

LabWindows™ /CVI™

Evaluation Guide

Worldwide Technical Support and Product Information

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About This Manual

The *LabWindows/CVI Evaluation Guide* provides an introduction to National Instruments, virtual instrumentation, and the LabWindows™/CVI™ development environment. This document contains a step-by-step tutorial that guides you through the process of creating a LabWindows/CVI project that retrieves data from a simulated instrument. In the tutorial, you learn how to create a user interface, generate code, and add an instrument driver to the project.

Conventions

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 symbol also leads you through the LabWindows/CVI Library Tree to a function panel. For example, **User Interface Library»Pop-up Panels»InstallPopup** directs you to expand the User Interface Library in the Library Tree, expand the Pop-up Panels class, and select InstallPopup.



This icon denotes an activity that you can complete to practice the concepts presented in that section.



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 in the software, such as menu items and dialog box options. Bold text also denotes parameter names.

<i>italic</i>	Italic text denotes variables, emphasis, a cross reference, or an introduction to a key concept. Italic text 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.

Related Documentation

The following documents contain information that you might find helpful as you read this manual:

- *LabWindows/CVI Help*
- *Getting Started with LabWindows/CVI*
- *LabWindows/CVI Quick Reference*
- *LabWindows/CVI Release Notes*
- *LabWindows/CVI Instrument Driver Developers Guide*

National Instruments, Virtual Instrumentation, and LabWindows/CVI

National Instruments is committed to providing hardware and software for engineers and scientists who create test, measurement, and automation applications. With NI products, you can rapidly develop high-performing virtual instrumentation applications that seamlessly integrate into your test and measurement systems.

National Instruments developed NI LabWindows/CVI for C programmers. You can use the LabWindows/CVI development environment to build C-based virtual instrumentation applications.

This chapter provides an introduction to virtual instrumentation and LabWindows/CVI.

Virtual Instruments

NI pioneered the area of virtual instrumentation, which revolutionized the test and measurement industry. A virtual instrument consists of an industry-standard computer or workstation equipped with powerful application software, cost-effective hardware such as a plug-in board, and driver software, which together perform the functions of traditional instruments. You can use virtual instruments to acquire and control data much like you use traditional laboratory instruments. However, virtual instruments can provide more customization, scalability, and modularity than traditional instruments.

LabWindows/CVI

LabWindows/CVI has become the most popular software development environment for C programmers who develop test, measurement, control, and automation applications. LabWindows/CVI is a proven ANSI C development environment and compiler with built-in libraries for acquisition, analysis, and presentation. LabWindows/CVI combines the power and flexibility of ANSI C with easy-to-use tools for building virtual instrumentation systems.

You can use LabWindows/CVI to control, configure, and acquire data using NI-DAQ, GPIB, modular instruments, PXI, VXI, serial, and ethernet-based devices.

LabWindows/CVI is built on an open software architecture, which means that you can reuse existing programs within the LabWindows/CVI environment. You can incorporate standard ANSI C code, object files, and DLLs into your applications.

Measurement Libraries and Components

Because LabWindows/CVI is a programming environment for measurement applications, it includes a large set of run-time libraries for instrument control, data acquisition, analysis, and user interface design. LabWindows/CVI provides libraries for using the following technologies:

- GUI design
- Data acquisition
- Data analysis
- Data formatting
- Internet communication
- DIAdem connectivity
- Network variables
- Technical Data Management Streaming (TDMS) file format
- File I/O
- COM/ActiveX support
- .NET support
- Controller Area Network (CAN)
- GPIB
- RS-232
- VISA
- VXI
- TCP
- User Datagram Protocol (UDP)
- Windows Dynamic Data Exchange (DDE) communication

LabWindows/CVI also contains many features that make developing measurement applications much easier than developing in traditional C environments. LabWindows/CVI provides the following tools:

- A development environment that manages projects and source code with complete editing, debugging, and user protection features
- A graphical User Interface Editor, CodeBuilder wizard, and library for building, displaying, and controlling a graphical user interface

- A wizard and library for creating IVI instrument drivers, which are highly structured VXIplug&play-compatible instrument drivers that use an attribute model to enable advanced features, such as state-caching, simulation, and compatibility with generic instrument classes
- An interactive tool for creating and editing data acquisition tasks
- An interactive tool for creating instrument control tasks
- An installer creation tool that makes it easy to deploy your finished application
- Multithreaded application development and debugging capabilities
- A command line compiler

Using LabWindows/CVI to Create Virtual Instruments

Creating virtual instruments is a three-step process when you use NI hardware with LabWindows/CVI.

Step 1—Acquire

Acquire your raw data through a hardware interface. LabWindows/CVI provides a high-level interface for acquiring data—whether you use a GPIB or serial instrument, a plug-in data acquisition board, PXI hardware, modular instruments, an image acquisition device, or a motion control device.

Step 2—Analyze

Analyze your raw data. Rather than collecting a list of raw signals and later analyzing them with a separate application, use LabWindows/CVI analysis tools to obtain fast and meaningful results. You can employ a variety of signal processing and data analysis tools—including statistical analysis, curve fitting, spectral analysis, and visualization functions—for research and development, engineering and validation, or manufacturing and service applications.

Step 3—Present

Present your results in an intuitive way. Interact with the instrumentation system through a GUI—the interactive user interface of a virtual instrument. LabWindows/CVI delivers ready-to-use, measurement-specific user interface components with which you can create professional measurement applications. Use three-dimensional, instrument-style controls and indicators—including buttons, knobs, thermometers, tanks, LEDs, slides, numerical displays, strip charts, graphs, trees, and tables—to build panels that represent traditional test and measurement instruments.

New Features in LabWindows/CVI 8.5

LabWindows/CVI 8.5 incorporates new tools and features to improve virtual instrumentation development and execution. The following list introduces some of the new features for LabWindows/CVI 8.5. For a complete list of new features, refer to the *LabWindows/CVI Release Notes*, which you can download from ni.com/manuals.

- Use the Welcome Page at startup to directly access various commonly used resources, such as most recently used projects, example programs, project templates, Web resources, and documentation.
- Shorten the time between identifying a bug and implementing a fix by editing a program while debugging. You also can open files while a program is running.
- Achieve reliable multicore performance with the LabWindows/CVI Real-Time Module. Realize increased determinism and reliability in real-time applications by assigning time-critical tasks to specific processor cores with the LabWindows/CVI Real-Time Module.
- Improve source code readability with collapsible source code regions to help you view your code in smaller sections. You also can enclose lines of code with tags to define your own collapsible region.
- Eliminate clutter with the streamlined tabbed workspace. Open multiple function panels and `.c`, `.h`, `.uir`, and `.fp` files in tabs. Drag tabs to rearrange their order and position.
- Enable auto backup so LabWindows/CVI can recover `.uir`, `.c`, `.h`, `.prj`, and `.fp` files with unsaved changes if LabWindows/CVI fails to shut down normally.
- Use the functions in the UDP Support Library to send a message to a single computer, broadcast a message to all computers on a subnet, or send a message to all computers that subscribe to a multicast address. UDP is a connectionless protocol that runs on IP networks, like TCP.
- Use the functions in the Configuration Functions class of the Network Variable Library to create a single network variable or an entire collection of network variables.
- Create dynamic user interfaces by enabling autoscaling, scrolling, and legends on strip charts.
- Specify an angle of rotation for text messages; table and row column labels; tree column labels; graph annotations; and graph, strip chart, and digital graph axis labels.
- Assign 64-bit integer as the data type for user interface controls.
- Choose from four versatile zooming modes on graphs: zoom to rectangle, x-zoom, y-zoom, and zoom around point.
- Add a color ramp to delineate different ranges in numeric slide controls such as thermometers, tanks, and gauges.
- Use hash table functions in the Programmer's Toolbox to create a hash table. Hash tables can store keys and their associated data values.

- Use a .NET delegate from the .NET Library or the wrappers you generate using the .NET Controller Wizard to call a callback function when an event occurs.

Related Software Packages

NI offers additional packages for targeted applications with LabWindows/CVI. Visit the Product Catalog at ni.com for more information about the following software packages:

- **NI Developer Suite**—The NI Developer Suite Automated Test Option includes the following components:
 - LabWindows/CVI Full Development System
 - LabVIEW Professional Development System for graphically developing test, measurement, and automation applications
 - Measurement Studio Enterprise Edition for developing test, measurement, and automation applications in Microsoft Visual C++, Visual Basic .NET, and Visual C#
 - A comprehensive set of LabWindows/CVI, LabVIEW, and Measurement Studio add-ons that include toolkits for database communication, signal processing, and VI development
 - A one-year subscription to Standard Service, which provides quarterly software updates automatically and gives you one-on-one access to NI Applications Engineers for your technical support questions
- **LabWindows/CVI Real-Time Module**—Create reliable and deterministic applications that target dedicated real-time hardware with this module that extends the LabWindows/CVI development environment. National Instruments provides a commercial off-the-shelf platform for real-time application development by combining flexible, high-performance software with rugged, modular hardware.
- **Real-Time Execution Trace Toolkit**—Create execution traces for LabWindows/CVI Real-Time applications with this toolkit. Interactively analyze and benchmark thread and function execution. Optimize performance by identifying memory allocation, sleep spans, and contention. Print trace sessions for documentation and code reviews and visually debug multicore applications.
- **Measurement Studio**—Measurement Studio is an integrated suite of native test, measurement, and control tools and class libraries for Microsoft Visual Studio .NET. Measurement Studio dramatically reduces application development time with wizards, simplified data networking, and .NET user interface controls. The LabWindows/CVI Full Development System includes Measurement Studio.
- **NI TestStand**—TestStand is a ready-to-run test executive for organizing, controlling, and executing automated prototype, validation, or manufacturing test systems. TestStand is completely customizable, so you can modify and enhance it to match your specific needs. TestStand comes complete with integrated LabWindows/CVI tools.

- **NI Vision Development Module**—Use the NI Vision Development Module to develop machine vision and scientific imaging applications. The NI Vision Development module includes NI Vision, a library of powerful functions for image processing, and NI Vision Assistant, an interactive environment to quickly prototype vision applications without programming.
- **DIAdem**—DIAdem is an interactive tool for mathematical and visual data analysis, report generation, task automation, and data management. DIAdem imports data from files and industry-standard databases and can optimally handle datasets with more than one billion parts. Use the DIAdem Connectivity Library in LabWindows/CVI to create and edit DIAdem data (.tdm) files.
- **LabWindows/CVI Enterprise Connectivity Toolset**—The LabWindows/CVI Enterprise Connectivity Toolset provides enterprise connectivity tools that help you track progress from research and development to the production, testing, and servicing of products. This toolset includes the LabWindows/CVI SQL Toolkit for Structured Query Language (SQL) database operations and the LabWindows/CVI SPC Toolkit for statistical process control (SPC) quality control.
- **LabWindows/CVI Signal Processing Toolkit**—The LabWindows/CVI Signal Processing Toolkit provides tools for digital filter design, joint time-frequency analysis, wavelet and filter bank design, and super-resolution spectral analysis.
- **PID Control Toolkit**—The PID Control Toolkit adds sophisticated control algorithms to LabWindows/CVI. With this package, you can build data acquisition and control systems for your own control application.



Tip Visit ni.com/idnet to access the online Instrument Driver Network—the industry’s largest source of instrument drivers, featuring drivers for over 5,000 instruments from over 200 vendors. Here you can download and submit drivers for controlling instruments from LabWindows/CVI. Browse through instrument drivers by instrument type, manufacturer, or development language.

- **Modulation Toolkit**—Use this toolkit to generate and analyze analog and digital modulated signals. You can use this toolkit to build applications that measure signal impairments, bit error rate, burst timing, phase noise, carrier frequency shift, modulation index, and complementary cumulative distribution function (CCDF) values of signals generated by a unit under test.
- **LabWindows/CVI Run-Time Module for Linux**—Create high-performance, stable applications on a Windows system and later compile and run these applications on a Linux® target.

Getting Started with LabWindows/CVI

This chapter introduces the LabWindows/CVI Evaluation Package, provides system requirements and installation information, and includes an exercise to help familiarize you with the LabWindows/CVI environment.

The LabWindows/CVI CD includes both the LabWindows/CVI Evaluation Package and the licensed version of LabWindows/CVI. When you launch LabWindows/CVI during the evaluation period and before you have purchased a valid license, LabWindows/CVI displays the dialog box shown in Figure 2-1.

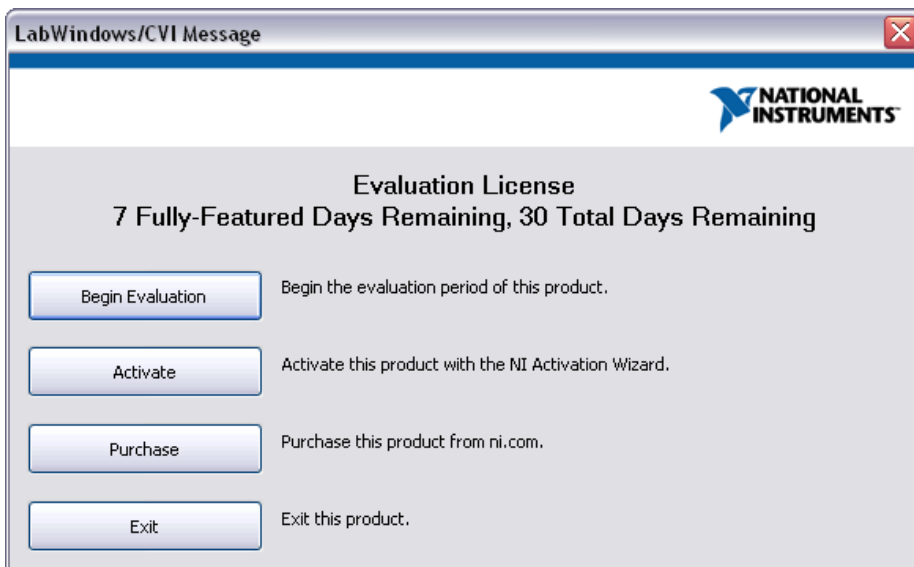


Figure 2-1. Evaluation License Dialog Box

Click **Begin Evaluation** to begin running the software in evaluation mode for the duration of the evaluation period.

To purchase LabWindows/CVI, click **Purchase**. You also can contact National Instruments to purchase LabWindows/CVI. For contact information, refer to ni.com/contact or

ni.com/niglobal. To activate LabWindows/CVI after you purchase a license, click **Activate** and follow the activation instructions.

About this Evaluation Package

The LabWindows/CVI Full Development System includes data acquisition, instrument control, user interface, advanced analysis, digital signal processing, and networking tools. With LabWindows/CVI, you can acquire data with NI data acquisition (DAQ) boards; control serial, GPIB, PXI, USB, Ethernet, and VXI instruments and controllers; analyze the data you acquired from a device; develop custom user interfaces to present data; and share live data between different applications over the Internet.

The LabWindows/CVI Evaluation Package does not include components from the National Instruments Device Drivers CD set. You can download drivers from ni.com/support and select the **Drivers and Updates** link.

The LabWindows/CVI Evaluation Package contains the LabWindows/CVI Full Development System with the following restrictions:

- 30-day expiration
- 10-minute run-time timeout
- No external compiler support
- Disabled installer creation
- Disabled Create Object File feature
- Disabled generation of import libraries from header files
- No IVI Wizard support (disabled Create IVI Specific Driver and Create IVI Custom Class Driver features)



Note After you activate LabWindows/CVI, you must rebuild any projects you created in evaluation mode. If you do not rebuild a project you created in evaluation mode, the project continues to have a 10-minute run-time timeout.

Minimum System Requirements

To run LabWindows/CVI, you must have the following items:

- Personal computer using a Pentium 1 GHz or higher microprocessor
- Microsoft Windows Vista/XP or Windows 2000 Service Pack 3 or later
- 1024 × 768 resolution (or higher) video adapter
- Minimum of 128 MB of RAM, 512 MB recommended

- 200 MB free hard disk space
- Microsoft-compatible mouse

Installation Instructions

Complete the following steps to install the LabWindows/CVI Evaluation Package.

1. Insert the CD in the CD drive. If the CD does not run automatically, open Windows Explorer, right-click the CD drive icon, and select **AutoPlay**.
2. Select **Install LabWindows/CVI** on the National Instruments LabWindows/CVI screen.
3. In the **User Information** panel, select **Install this product for evaluation**. Continue to follow the instructions on the screen.
4. Install driver software if you plan to use LabWindows/CVI with NI hardware.
5. Install the NI hardware. Refer to the hardware installation guide for installation information.
6. Configure the NI hardware with NI Measurement & Automation Explorer (MAX).

Exploring LabWindows/CVI

As you develop applications in LabWindows/CVI, you work within the Workspace window. The Workspace window contains the following areas:

- **Project Tree**—Contains files for each project in the workspace
- **Library Tree**—Provides access to function panels for the functions in LabWindows/CVI libraries and loaded instruments
- **Window Confinement Region**—Contains open Source windows, User Interface Editor windows, Function Tree Editor windows, Function Panel Editor windows, and function panels
- **Source Code Browser**—Lists selected files, functions, variables, data types, and macros in a program
- **Debugging Region**—Contains the Variables, Watch, and Memory Display windows
- **Output Region**—Contains various error, output, and results windows



You can complete this activity in 5 minutes.

1. Launch LabWindows/CVI. The first screen you see is the Welcome Page, which displays helpful resources, new features, and recently opened files. You can choose a project template or a recently opened file to launch the application. For this exercise, dismiss the Welcome Page to explore an empty workspace.

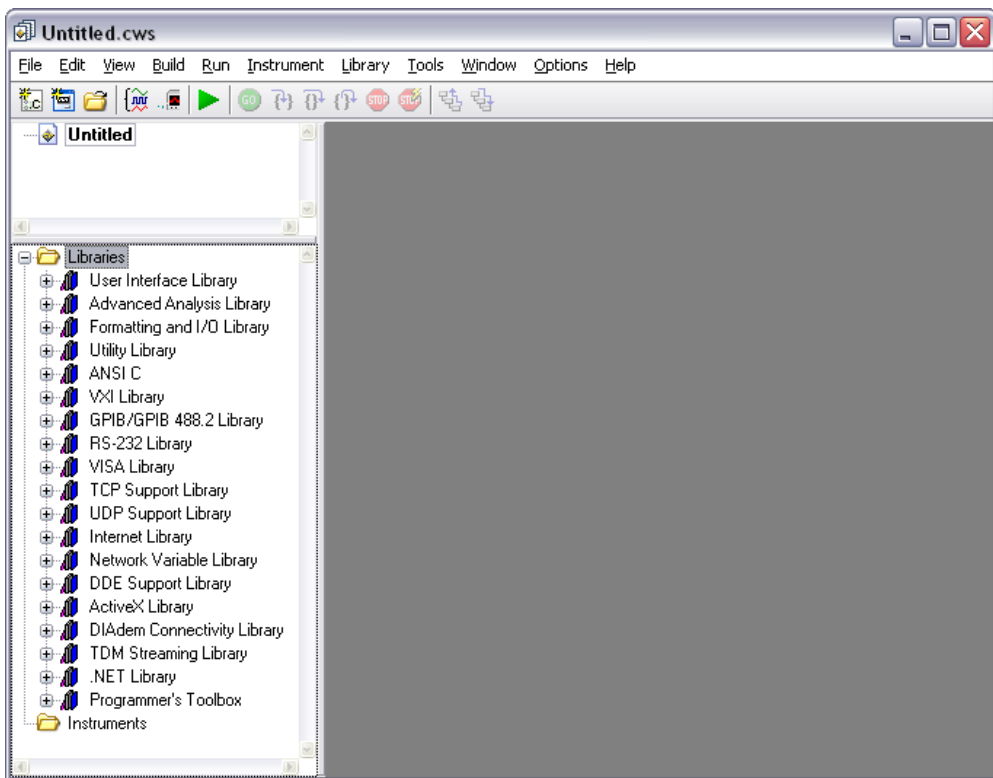


Figure 2-2. LabWindows/CVI Workspace Window

2. Explore the main windows in LabWindows/CVI. To open the Source window, select **File»New»Source (*.c)**. To open the User Interface Editor, select **File»New»User Interface (*.uir)**. To open the Function Tree Editor, select **File»New»Function Tree (*.fp)**. Access the context menu in each window by right-clicking an empty area of the window.
3. Notice that the menus and toolbars change depending on the window with which you interact.

For more information about the LabWindows/CVI environment, refer to the *Using LabWindows/CVI* section of the *LabWindows/CVI Help*.

Context-Sensitive Help

NI designed LabWindows/CVI to deliver the appropriate information when you need it. In addition to traditional help files, you can find context-sensitive help throughout LabWindows/CVI. Use the following resources to learn more about LabWindows/CVI:

- **LabWindows/CVI Help**—Select **Help»Contents** in LabWindows/CVI to access the *LabWindows/CVI Help*.
- **Menu Help**—Press <F1> on menus or right-click menus and select **Menu Help** to learn more about the options and features available in that menu.
- **Dialog Box Help**—Press <F1> or click the **Help** button in dialog boxes to access help about the options and features available in that dialog box.
- **Source Window Keyword Help**—Press <F1> on a LabWindows/CVI function name in the Source window to access help for that function. If you use the **Edit»Show Prototype** option to view the function prototype tooltip of the current function in the Source window, you can click the question mark button to the left of the function prototype or press <F1> to view help for the currently highlighted function or parameter.
- **Function Panel Help**—Right-click the panel or any parameter for help about that function or parameter.
- **User Interface Editor Help**—Right-click any control and select **Control Help** or select a control and press <F1> to open help for a GUI control. You also can access help in Edit Control dialog boxes. Click the question mark button in the Edit Control dialog box title bar and then select a control to view help.

Creating a LabWindows/CVI Project

This chapter guides you through the process of creating a project that retrieves data from a simulated instrument. You will learn how to create a user interface, generate code, and add an instrument driver to the project.

Creating a New LabWindows/CVI Project



You can complete this activity in 2 minutes.

To create a project, complete the following steps:

1. Select **File»New»Project from Template** to open the New Project from Template dialog box.
2. Select **User Interface Application**.
3. Change **Project Name** to `AcquireWaveform`.
4. Change the **Project Folder** to the tutorial folder. For Windows XP/2000, browse to `C:\Documents and Settings\All Users\Documents\National Instruments\CVIxx\tutorial\`. For Windows Vista, enter `C:\Users\Public\Documents\National Instruments\CVIxx\tutorial\`.
5. Verify that **Add this project to the current workspace** is not selected.
6. Click **OK**.

Creating a Graphical User Interface

LabWindows/CVI provides a collection of highly configurable, instrument-style user interface controls and indicators so that application users can interact with and monitor the measurement or control system. Choose from the following controls to create a user interface:

- Knobs, meters, gauges, dials
- Binary switches, LEDs
- Slides, tanks, thermometers
- Graphs, strip charts, digital graphs

- Trees, tables, tabs, splitters
- ActiveX controls
- Timers

User Interface Editor

The User Interface Editor is an interactive drag-and-drop environment you can use to design GUIs. You can select controls from the **Create** menu and position them on the GUI. You then can use dialog boxes to set control attributes, such as labels, colors, and hot key connection settings. In the following sections, you build a GUI that acquires and displays a waveform.



You can complete the following activity in 10 minutes.

Figure 3-1 shows the GUI you will build in this exercise.

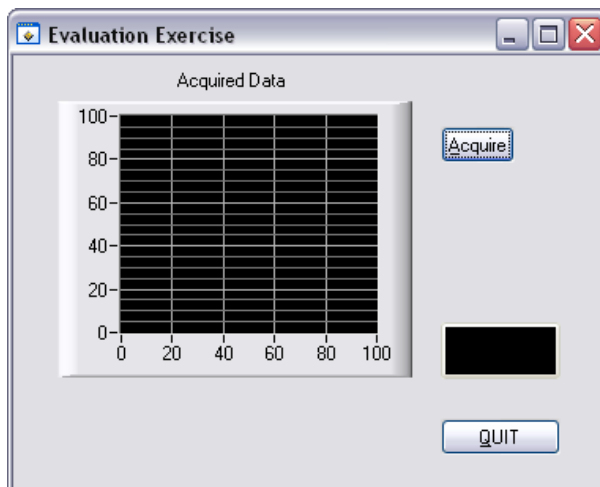


Figure 3-1. Evaluation Exercise GUI

Creating a New User Interface Resource (.uir) File

1. Double-click `AcquireWaveform.uir` in the Project Tree. The User Interface Editor opens an untitled and empty panel.
2. Double-click the panel. Enter `Evaluation Exercise` as the **Panel Title** and click **OK**.
3. Save `AcquireWaveform.uir`.



Note When you save a `.uir` file, LabWindows/CVI automatically creates a header (`.h`) file with the same base name as the `.uir` file. LabWindows/CVI stores this header

file in the same directory as the .uir file. To view this header file, select **View»Preview User Interface Header File**.

Adding Command Buttons

1. Select **Create»Command Button»Square Command Button**. LabWindows/CVI places a button labeled **OK** on the panel. Position the button in the upper right corner of the panel.
2. To edit the button attributes, double-click the button. In the Edit Command Button dialog box, enter `ACQUIRE` as the **Constant Name** for the command button.
3. Enter `AcquireData` as the **Callback Function** for the command button. The program calls the callback function when a user clicks the button. Refer to the [Generating Program Code with CodeBuilder](#) section for more information about callback functions.
4. Enter `__Acquire` as the **Label** for the command button. Because there is a double underscore before the `A` in the **Label** field, `A` is underlined in the label. You can operate this command button by pressing `<Alt-A>`.
5. Verify the Edit Command Button dialog box matches the one shown in Figure 3-2 and then click **OK**.

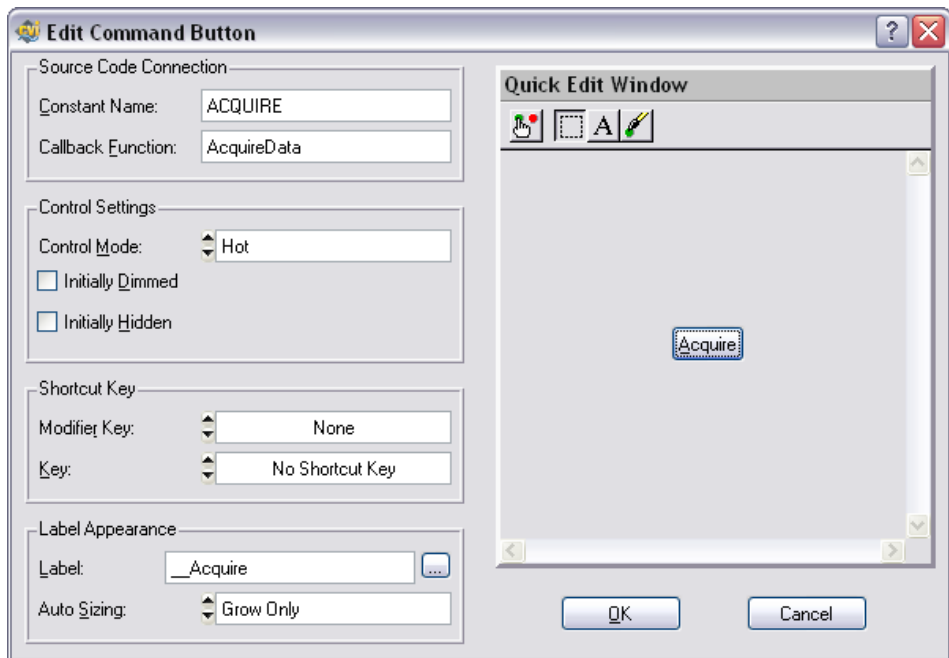


Figure 3-2. Edit Command Button Dialog Box

6. Select **Create»Custom Controls»Quit Button**. Custom controls are controls that you can configure and reuse in future LabWindows/CVI sessions.
7. Position the **QUIT** button in the lower right corner of the panel.
8. Double-click the **QUIT** button to open the Edit Command Button dialog box. Notice the **Constant Name** is `QUITBUTTON` and the **Callback Function** is `QuitCallback`. Do not change these settings. Click **OK** to close the dialog box.

Adding a Graph Control

1. Select **Create»Graph»Graph**.
2. Position the graph control to the left of the **Acquire** button and above the **QUIT** button.
3. Double-click the graph control to open the Edit Graph dialog box.
4. Enter `WAVEFORM` as the **Constant Name** for the graph control.



Note Because this graph does not require an action from the user interface, you do not need to assign a callback function to this control. Callback functions are necessary only when the operation of the control initiates an action.

5. Enter `Acquired Data` as the **Label** for the graph control.
6. Click **OK** to close the dialog box.
7. Save `AcquireWaveform.uir`.

Generating Program Code with CodeBuilder

LabWindows/CVI provides a code generation tool called CodeBuilder. CodeBuilder uses information that you specify in control and event dialog boxes to create a code skeleton. The code skeleton includes the `main` function, event callbacks, and an application shutdown callback.

LabWindows/CVI provides event-driven programming through callback functions. You can associate a specific callback function with a specific user interface control in the Edit dialog box for the control, as you did in the previous section. As you set the properties for the control, think about what events you want the control to recognize—a single mouse click, double-click, or keypress—and specify the callback function to execute when those events occur.

You can specify default events for both the panel and controls on the panel. To select events, select **Code»Preferences»Default Events**. When you generate code, CodeBuilder creates a case statement for each event you select. Then you fill in the code to handle that event.

At this point, you have created a GUI with user interface objects to acquire a waveform (the **Acquire** button), display the waveform (the graph control), and terminate program execution (the **QUIT** button). Now, use CodeBuilder to create skeleton source code.



You can complete this activity in 5 minutes.

1. Open `AcquireWaveform.uir` if it is not already open. Select **Code»Preferences»Default Events**.
2. In the Callback Events dialog box, select the events that a control can generate. In this project, the controls respond to one type of event: a commit event (left-click or <Enter>). Select **All control types** from the left tree and verify that `EVENT_COMMIT` is the only event selected on the right tree. Click **OK**.



Tip For more information on events, refer to *Library Reference»User Interface Library»Events* in *LabWindows/CVI Help*.

3. Select **Code»Generate»All Callbacks**. By default, CodeBuilder generates `EVENT_COMMIT` events for every panel or control that you define a callback function for.
4. The Generate Code dialog box appears with the `panelCB` callback function highlighted. The project template provides the `panelCB` callback function, so you do not need CodeBuilder to generate it. Click **Skip**. CodeBuilder proceeds and generates the callback functions the other controls.
5. LabWindows/CVI opens a Source window, `AcquireWaveform.c`, which contains the generated source code.
6. In the Source window, insert a line after `case EVENT_COMMIT:` in the `QuitCallback` function with the following code.

```
QuitUserInterface(0);
```



Note The project template provides only one option for closing the panel, clicking the X button in the upper right corner. By inserting a call to `QuitUserInterface` in `QuitCallback`, you add a second option for closing the panel, clicking the **QUIT** button.

Reviewing the Source Code

CodeBuilder generates two functions: `AcquireData` and `QuitCallback`. The project template provides the main function.

main Function

The `main` function is the first component you need when you build any application. The `main` function for this project consists of the following lines of code:

```
int main (int argc, char *argv[])
{
    int error = 0;

    /* initialize and load resources */
    nullChk (InitCVIRTE (0, argv, 0));
    errChk (panelHandle = LoadPanel (0, "sample1.uir", PANEL));

    /* display the panel and run the user interface */
    errChk (DisplayPanel (panelHandle));
    errChk (RunUserInterface ());

Error:
    /* clean up */
    DiscardPanel (panelHandle);
    return 0;
}
```

The functions within `main` perform the following actions:

- `LoadPanel` loads the panel from the `.uir` file into memory.
- `DisplayPanel` displays the panel on the screen.
- `RunUserInterface` allows LabWindows/CVI to send events from the user interface to the C program.
- `DiscardPanel` removes the panel from memory and clears it from the screen if visible.

AcquireData Function

The `AcquireData` function automatically executes when a user clicks the **Acquire** button. Currently, the `AcquireData` function contains no code to execute. In the following sections, you will add data acquisition functions within the `AcquireData` function.

QuitCallback Function

The `QuitCallback` function automatically executes when a user clicks the **QUIT** button. This function terminates event processing and stops program execution.

```
int CVICALLBACK QuitCallback (int panel, int control, int event,
    void *callbackData, int eventData1, int eventData2) {
    switch (event)
    {
        case EVENT_COMMIT:
            QuitUserInterface (0);
            break;
    }
    return 0;
}
```

Running the Project

To run the project, select **Run»Debug AcquireWaveform_dbg.exe**. Currently, only the **QUIT** button responds to events.

Adding an Instrument Driver to the Project

An instrument driver is a set of functions that controls an instrument or a group of related instruments. The high-level functions in an instrument driver incorporate many low-level operations, including GPIB, VXI, or RS-232 read and write operations; data conversion; and scaling. The sample instrument driver you use in this project communicates with a simulated instrument and shows you how to use an instrument driver to acquire a waveform from an oscilloscope.

In LabWindows/CVI, an instrument driver is represented by an instrument (`.fp`) file, which contains the programmatic interface of the instrument driver. This interface is represented by a hierarchical set of function panels.

To be complete, the program must read an array of simulated data from an instrument driver and plot the array on the graph. Modify the `AcquireData` function in the `AcquireWaveform.c` source file as described in the following steps. Then, when you click the **Acquire** button, the program reads the data from the instrument and plots the data on the graph.



You can complete this activity in 15 minutes.

Loading the Instrument Driver

1. Select **Edit»Add Files to Project»Instrument (*.fp)** in the Workspace window.
2. In Windows XP/2000, browse to C:\Documents and Settings\All Users\Documents\National Instruments\CVI85\tutorial\. In Windows Vista, browse to C:\Users\Public\Documents\National Instruments\CVI85\tutorial\. Then select the `scope.fp` file. Click **Add** and then click **OK** to add the driver to the project.
3. In the Workspace window, open `AcquireWaveform.c`.
4. Place the cursor on the blank line immediately after the `EVENT_COMMIT:` statement in the `AcquireData` function.

Initializing the Instrument

1. Expand **Instruments»Sample Oscilloscope** in the Library Tree. The sample oscilloscope driver contains four functions for communicating with a scope, as shown in Figure 3-3.

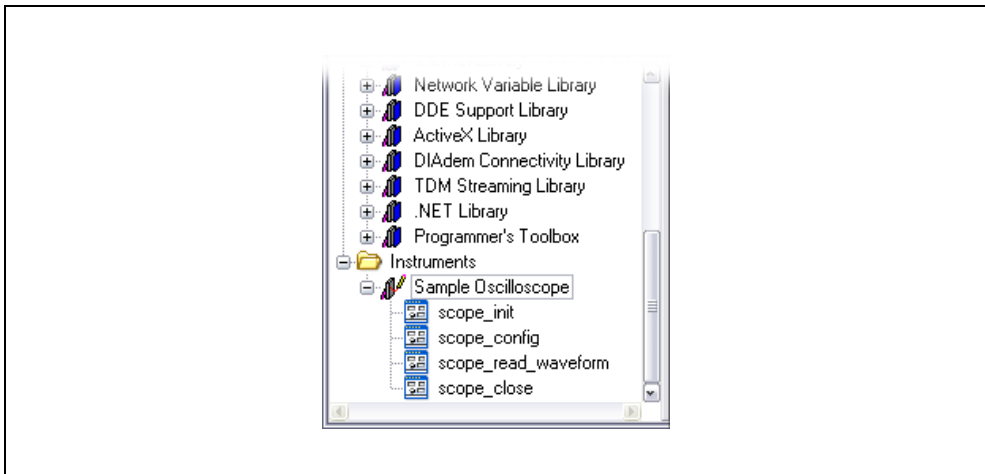


Figure 3-3. Sample Oscilloscope Instrument Driver

2. Double-click **scope_init** to open the Initialize function panel, as shown in Figure 3-4.



Tip You can use function panels to interact with LabWindows/CVI libraries and loaded instrument drivers. Function panels are graphical representations of LabWindows/CVI functions and their parameters. Use function panels to interactively test function calls and paste them into a program. When you enter values in the function panel controls, LabWindows/CVI builds the function call at the bottom of the panel.

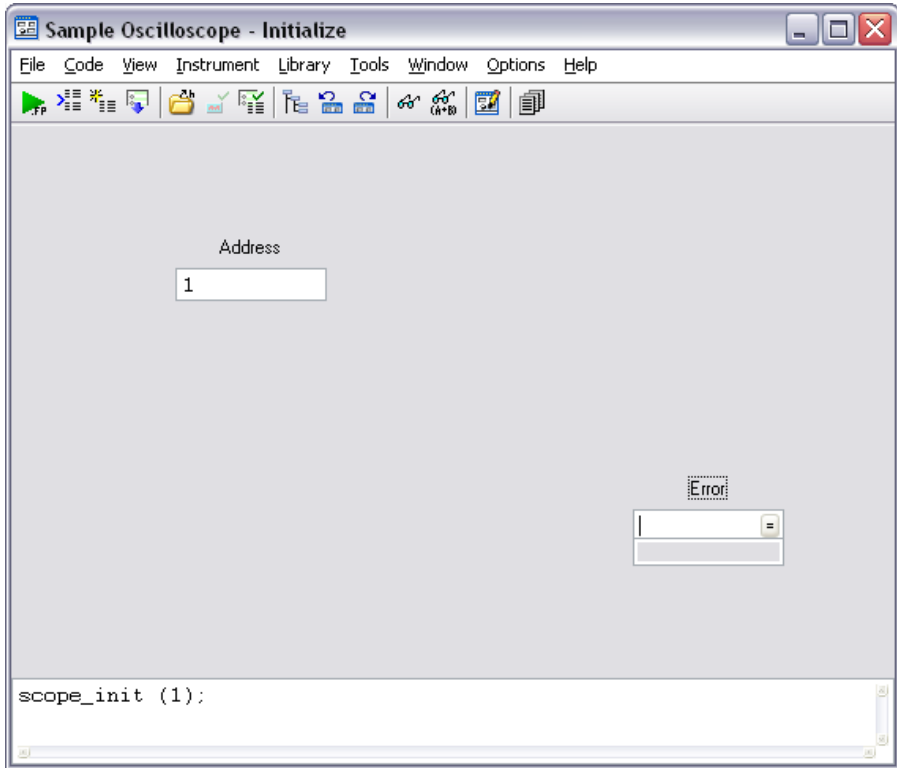


Figure 3-4. Initialize Function Panel

3. Enter 1 in the **Address** control.
4. Enter **err** in the **Error** control.
5. Select **Code»Declare Variable** to declare the `err` variable.
6. In the Declare Variable dialog box, enable the **Execute declaration in Interactive Window** and **Add declaration to top of target file "AcquireWaveform.c"** options. Click **OK**.
7. Select **Code»Run Function Panel**. If LabWindows/CVI does not detect any errors during execution, the **Error** control returns 0.
8. Select **Code»Insert Function Call** to copy the generated code into the Source window. LabWindows/CVI places the function call to initialize the instrument driver in the source code below the `EVENT_COMMIT:` code, as follows:


```
err = scope_init (1);
```

Reading Data from the Instrument

An instrument driver reads data from an instrument and converts the raw data into a format the program can use. For example, a digital oscilloscope returns a waveform as a string of comma-separated ASCII numbers. The instrument driver parses the string, scales the data to volts, and places the data into an array in memory.

1. Select **Instruments»Sample Oscilloscope»scope_read_waveform** in the Library Tree.
2. In the Read Waveform function panel, set the **Channel** control to 2. Channel 1 is sine wave data, and Channel 2 is random data.
3. Enter `datapoints` in the **Waveform** control.
4. Select **Code»Declare Variable** to declare the `datapoints` variable in memory. In the Declare Variable dialog box, enter 100 in the **Number of Elements** control.
5. Verify that the **Execute declaration in Interactive Window** and **Add declaration to top of target file “AcquireWaveform.c”** options are selected. Click **OK** to declare the `datapoints` array.
6. Enter `delta_t` in the **Sample Period** control.
7. Select **Code»Declare Variable**. Verify that the **Execute declaration in Interactive Window** and **Add declaration to top of target file “AcquireWaveform.c”** options are selected and click **OK**.

Notice that LabWindows/CVI adds a leading ampersand, `&`, to the variable name when you declare the variable. LabWindows/CVI automatically prefixes scalar output variables with an ampersand.

8. Enter `x_zero` in the **X Zero** control.
9. Select **Code»Declare Variable**. Verify that the **Execute declaration in Interactive Window** and **Add declaration to top of target file “AcquireWaveform.c”** options are selected and click **OK**.

10. Enter `err` in the **Error** control. Verify that the function panel appears as shown in the following figure.

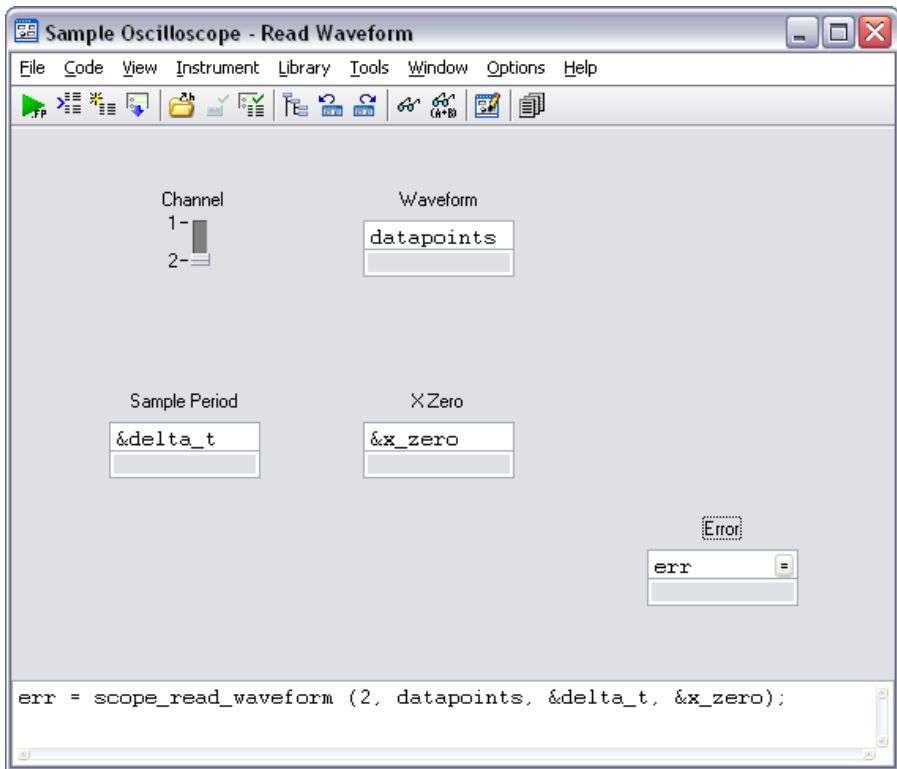


Figure 3-5. Completed Read Waveform Function Panel

11. Select **File»Save All**. Select **Code»Run Function Panel** to execute the function panel. If the `scope_read_waveform` function executes correctly, the **Error** control returns 0. After the function executes, a row of boxes in the **Waveform** control signifies that the data is in the waveform array.
12. (Optional) You can double-click the row of boxes to display two windows of data returned by the function call—the Variables window shows variable values, and the Array Display window shows the waveform data collected in the array. If you choose to display these windows, close both of them before continuing.
13. From the Read Waveform function panel, select **Code»Insert Function Call** to copy the generated code into the Source window. LabWindows/CVI places the following line of code within the `AcquireData` callback function:

```
err = scope_read_waveform (2, datapoints, &delta_t, &x_zero);
```

Displaying the Waveform on a Graph Control

At this point, you have completed the steps necessary to acquire data. You now need to plot the acquired data array to the graph control on the user interface using the `PlotY` function.

In this exercise, you use the LabWindows/CVI source code completion options to write code. With the source code completions options, you can view functions, variables, prototypes, constant values, and help while you type in the Source window.



You can complete this activity in 5 minutes.

1. Type `PlotY(` in the blank line below the `scope_read_waveform` function call and press `<Ctrl-Shift-Space>` to display the function prototype tooltip. Notice the question mark button to the left of the function prototype. When you click this button or press `<F1>`, LabWindows/CVI displays help for the currently highlighted function or parameter.
2. Enter `panelHandle` as the value for the **PanelHandle** parameter. LabWindows/CVI highlights the next parameter in the function prototype after you enter a parameter value.
3. The next parameter, **ControlID**, has a `...` button to the right of the parameter name. This button indicates that LabWindows/CVI provides an input selection dialog box or list of constant values for the parameter. Click this button or press `<Ctrl-Shift-Enter>` to display the Select UIR Constant dialog box. Select **PANEL_WAVEFORM** and click **OK** to insert the value into the function call and to close the dialog box.
4. Enter `datapoints` for **YArray** and `100` for **NumberofPoints**.
5. When you reach the **YDataType** parameter, LabWindows/CVI displays another `...` button. Click this button or press `<Ctrl-Shift-Enter>` to display a list of constant values for the **YDataType** parameter. Select **VAL_DOUBLE** from the list to insert this value into the code.
6. Enter the following values for the remaining parameters. Select from the list of constant values if LabWindows/CVI displays a `...` button for the parameter name.

Parameter	Value
PlotStyle	VAL_THIN_LINE
PointStyle	VAL_EMPTY_SQUARE
LineStyle	VAL_SOLID
PointFrequency	1
Color	VAL_RED

Deleting Existing Graph Plots

If you click the **Acquire** button more than once, the data from previous acquisitions remains on the graph with the new data plot. Modify the `AcquireData` callback to include the `DeleteGraphPlot` function, which deletes one or all plots from a graph control.



You can complete this activity in 5 minutes.

1. Add a blank line immediately following the `EVENT_COMMIT:` statement in the `AcquireData` callback, type `Delete`, and press `<Ctrl-Space>` to view a list of potential matches for the function you are typing. Select **DeleteGraphPlot** from the list.



Note You also can use the **Show Completions** option to view potential matches for variables, structure members, enum members, and macros after you compile the source code.

2. Display the function prototype tooltip if it is not already visible. Enter the following values for the function parameters:

Parameter	Value
PanelHandle	<code>panelHandle</code>
ControlID	PANEL_WAVEFORM
PlotHandle	<code>-1</code>
Refresh	VAL_DELAYED_DRAW



Note If you specify `-1` for the **PlotHandle** parameter, LabWindows/CVI deletes all the plots for the specified graph control when you call `DeleteGraphPlot`.

3. Select **File»Save AcquireWaveform.c** to save `AcquireWaveform.c`.

Running the Completed Project

Now that you have a completed project, saved as `AcquireWaveform.prj`, you can run the code.

1. Select **Run»Debug AcquireWaveform_dbg.exe** to execute the code.
2. In the dialog box that prompts you that the action will clear your Interactive Execution declarations, select **OK**.
3. During the compile process, LabWindows/CVI recognizes that the program is missing the `scope.h` header file statement and prompts to insert it into the source code. Click **Yes** to add this include file to the program.
4. When your application launches, click the **Acquire** button. The program generates a waveform and plots it on the graph control. Click **Acquire** again. The program deletes the existing plot, generates a waveform again, and plots it on the graph.
5. Click **QUIT**.

Now that you have completed a LabWindows/CVI project, which is shown in Figure 3-6, look through the rest of the libraries for functionality not covered in this manual. Also, explore the samples included in the evaluation version of LabWindows/CVI. To view the example programs, double-click the `CVI samples` shortcut in the `\samples` folder of the LabWindows/CVI installation. You also can use NI Example Finder to search for example programs included in the LabWindows/CVI installation and on ni.com. To launch NI Example Finder, select **Help»Find Examples**.

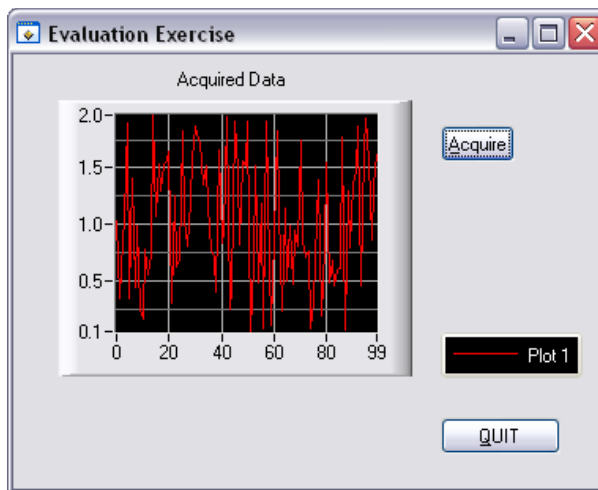


Figure 3-6. Completed Project

Where to Go from Here

LabWindows/CVI is yet another long-standing commitment by NI to provide tools that simplify instrumentation, data acquisition, and control system development. When you choose LabWindows/CVI, you join thousands of scientists and engineers who take advantage of the power of this versatile tool for quick and easy test and measurement development.

Visit the LabWindows/CVI Web site at ni.com/cvi and NI Developer Zone at ni.com/zone for more information. You also can visit the NI Discussion Forms at ni.com/forums to participate in discussion forums and exchange code with other LabWindows/CVI users around the world.

Tutorials and Documentation

Use the *Guide to LabWindows/CVI Documentation* topic to find resources that can help you develop applications in LabWindows/CVI. The *Guide to LabWindows/CVI Documentation* contains information for new and upgrade users, directions for searching installed PDFs and using context-sensitive help, and links to PDFs of LabWindows/CVI manuals, application notes, and white papers. You can access this topic in the *LabWindows/CVI Help*.



Note You must have Adobe Acrobat Reader to view documents in PDF format. You can download a free version of Adobe Reader from www.adobe.com.

The *Getting Started with LabWindows/CVI* manual provides a hands-on introduction to the LabWindows/CVI software package.

The *LabWindows/CVI Release Notes* provide system requirements, installation and activation instructions, and information about new features in LabWindows/CVI.

The *LabWindows/CVI Quick Reference* provides outlines of product resources and lists of the LabWindows/CVI libraries.

The *LabWindows/CVI Help* contains complete reference information. The *LabWindows/CVI Help* contains the following sections:

- *Using LabWindows/CVI* provides detailed descriptions and instructions for using the LabWindows/CVI environment, menus, options, tools, and features. This section describes steps for creating an application.

- *Library Reference* provides in-depth function reference for each LabWindows/CVI function. This section includes code examples and overviews of LabWindows/CVI libraries.
- *Programmer Reference* provides information to help you develop programs in LabWindows/CVI. This section includes topics about the LabWindows/CVI compiler, external compilers, user protection, and LabWindows/CVI DLLs for real-time targets.
- *Tools Library* provides an overview of additional utilities included in LabWindows/CVI and function reference for each Tools Library function.

To launch the help file, select **Help»Contents**.

LabWindows/CVI Examples

The LabWindows/CVI Evaluation Package installs example programs. Find examples with the NI Example Finder, which you can access by selecting **Help»Find Examples**. From Example Finder, you can access NI Developer Zone at ni.com/zone for additional examples, discussion forums, user groups, and more.



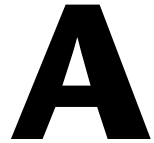
Tip Examples are an excellent way to get started. Look for an example that is similar to the application you want to develop and modify it according to your specifications.

Customer Education and Certification

For additional training, NI offers hands-on LabWindows/CVI courses. These courses, taught by a LabWindows/CVI expert instructor, provide in-depth training, so you can create sophisticated applications for data acquisition and instrument control. The courses greatly improve your productivity with LabWindows/CVI whether you are a new or intermediate user.

National Instruments also offers the Certified LabWindows/CVI Developer program. The goal of this program credential is to ensure that candidates are equipped with a high level of technical ability with LabWindows/CVI to provide comprehensive measurement and automation solutions for business and industry. To obtain certification, a candidate must successfully complete an examination on LabWindows/CVI programming. The evaluation focuses on the candidate's understanding of programming concepts and style and the candidate's applied use of LabWindows/CVI to solve specific problems.

Visit ni.com/training for information about courses, certification, training, technical workshops, and more.



Technical Support and Professional Services

Visit the following sections of the National Instruments Web site at ni.com for technical support and professional services:

- **Support**—Technical support resources at ni.com/support include the following:
 - **Self-Help Technical Resources**—For answers and solutions, visit the award-winning National Instruments Web site for software drivers and updates, a searchable KnowledgeBase, product manuals, step-by-step troubleshooting wizards, thousands of example programs, tutorials, application notes, instrument drivers, and so on. Registered users also receive access to the NI Discussion Forums at ni.com/forums. NI Applications Engineers make sure every question submitted online receives an answer.
 - **Standard Service Program Membership**—This program entitles members to direct access to NI Applications Engineers via phone and email for one-to-one technical support as well as exclusive access to ondemand training modules via the Services Resource Center. NI offers a trial membership for the first 30 days after purchase after which you may purchase a full year’s membership.

For information about other technical support options in your area, visit ni.com/services, or contact your local office at ni.com/contact.

- **Training and Certification**—Visit ni.com/training for self-paced training, eLearning virtual classrooms, interactive CDs, and Certification program information. You also can register for instructor-led, hands-on courses at locations around the world.
- **System Integration**—If you have time constraints, limited in-house technical resources, or other project challenges, National Instruments Alliance Partner members can help. To learn more, call your local NI office or visit ni.com/alliance.

If you searched ni.com and could not find the answers you need, contact your local office or NI corporate headquarters. Phone numbers for our worldwide offices are listed at the front of this manual. You also can visit the Worldwide Offices section of ni.com/niglobal to access the branch office Web sites, which provide up-to-date contact information, support phone numbers, email addresses, and current events.