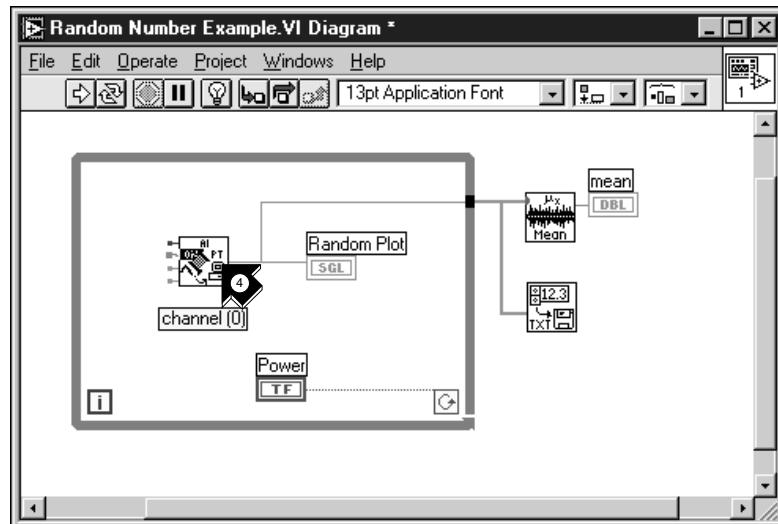


Tip Be sure that you select AI Sample Channel.vi and not AI Sample Channels.vi.

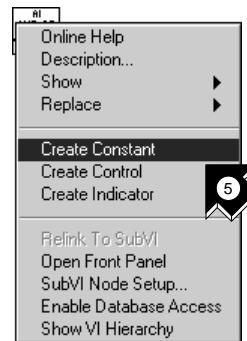


Wiring tool

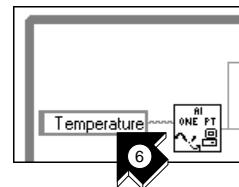
3. Select the **Wiring** tool from the Tools palette. The Wiring tool allows you to see the tip strip labels for terminals on nodes in the block diagram.



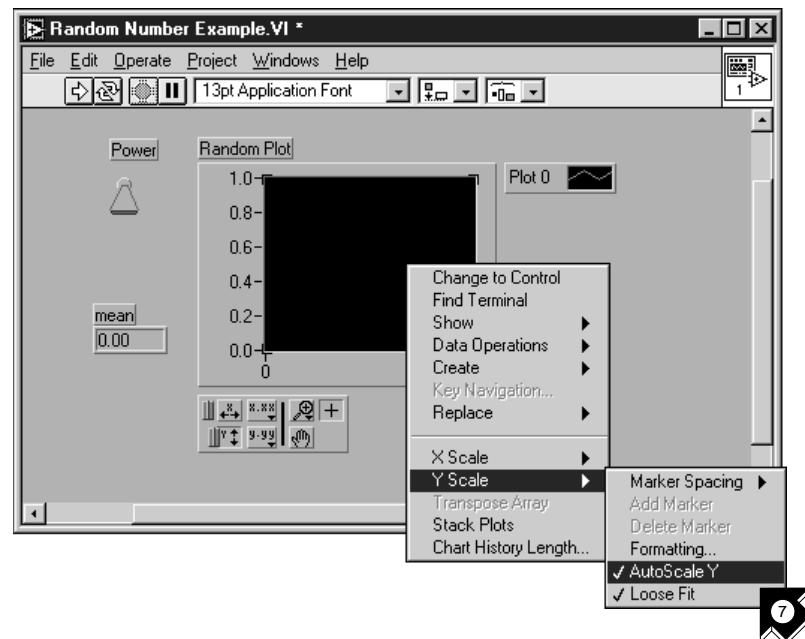
4. Move your pointer over the **channel (0)** terminal of the AI Sample Channel VI. A tip strip that labels the terminal appears.



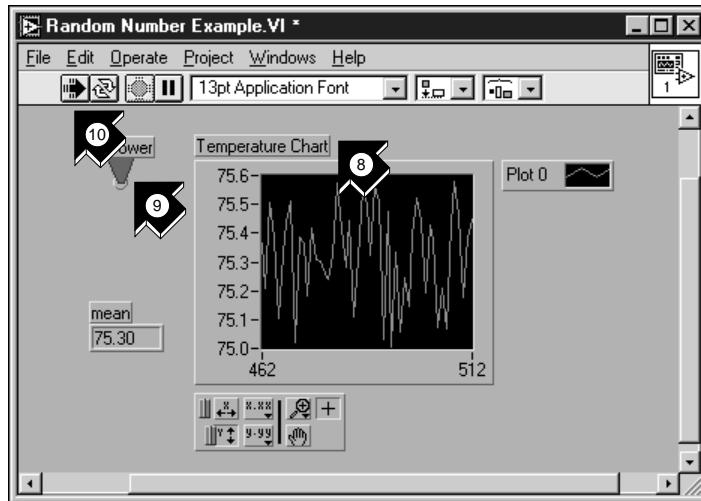
5. From the pop-up menu on the highlighted **channel (0)** terminal, choose **Create Constant**. To access the pop-up menu, right-click on the terminal (on the Macintosh, command-click on the terminal).



6. Type Temperature or the name of the channel you configured in the DAQ Solution Wizard.



7. Go to the front panel. From the pop-up menu on the graph, choose **Y Scale»AutoScale Y**.



Labeling tool



Operating tool



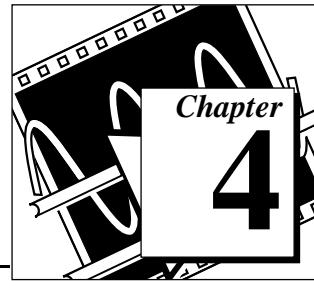
Run

8. Using the **Labeling** tool, highlight the chart label and change the label to **Temperature Chart**.
9. Using the **Operating** tool, click the Power toggle switch to the **TRUE** position.
10. Click the **Run** button to see the data chart.
11. Click the Power toggle switch to stop the VI.
12. In the file dialog box, enter a name such as `data.txt` and click **Save**. This saves your temperature data to a spreadsheet file.
13. Save this VI as `Acquire Temperature.vi` in the `LabVIEW\vi.lib\tutorial.llb` directory.

For multiple point acquisition, waveform generation, digital I/O, or counter timer applications, see the *LabVIEW Data Acquisition Basics Manual*.

Use the **Search Examples** feature found in both the LabVIEW dialog box and the Help menu for examples and information. Search Examples guides you to DAQ examples for reference.

Use the **DAQ Solution Wizard** found in both the LabVIEW dialog box and the File menu to automatically generate DAQ applications that you can customize.



Instrumentation

This chapter teaches you how to use LabVIEW to acquire data from standalone instruments controlled by GPIB, VXI, RS-232, and other hardware standards.

You will learn to do the following:

- Use an instrument driver to communicate with your instrument
- Run the Demo Scope VI if you do not have instrument I/O hardware installed

Instrument I/O

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 command set 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 called instrument driver VI automatically sends the appropriate instrument-specific command strings to the instrument.

The foundation for LabVIEW instrument 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. Instrument drivers using VISA are scalable across instrument I/O interfaces.

Use an Instrument Driver

In this activity, you use an instrument driver to communicate with your instrument.

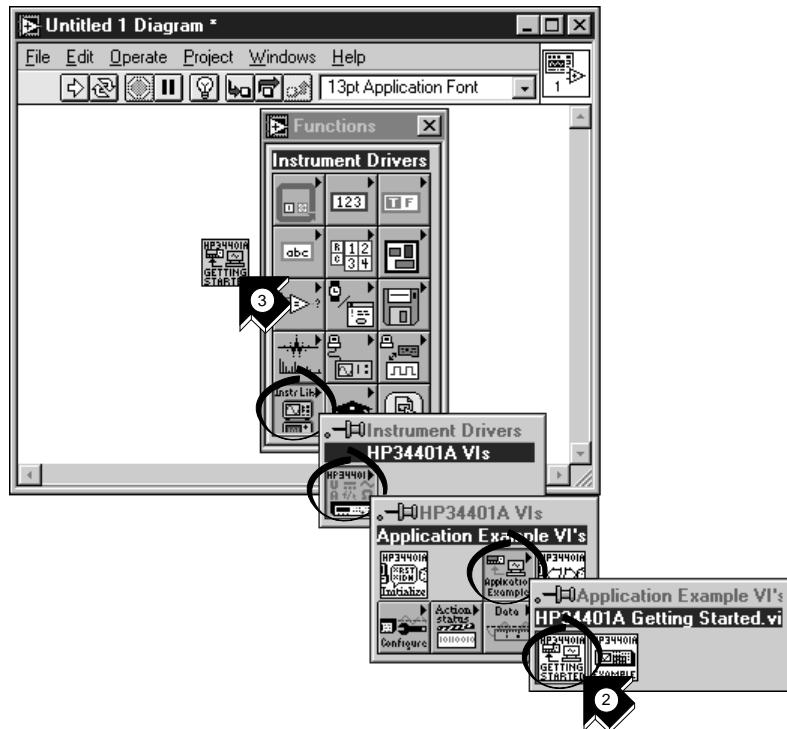


You can complete this activity in approximately 5 minutes.



Tip If you do not have instrument I/O hardware installed, see the *Run the Demo Scope VI activity in this chapter*.

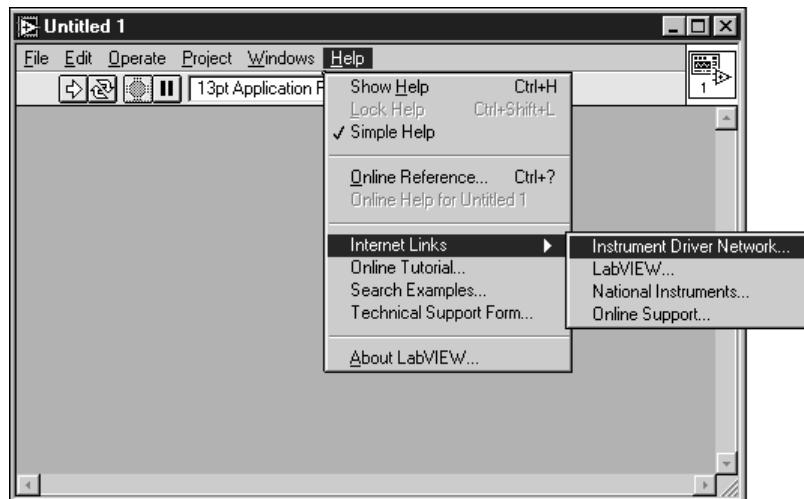
1. Create a new VI and go to the block diagram.



2. Select **Functions»Instrument Drivers»HP34401A VI's»Application Example VI's»HP34401A Getting Started.vi**, or select your instrument name and its Getting Started VI.

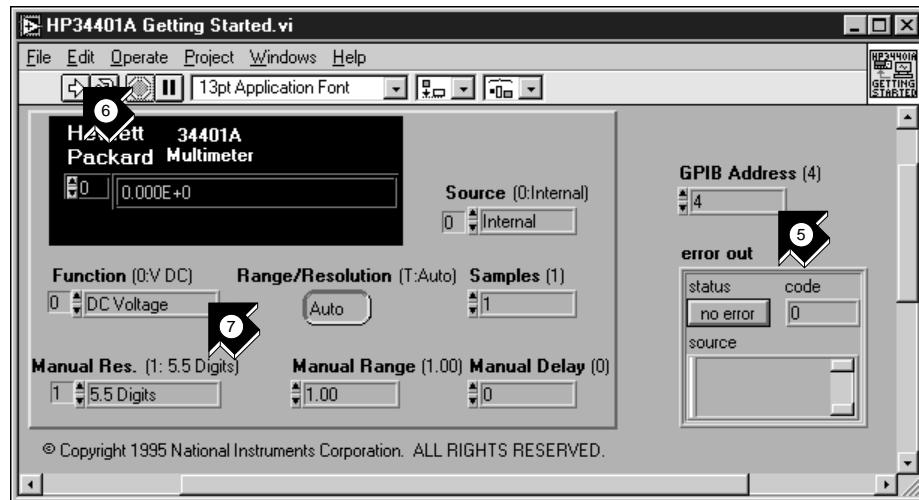


Tip If you cannot find your instrument here, check your LabVIEW CD or the National Instruments *Instrument Driver Library CD* and install the driver for your instrument into the `instr.lib` folder in the LabVIEW root directory.



If you have a web browser installed, you can select Internet Links»Instrument Driver Network... from the Help menu to link automatically to the National Instruments Instrument Driver Network. In this web page, you can search for your instrument among over 600 instrument drivers available with free source code. You then can download the instrument driver you need.

3. Place the VI on the block diagram.
4. Double-click this HP34401A Getting Started VI to see the front panel and block diagram. This VI controls the HP34401A Digital Multimeter. The Getting Started VI is an example of a higher-level program that calls the instrument driver *subVIs* to control the instrument. You see these subVIs in the palette of the instrument driver.



5. On the front panel, verify the GPIB address of the HP34401A Getting Started VI. The default address is 4.

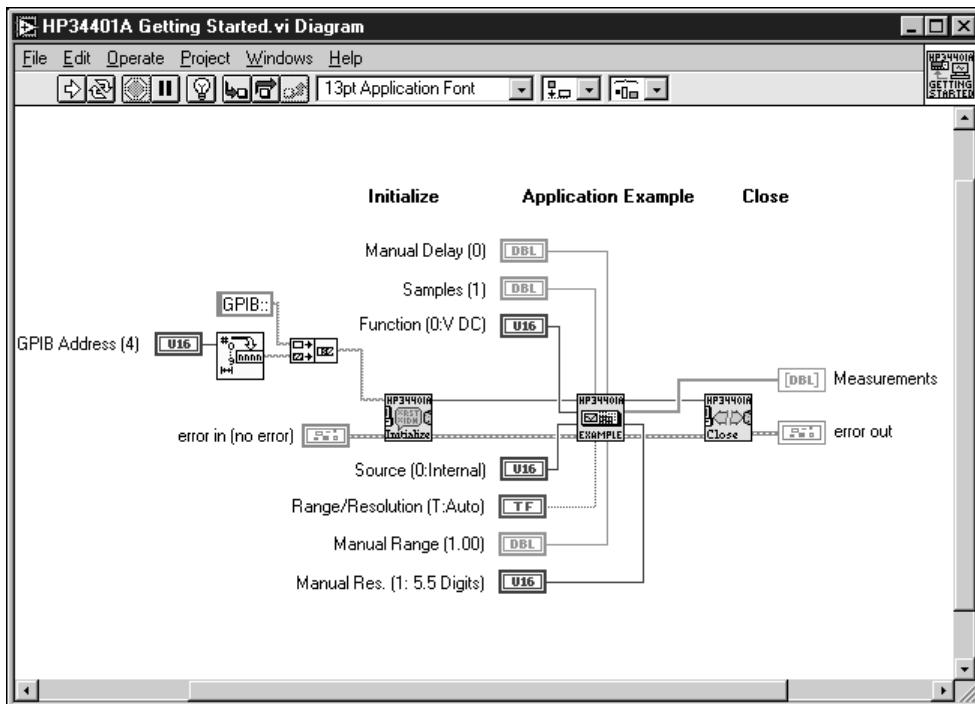


Run

6. Run the VI to measure DC voltage.
7. Using the **Operating** tool, change the **Function** input and run the VI again to see other measurements.



Operating tool



8. Examine the block diagram. The **HP34401A Initialize** subVI is called first, followed by a subVI to control the instrument, and ending with the **HP 34401A Close** subVI.



Tip **You can find the instrument driver subVIs under Functions»Instrument Drivers»Your Instrument.**

When you write your own program with an instrument driver, remember to call Initialize first, followed by the series of subVIs you want to use to control the instrument, and finally the Close subVI to close the instrument session.

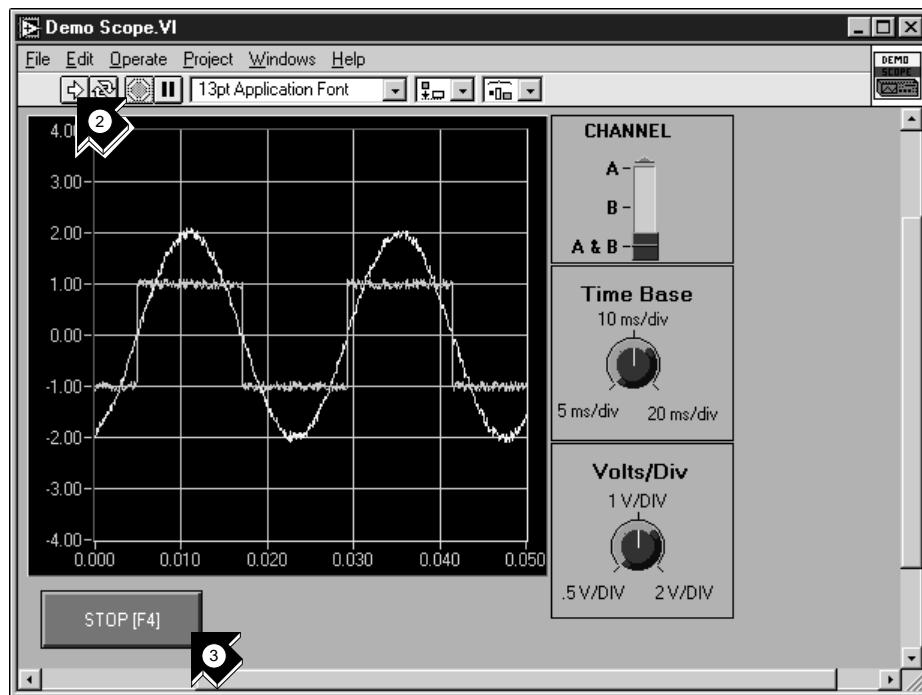
Run the Demo Scope VI

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

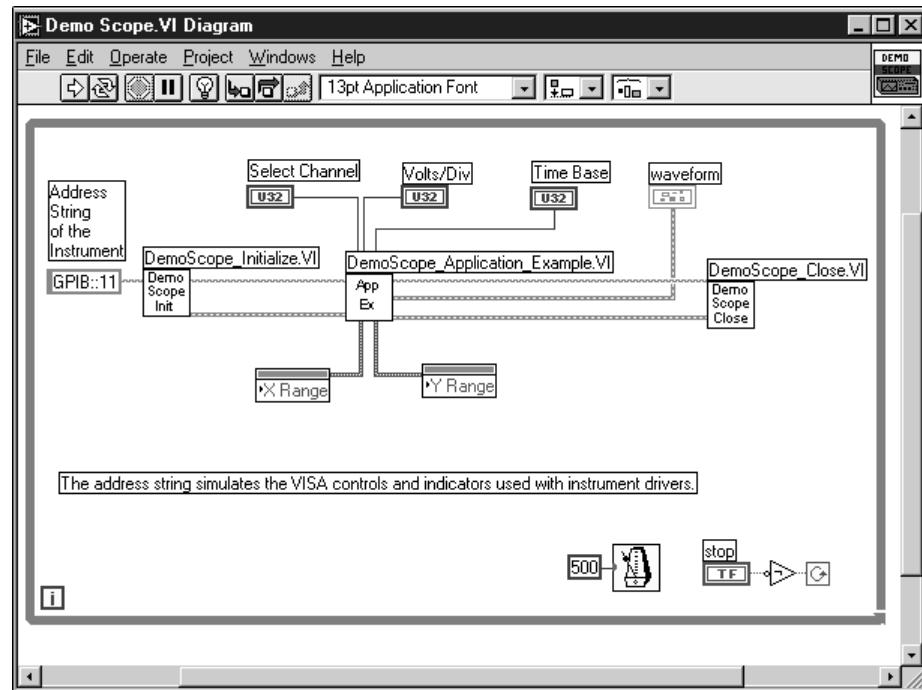


You can complete this activity in approximately 5 minutes.

1. Open the Demo Scope VI instrument driver in `LabVIEW\vi.lib\tutorial.llb`.

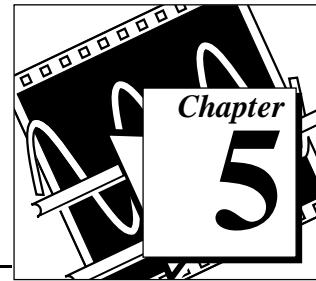


2. Run the program to acquire data from one or two channels on your oscilloscope. Change timebase and volts per division settings to see the effect.
3. Click the square **STOP [F4]** button to stop the VI.



4. Go to 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 out communication with the instrument. When you program with LabVIEW instrument drivers, follow this model of initializing the instrument, then calling the functions to control the instrument, and finally closing the instrument for communication.

Debugging



This chapter teaches you how to use some of the comprehensive debugging utilities in LabVIEW.

Use Execution Highlighting

Execution highlighting traces the data flow of a VI during execution.

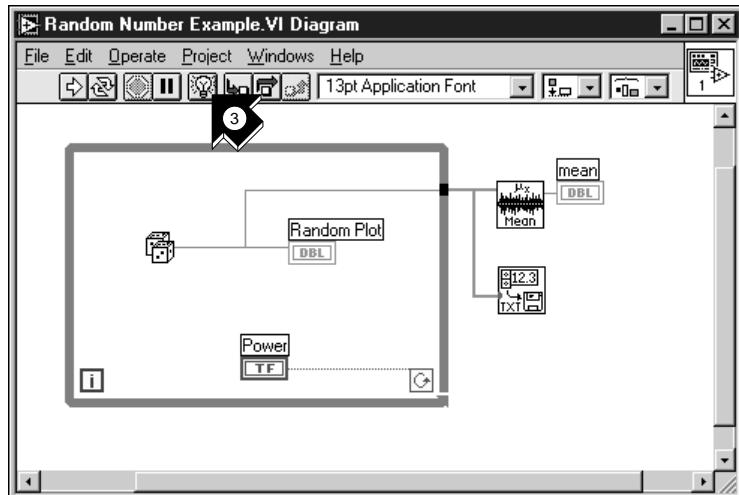


You can complete this activity in approximately 5 minutes.



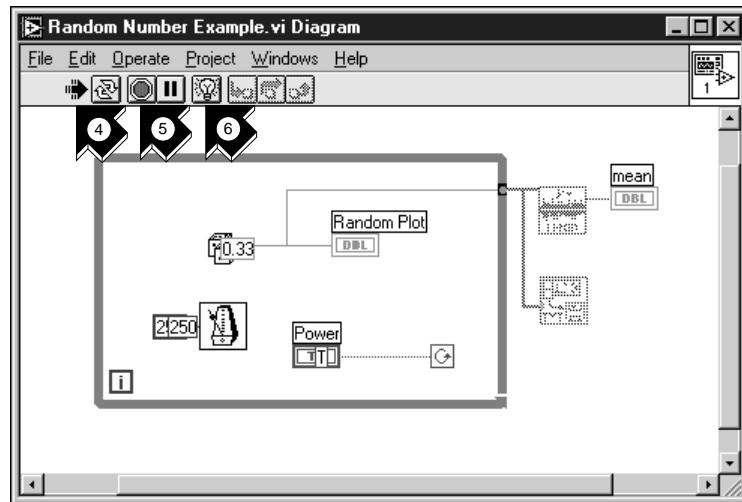
Operating tool

1. From the `LabVIEW\vi.lib\tutorial.llb` directory, open the Random Number Example VI you created earlier.
2. Using the **Operating** tool, turn on the Power toggle switch.



execution highlighting

3. Go to the block diagram and click the execution highlighting button on the toolbar.



Run

4. 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.



Abort



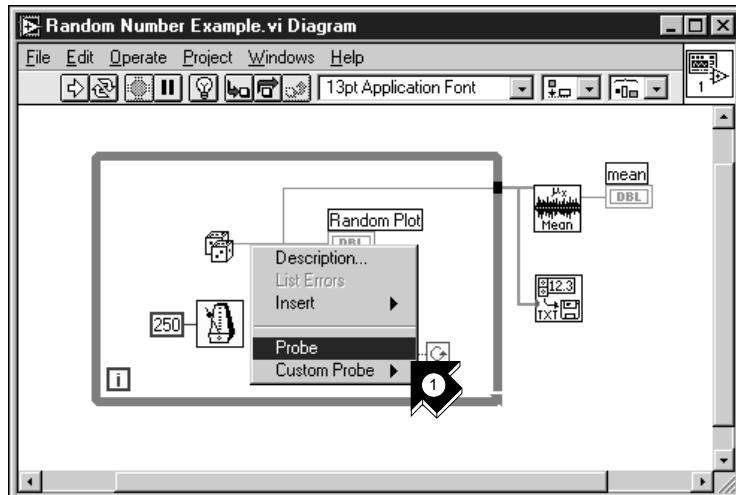
execution highlighting

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 single-step through a VI and how to insert probes to monitor your data while the VI runs.



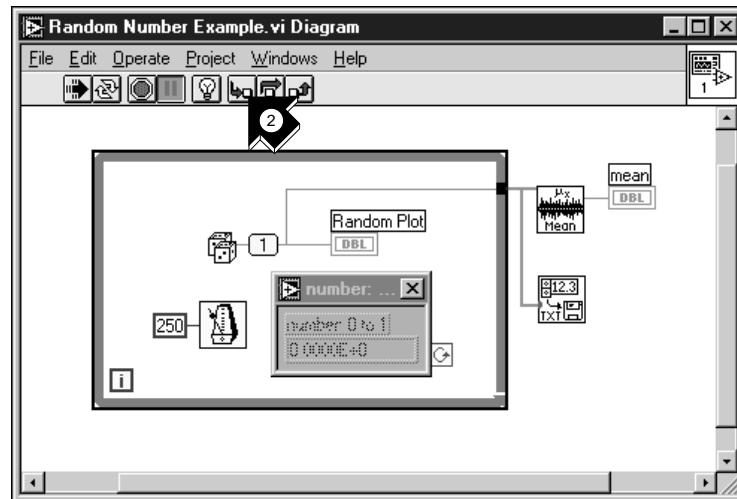
You can complete this activity in approximately 5 minutes.



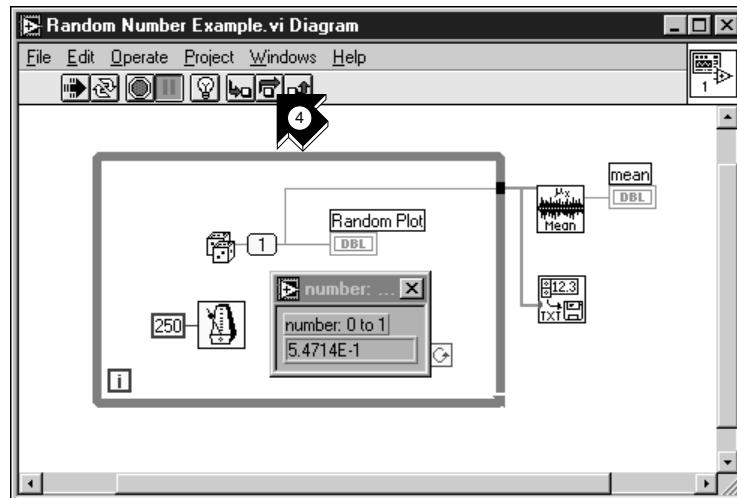
1. From the pop-up menu on the output wire of the Random Number function, choose **Probe**. A small **number: ...** window appears to show the value of the data at that point.



Tip Make sure the Power toggle switch is turned on in the front panel.

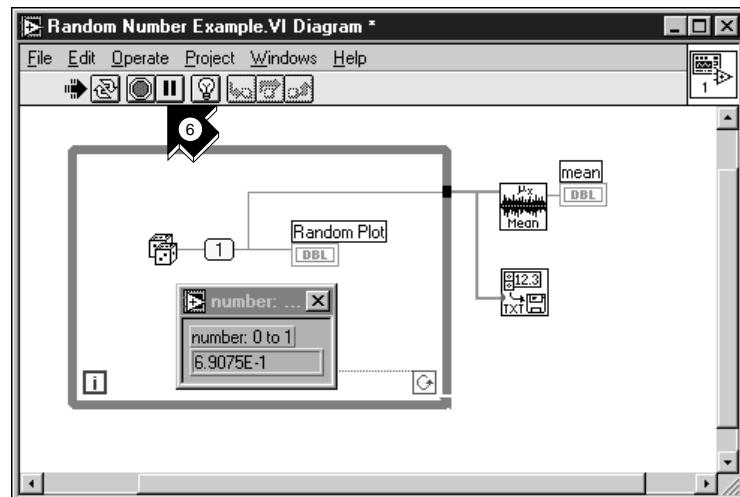


2. Click the **Step Into** button on the toolbar. The While Loop now flashes, indicating that the program is executing in single step mode.
3. Click the **Step Into** button again. The Random Number function now flashes.



4. Click the **Step Over** button to step over the Random Number function. The random number function executes, so the output now appears in the probe.

5. Using **Step Into** and **Step Over** buttons, single step a few more times through the loop to view each random number as it is generated in the VI.



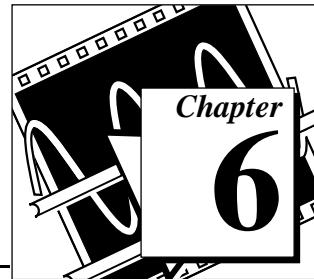


6. To run your VI in normal mode, deselect the **Pause** button.

Pause

7. Go to the front panel and turn off the Power toggle switch to stop the VI. Save the collected data to `data.txt`.

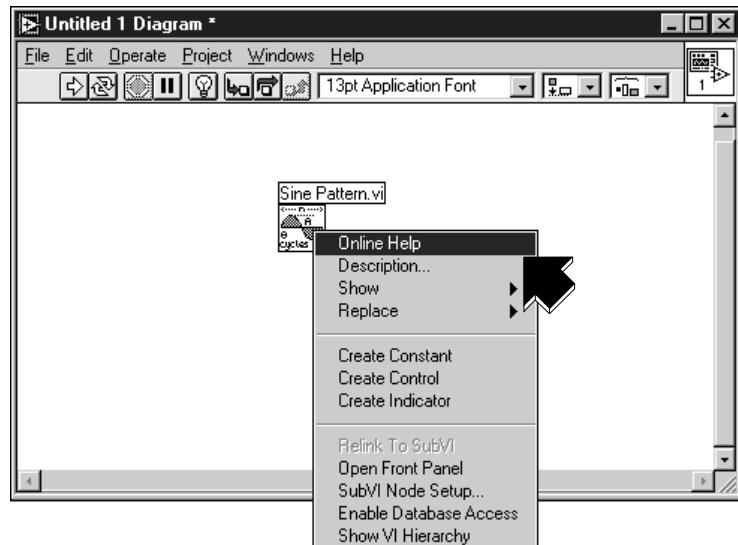
Where To Go From Here



This chapter teaches you how to use Online Help in LabVIEW. It also outlines National Instruments' commitment to your success and the additional resources available to you. To learn more about LabVIEW programming techniques, consult the *LabVIEW Tutorial Manual* and the *LabVIEW User Manual*, available with the LabVIEW development system.

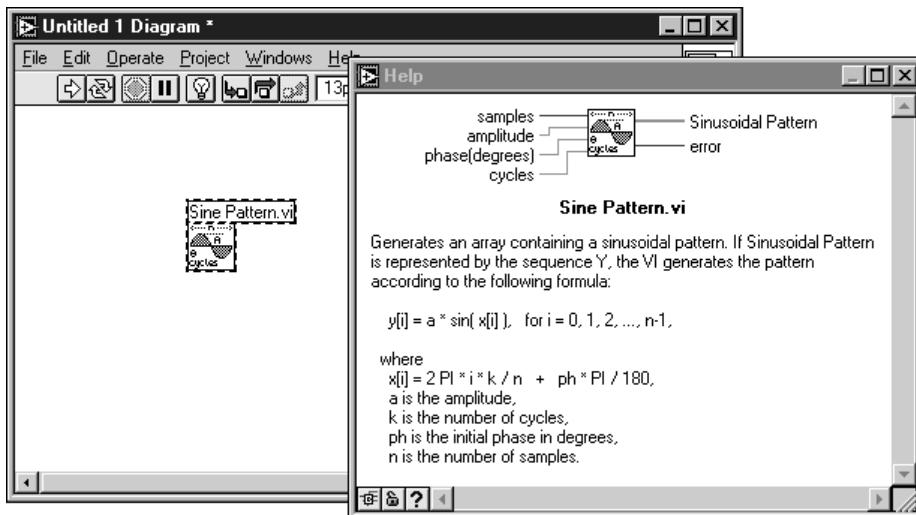
Online Help

All built-in LabVIEW VIs come with a complete online reference. When you find an unfamiliar VI, place it on your block diagram and choose **Online Help** from the pop-up menu on the VI. Online Help gives you a complete description of the VI functionality and parameters.



Show Help

If you need a quick reference to remind you about VI functionality or input and output parameters, select **Help»Show Help**.

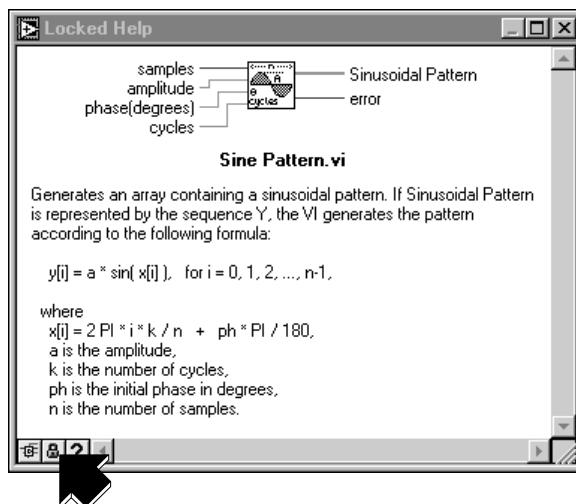


Unlocked



Locked

The Help window is context-sensitive, so when you need information about a VI, place your pointer over the VI icon. Click the lock button at the bottom of the Help window to lock the current contents of the Help window.



National Instruments' Commitment to You

LabVIEW represents a long-standing commitment by National Instruments to provide tools that simplify the development of instrumentation 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.

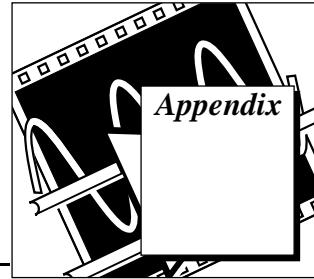
National Instruments' comprehensive training courses on LabVIEW can help you learn to build applications quickly. The three-day Basics course and two-day Advanced course give you concentrated instruction, as well as design tips, on the LabVIEW development environment from our applications engineers. These courses take place monthly at our corporate headquarters in Austin, Texas, and also at our branches around the world. In addition, we offer two-day courses on GPIB, DAQ, VXI, and other topics to help you develop your entire system.

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 *Solutions* directory lists additional libraries and utilities developed by our Alliance members to help you use LabVIEW. In addition, the *Solutions* directory lists expert LabVIEW consultants who can help you develop custom applications.

Technical Support

National Instruments offers you complete technical support. You can use our Internet sites (Web and FTP), BBS, or fax-on-demand systems to download valuable information and product examples, question-and-answer documents, and technical development tips. A technical forum for LabVIEW is available on the Internet where you can discuss issues with other LabVIEW users. In addition, National Instruments has experienced Applications Engineers located throughout the world to assist you.



Installation Instructions

This appendix describes the system requirements and installation procedures for LabVIEW.

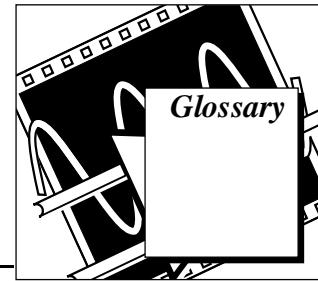
Required System Configuration

LabVIEW has the following system configuration requirements for Windows platforms:

- Windows 3.1
 - LabVIEW runs in 386 enhanced mode with a minimum of 8 MB of RAM. LabVIEW runs optimally on a computer with an 80486 CPU, but LabVIEW can run on an 80386-based PC. LabVIEW for Windows requires a coprocessor.
- Windows 95
 - LabVIEW runs under any system that supports Windows 95, with 8 to 12 MB of RAM for effective operation.
- Windows NT
 - LabVIEW requires Windows NT version 3.5.1 or greater, with a minimum of 12 to 16 MB of RAM for effective operation. LabVIEW for Windows NT only runs under Windows NT 80x86 computers.

Installation Procedures

- LabVIEW Development System
 - For instructions on how to install LabVIEW, see the *LabVIEW Release Notes*.
- Evaluation Software
 - If you are installing from the Software Showcase CD, run *Showcase.exe*. Go to the LabVIEW section in *Virtual Instrumentation Tools* and click **demo**.
 - If you are installing from the *LabVIEW Evaluation Version CD*, see the *readme.txt* file for installation instructions.



B

block diagram

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

C

conditional terminal

The terminal of a While Loop that contains a Boolean value that determines whether the VI performs another iteration.

control

Front panel object for entering data to a VI interactively or to a subVI programmatically.

Controls palette

Palette containing front panel controls and indicators.

D

data flow

Programming system consisting of executable nodes in which nodes execute only when they have received all the required input data and produce output automatically when they have executed. LabVIEW is a dataflow system.

DAQ Channel Wizard

Utility that guides you through naming and configuring your DAQ analog input channels.

DAQ Solution Wizard

Utility that guides you through specifying your DAQ application, from which it provides a custom DAQ solution.

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 | Feature that animates VI execution to illustrate the data flow in a VI. |

F

| | |
|-------------------|--|
| front panel | The interactive user interface of a VI. Modeled from the front panel of physical instruments, it is composed of switches, slides, meters, graphs, charts, gauges, LEDs, and other controls and indicators. |
| function | Built-in execution element, comparable to an operator, function, or statement in a conventional language. |
| Functions palette | Palette containing block diagram structures, constants, communication features, and VIs. |

G

| | |
|------|--|
| G | The graphical programming language used to develop LabVIEW applications. |
| GPIB | General Purpose Interface Bus is the common name for the communications interface system defined in ANSI/IEEE Standard 488.1-1987 and ANSI/IEEE Standard 488.2-1987. Hewlett-Packard, the inventor of the bus, calls it the HP-IB. |

I

| | |
|-----------|--|
| indicator | Front panel object that displays output. |
|-----------|--|

L

| | |
|---------------|---|
| Labeling tool | Tool used to create labels and enter text into windows. |
| LabVIEW | Laboratory Virtual Instrument Engineering Workbench. |

N

nodes Execution elements of a block diagram consisting of functions, structures, and subVIs. *See also* data flow, wire.

O

Operating tool Tool used to enter data into controls as well as operate them.

P

Palette A display of pictures that represent possible options. *See also* Controls palette, Functions palette, subpalette, Tools palette.

Positioning tool Tool used to move, select, and resize objects.

probe Debugging feature for checking intermediate values in a VI.

R

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

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

S

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 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 passes.

| | |
|---------------|---|
| tip strip | A text banner that displays the name of an object, control, or terminal. |
| Tools palette | Palette containing the 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 | <i>See</i> virtual instrument. |
| virtual instrument | A program in the graphical programming language G that models the appearance and function of a physical instrument. |
| VISA | Virtual Instrument Software Architecture. A single interface library for controlling GPIB, VXI, RS-232, and other types of instruments. |
| VXI | VME eXtensions for Instrumentation (bus). |

W

| | |
|----------------|---|
| waveform chart | An indicator that plots data points at a certain rate. |
| While Loop | Loop structure that repeats a section of code until a condition is met. Comparable to a Do loop or a Repeat-Until loop in conventional programming languages. |
| wire | Data path between nodes. <i>See also</i> data flow. |
| wire branch | A section of wire that contains all the wire segments from one junction to another, from a terminal to the next junction, or from one terminal to another if there are no junctions in between. |
| wire junction | The point where three or more wire segments join. |
| wire segment | A single, horizontal or vertical piece of wire. |
| Wiring tool | Tool used to define data paths between terminals. Resembles a spool of wire. |