# Measurement Studio™ Measurement Computing™ Edition

## Evaluation Guide

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MEASUREMENT COMPUTING

**Worldwide Technical Support and Product Information**

ni.com

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# Contents

# About This Manual

The *Measurement Studio Measurement Computing Evaluation Guide* introduces the concepts associated with the Measurement Studio class libraries and development tools. This guide assumes that you have a general working knowledge of Microsoft Visual Studio, including .NET Windows, and ASP.NET.

## How To Use This Manual

The Measurement Studio Measurement Computing Evaluation package contains the Measurement Studio evaluation software. Any applications you build with the Measurement Studio Evaluation package have a 30-day evaluation period.

Measurement Studio includes support for Visual Studio .NET 2003 and Visual Studio 2005. The Measurement Studio Visual Studio .NET 2003 and Visual Studio 2005 CD includes separate, parallel sets of class libraries, integration features, and support documentation for developing with Visual Studio .NET 2003 and Visual Studio 2005. This manual documents the Visual Studio .NET 2003 and Visual Studio 2005 CD.

The *Measurement Studio Measurement Computing Evaluation Guide* is organized into three chapters. Chapter 1, *Measurement Studio Measurement Computing Edition Installation Instructions*, is an overview of Measurement Computing, National Instruments, virtual instrumentation, and Measurement Studio. This chapter includes installation requirements and installation and evaluation instructions. Chapter 2, *Measurement Studio Measurement Computing Edition .NET Class Libraries*, includes information about Measurement Studio features and functionality. Chapter 3, *Getting Started with Measurement Studio Measurement Computing Edition*, includes walkthroughs that guide you through step-by-step instructions on how to develop with Measurement Studio features.

Use this guide as a starting point to learn about Measurement Studio. Refer to the *NI Measurement Studio Help* within the Visual Studio environment for function reference and detailed information about the Measurement Studio class libraries, wizards, assistants, and other features.

# Conventions

The following conventions appear in this manual:

<> — Text enclosed in angle brackets represents directory names and parts of paths that may vary on different computers, such as <Windows\System>.

[ ] — Square brackets enclose optional items—for example, [response].

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

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

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

**bold** — Bold text denotes items that you must select or click on in the software, such as menu items and dialog box options. Bold text also denotes class library member names or emphasis.

*italic* — Italic text denotes parameters, variables, cross-references, 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.

# 1

# Measurement Studio Measurement Computing Edition Installation Instructions

## Evaluating Measurement Studio on Your Machine

The following sections contain information and instructions for installing the Measurement Studio Evaluation Package.

**Note** Any applications you build with the Measurement Studio Evaluation package have a thirty day evaluation period.

To use Measurement Studio, your computer must have the following:

- Microsoft Windows 2000/XP
- Microsoft .NET Framework 1.1 for Visual Studio .NET 2003 or Microsoft .NET Framework 2.0 for Visual Studio 2005
- Standard, Professional, Enterprise Developer, Enterprise Architect, or Academic edition of Microsoft Visual Studio .NET 2003 or Microsoft Visual Studio 2005
- Intel Pentium II class processor, 733 MHz or higher
- Video display—800 × 600, 256 colors (16-bit color recommended for user interface controls)
- Minimum of 256 MB of RAM (512 MB or higher recommended)
- Minimum of 405 MB of free hard disk space for Visual Studio .NET 2003 support and minimum of 385 MB of free hard disk space for Visual Studio 2005 support
- Microsoft-compatible mouse
- Microsoft Internet Explorer 6.0 or later

**Optional Installation**—In order for links from Measurement Studio help topics to .NET Framework help topics to work, you must install the

Microsoft .NET Framework SDK 1.1 or Microsoft .NET Framework SDK 2.0.

## Installing the Current Version of Measurement Studio over Previous Versions of Measurement Studio

You can have only one version of Measurement Studio installed on a system for each version of Visual Studio or the .NET Framework installed on the system. For example, you can have Measurement Studio 8.0.1 for Visual Studio .NET 2003 installed on the same system as Measurement Studio 8.1 for Visual Studio 2005, but you cannot have Measurement Studio 8.0.1 for Visual Studio 2005 installed on the same system as Measurement Studio 8.1 for Visual Studio 2005.

If you install a newer version of Measurement Studio on a machine that has a prior version of Measurement Studio installed, the newer version installer replaces the prior version functionality, including class libraries. However, the prior version assemblies remain in the global assembly cache (GAC); therefore, applications that reference the prior version continue to use the prior version .NET assemblies.[1]

# Installing Measurement Studio

Complete the following steps to install Measurement Studio. These steps describe a typical installation. Please carefully review all additional licensing and warning dialog boxes.

1. Insert the Measurement Studio CD into the CD drive. `autorun.exe` automatically starts. If it does not automatically start, double-click the `autorun.exe` icon.
2. Click **Next** to install all NI software to the default installation directory, or click **Browse** to select a different installation directory. Click **Next**.

**Note** The option to browse for an installation location is valid only if you have not already installed any Measurement Studio features for the version of Visual Studio that you are installing. If you have any Measurement Studio features installed, then Measurement Studio installs to the same root directory to which you installed other Measurement Studio features.

[1] This does not apply to `NationalInstruments.Common.dll`. `NationalInstruments.Common.dll` uses a publisher policy file to redirect applications to always use the newest version of `NationalInstruments.Common.dll` installed on the system, for each version of the .NET Framework. `NationalInstruments.Common.dll` is backward compatible.

3. From the feature tree, select the features you want to install. To change the Measurement Studio installation directory, select the first feature in the list and click **Browse**. You must install Measurement Studio to a local drive. If you install Measurement Studio support for more than one version of Visual Studio, install them to different directories. Click **Next**.
4. Review the license agreement and select **I accept the License Agreement(s)**. Click **Next**.
5. In the Installation Summary dialog box, review the features you selected. Click **Next**.

**Note** Step 6 starts the installation of Measurement Studio. Be aware that when the installer indicates that it is removing backup files, this is a normal operation. The installer may take several minutes to complete this step.

6. In the Installation Summary dialog box, review the features you selected. Click **Next**.

**Note** Step 8 starts the installation of Measurement Studio. Be aware that when the installer indicates that it is removing backup files, this is a normal operation. The installer may take several minutes to complete this step.

7. In the MCC Drivers for Measurement Studio dialog box, select the Device Drivers components you want to install. Click **Install**.
8. If you choose to install InstaCal and Universal Library, continue with the following steps. If not, skip to step 13. In the Welcome to InstaCal and Universal Library dialog box, click **Next**.
9. In the Destination Folder dialog box, click **Next** to install InstaCal and Universal Library to the default location or click **Change** to install to a different location.
10. In the Ready to Install dialog box, click **Install** to install InstaCal and Universal Library.
11. Click **Finish**.
12. If you choose to install GPIB-488, continue with the following steps. If not, skip to step 19. In the GPIB-488 Installation Wizard, select **Next**.
13. Review the license agreement and select **I accept the License Agreement(s)**. Click **Next**.

14. In the Destination Folder dialog box, click **Next** to install GPIB-488 to the default location or click **Browse** to install the driver to a different location.
15. In the Select Features dialog box, select the features you want to install. Click **Next**.
16. Click **Next** to start the installation.
17. Click **Finish** to complete the installation.
18. In the Installation Summary dialog box, review the features you selected. Click **Next**.
19. Click **Finish** to complete the installation.
20. If prompted, click the appropriate restart option. If you did not install a component that requires a restart, you will not be prompted to restart.

# Learning More About NI and Measurement Studio

## MCC Platform

The mission of Measurement Computing Corporation is to provide our customers with PC-based data acquisition hardware and software that will save time and save money.

## NI Platform

National Instruments is committed to providing software and hardware for engineers and scientists who develop measurement and automation applications. NI provides high performance, tight integration, and rapid application development of virtual instruments at a lower cost than traditional measurement instruments.

## Virtual Instrumentation

Virtual instruments represent a fundamental shift from traditional hardware-centered instrumentation systems to software-centered systems that exploit the computing power, productivity, display, and connectivity capabilities of popular desktop computers and workstations. With virtual instruments, engineers and scientists build user-defined measurement and automation systems that suit their needs exactly, instead of being limited by traditional vendor-defined instruments.

## What Is Measurement Studio?

Measurement Studio is the software tool for creating virtual instruments with Microsoft Visual Studio. Measurement Studio is an integrated suite of tools and class libraries that are designed for developers using Microsoft .NET Windows and ASP.NET to develop measurement and automation applications.

This evaluation package includes Measurement Studio tools for Visual C# and Visual Basic .NET.

**Tip** As you work through this manual, you will see italicized references to relevant Measurement Studio help topics. To find these topics, use the table of contents in the *NI Measurement Studio Help*.

## Why Should I Use Measurement Studio?

Measurement Studio is an integrated suite of tools and class libraries that are designed for developers using Microsoft Visual Basic .NET, Visual C#, and ASP.NET to develop measurement and automation applications.

Measurement Studio dramatically reduces application development time through object-oriented measurement hardware interfaces, advanced analysis libraries, scientific user interface controls for Windows and Web applications, measurement data networking, wizards, interactive code designers, and highly extensible .NET classes. You can use Measurement Studio to develop a complete measurement and automation application that includes data acquisition, analysis, and presentation functionalities.

# 2

# Measurement Studio Measurement Computing Edition .NET Class Libraries

This chapter provides overview information about features and functionality included in Measurement Studio 8.1 support for Visual Studio .NET 2003 and Visual Studio 2005. Refer to the *NI Measurement Studio Help* for detailed information about these features. Refer to Chapter 3, *Getting Started with Measurement Studio Measurement Computing Edition*, for step-by-step instructions on developing Measurement Studio applications.

Measurement Studio includes the following features and functionality:

- User Interface controls
- Analysis class libraries
- Common class library
- Data acquisition
- Instrument control
- Integration into the Visual Studio environment

## User Interface Controls

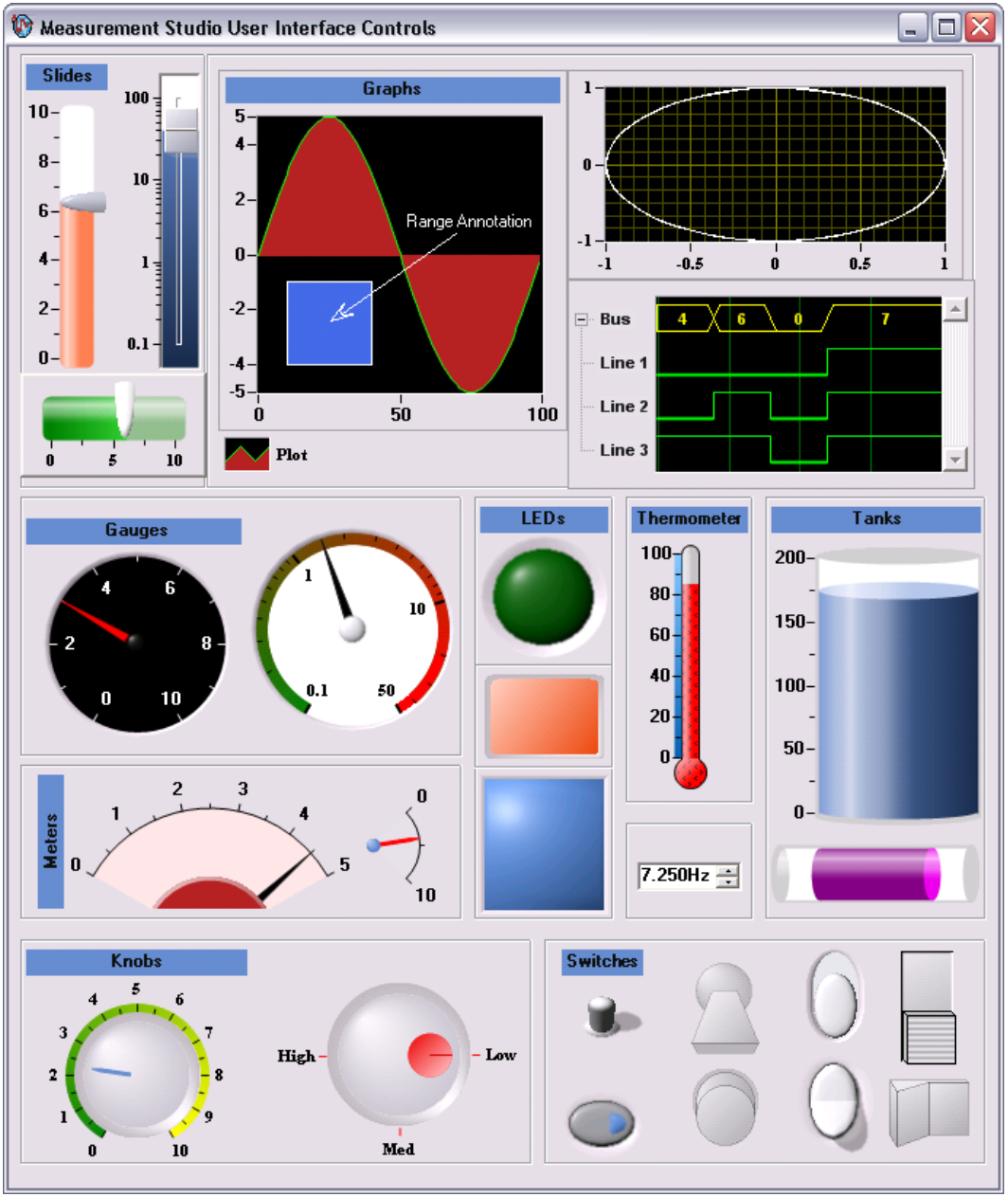
Measurement Studio includes managed .NET user interface Windows Forms and Web Forms controls designed specifically for test and measurement applications.

The Measurement Studio ASP.NET Web Forms controls are designed to provide a rich user interface experience through the web browser. The browsers are divided into two broad categories: uplevel and downlevel. Uplevel browsers include recent versions of Microsoft Internet Explorer and Mozilla Firefox. All other browsers are downlevel browsers.

By using Measurement Studio controls, you can focus on creating an end solution instead of developing UI components.

| User Interface Controls | Visual Studio 2005 | | Visual Studio 2003 |
|---|---|---|---|
| | Windows Forms | Web Forms | Windows Forms |
| Waveform graph | ✔ | ✔ | ✔ |
| Scatter graph | ✔ | ✔ | ✔ |
| Digital waveform graph | ✔ | ✔ | ✔ |
| Complex graph | ✔ | ✔ | ✔ |
| Legend | ✔ | ✔ | ✔ |
| Knob | ✔ | ✔ | ✔ |
| Gauge | ✔ | ✔ | ✔ |
| Meter | ✔ | ✔ | ✔ |
| Slide | ✔ | ✔ | ✔ |
| Thermometer | ✔ | ✔ | ✔ |
| Tank | ✔ | ✔ | ✔ |
| Numeric edit | ✔ | ✔ | ✔ |
| Switch | ✔ | ✔ | ✔ |
| LED | ✔ | ✔ | ✔ |
| Property editor | ✔ | | ✔ |
| Array controls | ✔ | | |
| AutoRefresh control | | ✔ | |
| Instrument control strip | ✔ | | |

The following figure shows the Measurement Studio controls.



## Graph and Legend Controls

Measurement Studio includes four graphs: the waveform graph, the scatter graph, the digital waveform graph, and the complex graph. Use the graphs to display data in the application type you need.

You can use the Measurement Studio waveform graph and scatter graph controls, as shown in Figure 2-1, to display two-dimensional data on a Windows Forms user interface or in a Web browser. Use the waveform graph to display two-dimensional linear data. You explicitly specify each value in one dimension and provide an initial value and interval to implicitly specify the values in the other dimension. You can use the scatter graph to display two-dimensional linear or nonlinear data by explicitly specifying each value in both dimensions.

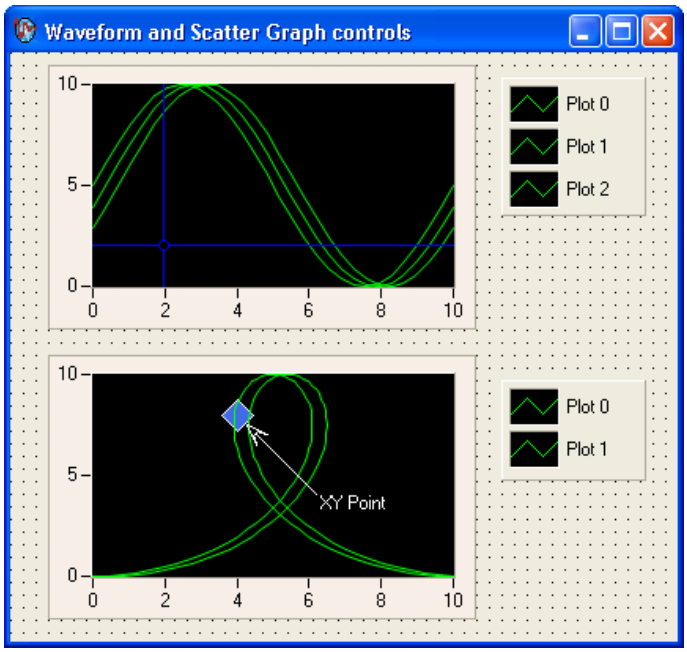



**Figure 2-1.** Waveform Graph with Cursors and Scatter Graph with XY Point Annotation; Both Graphs Have Corresponding Legends

You can use the Measurement Studio digital waveform graph control, as shown in Figure 2-2, to display `DigitalWaveform` data on a Windows Forms user interface or in a Web browser. You can use the Measurement Studio complex graph control to display `ComplexDouble` data on a Windows Forms user interface or in a Web browser. A `ComplexDouble` number consists of a real part and an imaginary part. You can use the

Measurement Studio legend control, as shown in Figure 2-1, to display symbols and descriptions for a specific set of elements of another object, such as the plots or cursors of a graph.

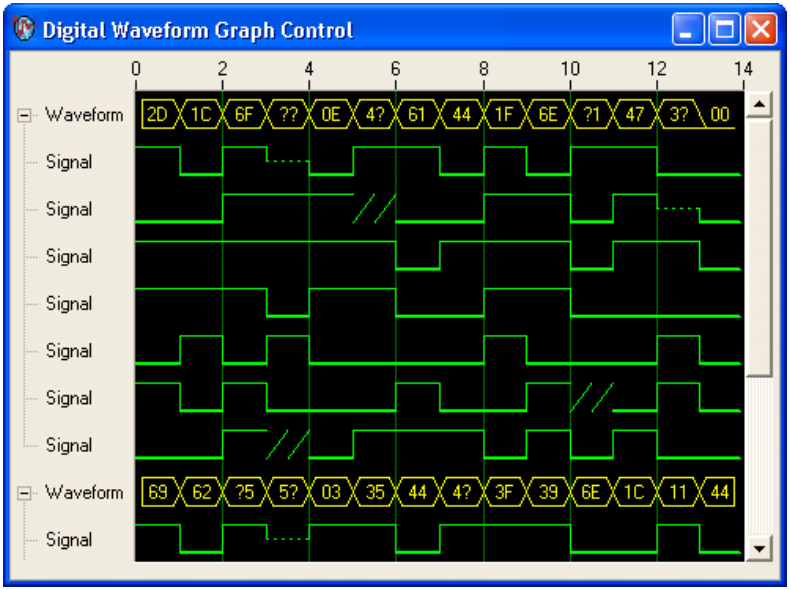



**Figure 2-2.** .NET Digital Graph

The following sections list the operations you can perform with the Measurement Studio graphs.

**Note** The following sections include a sample of the functionality available with the graph controls; however, for a complete list of graph control functionality, refer to the *Measurement Studio User Manual* online at `ni.com/manuals`.

## Waveform and Scatter Graph Controls

With the waveform graph and scatter graph controls and the classes that interface with the controls, you can perform many operations, including:

### Plot Operations

- Plot and chart data.
- Configure a graph to contain multiple plots to show separate but related data on the same graph.
- Plot error bands.

### Axis Operations

- Configure a graph to include multiple axes or independent ranges so that plot data fits the graph plot area.

### Cursor Operations

- Use cursors to identify key points in plots and the plot area.

### Annotation Operations

- Configure text labels, arrows, and drawing shapes to annotate a point anywhere in the plot area of the graph.

### Additional Operations

- Zoom interactively.
- Pan interactively.
- Edit axis ranges interactively.

## Digital Waveform Graph Control

With the digital waveform graph control and the classes that interface with the control, you can perform many operations, including:

### Plot Operations

- Plot digital waveform data. Data values can represent up to eight different digital states.
- Expand and collapse signal plots interactively.

### Waveform Sample and Signal State Operations

- Create custom waveform sample and signal state labels.

### Axis Operations

- Configure the axis modes to fixed, exact autoscaling, or loose autoscaling.

### Additional Operations

- Display data in sample or time mode.
- Zoom interactively.
- Pan interactively.

## Complex Graph Control

With the complex graph control and the classes that interface with the control, you can perform many operations, including:

### Plot Operations

- Plot and chart `ComplexDouble` data.
- Configure a graph to contain multiple plots to show separate but related data on the same graph.
- Configure the plot to display arrows. The arrows indicate the direction of the complex data.
- Plot error data.

### Axis Operations

- Configure a graph to include multiple axes or independent ranges so that plot data fits the graph plot area.

### Cursor Operations

- Use cursors to identify key points in plots and the plot area.

### Annotation Operations

- Configure text labels, arrows, and drawing shapes to annotate a point anywhere in the plot area of the graph.

### Additional Operations

- Zoom interactively.
- Pan interactively.
- Edit axis ranges interactively.

**Tip** For more information about using the waveform, scatter, digital waveform, and complex graph and legend controls, refer to the *Using the Measurement Studio Graph .NET Controls* and *Using the Measurement Studio Legend .NET Control* sections in the *NI Measurement Studio Help*.

# Numeric Controls

## Numeric Pointer Controls

Use the Measurement Studio numeric controls to display numerical information with the look of scientific instruments on a Windows Forms user interface and in an ASP.NET Web application. The numeric controls include a knob, gauge, meter, slide, thermometer, and tank. The following sections describe operations available with the controls and the classes that interface with them.

**Note** The following sections include a sample of the functionality available with the numeric controls; however, for a complete list of numeric control functionality, refer to the *Measurement Studio User Manual* online at `ni.com/manuals`.

With the numeric controls and the classes that interface with them, you can perform many operations, including:

- Configure the scale to be linear or logarithmic and toggle the visibility of the scale.
- Fill the scale and configure the range, color, dimensions, and style of the fill.
- Connect to the Measurement Studio .NET numeric edit control so that if you change the value of one control, it changes the value of the other control.

Use the Measurement Studio knob, gauge, and meter controls, as shown in Figure 2-3, to input and display numeric data on your user interface.

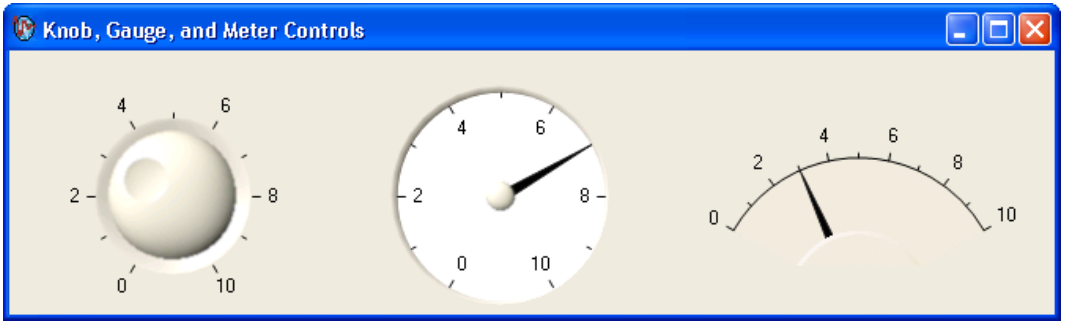



**Figure 2-3.** Knob, Gauge, and Meter .NET Controls

With the knob, gauge, and meter controls and the classes that interface with the controls, you can perform many operations, including:

- Specify the start and sweep angle of the arc programmatically or from the Properties window.

Use the Measurement Studio slide, tank, and thermometer controls, as shown in Figure 2-4, to input and display numeric data on your interface.

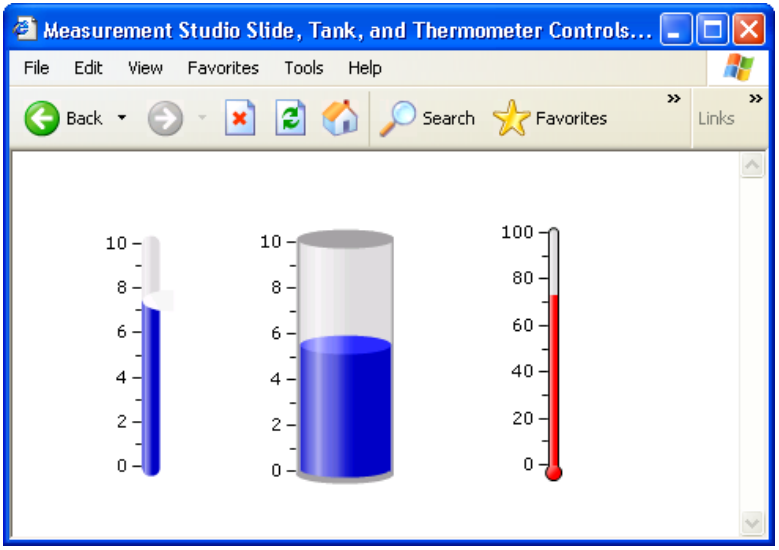



**Figure 2-4.** Slide, Tank, and Thermometer .NET Controls

With the slide, tank, and thermometer controls and the classes that interface with them, you can perform many operations, including:

- Fill to the minimum or maximum value of the scale.
- Position the scale horizontally with left, right, or both and position the scale vertically with top, bottom, or both.

**Tip** For more information about using the Windows Forms and Web Forms knob, gauge, meter, slide, tank, or thermometer controls, refer to the *Knob*, *Gauge*, *Meter*, *Slide*, *Tank*, or *Thermometer Class* sections in the *NI Measurement Studio Help*.

## Numeric Edit Control

Use the Measurement Studio numeric edit control to display numeric values and to provide a way by which end users can edit numeric values. Typically, you use a numeric edit control to input or display double numerical data instead of using a Windows Forms TextBox control,

Windows Forms NumericUpDown control, or a Web Forms TextBox control.

**Note** The following section includes a sample of the functionality available with the numeric edit control; however, for a complete list of numeric edit control functionality, refer to the *Measurement Studio User Manual* online at `ni.com/manuals`.

With the numeric edit control and the classes that interface with the control, you can perform many operations, including:

- Set the minimum range value to negative infinity and the maximum range value to positive infinity.
- Create custom formats or use built-in numeric formats including generic, engineering, and simple double.

**Tip** For more information about using the Windows Forms or Web Forms numeric edit control, refer to the *NumericEdit Class* section in the *NI Measurement Studio Help*.

# Boolean Controls

## Switch and LED Controls

Use the Measurement Studio switch and LED controls as Boolean controls on a Windows Forms or Web Forms user interface. You typically use a switch control, as shown in Figure 2-5, to receive and control Boolean input on an application user interface.

**Figure 2-5.** Switch Control in Vertical Toggle 3D Style

You typically use an LED control, as shown in Figure 2-6, to indicate a Boolean value on an application user interface.

**Figure 2-6.** LED Control in Square 3D Style

**Note** The following section includes a sample of the functionality available with the Boolean controls; however, for a complete list of Boolean control functionality, refer to the *Measurement Studio User Manual* online at `ni.com/manuals`.

With the switch and LED controls and the classes that interface with the controls, you can perform many operations, including:

- Receive notification before or after the state of the control changes.
- Configure how the control behaves when you click it with the mouse or press the spacebar when the control has focus.

**Tip** For more information about using the switch and LED controls, refer to the *Using the Measurement Studio Windows Forms Switch and LED .NET Controls* section or the *Using the Measurement Studio Web Forms Switch and LED .NET Controls* section in the *NI Measurement Studio Help*.

# Additional Controls

## Property Editor Control

Use the Measurement Studio property editor control, as shown in Figure 2-7, to configure properties for Windows Forms controls at run time.

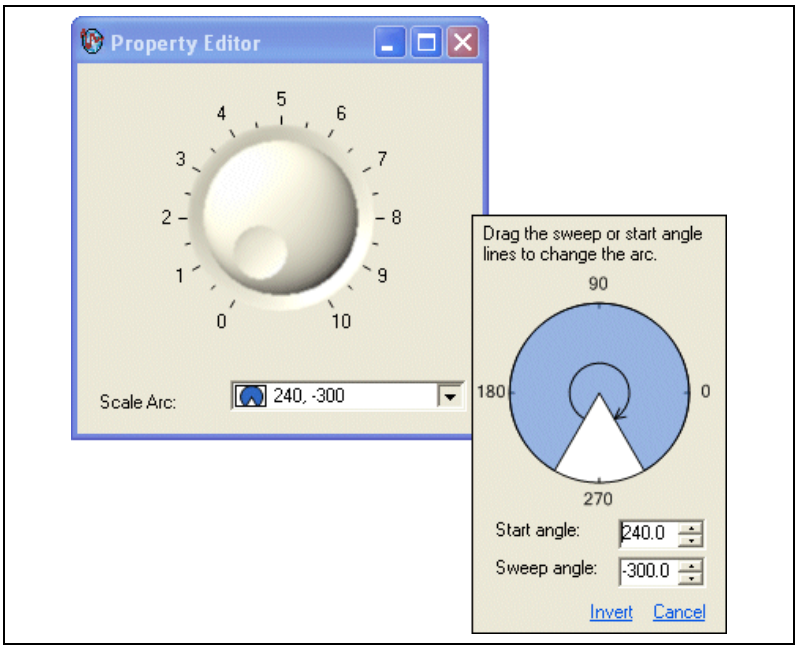



**Figure 2-7.** Property Editor Control for the Knob Control Scale Arc Property

**Note** The following section includes a sample of the functionality available with the property editor control; however, for a complete list of property editor control functionality, refer to the *Measurement Studio User Manual* online at `ni.com/manuals`.

With the property editor control and the classes that interface with the control, you can perform many operations, including:

- Edit any .NET type at run time, including collections.
- Edit expandable properties that represent nested properties of another object, such as major divisions of an axis.

**Tip** For more information about using the property editor control, refer to the *Using the Measurement Studio Property Editor Control* topic in the *NI Measurement Studio Help*.

## Instrument Control Strip Control

Use the Measurement Studio instrument control strip control to display a set of Measurement Studio property editor controls through the `ToolStripPropertyEditor`. The instrument control strip control is available in Visual Studio 2005 only.

Figure 2-8 shows the Measurement Studio instrument control strip control.

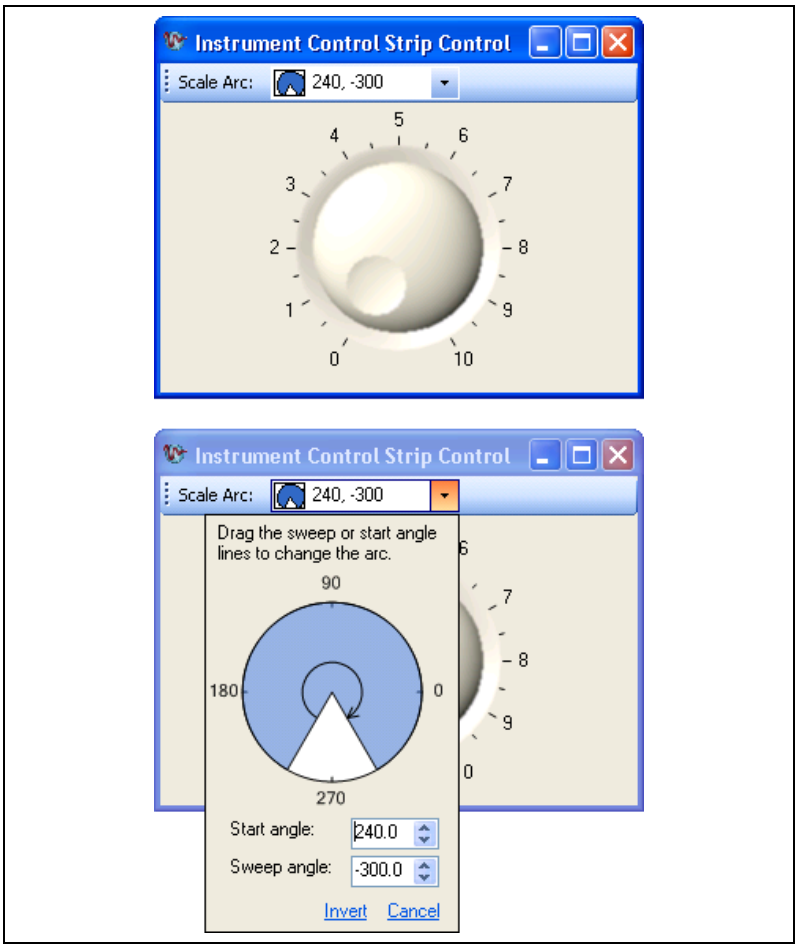



**Figure 2-8.** Instrument Control Strip Control

With the instrument control strip control and the classes that interface with the control, you can perform the following operations:

- Use the instrument control strip control as a toolbar for editing property values of another control through the associated editors at run time.
- Edit multiple property values of controls with one instrument control strip control.
- Add other types of controls, such as the tool strip button or tool strip label control, to the instrument control strip control.
- Customize the appearance of the control.

**Tip** For more information, refer to the *Using the Instrument Control Strip Control* topic in the *NI Measurement Studio Help*.

## Windows Forms Array Controls

You can create an array of Measurement Studio controls that behave as a single unit. For example, you can use these array controls to visualize and control ports of a digital line or values of an array. Measurement Studio includes switch, LED, and numeric edit array controls. You can create control arrays of other controls if those controls meet the constraints of the generic type parameter `TControl`. The Windows Forms array controls are available in Visual Studio 2005 only.

**Note** The following sections include a sample of the functionality available with the array controls; however, for a complete list of array control functionality, refer to the *Measurement Studio User Manual* online at `ni.com/manuals`.

## Switch and LED Array Controls

Use the Measurement Studio switch and LED array controls as an array of Boolean controls on a Windows Forms user interface. You typically use a switch array control, as shown in Figure 2-9, to control ports of a digital line or values of an array. You typically use an LED array control, as shown in Figure, to visualize ports of a digital line or values of an array.

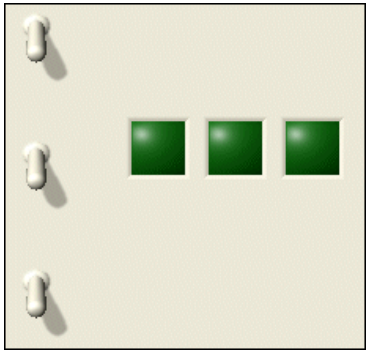


**Figure 2-9.** Switch and LED Array Controls

With the switch and LED array controls and the classes that interface with the controls, you can perform many operations, including:

- Set values by passing an array of data.
- Modify the number of controls displayed based on the length of the specified values.

**Tip** For more information about using the switch and LED array controls, refer to the *Using the Measurement Studio Control Array .NET Controls* topic in the *NI Measurement Studio Help*.

## Numeric Edit Array Control

Use the Measurement Studio numeric edit array control, as shown in Figure 2-10 to control and visualize values of an array of `double` values.

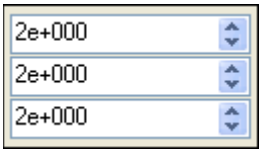



**Figure 2-10.** Numeric Edit Array Control

With the numeric edit array control and the classes that interface with the control, you can perform many operations, including:

- Set values by passing an array of data.
- Modify the number of controls displayed based on the length of the array of values you specify.

**Tip** For more information about using the numeric edit array control, refer to the *Using the Measurement Studio Control Array .NET Controls* topic in the *NI Measurement Studio Help*.

## AutoRefresh Control

Use the AutoRefresh control to update a Web control or a group of Web controls on the client at a specified interval. The AutoRefresh control is available in Visual Studio 2005 only.

The AutoRefresh control renders JavaScript on the client to create a timer in the browser. When the timer elapses, the AutoRefresh updates the controls in the AutoRefresh group. For down-level browsers, the controls update when the page posts back to the server. If the client browser supports client callbacks, the client-side script rendered by the AutoRefresh control uses a client callback to update the associated controls on the client without posting the page back to the server.

# Analysis

The Measurement Studio Analysis .NET class library is in the `NationalInstruments.Analysis` namespace. The Analysis class library includes a set of classes that provides various digital signal processing, signal filtering, signal generation, peak detection, and other general mathematical functionality. Use this library to analyze acquired data or to generate data.

The Analysis class library includes the following functionality:

- Sawtooth, sine, square, triangle, and basic function wave generators
- Bessel, Chebyshev, Inverse Chebyshev, Windowed, Kaiser, and Elliptic Low, High, Bandpass, and Bandstop filters
- Signal processing functions such as convolution, deconvolution, correlation, decimation, integration, and differentiation
- FFT, Inverse FFT, Real FFT, Fast Hartley, Inverse Fast Hartley, Fast Hilbert, Inverse Fast Hilbert, DST, Inverse DST, DCT, and Inverse DCT transformations
- Linear algebra functions such as determinant, check positive definiteness, calculate dot product, and other various matrix functions
- Scaled and unscaled windowing classes
- Common statistical functions such as mean, median, mode, and variance
- Exponential, linear, and polynomial curve fitting functions
- Signal generation functions

**Tip** For more information about analyzing or generating data with the Analysis class library, refer to the *Using the Measurement Studio Analysis .NET Library* topic in the *NI Measurement Studio Help*. For more information about the functionality included in the Analysis class library, visit `ni.com/analysis` and select **Analysis in Measurement Studio**.

# Common

The Measurement Studio Common .NET class library is in the `NationalInstruments` namespace. The Common class library provides a set of classes that facilitates the exchange of data between the acquisition, analysis, and user interface portions of your application. The Common class library includes the following features:

- A `ComplexDouble` data type. This data type represents a complex number of type `Double` that is composed of a real part and an imaginary part.
- A `DigitalWaveform` data type. This data type represents a set of digital states that are grouped by samples or signals.
- An `AnalogWaveform` data type. This data type represents an analog signal that varies over time.
- A `DataConverter` class that converts data from one data type to another data type, such as converting an array of integers to an array of doubles.
- An `EngineeringFormatInfo` class that defines a custom formatter to format numeric values as strings with engineering notation and International System of Units (SI) prefixes and symbols.
- A `PrecisionWaveformTiming` class that you can use to represent the timing of an analog or digital waveform that is accurate to the nearest $2^{-64}$ second. `PrecisionWaveformTiming` is available only in Measurement Studio support for Visual Studio 2005.

**Tip** For more detailed information about the Common class library, refer to the *NationalInstruments* section in the *NI Measurement Studio Help*.

# Network Variable

The Measurement Studio Network Variable .NET class library includes three namespaces: `NationalInstruments.NetworkVariable`, `NationalInstruments.NetworkVariable.WindowsForms`, and `NationalInstruments.NetworkVariable.WebForms`. Use the Network Variable class library to transfer live measurement data between applications and servers over the network.

**Note** The Network Variable class library is intended to supersede the Measurement Studio DataSocket .NET class library. The Measurement Studio DataSocket .NET library is not available from the Toolbox in Visual Studio 2005. However, you can add DataSocket back

to the Toolbox. Right-click the Toolbox. Select **Choose Items**. In the Choose Toolbox Items dialog box, select **DataSocket**.

Use the features in the Network Variable class library to perform the following operations:

- Exchange different types of data between Measurement Studio, LabVIEW, LabWindows™/CVI™, and other applications that support NI-Publish Subscribe Protocol (psp:) and OLE for Process Control (opc:) servers. Exchanging data between Measurement Studio applications and OPC servers requires LabVIEW DSC.

**Note** Measurement Studio and LabWindows/CVI refer to variables as network variables and LabVIEW refers to variables as shared variables. However, you can read to and write from Measurement Studio and LabWindows/CVI network variables with LabVIEW shared variables.

- Use Windows Forms and Web Forms data sources to expose Network Variable data items that you can bind to properties of a Windows Forms or a Web Forms control.
- Use the Network Variable Browser dialog box to quickly locate and select data items on other computers and servers. The Browser Dialog is included in the `NationalInstruments.NetworkVariable.WindowsForms` class.

**Tip** For more detailed information about the Network Variable class library, refer to the *Using the Meausrement Studio Network Variable .NET Library* section in the *NI Measurement Studio Help*.

# Hardware Connectivity

NI is committed to providing seamless connectivity for data acquisition and instrument control devices, allowing you to quickly take measurements.

## Data Acquisition

### Universal Library

The Measurement Studio Universal Library .NET class library is in the `MccDaq` namespace. This class library is included when you install the Universal Library driver. Use the Universal Library class library to communicate with and control Measurement Computing data acquisition (DAQ) devices.

Use the Universal Library class library to perform the following types of tasks:

- Analog signal measurement
- Analog signal generation
- Digital I/O
- Counting and timing
- Temperature measurement

### MccDaq Scan Components

The Measurement Studio Scan Components .NET class library is in the `MccDaq.ScanComponents` namespace. The MccDaq Scan Components library includes a set of components for reading and writing multiple channels of analog data.

Use the MccDaq Scan Components library to perform the following types of tasks:

- Analog input scans
- Analog output scans

## Instrument Control

### MCC-488.2

The Measurement Studio MCC-488.2 .NET class library is in the `MccDaq.Mcc4882`namespace. This class library is included when you install the MCC-488.2 driver. The MCC-488.2 class library includes a set of classes for communicating with GPIB instruments, controlling GPIB devices, and acquiring GPIB status information. Use this library to design code that communicates with and controls instruments on a GPIB interface. Use the MCC-488.2 class library to configure and communicate with GPIB devices using the `Device` and `Board` classes.

# Measurement Studio Integration with Visual Studio

Measurement Studio seamlessly integrates into Visual Studio, allowing you to quickly create test and measurement applications without ever leaving the Visual Studio environment.

## Measurement Studio Menu

The Measurement Studio Menu provides an easy way to access the following National Instruments resources and tools:

- **Add/Remove Class Libraries Wizard**—Use the Measurement Studio Add/Remove Class Libraries wizard to add or remove Measurement Studio class libraries or assemblies in existing Visual Basic .NET and Visual C# projects. Select **Measurement Studio» View .NET Class Library Wizard** to access this menu item in Visual Studio 2005.
- **Measurement Computing»InstaCal**—Use *Insta*Cal to configure, calibrate, and test MCC hardware.
- **MCC Tools»GPIBConfig**—Use GPIBConfig to configure MCC GPIB hardware. Select **MCC Tools»GPIBConfig** to access this menu item in Visual Studio 2005.
- **Discussion Forums**—Use the NI Discussion Forums at `forums.ni.com` to participate in discussion forums and exchange code with measurement and automation developers around the world. Select **Measurement Studio Online Resources»Discussion Forums** to access this menu item in Visual Studio 2005.
- **Instrument Driver Network**—Use the NI Instrument Driver Network at `ni.com/idnet` as a central resource for downloading, developing, and submitting instrument drivers. Select **Measurement Studio Online Resources»Instrument Driver Network** to access this menu item in Visual Studio 2005.
- **Search Technical Support**—Use NI Technical Support at `ni.com/support` to find support resources available for most products, including software drivers and updates, KnowledgeBase articles, product manuals, step-by-step troubleshooting wizards, conformity documentation, example code, tutorials and application notes, instrument drivers, discussion forums, and a measurement glossary. Select **Measurement Studio Online Resources»Search Technical Support** to access this menu item in Visual Studio 2005.
- **NI Measurement Studio Help**—Use the *NI Measurement Studio Help* to access detailed Measurement Studio help, including function

reference, walkthroughs, and conceptual topic documentation on developing with Measurement Studio.

- **Additional Online Resources»Measurement Studio Home Page**—Use the Measurement Studio Web site at `ni.com/mstudio` to find Measurement Studio news, support, downloads, and evaluation software. Select **Measurement Studio Online Resources» Measurement Studio Home Page** to access this menu item in Visual Studio 2005.
- **Additional Online Resources»Measurement Encyclopedia**—Use the online NI Measurement Encyclopedia to find information on measurement principles, standards organizations, and a wide range of technology and measurement terms. Select **Measurement Studio Online Resources»Measurement Encyclopedia** to access this menu item in Visual Studio 2005.
- **Preferences**—Use the Measurement Studio Preferences dialog box to configure Measurement Studio settings, such as conversion options and add-in preferences. Select **Tools»Options** to access this menu item in Visual Studio 2005.
- **Patents**—Use the Patents dialog box to view information about NI patents.
- **Licenses**—Use the Licenses dialog box to view information about NI licenses.
- **About NI Measurement Studio**—Use the NI Measurement Studio About box to view version information.

**Tip** For more information about the resources included in the Measurement Studio Menu, refer to the *Measurement Studio Menu* topic in the *NI Measurement Studio Help*.

## Creating a Measurement Studio Project

Measurement Studio includes class library and application templates that you can use to quickly create measurement applications with Visual Basic .NET, Visual C#, and ASP.NET. Refer to Chapter 3, *Getting Started with Measurement Studio Measurement Computing Edition*, for step-by-step instructions on how to create a Measurement Studio project. Use the Visual Studio New Project dialog box, as shown for Visual Studio 2005 in Figure 2-11, to access these templates and to create projects. You can create the following projects in Measurement Studio:

- Measurement Studio Visual Basic .NET project
- Measurement Studio Visual C# project
- Measurement Studio ASP.NET project

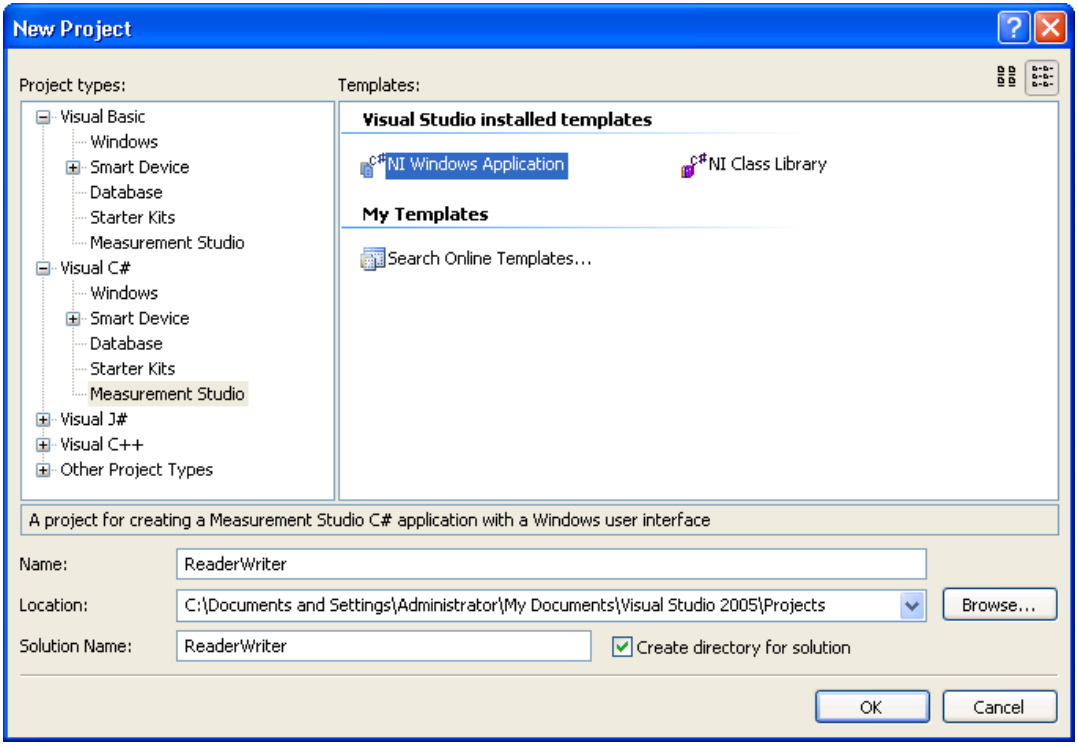



**Figure 2-11.** New Project Dialog Box in Visual Studio 2005

**Tip** For more information about using project templates to create a new Measurement Studio project, refer to the *Creating a New Measurement Studio Project* section in the *NI Measurement Studio Help*.

# 3

# Getting Started with Measurement Studio Measurement Computing Edition

The following sections include overview information and step-by-step instructions on developing applications with Measurement Studio tools and features. Refer to the *Developing with Measurement Studio* section and the *Getting Started with the Measurement Studio Class Libraries* section of the *NI Measurement Studio Help* for more information about the functionality of these tools and features.

**Note** The *Getting Started with the Measurement Studio Class Libraries* section of the *NI Measurement Studio Help* includes Measurement Studio walkthroughs for Visual Studio 2003.

## Walkthrough: Creating a Measurement Studio MCC DAQ Application in Visual Studio 2003

Measurement Studio includes class library and application templates that you can use to quickly create MCC DAQ applications with Visual Basic .NET and Visual C#.

Measurement Studio Measurement Computing Edition includes user interface controls, such as a meter control, and MCC DAQ functionality such as analog input and digital I/O. This walkthrough is designed to help you learn how to add MCC DAQ functionality to a Windows Forms application by taking you through the following steps:

**Note** This walkthrough refers to Visual Studio .NET 2003, but Visual Studio 2005 users can follow the same process.

- **Setting up the project**—Using the Visual Studio New Project dialog, you will create a new project that references the Measurement Studio

Measurement Computing DAQ class library and Windows Forms controls.

- **Adding user interface controls to the project**—Using the Toolbox and the Properties window, you will add and configure user interface controls, including a button and meter.
- **Generating and displaying the data**—Using `MCCDaq.MCCBoard.AIn` and `MCCDaq.MCCBoard.ToEngUnits`, you will read a raw data point from a channel on an MCC device, convert the data point to volts, and show the value on a meter.

## Before You Begin

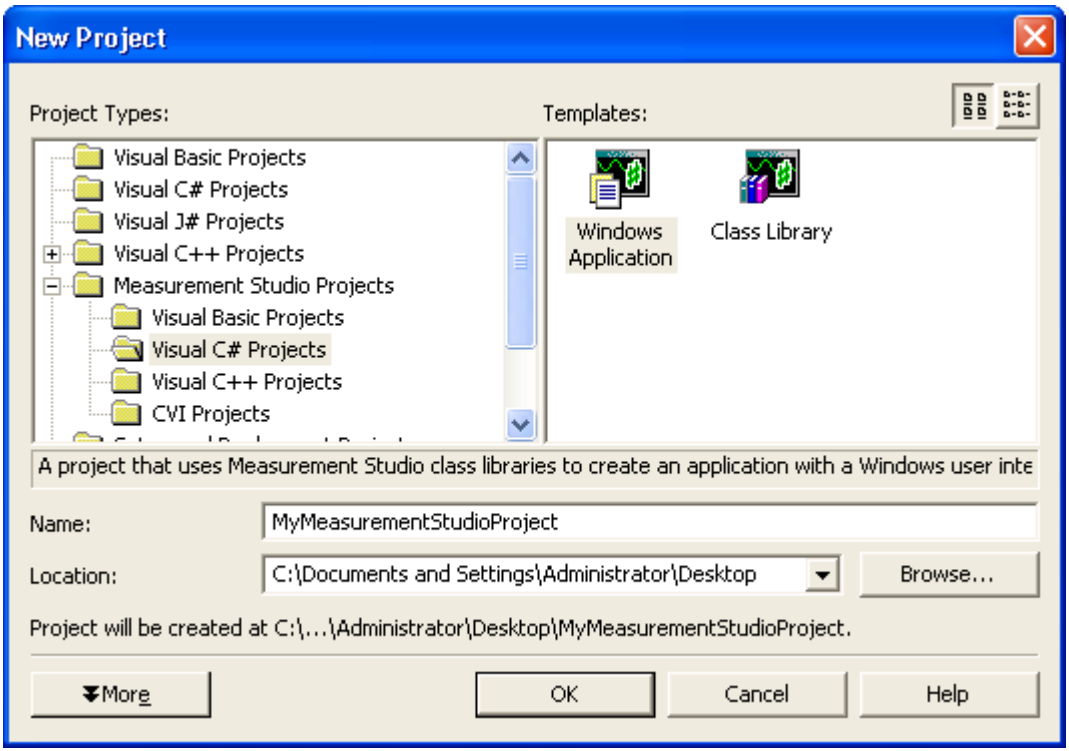
The following components are required to complete this walkthrough:

- Microsoft Visual Studio .NET 2003 or Microsoft Visual Studio 2005
- Measurement Studio
- Universal Library
- Measurement Computing DAQ device

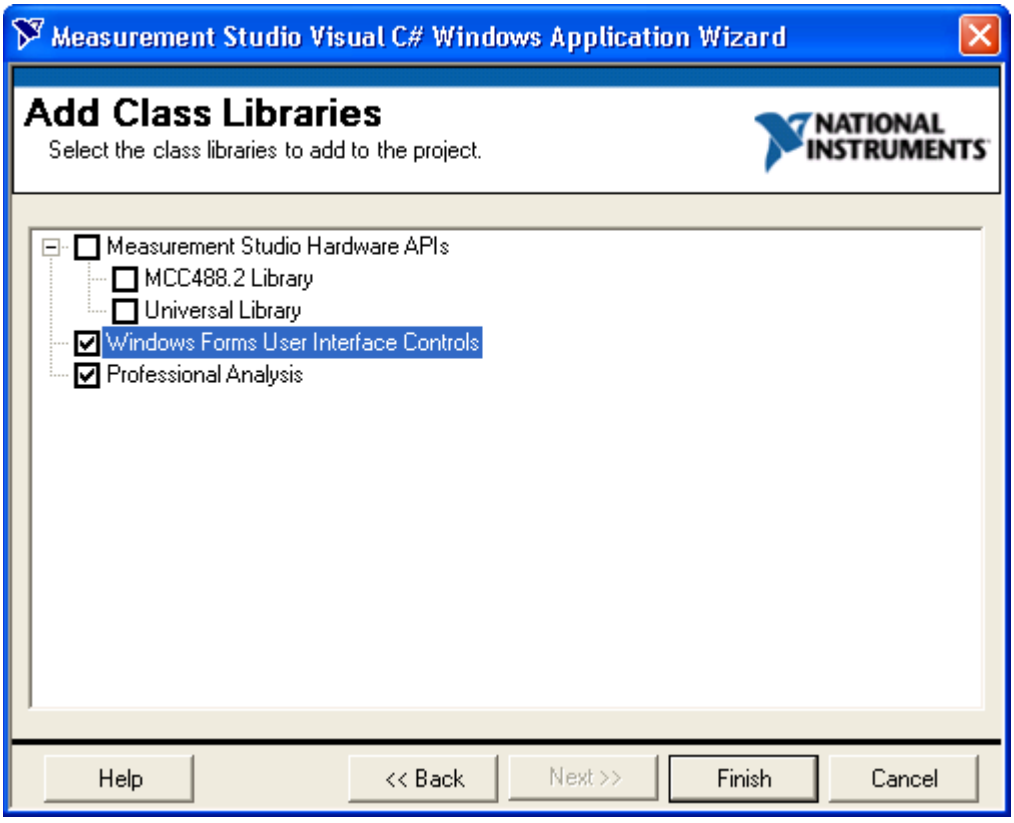
**Note** For information about installing and configuring your Measurement Computing DAQ device, refer to the *Quick Start Guide* that ships with your device. You can also use the DEMO-BOARD simulated DAQ device to complete this walkthrough.

### Setting up the project

1. Select **Start»All Programs»Microsoft Visual Studio .NET 2003»Microsoft Visual Studio .NET 2003**.
2. Select **File»New»Project**. The New Project dialog box launches.




3. In the Project Types pane, expand the **Measurement Studio Projects** folder. Select **Visual Basic Projects** or **Visual C# Projects**, depending on which language you want to create the project in.
4. In the Templates pane, select **Windows Application**. Specify `MyMCCDAQProject` for **Name** and specify a **Location** of your choice.
5. Click **OK**. The Measurement Studio Application Wizard launches.
6. Select **Universal Library** and **Windows Forms User Interface Controls**. When you select these libraries, the Measurement Studio Application Wizard automatically adds references to the appropriate class libraries.



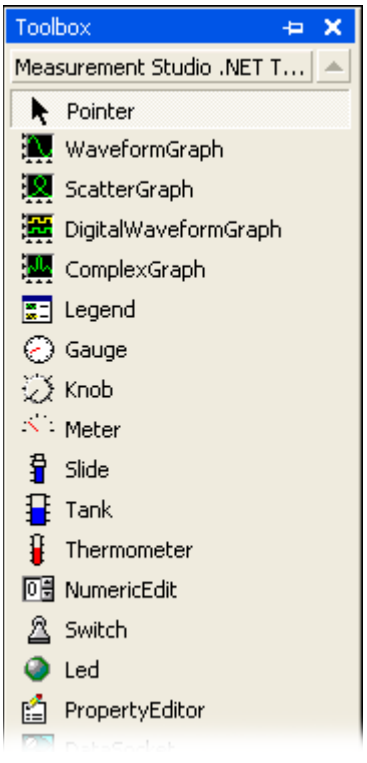

**Tip** If you are working with an existing project, you can access the Add Class Libraries dialog box by selecting **Measurement Studio»Add/Remove Class Libraries Wizard**.

7. Click **Finish** to display `Form1` in the Windows Forms Designer.

**Adding user interface controls to the project**

1. Select **View»Toolbox** to display the Toolbox. The Toolbox contains components and controls that you can add to your project.
2. Select the **Windows Forms** tab. The Windows Forms tab contains controls and components included in the `System.Windows.Forms` namespace.
3. Select the **Button** control and drag and drop it onto the form.
4. Right-click the button and select **Properties** to display the Properties window. You configure the properties of the control in the Properties window.

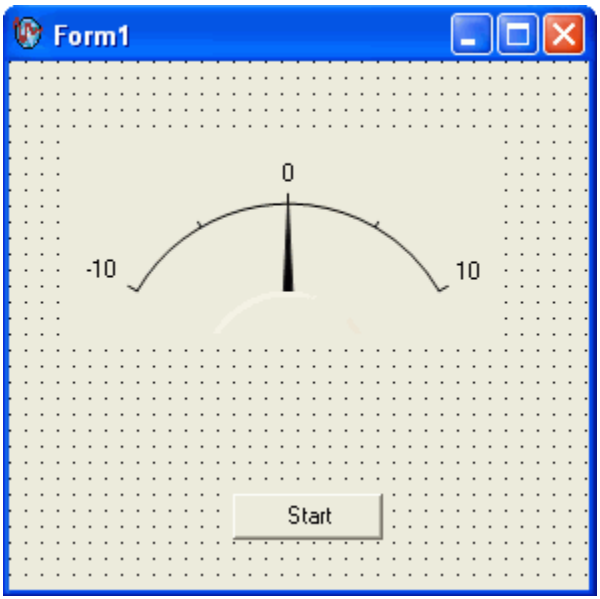
5. The Text property will be highlighted. Type `Start` for the button text.
6. Select the **Measurement Studio .NET Tools** tab on the Toolbox.




7. Select the **Meter** control and drag and drop it onto the form.
8. Right-click the meter and select **Properties** to display the Properties window.
9. Set the `CoercionIntervalBase` property for the meter to –10.

10. Set the Range property for the meter with the drop-down Range type editor. Type –10 for the minimum value. Leave the default of 10 for the maximum value.

The following screenshot shows `Form1` with the user controls.




**Generating and displaying the data**

1. Double-click on Form1 to display the `Form1` code.
2. Add the following code to declare a new Measurement Computing board object.

[VB.NET]

```
' Declare a new Measurement Computing board object that uses board 0
Public DaqBoard As MCCDaq.MCCBoard = New MCCDaq.MCCBoard(0)
```

[C#]

```
private System.Windows.Forms.Button button1;
   private MCCDaq.MCCBoard daqBoard;
   private NationalInstruments.UI.WindowsForms.Meter meter1;
   /// <summary>
   /// Required designer variable.
   /// </summary>
  private System.ComponentModel.Container components = null;
```

```
  public Form1()
{
  // Required for Windows Form Designer support
  InitializeComponent();
  daqBoard =new MCCDaq.MCCBoard(0);
```

3. Scroll down to move the cursor inside the click event handler of the button control.
4. Add the following code to read a raw data point from a specified channel on the Measurement Computing device, convert the data to volts, and display the value on the meter.

[VB.NET]

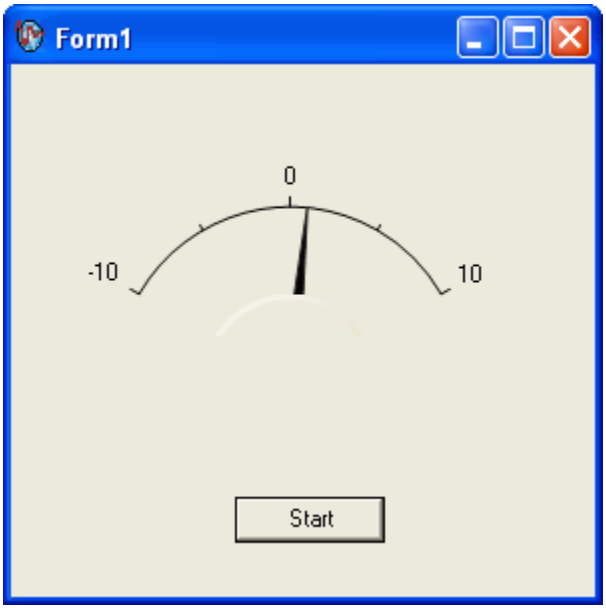
```
'Set channel, range, raw value, and volt variables.
Dim Channel As Integer = 0
Dim Range As MCCDaq.Range = MCCDaq.Range.Bip10Volts
Dim RawValue As Integer = 0
Dim Volts As Double = 0.0F
' Perform analog input operation with Measurement Computing board,
' channel, and range, and return raw value.
DaqBoard.AIn(Channel, Range, RawValue)
' Convert raw value to engineering units.
DaqBoard.ToEngUnits(Range, RawValue, Volts)
' Display value on meter.
Meter1.Value = Volts
```

[C#]

```
// Set channel, range, raw value, and volt variables.
int channel = 0;
MCCDaq.Range range =MCCDaq.Range.Bip10Volts;
ushort rawValue =0;
float volts =0.0f;
// Perform analog input operation with Measurement Computing board,
/// channel, and range, and return raw value.
daqBoard.AIn(channel, range, out rawValue);
// Convert raw value to engineering units.
daqBoard.ToEngUnits(range, rawValue, out volts);
// Display value on meter.
meter1.Value =volts;
2003
```

5. Select **File»Save Form1.cs** to save your application.
6. Select **Debug»Start Without Debugging** to run the application.
7. After your program builds, click **Start**. Notice each time you click the Start button, the meter shows the acquired value.

The following screenshot shows `Form1` with the meter displaying the acquired value.




# Walkthrough: Creating a Measurement Studio MCC DAQ Scan Components Application in Visual Studio 2003

Measurement Studio includes a component library and application templates that you can use to quickly create MccDaq Components applications with Visual Basic .NET and Visual C#. Refer to the following section, Walkthrough: Creating a Measurement Studio MccDaq Components Application, for step-by-step instructions on how to create a Measurement Studio MccDaq Components project.

Measurement Studio MCC Edition includes user interface controls, such as a waveform graph control, and MccDaq scan components that perform analog input scans and analog output scans. This walkthrough is designed to help you learn how to add analog scan and presentation functionality to a Windows Forms application by taking you through the following steps:

**Note** This walkthrough refers to Visual Studio .NET 2003, but Visual Studio 2005 users can follow the same process.

- **Setting up the project**—Using the Visual Studio New Project dialog, you will create a new project that references the Measurement Studio MccDaq Scan Components library and Windows Forms controls.
- **Adding user interface controls to the project**—Using the Toolbox and the Properties window, you will add and configure user interface controls and `MccDaq.Scan` components, including a button and waveform graph, and an `AiScan` component.
- **Generating and displaying the data**—Using the `MccDaq.Scan` components, you will read data from a channel on an MCC device, convert the data object to an array, and show the value on a waveform graph.

## Before You Begin

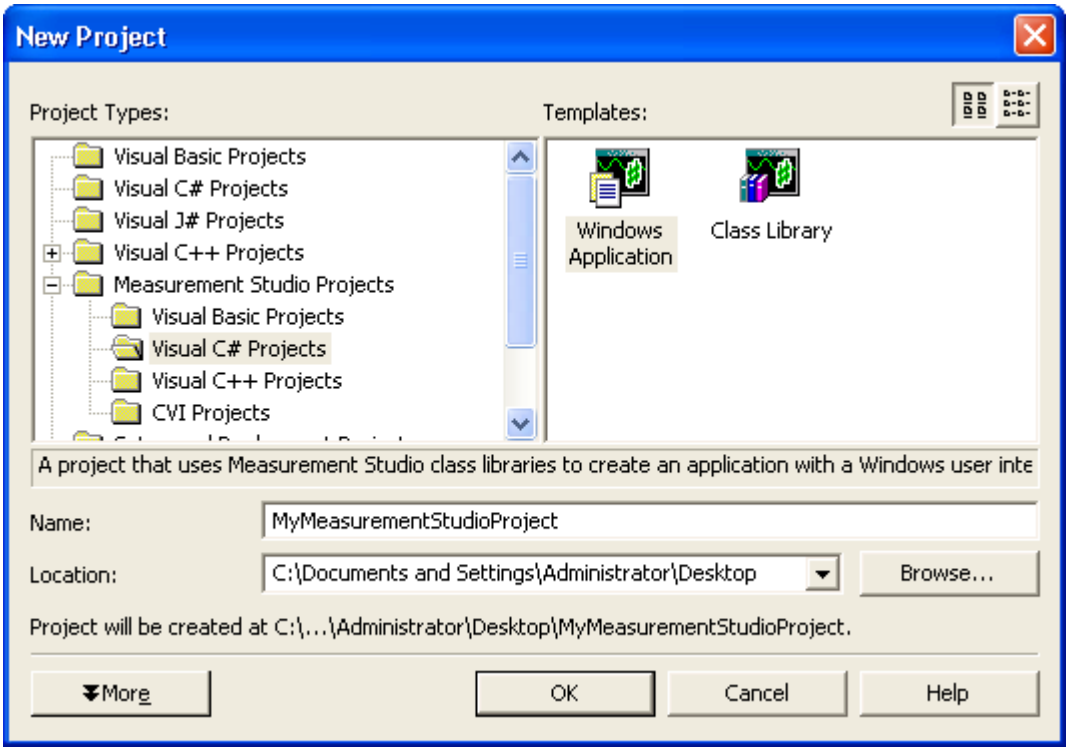
The following components are required to complete this walkthrough:

- Microsoft Visual Studio .NET 2003 or Microsoft Visual Studio 2005
- Measurement Studio
- MccDaq Scan Components
- MCC DAQ device

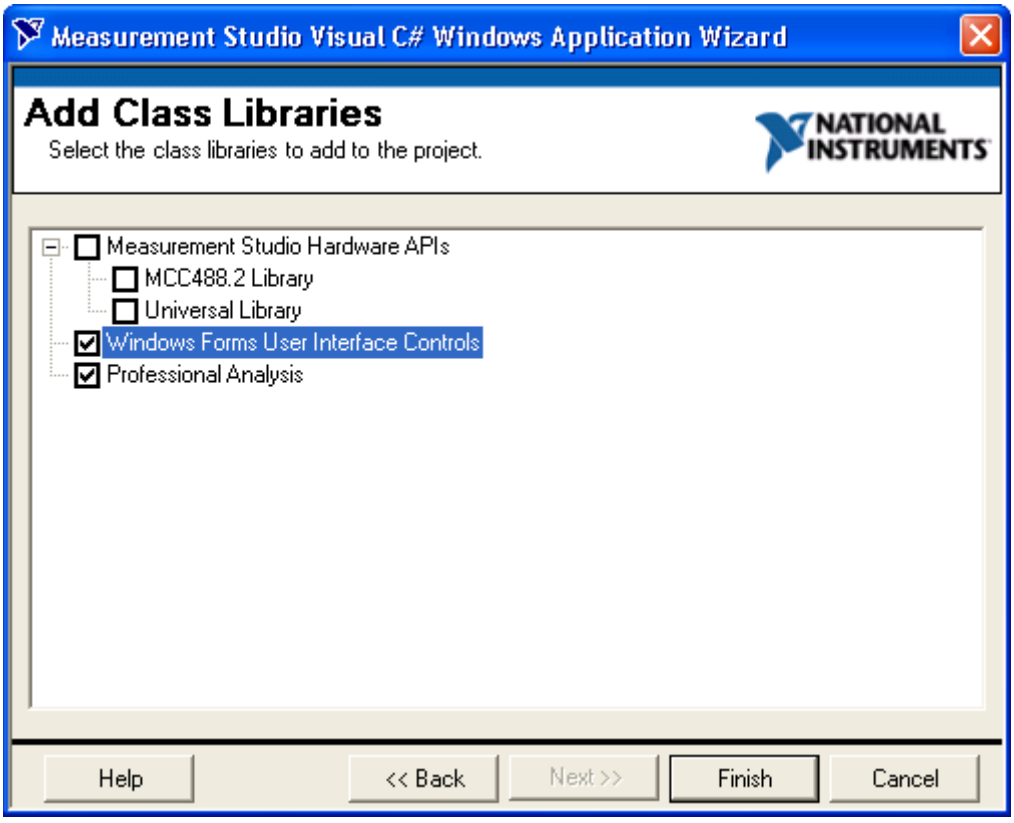
**Note** For information about installing and configuring your MCC DAQ device, refer to the *Quick Start Guide* that ships with your device. You can also use the DEMO-BOARD simulated DAQ device to complete this walkthrough.

### Setting up the project

1. Select **Start»All Programs»Microsoft Visual Studio .NET 2003» Microsoft Visual Studio .NET 2003**.
2. Select **File»New»Project**. The New Project dialog box launches.




3. In the Project Types pane, expand the **Measurement Studio Projects** folder. Select **Visual Basic Projects** or **Visual C# Projects**, depending on which language you want to create the project in.
4. In the Templates pane, select **Windows Application**. Specify `MyMCCScanProject` for **Name** and specify a **Location** of your choice.
5. Click **OK**. The Measurement Studio Application Wizard launches.
6. Select **MccDaq Scan Components** and **Windows Forms User Interface Controls**. When you select these libraries, the Measurement Studio Application Wizard automatically adds references to the appropriate class libraries.



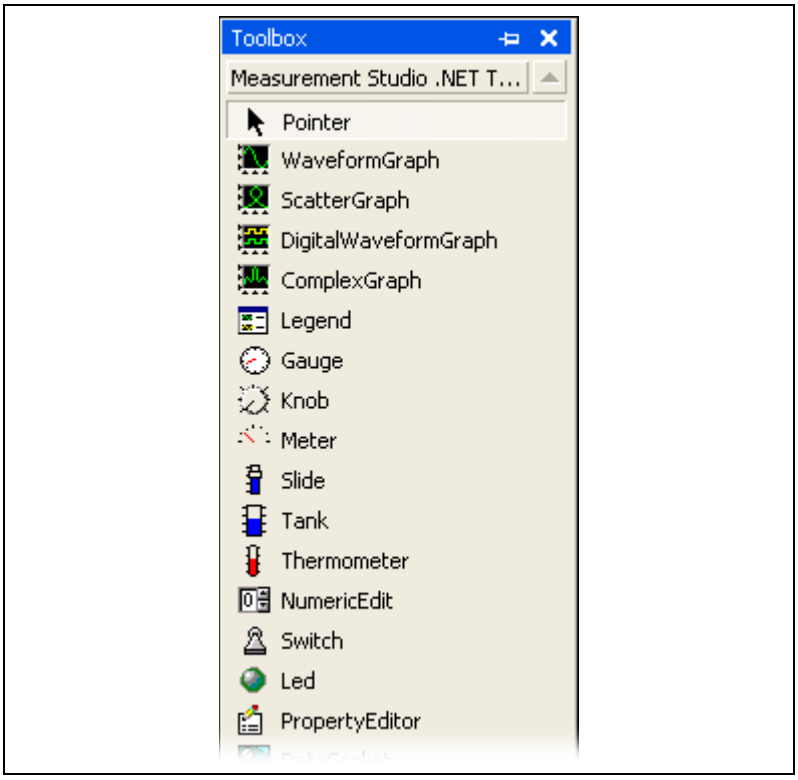

**Tip** If you are working with an existing project, you can access the Add Class Libraries dialog box by selecting **Measurement Studio»Add/Remove Class Libraries Wizard**.

7. Click **Finish** to display `Form1` in the Windows Forms Designer.

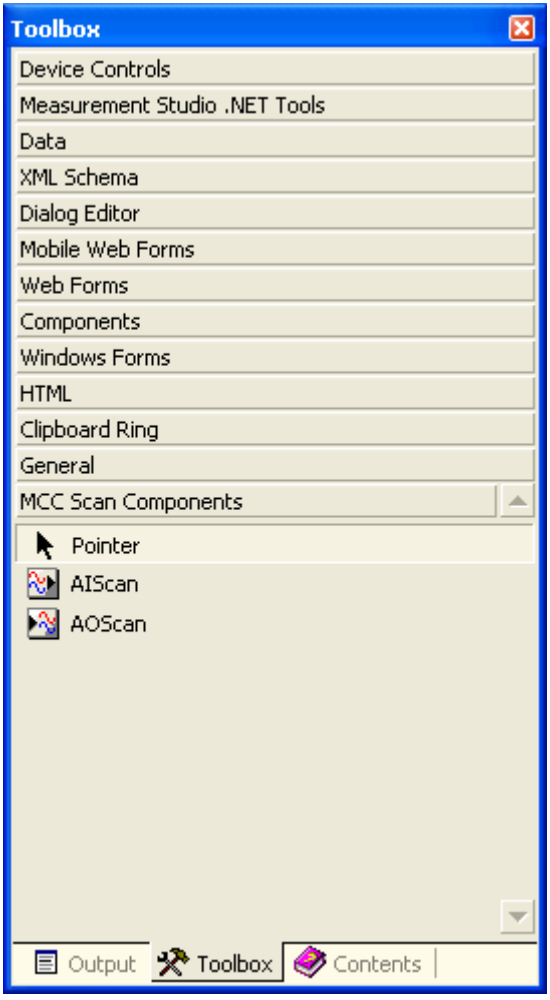
**Adding user interface controls to the project**

1. Select **View»Toolbox** to display the Toolbox. The toolbox contains components and controls that you can add to your project.
2. Select the **Windows Forms** tab. The Windows Forms tab contains controls and components included in the `System.Windows.Forms` namespace.
3. Select the **Button** control and drag and drop it onto the form.
4. Right-click the button and select **Properties** to display the Properties window. You configure the properties of the control in the Properties window.

5. The Text property will be highlighted. Type `Start Scan` for the button text.
6. Select another button control and drag and drop it onto the form. Type `Stop Scan` for the button text.
7. Select the **Measurement Studio .NET Tools** tab on the Toolbox.

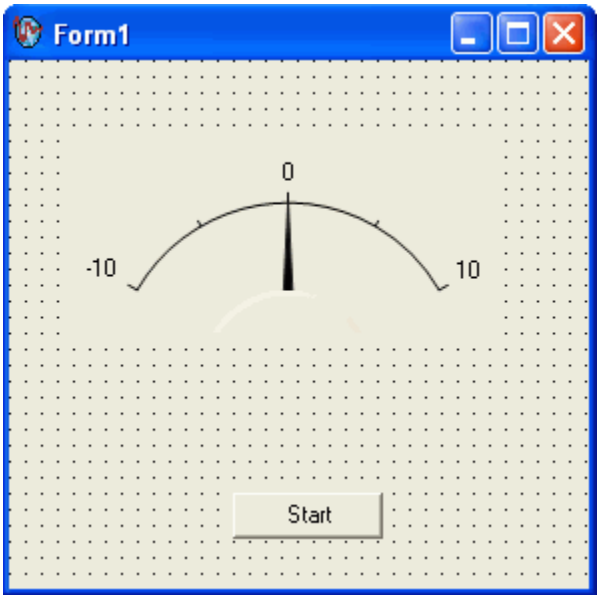



8. Select the **Waveform graph** control and drag and drop it onto the form.
9. Select the **MCC Scan Components** tab on the Toolbox.




10. Double-click on the **AIScan** component (`aiScan1`) to add it to the component tray beneath the form.
11. Right-click the **AIScan** component (`aiScan1`) and select **Properties** to display the Properties window.
12. Click on the **ClockRate** property and type `500` for this property setting.

The following screenshot shows `Form1` with the user controls. The `AIScan` component is shown in the component tray.




**Generating and displaying the data**

1. Double-click on the Start Scan button to display the `Form1` code.
2. Add the following line of code to start an analog in scan.

[VB.NET]

```
' This starts the scan
AiScan1.Operate()
```

[C#]

```
// This starts the scan
private void button1_Click(object sender, System.EventArgs e)
{
  aiScan1.Operate();
}
```

3. Double-click on the Stop Scan button to open the code window.

4. Add the following line of code that stops the analog in scan.

[VB.NET]

```
' This stops the scan
AiScan1.Break = True
```

[C#]

```
// This stops the scan
private void button2_Click(object sender, System.EventArgs e)
{
    aiScan1.Break =true;
}
```

5. Double-click on the `AIScan` component to open the code window.
6. Add the following lines of code to the DataReady event of the `aiScan1` component to copy the analog data to an array.

[VB.NET]

```
Private Sub AiScan1_DataReady(ByVal sender As Object, ByVal e As
System.EventArgs) Handles AiScan1.DataReady
Dim I As Integer
Dim yData() As Double
ReDim yData(UBound(AiScan1.Values) - 1)
For I = 0 To UBound(AiScan1.Values) - 1
yData(I) = AiScan1.Values(I)
Next
WaveformGraph1.PlotY(yData, 0, 1.0 / AiScan1.ActualRate)
End Sub
```

[C#]

```
private void aiScan1_DataReady(object sender, System.EventArgs e)
{
    Array tempArray =aiScan1.Values as Array;
    double[] yData =new double[tempArray.Length];
    Array.Copy(tempArray, yData, tempArray.Length);
    waveformGraph1.PlotY(yData, 0, 1.0/aiScan1.ActualRate);
}
```

7. Add the following lines of code to the ErrorOccurred event of the `aiScan1` component to display a message box if an error occurs.

[VB.NET]

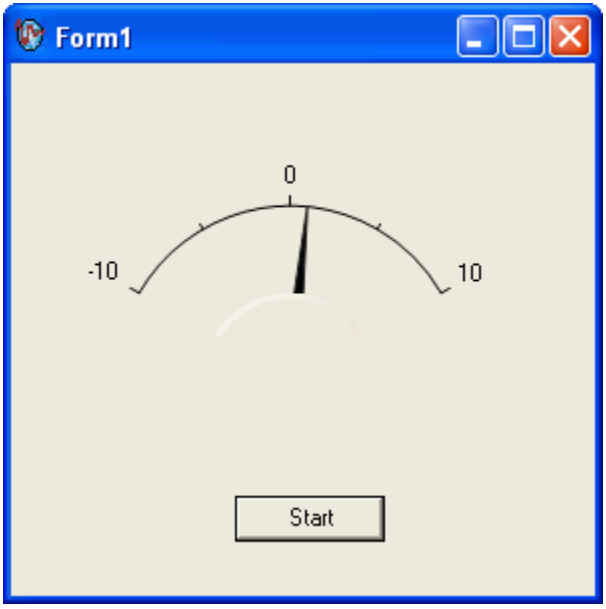
```
Private Sub AiScan1_ErrorOccurred(ByVal sender As Object, ByVal e As
MccDaq.ScanComponents.ErrorOccurredEventArgs) Handles AiScan1.ErrorOccurred
AiScan1.Break = True
MessageBox.Show(AiScan1.Status, "AI Scan Error")
End Sub
```

[C#]

```
private void aiScan1_ErrorOccurred(object sender,
MccDaq.ScanComponents.ErrorOccurredEventArgs e)
{
    aiScan1.Break =true;
    MessageBox.Show(aiScan1.Status, "AI Scan Error");
}
```

8. Select **File»Save Form1.cs** to save your application.
9. Select **Debug»Start Without Debugging** to run the application.
10. After your program builds, click **Start Scan**.

The following screenshot shows `Form1` with the waveform graph displaying the acquired values.



# Walkthrough: Creating a Measurement Studio MCC 488.2 Application in Visual Studio 2003

**Note** This walkthrough refers to Visual Studio .NET 2003, but Visual Studio 2005 users can follow the same process.

- **Setting up the project**—Using the Visual Studio New Project dialog, you will create a new project that references the Measurement Studio Measurement Computing 488.2 class library and Windows Forms controls.
- **Adding user interface controls to the project**—Using the Toolbox and the Properties window, you will add and configure user interface controls, including a button and waveform graph.
- **Generating and displaying data**—Using `MCC.488.2.Device` and `MCC.488.2.Address`, you will read and plot 100 data points from a GPIB device at the specified address.

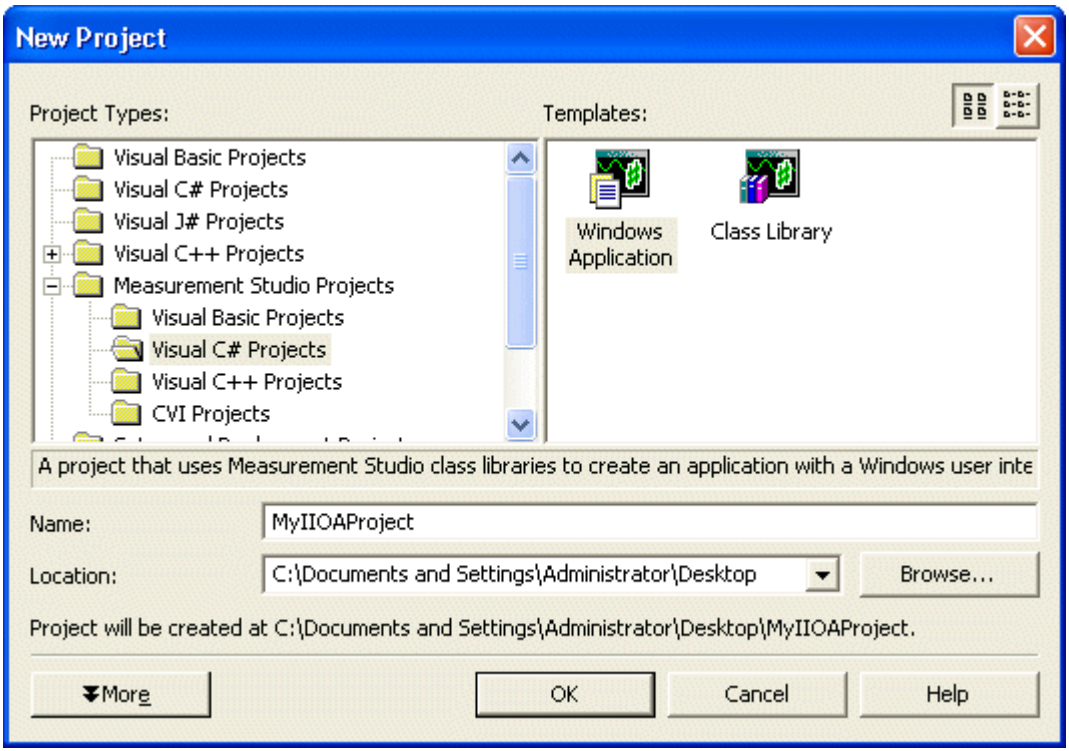
## Before You Begin

The following components are required to complete this walkthrough:

- Microsoft Visual Studio .NET 2003 or Microsoft Visual Studio 2005
- Measurement Studio 8.0
- Measurement Computing 488.2 Library
- Measurement Computing GPIB Device

### Setting up the project

1. Open Visual Studio .NET from **Start»All Programs»Microsoft Visual Studio .NET 2003»Microsoft Visual Studio .NET 2003**.
2. Select **File»New»Project**. The New Project dialog box launches.




3. In the Project Types pane, expand the **Measurement Studio Projects** folder. Select **Visual Basic Projects** or **Visual C# Projects**, depending on which language you want to create the project in. This walkthrough refers to Visual C#, but Visual Basic .NET users can follow the same process.
4. In the Templates pane, select **Windows Application**. Specify `MyMCCGPIBProject` for **Name** and select a **Location** of your choice.
5. Click **OK**. The Measurement Studio Application Wizard launches.

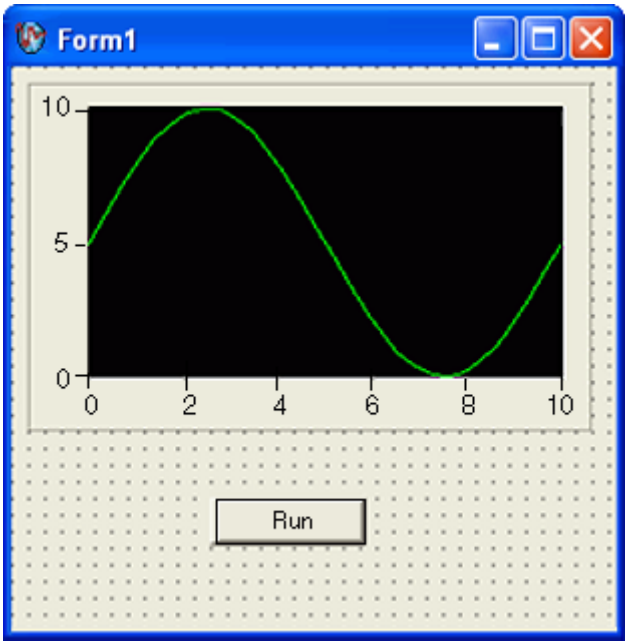
**Tip** If you are working with an existing project, you can access the Add Class Libraries dialog box by selecting **Measurement Studio»Add/Remove Class Libraries Wizard**.

6. In the Application Wizard dialog box, select **Windows Forms User Interface Controls** and **MCC 488.2 Library**. The wizard automatically adds references to the appropriate class libraries and sets up the project for you.
7. Click **Finish** to display Form1 in the Windows Forms Designer.

### Adding user interface controls to the project

1. Select **View»Toolbox** to display the Toolbox. The Toolbox contains components and controls that you can add to your project.
2. Select the **Windows Forms** tab. The Windows Forms tab contains controls and components included in the `System.Windows.Forms` namespace.
3. Select the **Button** control and drag and drop it onto the form.
4. Right-click the button and select **Properties** to display the Properties window. You configure the properties of the control in the Properties window.
5. The Text property will be highlighted. Type `Run` for the button text.
6. Select the **WaveformGraph** control and drag and drop it onto the form.

The following screenshot shows `Form1` with the user controls.



### Generating and displaying the data

1. Double-click the button control to display the `Form1` code, with the cursor inside the click event handler of the button control.
2. Add the following code to read a raw data point from a specified channel on the Measurement Computing device, convert the data to volts, and display the value on the graph.

[VB.NET]

```
Dim I As Integer
Dim WrtString As String = "val?"
Dim RdBufSize As Integer = 100
Dim NlChar As Char = "\n"
Dim NullChar As Char = "\0"
Dim PrimaryAddress As New Address(2)
Dim BoardNum As Integer = 0
' Open a gpib device
Dim Device As New Device(BoardNum, PrimaryAddress)
' Allocate a buffer to hold the data
Dim Buffer As IntPtr =
System.Runtime.InteropServices.Marshal.AllocHGlobal(RdBufSize)
' Read and plot 100 samples
For I = 0 To 99
' Write the string (val?) to the Fluke45
Device.Write(WrtString)
' Read the response from the Fluke45
Dim S As String = Device.ReadString(RdBufSize)
' Replace the newline character with a null and
' convert the string to a double
Dim D As Double = Convert.ToDouble(S.Replace(NlChar, NullChar))
'Plot the point
WaveformGraph1.PlotYAppend(D, 1)
Next
System.Runtime.InteropServices.Marshal.FreeHGlobal(Buffer)
```

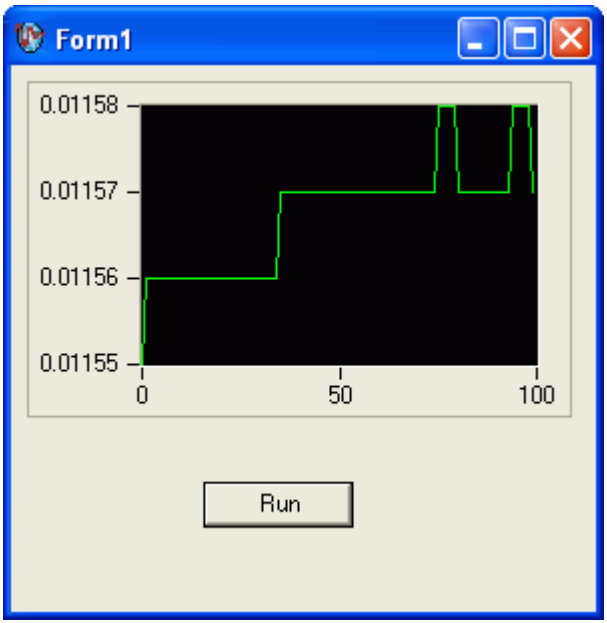
[C#]

```
stringwrtString = "val?";
    int    rdBufSize = 100;
    char   nlChar = '\n';
    char   nullChar = '\0';
    addressprimaryAddress = new Address(2);
    int    boardNum = 0;
// open a gpib device
    Device device = new Device(boardNum, primaryAddress);
// allocate a buffer to hold the data
    IntPtr buffer =
```

```
System.Runtime.InteropServices.Marshal.AllocHGlobal(rdBufSize);
// read and plot 100 samples
    for (int i=0; i<100; i++)
    {
        // write the string (val?) to the Fluke45
        device.Write(wrtString);
        // read the response from the Fluke45
        string s = device.ReadString(rdBufSize);
        // replace the newline character with a null and
        // convert the string to a double
        double d = Convert.ToDouble(s.Replace(nlChar, nullChar));
        // plot the point
        waveformGraph1.PlotYAppend(d, 1);
    }
    System.Runtime.InteropServices.Marshal.FreeHGlobal(buffer);
```

3. Select **File»Save Form1.cs** to save your application.
4. Select **Debug»Start Without Debugging** to run the application.
5. After your program builds, click **Run**. Notice each time you click the Run button, the graph shows the acquired value.

The following screenshot shows `Form1` with the graph displaying the acquired value.



# Measurement Studio Walkthroughs for Visual Studio 2005

Use the following walkthroughs to help you develop Measurement Studio applications in Visual Studio 2005:

- *Walkthrough: Creating a Measurement Studio Application with Windows Forms Controls and Analysis in Visual Studio 2005*
- *Walkthrough: Creating a Measurement Studio Application with Web Forms Controls and Analysis in Visual Studio 2005*
- *Creating a Measurement Studio Application with Web Forms Controls and Network Variable in Visual Studio 2005*

# Walkthrough: Creating a Measurement Studio Application with Windows Forms Controls and Analysis in Visual Studio 2005

Measurement Studio includes user interface controls, such as a waveform graph control and a gauge control, and analysis functionality, such as signal generation and mathematical functions. This walkthrough is designed to help you learn how to add analysis and presentation functionality to a Windows Forms application by taking you through the following steps:

- **Setting up the project**—Using the Measurement Studio Application Wizard, you will create a new project that references the Measurement Studio Analysis class library and Windows Forms controls.
- **Adding user interface controls to the project**—Using the Toolbox, smart tags, and the Properties window, you will add and configure a button, waveform graph, legend, gauge, and numeric edit user interface control.
- **Generating, plotting, and analyzing the data**—Using `NationalInstruments.Analysis.SignalGeneration.WhiteNoiseSignal` and `NationalInstruments.Analysis.Math.Statistics.Mean`, you will generate data, plot the generated data on a waveform graph, and calculate the mean of the data.
- **Customizing the user interface**—Using smart tags and the Collection Editor and Auto Format dialog boxes, you will display the mean value on the gauge and the numeric edit, as well as customize your user interface.

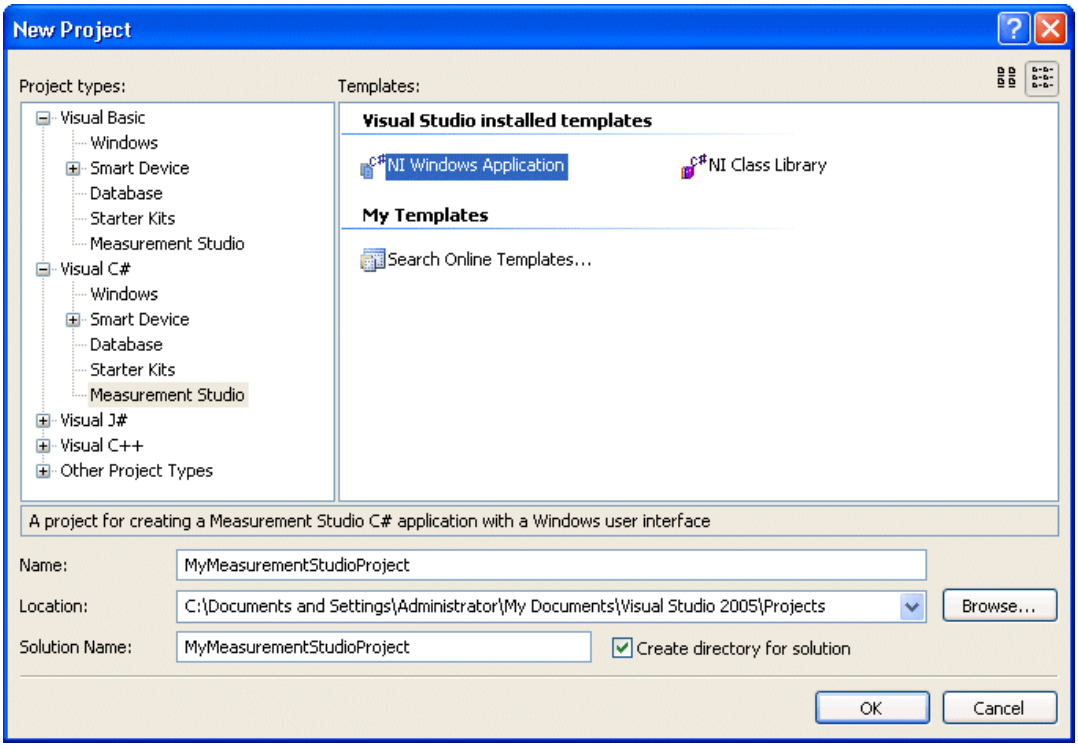
### Before you begin

The following components are required to complete this walkthrough:

- Microsoft Visual Studio .NET 2005
- Measurement Studio 8.0.1 or later (Professional or Enterprise package)

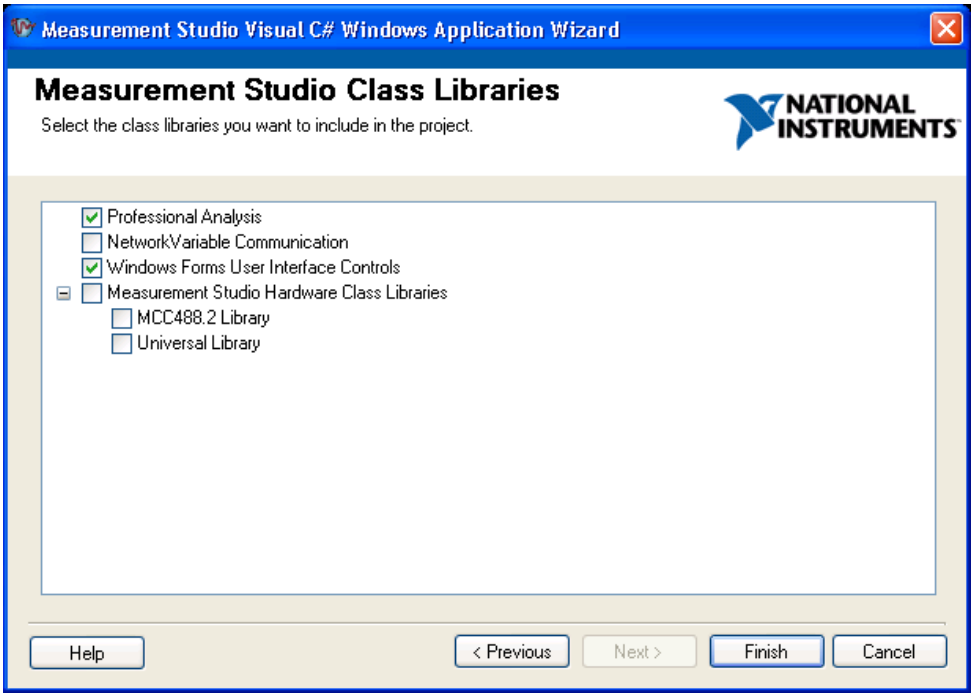
### Setting up the project

1. Select **Start»All Programs»Microsoft Visual Studio 2005»Microsoft Visual Studio 2005**.
2. Select **File»New»Project**. The New Project dialog box launches.




3. In the Project Types pane, select **Measurement Studio** under Visual C# or Visual Basic, depending on which language you want to create the project in.
4. In the Templates pane, select **NI Windows Application**. Specify `MyMeasurementStudioProject` for **Name** and specify a **Location** of your choice.

5. Click **OK**. The Measurement Studio Application Wizard launches.
6. Select **Analysis** and **Windows Forms User Interface Controls**.



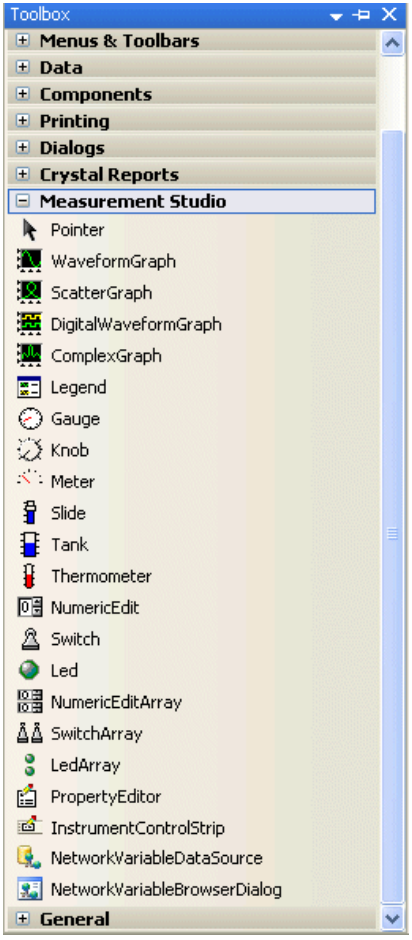

**Tip** If you are working with an existing project, you can access the Add/Remove Class Libraries dialog box by selecting **Measurement Studio»View .NET Class Library Wizard**.

7. Click **Finish** to display `Form1` in the Windows Forms Designer.

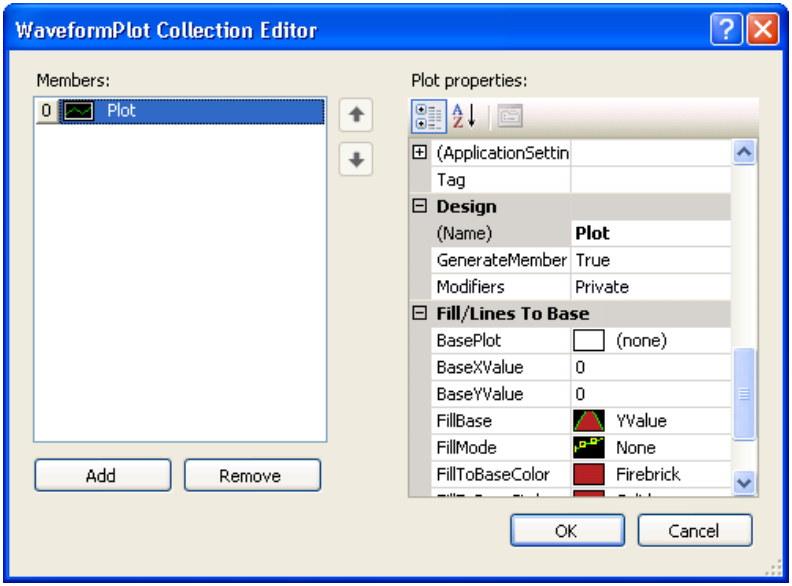
**Adding user interface controls to the project**

1. Select **View»Toolbox** to display the Toolbox. The Toolbox contains components and controls that you can add to your project.
2. Expand the **All Windows Forms** group. The All Windows Forms group contains controls and components included in the `System.WindowsForms` namespace.
3. Select the **Button** control and drag and drop it onto the form.
4. Right-click the button and select **Properties** to display the Properties window. You configure the properties of the control in the Properties window.

5. The Text property will be highlighted. Type `Start` for the button text.
6. Expand the **Measurement Studio** group in the Toolbox.



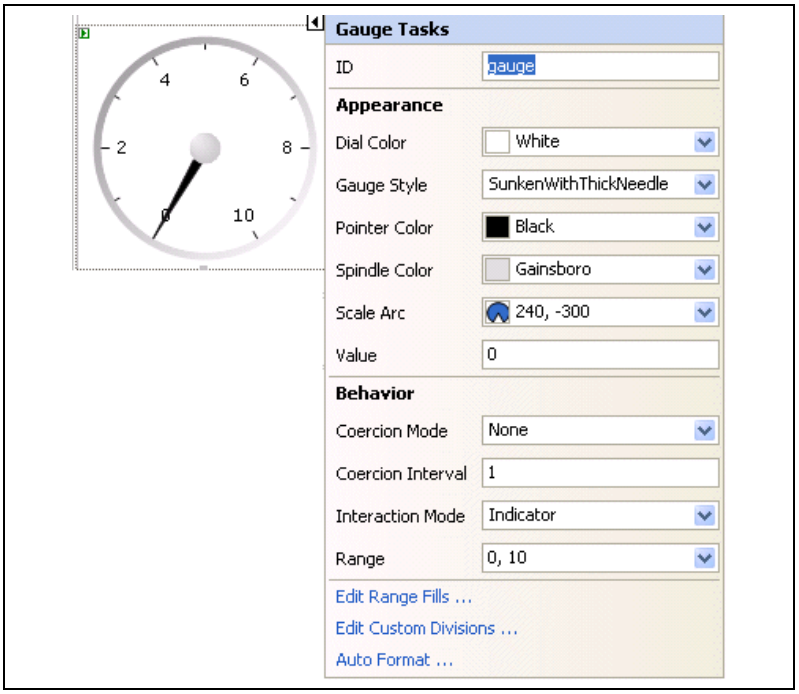

7. Select the **WaveformGraph** control and drag and drop it onto the form.
8. Right-click the waveform graph and select **Edit Plots** to display the WaveformPlot Collection Editor dialog box. You use the WaveformPlot Collection Editor dialog box to add or remove plots and to configure plot properties.

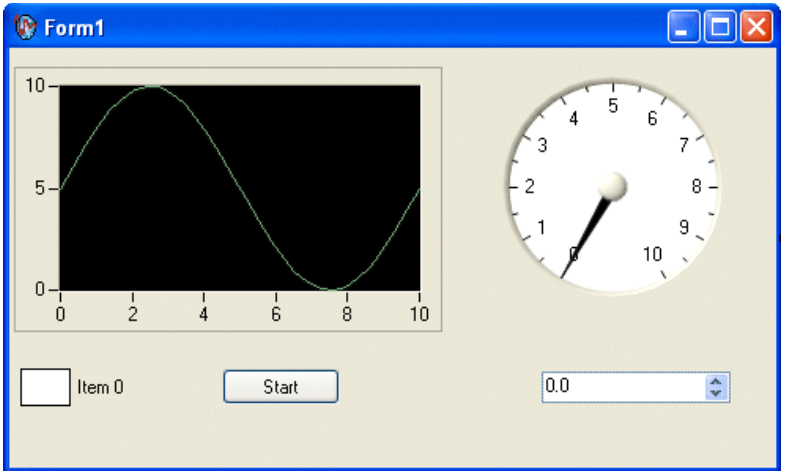



**Note** You can also access the WaveformPlot Collection Editor dialog box by clicking the waveform graph smart tag. To access the smart tag, left click on the control to select it and then left click on the arrow button in the upper right corner of the control.

9. Type `Plot` for the Name. Click **OK**.
10. Before you add the Measurement Studio legend, numeric edit, and gauge controls, you need to resize the form to accommodate them. Select the form and use the double-sided arrow to resize it.
11. Select the **Legend** control and drag and drop it onto the form.
12. Select the **NumericEdit** control and drag and drop it onto the form.
13. Select the **Gauge** control and drag and drop it onto the form.

14. Click the gauge smart tag to display the Gauge Tasks.
15. Type `gauge` for the name of the gauge.



### Generating, plotting, and analyzing the data

1. Double-click the button control to display the `Form1` code, with the cursor inside the click event handler of the button control.
2. Add the following code to generate random data, plot the data, calculate the mean of the data, and display the mean on the gauge.

[VB.NET]

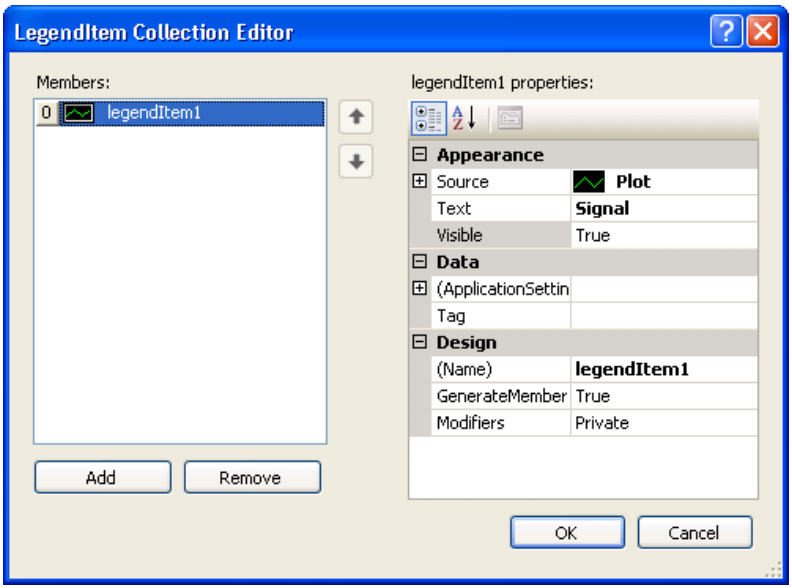
```
' Declare and initialize an instance of WhiteNoiseSignal.
Dim whiteNoise As New WhiteNoiseSignal()
' Store the generated data in a double array named data.
Dim data As Double() = whiteNoise.Generate(1000.0, 256)
' Use the PlotY method to plot the data.
Plot.PlotY(data)
' Use the Mean method to calculate the mean of the data.
Dim mean As Double = Statistics.Mean(data)
' Display the mean on the gauge.
gauge.Value = mean
```

[C#]

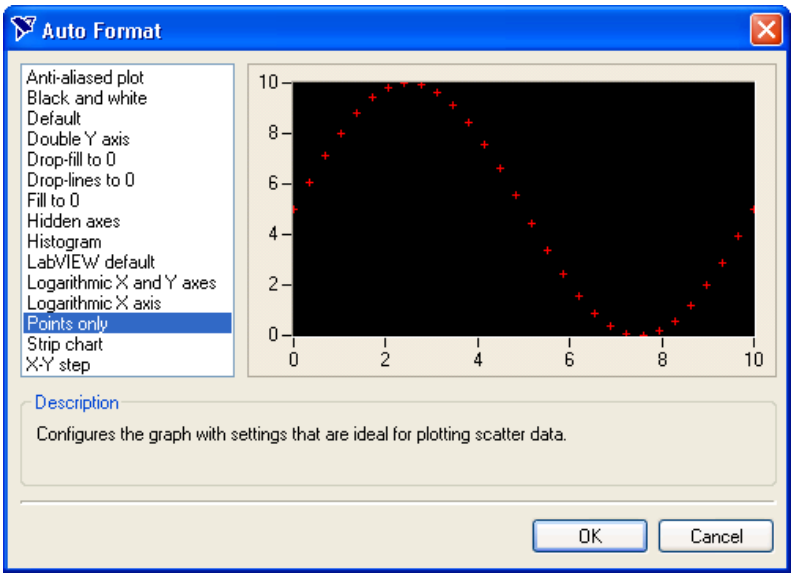
```
// Declare and initialize an instance of WhiteNoiseSignal.
WhiteNoiseSignal whiteNoise = new WhiteNoiseSignal();

// Store the generated data in a double array named data.
double[] data = whiteNoise.Generate(1000.0, 256);

// Use the PlotY method to plot the data.
Plot.PlotY(data);

// Use the Mean method to calculate the mean of the data.
double mean = Statistics.Mean(data);

// Display the mean on the gauge.
gauge.Value = mean;
```

### Customizing your user interface

1. Right-click the legend and select **Edit Items** to display the LegendItem Collection Editor dialog box. You use the LegendItem Collection Editor dialog box to add or remove legend items and to configure legend item properties.



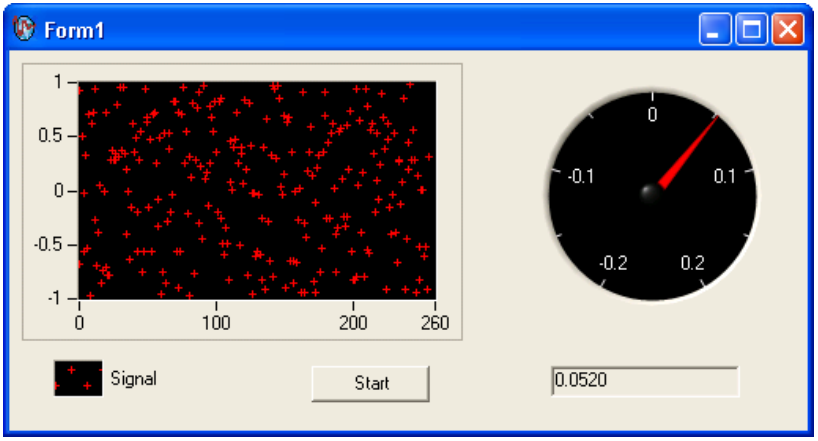

2. Select **Plot** in the **Source** drop-down list and enter `Signal` in the **Text** box. Click **OK**. Now that you have specified a legend item for the plot, changes you make to the plot will be reflected on the legend.
3. Right-click the graph and select **Auto Format** to display the Auto Format dialog box. The Auto Format dialog box provides a set of pre-configured control styles. When you select a style and click **OK**, the Auto Format feature configures the appropriate control properties to reflect the style you chose.
4. Select **Points Only**. Click **OK**. Notice that the legend changed automatically to match the formatting of the graph.




5. Click the gauge smart tag to display the Gauge Tasks.
6. Select **Auto Format** to display the Auto Format dialog box.
7. Select **Dark** and click **OK**.
8. Right-click the gauge and select **Properties** to display the Properties window.
9. Set the Range property for the gauge with the drop-down Range type editor. Type `-0.2` for the minimum value and type `0.2` for the maximum value.
10. Click the numeric edit smart tag to display the Numeric Edit Tasks.
11. Select **Gauge** in the **Source** drop-down list. Setting the Source property to the gauge allows two-way binding between the controls.
12. Deselect **ArrowKeys**, **Buttons**, and **Text** for the **InteractionMode** property of the numeric edit control. Deselecting these interaction modes makes the numeric edit an indicator. The numeric edit control only displays the calculated mean.
13. Select the Format Mode property and in the Numeric Edit Format Mode Editor dialog box, change the Precision to `4` to show four decimal places of precision.
14. Select **File»Save Form1.cs** to save your application.
15. Select **Debug»Start Without Debugging** to run the application.

16. After your program builds, click **Start**. Notice the graph shows the data plot, and the gauge and the numeric edit display the mean of the data.

The following screenshot shows `Form1` with customization.




# Walkthrough: Creating a Measurement Studio Application with Web Forms Controls and Analysis in Visual Studio 2005

Measurement Studio includes user interface controls, such as a waveform graph control and a gauge control, and Analysis functionality, such as signal generation and mathematical functions. This walkthrough is designed to help you learn how to add analysis and presentation functionality to a Web Forms application by taking you through the following steps:

- **Setting up the project**—Using the Measurement Studio Application Wizard, you will create a new project that references the Measurement Studio Analysis class library and Web Forms controls.
- **Adding user interface controls to the project**—Using the Toolbox and the Properties window, you will add and configure a button, waveform graph, legend, gauge, and numeric edit user interface control.
- **Generating, plotting, and analyzing the data**—Using `NationalInstruments.Analysis.SignalGeneration.WhiteNoiseSignal` and `NationalInstruments.Analysis.Math`.

`Statistics.Mean`, you will generate data, plot the generated data on a waveform graph, and calculate the mean of the data.

- **Customizing the user interface**—Using the Collection Editor and Auto Format dialog boxes, you will display the mean value on the gauge and the numeric edit, as well as customize your user interface.

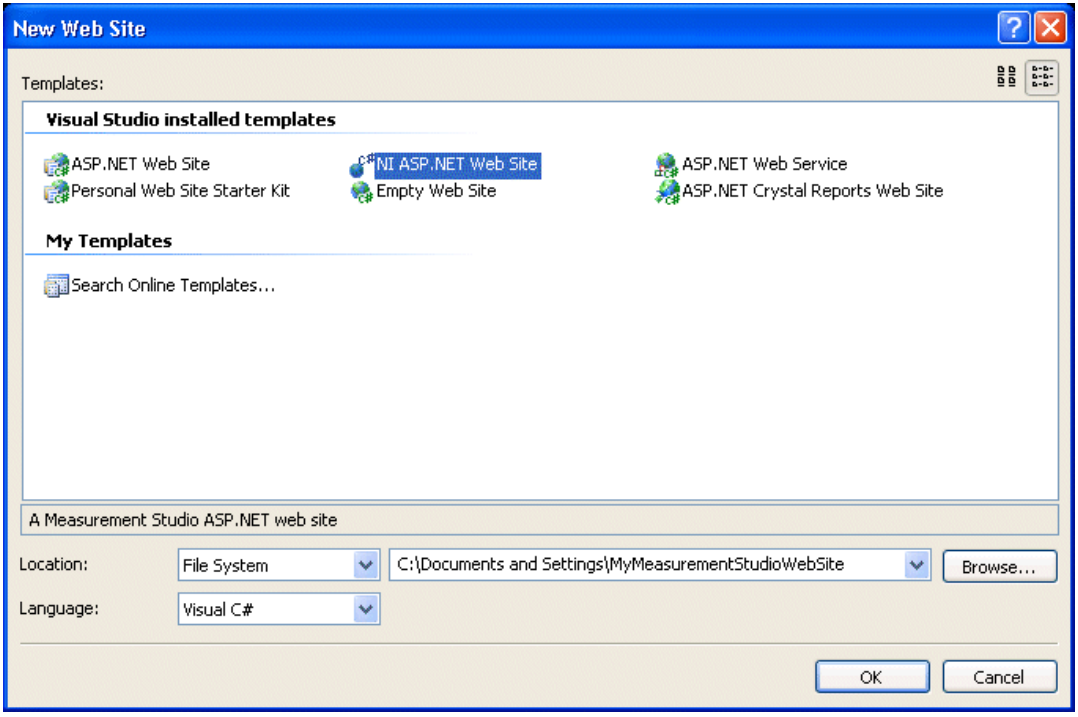
### Before you begin

The following components are required to complete this walkthrough:

- Microsoft Visual Studio .NET 2005
- Measurement Studio 8.0.1 or later (Professional or Enterprise package)

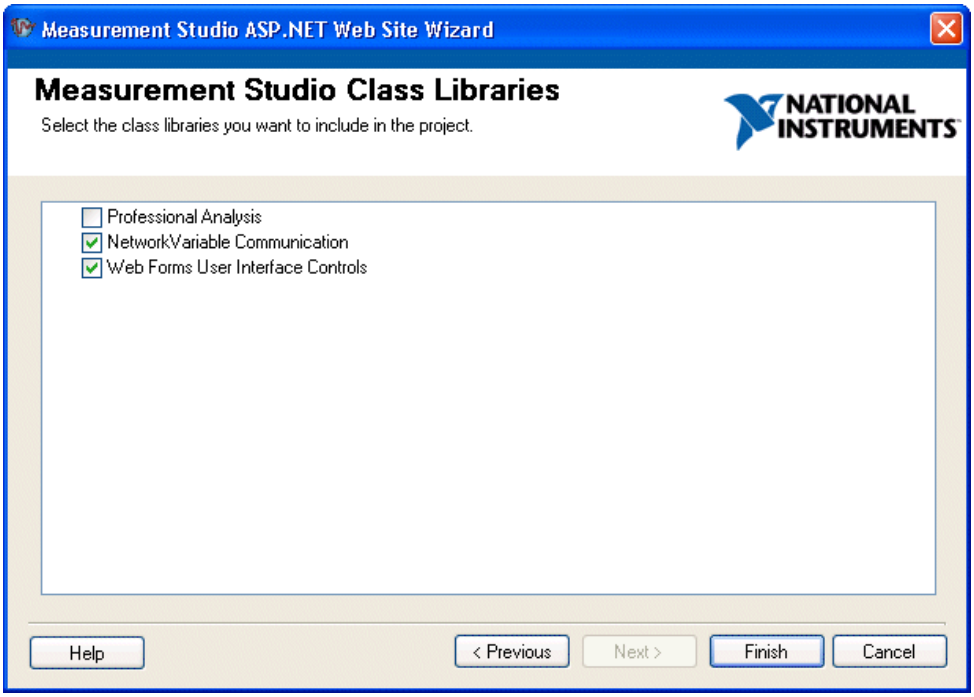
### Setting up the project

1. Select **Start»All Programs»Microsoft Visual Studio 2005» Microsoft Visual Studio 2005**.
2. Select **File»New»Web Site**. The New Web Site dialog box launches.




3. In the Templates pane, select **NI ASP.NET Web Site**. Select `File System` and specify a file path of your choice.

4. Use the drop-down box to select **Visual C#** or **Visual Basic**, depending on which language you want to create the project in.
5. Click **OK**. The Measurement Studio ASP.NET Web Site Wizard launches.
6. Select **Analysis** and **Web Forms User Interface Controls**.

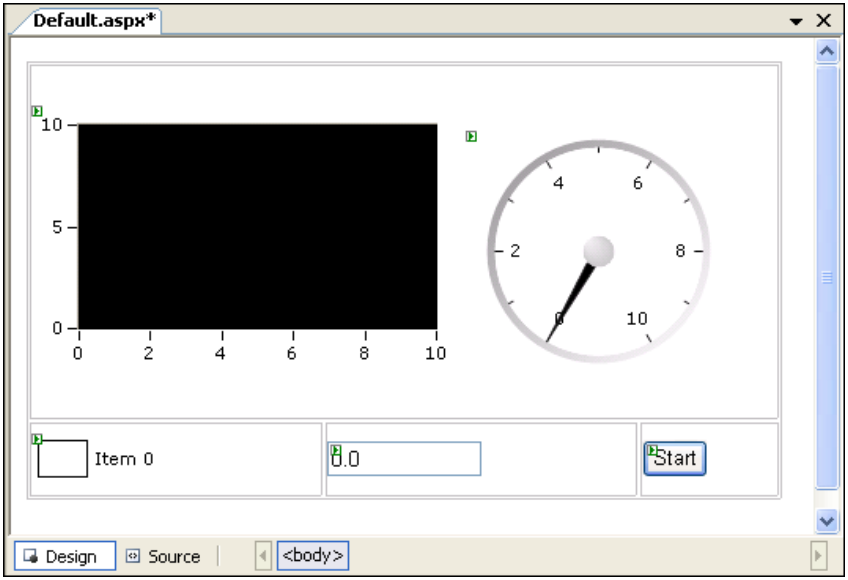



**Tip** If you are working with an existing project, you can access the Add/Remove Class Libraries dialog box by selecting **Measurement Studio»Add/Remove Class Libraries Wizard**.

7. Click **Finish** to display `Default.aspx` in the Web Forms Designer.
8. You can change the title of your Web page. Click inside the `<title>` tag and rename the title to **Measurement Studio Web Forms Controls and Analysis Walkthrough**.

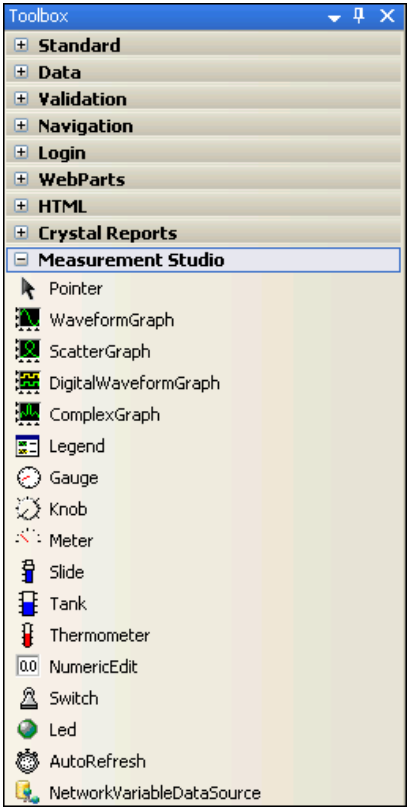
### Adding user interface controls to the project

1. In this section, you will build a Web page that looks like the following screenshot.




2. Click **Design** in the lower left corner to switch from Source View to Design View.
3. Select **View»Toolbox** to display the Toolbox. The Toolbox contains components and controls that you can add to your project.
4. Expand the **HTML** group on the Toolbox. Select the Table control in the Toolbox and drag and drop it on the form. You use the table cells to arrange the user interface controls on your Web page, as shown in the previous screenshot.
5. The default table that appears is 3×3. This table provides a customizable form for arranging the user interface controls for your Web page. Expand the table to approximately 300 px (pixels) tall by 550 px wide by clicking and dragging the table borders.
6. Merge the top two cells of all three columns by selecting the cells, right-clicking, and selecting **Merge**.
7. Expand the **Standard** group on the Toolbox. The Standard group contains ASP.NET server controls included in the `System.Web.UI` namespace.
8. Select the **Button** control and drag and drop it into the lower right table cell.

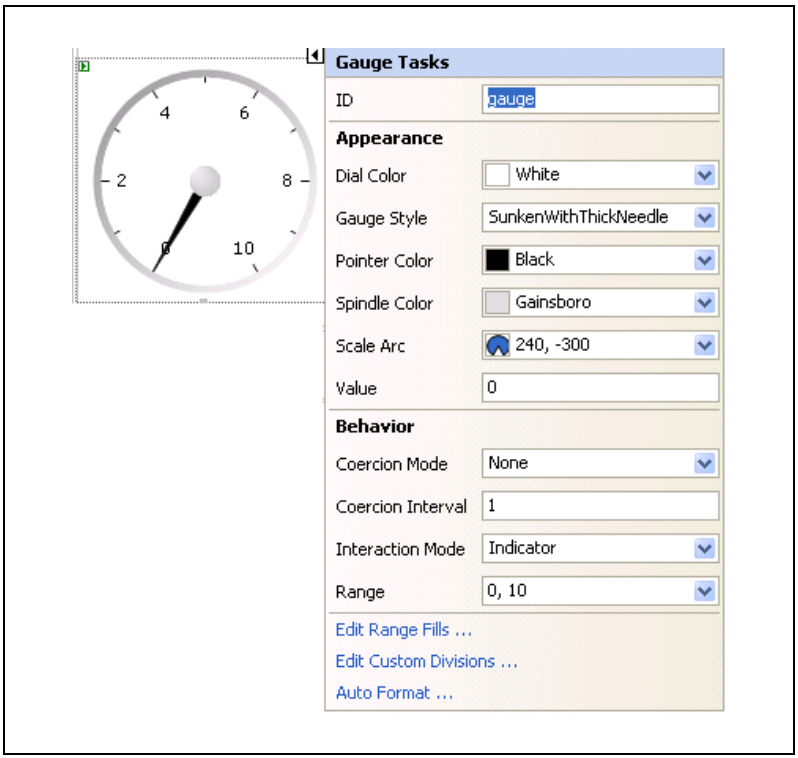
9. Right-click the button and select **Properties** to display the Properties window. You configure the properties of the control in the Properties window.
10. Scroll to the Text property in the Properties window. Type `Start` for the button text.
11. Expand the **Measurement Studio** group on the Toolbox.



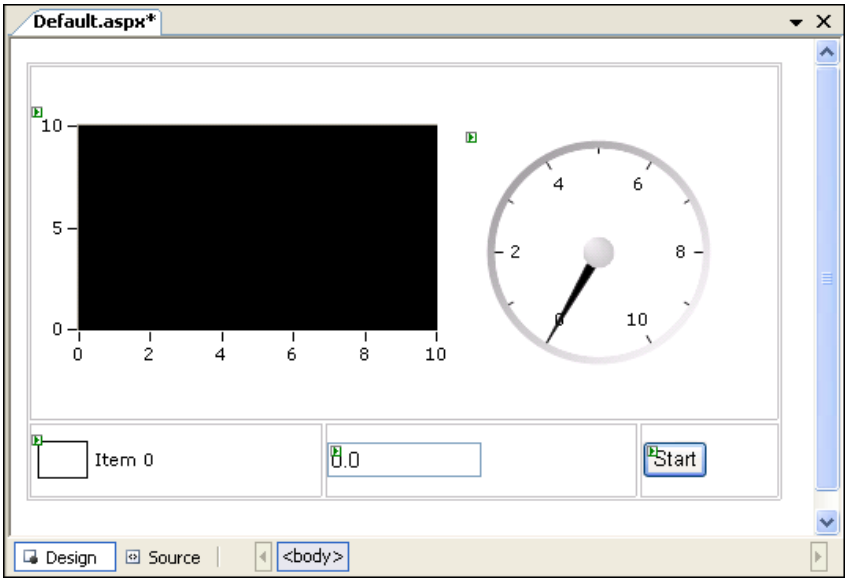

12. Select the **WaveformGraph** control and drag and drop it into the top table cell.
13. On the waveform graph smart tag, type `graph` for the name of the waveform graph ID.

**Tip** To access the smart tag, left click on a control to select it and then left click on the arrow button in the upper right corner of the control.

14. Select the **Legend** control and drag and drop it into the bottom left table cell.
15. Select the **NumericEdit** control and drag and drop it into the bottom center table cell.
16. On the numeric edit smart tag, type `numericedit` for the name of the numeric edit ID.
17. Select the **Gauge** control and drag and drop it into the top table cell, to the right of the waveform graph. Resize controls and table cells as necessary.
18. On the gauge smart tag, type `gauge` for the name of the gauge ID.



The following screenshot shows `Default.aspx` with the user controls.




**Generating, plotting, and analyzing the data**

1. Double-click the button control to display the `Default.aspx.cs` code, with the cursor inside the click event handler of the button control.
2. Add the following code to generate random data, plot the data, calculate the mean of the data, and display the mean on the gauge.

[VB.NET]

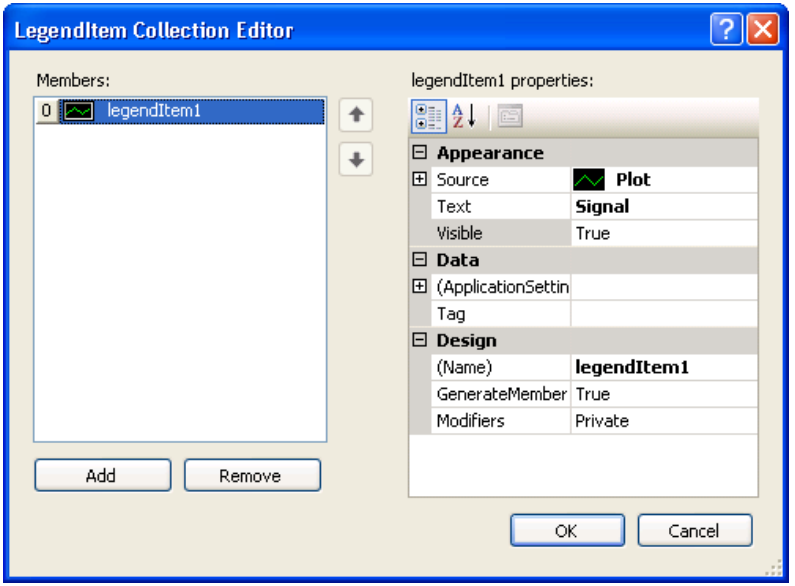
```
' Declare and initialize an instance of WhiteNoiseSignal.
Dim whiteNoise As New WhiteNoiseSignal()
' Store the generated data in a double array named data.
Dim data As Double() = whiteNoise.Generate(1000.0, 256)
' Use the PlotY method to plot the data.
graph.PlotY(data)
' Use the Mean method to calculate the mean of the data.
Dim mean As Double = Statistics.Mean(data)
' Display the mean on the numeric edit.
numericedit.Value = mean
' Display the mean on the gauge.
gauge.Value = mean
```

[C#]

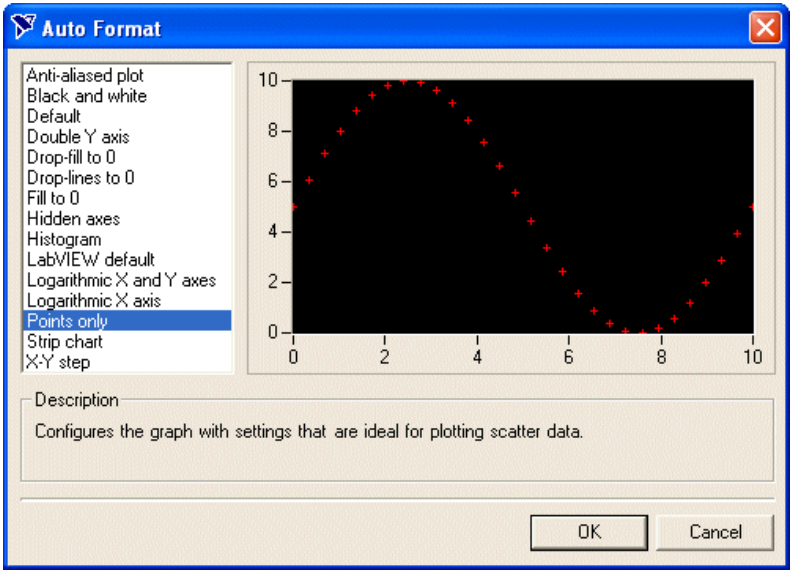
```
// Declare and initialize an instance of WhiteNoiseSignal.
WhiteNoiseSignal whiteNoise = new WhiteNoiseSignal();

// Store the generated data in a double array named data.
double[] data = whiteNoise.Generate(1000.0, 256);

// Use the PlotY method to plot the data.
graph.PlotY(data);

// Use the Mean method to calculate the mean of the data.
double mean = Statistics.Mean(data);

// Display the mean on the numeric edit.
numericedit.Value = mean;

// Display the mean on the gauge.
gauge.Value = mean;
```

### Customizing your user interface

1. Select the **Default.aspx** tab to return to the Web Forms Designer.
2. Right-click the legend and select **Edit Items** to display the LegendItem Collection Editor dialog box. You use the LegendItem Collection Editor dialog box to add or remove legend items and to configure legend item properties.

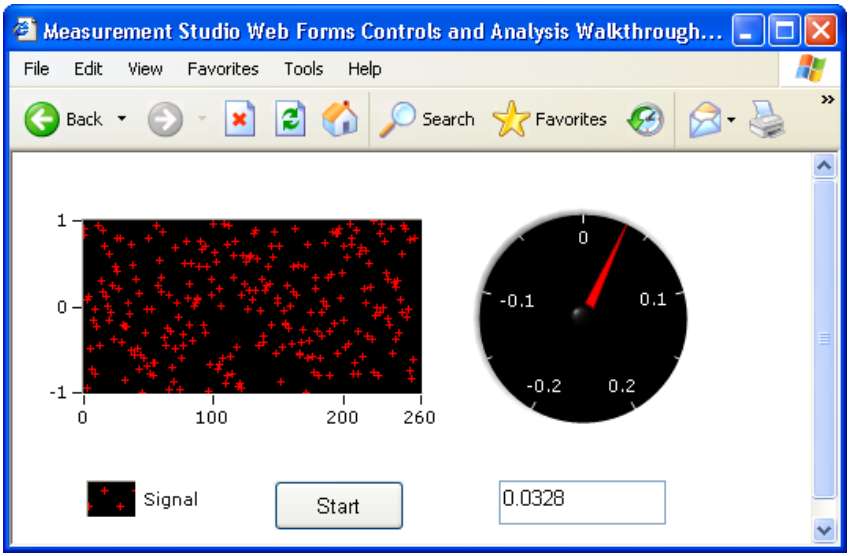


3. Select **Plots[0]** in the **Source** drop-down list and enter `Signal` in the **Text** box. Click **OK**. Now that you have specified a legend item for the plot, changes you make to the plot will be reflected on the legend.
4. Right-click the graph and select **Auto Format** to display the Auto Format dialog box. The Auto Format dialog box provides a set of pre-configured control styles. When you select a style and click **OK**, the Auto Format feature configures the appropriate control properties to reflect the style you chose.
5. Select **Points Only**. Click **OK**. Notice that the legend changed automatically to match the formatting of the graph.




6. Right-click the gauge and select **Auto Format** to display the Auto Format dialog box.
7. Select **Dark** and click **OK**.
8. On the gauge smart tag, set the Range property for the gauge with the drop-down Range type editor. Type `-0.2` for the minimum value and type `0.2` for the maximum value.
9. On the numeric edit smart tag, select **Indicator** for the **InteractionMode** property of the numeric edit control.
10. On the numeric edit smart tag, select Format Mode and in the Numeric Format Mode Editor dialog box, change the Precision to `4` to show four decimal places of precision.
11. Select **File»Save Default.aspx** to save your application.

12. Select **Debug»Start Without Debugging** to run the application.
13. After your program builds, click **Start**. Notice the graph shows the data plot, and the gauge and the numeric edit display the mean of the data. The following screenshot shows `Default.aspx` in its final form.




# Creating a Measurement Studio Application with Web Forms Controls and Network Variable in Visual Studio 2005

Measurement Studio includes user interface controls, such as a waveform graph control, and network variable functionality to transfer live measurement data between applications over the network. This walkthrough is designed to help you learn how to add network variable functionality to a Web Forms application by taking you through the following steps:

- **Writing an array of data to the server**—Using `NationalInstruments.NetworkVariable.NetworkVariableBufferedWriter<TValue>`, you will create and run a console application that writes an array of values to the server.
- **Setting up a Web Forms project**—Using the Measurement Studio Application Wizard, you will create a new project that references the

Measurement Studio Network Variable class library and Web Forms controls.

- **Configuring the network variable data source control**—Using the Toolbox and the `NationalInstruments.NetworkVariable.WebForms.NetworkVariableDataSource` smart tag, you will add and configure a data source control to your application.
- **Displaying the array of data on a Web page**—Using the Toolbox, you will add and configure an `NationalInstruments.UI.WebForms.AutoRefresh` control and a `NationalInstruments.UI.WebForms.WaveformGraph` control to display the data.

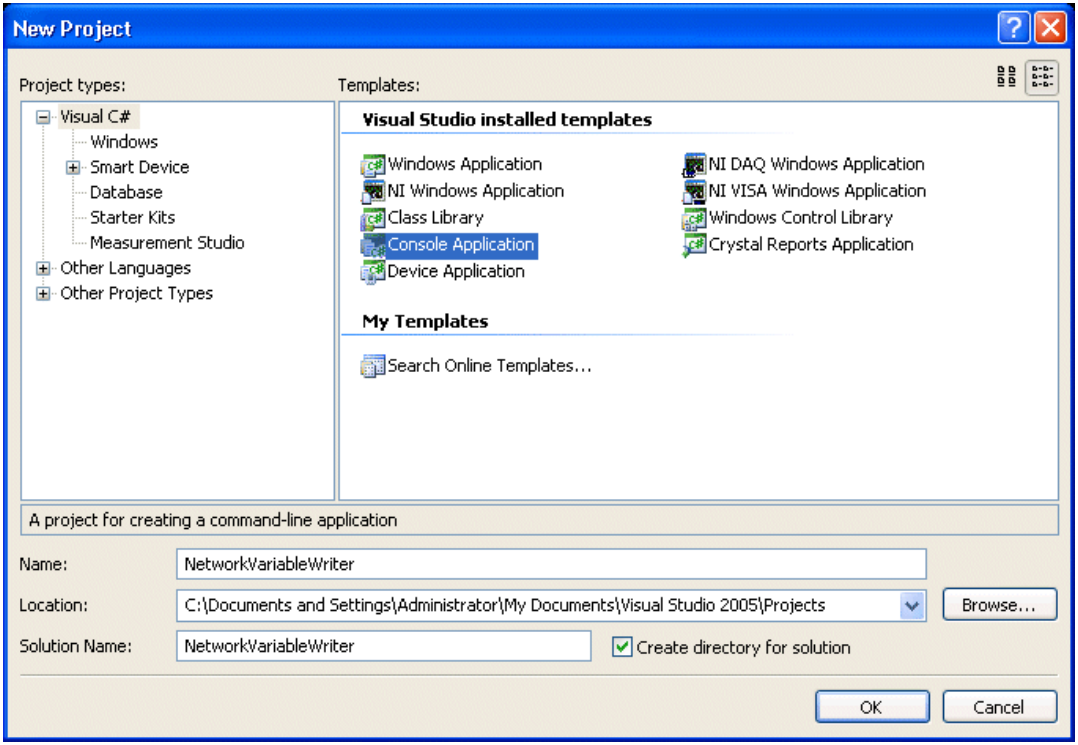
**Before you begin**

The following components are required to complete this walkthrough:

- Microsoft Visual Studio .NET 2005
- Measurement Studio 8.1 or later (Professional or Enterprise package)

**Writing an array of data to the server**

1. Select **Start»All Programs»Microsoft Visual Studio 2005»Microsoft Visual Studio 2005**.
2. Select **File»New»Project**. The New Project dialog launches.




3. In the Project Types pane, select **Visual C#** or **Visual Basic**, depending on which language you want to create the project in.
4. In the Templates pane, select **Console Application**. Specify `NetworkVariableWriter` for **Name** and specify a **Location** of your choice.
5. Click **OK**.
6. Select **Measurement Studio»Add/Remove .NET Class Libraries**. The Measurement Studio Add/Remove Class Libraries Wizard launches. You use this wizard to add Measurement Studio components to your project.

7. In `Program.cs`, add the following code to write an array of data to the server:

[VB.NET]

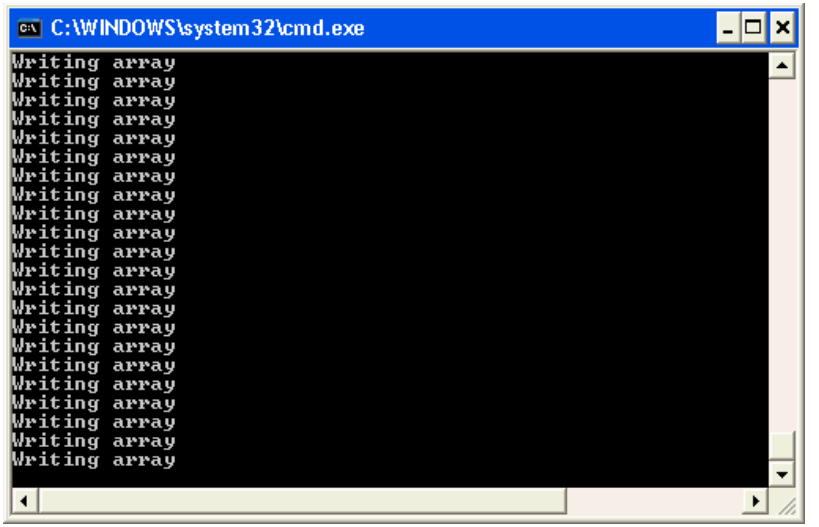
```
Imports NationalInstruments.NetworkVariable
Imports System.Threading
Module Module1
    Private Function GenerateDoubleArray(ByVal phase As Double) As Double()
        Dim values(999) As Double
        Dim x As Integer
        For x = 0 To 999
            values(x) = Math.Sin(((2 * Math.PI * x) / 1000) + phase) * 2
        Next x
        Return values
    End Function
    Sub Main()
        Const location As String = "\\localhost\system\double"
        Dim bufferedWriter As NetworkVariableBufferedWriter(Of Double()) =
New NetworkVariableBufferedWriter(Of Double())(location)
        bufferedWriter.Connect()
        Dim phase As Integer = 0
        While (True)
            Dim values As Double() = GenerateDoubleArray(phase)
            Console.WriteLine("Writing Array")
            bufferedWriter.WriteValue(values)
            Thread.Sleep(500)
            phase = phase + 1
        End While
    End Sub
End Module
```

[C#]

```
using System;
using System.Threading;
using NationalInstruments.NetworkVariable;
namespace NetworkVariableWriter
{
    class Program
    {
        private static double[] GenerateDoubleArray(double phase)
        {
            double[] values = new double[1000];
            for (int x = 0; x < 1000; x++)
                values[x] = Math.Sin(((2 * Math.PI * x) / 1000) + phase) * 2;
            return values;
        }
```

```
        static void Main(string[] args)
        {
            const string Location = @"\\localhost\system\double";
            NetworkVariableBufferedWriter<double[]> bufferedWriter = new
NetworkVariableBufferedWriter<double[]>(Location);
            bufferedWriter.Connect();
            int phase = 0;
            while (true)
            {
                double[] value = GenerateDoubleArray(phase);
                Console.WriteLine("Writing array");
                bufferedWriter.WriteValue(value);
                Thread.Sleep(500);
                phase++;
            }
        }
    }
}
```

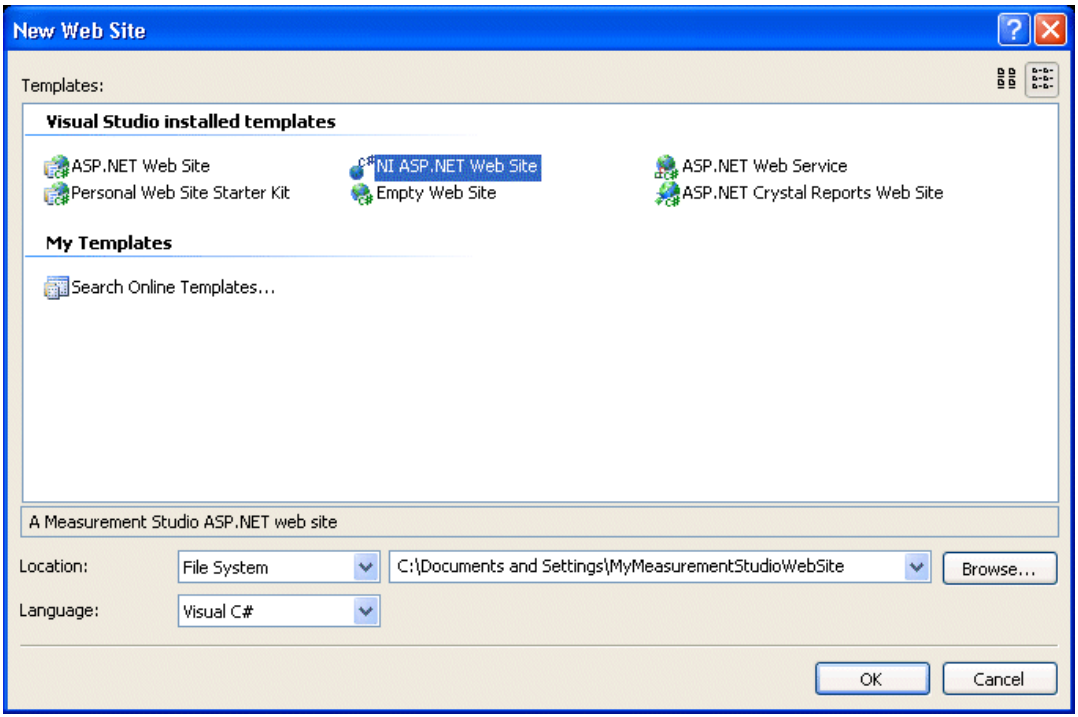
8. Select **Debug»Start Without Debugging** to run the application.




9. Minimize the console application, but keep the application running.

**Setting up the Web Forms project**

1. Select **Start»All Programs»Microsoft Visual Studio 2005» Microsoft Visual Studio 2005**.
2. Select **File»New»Web Site**. The New Web Site dialog box launches.

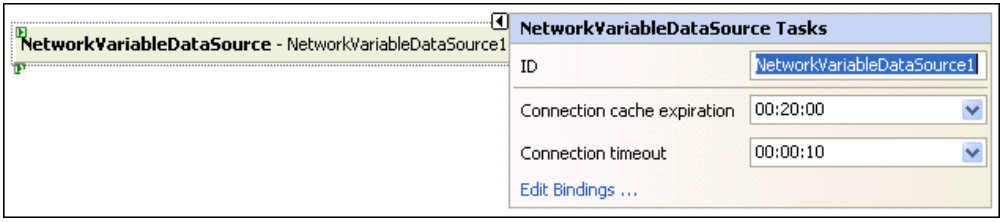



3. In the Templates pane, select **NI ASP.NET Web Site**. Select `File System` for Location and specify a file path of your choice.
4. Use the drop-down box to select **Visual C#** or **Visual Basic**, depending on which language you want to create the project in.
5. Click **OK**. The Measurement Studio ASP.NET Web Site Wizard launches.
6. Click **Finish** to display `Default.aspx` in the Web Forms Designer.
7. You can rename the title of your Web page. Click inside the `<title>` tag and rename the title to **Measurement Studio Network Variable and Web Forms Controls Walkthrough**.

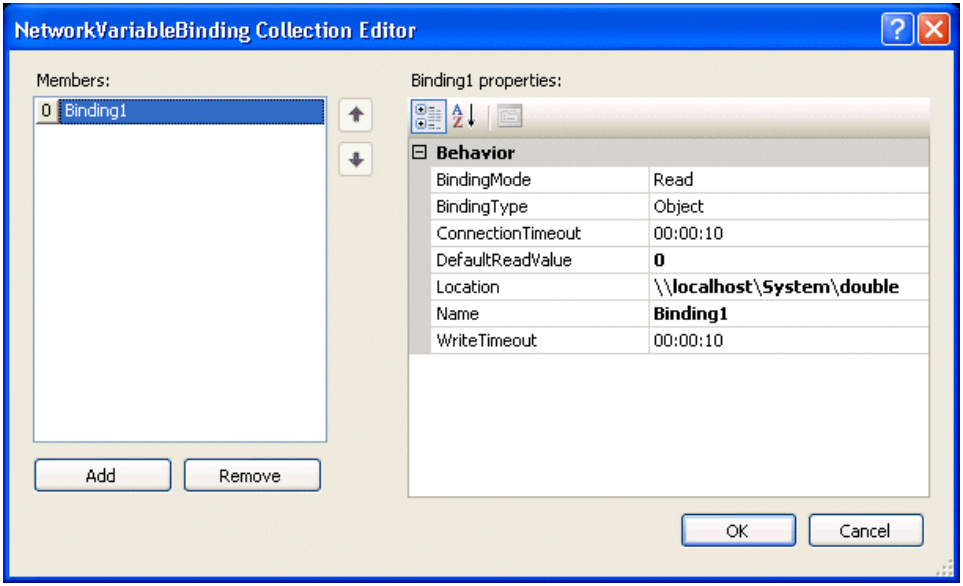
### Configuring the network variable data source control

1. Click **Design** in the lower left corner to switch from Source View to Design View.
2. Select **View»Toolbox** to display the Toolbox. The toolbox contains components and controls that you can add to your project.
3. Expand the **Measurement Studio** group on the Toolbox.

4. Select the NetworkVariableDataSource control in the toolbox and drag and drop it on the form. The `NationalInstruments.NetworkVariable.WebForms.NetworkVariableDataSource` control is a data source control with functionality similar to `System.Web.UI.WebControls.ObjectDataSource` and `System.Web.UI.WebControls.SqlDataSource`in the .NET Framework. The `NationalInstruments.NetworkVariable.WebForms.NetworkVariableDataSource` control encapsulates `NationalInstruments.NetworkVariable` functionality.
5. In the NetworkVariableDataSource smart tag, select **Edit Bindings** to launch the NetworkVariableBinding Collection Editor dialog box.



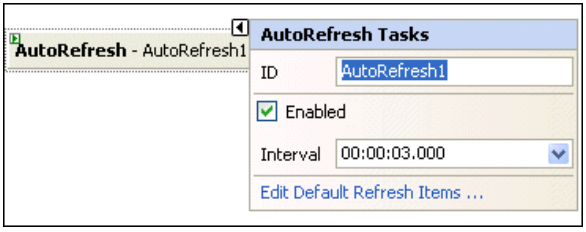

6. Select **Add**. You add a binding to create a connection with the underlying network variable, and you use the NetworkVariableBinding Collection Editor to configure the binding properties. Select **Object** for the BindingType. You select **Object** because this walkthrough binds to `NationalInstruments.UI.WebForms.WaveformGraph.BindingData`. Enter **0** as the **DefaultReadValue**.



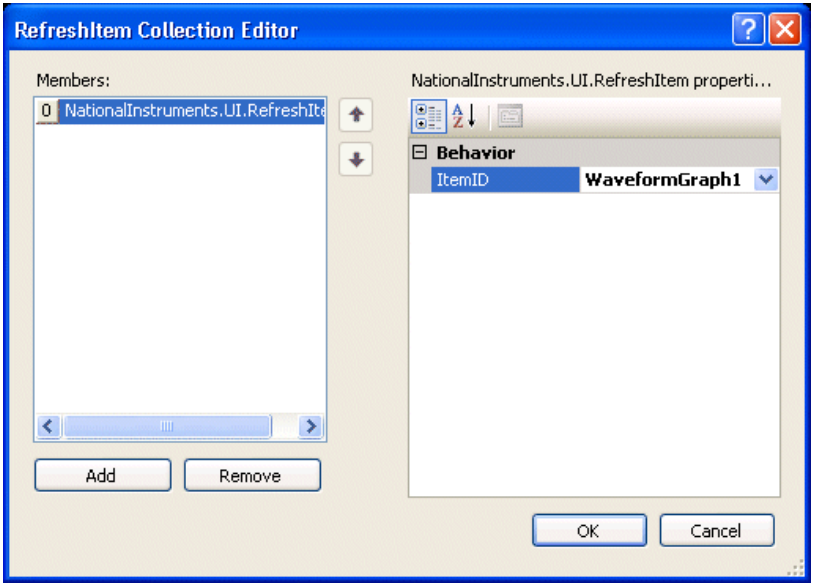

7. Click **OK** to return to the NetworkVariableBinding Collection Editor dialog box.
8. After you configure the binding properties, click **OK** to return to the ASP.NET Designer.

**Displaying the array of data on a Web page**

1. Select **WaveformGraph** in the Toolbox and drag and drop it on the form.
2. Select **AutoRefresh** in the Toolbox and drag and drop it on the form.
3. In the AutoRefresh smart tag, check **Enabled**. Select **Edit Default Refresh Items** to launch the RefreshItem Collection Editor dialog box.




4. Select **Add**. Select **WaveformGraph1** for the ItemID and click **OK**.




5. Double-click the AutoRefresh control. Add the following code to the AutoRefresh event handler to bind the waveform graph control to the network variable data source control:

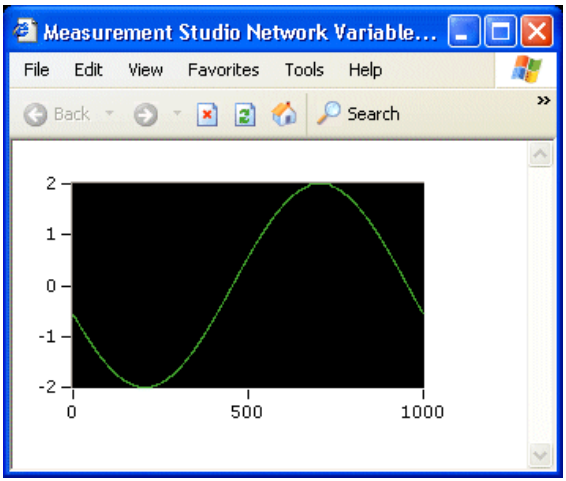
[VB.NET]

```
WaveformGraph1.BindingData =
NetworkVariableDataSource1.Bindings(0).GetValue()
```

[C#]

```
WaveformGraph1.BindingData =
NetworkVariableDataSource1.Bindings[0].GetValue();
```

6. Select **File»Save Default.aspx** to save your application.
7. Select **Debug»Start Without Debugging** to run the application. The waveform graph displays the array of data.


Measurement Studio Network Variable...
File
Edit
View
Favorites
Tools
Help
Back
Search
2
1
0
-1
-2
0
500
1000

# A

# Contacting Measurement Computing Corp.

You can reach Measurement Computing Corp. through the following ways:

**Mail**
Measurement Computing Corp.
16 Commerce Blvd.
Middleboro, MA 02346

**Telephone**
508-946-5100

**FAX**
508-946-9500

**Technical Support**
techsupport@MeasurementComputing.com

**Sales**
sales@measurementcomputing.com

**Other correspondence**
info@measurementcomputing.com

Visit our Web site at www.measurementcomputing.com.

# Glossary

## A

| | |
|---|---|
| analog I/O | Reading or writing data in continuously variable physical quantities, such as voltage or current. |
| annotate | Adding text, arrows, or shapes to describe or highlight a point or region on a graph. |
| API | Application Programming Interface. A specification of software functions and their input and return parameters. |
| array control | An array of Measurement Studio user interface controls that behave as a single unit. |
| assembly | A collection of one or more files that are versioned and deployed as a unit. An assembly is the primary building block of a .NET Framework application. All managed types and resources are contained within an assembly and are marked either as accessible only within the assembly or as accessible from code in other assemblies. |
| asynchronous | Function that begins an operation and returns control to the program prior to the completion or termination of the operation. |

## B

| | |
|---|---|
| button | A control used to input or display Boolean information or to initiate an action in a program. |

## C

| | |
|---|---|
| chart | To append new data points to the end of an existing plot over time. |
| client callback | In Web Forms, page calls back to the server without fully posting back. Callbacks are asynchronous and are accomplished with XML-HTTP. Client callbacks do not include postback data, and they do not force the page to refresh. Client callbacks do require a browser that supports the XML-HTTP protocol. |

| | |
|---|---|
| coercion | Automatic conversion that Measurement Studio controls perform to change the numeric representation of a data element. |
| complex graph | A control that displays a `ComplexDouble` data type; the `ComplexDouble` data type represents a complex number of type `Double` that is composed of a real part and an imaginary part. |
| context-sensitive help | Help for dialog boxes, the controls in dialog boxes, and keywords in source code that you can access with the key or a Help button, or by clicking the link that appears in the Dynamic Help window in Visual Studio. |
| control | Object for entering, displaying, or manipulating data on a user interface. |
| counter/timer I/O | Reading or writing data based on high-precision timing through a counter or timer. By combining a counter with a highly accurate clock, you can create a wide variety of timing and counting applications, such as monitoring and analyzing digital waveforms and generating complex square waves. |
| cursor | Flashing rectangle that shows where you may enter text on the screen. If you have a mouse installed, there is a rectangular mouse cursor, or pointer. |
| cursor label | Text object used to display X and Y coordinates that a cursor crosshair points to on a graph. |

## D

| | |
|---|---|
| DAQ | Data acquisition. Process of acquiring data, typically from A/D or digital input plug-in boards. |
| DAQ device | A device that acquires or generates data and can contain multiple channels and conversion devices. DAQ devices include plug-in devices which connect to a computer USB port or PCI bus. |
| device | An instrument or controller you can access as a single entity that controls or monitors real-world I/O points. A device is often connected to a host computer through some type of communication network. |
| digital I/O | Reading or writing digital representations of data in discrete units (the binary digits 1 and 0). Digital information is either on or off. |
| digital waveform graph | A control that displays `DigitalWaveform` data on a Windows Forms or Web Forms user interface; the `DigitalWaveform` data type represents a set of digital states that are grouped by samples or signals. |

| | |
|---|---|
| distribution | Ability to install programs you develop with Measurement Studio to others working on different computers. |
| DLL | Dynamic Link Library. A library of functions that link to a program and load at run time rather than being compiled into the program. Loading libraries only when they are needed saves memory in software applications. |
| DMM | Digital Multimeter. A common measurement instrument that measures resistance, current, and voltage in a wide variety of applications. |
| downlevel browser | Previous generation Web browser with limited client interaction. *See also* uplevel browser. |
| driver | Software that controls a specific hardware device, such as a data acquisition board or GPIB interface board. *See also* instrument driver. |

## E

| | |
|---|---|
| Ethernet | Standard connection type for networks, where computers are connected by coaxial or twisted-pair cable. |
| event | Object-generated response to some action or change in state, such as a mouse click or a completed acquisition. The event calls an event procedure that processes the event. |
| executable | Program file with a `.exe` extension that you can run independently of the development environment in which it was created. |

## F

| | |
|---|---|
| form | Window or area on the screen on which you place controls and indicators to create the user interface for your program. |
| front panel | Interactive user interface of a virtual instrument. Modeled after the front panel of physical instruments, it is composed of switches, slides, meters, graphs, charts, gauges, LEDs, and other controls and indicators. |
| FTP | File Transfer Protocol. Protocol based on TCP/IP to exchange files between computers. |

## G

| | |
|---|---|
| gauge | A control used to input or display numerical data. |
| GPIB | General Purpose Interface Bus. The standard bus used for controlling electronic instruments with a computer. Also called IEEE 488 bus because it is defined by ANSI/IEEE Standards 488-1978, 488.1-1987, and 488.2-1987. |
| graph | A 2D or 3D display of one or more plots. |

## H

| | |
|---|---|
| HTTP | HyperText Transfer Protocol. Protocol based on TCP/IP, which is used to download Web pages from an HTTP server to a Web browser. |

## I

| | |
|---|---|
| IEEE 488 | Shortened notation for ANSI/IEEE Standards 488-1978, 488.1-1987, and 488.2-1987. *See also* GPIB. |
| indicator | A control in read-only mode. |
| installer | Software program that copies program, system, and other necessary files to computers. |
| instrument driver | Library of functions to control and use one specific physical instrument. Also a set of functions that adds specific functionality to an application. |
| interface | Connection between one or more of the following: hardware, software, and the user. For example, hardware interfaces connect two other pieces of hardware. |

## K

| | |
|---|---|
| knob | A control used to input or display numerical data. |

## L

| | |
|---|---|
| LED | Light-Emitting Diode. An indicator that emits a light when current passes through it. For example, an LED shows if your computer or printer is turned on. |
| legend | A control that displays symbols and descriptions for a specific set of elements of another object, such as the plots or cursors of a graph. |

## M

| | |
|---|---|
| matrix | A rectangular array of numbers or mathematical elements that represent the coefficients in a system of linear equations. |
| MB | Megabytes of memory. |
| MCC-488.2 | Driver-level software to control and communicate with Measurement Computing GPIB hardware. |
| Measurement Studio | National Instruments software that includes tools to build measurement applications in Visual Basic .NET and Visual C#. |
| meter | A control used to input or display numerical data. |
| method | Function that performs a specific action on or with an object. The operation of the method often depends on the values of the object properties. |

## N

| | |
|---|---|
| numeric edit | A control used to display and edit numeric values. |

## O

| | |
|---|---|
| oscilloscope | Measurement instrument widely used in high-speed testing applications, such as telecommunication physical layer testing, video testing, and high-speed digital design verification. |

# P

| | |
|---|---|
| PCI | Peripheral Component Interconnect. High-performance expansion bus architecture commonly found in PCs. |
| plot | 1. Trace (data line) on a graph representing the data in one row or column of an array.<br>2. To display a new set of data while deleting any previous data on the graph. |
| point | Structure that contains two 16-bit integers that represent horizontal and vertical coordinates. |
| postback | The process in which a Web page sends data back to the same page on the server. |
| property | Attribute that defines the appearance or state of an object. The property can be a specific value or another object with its own properties and methods. For example, a value property is the color (property) of a plot (object), while an object property is a specific Y axis (property) on a graph (object). The Y axis itself is another object with properties, such as minimum and maximum values. |
| property editor | A control used to configure properties for Windows Forms controls at run time. |
| property pages | Window or dialog box that displays current configuration information and allows users to modify the configuration. |

# R

| | |
|---|---|
| range | Region between the limits within which a quantity is measured, received, or transmitted. The range is expressed by stating the lower and upper range values. |

# S

| | |
|---|---|
| scalar | Number that a point on a scale can represent. The number is a single value as opposed to an array. |
| scale | Part of graph, chart, and some numeric controls and indicators that contains a series of marks or points at known intervals to denote units of measure. |

| | |
|---|---|
| scatter graph | A control that displays two-dimensional data on a Windows Forms or Web Forms user interface; displays a graph of X and Y data pairs. |
| scope | *See* oscilloscope. |
| serial | Standard serial bus on a computer used to communicate with instruments. Also known as RS-232. |
| slide | A control used to input or display numerical data. |
| slider | Moveable part of a slide control. |
| smart tag | A glyph attached to a Measurement Studio control or component that exposes commonly performed tasks. |
| switch | A control used to receive and control Boolean input in an application user interface. |
| synchronous | Property or operation that begins and returns control to the program only when the operation is complete. |

## T

| | |
|---|---|
| tank | A control used to input or display numerical data. |
| TCP/IP | Transmission Control Protocol/Internet Protocol. A standard format for transferring data in packets from one computer to another. The two parts of TCP/IP are TCP, which deals with the construction of data pockets, and IP, which routes them from computer to computer. |
| thermometer | A control used to input or display numerical data. |

## U

| | |
|---|---|
| UI | User Interface. |
| uplevel browser | Recent generation Web browser that supports rich client interaction and functionality. *See also* downlevel browser. |

## V

| | |
|---|---|
| vector | 1D array. |
| VXI | VME eXtension for Instrumentation. Instrumentation architecture and bus based on the VME standard. Used in high-end test applications. |

## W

| | |
|---|---|
| waveform graph | A control that displays two-dimensional data on a Windows Forms or Web Forms user interface; displays data that is uniformly spaced in one dimension. |

# Index

## M



## N



## O



## P



## S



## T



## U



## W