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User Manual

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May 1998 Edition
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About This Manual

The *BridgeVIEW User Manual* contains the information you need to get started with the BridgeVIEW software package. This manual explains the BridgeVIEW environment, tag configuration, human machine interfaces, alarms and events, and historical data logging and extraction. This manual also reviews the concepts of G programming.

Throughout both sections of this manual, there are activities that teach you what you need to know to build your own virtual instruments, and ultimately, your own SCADA system. This manual assumes that you know how to operate your computer and that you are familiar with its operating system.

Organization of This Manual

This manual is divided into two parts. Part I, *BridgeVIEW Concepts*, introduces you to the basic BridgeVIEW concepts, and includes Chapters 1 through 8. Part II, *G Tutorial*, describes the G programming language, and how it works within BridgeVIEW, and includes Chapters 9 through 15.

We encourage you to work through all the activities in this manual before you begin building your applications. You should save all of the VIs you create with the BridgeVIEW activities in the `BridgeVIEW\Activity` directory. To view the VI(s) for an activity that you have not completed yourself, see the `BridgeVIEW\Activity\Solutions` directory for the solutions to the activities from the *BridgeVIEW Concepts* section of this manual, and the `BridgeVIEW\Activity\Solution` directory for the solutions to the activities in the *G Tutorial* section of this manual.

BridgeVIEW Concepts

Part I, *BridgeVIEW Concepts*, contains the following chapters.

- Chapter 1, *Introduction*, describes the unique BridgeVIEW approach to Human Machine Interface (HMI) and Supervisory Control and Data Acquisition (SCADA). It also contains system configuration, installation instructions and basic information that explains how to start using BridgeVIEW to develop industrial automation applications.
- Chapter 2, *BridgeVIEW Environment*, describes the BridgeVIEW environment. It explains the basic concepts behind G, the

programming language upon which BridgeVIEW is built, the BridgeVIEW Engine Manager, system errors and events, the Tag Monitor utility, and the Tag Browser utility. This chapter also explains how to access online help for BridgeVIEW and provides an activity that illustrates how to examine the front panel and block diagram of a virtual instrument (VI).

- Chapter 3, *Tag Configuration*, explains tags, the Tag Configuration Editor, and how you edit tags within the BridgeVIEW system.
- Chapter 4, *Human Machine Interface*, explains what a Human Machine Interface (HMI) is and how you can monitor and control tags from your HMI.
- Chapter 5, *Alarms and Events*, introduces the basic concepts of alarms and events, and explains how to view, acknowledge, and configure them within the BridgeVIEW system.
- Chapter 6, *Historical Data Logging and Extraction*, explains the concept of a trend, how to log and extract historical data, and how to use the Historical Trend Viewer (HTV), a utility that displays historical data that has been logged to disk with BridgeVIEW.
- Chapter 7, *Advanced Application Topics*, explains the advanced topics you need to understand to make optimum use of BridgeVIEW for developing applications. The advanced topics covered in this chapter are the Panel G Wizard, BridgeVIEW System Control, Tag Attributes VIs, and BridgeVIEW Security.
- Chapter 8, *Servers*, explains how to use servers with BridgeVIEW. BridgeVIEW supports several types of servers including OPC Servers, DDE Servers, and IA Device Servers.

G Tutorial

Part II, *G Tutorial*, contains the following chapters.

- Chapter 9, *Creating VIs*, introduces the basic concepts of virtual instruments and provides activities that explain how to create the icon and connector, how to use a VI as a subVI, how to use the **VI Setup…** option, and how to use the **SubVI Node Setup…** option.
- Chapter 10, *Customizing VIs*, introduces the basic concepts used for customizing VIs.
- Chapter 11, *Loops and Charts*, introduces structures and explains the basic concepts of charts, the While Loop, and the For Loop.

- Chapter 12, *Case and Sequence Structures and the Formula Node*, introduces the basic concepts of Case and Sequence structures, and provides activities that explain how to use the Case structure, how to use the Sequence structure, and what sequence locals are and how to use them.
- Chapter 13, *Front Panel Object Attributes*, describes objects called attribute nodes, which are special block diagram nodes that control the appearance and functional characteristics of controls and indicators.
- Chapter 14, *Arrays, Clusters, and Graphs*, introduces the basic concepts of polymorphism, arrays, clusters, and graphs and provides activities that explain auto-indexing and the Graph and Analysis VIs.
- Chapter 15, *Application Control*, introduces the VI Server and provides an activity that explains how to use it within BridgeVIEW. The VI Server allows you to control when a VI is loaded into memory, run, and unloaded from memory.
- Chapter 16, *Program Design*, suggests some techniques to use when creating programs and offers programming style recommendations.

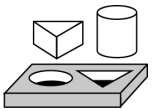
Appendices, Glossary, and Index

- Appendix A, *HMI Function Reference*, describes error handling for BridgeVIEW VIs and contains an explanation of the VIs in the BridgeVIEW VI library. In this appendix, the VIs are arranged alphabetically, first by VI Library name (Alarms and Events, Historical Data, System, Tags, and Tag Attributes), then by VI name.
- Appendix B, *Citadel and Open Database Connectivity*, describes the Citadel database and the Open Database Connectivity (ODBC) driver, and includes several examples of how to use it.
- Appendix C, *Customer Communication*, contains forms to help you gather the information necessary to help us solve your technical problems, and a form you can use to comment on the product documentation.
- The *Glossary* contains an alphabetical list of terms used in this manual, including abbreviations, acronyms, metric prefixes, mnemonics, and symbols.
- The *Index* contains an alphabetical list of key terms and topics in this manual, including the page where you can find each one.

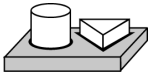
Conventions Used in This Manual

The following conventions are used in this manual:

bold	Bold text denotes a parameter, menu name, palette name, menu item, return value, function panel item, or dialog box button or option.
italic	Italic text denotes mathematical variables, emphasis, a cross reference, or an introduction to a key concept.
bold italic	Bold italic text denotes an activity objective, note, caution, or warning.
`monospace`	Text in this font denotes text or characters that you should literally enter from the keyboard. Sections of code, programming examples, and syntax examples also appear in this font. This font also is used for the proper names of disk drives, paths, directories, programs, subprograms, subroutines, device names, variables, filenames, and extensions, and for statements and comments taken from program code.
`monospace bold`	Bold text in this font denotes the messages and responses that the computer automatically prints to the screen. This font also emphasizes lines of code that are different from the other examples.
`monospace italic`	Italic text in this font denotes that you must enter the appropriate words or values in the place of these items.
<>	Angle brackets enclose the name of a key on the keyboard—for example, <PageDown>.
-	A hyphen between two or more key names enclosed in angle brackets denotes that you should simultaneously press the named keys—for example, <Control-Alt-Delete>.
<Control>	Key names are capitalized.
»	The » symbol leads you through nested menu items and dialog box options to a final action. The sequence **File»Page Setup»Options»Substitute Fonts** directs you to pull down the **File** menu, select the **Page Setup** item, select **Options**, and finally select the **Substitute Fonts** option from the last dialog box.
paths	Paths in this manual are denoted with backslashes (\) to separate drive names, directories, and files, as in `C:\dir1name\dir2name\filename`.



This icon to the left of bold text denotes the beginning of an activity, which contains step-by-step instructions you can follow to learn more about BridgeVIEW.



This icon to the left of bold text denotes the end of an activity, which contains step-by-step instructions you can follow to learn more about BridgeVIEW.

This icon to the left of bold italicized text denotes a note, which alerts you to important information.

Abbreviations, acronyms, metric prefixes, mnemonics, symbols, and terms are listed in the *Glossary*.

Related Documentation

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

- *G Programming Reference Manual*
- BridgeVIEW *Online Reference*, available online by selecting **Help»Online Reference**

Customer Communication

National Instruments wants to receive your comments on our products and manuals. We are interested in the applications you develop with our products, and we want to help if you have problems with them. To make it easy for you to contact us, this manual contains comment and configuration forms for you to complete. These forms are in Appendix C, *Customer Communication*, at the end of this manual.

Part I

BridgeVIEW Concepts

This section contains information about the BridgeVIEW environment, tag configuration, Human Machine Interface, alarms and events, historical data logging and extraction, servers, and advanced application topics such as system control and security.

Part I, *BridgeVIEW Concepts*, contains the following chapters.

- Chapter 1, *Introduction*, describes the unique BridgeVIEW approach to Human Machine Interface (HMI) and Supervisory Control and Data Acquisition (SCADA). It also contains system configuration, installation instructions and basic information that explains how to usestart using BridgeVIEW to develop industrial automation applications.
- Chapter 2, *BridgeVIEW Environment*, describes the BridgeVIEW environment. It explains the basic concepts behind G, the programming language upon which BridgeVIEW is built, the BridgeVIEW Engine Manager, system errors and events, the Tag Monitor utility, and the Tag Browser utility. This chapter also explains how to access online help for BridgeVIEW and provides an activity that illustrates how to examine the front panel and block diagram of a virtual instrument (VI).
- Chapter 3, *Tag Configuration*, explains tags, the Tag Configuration Editor, and how you edit tags within the BridgeVIEW system. Before you can run a BridgeVIEW application, you must specify a tag configuration.
- Chapter 4, *Human Machine Interface*, explains what a Human Machine Interface (HMI) is and how you can monitor and control tags from your HMI.
- Chapter 5, *Alarms and Events*, introduces the basic concepts of alarms and events, and explains how to view, acknowledge, and configure them within the BridgeVIEW system.

- Chapter 6, *Historical Data Logging and Extraction*, explains the concept of a trend, how to log and extract historical data, and how to use the Historical Trend Viewer (HTV), a utility that displays historical data that has been logged to disk with BridgeVIEW.
- Chapter 7, Advanced Application Topics, explains BridgeVIEW Environment Securitythe advanced topics you need to understand to make optimum use of BridgeVIEW for developing applications. The advanced topics covered in this chapter are the Panel G Wizard, BridgeVIEW System Control, Tag Attributes VIs, and BridgeVIEW Security.
- Chapter 8, *Servers*, explains how to use servers with BridgeVIEW. BridgeVIEW supports several types of servers including OPC Servers, DDE Servers, and IA Device Servers.

1

Introduction

This chapter describes the unique BridgeVIEW approach to *Human Machine Interface (HMI)* and Supervisory Control and Data Acquisition (SCADA). It also contains system configuration, installation instructions, and basic information that explains how to start using BridgeVIEW to develop industrial automation applications. This chapter refers you to other chapters or manuals for more information.

Welcome to BridgeVIEW

BridgeVIEW adds real-time process monitoring, historical trending, alarm and event reporting, online configuration tools and PLC connectivity to a premiere graphical development environment, G.

BridgeVIEW makes use of an intuitive graphical user interface combined with a powerful graphical programming language, G, that enables you to perform data acquisition and analysis, create an operator interface or Human Machine Interface (HMI), and develop advanced supervisory control applications.

BridgeVIEW provides the following features for the development of your Industrial Automation applications.

- Graphical human-machine interface (HMI)
- Easy-to-use, fill in the blank configuration utilities
- Graphical programming tools
- Real-Time Database (RTDB)
- Historical data collection and trending (Citadel)
- Alarm and event reporting and logging
- Security
- Connectivity to PLC and industrial device networks
- OPC Server Support

Required System Configuration

BridgeVIEW is distributed on a CD-ROM that includes the complete BridgeVIEW 2.0 release.

The Windows 95/NT version of BridgeVIEW runs on any system that supports Windows 95 or Windows NT 4.0. A minimum of 24 MB of RAM is required for this version to run effectively. We recommend 32 MB of RAM and at least 30 MB of swap space available on your system.

☞ **Note** ***The standard BridgeVIEW installation requires approximately 110 MB of disk space. A full installation requires approximately 150 MB. If you plan to install the NI-DAQ Server as well, an additional 30 MB of disk space is required.***

Installation

Complete the following steps to install BridgeVIEW.

1. Insert the CD in your CD-ROM drive.
2. Run the BridgeVIEW installer.
   a. If you have Windows 95 or Windows NT 4.0 and your system uses the AutoPlay feature, the Welcome to BridgeVIEW screen appears a short time after you insert the CD.
   b. If you have a system not using AutoPlay, run the following program:
   `X:\bvsetup.exe`
   where *X* is the letter of your CD-ROM drive.
3. Choose an installation. The installer offers several installation types: Standard, Full, Minimum, and Custom. The Standard installation requires approximately 110 MB. The Full installation, which also includes Data Acquisition, GPIB, and VISA libraries and examples, requires approximately 150 MB of disk space. The Standard installation is recommended.
4. After selecting an installation, follow the instructions that appear on your screen.

☞ **Note** ***If you plan to use National Instruments Data Acquisition (DAQ) devices, VISA, or GPIB instrumentation, you can perform either the Full installation, which installs all necessary drivers and example programs, or the Custom installation, in which you select the items to install.***

After you have installed BridgeVIEW completely, it is ready to run. You might need to re-boot your machine after installation so that updated system, DAQ, VISA, or GPIB drivers can be loaded properly.

What Is BridgeVIEW?

BridgeVIEW is a software package specifically targeted at industrial automation applications. BridgeVIEW provides configurable solutions for common HMI and SCADA functions while leveraging the flexibility of graphical programming. BridgeVIEW is built around the G programming language, created by National Instruments Corporation.

With BridgeVIEW, you can acquire data and control one or more distributed devices in an overall facility. BridgeVIEW can change set points or send control instructions to the individual devices while monitoring the entire system. It also can gather information like alarms and measurement points from these devices.

Common devices used for data acquisition include Programmable Logic Controllers (PLCs), plug-in Data Acquisition boards, and other distributed Input/Output (I/O) modules. BridgeVIEW device servers communicate with these non-plug-in devices through RS-232, RS-485, TCP/IP, DDE, netDDE, direct I/O, or other proprietary interfaces. BridgeVIEW device servers provide the necessary protocol software to communicate with these devices. BridgeVIEW also operates directly with OPC servers.

How Does BridgeVIEW Work?

BridgeVIEW uses a combination of tags, events, and data. A *tag* is a connection to a real-world I/O point, while an *event* is anything that happens to a tag or to the BridgeVIEW Engine in general. The BridgeVIEW Engine communicates with device servers on one end, and with your HMI application at the other end. The BridgeVIEW Engine maintains a Real-Time Database (RTDB) of tag information and logs historical data and events. You can build your HMI to interface with the BridgeVIEW Engine using *virtual instruments (VIs)* to read and write tag values, view alarm information and trend data. A virtual instrument is a BridgeVIEW function, written in the graphical programming language G. For more information about G, see any of the chapters in the *G Tutorial* section of this manual.

Start by configuring all the tags in your system with the Tag Configuration Editor. Then, you can launch the BridgeVIEW Engine, which reads your configuration file and starts monitoring tags, logging data and events. You can create your HMI application to display tag values, trends, and alarms. You also can acknowledge alarms and control output tags. You can build the HMI using BridgeVIEW VIs to read and write tag values, view alarm

information, acknowledge alarms, view real-time trends and retrieve historical data. For more information about how to get started with BridgeVIEW, see the *Where Should I Start?* section at the end of this chapter.

G Programming

G is the easy-to-use graphical data flow programming language BridgeVIEW is based upon. G simplifies scientific computation, process monitoring and control, test and measurement, and a wide variety of other applications.

G was first introduced by National Instruments as the programming language behind LabVIEW, the program development application used commonly for test and measurement purposes. BridgeVIEW has taken all the functionality of G and enhanced it for your industrial automation needs.

The *G Tutorial* section of this manual covers the functionality of G that you need to get started with most BridgeVIEW applications. For a more extensive explanation of BridgeVIEW functionality, see the *G Programming Reference Manual*.

The basic concepts of G that are covered in this manual are as follows:

- VIs—Virtual instruments (VIs) have three main parts: the front panel, the block diagram, and the icon/connector. The front panel specifies the user interface of the VI. The block diagram consists of the executable code that you create using nodes, terminals, and wires. With the icon/connector, you can use a VI as a subVI in the block diagram of another VI. For more information about VIs, refer to Chapter 9, *Creating VIs*, and Chapter 10, *Customizing VIs*.
- Loops and Charts—G has two structures to repeat execution of a sub-diagram—the *While Loop* and the *For Loop*. Both structures are resizable boxes. You place the subdiagram to be repeated inside the border of the loop structure. The While Loop executes as long as the value at the conditional terminal is TRUE. The For Loop executes a set number of times. Charts are used to display real-time trend information to the operator. For more information about loops and charts, refer to Chapter 11, *Loops and Charts*.
- Case and Sequence Structures—The *Case structure* is a conditional branching control structure, which executes a subdiagram based on certain input. *sequence structure* is a program control structure that executes its subdiagrams in numeric order. For more information about Case or Sequence structures, refer to Chapter 12, *Case and Sequence Structures and the Formula Node*.

- Attribute Nodes—*Attribute nodes* are special block diagram nodes that you can use to control the appearance and functional characteristics of controls and indicators. For more information about attribute nodes, refer to Chapter 13, *Front Panel Object Attributes*.
- Arrays, Clusters and Graphs—An *array* is a resizable collection of data elements of the same type. A *cluster* is a statically sized collection of data elements of the same or different types. Graphs commonly are used to display data. For more information about arrays, clusters, and graphs, refer to Chapter 14, *Arrays, Clusters, and Graphs*.
- VI Server—The VI Server allows you to control when a VI is loaded into memory, run, and unloaded from memory. For more information about VI Control VIs, refer to Chapter 15, *Application Control*.

Tag Configuration

A tag value is acquired and/or controlled by a device server that communicates with the BridgeVIEW Engine and can be read or set by a VI in your HMI application. Tags can be of the following types: input, output, Input/Output, or memory. You can configure tags through the Tag Configuration Editor. A tag configuration consists of its data type, connection, scaling, operations, and alarms settings. For more information about this topic, refer to Chapter 3, *Tag Configuration*.

Data Type

A tag *data type* can be analog, discrete, bit array, or string. Analog tags have continuous values with a specified range (such as 0.0 to 100.0). Discrete tags have values that are either ON (1) or OFF (0). Bit array tags are comprised of up to 32 bits, each of which can have an ON (1) or OFF (0) state. String tags consist of ASCII characters or binary data and can be of any length.

General

General includes the following tag attributes:

- Tag name
- Tag description
- Tag group
- Length (for bit array and string tags)

Connection

Connection includes the following tag attributes:

- Access rights (input only, output only, Input/Output, or memory)
- Server name
- I/O group name
- Item name
- Access path (for OPC servers)

Scaling

Scaling controls the type of scaling to perform on a tag when communicating with a device server, and the expected engineering range and units for the tag.

Operations

You can specify how the BridgeVIEW Engine updates the *Real-Time Database (RTDB),* when it logs the tag data to disk, if it logs events associated with the tag, and what value exists in the database at startup. The *operations* that can be performed on a tag are as follows:

- Updating the Real-Time Database
- Historical logging
- Event logging
- Event printing

Alarms

An *alarm* is an abnormal process condition. For example, an analog tag can be configured to be in a HI alarm state when its value is greater than 25. You can set alarm limits for a tag in the Tag Configuration Editor. Each alarm limit has a priority associated with it to determine the severity of the alarm.

Events

An event is something that happens within the BridgeVIEW system. Events can be divided into two groups: those that pertain to individual tags and those that pertain to the overall BridgeVIEW system. Events pertaining to tags include the following:

- A tag going in or out of alarm
- An operator changing the value of a tag
- An operator acknowledging an alarm

Events pertaining to the system include the following:

- The launching or shutting down of the Engine
- A new operator logging on
- An error from a server

The Engine also maintains alarm summary and event history information pertaining to tags. This information can be viewed by the user's HMI and/or be logged to disk.

Historical Data Logging and Extraction

You can extract data from the historical database to view the trend of tag data over time. The BridgeVIEW Engine manages logging data to the Citadel Historical Database. A *trend* is a view of data over time. Trends can be real-time (current data) or historical (logged data). You can view logged data with a user interface (HMI) or with the Historical Trend Viewer (HTV). For more information about historical data logging and extraction or the Citadel Historical Database, see Chapter 6, *Historical Data Logging and Extraction*, or Appendix B, *Citadel and Open Database Connectivity*.

Security

Environment security is built into BridgeVIEW and determines access to certain parts of the BridgeVIEW environment. BridgeVIEW security is broken into two general categories:

- BridgeVIEW Environment Access Privileges
- Operator Interface Security

What Is the BridgeVIEW System Architecture?

The BridgeVIEW system contains three sets of processes: the user HMI Application, the BridgeVIEW Engine, and industrial automation device servers, as shown in Figure 1-1. These processes interact through a client-server relationship.

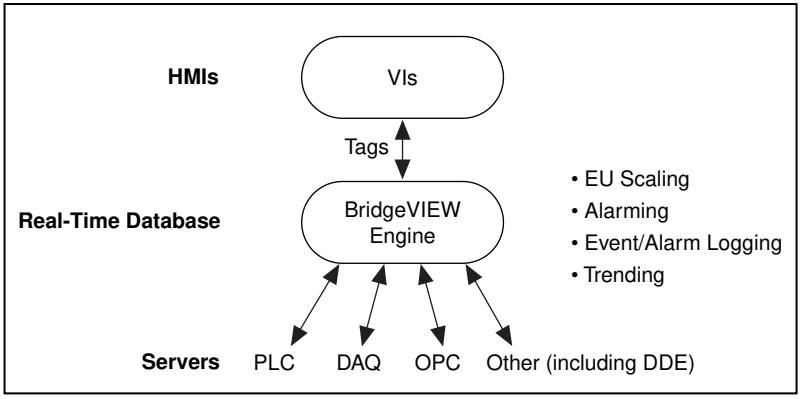


Figure 1-1. BridgeVIEW Architecture

The BridgeVIEW Engine, with any device servers, runs as a separate process independent of your HMI application. Your HMI application is built as a collection of VIs developed using the G programming language.

BridgeVIEW maintains a high performance Real-Time Database in the BridgeVIEW Engine that provides information to client applications. The BridgeVIEW Engine also performs other functions including the following:

- Data acquisition, engineering unit (EU) scaling, and alarm processing
- Alarm and event logging
- Historical data collection and trending

EU scaling converts the Raw Range value from the device server to the engineering value used in the user application and vice versa.

User HMI Application

The end user of the BridgeVIEW system sees and interacts with an HMI. The HMI application is a collection of VIs that you build with the G programming language in BridgeVIEW. You build VIs that interact

with the BridgeVIEW Engine to read and write tag values, acknowledge alarms, access historical data, and read and write tag attributes.

BridgeVIEW makes development of operator graphic displays easy and fast. Floating palettes provide controls and functions necessary to develop effective HMI and SCADA applications. The Controls palette provides a number of predefined objects, selected from the automation symbol library, for building your HMI. The Functions palette provides a set of functions and VIs you can use for I/O, analysis, historical data, and networking.

BridgeVIEW Engine

The *BridgeVIEW Engine* is the heart of the BridgeVIEW System. It runs as a separate process, independent of your HMI application. This minimizes interference between the Engine and your HMI. The BridgeVIEW Engine maintains the Real-Time Database of all tag values and alarm states. It reads values from the various device servers. These values are scaled and compared with their alarm limits. If a tag is in an alarm state, the Engine generates appropriate events and logs them to disk.

The Real-Time Database (RTDB) is an in-memory snapshot of the state of all tags in the system. If a tag value changes more than its update deadband, or its alarm state changes, the RTDB is updated. Along with tag values, the RTDB also stores status, date, time, and alarm information.

Device Servers

A *device server* is the application that communicates with the I/O devices such as PLCs and plug-in cards. Several National Instruments device servers are written to a National Instruments standard client/server Application Programming Interface (API) for the BridgeVIEW Engine. BridgeVIEW also communicates with OPC and DDE Servers. There are different servers for different device manufacturers and communication networks.

The device servers that support the BridgeVIEW Engine are stand-alone programs launched by the BridgeVIEW Engine, and thereafter run in the background, reading selected input items and writing them on demand. Each server either is configured by BridgeVIEW when tags are created, or has a specific configuration utility that determines communication parameters, I/O poll rates, and device addresses. A server completes operation only when the BridgeVIEW Engine shuts down.

Input items are polled by servers at a rate determined by the BridgeVIEW I/O group configuration. For each input item, the device server passes

the value, the timestamp of when the item was sampled, and status information to the BridgeVIEW Engine. Output items are written on demand only when the BridgeVIEW Engine passes a new output value to the server.

The device server monitors the items and encapsulates all device and hardware-specific details, thereby providing a hardware- and software-independent layer to the user HMI and SCADA application. For more information about device servers, see Chapter 8, *Servers*.

Where Should I Start?

The following table lists what is included in the different installation types.

Installation Type	Includes
Minimum	Tag Configuration Editor, basic security tools, core VI libraries
Standard	Tag Configuration Editor, all security tools, Historical Trend Viewer, Tag Browser, Tag Monitor, core VI libraries, advanced analysis libraries, online help, activities, and graphics files
Full	Tag Configuration Editor, all security tools, Historical Trend Viewer, Tag Browser, Tag Monitor, core VI libraries, advanced analysis libraries, online help, activities, graphics files, Instrument Wizard, DAQ, GPIB, and VISA libraries
Custom	Select which utilities and libraries to install.

We recommend that you work through the activities in this manual. These activities comprehensively illustrate how BridgeVIEW works. If you are new to the G programming language, begin with the activities in Chapters 9 through 16, and then continue with those in Chapters 2 through 8. If you are an experienced G programmer, begin with Chapter 2 and continue through the entire manual so that you might learn the important BridgeVIEW concepts, and review any G programming techniques that you might be familiar with already.

Save all of the VIs you create with the BridgeVIEW activities in the `BridgeVIEW\Activity` directory. There is also a Solution directory

(`BridgeVIEW\Activity\Solutions`) that contains the completed VIs for each activity in this manual. You can view the VI for an activity that you have not completed yet, or use the VIs in this directory as a means of verifying your work.

Another good place to start is the `Examples` directory. Use the VI called `readme.vi`, at the top level of this directory, to browse through the available examples.

If you are going to use device servers, including OPC servers, read Chapter 8, *Servers*, which contains important information about servers, including what you need to develop your own device servers.

2

BridgeVIEW Environment

This chapter describes the BridgeVIEW environment. It explains the basic concepts behind G, the programming language upon which BridgeVIEW is built, the BridgeVIEW Engine Manager, system errors and events, the Tag Monitor utility, and the Tag Browser utility. This chapter also explains how to access online help for BridgeVIEW and provides an activity that illustrates how to examine the front panel and block diagram of a virtual instrument (VI).

What Is G?

G is a programming language, much like various commercial C or BASIC development languages. However, G is different from those applications in one important respect. Other programming languages are text-based languages that create lines of code, while G is a graphical programming language that creates programs in block diagram form.

You can use G with little programming experience. G engineers and programmers rely on graphical symbols and *data flow* rather than textual language to describe programming actions. Data flow is a programming system in which nodes execute when they have received all required input data, and produce output automatically when they have executed.

G has extensive libraries of functions and subroutines for most programming tasks. BridgeVIEW includes conventional program development tools for G, so you can set breakpoints, animate program execution to see how data passes through the program, and single-step through the diagram to make debugging and program development easier.

How Does G Work?

G includes libraries of functions and development tools designed specifically for HMI development, data acquisition, and instrument control. G programs are called *virtual instruments (VIs)* because their appearance and operation imitate actual instruments. However, they are analogous to functions in conventional programming languages.

Virtual Instruments

VIs have both an interactive user interface and a source code equivalent, and accept parameters from higher-level VIs. VIs have three main parts:

- The front panel
- The block diagram
- The icon/connector

With these features, G promotes and adheres to the concept of modular programming. You divide an application into a series of tasks, which you can divide again until a complicated application becomes a series of simple subtasks. You build a VI to accomplish each subtask and then combine those VIs on another block diagram to accomplish the larger task. Finally, your top-level VI contains a collection of subVIs that represent application functions.

Because you can execute each subVI by itself, apart from the rest of the application, debugging is much easier. Furthermore, many low-level subVIs often perform tasks common to several applications, so you can develop a specialized set of subVIs and reuse them in different applications.

For more information about VIs, see Chapter 9, *Creating VIs*, and Chapter 10, *Customizing VIs*, in this manual, or refer to the *G Programming Reference Manual*.

Front Panel

VIs contain an interactive user interface, which is called the *front panel*, because it simulates the panel of a physical device. The front panel can contain knobs, push buttons, graphs, and other controls and indicators. You input data using a keyboard, mouse, touch screen, or other device and then view the results on the computer screen.

The front panel contains a toolbar of command buttons and status indicators that you use for running and debugging VIs. It also contains font options and alignment and distribution options for editing VIs. Pictures of the front panel toolbar, and its buttons, are shown below.

Run button—Runs the VI.

Continuous Run button—Runs the VI over and over; useful for debugging.

Stop button—Aborts VI execution.

Pause/Continue button—Pauses VI execution/Continues VI execution.

Font ring—Sets font options, including font type, size, style, and color.

Alignment ring—Sets alignment options, including vertical, top edge, left, and so on, for two or more objects.

Distribution ring—Sets distribution options, including gaps, compression, and so on, for two or more objects.

Reorder ring—Allows you to restack overlapping objects by moving a selected object above or below the others.

Block Diagram

VIs are executed from a *block diagram*, which you construct in G. The block diagram supplies a pictorial solution to a programming problem. The block diagram contains the source code for the VI.

The block diagram toolbar contains additional options that are not included on the front panel toolbar. Use these additional options for debugging VIs. The block diagram toolbar is shown below.

Highlight Execution button—Displays data as it passes through wires.

Step Into button—Steps into loops, subVIs, and so on.

Step Over button—Begins single stepping, steps over a loop, subVI, and so on.

Step Out button—Completes execution of loops, VIs, block diagrams, and so on.

Icon/Connector

VIs use a hierarchical and modular structure. You can use them as top-level programs, or as subprograms within other programs. A VI within another VI is called a subVI. The *icon/connector* pane of a VI works like a graphical parameter list so that other VIs can pass data to it as a subVI.

Tools Palette

BridgeVIEW has a floating **Tools** palette, which you can use to edit and debug VIs. You use the <Tab> key to tab through the commonly used tools on the palette. If you have closed the **Tools** palette, select **Windows»Show Tools Palette** to display the palette. A shortcut for bringing up the **Tools** palette is to right click while pressing the <Shift> key. The following illustration shows the **Tools** palette.

Operating tool—Places **Controls** and **Functions** palette items on the front panel and block diagram.

Positioning tool—Positions, resizes, and selects objects.

Labeling tool—Edits text and creates free labels.

Wiring tool—Wires objects together in the block diagram.

Object pop-up menu tool—Brings up a pop-up menu for an object.

Scroll tool—Scrolls through the window without using the scrollbars.

Breakpoint tool—Sets breakpoints on VIs, functions, loops, sequences, and cases.

Probe tool—Creates probes on wires.

Color Copy tool—Copies colors for pasting with the Color tool.

Color tool—Sets foreground and background colors.

Note ***You can pop up on an object by clicking on it with the right mouse button.***

Controls Palette

The **Controls** palette consists of a graphical, floating palette that opens when you launch BridgeVIEW. You use this palette to place controls and indicators on the front panel of a VI. Each top-level icon contains subpalettes. If the **Controls** palette is not visible, you can open it by selecting **Windows»Show Controls Palette** from the front panel menu. You also can right-click, or *pop up*, on an open area in the front panel to access a temporary copy of the **Controls** palette. The **Controls** palette is available only when the front panel is the active window. The following illustration displays the top-level of the **Controls** palette.

Functions Palette

The **Functions** palette consists of a graphical, floating palette that opens automatically when you switch to the block diagram. You use this palette to place nodes (constants, indicators, VIs, and so on) on the block diagram of a VI. Each top-level icon contains subpalettes.

If the **Functions** palette is not visible, you can select **Windows»Show Functions Palette** from the block diagram menu to display it. You can also pop up on an open area in the block diagram to access the **Functions** palette. The **Functions** palette is available only when the block diagram is the active window. The following illustration displays the top-level of the **Functions** palette.

Controls and Indicators

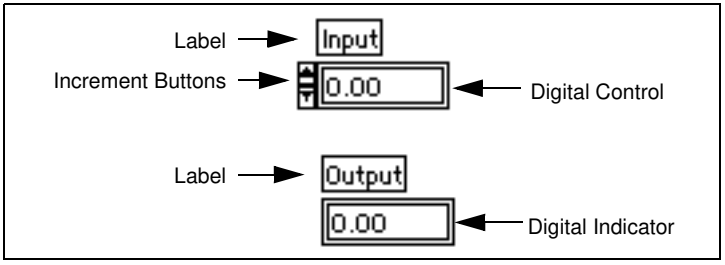
Controls and *indicators* in G are similar to input and output parameters or graphs in traditional programming languages. BridgeVIEW contains a variety of controls and indicators that you can choose according to the kind of values or quantities you want to evaluate or display.

You can configure all the controls and indicators using options from their pop-up menus. Popping up on individual components of controls and indicators displays menus for customizing those components. To access the pop-up menu, right-click on any object that has a pop-up menu.

The primary data types you use in BridgeVIEW applications—numeric, Boolean, string, and tag, are described in the following sections.

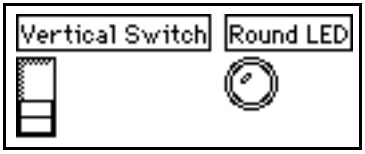
Numeric

You use numeric controls to enter numeric quantities, while numeric indicators display numeric quantities. The two most commonly used numeric objects are the digital control and the digital indicator, shown below. You can find these controls and indicators in the **Numeric** subpalette of the **Controls** palette.



Boolean

You use Boolean controls and indicators for entering and displaying Boolean (TRUE/FALSE) values. Boolean objects simulate switches, buttons, and LEDs. The most commonly used Boolean objects are the vertical switch and the round LED, shown below, found in the **Boolean** subpalette.

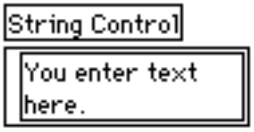


String

You use string controls and indicators for entering and displaying ASCII characters. You can use strings for simple text messages displayed to the user and for character streams sent to serial devices, instruments, or files.

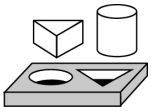
You can find the string control and indicator in **Controls»String Table Tags**. You can enter or change text inside a string control using the Operating tool or the Labeling tool. Enlarge string controls and indicators by dragging a corner with the Positioning tool.

If you want to minimize space that a front panel string control or indicator occupies, select **Show»Scrollbar**. If this option is dimmed, you must increase the vertical size of the window to make it available.



Tag

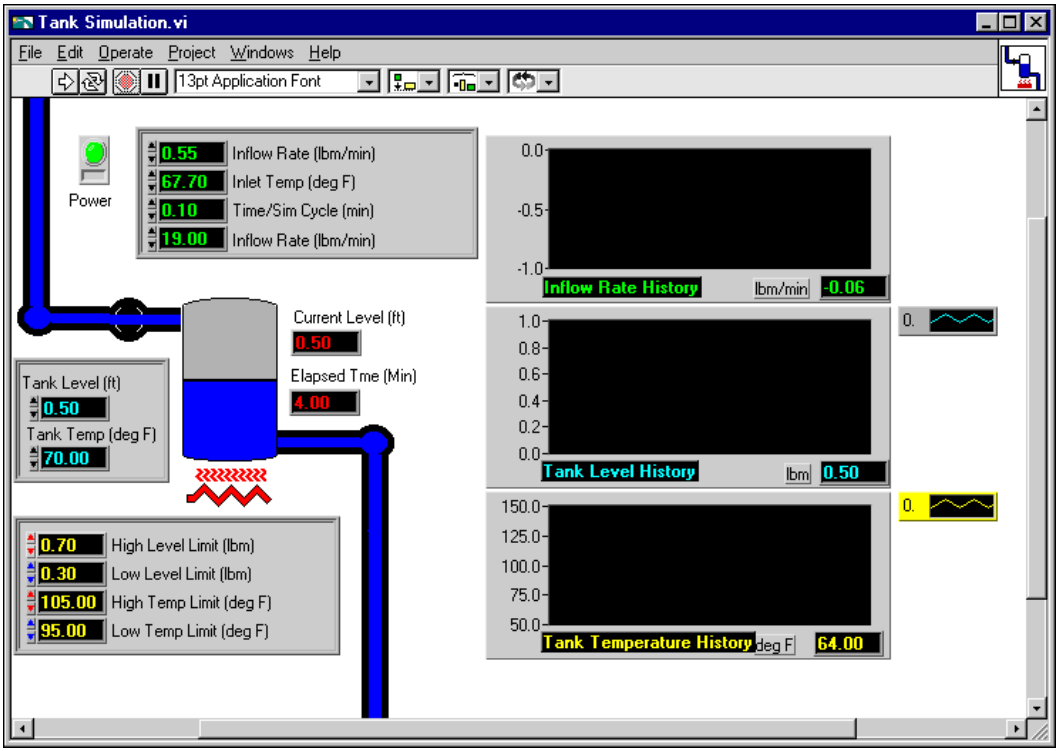
You use tag controls and indicators for entering and displaying tag names or group names contained in the loaded tag configuration (`.scf`) file. You can find tag controls and indicators in **Controls»String Table Tags**. For more information about the tag data type, see the section *Tag Data Type*, in Chapter 4, *Human Machine Interface*.



Activity 2-1. Open and Run a VI

Your objective is to familiarize yourself with the basic concepts of virtual instruments. You will open, examine, and operate the front panel and block diagram of a VI.

1. Select **File»Open**, and open `Tank Simulation.vi` from the `BridgeVIEW\Examples\G Examples\Apps\tankmntr.llb`. The front panel appears as shown in the following illustration.

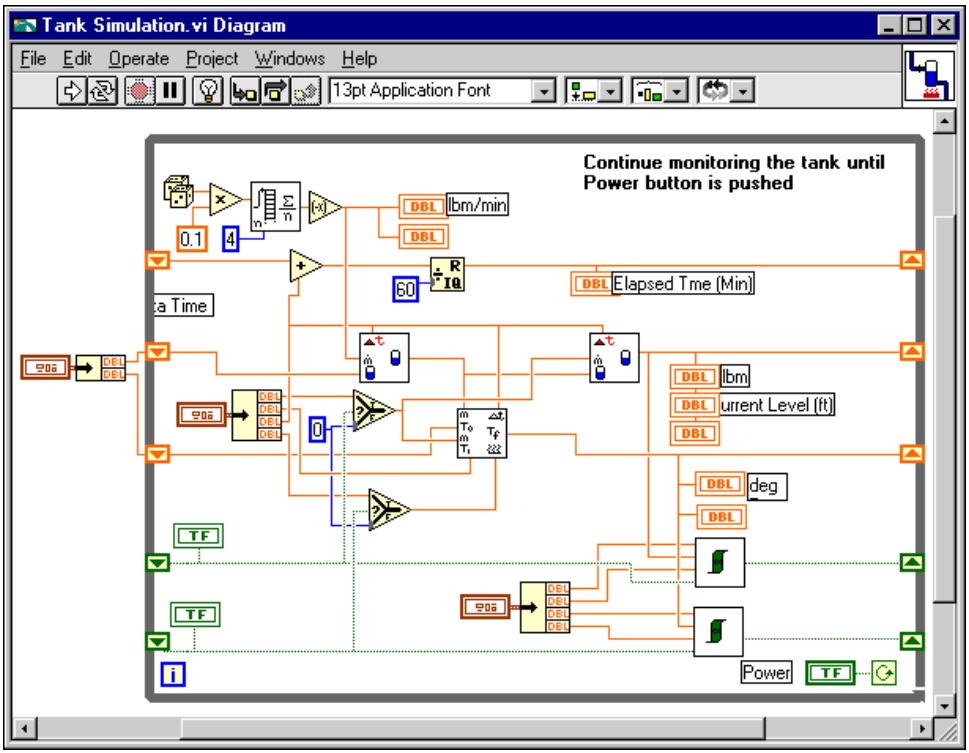


2. Run the VI by clicking on the **Run** button in the toolbar. The button changes appearance to indicate that the VI is running.

3. Use the Operating tool to change the values of the Inflow Rates and other controls. First, highlight the old value, either by double-clicking on the value you want to change, or by clicking and dragging across the value with the Labeling tool. When the initial value is highlighted, type a new value and press <Enter>. You also can click on the **Enter** button in the toolbar, or click the mouse in an open area of the window to enter the new value.

4. Stop the VI by clicking on the **Stop** button.
5. Open the block diagram of the Tank Simulator VI by choosing **Windows»Show Diagram**.

The following illustration shows the block diagram.



6. Examine the different objects in the block diagram.

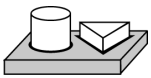
   Every front panel in BridgeVIEW has an accompanying block diagram, which is the VI equivalent of a program. Think of the block

diagram as source code. The components of the block diagram represent program nodes such as For Loops, Case structures, and multiplication functions. The components are wired together to show the flow of data within the block diagram.

The outermost structure in this diagram is the While Loop. It continues to run until the power switch is turned off. The objects inside the loop include functions and subVIs that generate simulated data that is displayed on the historical trends and other objects on the front panel.

At this point, you do not need to understand all of the structures and objects completely. Chapters 9 through 16 of this manual describe in greater detail each element that appears in a VI.

7. Close the VI.



End of Activity 2-1.

BridgeVIEW Environment Project Menu

The BridgeVIEW system is comprised of the G programming language and a collection of software tools designed specifically for industrial automation applications. You can access these tools through the **Project** menu in your BridgeVIEW system. Table 2-1 provides a brief description of the items in the **Project** menu.

Table 2-1. BridgeVIEW Project Menu Items

Project Menu Item	Description
Configure BridgeVIEW Startup	Opens a utility you can use to configure BridgeVIEW to start particular VIs whenever you start BridgeVIEW.
Historical Trend Viewer	Launches the Historical Trend Viewer (HTV). You can use the HTV to view historical data logged in the Citadel Historical Database. For more information about the HTV, see Chapter 6, *Historical Data Logging and Extraction*.

Table 2-1. BridgeVIEW Project Menu Items (Continued)

Project Menu Item	Description
Launch Engine	Launches the BridgeVIEW Engine. The BridgeVIEW Engine manages the Real-Time Database, communicates with device servers, and performs alarm management and historical data logging. The BridgeVIEW Engine runs according to a configuration file called a `.scf` (SCADA Configuration File) file. You can create and edit `.scf` files using the Tag Configuration Editor. For more information about the BridgeVIEW Engine, see the section *What Is the BridgeVIEW Engine Manager?* in this chapter.
Security»Access Levels	Opens a utility you can use to add, remove, and modify access levels in your BridgeVIEW system. If user accounts are defined in your system, you must have Administration privileges to edit the list of access levels. For more information about security and access levels, see Chapter 7, *Advanced Application Topics*.
Security»Change Password	Opens a dialog box to change the current user password. You must be logged in to change your password. For more information about security and passwords, see Chapter 7, *Advanced Application Topics*.
Security»Edit User Accounts	Opens a utility you can use to create and edit user accounts in your BridgeVIEW system. If user accounts are defined in your system, you must have Administration privileges to create and edit user accounts. For more information about security and user accounts, see Chapter 7, *Advanced Application Topics*.
Security»Login	Opens a dialog box you can use to log in to the system. For more information about security, see Chapter 7, *Advanced Application Topics*.
Security»Logout	Opens a dialog box you can use to log out of the system. For more information about security, see Chapter 7, *Advanced Application Topics*.
Security»Privileges	Opens a utility you can use to view your access privileges. For more information about security and access levels, see Chapter 7, *Advanced Application Topics*.
Server Tools»Server Browser	Launches the Server Browser. You can use the Server Browser to view information about the BridgeVIEW device servers. For more information about the Server Browser, see Chapter 8, *Servers*.

Table 2-1. BridgeVIEW Project Menu Items (Continued)

Project Menu Item	Description
Tag»Browser	Launches the Tag Browser. You can use the Tag Browser to view information on all of the tags in the currently-loaded `.scf` file. If the BridgeVIEW Engine is not running, you can use the Tag Browser to load a different `.scf` file. For more information about the Tag Browser, see the section *What Is the Tag Browser?* in this chapter.
Tag»Configuration	Launches the Tag Configuration Editor. You can use the Tag Configuration Editor to define all of the tags in your BridgeVIEW system. Also, you can configure other Engine parameters in the Tag Configuration Editor. For more information about the Tag Configuration Editor, see Chapter 3, *Tag Configuration*.
Tag»Monitor	Launches the Tag Monitor. You can use the Tag Monitor to monitor the value, alarm state, and status of all tags in the system, as well as write the value to an output or input/output tag. The Tag Monitor launches the BridgeVIEW Engine if it is not already running. For more information on the Tag Monitor, see the *What Is the Tag Monitor?* section in this chapter.

What Is the BridgeVIEW Engine Manager?

When you run any G application that accesses the BridgeVIEW Real-Time Database, the BridgeVIEW Engine launches automatically, opening either the configuration (`.scf`) file you edited most recently or the one your application selects programmatically.

Launching the BridgeVIEW Engine brings up the Engine Manager display, shown in Figure 2-1. The Engine Manager is a window into the BridgeVIEW Engine, through which you can control some of the behavior of the BridgeVIEW Engine.

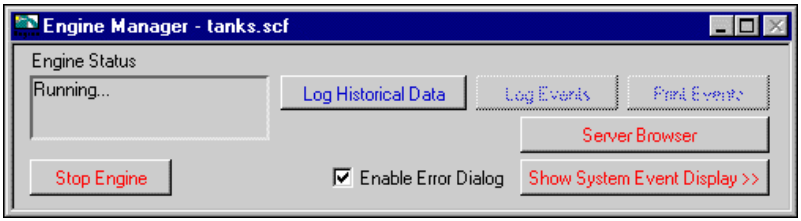


Figure 2-1. Engine Manager Display

Table 2-2 provides a description of each of the fields in the Engine Manager dialog box. This table provides basic information about the Engine Manager dialog box options. For a more complete understanding of how or why you might use the Engine Manager in a BridgeVIEW application, you must understand how to configure tags. See Chapter 3, *Tag Configuration*.

Table 2-2. Engine Manager Field Descriptions

Field	Description
Engine Status	Displays the current status of the BridgeVIEW Engine—whether launching, running, or stopped.
Log Historical Data	Turns on or off logging of historical data to file. This button is pressed automatically if you selected **Start logging on system start-up** in your configuration file. If you do not have a valid event log path configured, or do not have a printer configured, this checkbox is disabled.
Log Events	Turns on or off logging of alarms and events to file. This button is pressed automatically if you selected **Start event logging on system start-up** in your configuration file. If you do not have a valid event log path configured, this checkbox is disabled.
Print Events	Turns on or off printing of alarms and events to your line printer. This button is pressed automatically if you selected **Start printing on system start-up** in your configuration file. If you do not have a printer configured, this checkbox is disabled.
Run/Stop Engine	Starts the BridgeVIEW Engine, or stops the BridgeVIEW Engine and shuts down any loaded servers.
Quit Engine	Closes and exits the BridgeVIEW Engine process.
Enable Error Dialog	Enables or disables the showing of the Error dialog box. If this box is checked, a System Error Display dialog box pops up for you to acknowledge the event when a system error occurs.
Server Browser	Launches the Server Browser Utility. With this utility, you can see the servers in your system, including OPC servers; view server information; and display the server front panel if the server is running (VI-based servers only).
Show/Hide System Event Display	Shows or hides the System Event Display.

The Engine Manager shows the current state of the Engine, and has a System Event Display that shows the following:

- BridgeVIEW System Events
- When the Engine started and stopped
- Which servers have been launched
- Any System Errors that have occurred

This information is written to the current BridgeVIEW System Log File, found in the `BridgeVIEW\Syslog` folder. Figure 2-2 shows how the Engine Manager Display looks when the **Show System Events Display** button is enabled.

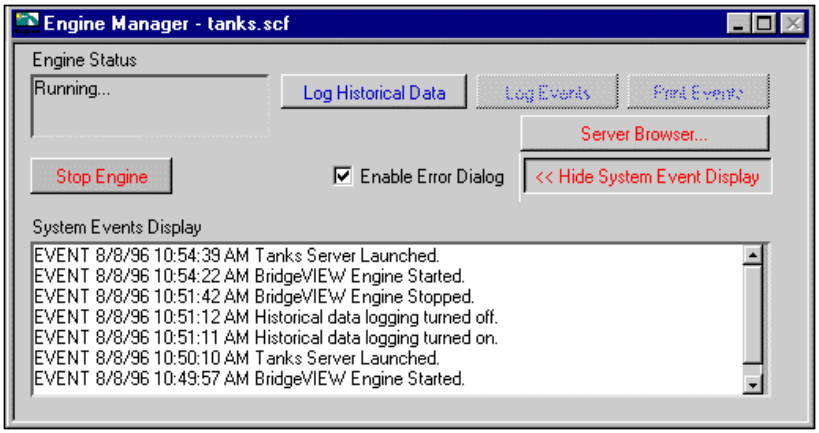


Figure 2-2. Engine Manager with System Events Displayed

Once the BridgeVIEW Engine is launched and running, the Engine Manager is minimized and appears in your Windows taskbar. Click on the BridgeVIEW Engine icon in your taskbar to bring up the Engine Manager display.

You can leave the BridgeVIEW Engine Manager display minimized unless you want to start or stop the Engine, or start or stop historical logging, event logging and printing, view system events, or view server information.

From the Engine Manager, you can reach the Server Browser utility, shown in Figure 2-4, by pressing the **Server Browser…** button. With this utility, you can see the servers in your system, view server information, and display the server front panel if the server is running (VI-based servers only).

The Server Browser is shown in the following illustration. For more information about device servers, see Chapter 8, *Servers*.

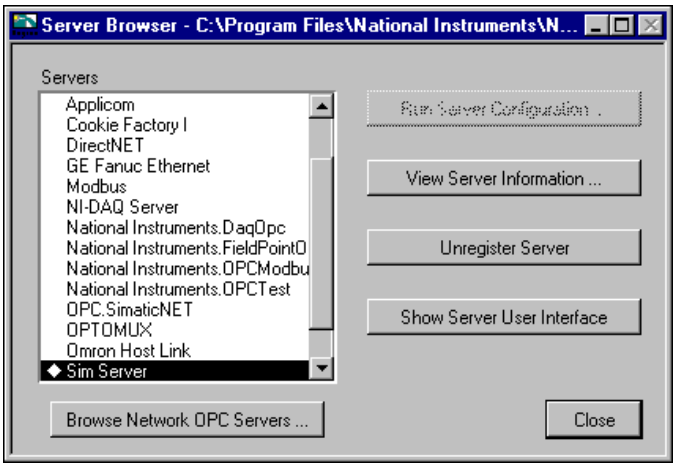


Figure 2-3. Server Browser

The **Show Server User Interface** button appears on the Server Browser dialog box only when you invoke the Server Browser from the Engine Manager.

If your application does not shut down within a few seconds after you close the BridgeVIEW Engine Manager, BridgeVIEW displays a dialog box notifying you to shut down your HMI application. You can ensure your application shuts down when the Engine shuts down by monitoring the **shutdown** output of any Tags or Alarms VI or the Engine Status VI in your diagram. This technique is explained in Chapter 4, *Human Machine Interface*.

What Are System Errors and Events?

System errors are conditions on a system level (as opposed to a per tag basis) that result in problematic functioning of the BridgeVIEW system. When a system error occurs, BridgeVIEW prompts the user with a dialog box. You can turn this dialog box on or off.

System events are changes in the system that cause a change in behavior that is not problematic. These include events reported by utilities such as the Tag Configuration Editor.

Detailed system error and event messages are logged to a system log file. The messages are written to an ASCII file with a `.log` extension in the `SYSLOG` directory. BridgeVIEW automatically creates this directory, if it does not exist already. The system log file names take the format, `YYMMDDHHMM.log` where `YY` = year, `MM` = month, `DD` = day, `HH` = hour, and `MM` = minute.

What Is the Tag Browser?

With the Tag Browser utility, shown in Figure 2-4, you can view the general configuration of all configured tags in the system. Launch the Tag Browser by selecting **Project»Tag»Browser**.

A list of all the configured tags appears in the listbox. Select a tag by clicking on it, and the configuration for that tag displays on the right. For more detailed tag configuration information or to learn how to edit a tag configuration, see Chapter 3, *Tag Configuration*.

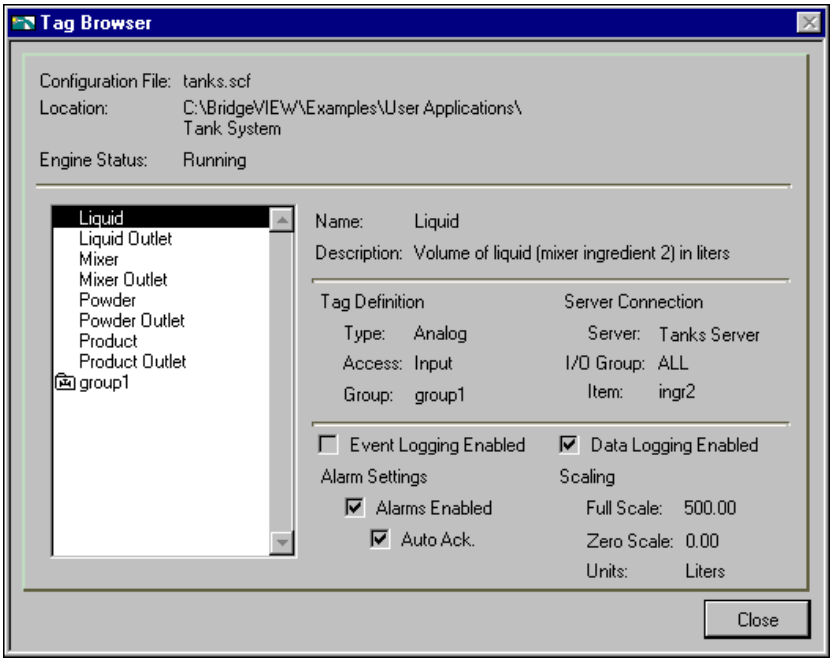


Figure 2-4. Tag Browser Utility

Table 2-4 describes each of the fields in the Tag Browser Utility dialog box.

Table 2-3. Tag Browser Field Descriptions

Field	Description
Configuration File	Displays the name of the configuration file you are browsing.
Browse	If the BridgeVIEW Engine is not running, press this button to select a different configuration file.
Location	Displays the full path of the directory containing the configuration file you are browsing.
Engine Status	Displays the current state of the BridgeVIEW Engine, whether it is loaded, running or stopped.
Configured Tags	Displays the list of all tags currently configured. Click on a tag to display the tag configuration on the right.
Edit	Edits the selected tag in the Tag Configuration Editor.
Name	Displays the name of the currently selected tag. Use this display to select and copy the tag name and paste it into your HMI diagram.
Description	Displays the description field for the currently selected tag.
Type	Displays the type of the currently selected tag: analog, discrete bit array, or string.
Access	Displays the access rights for the currently selected tag: Memory, Input, Output, or Input/Output.
Group	Displays the group to which the selected tag belongs. If this field is blank, the tag does not belong to a group.
Server	Displays the name of the server connected to the currently selected tag. If the tag is a memory tag, no server is associated with it.
I/O Group	Displays the name of the I/O group for the currently selected tag. If the tag is a memory tag, no server or I/O group is associated with it.
Item	Displays the name of the item connected to the selected tag. If the tag is a memory tag, no server, I/O group, or item is associated with it.
Alarms Enabled	Displays whether alarms are enabled for the selected tag.
Auto Ack	Displays whether alarms for the selected tag are acknowledged automatically.
Full Scale	Displays the full scale engineering value for the tag. This is displayed for analog tags only.

Table 2-3. Tag Browser Field Descriptions (Continued)

Field	Description
Zero Scale	Displays the zero scale engineering value for the tag. This is displayed for analog tags only.
Units	Displays the engineering unit for the tag. This is displayed for analog tags only.

If the BridgeVIEW Engine is loaded, you can view the tags currently loaded with the Tag Browser. If the BridgeVIEW Engine is not loaded, the Tag Browser displays the currently loaded `.scf` file. Use the **Browse…** button to change the `.scf` file.

The Tag Browser is a useful tool if you need to look at how a tag is configured while you are building your MMI VIs. You also can use the Tag Browser to change the loaded configuration file.

If you want to access the configuration information for a tag programmatically, you can use the VIs in the **Tag Attributes** palette. For more information about the Tag Attributes VIs, refer to Appendix A, *HMI Function Reference*.

What Is the Tag Monitor?

With the Tag Monitor, you can monitor the value, unit, timestamp, alarm state, and status for selected tags in the system, as well as write the value to an output or input/output tag. You launch the Tag Monitor by selecting **Project»Tag»Monitor**. When you first launch the Tag Monitor, a tag selection dialog box displays all the tags configured in the currently selected tag configuration file. For more information about configuring tags, refer to Chapter 3, *Tag Configuration*.

Figure 2-5 shows the Tag Monitor.

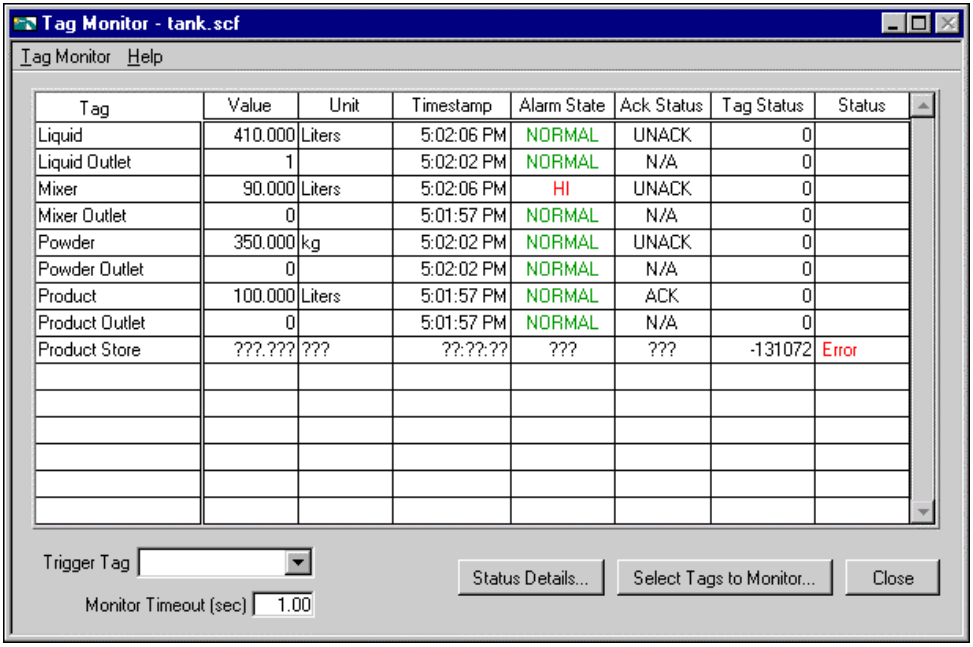


Figure 2-5. Tag Monitor Utility

Note ***Selecting the Tag Monitor from the* Project *menu automatically launches the BridgeVIEW Engine if it is not running already.***

Tag information is shown in a table format, sorted by tag name. When a tag has a non-zero tag status, the Status column indicates if the tag status is `Warning` or `Error`.

Table 2-4 describes the fields and captions in the Tag Monitor Utility.

Table 2-4. Tag Monitor Utility Field Descriptions

Field	Descriptions
Tag Display Table	Alphabetically lists the information for tags you have selected, including the value, units, timestamp, status, alarm state and error, if any. For writable tags, which have a yellow background, clicking on the tag's value field brings up the **Write to Tag** dialog box, that lets you specify a new value for that tag. For bit array tags, the radix of the input value must be the same as that of the tag's value field in the Tag Display Table. Click **OK** to write the value in **Value to Input** and exit the dialog box. Click **Apply** to write the value in **Value to Input** and keep the dialog box open.
Trigger Tag	Displays which tag, if any, you have selected to trigger refreshing of the Tag Display Table. If you selected a tag to trigger refreshing of the Tag Display Table, the display refreshes when that tag changes value in the database, or the monitor timeout period is exceeded, whichever occurs first.
Monitor Timeout (sec)	Displays the time interval in seconds that the Tag Display Table is configured to refresh or update. If no trigger tag is selected, the display updates at this time interval. Otherwise, the Tag Display Table refreshes when the tag changes or the timeout interval is exceeded, whichever occurs first.
Status Details	Brings up the **Status Details** dialog box, shown in Figure 2-6, that displays a summary of the status for each tag in the system.
Select Tags to Monitor	Brings up the **Select Tags to Monitor** dialog box, shown in Figure 2-7, that lets you select which tags to monitor and configure how often to refresh the monitor display.

The **Status Details** dialog box, shown in Figure 2-6, displays a summary of the status for each tag in the system. Tags that have a warning are highlighted in blue, and tags in error are red. BridgeVIEW provides a description of the error or warning when possible. Internal codes are reported by BridgeVIEW; the Server Code is returned by the server of the tag. Clicking on **Status Details** is equivalent to selecting **Tag Monitor»Status Details…**.

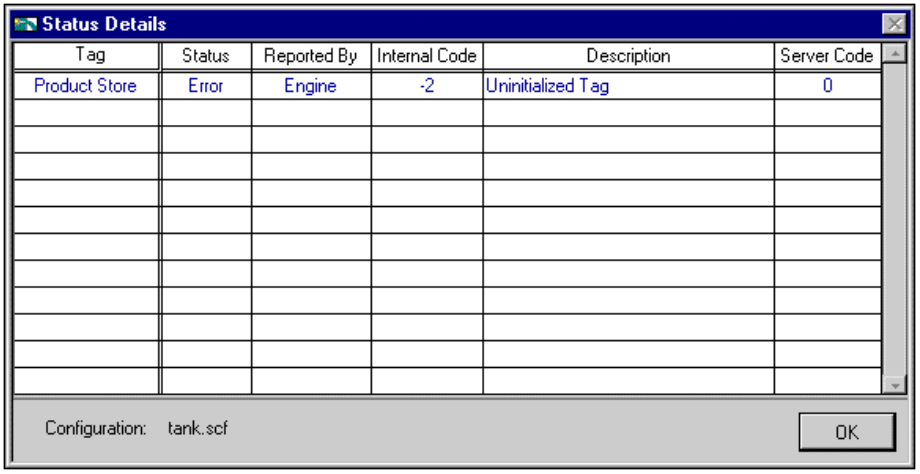


Figure 2-6. Status Details Dialog Box

With the **Select Tags to Monitor** dialog box, shown in Figure 2-7, you can select which tags to monitor and configure how often to refresh the monitor display. The Available Tags list box shows the tags not displayed in the Tag Display Table. By default, the timeout is set to 1.00 second. This controls how often the Tag Display Table is refreshed. By default, no tag is selected to trigger a refresh of the Tag Display Table. You can select a tag to trigger a refresh of the Tag Display Table from the Trigger Tag Ring. Then, the Tag Display Table refreshes each time that tag is updated in the database, or when the timeout interval elapses, whichever occurs first. Clicking on **Select Tags to Monitor** is equal to selecting **Tag Monitor»Select Tags…**.

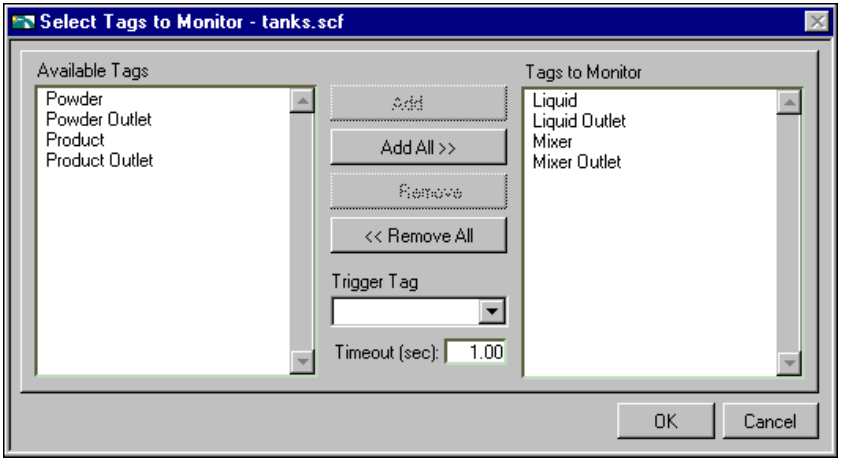


Figure 2-7. Select Tags to Monitor Dialog Box

Select **Tag Monitor»Preferences** to bring up the **Tag Monitor Preferences** dialog box, shown in Figure 2-8, which lets you choose how certain types of tags are displayed. You can control how the displayed precision for analog tags by modifying the Digits of Precision field. For bit array tags, the values can be in binary, octal, or hexadecimal format. The possible values for discrete tags can be 0 and 1 corresponding to Numeric Value; or a set of user-customizable strings, one equivalent to TRUE and the other to FALSE. Check the **Monitor Same Tags in Next Session** check box to keep the same tag list for the next time you launch the Tag Monitor.

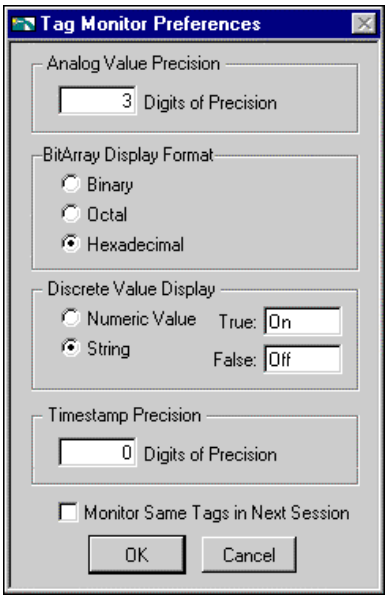
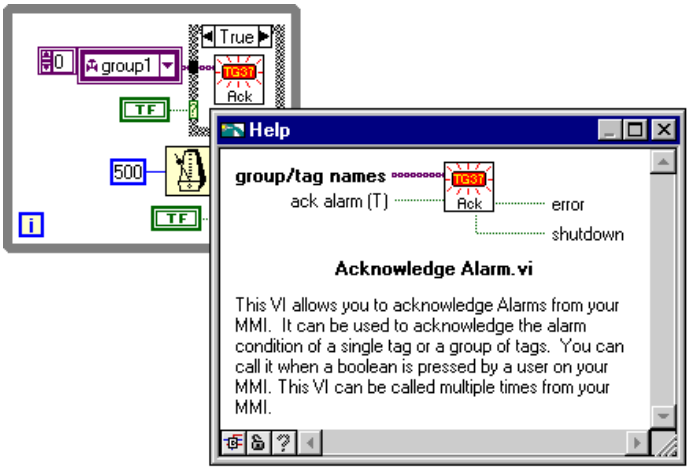


Figure 2-8. Tag Monitor Preferences Dialog Box

How Do You Access Online Help?

Choose **Help»Show Help**. When you place one of the tools on a subVI node, the **Help** window shows the icon for the subVI with wires attached to each terminal. The following illustration shows an example of online help. This is the Acknowledge Alarm VI from the **Functions»Alarms & Events** subpalette.



Simple/Complex Help View

In the **Help** window, you can specify whether you want to display the simple or complex view for block diagram objects.

☞ **Note** ***When you open the* Help *window, BridgeVIEW automatically defaults to the simple help view.***

In simple help view, BridgeVIEW displays only the required and recommended inputs for VIs and functions. In complex help view, BridgeVIEW displays the required, recommended, and optional inputs for VIs and functions. It also displays the full path name of a VI. To access the simple help view, press the Simple/Complex Diagram Help switch or choose **Help»Simple Help**.

In the **Help** window, required inputs appear in bold text, recommended inputs appear in plain text, and optional inputs appear in gray text. When designing your own VIs, you can specify which inputs are required, recommended, or optional by popping up on an input or output on the connector pane and selecting the correct option from the **This Connection Is** submenu.

Links to Online Help Files

In the **Help** Window, you can click on the **Online Help** button to access BridgeVIEW online help as well as help files you have created using a help compiler. For more information on creating help files, see the section *Creating Your Own Help Files*, in Chapter 5, *Printing and Documenting VIs in G*, in the *G Programming Reference Manual*.

3

Tag Configuration

This chapter describes tags, the Tag Configuration Editor, how you edit tags within the BridgeVIEW system, and includes an activity that illustrates how to use the Tag Configuration Editor. Before you can run a BridgeVIEW application, you must specify a tag configuration.

What Is a Tag?

A *tag* is a data value in the BridgeVIEW Engine. Tags can be used to monitor an I/O point, to store a result of a calculation based on other tags, or to monitor a tag on another BridgeVIEW Engine. A *memory tag* is a tag used for user-specified calculations, and a *network tag* is a tag remotely connected to any type of tag on another BridgeVIEW Engine.

This section defines a tag in terms of its attributes and describes how tag attributes affect Engine operations. You can define and configure tags with the Tag Configuration Editor, described later in this chapter.

Tag Attributes

The BridgeVIEW Engine manages the Real-Time Database (RTDB) which contains information about all the tags in the system. The Engine handles the following tasks:

- Communicates with device servers or other BridgeVIEW Engines
- Scales tag values
- Tracks alarms and events associated with tags, system errors and events
- Logs tag values, alarms, events and system messages to disk

You can customize these tasks by configuring each tag with the Tag Configuration Editor. The Tag Configuration Editor displays five categories of attributes for each tag: general information, connection, operations, scaling, and alarms.

Operations, scaling, and alarms attributes describe how the Engine handles a tag's data. Each attribute can be further classified by the effect on a running Engine from changing the attribute.

General Attributes

General attributes include data type, maximum length for string and bit array tags, and the name, description, and tag group of the tag. The BridgeVIEW system supports four types of tags: analog, discrete, string, and bit array. These types differ by the inclusion of attributes within the operations, scaling, and alarm categories. The tag type is fixed when it is created. You must use the tag name to identify a particular tag. For information on how to configure the general attribute of a tag, see the *General* section later in this chapter.

Connection Attributes

I/O connection attributes describe where the Engine sends or receives values for the tag and how to access that data. These tags have access rights of input, output or input/output. To configure the I/O connection attributes of a tag, refer to the *Connection* section later in this chapter.

Memory tags are not connected to a real world I/O point. Memory tags provide more complex monitoring, alarming, or control. For more information about memory tags, see the *What Is a Memory Tag?* section later in this chapter.

Operation Attributes

Operation attributes describe additional functionality that the Engine performs on a tag or its values. These operations include tasks such as setting initial values and enabling logging operations. To configure the operation attributes of a tag, refer to the *Operations* section later in this chapter.

Scaling Attributes

Scaling attributes describe what linear scaling function is applied to a tag's value. Scaling is useful for converting the range of values from measured units into a calculated range. Only analog (numeric) and Bit Array tags have Scaling attributes. To configure scaling attributes of a tag, see the *Scaling* section later in this chapter.

Alarm Attributes

Alarm attributes describe abnormal process conditions for a given tag. Alarms are useful for notifying users of abnormal conditions. For example, if an analog tag measures the volume of a tank, a HI alarm can be used to indicate that the tank is full and an operator must perform some action and acknowledge this state before processing can proceed. For information on how to configure alarming attributes of a tag, see the *Alarms* section later in this chapter.

Static vs. Dynamic Attributes

Tag attributes are classified as either static or dynamic attributes. *Static attributes* require you to restart the Engine when you change them from the Tag Configuration Editor. A static attribute change is marked with a solid diamond in the Tag Configuration Editor. Examples of static attributes are general attributes and I/O connection attributes, such as server, device, or item.

Dynamic attributes do not require the Engine to restart. The Tag Configuration Editor can change a dynamic tag attribute in a running Engine. A dynamic attribute change is marked with a hollow diamond in the Tag Configuration Editor. Examples of dynamic attributes include enabling logging operations, alarm attributes, and some scaling attributes. For more information about dynamic tag attributes, see the *Tag Attributes VIs* section of Chapter 7, *Advanced Application Topics*.

What Is the Tag Configuration Editor?

The Tag Configuration Editor is a tool that assists you in configuring all the parameters of the BridgeVIEW Engine. The chief component of this tool is the configuration of all tags in the system. Other configuration components include Alarm and Event Logging, and Historical Logging.

To start the Tag Configuration Editor, select **Project»Tag» Configuration…** from the menu bar of an open VI. Figure 3-1 shows the Tag Configuration Editor with `tanks.scf` loaded.

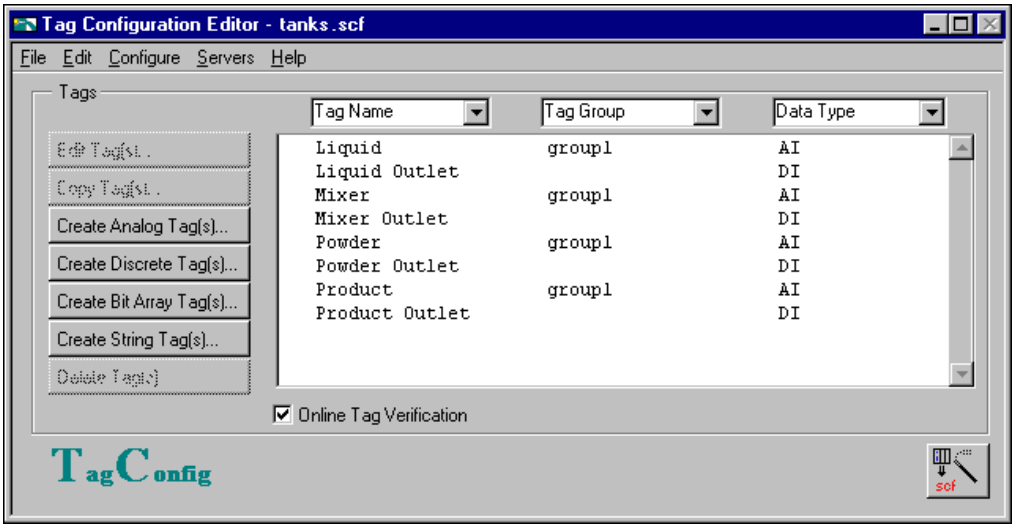


Figure 3-1. Tag Configuration Editor

The Tag Configuration Editor records all tag information and Engine parameters and stores this information in a BridgeVIEW Configuration File with the extension `.scf` (SCADA Configuration File). The BridgeVIEW Engine reads this file to determine all of the configuration parameters for execution. With the Tag Configuration Editor, you can specify the following:

- Tags used in the system
- File paths for historical data and event logging

The `.scf` file does not contain any information about the VIs in your HMI. In fact, it is not specific to a single user application. Multiple user applications can run concurrently as long as they use the same set of tags. When you launch the Tag Configuration Editor, the last opened `.scf` file opens automatically.

☞ **Note** ***Only one*** `.scf` ***file can be loaded and running in the BridgeVIEW Engine at a time.***

If you edit a `.scf` file while the Engine is running and select **Save** or **Save As…**, a dialog box confirms if you want to update the Engine with your latest changes. If you want to update the Engine and any static attributes have been changed, the Engine shuts down and restarts. If you have changed only dynamic attributes in the `.scf` file, the Engine is updated without restarting.

Note ***Communication between the BridgeVIEW Engine and any device server is stopped temporarily when the Engine shuts down and restarts.***

How Do You Create a Tag?

From the main panel of the Tag Configuration Editor, press one of the following buttons: **Create Analog Tag(s)…**, **Create Discrete Tag(s)…**, **Create String Tag(s)…**, or **Create Bit Array Tag(s)…**. A separate window prompts you to define a new tag. The tag name must be unique within a given configuration (`.scf`) file. Select **OK** on the pop-up window when you finish creating the new tag, or **Create New Tag** to finish creating the new tag and create another tag of the same type. Any changes are not written to disk until you select **Save** from the **File** menu. For step by step instructions on using the Tag Configuration Editor to create a tag, see Activity 3-1, later in this chapter.

How Do You Edit a Tag?

From the main panel of the Tag Configuration Editor, select one or more tags from the tags listed and press the **Edit Tag(s)...** button. A separate window displays the attributes for the tags you select, which you can then edit. When you finish editing a tag, select **OK** to save your changes and return to the main panel, **Edit Next Tag** to save your changes and go on to the next tag, or **Cancel** to discard your changes and return to the main panel. Selecting **Cancel** only cancels the changes made to the current tags. Any changes you make are not permanent until you save the configuration file.

You also can use a spreadsheet to edit multiple tags. Use **File»Export…** to export the tag information to a spreadsheet file, edit the fields, and then use **File»Import…** to import the tag configuration information from the edited spreadsheet file. For more information, see the section *How Do You Use Spreadsheet Files for Tag Configuration?* in this chapter.

How Do You Delete a Tag?

To delete a tag from a configuration, select the tag(s) from the main panel of the Tag Configuration Editor and press the **Delete Tag(s)** button, and then save the SCF. Tags that will be deleted when you save the SCF are marked with a trashcan symbol. The **Delete Tag(s)** button also serves as an **Undelete Tag(s)** button if all selected tags have a trash can symbol. If you decide you want to keep one or more deleted tags, select those tags and press the **Undelete Tag(s)** button.

Note ***If you delete a tag and save the .scf file, the tag and its configuration information are removed from the .scf file. You still can retrieve historical and event information about the tag, but information such as the tag description, units, range, and alarm settings is lost.***

What are Network Tags?

BridgeVIEW makes it easy to create distributed applications so more than one computer can be involved in an HMI application.

A *BridgeVIEW server* is a computer that allows tags configured in the current .scf file to be accessed by other machines connected to the server via a network. The server machine may or may not have an HMI running on it. In order for a machine to function as a BridgeVIEW server, the Engine must use an .scf file that has the **Allow Network Access** option enabled.

A *BridgeVIEW client* is a computer that gets its data through tags from one or more BridgeVIEW servers. Tags remotely accessed from BridgeVIEW servers are *network tags*. An .scf file for a BridgeVIEW client can have network tags from multiple BridgeVIEW servers. However, a BridgeVIEW client .scf can import network tags from only one .scf file per server machine.

A BridgeVIEW server can also act as a client and get its data from other BridgeVIEW server machines, as shown in the illustration below.

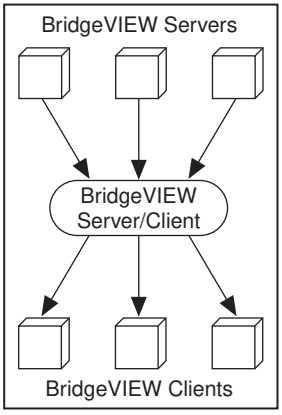


Figure 3-2. Flowchart of Server/Client Interaction

How Do You Add Network Tags?

On the BridgeVIEW server, all tags in an allowed `.scf` file can be viewed by another BridgeVIEW system by opening the Tag Configuration Editor and selecting **Configure»Allow Network Access**. The tags are not shared until the `.scf` file is saved on the server side.

On the BridgeVIEW client, open the Tag Configuration Editor and select **File»Import Network Tags…**. The **Select Tags for Network Import** dialog box, shown in Figure 3-3, allows you to browse the network for an `.scf` file and select tags you wish to import. After selecting the tags you wish to import, save the `.scf` file on the BridgeVIEW client and start the BridgeVIEW Engine.

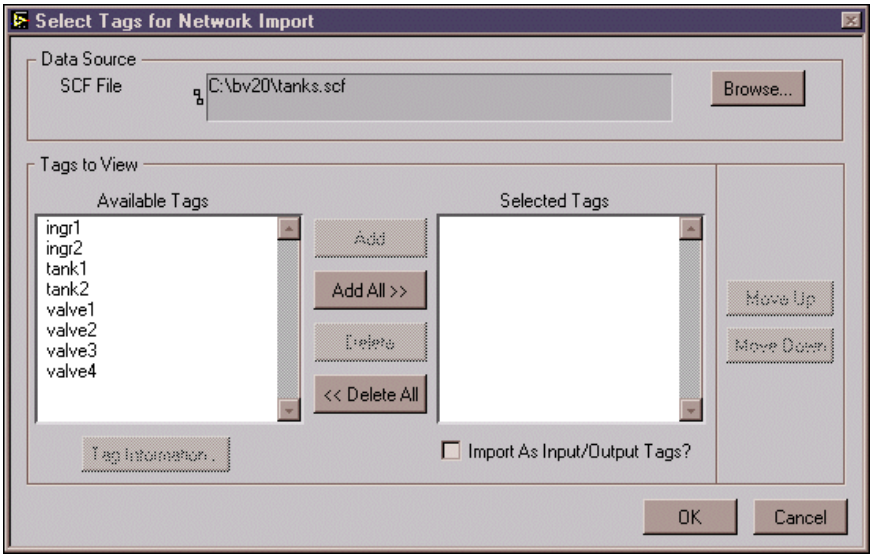
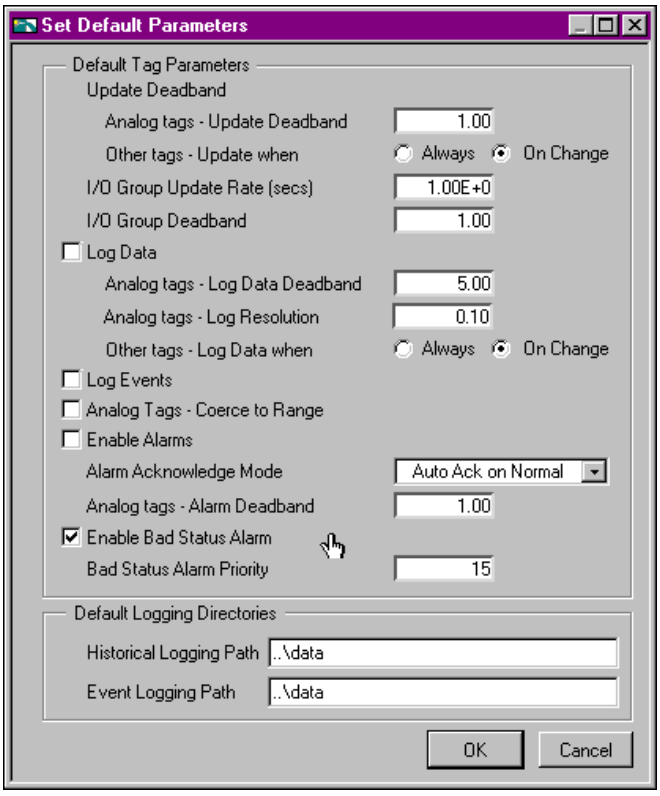


Figure 3-3. Select Tags for Network Import Dialog Box

How Do You Set Default Values for Tag Configuration Fields?

You can simplify the tag configuration process by defining default values for several fields. These default values are then used when you create tags automatically, such as with the Configuration Wizard or by importing. For example, you might want to set the default to **Log Data** or **Log Events**, or set the log deadband to a particular value by default. You can set default values for tag parameters using the Set Default Parameters dialog box, shown below. To access this dialog box, select **Configure»Default Parameters…**.



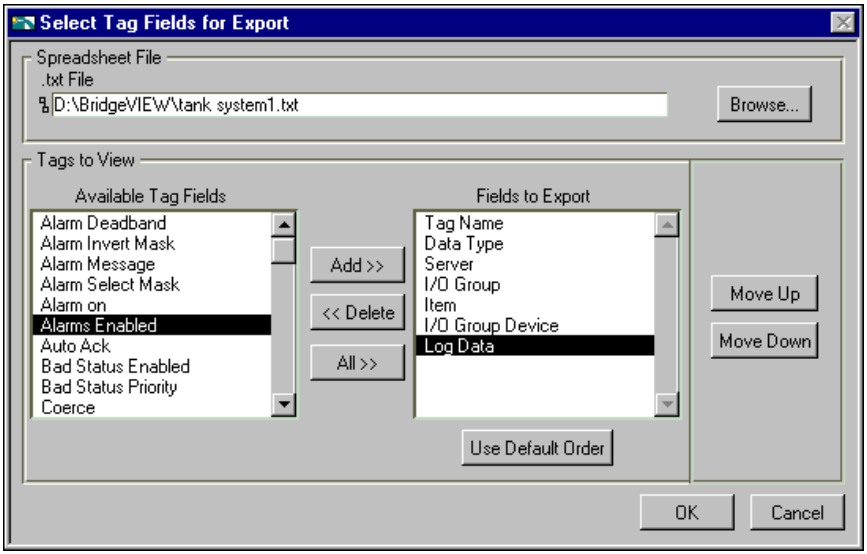
The default values apply when creating a new tag, importing a tag from the server registry, or importing a tag from a spreadsheet. In the case of spreadsheet, a value in the spreadsheet overrides the default value for the field. For more information about the individual fields, see the *How Do You Configure Tags?* section in this chapter.

How Do You Use Spreadsheet Files for Tag Configuration?

With the Tag Configuration Editor, you can export tag configuration information to spreadsheet files, and import tag configuration information from spreadsheet files. The files are tab-delimited text (`.txt`) files.

Select **File»Export…** to save the file as a tab-delimited `.txt` file. When you select **Export…**, a dialog box prompts you to select and order the fields you want in your spreadsheet file. If you intend to edit the spreadsheet file and then import the edited information back into the Tag Configuration Editor, select the **All>>** button to select all available fields.

For easy viewing and editing in the spreadsheet, press the **Use Default Order** button.



After you edit the file, save it as a `.txt` file. Then, from the Tag Configuration Editor, select **File»Import…** to import the information from the spreadsheet file.

If you use spreadsheet files with the Tag Configuration Editor, it is important that you understand the following points:

- If you do not choose all of the fields when exporting your data, you lose configuration information when you import it back to the Tag Configuration Editor.
- You might choose to export a subset of information, and then rely on tag default parameters when you import the data back in to the Configuration Editor. However, each row in the spreadsheet file must contain the tag name and data type fields, or the import mechanism cannot read it.
- Some configuration parameters, such as Historical Logging Configuration and Event Configuration, are inherited from the currently open `.scf` file when you import spreadsheet data.
- When importing, you can append the imported tags to the current `.scf` file.

☞ **Note** ***If the tag name and data type fields are missing, the* File»Import… *option does not work on the spreadsheet file.***

How Do You Configure Tags?

When you configure a tag with the Tag Configuration Editor, you define several attributes for the tag. You can separate these attributes into five categories: general, connection, operations, scaling, and alarms. Each of these categories is explained in detail later in this section.

If you import tag configuration information from a spreadsheet, follow the same format in your spreadsheet as indicated in the Attribute column of each of the tables listed above. For more information about using spreadsheets, see the *How Do You Use Spreadsheet Files for Tag Configuration?* section in this chapter.

Data Type

Configuration of a tag varies slightly depending on the data type. The following sections discuss the details of tag configuration for each data type.

Analog Tags

An *analog tag* is a continuous value representation of a connection to a real-world I/O point or memory variable. This type of tag can vary continuously over a range of values within a signal range.

Use an analog tag when you want to express a continuous value (for example, 0 to 100).

Discrete Tags

A *discrete tag* is a two-state (ON/OFF) value representation of a connection to a real-world I/O point or memory variable. This type of tag can be either a 1 (TRUE) or a 0 (FALSE).

Use a discrete tag when you want to express a two-state (ON/OFF) value.

Bit Array Tags

A *bit array tag* is a multi-bit value representation of a connection to a real-world I/O point or memory variable. This type of tag can be comprised of up to 32 discrete values.

Use a bit array tag when you have a multi-bit value in which each of the bits represents a flag or single value that is turned on or off. The maximum length of a bit array tag is 32.

String Tags

A *string tag* is an ASCII character representation of a connection to a real-world I/O point or memory variable.

Use a string tag when you have binary information or an ASCII value. For example, you might use a string tag to obtain values from a bar code reader, or if you have data that does not fit into any other data type.

General

The general attributes of a tag include the name of the tag you are configuring, the group name to use for the tag, a description of the tag, and the maximum length for string and bit array tags. Figure 3-4 shows the **General** tab of the Tag Configuration dialog box.

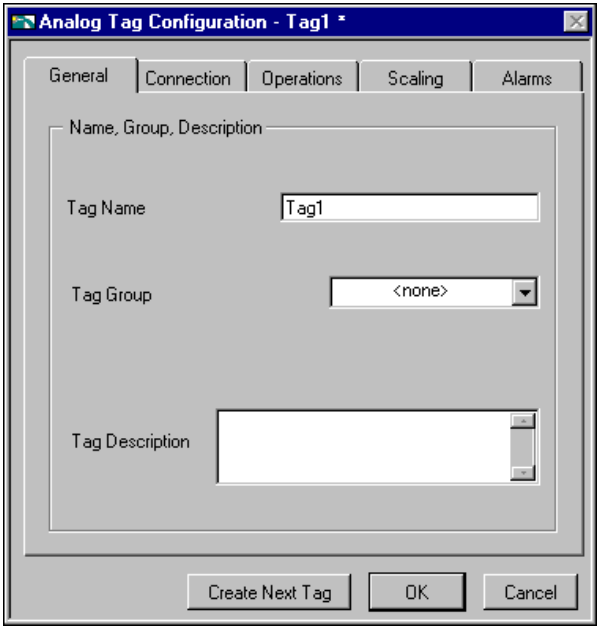


Figure 3-4. General Attributes Dialog Box

Table 3-1 provides descriptions of the general attributes of a tag. For tag attribute information about the other configuration categories, see Tables 3-2, 3-4, 3-5, and 3-7.

Table 3-1. General Configuration Attributes

Attribute	Applies to Data Types	Description
Tag Name	all	Determines the name of the tag you are configuring. Always refer to a tag by its name. Tag names are not case sensitive and can include any combination of printable characters (including space) with the exception of "/" (forward slash) and "\" (backslash).
Tag Group	all	Determines the group name to use for this tag. You can use groups to assist in alarm management and reporting and to help organize tags in an application.
Tag Description	all	Provides a description of the tag.
Maximum Length	string, bit array	Determines the maximum number of bits in the bit array. The length is between 1 and 32 for bit array tags. String tags can be of any length.

Connection

You associate a tag with its real-world I/O point by assigning it a **Server**, **I/O Group**, and **Item** in the **Connection** tab of the Tag Configuration dialog box, shown in Figure 3-5. If an I/O Group does not already exist for the server, you must create one before you can select or enter an item for the tag. The I/O Group is user-defined and provides you with a place to configure the rate and deadband for an item. For IAK and VI-based servers, you select the device as part of the I/O group configuration. For OPC servers, the I/O group conforms to an OPC group.

When you edit a tag, use the ring inputs to assign values to the tag. Use the **Create…**, **Edit…**, and **Delete** buttons to configure I/O Groups and Items. For more information about device servers, see Chapter 8, *Servers*.

Figure 3-5. Tag Connection Dialog Box

If a device server does not appear in the server name list, you must run the configuration or registration utility for your server before BridgeVIEW can access the server.

Table 3-2 provides descriptions of the connection attributes, and indicates the data types to which each attribute applies. For tag attribute information about the other configuration categories, see Tables 3-1, 3-4, 3-5, or 3-7.

Table 3-2. Connection Configuration Attributes

Attribute	Applies to Data Types	Description
Data Type	all	Determines the data type of the tag you are configuring. BridgeVIEW tags can be analog, discrete, bit array, or string.
Tag Access	all	Determines the access rights for a tag. Tags can have access rights of Memory, Input only, Output only, or Input/Output. Memory tags are not directly connected to real-world I/O points. You can use memory tags to monitor and control calculated values and enable historical trending and alarming on these values. Input only, Output only, and Input/Output tags are connected to real-world I/O points according to the Server, Device, and Item fields.
Server	all	Determines the device server that manages the communication of the tag value. If the tag is a memory tag, this attribute is not used.
I/O Group	all	Determines the I/O Group to use for this tag. Select the I/O Group this tag uses. The I/O Group is associated with the server. At least one I/O Group must be created for the server in order to configure a tag to use a server item. If the tag is a memory tag, this attribute is not used.
Item Name Filter	all	Determines the string to filter the list of configured items. If the tag is a memory tag, this attribute is not used.
Item	all	Determines the register, channel, or item on the device for this tag. This might be a PLC register, a data acquisition channel, an OPC item ID, or a DDE item, depending on the server used for this tag. If the tag is a memory tag, this field is not used.
Access Path	all	Determines the access path for the selected server. If the tag is a memory tag or if the server does not have access paths, this attribute is not used.

I/O Group Configuration

I/O Groups are used to configure item rate and deadband for items of a server and to select a specific device, if the server uses devices. For servers that support resource configuration, you also can use I/O groups to configure devices and communication resources. For OPC servers, an I/O group conforms to the concept of an OPC group, which is user-defined and controls timing. An I/O Group is associated with only one server and, if that

server uses devices, with only one device. A server can have multiple I/O Groups associated with it.

I/O Group Configuration Options

The **Create…** button invokes the I/O Group Configuration dialog box, which you can use to specify group name and timing parameters. For servers that support resource configuration, you also can use this dialog box to select and configure devices and to configure communication resources.

The **Edit…** button invokes the I/O Group Configuration dialog box for the I/O Group selected in the I/O Group list. Use this dialog box to change the group name and timing parameters. For servers that support resource configuration, you also can use this dialog box to select and configure devices and to configure communication resources.

The **Delete** button invokes a confirmation dialog box. If confirmed, the I/O Group is deleted from the server configuration. Deleting an I/O Group does not delete the device and communication resource from the server configuration.

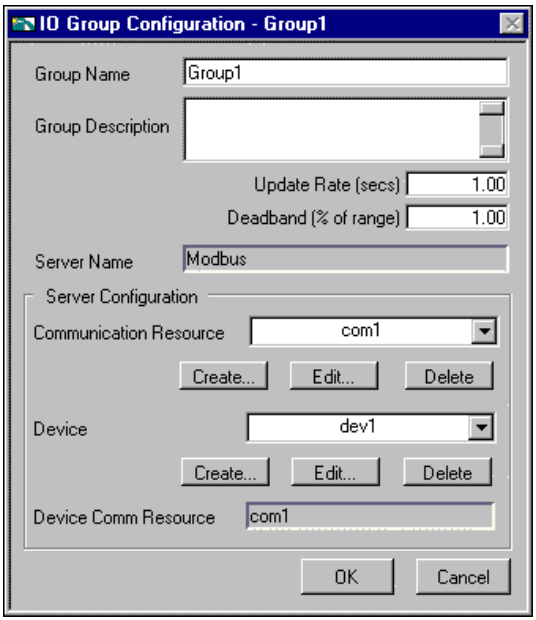


Figure 3-6. I/O Group Configuration Dialog Box

Table 3-3 provides descriptions of the operations that can be performed on an I/O Group. For information about other opeations that can be performed on an I/O Group, see Table 3-2.

Table 3-3. I/O Group Configuration Attributes

Attribute	Description
I/O Group Name	Determines the name of the I/O Group you are configuring. I/O Group names are not case sensitive and can include any combination of printable characters (including spaces) with the exception of "/" and "\".
I/O Group Description	Provides a description for the I/O Group.
I/O Group Update Rate (secs)	Determines the rate for the server to update the item value in the engine for all tags using the I/O Group. The server can have other configuration options that determine the actual update rate. This is the rate at which BridgeVIEW requests all tags configured with this update rate be updated.
I/O Group Deadband (% of range)	Determines the deadband for the server to update the item value in the engine for all tags configured with the I/O Group. Use 0% if you do not want the server to apply deadbands to the item. ☞ **Note** ***Not all servers support deadbands, and some might ignore this value.***
Server Name	Indicates the Server Name associated with the I/O Group you are configuring.
Communication Resource	Provides a means to configure (create, edit, or delete) a communication resource. This field is valid only for IAK servers.
Device	Determines a specific device used by the I/O Group and Server for this tag. If the associated server is an OPC Server, this attribute is not used.
Device Comm Resource	Indicates the communication resource associated with the selected device. This field is valid only for IAK servers.

Server Configuration Options

Use this group of fields to configure and select server resources. Some or all fields in this group might not be used depending on the server type. An IAK server has both Device and Communication Resource configuration capabilities.

Communication Resource Configuration Options

For IAK servers, use the **Create…** button to invoke a new, untitled IAK Create Communication Resource Configuration dialog box. This configuration option is not used for other classes of servers.

For IAK servers, use the **Edit…** button to invoke the IAK Edit Communication Resource dialog box for the currently selected communication resource. This configuration option is not used for other classes of servers.

For IAK servers, use the **Delete** button to remove the selected communication resource from the server configuration. This configuration option is not used for other classes of servers.

Device Configuration Options—Configuring Device Names

This option is available for servers that allow users to configure device names. OPC Servers do not use device names. For DDE Servers, the device name is used to specify the DDE application and topic. See the *How Do You Connect a Tag to a DDE Server?* section in this chapter for more information.

The **Add…** button invokes the Device Entry dialog box, which you can use to add a new device name for a selected server. If the server does not support device configuration, or if the selected device name is not valid, this button is disabled.

The **Edit…** button invokes the Device Entry dialog box, which you can use to edit an existing device name for a selected server. If the server does not support device configuration, or if the selected device name is not valid, this button is disabled.

The **Delete** button invokes a confirmation dialog box. If confirmed, the selected device name is removed from the device list. If the server does not support device configuration, or if the selected device name is not valid, this button is disabled.

Device Configuration Options—Configuring Device Resources

This option is supported by servers that allow users to configure device resources.

Use the **Create…** button to invoke a new, untitled Create Device Configuration dialog box. The options in this dialog box vary depending on the type of server. If the server does not support device configuration, this button is disabled.

Use the **Edit…** button to invoke the Edit Device Configuration dialog box for the device currently selected in the device list. The options in this dialog box vary depending on the type of server. If the server does not support device configuration, this button is disabled.

Use the **Delete** button to remove the selected device from the server configuration. If the server does not support device configuration, this button is disabled.

Item Configuration

Use the **Item Connection** fields in the **Connection** tab (see Figure 3-5) to select and configure the item and access path (for certain OPC Servers only) for a tag.

Item Configuration Options—Configuring Item Names

This option is available for servers that allow users to configure item names.

The **Add…** button invokes the Item Entry dialog box, which you can use to add a new item for a selected server. If the server has access paths, you also can use this dialog box to add an access path. If the server does not support item configuration, this button is disabled.

The **Edit…** button invokes the Item Entry dialog box, which you can use to edit an existing item name for a selected server. If the server has access paths, you also can edit an access path. If the server does not support item configuration, or if the selected item is not valid, this button is disabled.

The **Delete** button invokes a confirmation dialog box. If confirmed, the selected item is removed from the item list. If the server has access paths, the selected access path is removed from the access path list. If the server does not support item configuration, or if the selected item is not valid, this button is disabled.

Item Configuration Options—Configuring Item Resources

This option is supported by servers that allow users to configure item resources.

The **Create…** button invokes a server-dependent configuration dialog box, which you can use to configure a new item for a selected server. If the server does not support item configuration, this button is disabled.

The **Edit…** button invokes a server-dependent configuration dialog box, which you can use to edit the configuration of the selected item. If the server does not support item configuration, or if the selected item is not valid, this button is disabled.

The **Delete** button invokes a confirmation dialog box. If confirmed, the selected item is removed from the server configuration.

The **Browse…** button, which only applies to OPC Servers that support browsing, invokes the Browse OPC Server dialog box. Use this button to browse the list of available items and select an item and associated access path.

What Is a Memory Tag?

Memory tags are tags not connected directly to I/O points. They exist only in the BridgeVIEW RTDB. To configure a memory tag, set the **Access Rights** of a tag to **Memory**.

When Should You Use a Memory Tag?

Use memory tags when you want to perform alarm calculations, or log historical data and event information on data that is either a software-generated value or a combination of values from different I/O tag readings. Below are some examples illustrating when to use memory tags.

Example 1—When Not to Use a Memory Tag

You do not need to use a memory tag for program variables unless you want to use the historical and event logging or alarm management capabilities of the BridgeVIEW Engine.

An HMI displays the trend of a temperature tag and the difference between the current reading and a previous reading to allow operators to see the current rate of change in the temperature value. Although the individual values are logged for historical trends, the current difference is not.

You can configure the BridgeVIEW Engine to include the tag that reads temperature. The block diagram of the HMI reads the tag value and passes it to a real-time trend indicator. The difference between the current reading and the previous value is calculated in the diagram and passed to a front panel numeric indicator. The diagram retains the current temperature value and uses it after taking the next reading. Because the system does not need to perform any alarm management or historical logging based on the difference, no memory tag is used.

Example 2—When to Use a Memory Tag

A simple device server returns several items of data that, through a linear combination of values, represent a meaningful measurement in engineering units. The design of the device and its server software makes it difficult to combine these values within the server to make a single tag. The value of interest is not the individual points but the linear combination of these I/O points. The operators need historical trends and alarm management based on this single value.

In this situation, you can define a separate tag for each server item and a memory tag with engineering range and units of the final measurement. In the block diagram of the HMI VI, read individual tag values and calculate the linear combination of values in the diagram. Write the calculated value to the memory tag in the Real-Time Database and the BridgeVIEW Engine performs historical logging and alarm calculations according to the memory tag configuration.

☞ **Note** ***To learn more about how to build HMI VIs, refer to Chapter 4, Human Machine Interface.***

How Do You Automatically Generate Tags from Server Information?

Use the Configuration Wizard to create tags from the server information. The Configuration Wizard is useful if you want the BridgeVIEW Engine to monitor a large number of the I/O points in your system. To invoke the Configuration Wizard, press the **Configuration Wizard** button on the main screen of the Tag Configuration Editor or select **Edit»Configuration Wizard…**. For more information on servers, see Chapter 8, *Servers*.

When you run the server configuration utilities for the servers on your system, you can define devices and items for the I/O points the servers monitor and control. You can automatically create tags from these items with the Configuration Wizard. When the tags are created, the tag name, data type, I/O group, I/O connection, and scaling parameters are determined by the server information for each server item. The remaining tag parameters are determined by the default tag parameter settings. You can edit the default parameters by selecting opening the Tag Configuration Editor and selecting **Configure»Default Parameters…**.

For IAK and VI-based servers, server information is read from the Common Configuration Database (CCDB). For OPC servers that support it, server information is read by browsing the server address space. When you generate tags, you can either add them to the existing configuration by

selecting **Append Tags to SCF?** (default mode) or you can create a new configuration file.

How Do You Connect a Tag to an OPC Server?

You connect to an OPC server just like you connect to the National Instruments device servers from the **Connection** tab of the Tag Configuration dialog box. Any OPC servers installed on your machine are listed in the server name list. Select the OPC server you want to use. Create an I/O Group for the server, specifying the group deadband and update rate. Select or enter the Item name, which is the same as the OPC Server Item ID. You also can select or enter an access path for OPC servers if the server supports that.

How Do You Connect a Tag to a DDE Server?

Although no BridgeVIEW servers are based on Dynamic Data Exchange (DDE), you can connect a tag to any existing DDE Server. Select **DDE Server** as your server in the **Connection** tab of the Tag Configuration Editor to communicate with DDE servers. DDE Servers have an Application Name, Topic, and Item. In BridgeVIEW, the device in the I/O Group Configuration dialog box is set to `appname|topic` (| = the "pipe" symbol) and the item in the **Connection** tab of the Tag Configuration dialog box is set to `item`. For example, to connect a tag to cell `R1C1` (item) of spreadsheet `sheet1` (topic) in Excel (application), set the tag fields to the following:

Server: `DDE Server`
Device: `Excel|sheet1` (in I/O Group Configuration dialog box)
Item: `R1C1`

To specify a particular sheet (`sheet1`) within an open Excel file (`book1.xls`), set the device field to the following:

Device: `Excel|[book1.xls]sheet1` (in I/O Group Configuration dialog box)

How Do You Define a Group of Tags for Alarming?

While editing a tag, pull down the Tag Group Ring in the **General** tab of the Tag Configuration dialog box. You can select an existing tag group or define a new tag group by selecting **Enter New…**. To create, edit, or delete tag group definitions, select **Tag Groups…** from the **Configure** menu from the main Tag Configuration Editor panel.

You can use tag groups to help define a subset of tags in the system. Tag groups are helpful when you want to examine the alarm states for a subset of tags in the system. See Chapter 5, *Alarms and Events*, for more information on alarm groups.

Operations

The operations attributes include when to update the tag value in the RTDB, whether to log data to a historical file, whether to log events associated with the tag, and information about the initial value of the tag at Engine startup. Figure 3-7 shows the **Operations** Tab of the Analog Tag Configuration dialog box. With this section of the dialog box, you can inform the BridgeVIEW Engine of what to do with the data in the RTDB.

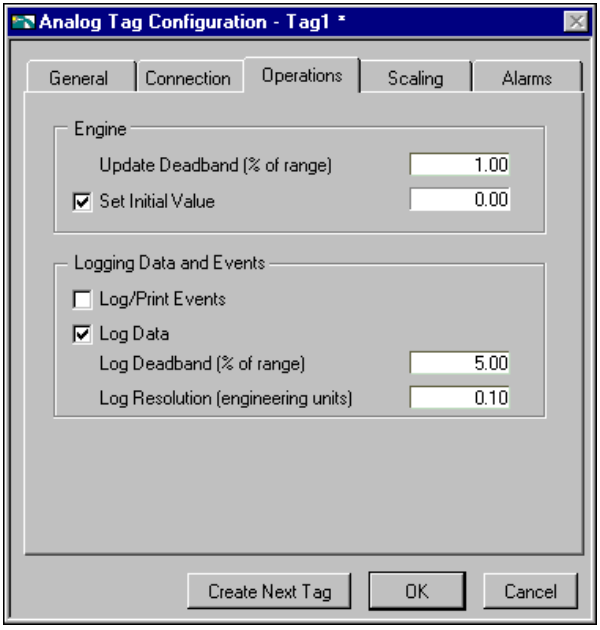


Figure 3-7. Tag Operations Dialog Box

Table 3-4 provides descriptions of the operations attributes, and indicates the data types to which each attribute applies. For tag attribute information about the other configuration categories, see Tables 3-1, 3-2, 3-5, and 3-7.

Table 3-4. Operations Configuration Attributes

Attribute	Applies to Data Types	Description
Update Deadband	all	Determines when the Real-Time Database (RTDB) updates the value for this tag. It is used to improve system performance and prevent unnecessary processing of tag values in the RTDB. The field is expressed differently for analog, discrete, string, and bit array tags. For analog tags, Update Deadband is a percent of full scale. The database updates analog tags only when a new tag value is different than the currently stored value by at least the Update Deadband. Use 0% if you want each new value for the tag to be saved in the RTDB. For discrete, string, and bit array tags, Update Deadband is expressed as either **Always** or **On Change**.
Log Data	analog, discrete, bit array	Determines whether a tag value is logged to historical files.
Log Data Deadband	analog, discrete, bit array	Determines when tag values are logged to disk. It is used to improve system performance and prevent unnecessary logging of data to disk. Like Update Deadband, the field is expressed differently for analog, discrete, and bit array tags. For analog tags, Update Deadband is a percent of full scale. The BridgeVIEW Engine writes new analog tag values to historical files only when a new tag value is different than the last logged value by at least the Log Data Deadband. Use 0% if you want each new value for the tag to be logged. For discrete and bit array tags, Update Deadband is expressed as either **Always** or **On Change**.
Log Resolution	analog	Determines the resolution in engineering units for logging a tag value in the Citadel Historical Database. Tag values are written to the database in a compressed format with the resolution specified by Log Resolution. Use `0.0` if you want the exact value written to the Citadel Historical Database. Notice that logging the exact value requires more time and disk space. The default value is `0.1`.
Log/Print Events	all	Determines whether events associated with the tag (for example, changes in alarm state) are logged to event log files or printed to a line printer.

Table 3-4. Operations Configuration Attributes (Continued)

Attribute	Applies to Data Types	Description
Set Initial Value	all	Determines whether an initial value is used for this tag. If Set Initial Value is OFF for this tag, the tag value is marked as uninitialized until its value is updated.
Initial Value	all	The initial value used for this tag when Set Initial Value is ON. If the tag is an Output only or Input/Output tag, the BridgeVIEW Engine sends the Initial Value to the server at Engine startup. If the tag is an Input only or Memory tag, the Initial Value is stored in the RTDB at startup.

What Is Deadband?

In process instrumentation, *deadband* is the range through which an input signal can vary without initiating an observable change in output signal. Deadband usually is expressed in percent of full scale. Although the term deadband generally applies only to analog tags, other tag types have a limited type of deadband. A checkbox allows you to determine if updates to the RTDB and historical data files should occur with any new data from the device server or if the value has changed.

☞ **Note** ***The BridgeVIEW Engine performs historical logging and alarm management operations based on new values in the RTDB. If you set the Update Deadband too high, the RTDB might not be updated. This might result in inadequate historical logging or alarm management.***

How Do You Use Deadband to Increase Engine Throughput?

The BridgeVIEW Engine uses Update Deadband and Log Deadband values to eliminate unnecessary processing on minor data value changes. Deadband allows you to define a significant change. The Engine ignores an operation if the change in data is not considered significant. Deadband is expressed as percent of full scale. For example, if the tag engineering range is 0 to 200 liters, a deadband of 5% is 10 liters. In addition, through I/O group configuration, you can configure a server to apply a deadband to any items associated with that I/O group. Not all servers implement deadbands. OPC servers support deadbands.

How Do You Configure a Tag to Log Its Data or Events?

While editing a tag, click on the **Log Data** or **Log/Print Events** checkbox. If you want to log historical data or events, the BridgeVIEW Engine must have these processes enabled. To turn them on, open the Engine Manager and turn on the processes with the panel buttons, or configure the Engine to turn on these processes automatically at startup by selecting **Configure» Historical…** or **Configure»Events…** from the Tag Configuration Editor. You also can enable these parameters programmatically with System VIs that enable event or historical data logging.

How Do You Set Initial Tag Value at Startup?

While editing a tag, select the **Set Initial Value** checkbox. Then enter the initial value in the adjacent **Initial Value** field.

Scaling

These attributes include what type of scaling to perform on a tag when communicating with the device server and the expected engineering range and units for the tag.

Table 3-5, provides descriptions of the scaling configuration attributes, and indicates the data types to which each attribute applies. For tag attribute information about the other configuration categories, see Tables 3-1, 3-2, 3-4, and 3-7.

Table 3-5. Scaling Configuration Attributes

Attribute	Applies to Data Types	Description
Raw Full Scale	analog	Determines the full scale (maximum) value used by the server for a tag.
Raw Zero Scale	analog	Determines the zero scale (minimum) value used by the server for a tag.
Eng Full Scale	analog	Determines the full scale (maximum) value used by the BridgeVIEW Engine and the user application for a tag. Engineering Full Scale must be greater than Engineering Zero Scale.

Table 3-5. Scaling Configuration Attributes (Continued)

Attribute	Applies to Data Types	Description
Eng Zero Scale	analog	Determines the zero scale (minimum) value used by the BridgeVIEW Engine and the user application for a tag. Engineering Zero Scale must be less than Engineering Full Scale.
Units	analog	Determines the engineering units for a tag. Examples include degrees Celsius, liters, and kilograms.
Scaling	analog, discrete, bit array	Determines the type of scaling algorithm to be used for a tag. The scaling methods differ according to tag data type. You can configure analog tags for linear or square root scaling, discrete tags for invert scaling, or bit array tags for mask scaling. All tags can be configured for no scaling.
Coerce	analog	Determines whether to coerce data so that it is valid for the target. If scaling to output, the value must be within the raw (device server) range. If scaling to input, the value must be within the engineering (HMI) range.
Scaling Invert Mask	bit array	Determines which bits are inverted for a bit array tag. Bits in the mask that are `1` are inverted; bits that are `0` are not inverted. The default mask is `0`, indicating none of the bits are inverted. In bit-wise logic terminology, the Engine performs an XOR with the Invert Mask to produce the scaled value.
Scaling Select Mask	bit array	Determines which bits are used for the bit array tag. Bits in the mask that are `1` have their values passed through to the RTDB; bits that are `0` are set to zero, regardless of the value received from the server. In bit-wise logic terminology, the Engine performs an AND with the Select Mask to produce the scaled value.

The next sections explain how to scale data. Often your application needs BridgeVIEW to manipulate the raw data used in the device server to put it in a form, called engineering units, suitable for the operators. The following sections describe the options for individual data types.

☞ **Note** ***There is no scaling for string tags.***

Analog Tags

You can define the raw range and engineering range for a tag to perform simple conversions between the two ranges. The raw range, defined by Raw Full Scale and Raw Zero Scale, refers to the values used by the device server. Engineering range, defined by Engineering Full Scale and Engineering Zero Scale, refers to the values used by the BridgeVIEW Engine and HMI. Pull down the Scaling ring and select **Linear** to enable a linear *(mx + b)* conversion between raw and engineering ranges. Select **Square Root** to enable a square root conversion between the raw and engineering ranges. Figure 3-8 shows the **Scaling** tab of the Analog Tag Configuration dialog box.

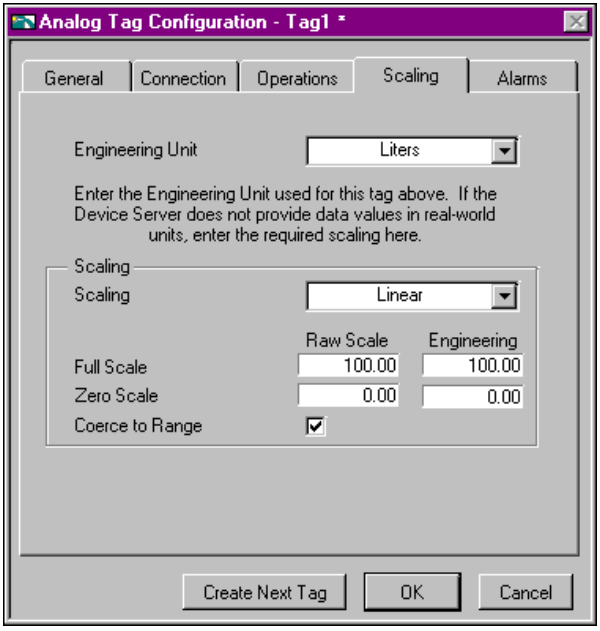


Figure 3-8. Analog Tag Scaling Dialog Box

The following examples describe linear and square root scaling.

Example—Linear Scaling

A device server returns a simple voltage from 0 to 5 V. The voltage is related to a position sensor, and the real-world position is measured in centimeters, with 0 volts mapped to 50 cm and 5 V mapped to 100 cm.

Configure the tag for raw range from zero (Raw Zero Scale) to five (Raw Full Scale). Select **Linear**, and set the engineering range from 50 (Eng Zero Scale) to 100 (Eng Full Scale).

Example—Square Root Scaling

A flow meter measures the flow rate of a liquid using a differential pressure reading. The device server provides 4–20 mA readings. The actual flow is measured in gallons per minutes (GPM). 4 mA corresponds to 0 GPM; 20 mA corresponds to 100 GPM.

Configure the tag for raw range from 4 (Raw Zero Scale) to 20 (Raw Full Scale). Select **Square Root Scaling** and set the engineering range from 0 (Eng Zero Scale) to 100 (Eng Full Scale).

How Do You Assign Units to an Analog Tag?

Use the **Engineering Unit** ring to assign units to a tag. If the desired unit is not in the list, select **Enter New…** and enter the desired unit. In the previous example, you select units of GPM.

Discrete Tags

The only scaling available for discrete tags is invert scaling. Click the **Invert Data** checkbox, shown in Figure 3-9 to advise the BridgeVIEW Engine to invert the discrete value when it communicates with the device server.

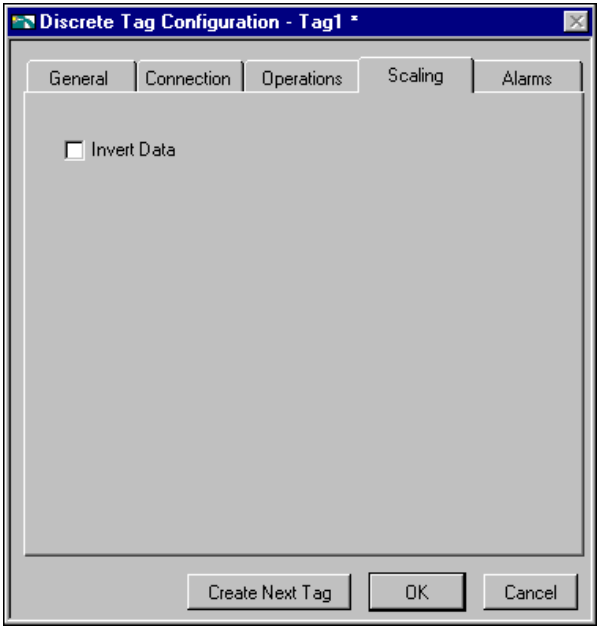


Figure 3-9. Scaling for Discrete Tag Configuration

Bit Array Tags

Bit array tags can have invert and/or select mask scaling. You can use the invert mask to determine which bits are inverted between the device server and the BridgeVIEW Engine. You can use the select mask to determine the bits you do not need. Figure 3-10 shows the **Scaling** tab of the Bit Array Tag Configuration dialog box, and Table 3-6 provides examples of tags configured for bit array scaling.

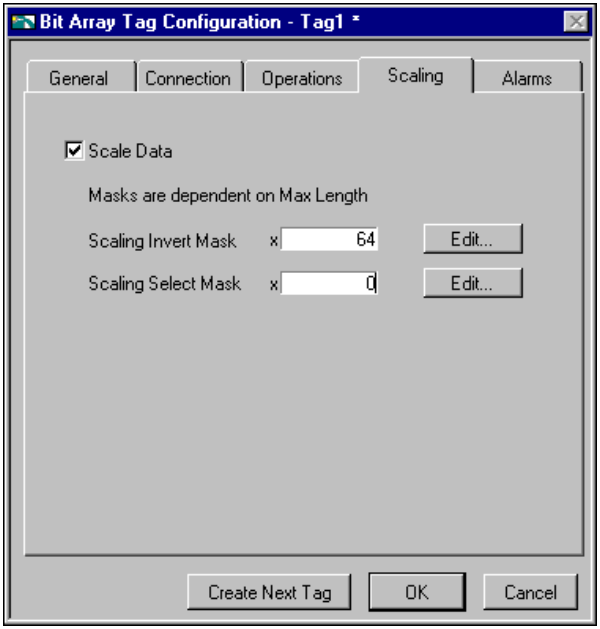


Figure 3-10. Scaling for Bit Array Tag Configuration

Table 3-6. Bit Array Scaling Examples

Tag Name	Length	Raw Value	Invert Mask	Select Mask	Scaled Value
Tag 1	8	0x0F	0x00	0xFF	0x0F
Tag 2	8	0x0F	0x33	0xFF	0x3C
Tag 3	8	0x0F	0x33	0x0F	0x0C
Tag 4	8	0x0F	0x00	0x33	0x30
Tag 5	8	0x0F	0x33	0x33	0x30
Tag 6	16	0x0FF0	0x000F	0x00FF	0x00FF

Alarms

These attributes include whether to enable alarms, under what circumstances a tag is in alarm, the priority level of an alarm, and how alarms are acknowledged. Each alarm limit has a priority, ranging between 1 and 15. In BridgeVIEW, 15 is the highest priority and 1 is the lowest.

There are two main types of alarms:

- Alarms based on status
- Alarms based on tag values

Configuration for alarms based on tag values is specific to data type. Therefore, many alarm attributes apply to only a subset of the BridgeVIEW tag data types. For more information about how to access alarm information, build alarm summary displays, and retrieve historical events files, see Chapter 5, *Alarms and Events*.

Table 3-7 provides descriptions of the alarm attributes, and indicates the data types to which each attribute applies. For tag attribute information about the other configuration categories, see Tables 3-1, 3-2, 3-4, or 3-5.

Table 3-7. Alarms Configuration Attributes

Attribute	Applies to Data Types	Description
Alarms Enabled	all	Determines whether alarms are enabled for a tag.
Alarm Deadband	analog	Determines the amount an analog tag value must diverge from an alarm limit before the alarm condition returns to normal. Alarm Deadband is expressed in percent of full scale.
Auto Ack	all	Determines how alarms can be acknowledged. If set to Auto Ack, the alarm is acknowledged automatically when the tag value returns to the Normal state. If set to User Must Ack, the alarm remains unacknowledged until the user acknowledges it, regardless of the alarm state.
Bad Status Enabled	all	Determines whether to enable Bad Status alarms for the tag.
Bad Status Priority	all	Determines the value (between 1 and 15) for the alarm priority for the Bad Status alarm, where 15 represents the highest priority.
HI_HI Enabled	analog	Determines whether to enable HI_HI alarms for a tag.

Table 3-7. Alarms Configuration Attributes (Continued)

Attribute	Applies to Data Types	Description
HI_HI Limit	analog	Determines the value, in engineering units, that invokes a HI_HI alarm condition. The tag alarm state remains HI_HI until the tag value goes below the HI_HI alarm limit minus the alarm deadband.
HI_HI Priority	analog	Determines the value (between 1 and 15) for the alarm priority for the HI_HI alarm, where 15 represents the highest priority.
HI Enabled	analog	Determines whether to enable HI alarms for a tag.
HI Limit	analog	Determines the value, in engineering units, that invokes a HI alarm condition. The tag alarm state remains HI until the tag value goes below the HI alarm limit minus the alarm deadband.
HI Priority	analog	Determines the value (between 1 and 15) for the alarm priority for the HI alarm, where 15 represents the highest priority.
LO Enabled	analog	Determines whether to enable LO alarms for the tag.
LO Limit	analog	Determines the value, in engineering units, that invokes a LO alarm condition. The tag alarm state remains LO until the tag value goes above the LO alarm limit plus the alarm deadband.
LO Priority	analog	Determines the value (between 1 and 15) for the alarm priority for the LO alarm, where 15 represents the highest priority.
LO_LO Enabled	analog	Determines whether to enable LO_LO alarms for a tag.
LO_LO Limit	analog	Determines the value, in engineering units, that invokes a LO_LO alarm condition. The tag alarm state remains LO_LO until the tag value goes above the LO_LO alarm plus the alarm deadband.
LO_LO Priority	analog	Determines the value (between 1 and 15) for the alarm priority for the LO alarm, where 15 represents the highest priority.
Discrete Enabled	discrete, bit array	Determines whether to enable tag value alarms for discrete and bit array tags.

Table 3-7. Alarms Configuration Attributes (Continued)

Attribute	Applies to Data Types	Description
Alarm on	discrete, bit array	Determines whether a discrete tag should be alarm on ON (high) or OFF (low). Determines whether a bit array goes into alarm if all of its bits are in alarm or if any of its bits are in alarm. This field is used only if both Alarms Enabled and Discrete Enabled fields are set to TRUE.
Discrete Priority	discrete, bit array	Determines the value (between 1 and 15) for the alarm priority for the tag value alarm, where 15 represents the highest priority.
Alarm Invert Mask	bit array	Determines which bits are inverted before calculating the alarm state. Bits in the mask that are `1` are inverted; thus cause an alarm when low (0). Bits that are `0` are not inverted; thus, cause an alarm when high (1). The default mask is 0, indicating none of the bits are inverted. In bit-wise logic terminology, the Engine performs an XOR with the Invert Mask to produce the alarm state. The Alarm Invert Mask is applied to the scaled value after any relevant scaling masks are applied.
Alarm Select Mask	bit array	Determines which bits are used for the bit array alarm calculation. Bits in the mask that are `1` are used in the alarm calculation; bits that are `0` do not cause an alarm, regardless of their value. In bit-wise logic terminology, the Engine performs an AND with the Select Mask to produce the alarm state. The Alarm Select Mask is applied to the scaled value after any relevant scaling masks are applied.
Alarm Message	discrete, bit array	Determines the string used to provide additional information about the meaning of an alarm condition.
Tag Last Modified	all	Indicates when the last edit to a tag occurred.

How Do You Configure Alarms for a Tag?

While editing a tag, click the **Enable Alarms** checkbox. Alarms are generated depending on the value or state of a tag. The alarms based on value vary with the tag data type. But for any tag, if the status is bad, a Bad Status alarm is generated. By default, Bad Status Alarm is enabled and has the highest priority (15). You can change this selection from the Alarms tab of the Tag Configuration Editor, shown in Figure 3-11.

Analog Tags

Analog tags have four alarm levels: HI_HI, HI, LO, and LO_LO. By providing separate alarm levels, you can provide more information about the nature of the alarm condition.

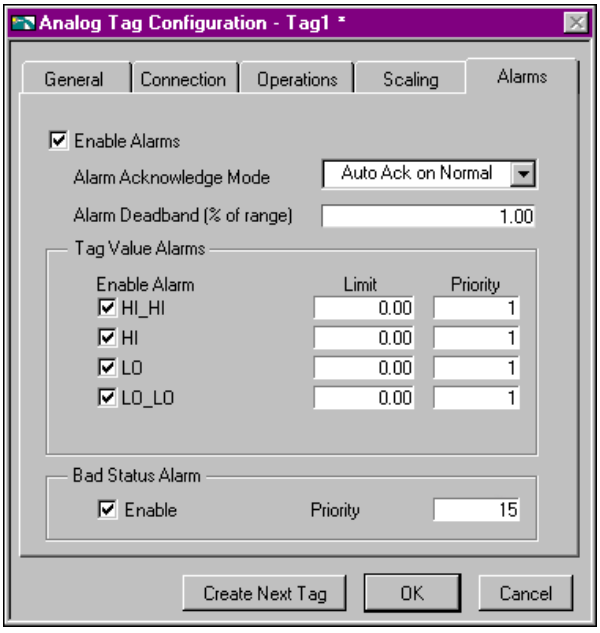


Figure 3-11. Alarms for Analog Tag Configuration

Alarms are calculated after scaling is performed. Alarm levels are expressed in engineering units.

Discrete Tags

Discrete tags have one alarm state—either the tag is in alarm or it is not. You can determine whether a tag is in alarm when it is ON (High) or OFF (Low). Figure 3-12 shows the **Alarms** tab of the Discrete Tag Configuration dialog box.

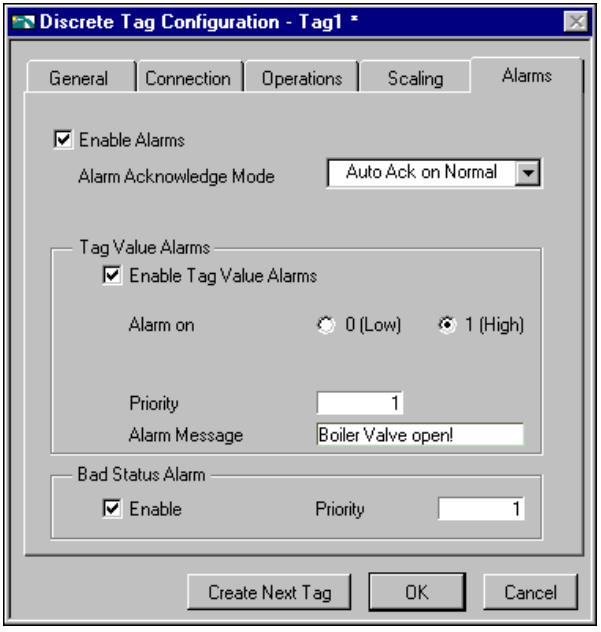


Figure 3-12. Alarms for Discrete Tag Configuration

Bit Array Tags

You can enable one of two types of alarms for bit array tags. Alarm on Any indicates the overall tag is in alarm if any of the bits are in alarm state. Alarm on All means the overall tag is in alarm only if all of the bits are in alarm state. You can use the Invert Mask to determine the bits that should use alarm on low (OFF) rather than the default alarm on high (ON). You can use the Select (AND) Mask to determine the bits that should be considered for the alarm. If you have bits in the Select Mask that are zero (OFF), these bits are not used in calculation of the tag alarm state. Figure 3-13 shows the **Alarms** tab of the Bit Array Tag Configuration dialog box.

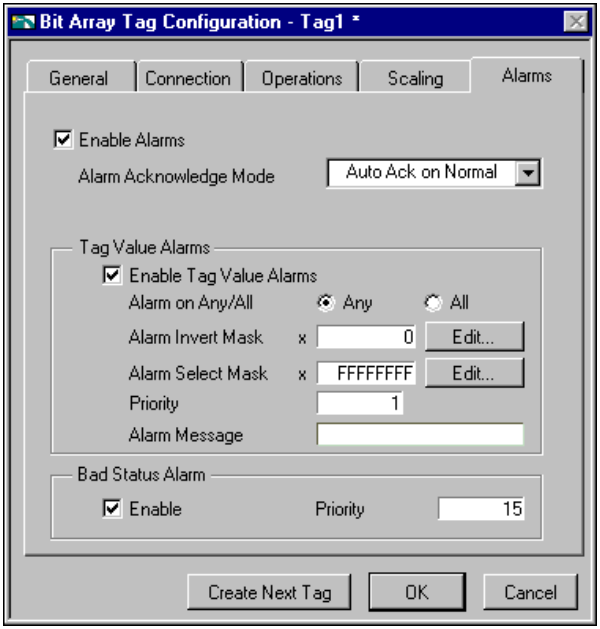


Figure 3-13. Alarms for Bit Array Tag Configuration

String Tags

String tags have no alarm states based on tag value. They only support Bad Status alarms.

What Is Alarm Deadband on Analog Tags?

Alarm Deadband is a method commonly used to avoid repetitive alarm messages because of a tag value that hovers near the alarm limit. Alarm Deadband defines how much a tag value must change from the alarm limit before it is considered normal. For example, if a tag that represents a temperature value hovers near an alarm limit of 40 degrees Celsius, the tag might go in and out of alarm many times in a relatively short period of time. Table 3-8 shows examples of events with Alarm Deadband set to 0.0%.

Table 3-8. Events with Alarm Deadband = 0.0%

Time	Value	Event	Alarm Type
9:15:05	40.1	Yes	HI
9:15:10	39.9	Yes	Normal

Table 3-8. Events with Alarm Deadband = 0.0% (Continued)

Time	Value	Event	Alarm Type
9:15:15	40.1	Yes	HI
9:15:20	38.5	Yes	Normal

This type of situation clogs event files with redundant information and can cause operators some frustration in having to acknowledge alarms constantly when the tag has not changed significantly. You can use the Alarm Deadband to alleviate this problem.

For the tag to go into alarm, it must go above the exact Alarm Value (in the above example, 40). However, to be considered normal again, it must leave the Alarm Value by an amount greater than the Alarm Deadband. For example, if the range is 0 to 100 degrees Celsius, an Alarm Deadband of 1.0% (one degree Celsius) eliminates unnecessary events. Table 3-9 shows examples of events with Alarm Deadband set to 1.0%.

Table 3-9. Events with Alarm Deadband = 1.0%

Time	Value	Event	Alarm Type
9:15:05	40.1	Yes	HI
9:15:10	39.9	No	HI
9:15:15	40.1	No	HI
9:15:20	38.5	Yes	Normal

How Do You Keep an Alarm Unacknowledged after the Alarm Returns to Normal?

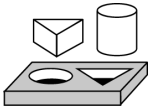
While editing a tag, select the **Alarm Acknowledgement Mode** ring and choose either **Auto Ack on Normal** or **User Must Ack**.

Auto Ack on Normal

With this option enabled, when a tag returns to normal state, the alarm is automatically acknowledged. A message is logged to the event file if event logging is turned on for the tag. By default, **Auto Ack On Normal** is enabled.

User Must Ack

With this option enabled, an alarm remains unacknowledged until the operator acknowledges the alarm.

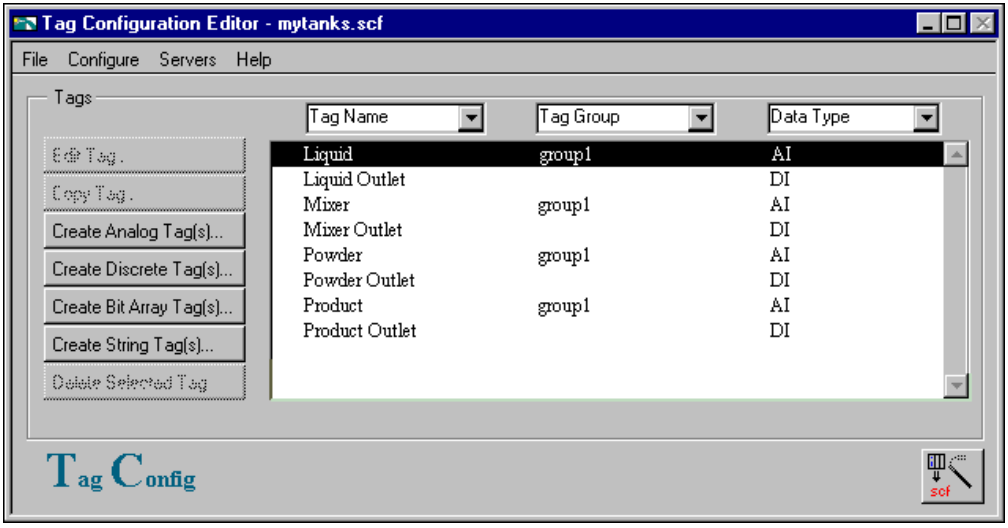


Activity 3-1. Configure a Tag, and View the Tag Configuration Parameters and Tag Values

The objective of this activity is to use the Tag Configuration Editor to configure tags for an HMI application and to become familiar with the Tag Browser and Tag Monitor utilities.

As with all servers, you must register the Tanks Server VI before you can use it. Most of the activities in this manual require the Tanks Server VI, so you must run the Register Tanks Server VI, as indicated in the steps below. For more information about registering servers, see Chapter 8, *Servers*.

1. Open the Register Tanks Server VI, which is located in the `BridgeVIEW\_servers\Tanks Server` directory.
2. Run the VI.
3. Close the VI.
4. Launch the Tag Configuration Editor by selecting **Project»Tag» Configuration…**. This launches the Tag Configuration Editor.
5. Select the configuration file by selecting **File»Open** and choosing `mytanks.scf` from the `BridgeVIEW\Activity` directory. This loads `mytanks.scf` into the Tag Configuration Editor, as shown in the following illustration.



☞ **Note** ***This configuration file uses data simulated by the Tanks Server. You must ensure that the*** `Tanks Server` ***is registered with the BridgeVIEW Engine by selecting*** **Project»Server Tools»Server Browser.** ***If you do not see*** `Tanks Server` ***in the*** **Registered Servers** ***list, run the*** `Register Tanks Server.vi` ***from the*** `BridgeVIEW\_servers\Tanks Server` ***directory.***

If any of the tags in the Tag Configuration Editor List have a prohibited symbol, shown at left, next to them, you have not registered the Tanks Server VI yet. You must register this server before you can use it. For information about how to register this server, see steps 1 through 3 in this activity.

6. Create a tag called `Product` by selecting the **Create Analog Tag(s)…** button.
7. Table 3-10 contains the settings you should choose when configuring your new analog tag. Enter the values listed in the **Setting** column for each attribute in the Tag Configuration dialog box to configure the tag connection, operations, scaling, and alarms. For example, in the **General** tab of the Tag Configuration dialog box, you should type in `Product` as the tag name. After entering all of the values, press the **OK** button to set the tag configuration.

☞ **Note** ***You also can specify a tag name by selecting the proper I/O connections (tag access, item, etc.) and then clicking on*** **Paste Item Name to Tag Name.** ***After doing so, the item name appears in the*** **Tag Name** ***field.***

Table 3-10. Configuration Settings for Activity 3-1

Category	Attribute	Setting
General	Tag Name	`Product`
	Tag Group	`group1`
	Tag Description	`Volume of finished product in liters`
Connection	Tag Access	`Input Only`
	Server Name	`Tanks Server`
	I/O Group	`ALL`
	Item	`tank2`
Operations	Update Deadband (% of range)	`1.00`
	Set Initial Value	Enabled, `0.00`
	Log/Print Events	Enabled
	Log Data	Enabled
	Log Deadband (% of range)	`5.00`
	Log Resolution (engineering units)	`0.10`
Scaling	Engineering Unit	`Liters`
	Scaling	`<none>`
	Raw Full Scale	`1000.00`
	Raw Zero Scale	`0.00`
	Coerce to Range	Disabled

Table 3-10. Configuration Settings for Activity 3-1 (Continued)

Category	Attribute	Setting
Alarms	Enable Alarms	Enabled
	Alarm Acknowledge Mode	`Auto Ack on Normal`
	Alarm Deadband (% of range)	`1.00`
	HI_HI	Enabled, `Limit = 950.00, Priority = 1`
	HI	Enabled, `Limit = 800.00, Priority = 1`
	LO	Disabled
	LO_LO	Disabled
	Bad Status Alarm	Enabled, `Priority = 1`

8. Modify the `Mixer`, `Liquid`, and `Powder` tags, as specified in Table 3-11, to configure them for Historical Logging and Alarm Acknowledgement. To edit a tag configuration, double-click the tag in the Tag Configuration Editor listbox or press the **Edit Tag…** button.

   You can select multiple tags by holding the <Shift> key while dragging or clicking the mouse. When you edit multiple tags, the Tag Configuration dialog box shows three buttons: **Edit Next Tag**, **OK**, and **Cancel**. Select the **Edit Next Tag** to record any edits from the Tag Configuration dialog box and then display the next tag selected. Select **OK** to record any edits from the Tag Configuration dialog and return to the Tag Configuration Editor. Select **Cancel** to discard changes to the current tag and return to the Tag Configuration Editor.

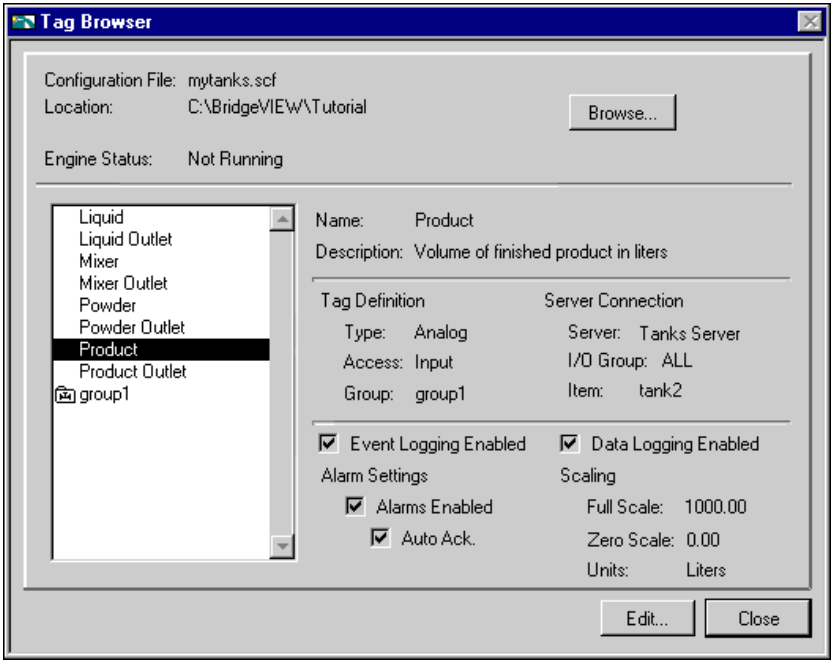
Table 3-11. Configuration Modifications for Activity 3-1

Category	Attribute	Setting
Operations	Log Data	Enabled
	Log Deadband (% of range)	`0.00`
	Log Resolution	`0.10`

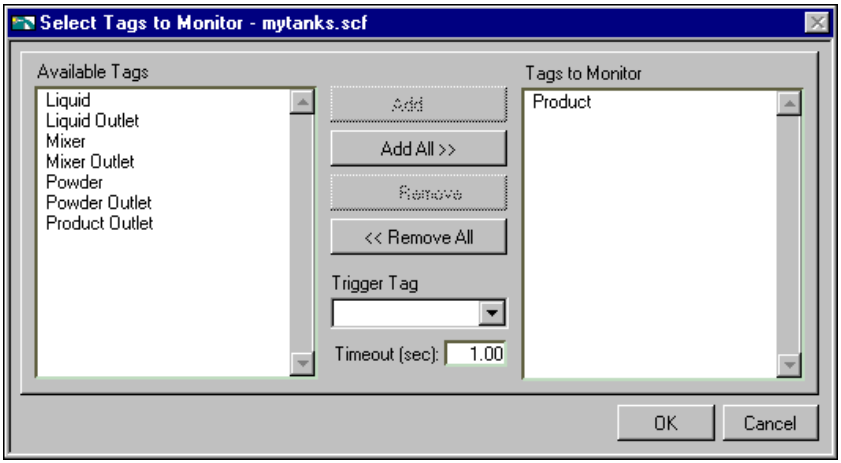
Table 3-11. Configuration Modifications for Activity 3-1 (Continued)

Category	Attribute	Setting
Alarms	Enable Alarms	Enabled
	Alarm Acknowledge Mode	`User must Ack`

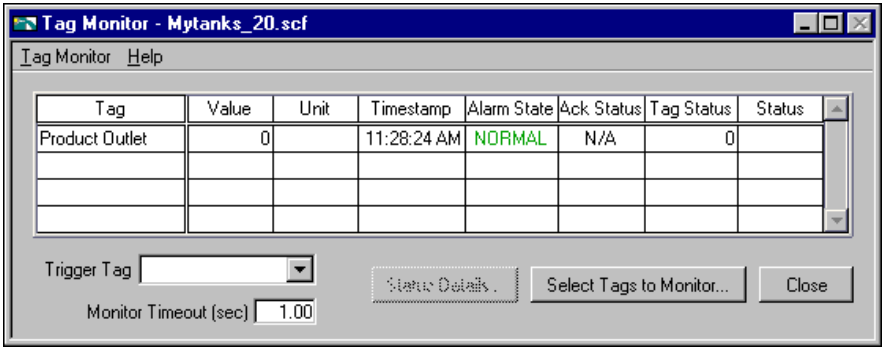
9. Save the configuration by selecting **File»Save**. The modified `.scf` file is provided for you in the `BridgeVIEW\Activity\Solutions` directory.
10. View the tag configuration using the Tag Browser. From a VI front panel, choose **Project»Tag»Browser…** and select different tag names to see the configuration parameters. The Tag Browser is shown in the following illustration.



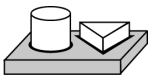
11. Close the Tag Browser.
12. View the tag value and status of the Product tag with the Tag Monitor. Select **Project»Tag»Monitor…**. Select **Product** and click on the **Add>>** button. Then select **OK**. The Select Tags to Monitor dialog box is shown in the following illustration.



The Tag Monitor is a quick way to look at tag values and alarm states without building an HMI. It is also a great debugging tool. When you launch the Tag Monitor, it automatically launches the Engine. The Engine loads the last `.scf` file saved. In this case, it uses `mytanks.scf`. The Tag Monitor is shown in the following illustration.



13. Close the Tag Monitor.



End of Activity 3-1.

How Do You Configure Other Engine Parameters?

There are other Engine parameters you can configure within the Tag Configuration Editor. You can define your Historical Logging Configuration and Event Configuration by selecting **Configure»Historical…** or **Events…** through the BridgeVIEW Tag Configuration Editor dialog box, shown in Figure 3-1.

How Do You Turn on Historical and Event Logging at Startup?

To turn on historical and event logging at startup, select **Configure»Historical…** or **Events…** from the Tag Configuration Editor. Checkboxes in each dialog box turn on historical and event logging at system startup. For more information, see Chapter 5, *Alarms and Events*, and Chapter 6, *Historical Data Logging and Extraction*.

How Do You Set the File Paths for Historical and Events Files?

From the main panel of the Tag Configuration Editor, select **Configure»Historical…** or **Events…**. The dialog box allows you to set the path to the directories containing historical or events files.

How Do You Configure Shifts?

Shifts are valuable in configuring event logging. Shift start and stop times determine how event files are segmented, and end of shift reports can use these configuration files to determine process and line statistics. From the main panel of the Tag Configuration Editor, select **Configure»Events…**. The panel has a shift display with which you can edit the configuration.

How Do You Configure Engine Parameters?

The BridgeVIEW Engine has several default settings for Engine parameters. However, you can override these defaults within the Buffer Configuration dialog box by selecting **Configure»Engine…** from the Tag Configuration Editor.

The BridgeVIEW Engine allocates certain amounts of memory for various queues. You can configure some of the parameters used by the Engine and Tags VIs to allocate memory for the Engine buffers yourself, but it is recommended you use the default values. The parameters you can configure are listed in Table 3-12. For more information about these parameters or the VIs that contain them, refer to Appendix A, *HMI Function Reference*.

Table 3-12. Configurable Memory Allocation Parameters

Parameter	Description	Default Value
System Events display (lines	Determines the maximum number of lines of text to be displayed in the System Errors and Events display of the Engine Manager.	20
Error Message repeat rate (seconds)	Determines the time, in seconds, that recurring error messages should be repeated to the user. For example, an undefined tag message error repeats only after this value is exceeded.	600 secs (10 minutes)
Event History Buffer size (elements)	Determines the length, in elements of the queue that handles event information sent from the Engine to `.evt` files.	2000
Historical Log Queue (elements)	Determines the length, in elements, of the queue that handles data sent from the engine to the Citadel historical database.	2000
Server Input Queue size (elements)	Determines the length, in elements, of the queue that handles data sent from the device servers to the Engine.	2000
Server Input Queue binary size (bytes)	Determines the length, in bytes, of the queue that handles binary data (string tags) sent from the device servers to the Engine.	2000
Server Output Queue size (elements)	Determines the length, in elements, of the queue that handles data sent from the Engine to the device servers.	2000
Server Output Queue binary size (bytes)	Determines the length, in bytes, of the queue that handles binary data (string tags) sent from the Engine to the device servers.	2000
Server Shutdown timeout (seconds)	Determines the time, in seconds, the Engine waits for all active device servers to shutdown before asking the user if the servers are to be forcefully terminated.	30

☞ **Note** ***Although you can configure these parameters, it is highly recommended you maintain the default values.***

How Do You Launch Server Configuration Utilities from the Tag Configuration Editor?

When you register a server in your system, BridgeVIEW registers the location of its configuration utility, if it exists. You can access the server configuration utilities from the **Servers** menu of the Tag Configuration Editor.

☞ **Note** ***When you update the server registry while the Tag Configuration Editor is running, select* Servers»Refresh *to prompt the Tag Configuration Editor to read the updated information.***

How Do You Access or Change Tag Configuration Information in Your Application?

BridgeVIEW allows you read/write access of tag configuration information to use in your application. This is often helpful when displaying engineering units, scales, and other information about the tag or changing a tag from `Offscan` to `Onscan`. The Tag Attributes VIs obtain and determine this information. The Tag Attributes VIs are listed below.

- Get Tag Attribute
- Set Tag Attributes
- Set Multiple Tag Attributes
- Get Tag Description Group
- Get Tag I/O Connection Info
- Get Tag Logging Info
- Get Tag Range and Units
- Get Tag Alarm Enabled
- Get Analog Tag Alarm Limit
- Get Discrete Tag Alarm Setting
- Get Bit Array Tag Alarm Setting
- Get Tag Bad Status Alarm

More information and an activity that use the Tag Attributes VIs can be found in the *Tag Attributes VIs* section of Chapter 7, *Advanced Application Topics*. For complete information about these, and other VIs, see Appendix A, *HMI Function Reference*.

4

Human Machine Interface

This chapter explains what a Human Machine Interface (HMI) is and how you can monitor and control tags from your HMI. This chapter also describes several general principles of HMI programming in G, and provides activities that illustrate how to accomplish the following:

- Build your HMI using the HMI G Wizard
- Customize front panel objects with imported graphics

Note ***To understand the concepts, and to complete most tasks associated with building an HMI, you should be familiar with the basic functionality of G programming. If you have not completed the G Tutorial section of this manual, you should do so now.***

The example diagrams shown in this chapter are taken from several HMI examples you can find in the `BridgeVIEW\Examples\HMI Examples` folder.

What Is an HMI?

An HMI is the interface through which an *operator* interacts with the BridgeVIEW system and with the outside environment that BridgeVIEW monitors and controls. The operator is the end user of the system.

To monitor the changes in configured tags in real time, you can build one or more Human Machine Interface (HMI) applications.

BridgeVIEW includes a set of VIs with which you can control your HMI, access the Real-Time Database and Citadel, perform calculations and logic, and switch between different displays. The BridgeVIEW VI library includes Alarms and Events VIs, Historical Data VIs, System VIs, Tags VIs, and Tag Attributes VIs. For more information about these VIs, see Appendix A, *HMI Function Reference*. For more information about the G VI Library, see the **Online Reference**.

There are several general G programming principles with which you should be familiar before you build an HMI. These principles are listed below:

- Building basic G front panels and diagrams
- Using controls and indicators
- Using the tag data type
- Using the basic principles of dataflow programming
- Using basic programming constructs such as the Sequence structure and While Loop
- Using the Time and Dialog VI library

To learn about any of the topics above, see the *G Tutorial* section of this manual and complete the activities. For more detailed information, see the *G Programming Reference Manual*.

For more advanced HMI programming, you also should know how to use the G control and indicator attribute nodes and the VI Server functions. For more information about this topic, see Chapter 13, *Front Panel Object Attributes*, and Chapter 15, *Application Control*.

You might want to divide your HMI into several panels so the operator can navigate through them using buttons on the screen. The Panel G Wizard helps you generate the navigation system by automatically generating code and attaching it to front panel buttons. For more information about the Panel G Wizard, see Chapter 7, Advanced Application Topics.

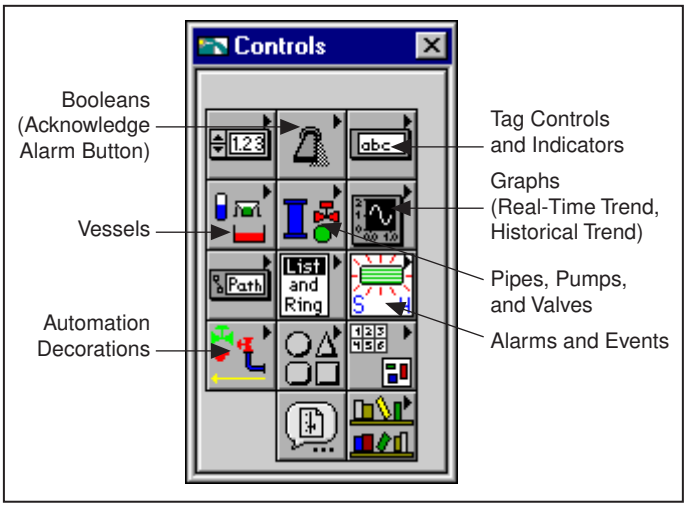
How Do You Build an HMI?

To build an HMI, use the graphical controls and indicators to lay out the user interface objects on the front panel, and a special set of VI libraries on the block diagram to do the following:

- Read and write tag values
- View and acknowledge alarm states and events
- Display historical and real-time data
- Read tag configuration and security information
- Control the BridgeVIEW system programmatically
- Access and change tag attributes
- Control output tags

Front Panel Objects

A *front panel* is the user interface of a virtual instrument (VI). You build the front panel of a VI with a combination of controls and indicators representing the values of the tags. Controls are the means of supplying data to your VI, and indicators display data that your VI generates. There are many types of controls and indicators available from the **Controls** palette, shown in the following illustration. You can choose objects to place on your front panel such as real-time trend displays, alarms and events displays, and numeric indicators. You also can choose automation symbols, such as vessels, pumps, and valves.



To develop an HMI application, configure your tags, create the front panel interface and then use the HMI G Wizard to build your block diagram. For more information about how to use the HMI G Wizard, refer to the *HMI G Wizard* section in this chapter. If you prefer to build the block diagram on your own, without the assistance of the HMI G Wizard, you may do so, or you can get started by building a basic block diagram with the HMI G Wizard and then building upon that to create a more advanced HMI on your own.

HMI G Wizard

The *HMI G Wizard* provides an easy interface for you to generate repetitive pieces of diagram code. If you are new to G programming, the HMI G Wizard can be an immense help in building simple tag monitoring and control loops.

The HMI G Wizard associates a front panel control or indicator with a tag, and generates the necessary Wizard subdiagram for a configuration that you specify. Table 4-1 provides a list of front panel objects, and explains how the HMI G Wizard operates on each of them.

Table 4-1. HMI G Wizard Operations

HMI Function	Front Panel Object	Description
Control analog tags	Numeric Control	Invoke the HMI G Wizard on a numeric control to associate an analog output tag value with that control. You can set the colors and blink options under alarm conditions, and specify the updates to happen only when the control value changes.
Display analog values	Numeric Indicator	Invoke the HMI G Wizard on a numeric indicator to associate an analog input tag value with that indicator. You can set the color and blink options under alarm conditions.
Control discrete tags Acknowledge alarms	Boolean Control	Invoke the HMI G Wizard on a Boolean control to associate a discrete output tag value or an alarm acknowledgement state (Alarm Acknowledgement) with that control. When you invoke the Wizard for the first time on a Boolean control, the Configuration dialog box is set for Tag Value. To change the control association from tag value to alarm acknowledgement mode, change the **Attach Control to:** ring to **Alarm Acknowledgement**. Select a set of tags that requires acknowledgement when the Control value is set to TRUE. You can set blink and color options under **Alarm Conditions**. A preformatted **Acknowledge Alarm** button is contained in the **Boolean Controls** palette.

Table 4-1. HMI G Wizard Operations (Continued)

HMI Function	Front Panel Object	Description
Display discrete values Indicate an alarm state	Boolean Indicator	Invoke the HMI G Wizard on a Boolean indicator to associate a discrete input tag value or an alarm state with that indicator. When you invoke the Wizard for the first time on a Boolean indicator, the Configuration dialog box is set for Tag Value. You can set blink and color options under **Alarm Conditions**. To change the control association from tag value to alarm state, change the **Attach Indicator to:** ring to **Tag Alarm State**. Select the tag for which the indicator will display the alarm state.
Control string tags	String Control	Invoke the HMI G Wizard on a string control to associate a string output tag value with that control. You can set the colors and blink options under alarm conditions, and specify the updates to happen only when the control value changes.
Display string values	String Indicator	Invoke the HMI G Wizard on a string indicator to associate a string input tag value with that indicator. You can set the color and blink options under alarm conditions.
Display alarm summary	Alarm Summary Display or any Table Indicator	Invoke the HMI G Wizard on a table indicator to obtain a summary of current alarms (Alarm Summary). You can set the HMI G Wizard to Alarm Summary mode by setting the value of the **Use this Indicator for:** ring to **Alarm Summary**. You can select a set of tags whose alarms require monitoring. You also can set colors of acknowledged and unacknowledged alarms and column format of the summary. Preformatted alarm summary indicators are contained in the **Alarms and Events** palette.

Table 4-1. HMI G Wizard Operations (Continued)

HMI Function	Front Panel Object	Description
Display event history information	Event History Display or any Table Indicator	Invoke the HMI G Wizard on a table indicator to obtain a history of past events and alarms (Event History). For an event history display, you can set the HMI G Wizard to Event History mode by setting the value of the **Use this Indicator for:** ring to **Event History**. You can select a set of tags whose history needs to be displayed. You also can set colors of acknowledged and unacknowledged alarms, normal and event entries, and column format of the summary. Preformatted event history indicators are contained in the **Alarms and Events** palette.
Display a real-time trend	Real-Time Trend or Waveform Chart Indicator	Invoke the HMI G Wizard on a real-time trend or waveform chart indicator to select a set of tags for which the values need to be displayed in a chart (real-time trend).
Display a historical trend	Historical Trend or XY Graph Indicator	Invoke the HMI G Wizard on a historical trend or XY graph indicator to select a set of tags for which the values need to be displayed in an XY graph (historical trend).

To invoke the Wizard, pop up on a front panel object, and select **HMI G Wizard…**. For example, the HMI G Wizard dialog box for an analog input tag appears in Figure 4-1 by popping up on a numeric indicator.

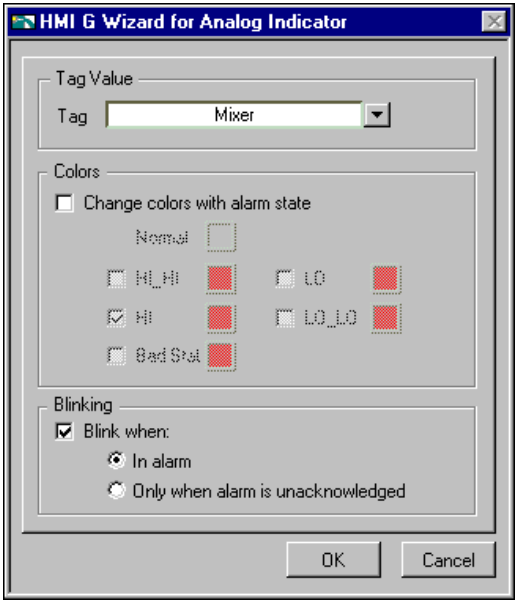


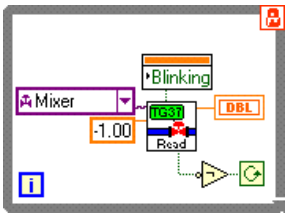
Figure 4-1. HMI G Wizard Dialog Box

When you invoke the HMI G Wizard on one of the front panel objects listed in Table 4-1, a dialog box appears for that object. You can associate the front panel object with a tag, and set the various parameters. When you select **OK** in the dialog box, the Wizard generates diagram code according to the dialog entries and pastes the code on the block diagram.

From the HMI G Wizard, you can also right-click on the tag selection list and select **Copy Tag…**, **Edit Tag…**, or **Create Tag…**, to edit or copy the selected tag, or create a new one using the Tag Configuration Editor. When you select **OK**, the newly created or edited tag is automatically saved to the current `.scf` file, and you are returned to the HMI G Wizard. For more information about the Tag Configuration Editor, see Chapter 3, *Tag Configuration*.

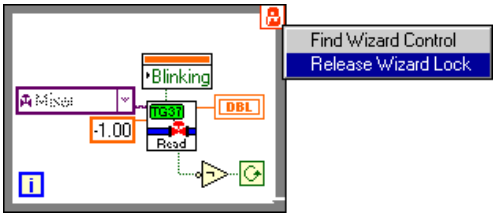
Generate the Block Diagram

Once you associate a front panel object with a tag and set the various parameters, the HMI G Wizard generates the appropriate code and places it on the block diagram. For example, using the HMI G Wizard for Analog Indicator, shown in Figure 4-1, the following Wizard subdiagram appears on the block diagram.

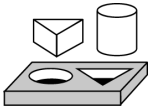


Front Panel Object and Wizard Subdiagram Association

When the HMI G Wizard has created a block diagram, there is an association between the front panel object and the generated Wizard subdiagram. The association is protected by a *Wizard lock* which prevents you from editing the Wizard subdiagram. The lock glyph on the loop, shown at left, indicates that the Wizard has locked the subdiagram. While the subdiagram is locked, you can pop up on the front panel object, select **HMI G Wizard…**, and change your selections in the dialog box. To edit the Wizard subdiagram, pop up on the Wizard subdiagram and select **Release Wizard Lock**, as shown below.



Note ***Once you have released the Wizard lock, the association is broken. The Wizard no longer identifies the Wizard subdiagram as being created by it.***



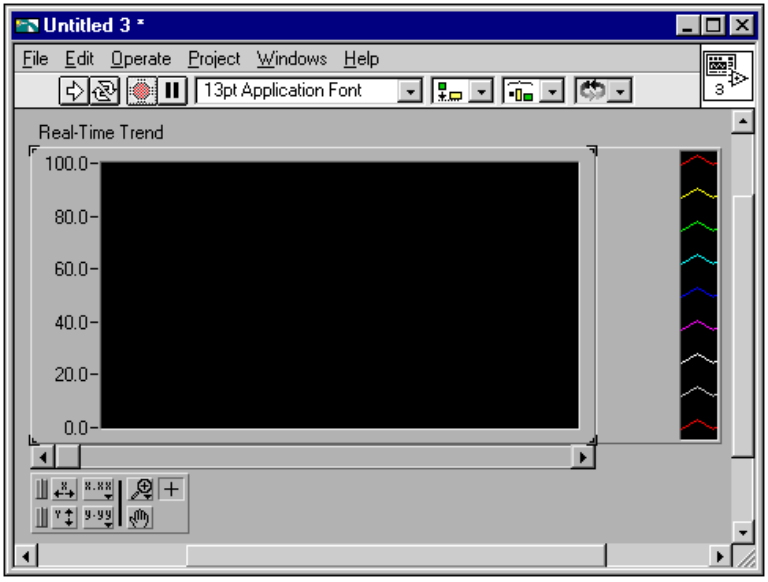
Activity 4-1. Use the HMI G Wizard

Your objective is to create a simple HMI using the HMI G Wizard.

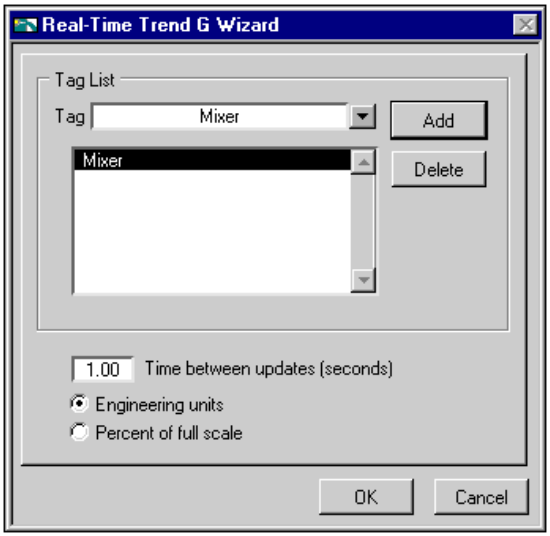
For this activity, you will use the tags configured in `mytanks.scf`, which you edited in Activity 3-1 and is located in the `BridgeVIEW\Activity` directory.

Note ***Before you can begin this activity, you must have completed Activity 3-1, Configure a Tag, and View the Tag Configuration Parameters and Tag Values, in Chapter 3.***

1. Place a real-time trend from the **Controls»Graph** subpalette on your front panel. Pop up on the object and select **Show»Label**. Type `Real-Time Trend` in the label.



2. Pop up on the trend and select **HMI G Wizard…**.
3. Now you can select a list of tags to monitor. Select **Mixer**, and click on **Add**, as shown in the following illustration.

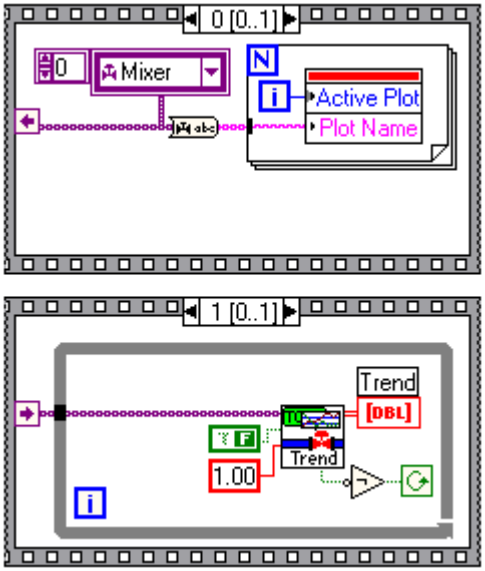


If you do not see a list of available tags or the tag name **Mixer** is not in the list when you click on the **Tag** menu ring, pop up on the menu ring and select **Tag Browser…** to select the correct `.scf` file. Press the **Browse…** button on the Tag Browser to bring up a dialog box and select `mytanks.scf`. This dialog box automatically appears if no `.scf` file is currently selected.

If the Engine is running already, the **Browse…** button is dimmed and you cannot change the `.scf` file until you stop the Engine. The Tag Browser shows you a summary of the configuration parameters of the tags in the file.

When you have selected the proper `.scf` file from the Tag Browser, click **OK** to return to the HMI G Wizard.

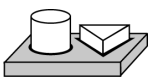
4. Click **OK**. Notice that the HMI G Wizard has created the block diagram for you, as shown in the following illustration.



5. Return to the front panel and run the VI. It launches the Engine if it is not running already. The Engine reads `mytanks.scf` and launches the Tanks Server.
6. Now, you can see the Mixer tag values being monitored in the real-time trend. Select **Operate»Stop** to stop the VI.

   Diagrams generated by the HMI G Wizard have a lock on the top right corner of the outermost structure. You cannot edit the code inside the structure until you release the lock. However, you can pop up on the front panel object, select HMI G Wizard, and change your selections in the dialog box. When you press **OK**, the changes are incorporated into the previously generated diagram.

   The locked code is very tightly coupled with the front panel object. If you delete the front panel object, the block diagram associated with it is deleted automatically.
7. Save the VI as `My Tank HMI.vi` in the `BridgeVIEW\Activity` directory.



End of Activity 4-1.

How Do You Customize Front Panel Objects?

You can customize BridgeVIEW controls and indicators to change their default appearance on the front panel with the Control Editor. You also can save these controls for use in other VIs. Programmatically, they function the same as standard BridgeVIEW controls.

Control Editor

You launch the Control Editor by selecting a control on the front panel with the Positioning tool and choosing **Edit»Edit Control…**. The Control Editor appears with the selected front panel object in its window. The Control Editor has two modes: the Edit mode and the Customize mode.

The Edit mode allows you to pop up on a control and manipulate its setting(s). The Control dialog box is shown below.

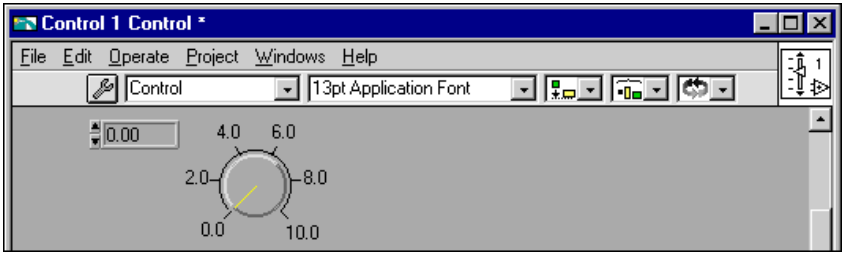


Figure 4-2. Control Dialog Box

While in the Customize mode, you can move the individual components of a control around with respect to each other. For a listing of what you can manipulate in customize mode, select **Windows»Show Parts Window**. Not only can you customize the appearance, but you can use the control in other VIs. Save it as a custom control by selecting **Save**. You can save it with different definitions such as control, type definition, or strict type definition which controls how much of the control can be modified in other VIs. After you save the control, you can place it on other front panels using the **Controls»Select a Control…** option. For more information, refer to Chapter 24, *Custom Controls and Type Definitions*, in the *G Programming Reference Manual*.

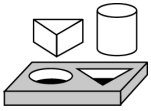
When you edit a control, a new window opens with a copy of the control. You can customize the control by coloring it, changing its size, adding new elements to clusters, and so on. These changes do not affect the original VI until you select **File»Apply Changes**, or you close the window and select **Yes** to the prompt concerning replacing the original control.

If you want to use the control in other VIs, you can save it as a custom control by selecting **File»Save**. After you save the control, you can place it on other front panels using the **Controls»Select a Control…**.

Importing Graphics

You can import graphics from other programs for use as background pictures, as items in ring controls, or parts of other front panel controls. Before you use a picture in BridgeVIEW, you must load it into the BridgeVIEW clipboard. To load an example of this type of control, right-click the front panel and select **Controls»Select a Control…**, and open `Example\G Examples\General\controls\custom.llb box`.

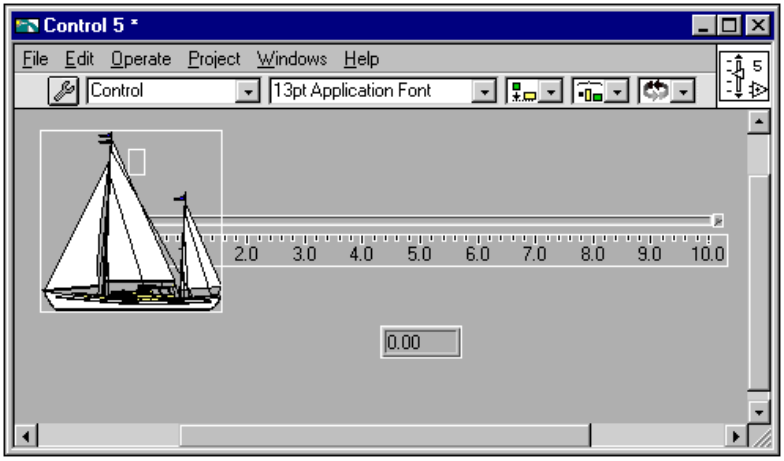
If you copy an image directly from a paint program to the Windows clipboard and then switch to BridgeVIEW, BridgeVIEW automatically imports the picture to the BridgeVIEW clipboard. Or you can select **Edit»Import Picture from File…** to import a graphics file into the BridgeVIEW clipboard. Once a picture is in the BridgeVIEW clipboard, you can paste it as a static picture on your front panel, or you can use the **Import Picture** option of a popup menu, or the **Import Picture** options in the Control Editor. Picture files supported include `EMF`, `BMP`, and `WMF` files.



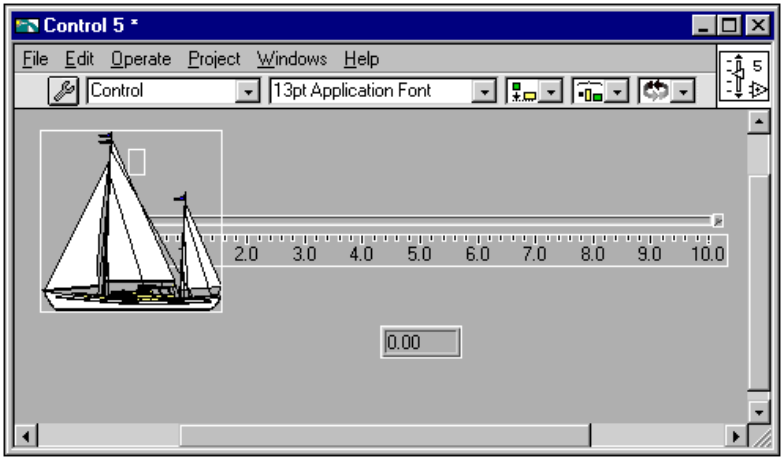
Activity 4-2. Import a Graphic Image into BridgeVIEW

Your objective is to use a graphic image created in an external drawing package in a BridgeVIEW front panel control.

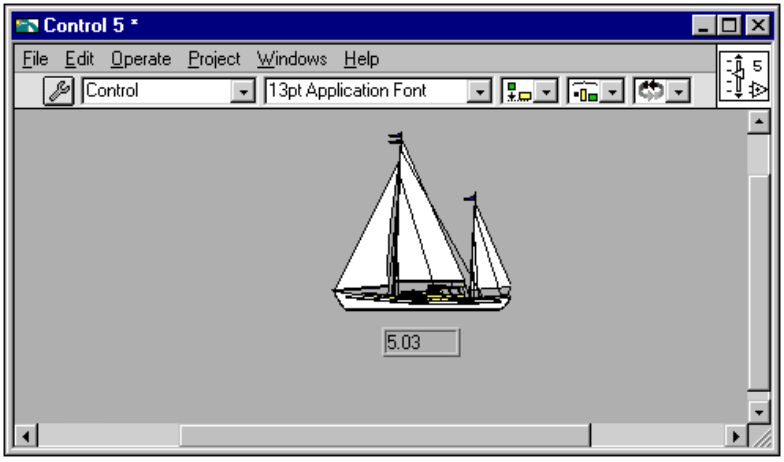
1. In BridgeVIEW, select **File»New** to create a new VI. With the front panel open, select a **Horizontal Pointer Slide** from **Controls»Numeric**. Pop up on the slide (click on it with the right mouse button) and select **Change to Indicator**.
2. With the Positioning tool, grab the upper-right corner of the slide and stretch it to the right, to make the slide longer. If you hold down the <Shift> key when you click and drag the mouse, you will restrict the stretch to one direction. Move the Digital Display of the slide to a central location below the slide.
3. Select the slide with the Positioning tool and select **Edit»Edit Control…**. The Control Editor window appears, as shown in the following illustration.



4. Click on the **Edit Mode** button in the Control Editor toolbar. The wrench changes to a pair of tweezers to illustrate that you are in Customize mode. In Customize mode, the control is broken into several parts. You cannot operate the control while the Control Editor is in Customize mode.
5. Select **Edit»Import Picture from File…** from the Control Editor menu bar. A file dialog box prompts you to select a picture file to open. Open `boat1.wmf` from the `BridgeVIEW\Activity` directory.
6. Pop up on the pointer of the slide and select **Import Picture**. The boat image is imported onto the triangular pointer of the slide, as shown in the following illustration.

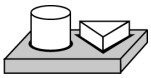


7. Click on the pair of tweezers to return to Edit mode. You can finish editing the control in Edit mode.
8. Pop up on the housing of the slide and select **Scale»Style»None**. The scale for the slide disappears.
9. Change tools to the Color tool. To do this, you either can select the tool from the palette, if visible, or you can use the <Tab> key to rotate through the tools until the Color tool is selected. Pop up on the housing for the slide with the Color tool, and select the transparent color. The housing disappears, as shown in the following illustration.



With the Operator tool, you can operate the "slide." Notice that the digital display continues to update as you move the boat on the screen. If you want to hide the digital display, pop up on the boat and deselect **Show»Digital Display**.

10. Save this control as `Boat1.ctl` in the `BridgeVIEW\Activity` directory.



End of Activity 4-2.

How Do You Configure Front Panel Objects Programmatically?

BridgeVIEW has objects called attribute nodes which are special block diagram nodes you can use to control the appearance and functional characteristics of controls and indicators from your diagram. You can set attributes such as display colors, visibility, position, blinking, trend scales, and many more. See Chapter 13, *Front Panel Object Attributes*, or Chapter 7, *Advanced Application Topics*, for more information.

How Do You Monitor and Control Tags?

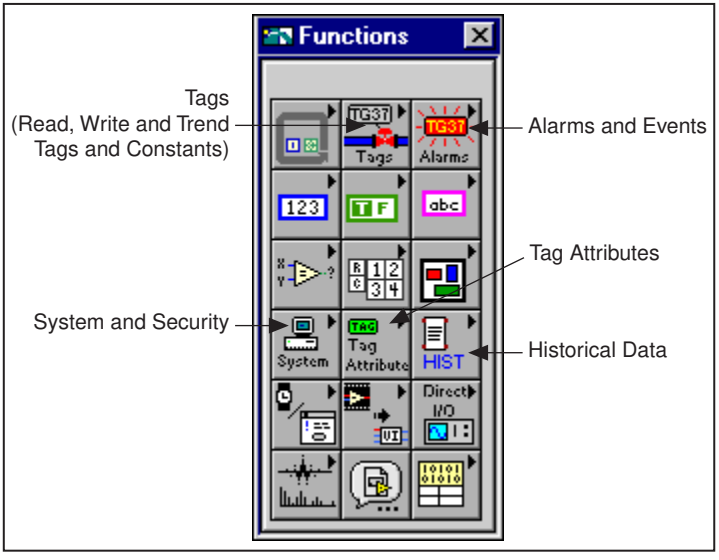
The Tags VI library and Alarms and Events VI library contain VIs for your HMI application to interact with the BridgeVIEW Real-Time Database. These are the primary VIs you use to build your HMI. You can use these VIs to accomplish the following:

- Read tag values
- Write tag values
- Monitor tag and tag group alarm and event states
- Acknowledge alarms by tag and tag group

There are other VI libraries that contain VIs with which you can add additional functionality and sophistication to your HMI. These VIs do not interact directly with the BridgeVIEW RTDB. Instead, you can query as well as control other features of the BridgeVIEW system. These VI libraries are as follows:

- Tag Attributes
- Historical Data
- System, which includes Security VIs

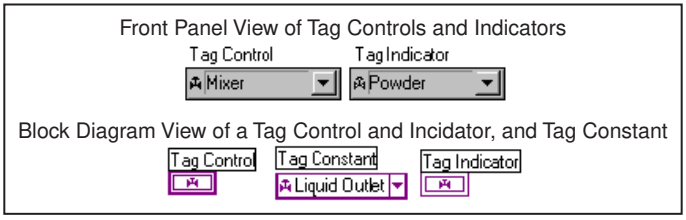
You can reach these VIs through the **Functions** palette, shown below.



Tag Data Type

BridgeVIEW has a special data type called the tag data type that is aware of the available tag names and tag group names contained in the current `.scf` file. All BridgeVIEW functions that can operate on tags or tag groups use the tag data type. The tag data type is marked with a valve glyph. Constants and wires in the block diagram carrying this tag information are displayed in purple.

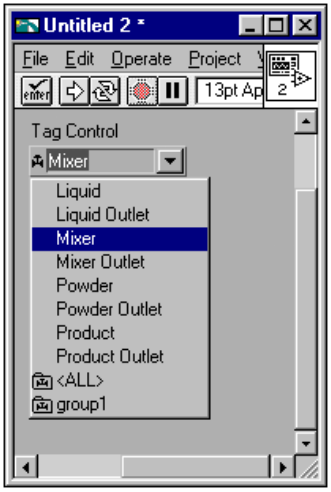
The tag control and indicator can be found in the **Controls»Strings** palette. The tag constant can be found in the **Functions»Tags** palette. The **Functions»Tags** palette also contains functions that convert between a tag data type and a string data type, and a special "not a tag" constant. The following illustration shows the tag control, indicator and constant as they appear on the front panel and block diagram.



Tag controls, indicators and constants also can be contained in arrays. Many BridgeVIEW VIs operate on arrays of tags.

When you drop a tag control, indicator, or constant on a front panel, you can click on the right menu ring button of the tag control to display a list of the available tags and tag groups and select one.

Tag groups are distinguished from individual tags in the list by a folder glyph. A special group `<ALL>` also appears in the list. This is a default group that contains all the tags in your `.scf` file. The following illustration shows a list of tags and tag groups.



You also can enter the name of the tag you want to use. The tag control performs a Type Look Ahead as you type, and displays the closest tag or group name to what you enter. By default, the tag control does not allow you to enter a name that is not contained in the current `.scf` file.

You can configure each tag control, indicator, or constant to permit entry of names not contained in the current `.scf` file by right-clicking on the tag object and selecting **Allow undefined tags**, as shown in the illustration below. If a tag name is not in your `.scf` file, you cannot select it.

The tag data type imports tag and tag group names from a tag configuration file (`.scf`). When you launch BridgeVIEW, the tag data type list of available tag names and tag group names is automatically updated from your default `.scf` file. The default `.scf` file is the last file you edited in the Tag Configuration Editor. If the list of names is empty, you have no default `.scf` file.

To change the currently selected `.scf` file, right-click on the tag control, indicator, or constant, and select **Tag Browser…**. Press the **Browse…** button to bring up a dialog box from which you can select the `.scf` file you want to use. This is possible as long as the BridgeVIEW Engine is not running. When the Engine is launched, the Tag Browser runs the currently selected `.scf` file. You cannot change the current `.scf` file until you stop the Engine.

You can create, edit or copy a tag by right-clicking on the tag control, indicator, or constant, and selecting **Create Tag…**, **Edit Tag…**, or **Copy Tag…**. Selecting any of these options invokes the Tag Configuration Editor. Any new or changed tags are automatically saved to the `.scf` file, and the list of available tags is then updated. For more information about the Tag Configuration Editor, see Chapter 3, *Tag Configuration*.

Tag constants in your diagram (and tag controls and indicators if they are saved with default values) retain the tag name or tag group name selected when your VI is saved. The name contained in the tag control, indicator or constant is dimmed when the name is not contained in the currently selected `.scf` file. This might be because the tag name has been deleted from the `.scf` file, or the VI was created using a different `.scf` file. If you try to run the VI at this point, you will get a system error for each tag that is undefined in the current `.scf` file. You can control which `.scf` file the BridgeVIEW Engine runs programmatically. This capability is covered in Chapter 7, Advanced Application Topics.

Tags VIs and Alarms and Events VIs

The Tags VIs and Alarms and Events VIs have several properties in common. With these VIs, you operate on tags by wiring the tag name or tag group name into the **tag name** or **group/tag name** input of the VI when you place them in your diagram. These are required inputs. Some VIs accept arrays of tag names or tag and tag group names.

The Tags VIs and Alarms and Events VIs return several flags that indicate the state of the BridgeVIEW Engine. They return a Boolean **error** flag to indicate whether the operation was successful. If the **error** flag is TRUE, the tag specific information returned by the VI might not be valid. Some VIs also return a more detailed **value status** variable.

All the VIs return a **shutdown** indication. If TRUE, this output indicates that the BridgeVIEW Engine is in the shutdown state, and your application must finish execution so that shutdown can finish. If the BridgeVIEW Engine goes into the shutdown state while these VIs are waiting on an event, the VI terminates the wait and returns immediately to the calling diagram. You can use this output to tell your diagram to complete execution.

All VIs that read information from the BridgeVIEW database can return information immediately or wait for the database to be updated with new information before returning. The **timeout** input controls this behavior. This input tells the VI how long to wait, in seconds, for the tag information to be updated in the Real-Time Database.

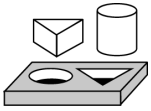
If **timeout** is 0 seconds, the VI immediately reads the database and returns the current tag information. If **timeout** is less than 0, the VI continues to wait until the tag is updated or the Engine shuts down. If **timeout** is greater than 0, the VI waits until the tag is updated in the database, or the timeout

period is exceeded, whichever occurs first, then reads the database and returns the current tag information. By default, **timeout** is 0 seconds.

If you wire nothing into the **timeout** input of your diagram, the VI reads the database and returns immediately. How you use the **timeout** input depends on whether you want to implement event-driven or polled programming techniques in your HMI.

All VIs that read information form the BridgeVIEW database have a **changed?** output that is TRUE if the returned information is new or updated. If the VI returns and **changed?** is FALSE, the VI might have timed out, or the information in the database did not change since the last time you read it. You can use this output to make your program more efficient by using a case statement to update the user interface only if the information has changed.

Some of the more advanced Tags VIs and Alarms and Events VIs also return an **initialize headers** or **config changed** output that tells your program whether your HMI object needs to be initialized with new information. In most cases, this corresponds to the first time the VI is called, and you only need to update that part of your user interface once. For more information about the Tags VI Library, refer to Appendix A, *HMI Function Reference*.



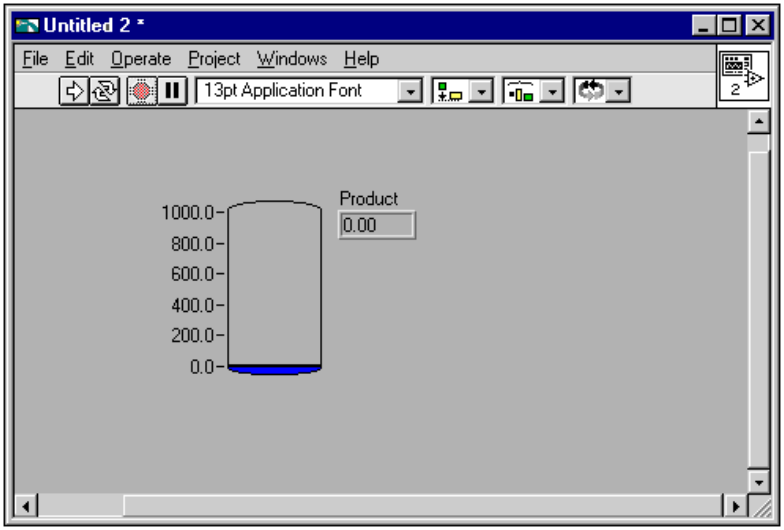
Activity 4-3. Read a Tag

Your objective is to monitor a single tag value using the Read Tag VI.

In this activity, the Read Tag VI returns when a new value for the tag is acquired from the Tanks Server, and updated in the RTDB, or a timeout of 1 second is exceeded, whichever occurs first. This loop continues executing until the Engine shuts down. You will use `mytanks.scf` in the `BridgeVIEW\Activity` directory, which you edited in Activity 3-1, *Configure a Tag, and View the Tag Configuration Parameters and Tag Values*.

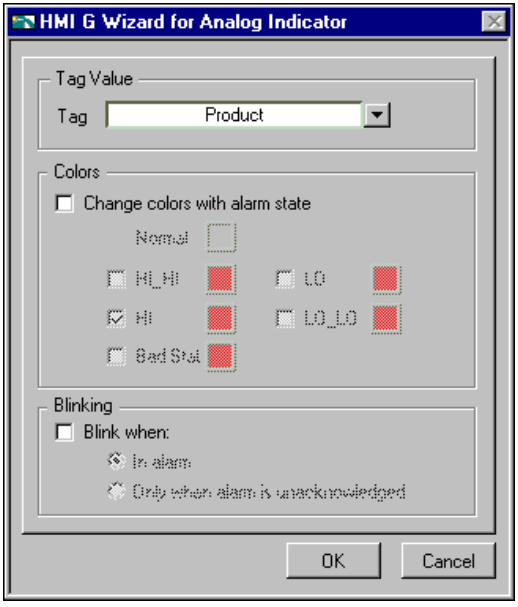
Front Panel

1. Open a new VI (**File»New**) and place a tank on the front panel (**Vessels»Tanks**). Label the tank `Product`. Edit the tank scale to range from 0 to 1000.

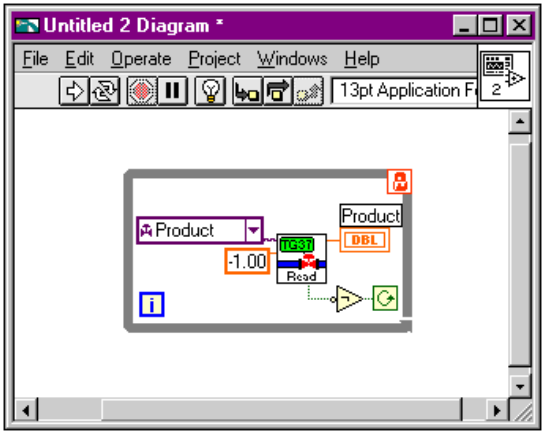


Block Diagram

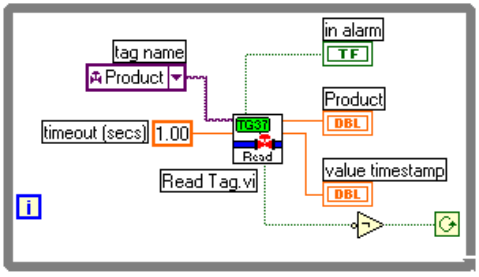
2. To create the block diagram, pop up on the tank and select **HMI G Wizard…**. Select **Product** for the Tag and click **OK**, as shown in the following illustration.



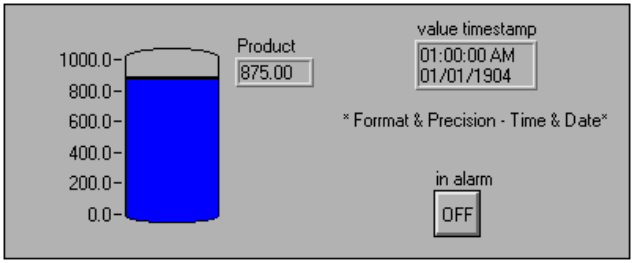
3. The HMI G Wizard generates a diagram for you that calls the Read Tag VI, as shown in the following illustration.



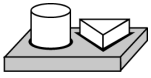
4. Pop up on the lock in the top right corner of the While Loop and select **Release Wizard Lock**.
5. Using the Labeling tool, edit the **timeout** input to the Read Tag VI from its default `-1.00` (indefinite) to `1.00`.
6. Using the Positioning tool, select the bottom right corner of the While Loop and expand it.
7. Using the Wiring tool, pop up on the **value timestamp** output of the Read Tag VI and select **Create Indicator**. Pop up on the **in alarm** output of the Read Tag VI and select **Create Indicator**. The block diagram should appear as shown in the following illustration.



8. From the front panel, change the format of **value timestamp** to display absolute time. Pop up on the `value timestamp` indicator, select **Format & Precision**, and set Format to **Time & Date**. Your front panel should appear as shown in the following illustration.



9. Save the VI as `Monitor Product.vi` in the `BridgeVIEW\Activity` directory.
10. Run the VI. The Engine launches, unless it is running already. The tank level changes to reflect the changing values of the Product tag. When the value goes over 800, the `in alarm` Boolean changes from OFF to ON, indicating an alarm condition.



End of Activity 4-3.

How Do the Tags, and Alarms and Events VIs Affect Startup/Shutdown?

When a user-defined VI runs and executes one of the Tags VIs or Alarms and Events VIs, that VI checks the status of the BridgeVIEW Engine. If it is not running, executing the VI automatically starts execution of the BridgeVIEW Engine. The BridgeVIEW Engine loads and executes all required device servers. When the VI returns, the Engine is running.

The BridgeVIEW Engine continues to run until you shut it down either programmatically or through the Engine Manager. As the Engine shuts down, first it checks to see if any application is running that requires its services. If so, it waits until that application halts before shutting down. Once it shuts down, it sends a shutdown message to the device servers.

You can monitor the status of the BridgeVIEW Engine with the **shutdown** output of any of the Tags VIs, Alarms and Events VIs, or the Get Engine Status VI.

Note ***If you write applications that do not use the BridgeVIEW VIs that access the Real-Time Database such as the VIs that retrieve historical data, those applications can run without the BridgeVIEW Engine running. They do not launch the BridgeVIEW Engine.***

General Principles of G HMI Programming

You can choose how to monitor and control tag values as well as operator interface controls and indicators in your HMI. Normally, you use one or more While Loops in a VI diagram with a single wait operation inside of each loop. Each While Loop executes once after its wait operation completes. The wait operation might be one of the Time and Dialog functions such as the Wait Until Next ms Multiple function. This is a polled technique in which your diagram controls loop execution.

Alternatively, the wait operation might be implemented using one of the Tags VIs or Alarms and Events VIs with **timeout** wired to a non-zero value. These are the types of diagrams created by the HMI G Wizard. This is an event-driven technique, in which a tag or alarm event controls loop execution. Either technique is appropriate, depending on your HMI needs.

You can wait on multiple events for which timing is not related to each other in parallel on the same diagram, as long as you wait for each event in a separate While Loop. This section covers the following topics:

- Event-driven programming
- Polled programming
- Multiple loop applications
- Real-time trends
- Programmatic HMI indicator configuration

How Do You Implement Event-Driven Programming in G?

Event-driven programming means your block diagram waits for one or more events to happen and, as each event occurs, the part of your program waiting on that event is executed. In G, you can develop applications that wait on different events and do operations in parallel by using multiple While Loops in your diagram.

Figure 4-3 shows an example using event-driven programming to monitor tag value and tag alarm state. One loop monitors the value of the `Mixer` tag and another loop monitors alarm information for the `Mixer` tag. These two loops run independently of each other. When the `Mixer` tag value changes, or when `1.00` second has elapsed, the Read Tag VI returns and updates the `Mixer in Alarm`, `Mixer`, `value timestamp`, and `bad value` indicators. When the `alarm state` of the `Mixer` tag changes, or `5.00` seconds have elapsed, the Read Tag Alarm VI returns and updates the

`alarm state` indicator, and controls the blinking of the `Mixer in Alarm` indicator. Both loops run in parallel until **shutdown** is TRUE.

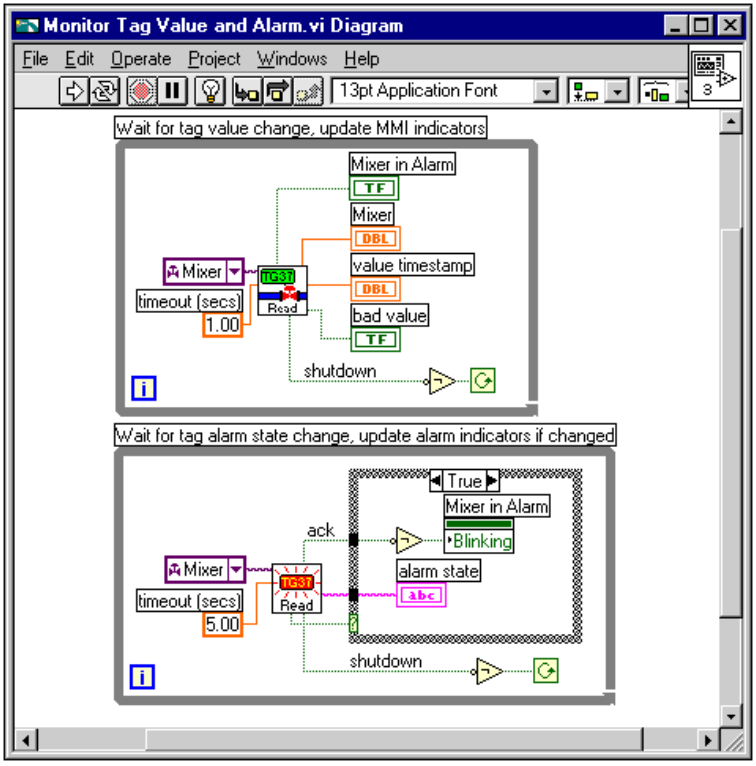


Figure 4-3. Monitor Tag Value and Alarm VI

The `Mixer in Alarm Blinking` attribute and the `alarm state` indicator are updated only when the **changed?** output of the Read Tag Alarm VI is TRUE. This example demonstrates how you might use the **changed?** output. In this example, it is not important to use the Case structure because BridgeVIEW indicators update only when the displayed information actually changes.

If you use a large number of indicators or attribute nodes or more complex indicators such as tables and graphs, updating the indicator when changed by using a Case structure in your diagram can improve the display performance of your VI.

How Do You Implement Polled Programming in G?

You do not have to use a separate loop for each Tags or Alarms and Events VI. This can be cumbersome to program for a large number of tag reads, although using the HMI G Wizard makes it easy to build separate loops quickly. The alternative is to poll the database for several tags at regularly timed intervals. You usually need one While Loop in your diagram to poll your front panel controls, so you can monitor what the operator is doing. Using polling, you can combine monitoring of HMI controls with the reading in of tag values and alarm states.

Figure 4-4 shows an example implementing a more complex user interface that polls all the input tags as well as the front panel **Start Batch** button at 100 m/s intervals. When you leave the **timeout** input unwired, all Read Tag VIs read the BridgeVIEW database immediately by default.

☞ **Note** ***In this case, you must explicitly program the loop wait time by using the Wait Until Next ms Multiple VI. If you do not, the loop operates as often as possible, and requires most of the CPU time.***

This example also illustrates use of the Write Tag VIs. In this case, the Write Tag (discrete) VI is called only when the front panel button is pressed. In other cases, you might want to write the tag value at each iteration. You also can use the Write Tag on Change VI to update the RTDB only when the value of the front panel control changes. This can improve your over all application performance.

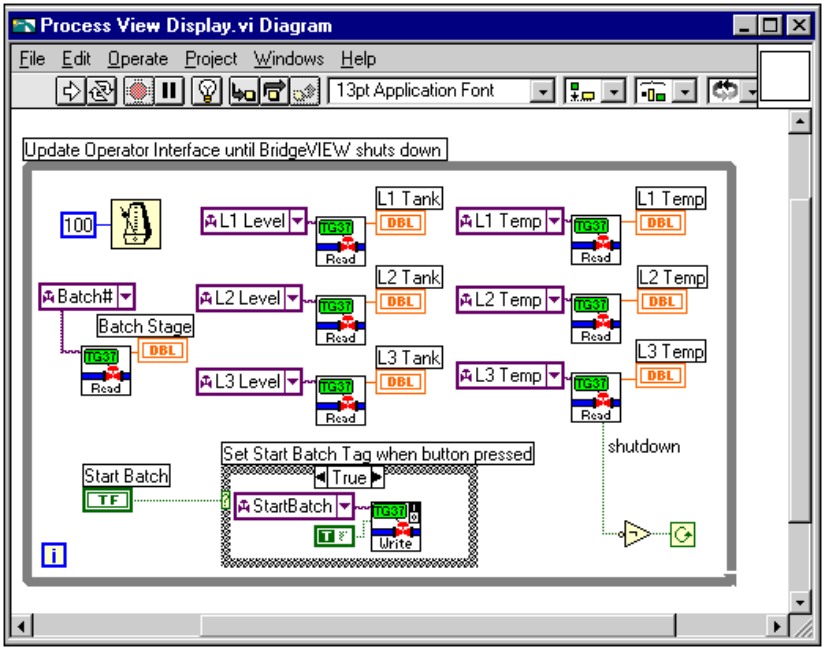


Figure 4-4. Process View Display VI

How Do You Initialize and Shut Down Multiple-Loop Applications?

When you have a multiple-loop application, you can add initialization code before executing the loops, and some cleanup or shutdown code after all the loops finish executing. You can use the Sequence structure for this purpose. Put the initialization code in the first frame of the Sequence structure, put all your loops in the second frame of the Sequence structure, and put the shutdown code in your final sequence. This guarantees that none of your loops start execution until your initialization code is complete and that all loops complete execution before you execute the shutdown code. Figures 4-7 and 4-8 demonstrate this technique.

You also can use dataflow programming to enforce sequential operation. In some cases, your diagram might be easier to read using this technique. It is possible that you might have some data flow between the initialization code and the loops anyway. There is no difference in performance using either technique. It is purely a diagram documentation issue. Figure 4-6 illustrates using this technique.

How Do You Display Real-Time Trends?

You can build a real-time trend by dropping a real-time trend indicator on your front panel and popping up on it to select the HMI G Wizard. Alternatively, you can assemble the diagram manually using a While Loop and the Trend Tags VI. Wire the output of the Trend Tags VI to the terminal for a real-time trend indicator. The Trend Tags VI accepts an array of tag names, and returns information for a real-time trend you can wire directly to the real-time trend or Waveform Chart indicator. You can control how often the trend updates by the **time interval** control, which, if left unwired, is once per second by default. The **scale to %** control controls the scale on the trend. If **scale to %** is TRUE, the trends return as a percent (%) of full scale for each tag. If **scale to %** is FALSE, the trends return in engineering units. If **scale to %** is left unwired, trend values return in engineering units, by default.

The Trend Tags VI always waits the specified time interval. For this reason, a Trend Tags VI usually is placed in its own While Loop because it controls the loop execution rate. If you want to execute other VIs at the same rate that the real-time trend updates, place them in the same loop.

Figure 4-5 shows an HMI with two real-time trend displays. The `Trend Tank Temperature` displays the trend in percent of full scale, and is updated every 1.0 second. The `Trend Tank Level` is displayed in engineering units, and is updated every 2.0 seconds. The tag names passed into the Trend Tags VI are tag array constants containing the tag names of interest. Notice that the Trend Tags VI only accepts tag names and not tag group names.

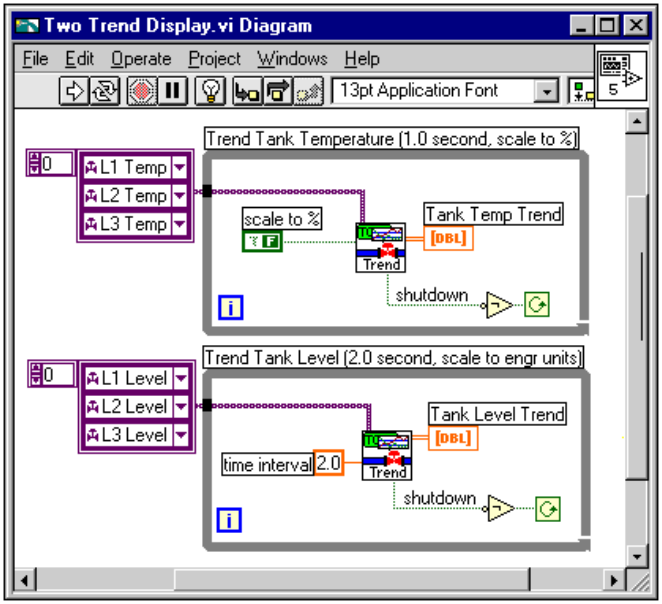


Figure 4-5. Two Trend Display VI

The real-time trend indicator updates with a value for each tag every time the indicator is written to. If a VI using this indicator is executed several times, it still has previous data displayed. For this reason, you might want to initialize the real-time trend indicator before the loop begins execution. You also can control attributes of the real-time trend indicator such as time scale. Figure 4-6 shows a single real-time trend display VI that initializes the time scale of the Trend indicator to the current time (read from Get Date Time in Seconds) and the interval corresponding to the Trend Tags **time interval** input. It also clears the trend display by writing an empty array to the Trends History Data attribute.

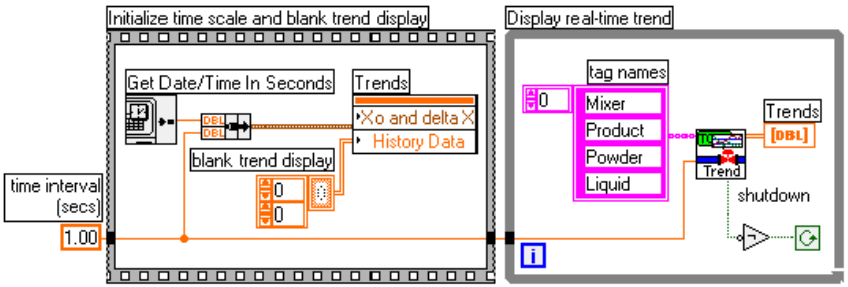


Figure 4-6. Initializing the Waveform Chart Indicator for a Real-Time Trend Display

This example illustrates the use of dataflow programming to enforce the order of two structures that otherwise are not related by data flow. By wiring the **time interval (secs)** constant through the Sequence structure and into the While Loop, the While Loop does not begin execution until the code in the Sequence structure has completed execution. Another way to enforce this order of execution is to put the While Loop inside the second frame of the Sequence structure. Both techniques are correct. The advantage of the technique used in Figure 4-6 is that it is easy to see the entire diagram at a glance.

How Can You Use Tag Attributes to Configure HMI Indicator Attributes Programmatically?

Use the Tag Attributes VI library to read or change specific configuration details of a tag. Anything you have configured in the Tag Configuration Editor can be queried programmatically using the Tag Attributes VIs. Use these VIs when you want to control attributes programmatically for your front panel controls or indicators, or to display configuration information on your HMI. Setting attributes programmatically for front panel controls and indicators is an alternative to changing attribute values for the control or indicator through the various front panel pop-up menus or by typing into various control and indicator fields.

Handling attributes programmatically is most useful when you use the same indicator or control for different tags. For more information on tag configuration, see Chapter 3, *Tag Configuration*. For more information about the Tag Attributes VIs, see the section *Tag Attributes VIs* in Appendix A, *HMI Function Reference*, and Chapter 7, Advanced Application Topics.

Figure 4-7 shows a simple case where the scale range for all the front panel level and temperature indicators are set to the engineering scale that is configured for the tag. A unit string display for each `L1` and `Temp` indicator is initialized to the engineering unit for the respective tag. The Get Tag Range and Units VI returns the engineering scale range information in a form that can be wired directly to a control or indicator scale range attribute node. The VI also returns the engineering units configured for the tag.

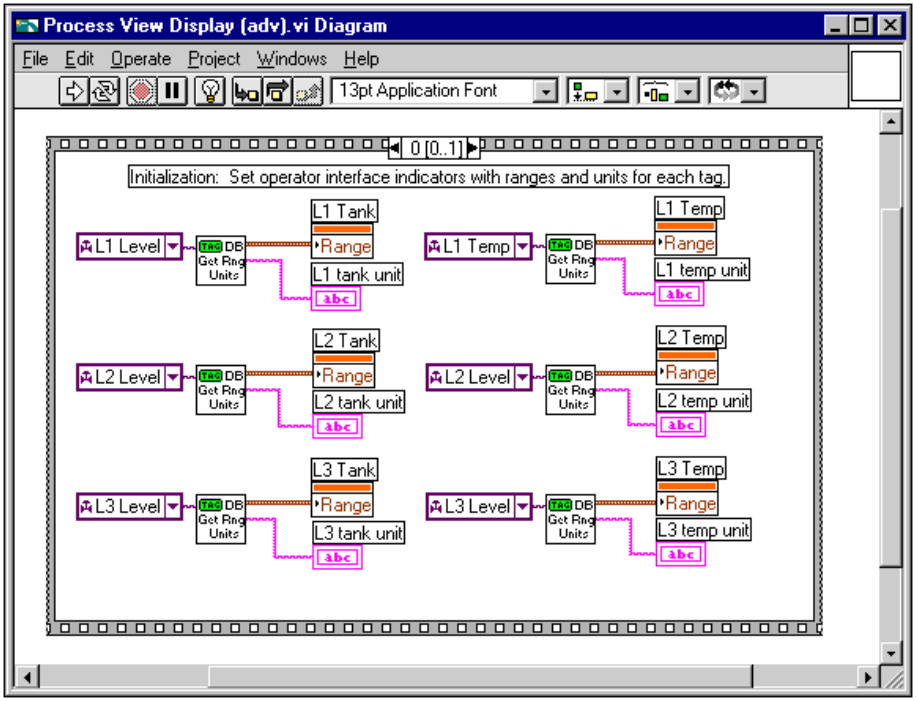


Figure 4-7. Using the Tag Attributes VIs to Initialize Front Panel Indicators, Frame 0

Figure 4-8 illustrates the subsequent frame of the Sequence structure. The HMI runs in a loop, monitoring the various tags and front panel controls until the BridgeVIEW Engine shuts down.

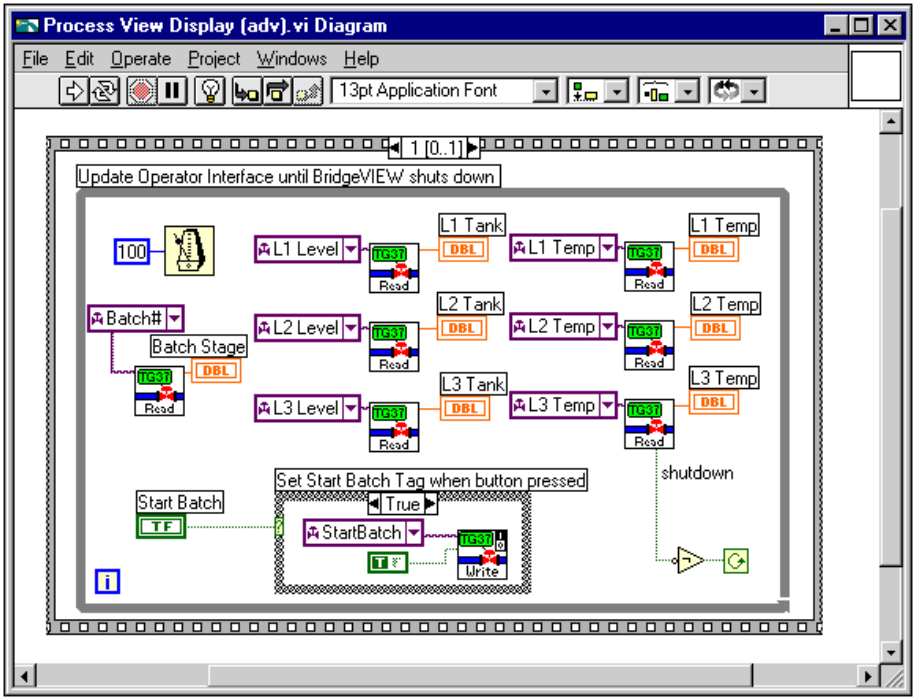


Figure 4-8. Using the Tag Attributes VIs to Initialize Front Panel Indicators, Frame 1

5

Alarms and Events

This chapter introduces the basic concepts of alarms and events, and explains how to view, acknowledge, and configure them within the BridgeVIEW system. This chapter also provides activities that explain how to build an alarm summary display and acknowledge alarms from your HMI.

What are Alarms and Events?

An alarm is an abnormal process condition pertaining to a tag. In BridgeVIEW, alarms are generated based on changes in a tag value or status.

An event is something that happens within the BridgeVIEW system. Events can be divided into two groups: those that pertain to individual tags and those that pertain to the overall BridgeVIEW system. An example of a tag event is a change of alarm state for a tag. Examples of system events include a user logging on, the Engine starting up, or historical logging being turned on. For more information about system events, see Chapter 2, *BridgeVIEW Environment*.

Alarm States

For analog tags, an alarm state can be of type HI_HI, HI, LO, or LO_LO. For all data types (analog, discrete, bit array, and string), if the server returns a bad status, and you have enabled alarming on bad status, the tag goes into Bad Status alarm. All data types except string also support alarms based on tag value. If an analog tag exceeds a preconfigured alarm limit, one of these alarms can occur. Discrete and bit array tags are either not in alarm or in alarm.

Alarm Limit

An *alarm limit* is the numeric value an analog tag must exceed to go into an alarm state.

Alarm Priority

An *alarm priority* indicates the severity of an alarm. Priorities range from 1 (lowest) to 15 (highest). You can filter the alarms displayed in your HMI by alarm priority.

Alarm Summary

An *alarm summary* is a collection of all the alarms that currently exist in the system. In addition, if a tag previously in alarm returns to normal but is unacknowledged, a notification is posted in the alarm summary. You can report alarms to your HMI by using the Alarm Summary Display, which is available in the **Controls»Alarms and Events** palette of the front panel, and the Read Alarm Summary VI, which is available in the **Functions»Alarms and Events** palette from the block diagram.

The alarms displayed in your Alarm Summary Display can be filtered by group or tag names, priority, and acknowledgment status.

Event History

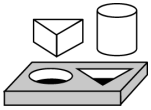
An *event history* is a collection of all the alarms and events pertaining to tag values that have occurred in the BridgeVIEW system since the Engine was started. You can report recent events to your HMI by using the Event History Display, available in the **Alarms and Events** palette from the front panel, and by using the Read Event History VI in the **Alarms and Events** palette from the block diagram. The alarms displayed in your Event History Display also can be filtered by group or tag names, priority, and acknowledgment status.

How Do You Display Alarm Summary Information?

To read the alarms currently in the BridgeVIEW system, drop an Alarm Summary Display from the **Controls»Alarms and Events** palette on your front panel. You can invoke the HMI G Wizard to create the block diagram for an alarm summary, or you can build your own diagram. For more information about the HMI G Wizard, see Chapter 4, *Human Machine Interface*.

If you are building your own block diagram, use the Read Alarm Summary VI in your block diagram. If you want to change the default fields (time, date, tag name, alarm limit) that are visible in the Alarm Summary Display, you can use the Alarm Summary Format control from the **Controls» Alarms and Events** palette and change the checkbox selections. You also

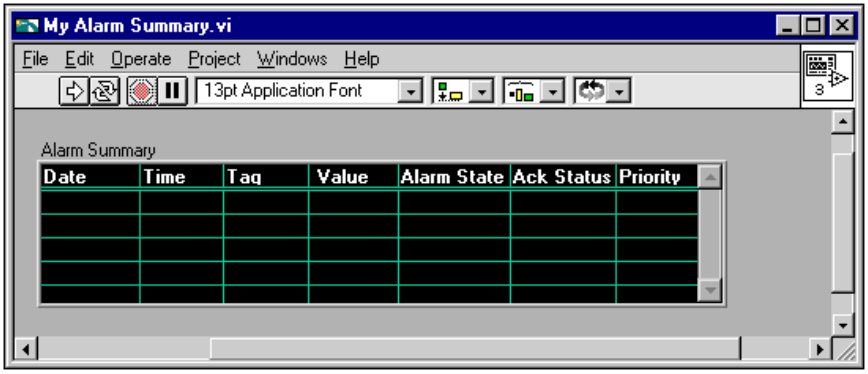
can change the default colors of alarms, acknowledged alarms and unacknowledged tags that have returned to normal with the Color Codes for Alarm Summary control, which also is available in the **Alarms and Events** palette.



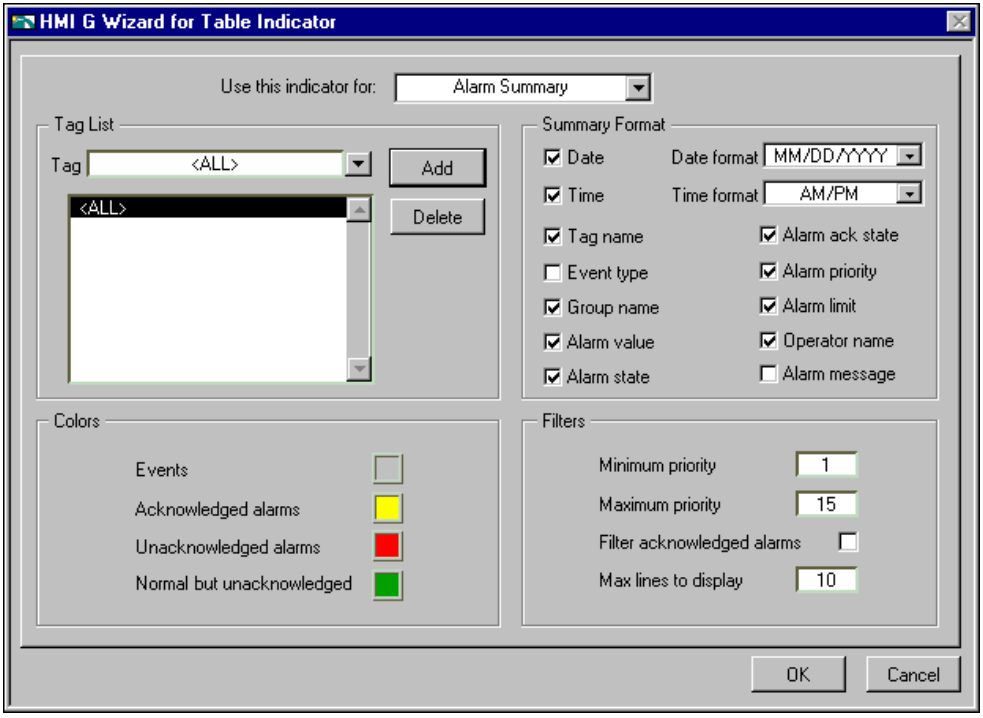
Activity 5-1. Build an Alarm Summary Display

Your objective is to use the HMI G Wizard to display alarm summary information.

1. Place an Alarm Summary Display from the **Controls»Alarms and Events** subpalette on a new front panel, as shown below.

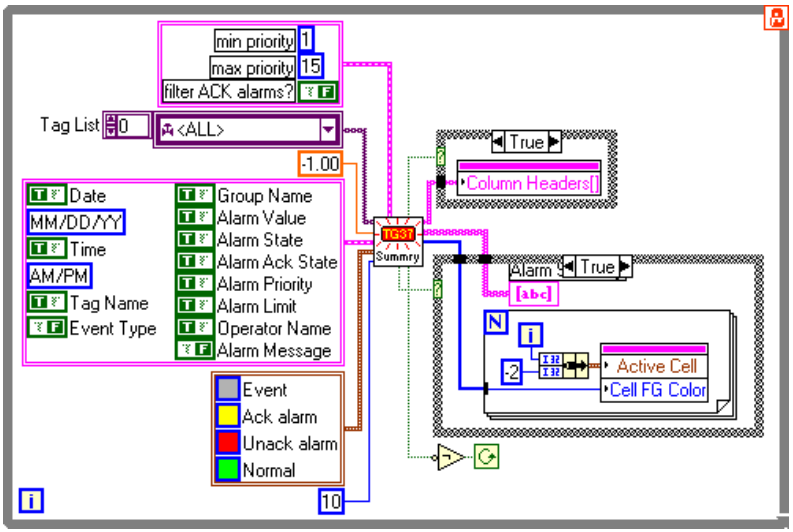


2. Pop up on the Alarm Summary Display, and select **HMI G Wizard…**. The following dialog box appears.



3. Now, you can select the tags to monitor. In the tag list, select `<ALL>` to view alarms on all the tags that have alarms configured. Click on the **Add** button to add all tags to the list. If you do not see a list of available tags when you click on the Tag menu ring, pop up with your right mouse button on the menu ring and select **Tag Browser…**. A dialog box appears and prompts you to select the desired `.scf` file containing the configuration of your tags. Select `mytanks.scf`. Click on the **OK** button.

   The HMI G Wizard creates the diagram shown in the following illustration.



The diagram above uses event-driven programming to wait for an alarm summary event before updating the Alarm Summary Display. The Read Alarm Summary VI returns when an alarm event occurs on any of the tags in the tag constant array. The column headers for the Alarm Summary Display are initialized when the Read Alarm Summary VI returns for the first time, and the **initialize** output is set. The Alarm Summary Display is updated when the Read Alarm Summary VI returns with **changed?** set.

4. Save the VI as `My Alarm Summary.vi` in the `BridgeVIEW\Activity` directory.
5. Run the VI. Now you can display the alarms on tags that have been configured for alarms. By default, the Alarm Summary Display shows alarms as red when they are in an unacknowledged alarm state, yellow when they are acknowledged and in alarm, and green when they are not in alarm but unacknowledged.

Note ***If there are no alarms being displayed, launch the Tag Configuration Editor (Project»Tag»Configuration) and open*** `mytanks.scf`***. Edit it as indicated in Activity 3-1, save it, and relaunch the Engine.***

End of Activity 5-1.

How Do You Display Event History Information?

To read all the alarms and events in the BridgeVIEW system that have occurred since the Engine was started (unless limited by buffer size) drop the Event History Display from the **Alarms and Events** palette on your front panel. Then, you can invoke the HMI G Wizard to create the diagram code for an event history. You also can build your own diagram and use the Read Event History VI in your block diagram. If you want to change the default fields (time, date, tag name, alarm limit) that are visible in the Event History Display, you can use the Event History Format control from the **Controls»Alarms and Events** palette and change the checkbox selections. You also can change the default colors of alarms, events, normal and acknowledged alarms with the Color Codes for Event History control, which also is available in the **Alarms and Events** palette.

You also can report the status of alarms currently in the system using the output of either Read Alarm Summary VI or Read Event History VI, or by using the Get Alarm Summary Status VI. This gives information on the number of active alarms and unacknowledged alarms in the system. You can use the Alarm Summary Status control available in the **Alarms and Events Controls** palette to display this information on your HMI.

How Do You Acknowledge Alarms?

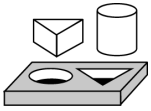
You can view the acknowledgment status of alarms in the Alarm Summary or Event History Display. To acknowledge alarms currently in the system, use the **ACK** button from the **Controls»Boolean** palette on the front panel and the Acknowledge Alarms VI in the **Functions»Alarms and Events** palette in the block diagram. Activity 5-2, *Acknowledge Alarms in the Alarm Summary Display*, takes you through this process.

When you acknowledge these alarms, the acknowledgment status in the Alarm Summary Display changes from `UNACK` to `ACK`, and the color of the text changes from red to yellow. These are the default colors, and you can change them.

There are two modes for handling tags that were previously in alarm but have returned to normal: *Auto Acknowledge* and *User Must Acknowledge*. These modes are configured in the Tag Configuration Editor for each tag. If a tag is configured for Auto Acknowledge, when the tag returns to normal, the acknowledgment status automatically changes from `UNACK` to `ACK`. However, if it is configured for User Must Acknowledge, the status

remains at UNACK until the user presses the **ACK** button on the HMI and acknowledges the alarm.

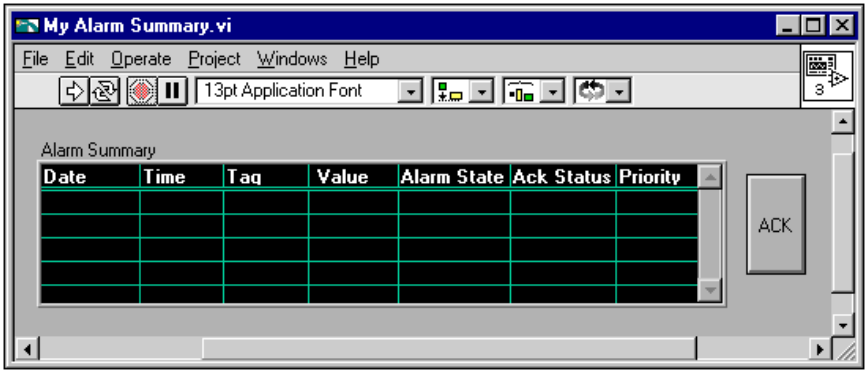
You can select the tags for which you want to acknowledge alarms. It is a good idea for this tag list to be identical to the list of tags you display alarms for in the Alarm Summary or Event History Display. For example, if you select group <ALL>, alarms for all tags that were configured for alarms are reported as they occur. In the tag selection, you also can select a combination of tag names and groups.



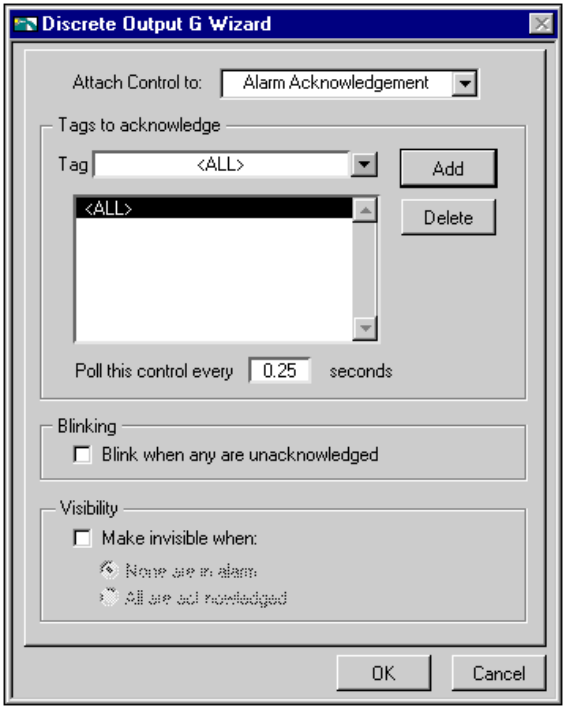
Activity 5-2. Acknowledge Alarms in the Alarm Summary Display

Your objective is to acknowledge alarms from the HMI you built in Activity 5-1, *Build an Alarm Summary Display.*

1. Place an **ACK** button from the **Boolean** subpalette on the front panel of the My Alarm Summary VI you created in Activity 5-1, *Build an Alarm Summary Display.* If your VI is running, you must stop the VI by pressing the **Stop** button or selecting **Operate»Stop** before you can do this. Your front panel should appear as shown in the following illustration.

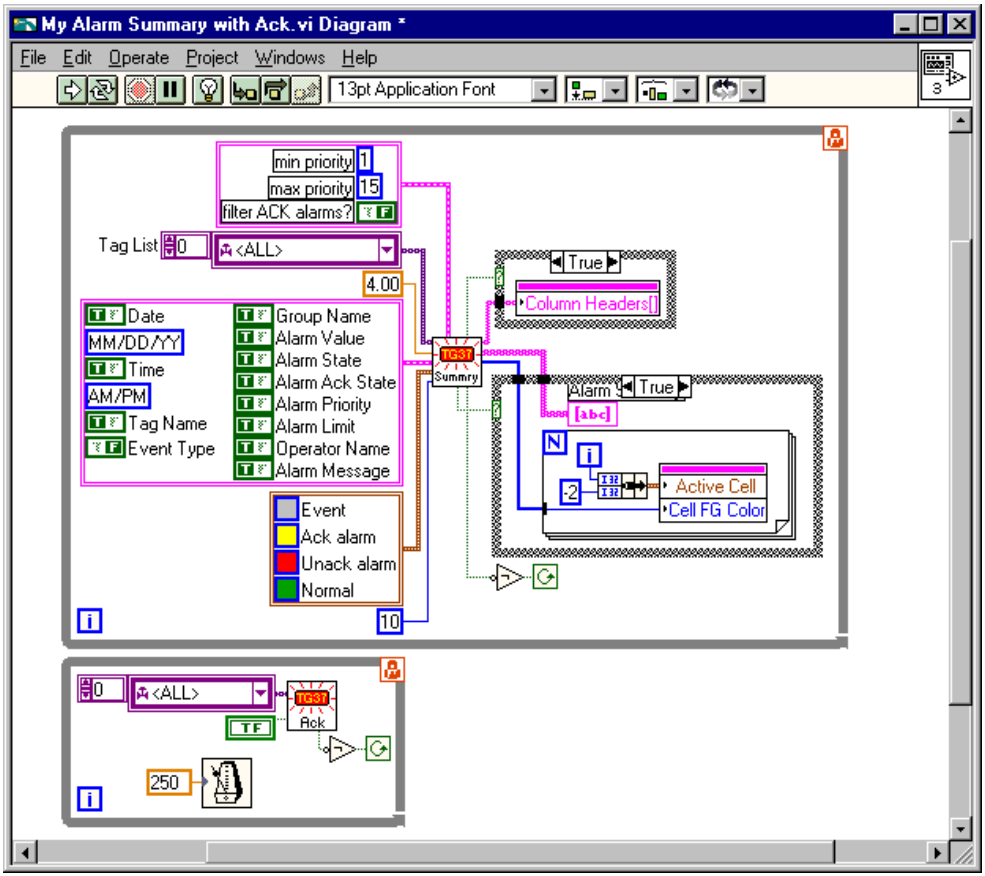


2. Pop up on the **ACK** button and select **HMI G Wizard**. The following dialog box appears.



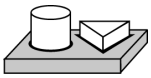
3. Select **Alarm Acknowledgement** for the **Attach Control to:** option.
4. Select the tags to monitor. In the tag list, select `<ALL>` to view alarms on all the tags that have alarms configured. Click the **Add** button to add all tags to the list. Click **OK**.

   The HMI G Wizard creates the diagram shown below.



The Acknowledge Alarm VI is called when the front panel **ACK** button is pressed. This button is polled in a separate While Loop and the Read Alarm Summary VI waits for events in its own While Loop.

5. Save the VI as `My Alarm Summary with Ack` in the `BridgeVIEW\Activity` directory.
6. Run the VI. When alarms appear in the Alarm Summary, click on the **ACK** button. You can see the color of the Alarms change from red to yellow. Acknowledged alarms that are normal disappear from the display.



End of Activity 5-2.

How Do You Configure Logging and Printing of Alarms and Events?

You can configure logging and printing options for Alarms and Events through the Event Configuration dialog box, shown in Figure 5-1. This configures the format of alarms and events written to `.evt` files or printed. You can reach this dialog box by choosing **Project»Tag»Configuration**, and then **Configure»Events** from the Tag Configuration Editor.

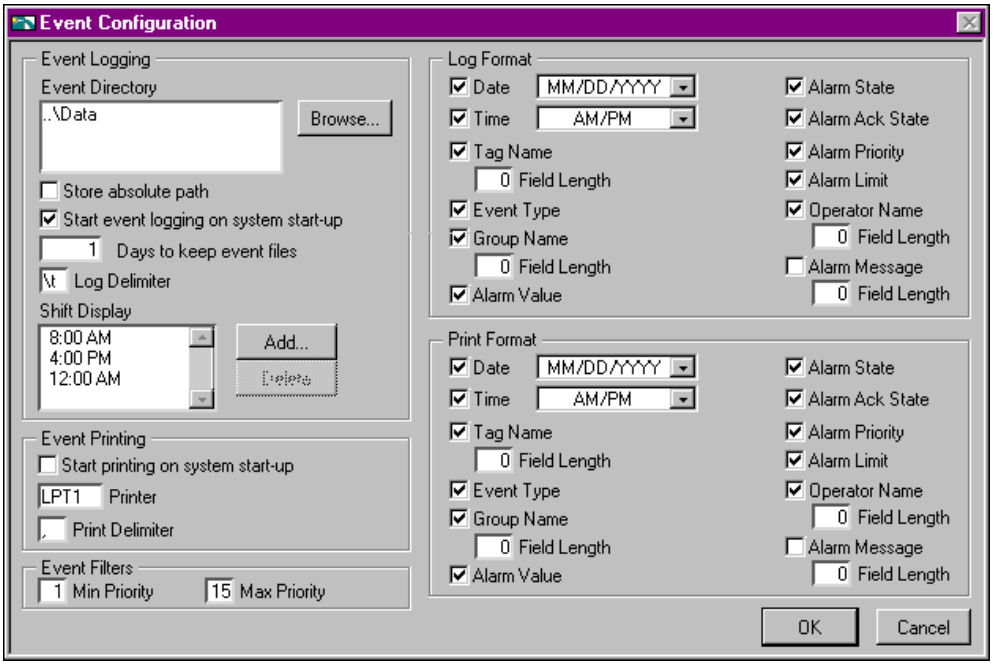


Figure 5-1. Event Configuration Dialog Box

Table 5-1 provides a description of the general event configuration selections.

Table 5-1. Tag Configuration Editor Event Configuration Selections

Selection	Description
Event Directory	Determines the path to the directory where the event files are stored on disk.
Store absolute path	Determines whether the absolute path is stored.

Table 5-1. Tag Configuration Editor Event Configuration Selections (Continued)

Selection	Description
Start event logging on system start-up	Determines whether the BridgeVIEW Engine automatically begins logging events when the Engine launches.
Days to keep event files	Determines how many days worth of event files are kept on disk. Anything older than the number of days specified here is deleted automatically.
Log Delimiter	Determines the separator between parameters on a line. By default, it is the tab character. This makes event files easy to import into a spreadsheet program. Spreadsheet programs can handle other delimiters as well.
Shift Display (00:00 – 23:59)	An array of numerics ranging between 00:00 and 23:59 hours to determine the length of the shift that events are logged in a file. At the end of the shift, a new event file is generated and written to.
Start printing on system start-up	Determines whether the BridgeVIEW Engine automatically begins printing events when the Engine launches.
Printer	Determines the port to which your printer is connected.
Print Delimiter	Determines the separator between different parameters on a line. By default, it is a comma.
Min Priority	Determines the minimum priority an event must have before it is logged. Events with priorities below this configured number are not logged. The minimum value is 1.
Max Priority	Determines the maximum priority an event can have to be logged. Events with priorities above this configured number are not logged. The maximum value is 15.

There are various format options for logging and printing. The print selections are a set of several parameters that determine the format of the data to be printed. Similarly, the log selections are a set of several parameters that determine the format of the data to be logged in an event file. These parameters are described in the following table.

Table 5-2. Event Configuration, Log, and Print Format Selections

Selection	Description
Date	Determines whether the date is logged or printed.
Date Format	A menu ring that allows you to pick a format for the date to be printed. This selection is valid only if **Date** is selected. The menu items are: `MM/DD/YYYY` and `DD/MM/YYYY`.
Time	Determines whether the time is logged or printed.
Time Format	Determines the format for the time logged or printed. This selection is valid only if **Time** is selected. The menu items are: `AM/PM` and `24 HOUR`.
Tag Name	Determines whether the tag name is logged or printed.
Tag Name Field Length	Determines the maximum number of characters for the tag name. This selection is valid only if **Tag Name** is checked.
Event Type	Determines whether the event name is logged or printed.
Group Name	Determines whether the group name is logged or printed.
Group Name Field Length	Determines the maximum number of characters for the group name. This selection is valid only if **Group Name** is checked.
Alarm Value	Determines whether the alarm value is logged or printed.
Alarm State	Determines whether the alarm state is logged or printed.
Alarm Ack State	Determines whether the alarm acknowledge state is logged or printed.
Alarm Priority	Determines whether the alarm priority is logged or printed.
Alarm Limit	Determines whether the alarm limit is logged or printed.
Operator Name	Determines whether the name of the current operator is logged or printed.
Operator Name Field Length	Determines the maximum number of characters for the operator name. This selection is valid only if **Operator Name** is checked.
Alarm Message	Determines whether the alarm message is logged or printed.
Alarm Message Field Length	Determines the maximum number of characters for the alarm message. This selection is valid only if **Alarm Message** is checked.

How Do You Log Alarms and Events?

Events are logged in ASCII files named in the format `YYMMDDHHMM.evt` using the timestamp of the first point to be logged. `YY` is the year, `MM` is the

month, DD is the day, HH is the hour, MM is the minute and .evt is the extension for all event log files.

There are three steps you must complete to log alarms and events:

1. Configure your tags to have Log/Print Events enabled. You configure it on a per tag basis. To select event logging for a single tag, go to the panel for configuring the tag.
2. Configure a path to a directory for the event (.evt) files. To choose the path, select **Configure»Events…** in the Tag Configuration Editor.
3. Turn on event logging for the BridgeVIEW Engine, according to one of the techniques outlined below.

There are three techniques for turning event data logging on or off:

- You can configure event logging in the Tag Configuration Editor. To turn on event logging, select **Configure»Events…**. Configure the path and set **Start logging on system start-up** to be TRUE.
- For programmatic control, you can call the Enable Event Logging VI in the **System** palette. With this VI, you can turn event logging on or off dynamically for all the tags in the system, while the BridgeVIEW Engine is running.
- The Engine Manager also has a button to turn event logging on or off. If you have Supervise or higher-level privileges, you can access this button.

Table 5-2 provides a description of the event logging configuration selections.

How Do You Print Alarms and Events?

In BridgeVIEW, events are printed to a standard line printer through a parallel port. There are three steps you must complete to print alarms and events:

1. Configure your tags to have Log/Print Events enabled. You configure it on a per tag basis. To select event printing for a single tag, go to the panel for configuring the tag.
2. Configure a printer for event printing. To choose the printer, select **Configure»Events…** in the Tag Configuration Editor.
3. Turn on event printing for the BridgeVIEW Engine, according to one of the techniques outlined below.

There are three techniques for turning event printing on or off:

- You can configure event printing in the Tag Configuration Editor. To turn on printing, select **Configure»Events…**. Configure the printer and set **Start printing on system start-up** to be TRUE.
- For programmatic control, you can call the Enable Printing VI in the **System** palette. With this VI, you can turn event printing on or off dynamically for all the tags in the system, while the BridgeVIEW Engine is running.
- The Engine Manager also has a button to turn event printing on or off. Those with Supervisor or higher-level privileges can access this button.

Table 5-2 provides a description of the printing configuration selections.

How Do You View Alarms and Events?

Event files are ASCII files, and can be read with any text editor. The default delimiter between the various parameters is a tab character, which makes viewing the file in a spreadsheet program, such as Excel, convenient.

6

Historical Data Logging and Extraction

This chapter explains the concept of a trend, how to log and extract historical data, and how to use the Historical Trend Viewer (HTV), a utility that displays historical data that has been logged to disk with BridgeVIEW.

What Is a Trend?

A *trend* is a display of tag values against time. BridgeVIEW displays tag values with two types of trends: real-time trends and historical trends. You can find these trends in the **Controls** palette.

Real-Time Trend

A real-time trend is a display of tag values as they are collected in real time over a relatively short period of time. You can display a real-time trend in your HMI by using the Trend Tags VI in the **Tags** palette in the block diagram. You also can use the HMI G Wizard to create a real-time trend. For more information about the HMI G Wizard, see Chapter 4, *Human Machine Interface*.

Historical Trend

A historical trend is a display of tag values that have been logged to disk. This is usually over a relatively long period of time. You can display a historical trend in your HMI by using the Get Historical Tag List VI and Read Historical Trend VI from the **Historical Data** palette from the block diagram. You also can view historical data by launching the HTV utility. You can use the HMI G Wizard to create a historical trend display.

What Is Citadel?

Citadel is a high performance historical database. With Citadel, BridgeVIEW can log tags while continually servicing data queries. BridgeVIEW also includes the Citadel ODBC driver that has special commands to perform data transforms, making it easy for you to retrieve,

manipulate, and analyze historical data automatically from outside the BridgeVIEW environment. For more information, see Appendix B, *Citadel and Open Database Connectivity*.

How Do You Log Historical Data?

There are three steps you must complete to log historical data:

1. Configure your tags to have historical logging enabled. You configure it on a per tag basis. To select historical logging for a single tag, go to the panel for configuring the tag.
2. Configure a path for the historical database. To choose the path, select **Configure»Historical…** in the Tag Configuration Editor.
3. Turn on historical logging for the BridgeVIEW Engine, according to one of the three techniques outlined below.

There are three techniques for turning historical data logging on or off:

- You can configure historical logging in the Tag Configuration Editor. To turn on logging, use the pull-down menu for **Configure»Historical…**. Configure the path and set **Start logging on system start-up** to be TRUE.
- For programmatic control, you can call the Enable Historical Data Logging VI in the **System** palette. With this VI, you can turn historical data logging on or off dynamically for all the tags in the system, while the BridgeVIEW Engine is running.
- The Engine Manager also has a button to turn historical data logging on or off. If you have Supervise or higher-level privileges, you can access this button.

When you log historical data for your application, there is a coupling between your configuration (`.scf`) file and the Citadel Historical Database. When you decide to archive these, take the `.scf` file along with your historical files to the new location. Although you can retrieve historical data without the `.scf` file, you will not have the tag configuration information, such as engineering range and unit, unless you archive the `.scf` file as well.

Preferably, maintain the relative path between the `.scf` file and the historical files in this new location. For example, if your `.scf` file is in `C:\ARCHIVE`, keep your historical database in `C:\ARCHIVE\DATA`. If you save a new `.scf` file and have not specified a historical data directory, you are prompted to specify the path and the directory is created for you.

How Do You Configure Historical Logging?

You can reach the Historical Logging Configuration dialog box by selecting **Configure»Historical…** from the Tag Configuration Editor. Figure 6-1 shows the Historical Logging Configuration dialog box and Table 6-1 lists parameters you can configure for historical logging.

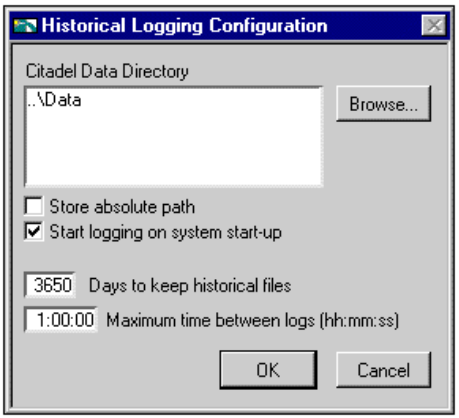


Figure 6-1. Historical Logging Configuration Dialog Box

Table 6-1. Parameters You Can Configure for Historical Logging

Selection	Description
Citadel Data Directory	Path that determines the directory where historical data files are stored on disk.
Store absolute path	Determines whether the absolute path is stored.
Start logging on system start-up	Determines whether the BridgeVIEW Engine automatically begins logging historical data when the Engine launches.
Days to keep historical files	Determines how many days worth of historical log files to keep on disk. Anything older than the number of days configured here is deleted automatically.
Maximum time between log records	Time, in seconds, that determines the logging rate for tags that vary slowly.

How Do You Extract and View Data from Historical Log Files?

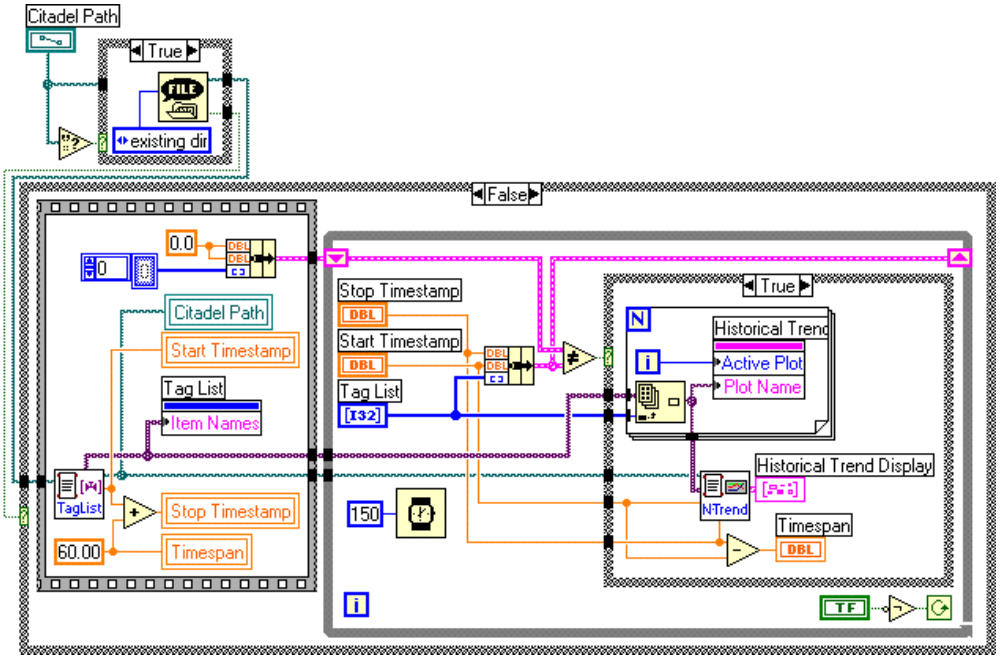
There are two methods for viewing historical data that has been logged to disk. One method is to use the Historical Data VIs and the other is to use the Historical Trend Viewer (HTV).

Historical Data VIs

There are several VIs you can use in your HMI to manipulate data logged in Citadel files. These VIs access disk files and do not require the BridgeVIEW Engine to be running. You can use these VIs to browse files, extract the information in a format that can be displayed in a Historical Trend indicator, or export the data to a spreadsheet file format. There are several examples in the `Examples\HMI Examples\Historical Data` folder to illustrate this. The main VIs for getting historical data and manipulating it are listed below. For complete information about these or any other VIs, refer to Appendix A, *HMI Function Reference*.

- Decimate Historical Trend
- Decimate Historical Trends
- Get Historical Tag List
- Get Historical Trend Info
- Historical Trend Statistics
- Historical Trends to Spreadsheet
- Historical Trends to Spreadsheet File
- Read Historical Trend
- Read Historical Trends

The following illustration shows a VI for viewing historical data files anywhere in the system.



If the Citadel Path is empty, the File Dialog function is executed. This brings up a File dialog box that lets the operator select the directory containing the historical data files.

The example then uses the `tag list` returned by the Get Historical Tag List VI to set up a list of names in the front panel Tag List listbox, found by selecting **List & Ring»Single Selection Listbox** from the controls palette. It uses the `first timestamp` output to initialize the `Start Timestamp` control on the front panel. By default, the example displays the first 60 seconds worth of data on the historical data display. Historical data is displayed using the XY Graph indicator named Historical Trend Display.

The Read Historical Trends VI returns historical data from `Start Timestamp` to `Stop Timestamp` for the tags that are selected in the Tag List listbox and returns data in a form that can be wired directly to an XY Graph.

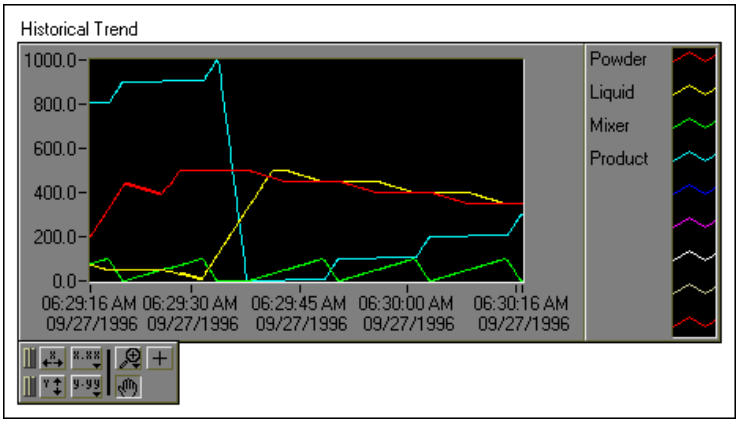
The shift register in the while loop is used to detect user input changes on the operator interface by remembering the previous `Start Timestamp`, `Stop Timestamp`, and the selected `tag list`. If any of these controls are changed, historical data is retrieved for the new settings and the XY Graph indicator is updated.

Activity 6-1. Use the Historical Data VIs

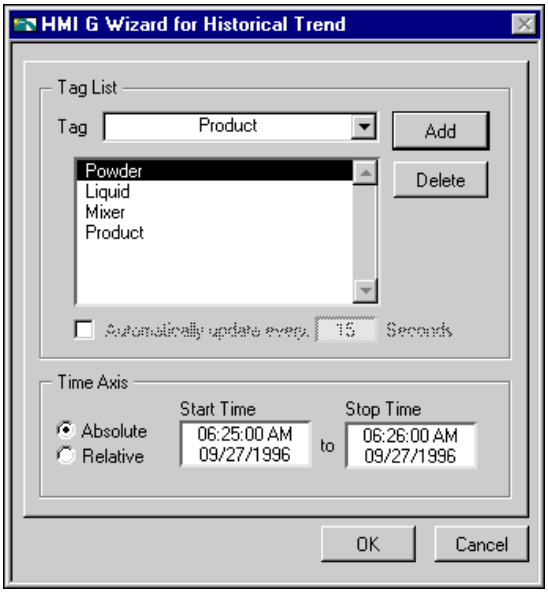
The objective of this exercise is to create a VI that programmatically reads historical information from Citadel and determines statistical information of the data.

In this activity, you will read previously logged data, which is included in the `BridgeVIEW\Activity\Data` directory. You will use `mytanks.scf` in the `BridgeVIEW\Activity` directory, as edited in Activity 3-1, *Configure a Tag, and View the Tag Configuration Parameters and Tag Values*.

1. Open a new VI and place a Historical Trend on the panel window from the **Controls»Graph** palette. Change the maximum of the Y scale to `1000`.

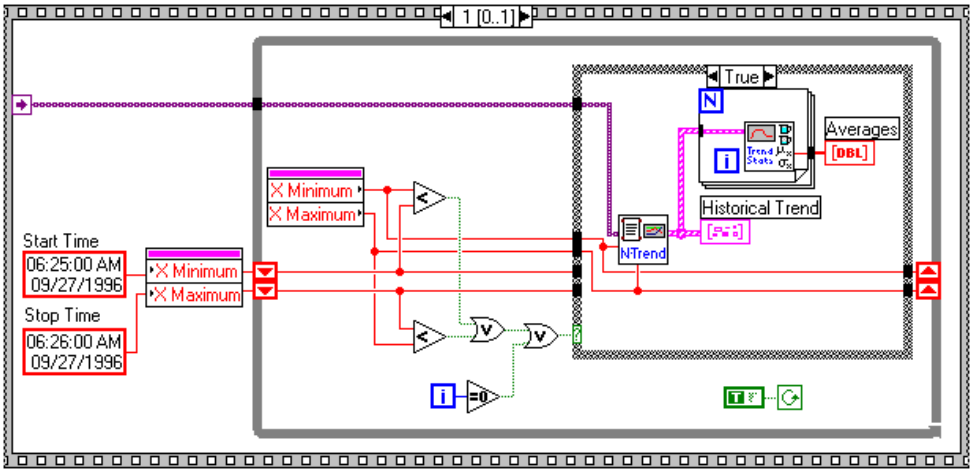


2. Pop up on the Historical Trend and select **HMI G Wizard…**. If a dialog box prompts you to locate a Citadel Data directory, open `BridgeVIEW\Activity\Data` and select the current directory. Complete the dialog box, as shown in the following illustration.

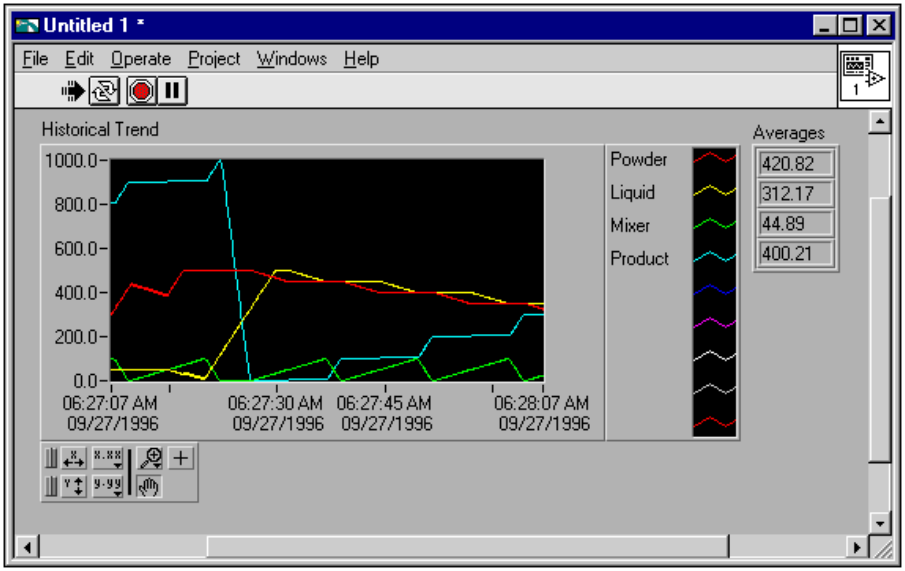


You will display previously logged data, which is included in the `BridgeVIEW\Activity\Data` directory. It contains a 25-minute run of data. You can change the time axis to display the first minute of this data.

3. Run the VI. The trend displays one minute of data. You can use the panning tool to grab the plot and scroll to the left or right to show more data. Hold down the <Shift> key while you pan to constrain the movement to the horizontal direction.
4. Stop the VI.
5. Modify the Block Diagram to incorporate statistics.
   a. In the block diagram, pop up on the wizard lock and select **Release Wizard Lock**. Now, you can edit the diagram to incorporate statistics into your data retrieval application.
   b. Using a For Loop and the `Historical Trend Statistics.vi` (**Functions»Historical Data**), build the diagram as shown below. If you click and drag the Positioning tool inside the case structure while holding down the <Ctrl> key, the diagram will expand to give you some room to add the new diagram code.



6. On the front panel, create an array of numeric indicators. Stretch the array indicator so that four fields are showing. Then pop up on the array indicator and select **Show»Index Display** to deselect the index display, as shown below.

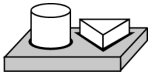


7. Run the VI.

   Initially, the historical trend displays the first minute of data in the set, along with the averages for the four tags. The averages are calculated

on the data that is displayed. You can use the panning tool to display a different section of data. The averages are updated automatically.

8. Save the VI as `Historical Data.vi` in the `BridgeVIEW\Activity` directory.



End of Activity 6-1.

Historical Trend Viewer (HTV)

The HTV is a stand-alone utility that enables you to look at historical data in your system. The HTV limits you to viewing no more than eight tags at a time. If you want to look at more tags in a single historical trend, you should build your own utility using the Historical Data VIs.

To start the HTV, select **Project»Historical Trend Viewer…**. The HTV is shown in the following illustration.

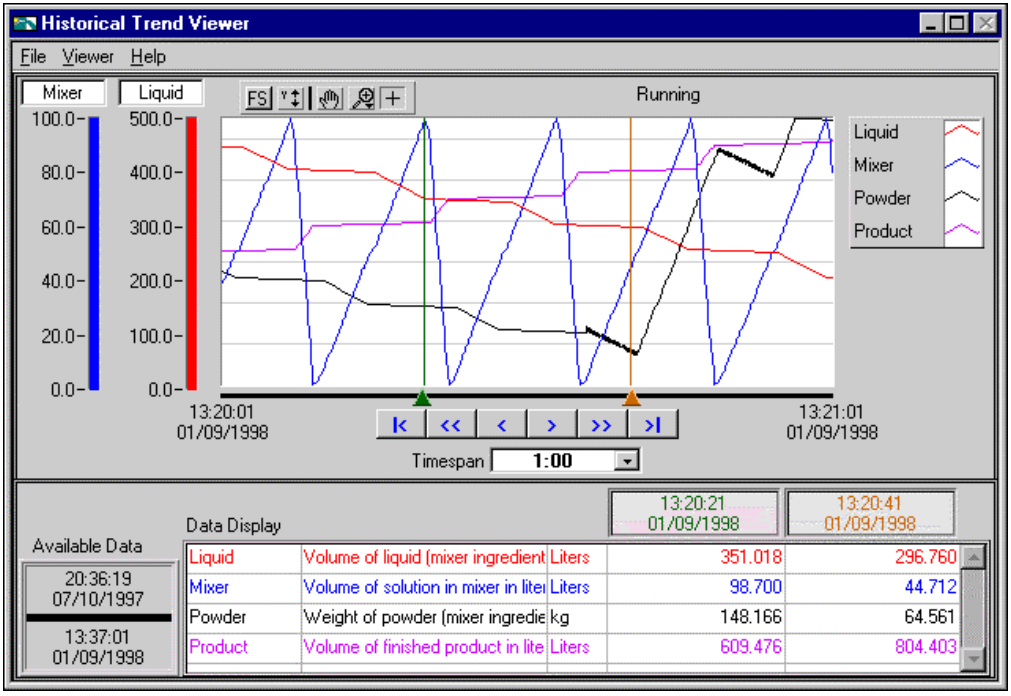


Figure 6-2. Historical Trend Viewer

How Do You Select the Tags to Display?

Select **File»Select Tags…**, and the Select Tags dialog box appears, as shown in Figure 6-3. With this dialog box, you can select either a `.scf` file or a directory of Citadel files. The default is to choose a `.scf` file. The `.scf` file you choose must point to a valid directory of Citadel files. If the BridgeVIEW Engine is running, the `.scf` file being used by the BridgeVIEW Engine is displayed.

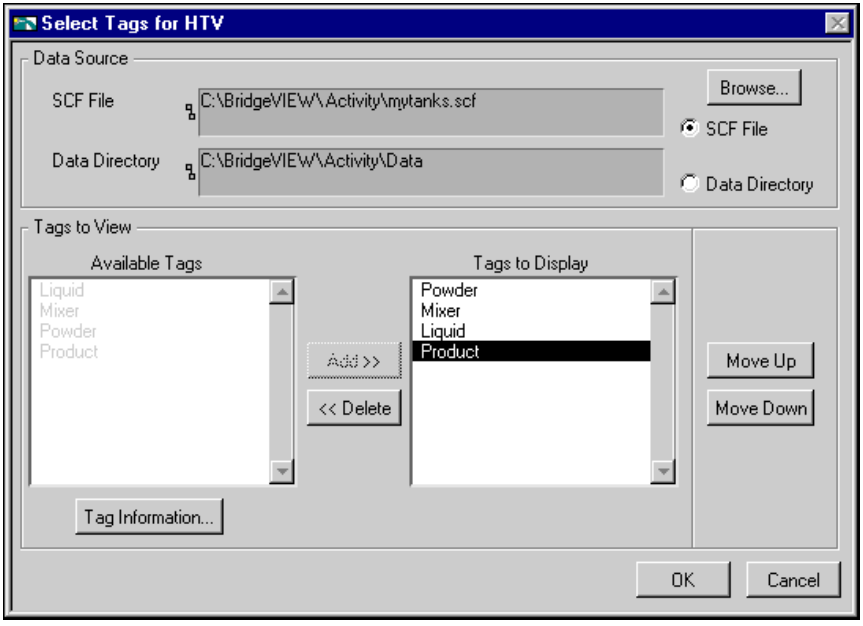


Figure 6-3. Select Tags Dialog Box

☞ **Note** ***You can look at data from only one Citadel database at a time.***

Select the tags from the Available Tags list that you want to display. The HTV displays the tags in the order that they are listed in the Tags to Display list.

☞ **Note** ***You can view configuration information about a tag by selecting it in the Available Tags list, and clicking on the* Tag Information *button.***

How Do You Change the Time Axis?

You can change the time axis for a trend within the HTV manually, or by using **Panning** buttons.

Panning Buttons

The **Panning** buttons allow you to move backward and forward through the historical data in the trend. The buttons do not affect the timespan of the trend. For example, if the trend displays data from 9:45 to 9:55 on the same day, the timespan is ten minutes. Table 6-2 describes the **Panning** button functions.

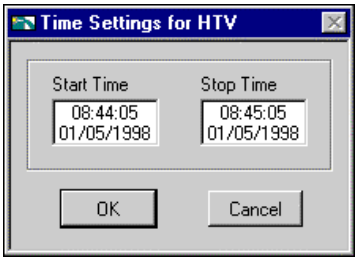
Table 6-2. Panning Button Functions

Button	Name	Description
|<	Retrieve oldest data	Displays the first available page of data.
<<	Back to closest point	Centers the display around the closest point to the left of the timespan. If there is no data in the previous time span, skips to the previous end of data.
<	Back one-half page	Moves the display back by half of the current timespan.
>	Forward one-half page	Moves the display forward by half of the current timespan.
>>	Forward to closest point	Centers the display around the closest point to the right of the timespan. If there is no data in the next time span, it skips to the next start of data.
>|	Most recent data	Displays the most recent available page of data.

Manual Changes

You can also select the text at either end of the time axis and change the data. You must enter the date in the correct format. If you make an error, the input is ignored.

You can select and enter the time and date on the time (X) axis of the historical trend on the HTV directly. However, the HTV responds immediately to any changes you make. If you want to make manual edits to both the start and stop time on the time axis, you can select the **Viewer»Time & Date** option. When you select this option, a dialog box appears, shown below, and you can enter the start and stop time of the data displayed in the trend.



How Do You Change the Timespan of Data Displayed?

The timespan indicator displays the amount of relative time between the start and end points of the time axis. To change the amount of time between these points, you either can manually reenter data in the start or end point on the time axis, or pull down the ring for the timespan indicator.

By default, the timespan ring contains the values 1:00, 5:00, 10:00, and 30:00. Select **Enter New…** in the timespan ring if you would like to enter a different amount of data to display.

How Do You View the Value of a Tag at a Specific Point in Time?

The Data Display table on the HTV, shown in Figure 6-2, shows the tags displayed in the trend, the tag description, and, for analog tags, the engineering units associated with the tag. The two rightmost columns show the values of the tags at the two cursor locations in the trend. For discrete tags, the values in these columns are either `On` or `Off`. To move the cursors, grab their pointers at the bottom of the trend display.

How Do You Change the Y Axis?

The HTV displays two Y axes at any time. Each Y axis displays the color of the tag associated with it. All discrete tags show their ranges as going from `On` to `Off`. Click on the Y axis to make it rotate through the tags displayed in the trend.

To change the range in the Y axis for analog and bit array tags, select the text at the top or bottom of the scale and type in the desired value. When you enter the value, that trend scale changes and the trend display updates. Discrete tags are displayed without Y axis scales, and ranges are shown as `On` or `Off`.

How Do You Change the Plot Colors and Style in the Trend?

Click on the **Trend Legend**. The pop-up window contains several options with which you can change the plot colors and styles used in the trend.

How Do You Zoom In on the Trend?

The **HTV Trend** palette contains a Zoom tool that allows you to zoom in on points of interest. The Zoom tool has five modes with which you can zoom in on the trend:

- Zoom by rectangle
- Zoom time scale
- Zoom Y scale
- Zoom in about one point
- Zoom out about one point

Undo Zoom resets the graph to its previous setting.

How Do You Export Data to a Spreadsheet?

From the HTV, select **File»Export…**. The HTV exports the information currently displayed in the trend to a tab-delimited file. A dialog box prompts you for the name and location of the file to create.

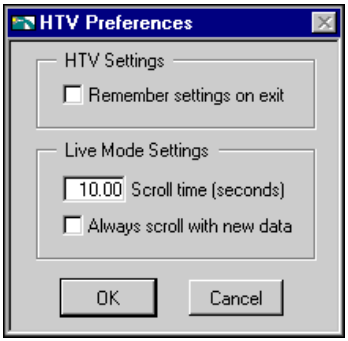
The HTV resamples data in periodic intervals so that all tags have the same number of data points. The frequency defaults to a value according to the frequency of data in the historical files. If you want to override this value, enter the frequency you want in the dialog box.

How Do You Get Online Help for the HTV?

From the HTV, pull down the **Help** menu and select **Show Help**. A floating window is displayed that shows help information for all of the objects on the HTV panel.

How Do You Set Tag, Time, and Color Preferences?

Set the preference for the HTV to remember settings for display time and color on exit by selecting **Viewer»Preferences…**. When you exit the HTV, the state of the viewer is recorded.



Select the **Remember settings on exit** checkbox if you want to update your settings each time you exit the HTV.

How Do You View New Data Automatically After It Has Been Logged to Citadel?

You can use Live Mode to watch incoming data after it has been logged. When the Engine is turned on with historical logging enabled, the **Live** button appears to the right of the panning buttons. When you click the **Live** button, the trend automatically updates periodically. Select **Viewer»Preferences…** in the HTV Preferences dialog box to set how often the trend will display the new data. The default is 10 seconds. If **Always scroll with new data** is checked, the display updates whenever new data is logged.

While Live Mode is turned on, the values for each tag are extrapolated to the last time the trend was updated. These extrapolated values are marked with an asterisk in the Data Display. When a cursor or slider is placed before the extrapolation begins for a tag, the asterisk will not be present. Turning off Live Mode also turns off extrapolation.

How Do You Incorporate the HTV into Your HMI Application?

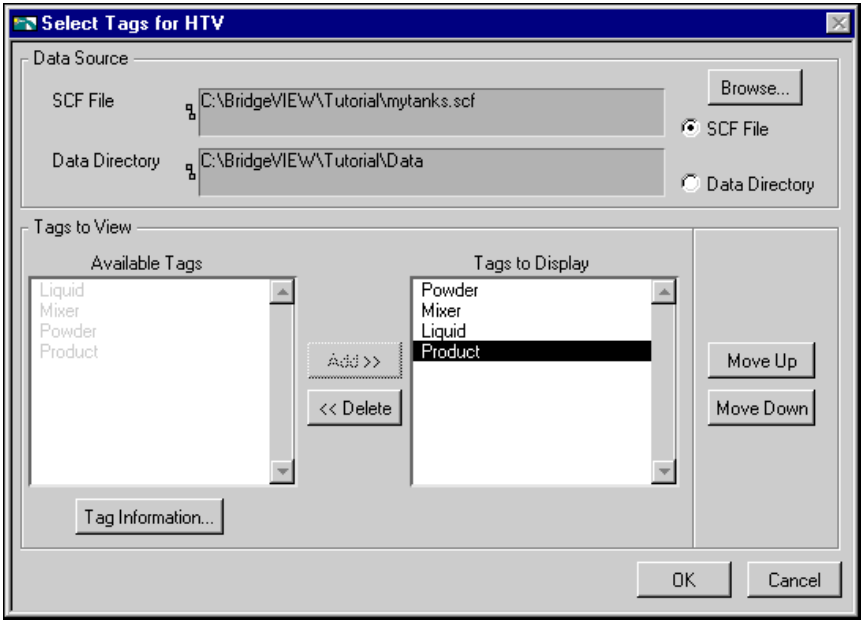
The HTV is available by selecting **Project»Historical Trend Viewer…**. However, in many HMI applications you might elect not to give the operator access to the standard menu bar. You can use the Call HTV VI, located in the **Historical Data** subpalette of the **Functions** palette, to call the HTV dynamically from your HMI application. See the section *Historical Data VIs* in Appendix A, *HMI Function Reference*, for details on how to use this or any other VI.

Activity 6-2. Use the Historical Trend Viewer

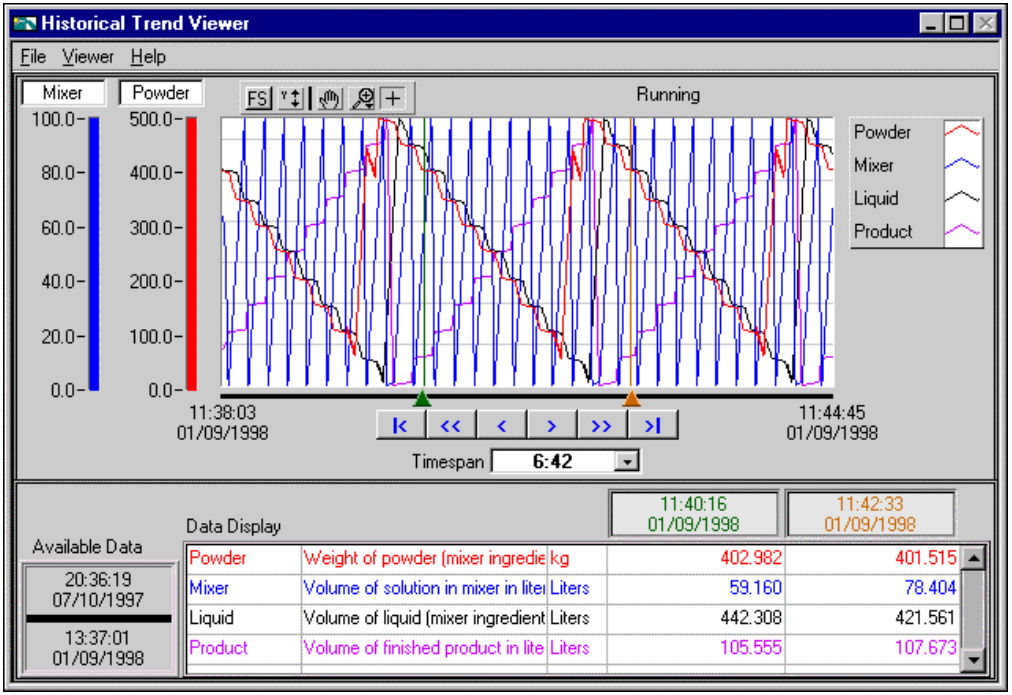
The objective of this activity is to view logged data with the Historical Trend Viewer.

You will use `mytanks.scf` in the `BridgeVIEW\Activity` directory, as edited in Activity 3-1, *Configure a Tag, and View the Tag Configuration Parameters and Tag Values*. You will view previously logged data spanning over 25 minutes, which is included in the `BridgeVIEW\Activity\Data` directory.

1. Launch the HTV by selecting **Project»Historical Trend Viewer…**.
2. The Select Tags for HTV dialog box appears. Select the Powder, Mixer, Liquid, and Product tags from the list of Available Tags and add them to the Tags to Display list. Click **OK**.

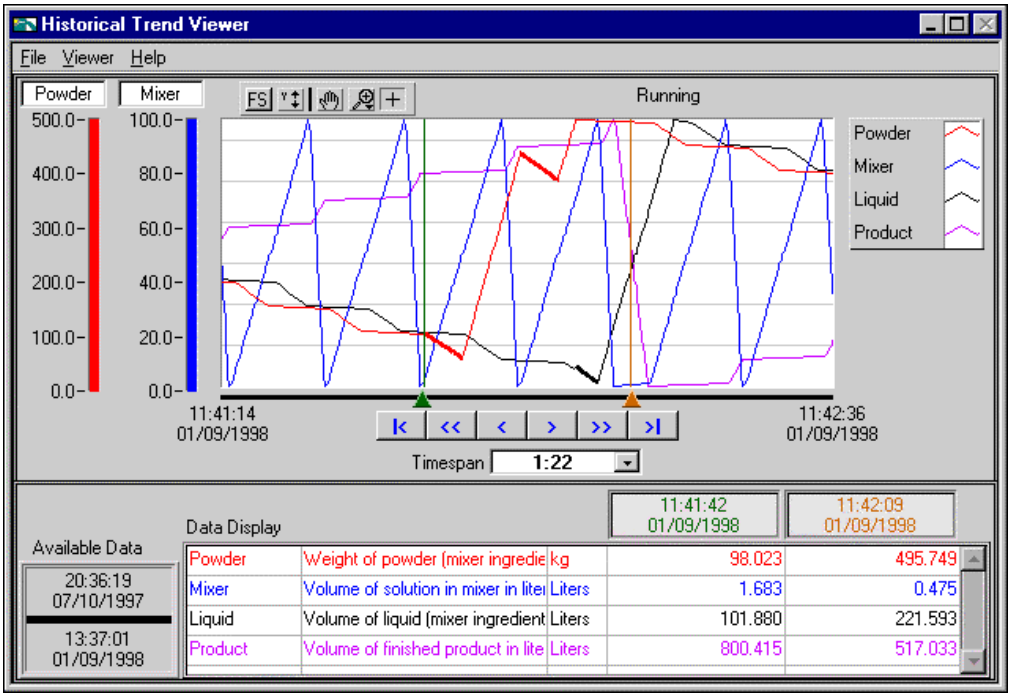


When you close the Select Tags for HTV dialog box, the Historical Trend Viewer appears, as shown in the following illustration.

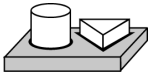


The HTV displays the trends for the Powder, Mixer, Liquid and Product tags. The Available Data display shows the start and stop timestamps of the logged data. The status of the HTV is displayed on top of the Historical Trend. You can see it change from Accessing Disk to Running. The legend to the right of the Historical Trend shows the tag names and the plot colors, as they appear on the trend and in the scales.

3. View the first five minutes in the data set by clicking on the first scroll button in the set below the Historical Trend. The beginning of the data is centered in the display.
4. Scroll through the data set using the other buttons below the Historical Trend.
5. The scales to the left of the Historical Trend show the minimum and maximum of the Mixer and Powder tags. To view the scales for the other tags, click on one of the scales. You can see the color and tag name in the display above the scale change. As you click, it rotates through the list of tags displayed in the HTV.
6. To zoom in on the data, select the magnifying glass from the palette, and click and drag over a section of the trend.



7. To see the value of a particular data point, use the two vertical cursors on the trend. You can see the value of the data point on each trend at the given cursor location in the Data Display.
8. Select **File»Exit** to terminate the HTV.



End of Activity 6-2.

7

Advanced Application Topics

This chapter explains advanced topics you need to understand to make optimum use of BridgeVIEW for developing applications. The advanced topics covered in this chapter are listed below:

- Using the Panel G Wizard
- BridgeVIEW System Control
- Tag Attributes VIs
- BridgeVIEW Security

How Do You Build an HMI with Multiple Panels?

Consider dividing your HMI into several panels so the operator can navigate through them using onscreen buttons. The Panel G Wizard helps you generate the navigation system by automatically generating code and attaching it to front panel buttons.

Front Panel Buttons

Buttons are the most common mechanism for navigating through different panels. Operators can use buttons to close windows, invoke login prompts, or display different panels. BridgeVIEW contains a variety of different buttons that you can use and customize. Buttons are located in the **Controls»Boolean** subpalette.

Panel G Wizard

The *Panel G Wizard* provides an easy interface for you to generate a panel navigation system for your operators. With the Panel G Wizard, you can attach code to buttons that, when pressed by the operator, will open your VIs. If your are new to G programming, the Panel G Wizard can be an immense help in producing applications with multiple windows and panels.

The Panel G Wizard provides the basic mechanism to attach panel management code to buttons. For more advanced capabilities, see the *VI Server Functions* section in this chapter.

How Do You Use the Panel G Wizard?

The Panel G Wizard only operates on Boolean controls. To invoke the Wizard, pop up on a front panel Boolean control and select **Panel G Wizard…**. Popping up on a button control brings up the Panel G Wizard shown in Figure 7-1.

☞ **Note** ***Because the code created by the Panel G Wizard contains file path information, some features do not generate correct code until the calling panel is saved to disk. For this reason, save your VI to disk before invoking the Panel G Wizard.***

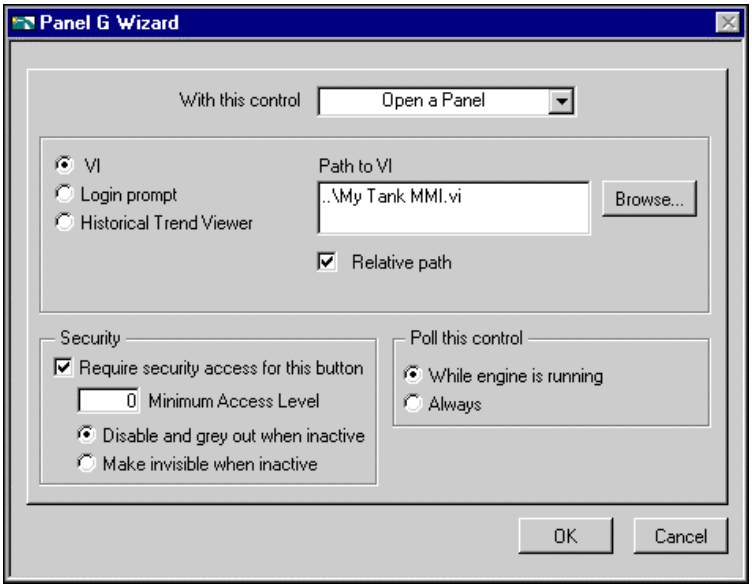


Figure 7-1. Panel G Wizard

The Panel G Wizard provides a mechanism to open or close a panel when the button is pressed. You determine this action by operating the **With this Control** ring near the top of the Panel G Wizard dialog box.

The Panel G Wizard can create code that will open three types of panels:

- VIs that you have created and saved to disk
- a Login prompt
- the Historical Trend Viewer

When opening VIs that you have created, you specify the path to the VI by typing it in the **Path to VI** control or by selecting the **Browse…** button.

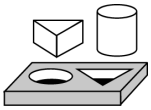
You can configure the Panel G Wizard to store the file path as a relative path or as an absolute path. If the VI that you connect to the button is generally kept in a path that is relative to the top-level VI, you should select the **Relative path** setting.

How Do You Configure Security with the Panel G Wizard?

The Panel G Wizard can create code that disables or hides the button if the operator does not have sufficient security access. You determine the access level required in the Panel G Wizard dialog box. Security is covered later in this chapter.

How Do You Configure When a Button Will Be Polled?

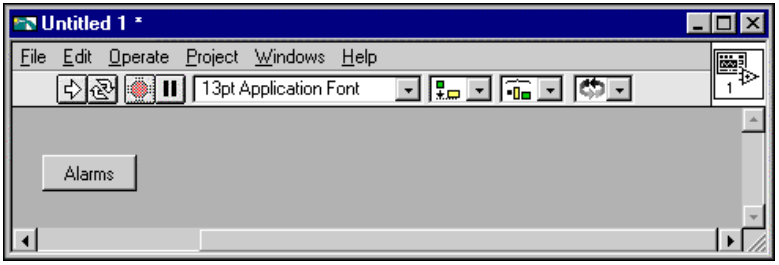
Like all user interface controls in BridgeVIEW, front panel buttons are monitored using a polling loop mechanism. Polling will occur either until the BridgeVIEW Engine shuts down, or, if the **Always** option is selected, until the VI stops.



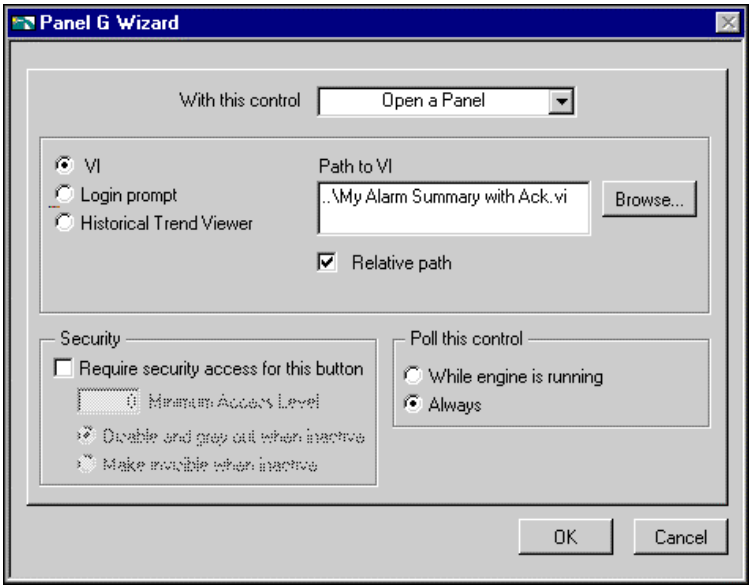
Activity 7-1. Use the Panel G Wizard

Your objective is to use the Panel G Wizard to attach buttons to VIs that you have created, to the HTV, and to a Login prompt. You will use VIs that you created in Chapters 4, 5, and 6 in this exercise. You will use `mytanks.scf` ***in the*** `BridgeVIEW\Activity` ***directory.***

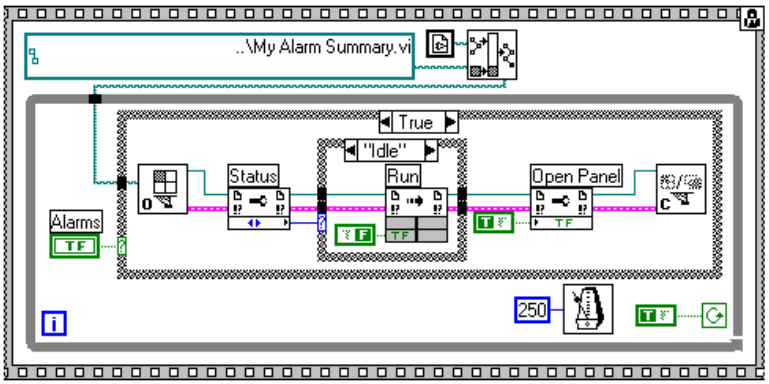
1. Place a front panel button on a new front panel, as shown below. Click on the button text with the labeling tool and name the button `Alarms`. Pop up on the button and make sure the **Mechanical Action…** is set to **Latch when Released**.



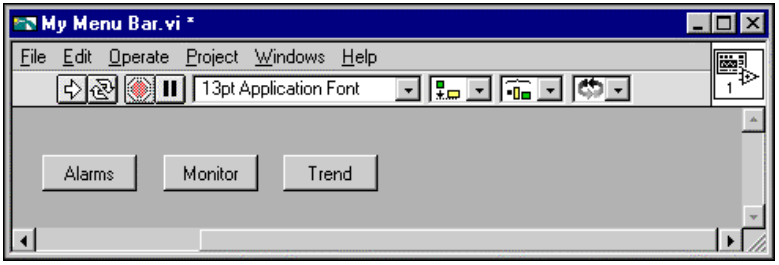
2. Save the VI as `My Menu Bar.vi` in the `BridgeVIEW\Activity` directory.
3. Pop up on the **Alarms** button and select **Panel G Wizard…**. Configure the button to open the `My Alarm Summary with Ack.vi` that you created in Activity 5-2, *Acknowledge Alarms in the Alarm Summary Display*, as shown below.



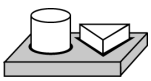
4. Examine the block diagram created by the Panel G Wizard. The diagram code is locked as indicated by the lock icon in the upper right corner of the window. The locking mechanism works the same way as it does for the HMI G Wizard.



5. Make a copy of the **Alarms** button. Click on the button text with the labeling tool and name the button `Monitor`.
6. Pop up on the **Monitor** button and select **Panel G Wizard…**. Use the same settings as before, but connect this button to the `Monitor Product.vi` you created in Activity 4-3, *Read a Tag*.
7. Make a copy of the **Monitor** button. Rename the button `Trend`. Using the Panel G Wizard, connect this button to the `My Tank HMI.vi` you created in Activity 4-1, *Use the HMI G Wizard*.
8. Your front panel should now look like this.



9. Before you run the VI, make sure that the correct `mytanks.scf` file is being used. If the engine is currently running, you can check the Engine Manager display. If an incorrect `.scf` file is in use, stop the engine and open the Tag Browser. Select **Tag Browser…** to configure BridgeVIEW to open the `mytanks.scf` file in the `BridgeVIEW\Activity` directory. Launch the engine either from the Engine Manager display or by selecting **Project»Launch Engine…**.
10. Save `My Menu Bar.vi`. Run the VI. When you press on one of the buttons, the appropriate panel should open and run.
11. Experiment with other buttons to open the Historical Trend Viewer, invoke a Login prompt, and so on. You can also configure security access checks on the buttons.

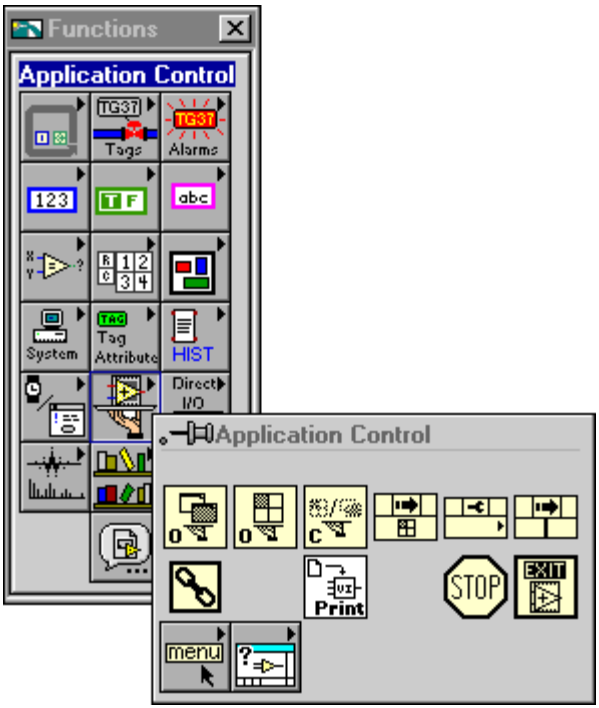


End of Activity 7-1.

VI Server Functions

The VI Server provides you with several functions to control your VIs, such as panel location, size, and visibility. These functions are useful when your application requires a large number of different operator screens.

For example, you might find it unnecessary to load certain panels into your application until they are needed. By using these functions, you can control when your panels are loaded into memory. You can reach the VI Server functions through the **Functions»Application Control** palette, shown below.



For more information about the VI Server, see Chapter 15, *Application Control*, or the **Online Reference** available by selecting **Help»Online Reference**.

How Do You Control Panel Size?

To query or set the size of an operator interface panel, use the property node function set to the `Virtual Instrument` VI Server Class, and read or write the **Front Panel Window»Window Bounds** or **Front Panel Window»Panel Bounds** property. The **Front Panel Window»Panel Bounds** property does not include the window title bar, scrollbars, menu bar, or toolbar, while the **Front Panel Window»Window Bounds** property includes all of these components. Both bounds are given in pixels.

How Do You Control Panel Visibility?

There are several ways to control the visibility of an operator interface panel from your application. These options are listed below:

- Enable the **Show Front Panel when Called** and **Close Afterwards if Originally Closed** options in the **VI Setup Execution** options. This option applies only to subVIs.
- Enable the **Show Front Panel when Called** and **Close Afterwards if Originally Closed** options in the **SubVI Node Setup** options. This option applies when you call the VI as a subVI.
- Use the property node function found under **Functions»Application Control**. Right-click on the property node and select **Select VI Server Class»Virtual Instrument**, and then left-click the property node and select **Front Panel Window»Open**.

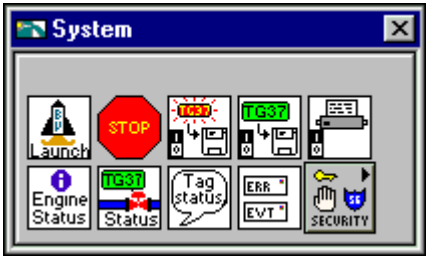
For more information about VI Server functions, see Chapter 15, *Application Control*.

BridgeVIEW System Control

As you develop more sophisticated user interfaces, you might find that you need to exercise control over portions of the BridgeVIEW environment from your own applications. The System VIs palette provides mechanisms to programmatically control the BridgeVIEW Engine.

System VIs

The System VIs provide you with several functions that control actions such as launching and shutting down the Engine, enabling and disabling logging, invoking the Login dialog box, and so on. You can reach the System VIs through the **Functions»System VIs** palette, shown below.



For more information about the System VIs, refer to Appendix A, *HMI Function Reference*.

How Do You Start or Stop the BridgeVIEW Engine from Your Application?

Use the Engine Launch VI to launch the BridgeVIEW Engine programmatically with a specified configuration file. Use the Engine Shutdown VI to stop the BridgeVIEW Engine and the servers currently executing. For more detailed information about these or any other VIs, refer to Appendix A, *HMI Function Reference*.

How Do You Start or Stop Historical Logging from Your Application?

Use the Enable Historical Data Logging VI to start historical logging. If the input value is TRUE, historical logging is turned on if it is currently off. If the input value is FALSE, historical logging is turned off if it is currently on.

How Do You Start or Stop Event Logging from Your Application?

Use the Enable Event Logging VI to start event logging. If the input value is TRUE, event logging is turned on if it is currently off. If the input value is FALSE, event logging is turned off if it is currently on.

How Do You Start or Stop Event Printing from Your Application?

Use the Enable Printing VI to start event printing. If the input value is TRUE, event printing is turned on if it is currently off. If the input value is FALSE, event printing is turned off if it is currently on.

Tag Attributes VIs

There is a set of VIs in the **Tag Attributes** palette with which you can read or change configuration information about tags programmatically. Most of these *tag attributes* are parameters you can configure for a tag with the Tag Configuration Editor. They fall into five categories:

- General Tag Information
- I/O Connection
- Operations
- Scaling
- Alarms

☞ **Note** ***Not all parameters configured in the Tag Configuration Editor can be changed programmatically. However, if you want to make persistent changes for several dynamic attributes in the Tag Configuration Editor, such changes can be applied to a running Engine.***

You can programmatically take a tag on or off scan. If a tag is off scan, it is not processed or updated in the Real-Time Database, alarms are not calculated, and data is not logged. You can start these activities by putting that tag back on scan.

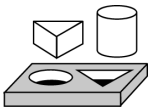
There are specific VIs you can use to obtain certain tag information, such as the Get Tag Logging Info VI or the Get Tag Alarm Enabled VI. For the Set Tag Attribute or Set Multiple Tag Attributes VIs, an error is returned if the Engine is not running. In addition, tag attribute changes only affect the current Engine process until they are subsequently changed or the Engine stops.

If the Engine is running, you can change tag attributes programmatically with the Set Tag Attribute VI, Set Multiple Tag Attributes VI, or the Tag Configuration Editor. These VIs return an error if the Engine is not running. Tag attribute changes stay in effect in the current run only. If you stop the Engine and start it again, the changes are lost. Use these VIs in your application when you want to change attributes of a tag dynamically, as with logging, alarm, or scaling information, or taking a tag on or off scan. For a complete description of the Tag Attributes VIs, refer to Appendix A, *HMI Function Reference*.

When you change programmatic attributes with the Tag Configuration Editor, you can update Engine processes without shutting down and restarting the Engine, provided no changes require the Engine to reconfigure. You can change all operations, alarms, and most scaling, and raw or engineering range information dynamically.

There are certain attributes you cannot change dynamically. These attributes require you to edit the `.scf` file with the Tag Configuration Editor, and they include tag information like tag name, tag description, scaling type, engineering unit, data type (analog, discrete, bit array, string), tag group name, and access rights (input only, output only, Input/Output, memory); and tag connection information like server, IO Group, and item.

For more information about tag attributes, refer to any one of the five configuration attributes tables in the section *How Do You Configure Tags?* in Chapter 3, *Tag Configuration*.

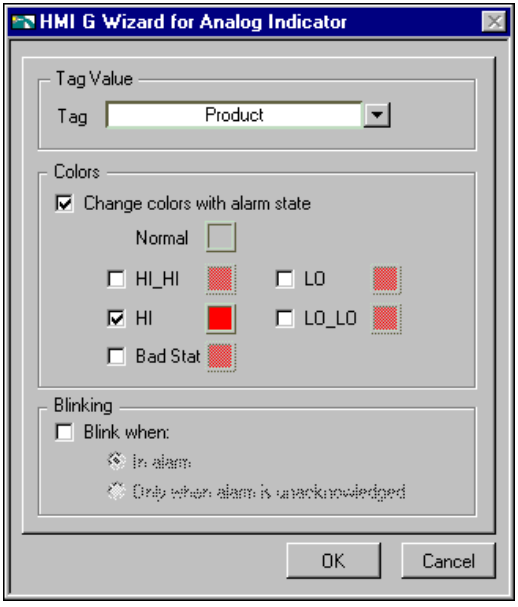


Activity 7-2. Use Tag Attributes

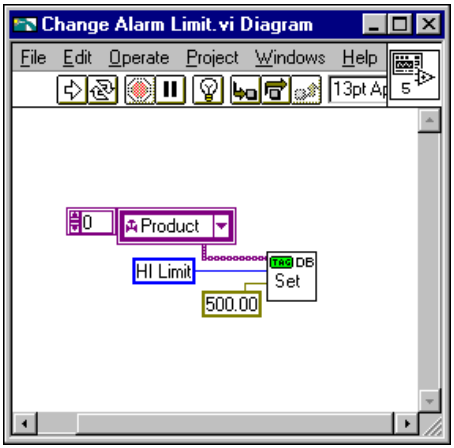
Your objective is to use tag attributes to change alarm limits dynamically.

You will use `mytanks.scf` in the `BridgeVIEW\Activity` directory, as edited in Activity 3-1, *Configure a Tag, and View the Tag Configuration Parameters and Tag Values*.

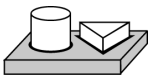
1. Open `Monitor Product.vi` from the `BridgeVIEW\Activity` directory. You created this VI in Activity 4-3, *Read a Tag*. If you did not complete this activity, you can open the VI from the `BridgeVIEW\Activity\Solutions` directory.
2. Open the block diagram, select the While loop, and delete it. Because you released the Wizard Lock in Activity 4-3, the HMI G Wizard will no longer replace the old code, but will generate additional code instead.
3. Pop up on the tank on the front panel and select **HMI G Wizard**. Change the Normal color to **Blue**, and select the alarms to show for the HI alarm state only, as shown in the following illustration.



4. Run the VI. Because the Product tag is configured to go into HI alarm when it exceeds a value of 800, you can see that the tank color is blue while the tag value is below 800. It changes from blue to red when the value goes above 800. Leave this VI running.
5. To change the HI alarm limit of Product dynamically, open a new VI. Drop the Set Tag Attribute VI from the **Functions»Tag Attributes** palette.
6. Using the wiring tool, create constants for the **group/tag names**, **tag attribute**, and **value** inputs.
7. Select **Product** for the **group/tag names** input, change **tag attribute** from the default `<none>` to `HI Limit`, and wire in `500.00` for the value as shown in the following illustration.



8. Save the VI as `Change Alarm Limit.vi` in the `BridgeVIEW\Activity` directory.
9. Run this VI. This dynamically changes the HI limit for the Product tag from 800 to 500.
10. Look at `Monitor Product.vi`. It still should be running. However, now you should see the color change from blue to red when the value exceeds 500, instead of 800.
11. Stop and close the VIs.



End of Activity 7-2.

BridgeVIEW Security

BridgeVIEW security is broken into two general categories:

- Environment Security (User Privileges)
- Operator Interface Security

Security does not take effect until you configure it. Configuration consists of adding users and assigning them access levels, privileges, and passwords.

Environment Security

Access to most BridgeVIEW utilities and the BridgeVIEW Engine can be configured on a per-user basis. For example, not all users should be able to configure the tags in the system or create and edit user accounts. The privileges that can be assigned to a user are defined in Table 7-1.

Table 7-1. Assignable BridgeVIEW Privileges

Type	Privilege	Description
Environment Privileges	Use Historical Trend Viewer	User can launch, configure, and use the Historical Trend Viewer utility.
	Use Tag Monitor	User can launch, configure, and use the Tag Monitor utility.
	Use Tag Browser	User can use the Tag Browser utility.
	Use Server Browser	User can use the Server Browser utility.
	Disable <Alt> Key	If enabled, the <Alt> key on the keyboard is disabled in BridgeVIEW.
	Configure Startup VIs	User can assign VIs to launch when BridgeVIEW is started.

Table 7-1. Assignable BridgeVIEW Privileges (Continued)

Type	Privilege	Description
Project Privileges	Configure Log File Locations	User can use the Tag Configuration Editor to edit the historical and event logging configuration of a tag configuration, but can not create, delete, or edit tags.
	Create/Edit Tags	User can create, delete, and edit tags in the Tag Configuration Editor.
	Use Interactive Server Tester	User can launch the Interactive Server Tester; this privilege can be configured only if the VI Server Developer Toolkit is installed.
Engine Privileges	Start/Stop Engine	User can start and stop the Engine via the Engine Manager.
	Start/Stop Historical Logging	User can start and stop Historical Logging via the Engine Manager.
	Start/Stop Event Logging	User can start and stop Event Logging via the Engine Manager.
	Start/Stop Printing	User can start and stop Event Printing via the Engine Manager.
Security Privileges	Change Password	User can change his or her own password.
	Create/Edit Access Levels	Using the Access Levels dialog box, the user can add, remove, and edit access levels lower than his or her own access level.
	Create/Edit User Accounts	User can create and edit user accounts which have an access level lower than his or her own access level.
	Configure User Privileges	User can change the privileges assigned to other users who have an access level lower than his or her own. This privilege requires that the user also have the Create/Edit User Accounts privilege, described above.

A user's BridgeVIEW Environment privileges are completely independent of the user's access level, and do not directly affect access to objects in the operator interfaces that you develop for your application. See the *Operator Interface Security* section in this chapter for more information.

How Do You Log In and Out?

To log in, choose **Project»Security»Login**. Type in your account name and password. If you do not know your login name, or have forgotten your password, contact your BridgeVIEW administrator.

To log out, choose **Project»Security»Logout**.

How Do You Find Your Access Level?

After you have logged in, you can find your access level by choosing **Project»Security»Access Levels…**. When you make this selection, the Access Levels dialog box appears, as shown in Figure 7-2.

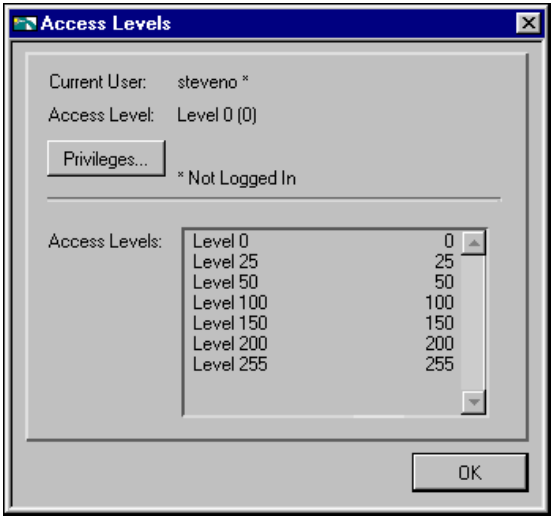


Figure 7-2. Access Levels Dialog Box

You also can view your privileges by clicking the **Privileges…** button. For more information about privileges, refer to Table 7-1 and to the section, *How Do You Find Your Environment Privileges?* in this chapter.

How Do You Find Your Environment Privileges?

After you have logged in, you can find your environment privileges by choosing **Project»Security»Privileges…**. When you make this selection, the Privileges dialog box appears, as shown in Figure 7-3.

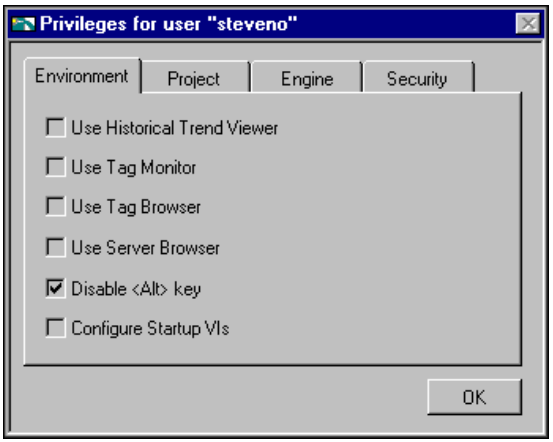


Figure 7-3. Privileges Dialog Box

For more information about BridgeVIEW user privileges, refer to Table 7-1.

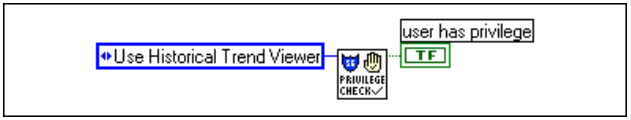
How Do You Change Your Password?

You must be logged in to change your password. Choose **Project»Security»Change Password**.

Type in your old password, then your new password. Type in your new password again to verify it.

How Do You Check a User's Privileges?

Use the Check Operator Privileges VI in the **System»Security** palette. This VI checks the current user's privileges to see if the user has a particular privilege. An example is shown below.



How Do You Prompt the Operator to Log In to Your Application?

Use the Invoke Login DialogVI in the **System»Security** palette. This VI launches the Login dialog box and returns the user name and access level. You can have your application control login as part of its HMI. For more

information about this or any other VI, refer to Appendix A, *HMI Function Reference*.

How Do You Programmatically Log an Operator In to Your Application?

Use the Programmatic Login VI in the **System»Security** palette. To use this VI, you must enter a user name and password. If successful, the user is logged in to the system, and no Login dialog box appears.

How Do You Programmatically Log an Operator Out of Your Application?

Use the Programmatic Logout VI in the **System»Security** palette. This VI logs the current user out of the BridgeVIEW system.

How Do You Identify the Current Operator?

Use the Get Operator Name VI in the **System»Security** palette. This VI returns the name and current BridgeVIEW operator name and access level. For more information about this or any other VI, refer to Appendix A, *HMI Function Reference*.

How Do You Restrict Access to the BridgeVIEW Environment?

When you install BridgeVIEW, no user accounts exist, so all users have full access to the system. You must create user accounts for the normal security features to take effect. When you create user accounts, you assign an access level to each account.

When a user logs in, BridgeVIEW obtains the user's privileges and access level. Your HMI VIs also can enforce security by determining whether the current user can operate, or even see, a particular control or indicator.

See the section *Operator Interface Security* in this chapter for more information about using security in your HMI.

How Do You Create and Modify User Accounts?

To create and modify user accounts, you must have the Create/Edit User Accounts privilege. To change a user's privileges, you also must have the Configure User Privileges privilege. To edit the list of user accounts,

choose **Project»Security»Edit User Accounts…**, and the Edit User Accounts dialog box appears, as shown in Figure 7-4.

Figure 7-4. Edit User Accounts Dialog Box

Click the **Add New Users>>** button to create a new user account. Type in a name, select an access level, and provide a password for the account. To modify the privileges for the account, click the **Privileges…** button. Click the **Add** button to complete the addition of the new user account.

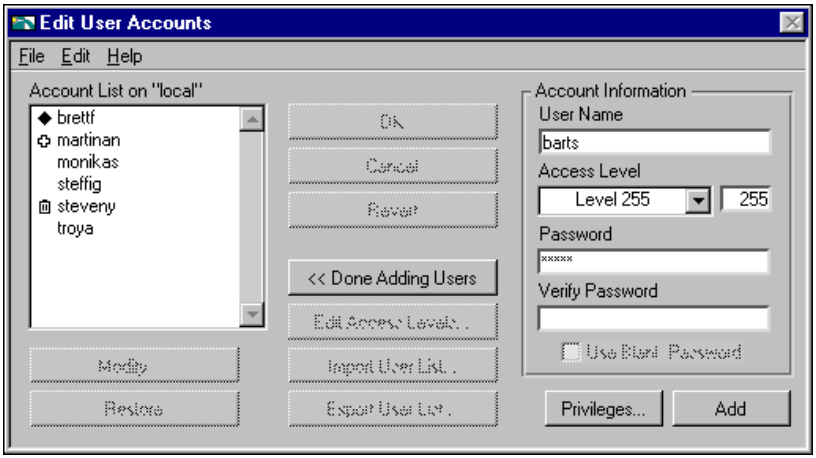


Figure 7-5. Add a User Account

After you have defined user accounts, you also can use this utility to create, remove, or modify accounts. To modify several user accounts at once (for

example, change the access level of several accounts to be the same value), hold down the <Shift> key when selecting users from the list.

☞ **Note** ***Once you have defined user accounts, you must have at least one "super user" account (Access Level 255, privileges to Create/Edit user Accounts and Configure User Privileges), unless you remove all user accounts.***

☞ **Note** ***You only can add, remove, or modify accounts if you have the Create/Edit User Accounts privilege. Also, unless you are a "super user," you can only create, remove, or edit user accounts that have an access level lower than your own. If you are not authorized to configure user privileges, default privileges are assigned to new user accounts.***

How Do You Modify the List of Available User Access Levels?

To edit the list of access levels, select **Project»Security»Access Levels**. You must have Administration privileges to edit the list of Access Levels. Click the **Edit…** button next to the list of access levels. The **Edit Access Levels** dialog box appears, in which you can add, remove, and modify access levels. You also can edit access levels within the **Edit User Accounts** dialog box by pressing the **Edit Access Levels** button, or choosing **New…** from the Access Level ring when creating or modifying a user account. In addition to the two permanent access levels 0 and 255, you can assign up to 254 access levels for use in your operator interface panels. If you remove an access level, users who have been assigned that access level are demoted to the next lower access level.

☞ **Note** ***You can rename, but not remove, access levels 0 and 255.***

How Do You Export a List of Users to a File?

You can export a list of users to binary or text files. Text files contain only the user name, access level, and privileges. To export all user account information, including passwords, you must export to a binary file.

To export the user list to a text file, click the **Export User List…** button or select **File»Export»Text File…**. You can export to tab-delimited or comma-delimited text files. For a description of how privileges are exported, see the *How Do You Import a List of Users from a File?* section later in this chapter.

To export a list of users to a binary file, choose **File»Export»Binary File…**. Exporting a list of users to a binary file is useful for distributing your list of users to other computers. The advantage of using a binary

file is that all user account information, including passwords, is included in the file.

How Do You Export Users to Another Computer on the Network?

You can put BridgeVIEW user accounts on other computers either by exporting the user list to a text or binary file on one machine and importing on another, or by choosing **File»Export»Network BridgeVIEW**.

If you choose the **File»Export»Network BridgeVIEW** option, a dialog box appears in which you can type in the name of the computer to export the accounts to, or you can browse the network. BridgeVIEW must be installed on the other computer for the export to function correctly.

☞ **Note** **(Windows 95)** ***To access the user account list on another computer over the network, you must have access to the Windows Registry on the remote machine. Remote Registry access does not function unless the Remote Administration service is installed and running on the Windows 95 machine attempting to access another computer's BridgeVIEW account list, or whose account list is to be accessed by another computer. Consult your Windows 95 documentation to determine if Remote Administration is enabled, and how to install it if it is not. This service is automatically available in Windows NT.***

How Do You Import a List of Users from a File?

You can import users into your BridgeVIEW system from a tab-delimited or comma-delimited text file, or from a binary file created by BridgeVIEW. To import a list of users from a text file, click the **Import User List…** button, or select **File»Import»Text File…**.

When importing from a text file, the first column should contain the user name, the second column the access level, and the third column a list of privileges enabled for the user. The privileges enabled for a user are separated by semicolons. Here is a list of privileges, and the abbreviation that must be used to enable the privilege for a user.

Table 7-2. Abbreviations Used to Enable Privileges for a User

Privilege	Abbreviation
Start/Stop Historical Logging	HistLog
Start/Stop Event Logging	EvtLog
Start/Stop Printing	Print

Table 7-2. Abbreviations Used to Enable Privileges for a User (Continued)

Privilege	Abbreviation
Use Historical Trend Viewer	HTV
Use Tag Monitor	TM
Use Tag Browser	TB
Use Server Browser	SB
Disable <Alt> Key	Alt
Configure Startup VIs	ConfigStartup
Configure Log File Locations	LogFileLoc
Create / Edit Tags	EditTags
Use Interactive Server Tester (if installed)	IST
Create / Edit User Accounts	EditUsers
Create / Edit Access Levels	EditAccessLevels

For example, a user named `user`, having access level 100 and privileges to use the Tag Monitor, Tag Browser, and launch the engine would have the following privileges string (in tab-delimited format):

```
user          100       Engine; TM; TB;
```

The default password for each user imported from a text file is the user account name. To change this, click the **Use Default Password** check box and type in a new password. Note that this changes the password for all imported accounts.

To import a list of users from a binary file, choose **File»Import»Binary File…** and select a file from the list that appears in the dialog box. For more information about creating and exporting to a binary file, see the *How Do You Export a List of Users to a File?* section earlier in this chapter.

How Do You Import Users from Another Computer on the Network?

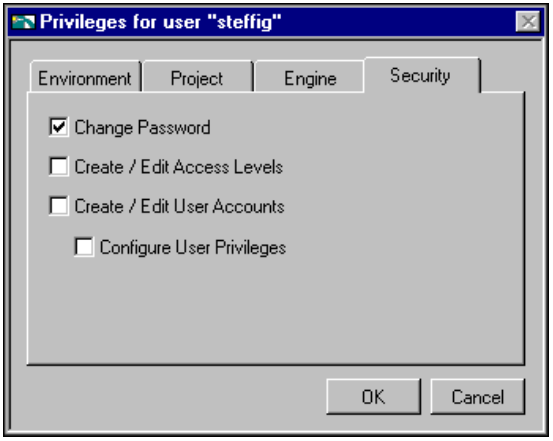
You can import BridgeVIEW user accounts from other computers from a text or binary file or by choosing **File»Import»Network BridgeVIEW**.

If you choose **File»Import»Network BridgeVIEW**, a dialog box appears in which you can type in the name of the computer to import the accounts from, or you can browse the network.

☞ **Note** **(Windows 95)** ***To access the user account list on another computer over the network requires access to the Windows Registry of the remote machine. Remote Registry access does not function unless the Remote Administration service is installed and running on any Windows 95 machine that attempts to access another computer's BridgeVIEW account list, or whose account list is to be accessed by another computer. Consult your Windows 95 documentation to determine if Remote Administration is enabled, and how to install it if it is not. This service is automatically available in Windows NT.***

How Do You Modify a User's BridgeVIEW Environment Privileges?

Use the **Edit User Accounts** dialog box to assign user privileges. To change user privileges, select **Project»Security»Edit User Accounts**. From the account list, select the account you want to modify and press the **Modify>>** button. Press the **Privileges…** button to open the **Privileges** dialog box.



To keep any changes, click the **OK** button in the **Privileges** dialog box and click the **Apply** button in the **Edit User Accounts** dialog box.

Operator Interface Security

Operator Interface Security refers to limiting user access to elements on your HMI screens. You can assign an access level to each HMI object to control which users can see or operate it.

How Do You Limit User Access to HMI Objects?

You can use security information to control visibility attributes on HMI objects. There is a set of security VIs you can use to implement security in your HMI, found in the **System»Security** palette. For more information about these or any other VIs, refer to Appendix A, *HMI Function Reference*.

As you develop your operator interface panels, you might want to restrict access to certain controls (inputs) or indicators (outputs). To do this, you must add a security loop to your Operator Interface VI. Figure 7-6 shows how to use the Security Monitor VI to control the visible and disabled attributes of a front panel control and indicator. You can apply two types of security to a control: *operability* and *visibility*. By default, controls always operate and are visible. A security level of zero applies to the control, meaning that any user with access level zero or higher (all users) can operate the control.

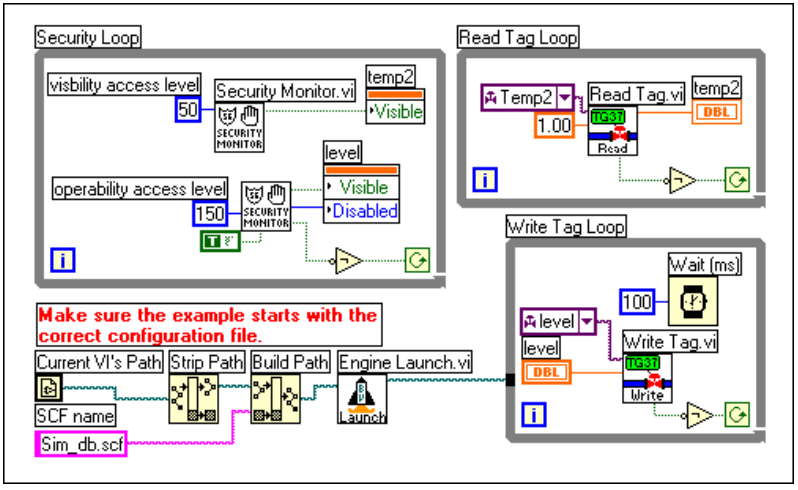


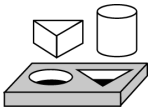
Figure 7-6. Using the Security Monitor VI to Control Visibility

To limit user access in your HMI, pop up on the control terminal in the diagram for which you want to apply security and select **Create»Attribute Node**. Resize the attribute node so both the **"Visible"** and **"Disabled"** attributes are available. Then wire the **"Visible" attribute setting** output to the **"Visible"** terminal and the **"Disabled"** attribute setting output to the **"Disabled"** terminal.

Also connect the shutdown output of the Security Monitor VI to a NOT function, and the output of the NOT function to the continuation node of

the security loop. This ensures that the security loop terminates when the Engine shuts down.

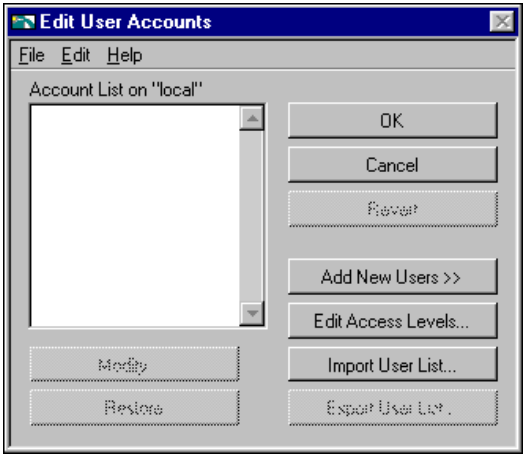
By placing the Security Monitor in a loop, as in Figure 7-6, this HMI can handle the operator access level changing dynamically and still behave appropriately.



Activity 7-3. Apply Security to the Alarm Summary Display

Your objective is to assign access privileges to the Alarm Summary application created in Activity 5-2, Acknowledge Alarms in the Alarm Summary Display. You also will associate specific access levels to an Acknowledge Boolean on your front panel.

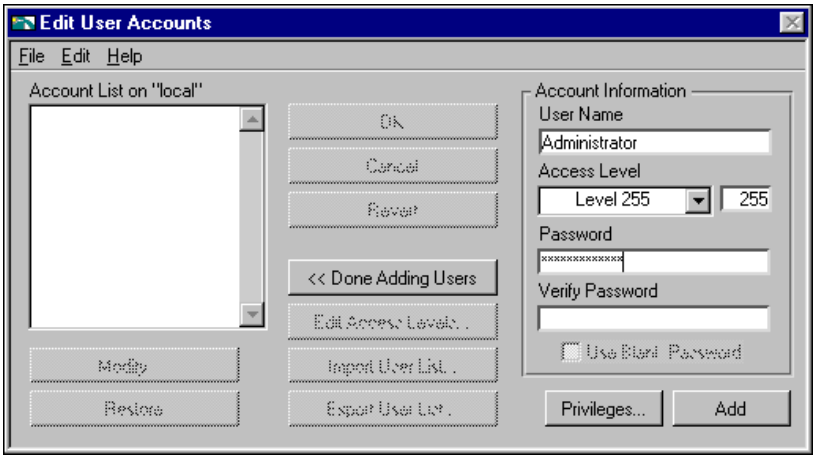
1. Configure the BridgeVIEW environment security by selecting **Project»Security»Edit User Accounts**.



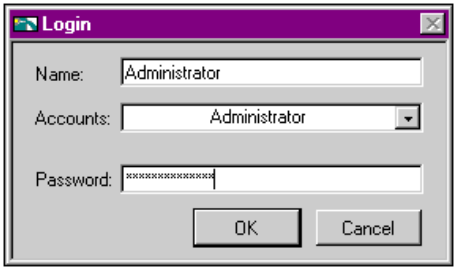
2. Select **Add New Users>>** and create the following new accounts:
   a. User Name: `Administrator`; Level: `255`; Password: `Administration`

      Press **Add** to create this new account.
   b. User Name: `Anyone`; Level: `25`; Password: `Viewer`

      Press **Add** to create this new account.



3. After creating the two accounts, select **<< Done Adding Users**. Click the **OK** button.
4. Unless you were previously logged in, a Login dialog box appears. Log in as `Administrator`, with Password `Administration`.



5. Open the `My Alarm Summary With Ack.vi` you created in Activity 5-2, *Acknowledge Alarms in the Alarm Summary Display*.
6. Edit the block diagram of `Alarm Summary with Ack.vi` to limit operability of the **Ack** button depending on the user logged in.
   a. Pop up on the **Ack** button and select **Create»Attribute Node**. The attribute node is created in the block diagram.
   b. From the block diagram, pop up on the Attribute Node. Choose **Select Item»Disabled**.
   c. Create a new While Loop and move the Attribute Node inside it.
   d. Pop up in the While Loop and drop the Security Monitor VI from the **Functions»System»Security** palette.

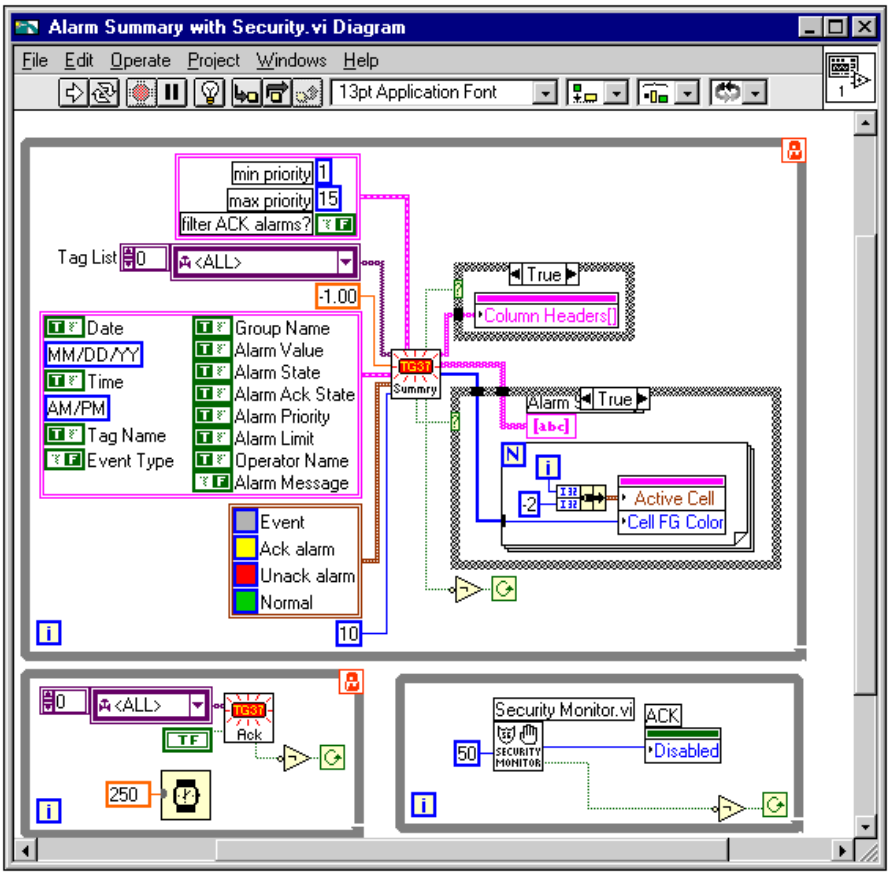
e. Wire the **"Disabled"** attribute value output of the VI to the Attribute Node.

f. Invert the **shutdown** output of the VI and wire it to the continuation terminal of the While Loop.

g. With the Wiring tool, pop up on the operability access level (0) input of the Security Monitor VI and select **Create Constant**. Enter `50` into the constant.

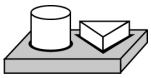
h. Save the VI as `Alarm Summary with Security.vi` in the `BridgeVIEW\Activity` directory.

The completed block diagram, including the new While Loop with the Security Monitor VI, is shown in the following illustration.



7. Run the VI. Because you are logged in as `Administrator`, you have privileges to acknowledge alarms.

8. Log in as `Anyone` with Password `Viewer` by selecting **Project»Security»Login**.
9. The **Acknowledge** button is now disabled. This is because operability access is given to users with Level 50 or above in BridgeVIEW. User `Anyone` has an access level of 25.
10. Close the VI and log in as `Administrator` again.



End of Activity 7-3.

8

Servers

This chapter explains how to use servers with BridgeVIEW. BridgeVIEW supports several types of servers including OPC Servers, DDE Servers, and National Instruments Standard IA Device Servers.

OPC Servers are written to the OPC Foundation OPC Data Access specification and are provided by many companies. A DDE Server is any server that supports the DDE Server interface. IA Device Servers are a type of server developed by National Instruments. There are two implementations of IA Device Servers: VI-based and DLL-based. The DLL-based servers are also known as IAK Device Servers.

This chapter also describes how to install and configure the IA Device Servers available from National Instruments and how to view the server configuration within BridgeVIEW.

BridgeVIEW includes the NI-DAQ Server, an IA Device Server that supports National Instruments data acquisition boards and SCXI, on the BridgeVIEW Development System CD. Additional device servers for other devices such as PLCs also are available for BridgeVIEW on the BridgeVIEW Device Servers CD. For more information about BridgeVIEW device servers, inquire about the Device Servers CD, available from National Instruments.

What Are BridgeVIEW Device Servers?

A *BridgeVIEW device server* is an application that communicates with and manages I/O devices such as PLCs, remote I/O (Input/Output) devices, remote BridgeVIEW Engines, and data acquisition plug-in cards. Device servers pass real-world tag values to the BridgeVIEW Engine in real time. Each server monitors the device items and encapsulates all device- and hardware-specific details, thereby establishing a device-independent I/O layer for BridgeVIEW.

An *item* in BridgeVIEW is a channel or variable in a real-world device. For more information about how to connect a tag to a server and item, see Chapter 3, *Tag Configuration*.

The device servers also handle and report communications and device errors to BridgeVIEW. There are different servers available for different device families and communication networks.

Each device server is a stand-alone component that might include a configuration utility as well as the run-time application that communicates with the BridgeVIEW Engine. IA Device Servers are not built into the BridgeVIEW Engine itself. These servers are written to a National Instruments standard client/server Applications Programming Interface (API) for communicating with the BridgeVIEW Engine and the Common Configuration Database.

When BridgeVIEW runs an application, it determines from the tag configuration (`.scf`) file which servers are needed, and which items are needed from those servers. BridgeVIEW launches each server it needs, and notifies each one to monitor the specific items of interest. Typically, servers monitor each input tag on a regular basis, passing the values to the BridgeVIEW Engine when they change, and updating each output tag when the BridgeVIEW HMI application writes that tag value. The update rates and deadband servers use for monitoring items can be configured as part of tag configuration. You define how a server monitors the items, how often it polls the devices, and other server-specific and device-specific parameters through each device server configuration utility.

How Do You Install and Configure a Device Server?

BridgeVIEW works with several device servers including the NI-DAQ OPC Server, the device servers available on the BridgeVIEW Device Servers CD, and the simulation servers installed with BridgeVIEW. In addition, you can use other servers available from companies other than National Instruments.

To use a device server with BridgeVIEW, first you must install the device server and register it or run its configuration utility. More specific information on installing and registering National Instruments servers follows later in this section. This information is written to the Common Configuration Database, where BridgeVIEW obtains the server information. For some servers, you configure devices and items with the server-specific Configuration Utility. Then, the Tag Configuration Editor imports server, device, and item information so you can create tags. IAK device servers allow you to directly create and configure communication resources, devices, and items from the Tag Configuration Editor.

When you register a device server, its name appears in the list of servers shown in the various Edit Tag screens of the Tag Configuration Editor. Once you configure your server, you can create a BridgeVIEW Configuration using that server. Depending on the server, different information is written to the Common Configuration Database (CCDB) when the server is registered.

The most simple servers register no more than their names and launch paths. You can select items by adding in the item strings in the **Edit Tag** dialog box for each tag using that server. To select a device, you must create an I/O Group and select or enter the device name in the I/O Group dialog box. Refer to your server documentation for the correct formats for these device and item strings.

The IAK Servers allow you to create and configure communication resources, devices, and items directly in the Tag Configuration Editor. Communication resources and devices are configured in the I/O Group dialog box. Items are configured in the Connection tab of the Tag Configuration dialog box.

Other servers register the devices to which they are connected and available items for those devices by name. These servers also can register the data type, directions, and engineering range and units of the various items, if applicable. When you select these servers in the Edit Tag screens of the BridgeVIEW Tag Configuration Editor, you must first create an I/O group and select a device. Then you see a list of available devices, and a list of items connected to that device in the Edit Tags screen. For a selected device and item, the BridgeVIEW Tag Configuration Editor imports any available item engineering range and unit information and also checks that the directions or access rights for an item are compatible with the access rights you have selected for the tag. Check your server documentation to find out if it registers device and item names and item parameters with BridgeVIEW.

Installing and Configuring the NI-DAQ OPC Server

The NI-DAQ OPC Server is available as part of NI-DAQ 6.*x*, and is included on the BridgeVIEW CD. You can choose to install the NI-DAQ OPC Server at the same time you install NI-DAQ, or you can install the NI-DAQ OPC Server at a later time. Select the NI-DAQ OPC Server when you are prompted to install servers.

After you install the NI-DAQ OPC Server, you must run the NI-DAQ Configuration Utility and the Channel Wizard to configure your DAQ system before you can use the NI-DAQ OPC Server with BridgeVIEW.

All Channels created with the NI-DAQ Channel Wizard appear as items when the DAQ OPC Server is selected in BridgeVIEW.

Installing and Configuring Device Servers from the BridgeVIEW Device Servers CD

The BridgeVIEW Device Servers CD contains servers for several PLCs and remote I/O devices. These device servers are DLL-based servers using the Device Server Toolkit interface to BridgeVIEW.

To install the BridgeVIEW Device Servers from the BridgeVIEW Device Servers CD, follow these steps.

1. Insert the CD in your CD-ROM drive.

   If you are running BridgeVIEW on Windows 95 or NT 4.0,

   select **Run…** from the **Start** menu.

2. Follow the instructions that appear on the screen.

The Installer prompts you to select one or more servers to install. It also installs the Server Explorer, which all the device servers contained on the CD use for server configuration. After you run the installer, you must run the Server Explorer to configure the device-specific parameters of your industrial network before using the server with BridgeVIEW. The Server Explorer also registers your server so you can use it with BridgeVIEW. Each server on-line help file documents configuration instructions specific to each server on the CD. See the on-line help files for your server for more information.

Registering Simulation Servers

BridgeVIEW automatically installs three servers used by several of the BridgeVIEW examples—the Tanks Server, the SIM Server, and the Cookie Server. You can use these servers to experiment with Tag Configuration and building your HMI. You also can look at the diagrams of these servers to see how a VI-based server works.

These servers must be registered for BridgeVIEW to recognize they exist. The three servers are contained in folders named `Tanks Server`, `SIM Server`, and `Cookie Server` in the `BridgeVIEW\_servers` folder. Within each folder, each server has a VI named `Register Tanks Server.vi`, `Register SIM Server.vi`, and `Register Cookie Server.vi` respectively. To register each server, open its register VI, run it, and close the VI. The server then appears in the BridgeVIEW list of servers whenever you configure a tag or look at servers in the Server

Browser utility. You can remove these servers from the server list by selecting the **Unregister Server** option in the Server Browser utility.

How Do You Use OPC Servers with BridgeVIEW?

BridgeVIEW can communicate with any server implementing the OPC Foundation OPC Server interface, a Microsoft COM-based standard. BridgeVIEW automatically finds all OPC Servers installed in your system and searches the network for OPC servers on other machines. Unlike Device Servers, OPC Servers do not store information in the Common Configuration Database, rather BridgeVIEW reads any available information about server capabilities and items from the server directly.

OPC Servers are listed in the Server Name List when you configure a BridgeVIEW tag using the Tag Configuration Editor. To connect a BridgeVIEW tag to an OPC Server item, you select the server and enter or choose the item name along with other parameters you might need to specify, such as the access path. You also create I/O Groups for the items, specifying update rate and deadband information for each group. Each BridgeVIEW I/O Group created in the Tag Configuration Editor is automatically mapped to an OPC Group in the OPC Server with the same attributes.

OPC Servers have an optional interface called the Server Browse Address Space Interface. If a server supports this interface, BridgeVIEW can query it to find which items are available from the server and display them in the item list when the server is selected in the Tag Configuration dialog box. In this case, the **Browse** button in the Tag Configuration dialog box is enabled, and you can press this button to view the hierarchical organization of the server Item IDs.

You can also view the OPC Server Items and their attributes using the Server Browser utility. Launch the Server Browser by selecting **Projects»Server Tools»Server Browser…** or pressing the **Server Browser…** button on the Engine Manager display.

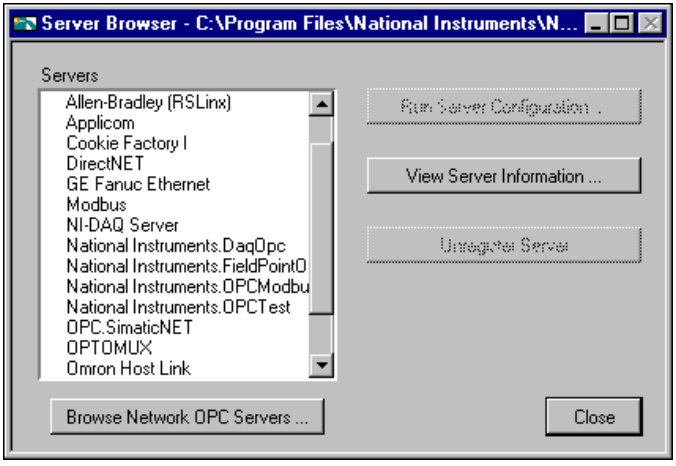


Figure 8-1. Server Browser

When an OPC server is selected in the Servers list, you can press the **View Server Information…** button to bring up the View Server Information for OPC Servers dialog box, as shown in Figure 8-2.

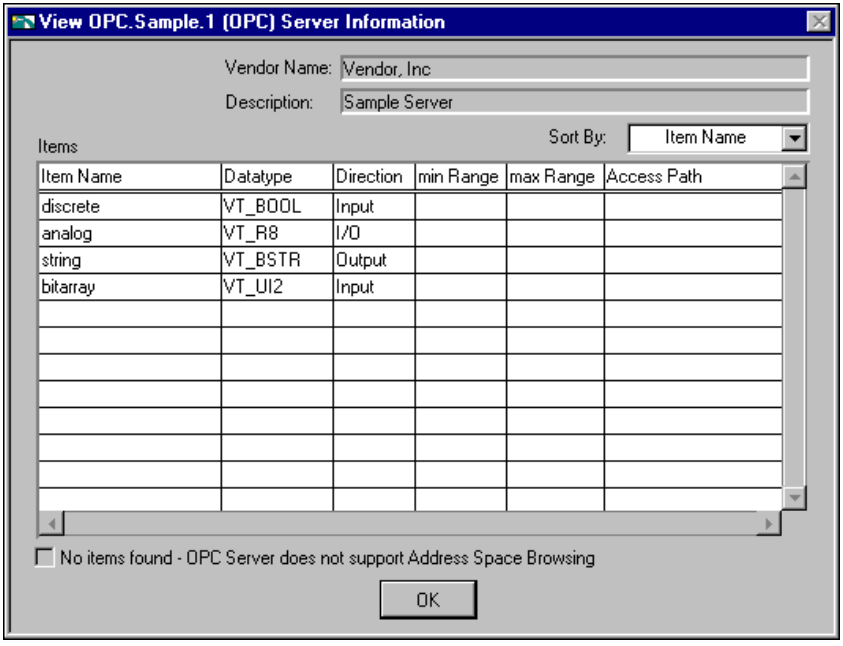


Figure 8-2. View Server Information Dialog Box

This dialog box displays general information about the OPC Server as read from your local system registry. If the OPC server supports the Server Browse Address Space interface, the View Server Information dialog box also displays the items available from the server and their attributes. If the OPC Server does not support this interface, the **No Items Found** checkbox and the item table appear dimmed.

Using Remote OPC Servers

You can use the Server Browser to configure BridgeVIEW to access OPC Servers on other machine on your network. Use this utility to select remote OPC Servers and add them to the BridgeVIEW server list.

To view the OPC servers available on other machines on your network, press the **Browse Network OPC Servers** button on the Server Browser. This brings up the Browse OPC Servers on Network dialog box shown below.

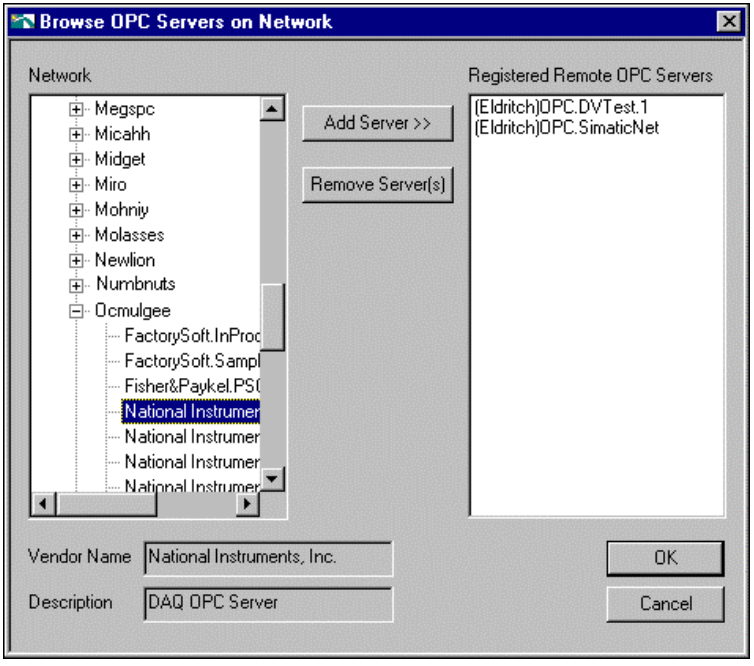


Figure 8-3. Browse OPC Servers on Network Dialog Box

Use this dialog to view the OPC servers registered on other machines on your network. The Registered Remote OPC Servers list shows which remote servers have been added to the BridgeVIEW servers list. If you wish

to use the server on another machine from your machine, use the network tree control to open the machine, and select one of the OPC servers shown on that machine and press the **Add Server>>** button. The information for the remote OPC server is now stored in your local machine registry, and the server will appear in your BridgeVIEW servers list with the server name format of `(machine name)programID`. BridgeVIEW runs the server on the remote machine when you configure a tag to use that server.

To remove one or more remote OPC server from the BridgeVIEW server list, select the servers and press the **Remove Server(s)** button. The servers will no longer appear in your BridgeVIEW server list.

You can also use the Windows utility `dcomcnfg.exe` to configure an OPC server to run on a remote machine rather than your local machine. In order to use `dcomcnfg.exe` to configure an OPC server on a remote machine, you must also have the server registered on your local machine.

To register an OPC server on your local machine, either install the server locally or run the server registration utility on your local machine. Then, launch `dcomcnfg.exe` and complete the following steps.

1. Select the OPC server in the **Applications** list, under the **Applications** tab, and press the **Properties** button.
2. Click the **Location** tab in the Properties dialog box. De-select the **Run application on this machine** checkbox and check the **Run application on the following computer:** checkbox. Enter the name of the machine or use the **Browse** button to select the remote machine. Press **OK** to close the Properties dialog box.
3. Select the **Default Properties** tab and make sure that the **Enable Distributed COM on this computer** checkbox is checked. Also, set the **Default Authentication Level** to **Connect**, and set the **Default Impersonation Level** to **Identify**.
4. Select the **Default Security** tab, and press the **Edit Default…** button. Make sure that the machine on which you plan to launch the OPC server is allowed to access your machine. This is necessary for the machine to call back the BridgeVIEW on your machine when supplying OPC values.

☞ **Note** ***If you use*** `dcomcnfg.exe` ***to select a remote server, you can only run one version of that server, either locally or on one remote machine. You cannot use the same server on more than one machine.***

How Do You Use DDE Servers with BridgeVIEW?

BridgeVIEW can communicate with any server using Microsoft Dynamic Data Exchange (DDE) as its interface. A DDE Server is treated as a simple server in which you type in a device and item string to select a specific point. For DDE Servers, you select DDE Server from the Server List in the Tag Configuration Editor, and type in `APPLICATION|TOPIC` for device in the I/O Group Configuration Dialog Box, and `ITEM` for item. See the *How Do You Connect a Tag to a DDE Server?* section in Chapter 3, *Tag Configuration* for more complete information on how to do this. If you are using Network DDE to use a DDE Server running on another machine, use the Network DDE name for the `APPLICATION` part of the name. Refer to your DDE Server documentation for the correct name for `APPLICATION`, the list of available `TOPICS` and `ITEMS` for each topic.

Note ***Unlike the servers written to the BridgeVIEW IA Device Server specification, off-the-shelf DDE Servers do not register themselves with BridgeVIEW. Therefore, BridgeVIEW cannot launch the DDE Server automatically when it runs your HMI application. To use a DDE Server, launch or run the DDE Server before you run your BridgeVIEW application. BridgeVIEW will post system error messages if it cannot connect to the DDE Server when it launches the BridgeVIEW Engine. Thereafter, it attempts to reconnect to the DDE Server periodically.***

How Do You View BridgeVIEW Server Configuration?

The Tag Configuration Editor shows the list of available servers, and any registered devices and items for the server in the various Edit Tag screens. You also can use the Server Browser to view information about the device servers registered with BridgeVIEW as well as the OPC Servers present in your system and on the network. Launch the Server Browser by selecting **Projects»Server Tools»Server Browser…** or by pressing the **Server Browser…** button on the Engine Manager display. Use this utility to view the properties of the devices and items registered by each server. For VI-based IA Device Servers, you can use this utility to display the server front panel while your application is running if you launch it from the Engine Manager. Typically, servers run with their front panel hidden. You can use the Server Browser to launch the server-specific configuration utility from within BridgeVIEW, if one is available.

The Server Browser utility shows the server information stored in the active Common Configuration Database (`.ccdb`) file. You can control which CCDB is active from the Server Explorer utility.

Use the Server Browser to unregister a device server that you no longer want to use (BridgeVIEW device servers only). This keeps the server and related information from appearing in the Edit Tag screens. Notice that this invalidates any tags that use that server. Once you have unregistered a server, you can no longer connect to it from BridgeVIEW, and you must run its configuration utility again to register it with BridgeVIEW.

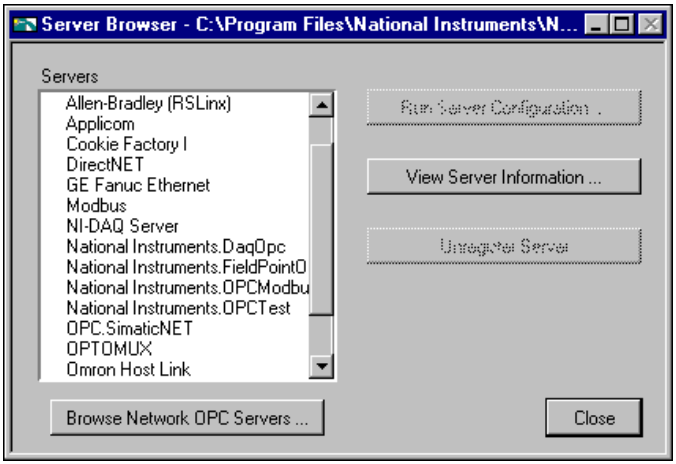


Figure 8-4. Server Browser

The main screen of the Server Browser displays a list of servers available to BridgeVIEW in the Registered Servers list box if launched from the Engine Manager. The symbol to the left of the server name indicates whether it is loaded and running. A black diamond indicates that the server is loaded and running. A white diamond indicates that the server is loaded but not running. No symbol indicates that the server is not being used in the current BridgeVIEW Tag Configuration. The Server Browser also displays the path to the active CCDB in its title bar.

To view information registered for a specific server, double-click on the server name in the Registered Servers list box, or press the **View Server Devices…** button. This invokes the View Server Device Information dialog box shown in Figure 8-5, *View Server Information Dialog Box*.

To unregister a server that you no longer want to connect to your tags, press the **Unregister Server** button with the server of interest selected in the Registered Servers list box. This invokes a dialog box asking you to confirm the operation.

Note ***Unregistering a server means that BridgeVIEW can no longer access that server, and any tag configured to use that server no longer has a valid configuration. Do this only if no tags are configured to use that server and you no longer want to access it from the Tag Configuration Editor. This does not apply to OPC or DDE Servers.***

Registered Server Device and Item Parameters

Use the View Server Information dialog box to see a list of devices registered by a specific server, and for the selected device, view a table of the registered items and item properties. The View Server Information dialog box for BridgeVIEW device servers is shown below.

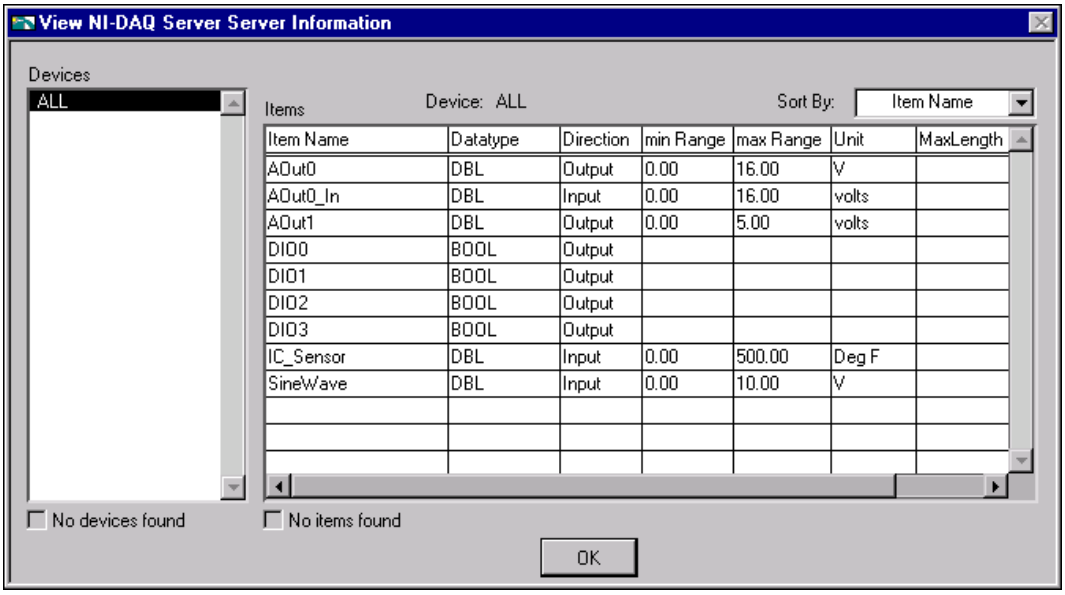


Figure 8-5. View Server Information Dialog Box

You can sort this table by item name, data type, or direction, by selecting which parameter you want to sort on in the **Sort By:** list.

How Do You Develop an IA Device Server?

You can write an IA Device Server as a BridgeVIEW VI. Several of the example simulation servers installed with BridgeVIEW are VI-based servers. Writing a VI-based IA server is a simple way to emulate hardware or connect BridgeVIEW to a simple device. You can use the same BridgeVIEW development environment to create the server as you used to develop your application. The toolkit for creating a VI-based device server is included on the BridgeVIEW CD.

You also can implement an IA Device Server as a 32-bit Windows Dynamic Link Library (DLL). Most of the PLC servers for BridgeVIEW are implemented as DLLs. Writing a DLL-based IA Device Server requires more work than writing a VI-based server, but can support clients other than BridgeVIEW.

Part II

G Tutorial

This section contains information about the functionality of G that you need to get started with most BridgeVIEW applications.

Part II, *G Tutorial*, contains the following chapters.

- Chapter 9, *Creating VIs*, introduces the basic concepts of virtual instruments and provides activities that explain how to create the icon and connector, how to use a VI as a subVI, how to use the **VI Setup…** option, and how to use the **SubVI Node Setup…** option.
- Chapter 10, *Customizing VIs*, introduces the basic concepts used for customizing VIs.
- Chapter 11, *Loops and Charts*, introduces structures and explains the basic concepts of charts, the While Loop, and the For Loop.
- Chapter 12, *Case and Sequence Structures and the Formula Node*, introduces the basic concepts of Case and Sequence structures, and provides activities that explain how to use the Case structure, how to use the Sequence structure, and what sequence locals are and how to use them.
- Chapter 13, *Front Panel Object Attributes*, describes objects called attribute nodes, which are special block diagram nodes that control the appearance and functional characteristics of controls and indicators.
- Chapter 14, *Arrays, Clusters, and Graphs*, introduces the basic concepts of polymorphism, arrays, clusters, and graphs and provides activities that explain auto-indexing and the Graph and Analysis VIs.
- Chapter 15, *Application Control*, introduces the VI Server and provides an activity that explains how to use it within BridgeVIEW. The VI Server allows you to control when a VI is loaded into memory, run, and unloaded from memory.
- Chapter 16, *Program Design*, suggests some techniques to use when creating programs and offers programming style recommendations.

9

Creating VIs

This chapter introduces the basic concepts of virtual instruments and provides activities that explain the following:

- How to create the icon and connector
- How to use a VI as a subVI

What is a Virtual Instrument?

A virtual instrument (VI) is a program in the graphical programming language G. Virtual instrument front panels often have a user interface similar to physical instruments. G also has built-in functions that are similar to VIs, but do not have front panels or block diagrams as VIs do. Function icons always have a yellow background.

How Do You Build a VI?

One of the keys to creating BridgeVIEW applications is understanding and using the hierarchical nature of the VI. After you create a VI, you can use it as a subVI in the block diagram of a higher-level VI.

VI Hierarchy

When you create an application, you start at the top-level VI and define the inputs and outputs for the application. Then, you construct subVIs to perform the necessary operations on the data as it flows through the block diagram. If a block diagram has a large number of icons, group them into a lower-level VI to maintain the simplicity of the block diagram. This modular approach makes applications easy to debug, understand, and maintain.

As with other applications, you can save your VI to a file in a regular directory. With G, you also can save multiple VIs in a single file called a VI library.

Saving VIs as individual files is more effective than using VI libraries because you can copy, rename, and delete files more easily than if you are

using a VI library. For a list of the advantages and disadvantages of using VI libraries and individual files, see the section *Saving VIs* in Chapter 2, *Editing VIs*, of the *G Programming Reference Manual*.

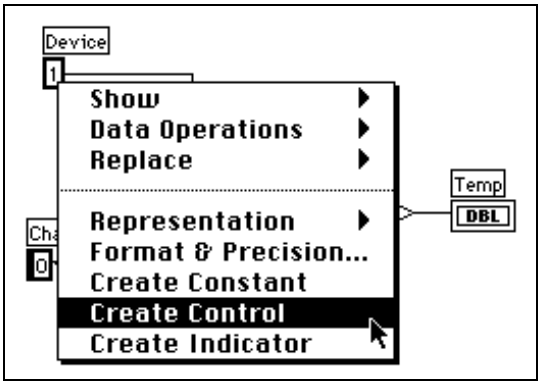
VI libraries have the same load, save, and open capabilities as other directories. VI libraries, however, are not hierarchical. That is, you cannot create a VI library inside of another VI library. You cannot create a new directory inside a VI library, either. There is no way to list the VIs in a VI library outside the BridgeVIEW environment.

After you create a VI library, it appears in the BridgeVIEW file dialog box as a folder with **VI** on the folder icon. Regular directories appear as a folder without the VI label.

Even though you might not save your own VIs in VI libraries, you should be familiar with how they work. In the various activities in this manual, you will save your VIs in the `BridgeVIEW\Activity` directory. Solutions to these activities are provided in the `BridgeVIEW\Activity\Solution` directory.

Controls, Constants, and Indicators

A control is an object you place on your HMI for entering data into a VI interactively or into a subVI programmatically. An indicator is an object you place on your HMI for displaying output. Controls and indicators in G are similar to input and output parameters, respectively, in traditional programming languages. An alternative to placing controls and indicators on the front panel and then wiring them to functions or VIs on the block diagram, is to create controls or indicators directly from the block diagram. To do this, pop up on the input terminal of a function or VI on the block diagram and select **Create Control**. This creates a control of the correct data type and wires it to the terminal.



You can create an indicator and wire it to an output terminal by popping up on the terminal and selecting **Create Indicator**. As an alternative to placing constants on the block diagram and wiring them to functions and VIs, you can pop up on a function or VI terminal and select **Create Constant**. You cannot delete a control or indicator from the block diagram. As with all front panel objects, you must go to the front panel, select the Positioning tool, and then delete the object.

Each time you create a new control or indicator on the front panel, BridgeVIEW creates the corresponding terminal in the block diagram. The terminal symbols suggest the data type of the control or indicator. For example, a DBL terminal represents a double-precision, floating-point number; a TF terminal is a Boolean; an I16 terminal represents a regular, 16-bit integer; and an ABC terminal represents a string. For more information about data types in G, and their graphical representations, see the *G Programming Quick Reference Card.*

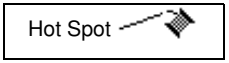
Terminals

Terminals are regions on a VI or function through which data passes. Terminals are analogous to parameters in text-based programming languages. It is important that you wire the correct terminals of a function or VI. You can view the icon connector to make correct wiring easier. To do this, pop up on the function or VI and choose **Show»Terminals**. To return to the icon, pop up on the function or VI and select **Show»Terminals** again.

Wires

A *wire* is a data path between nodes. Wires are colored according to the kind of data each wire carries. Blue wires carry integers, orange wires carry

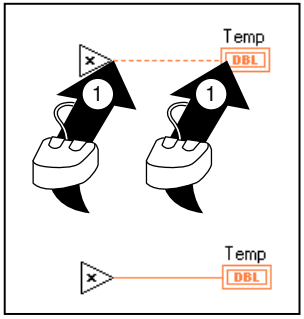
floating-point numbers, green wires carry Booleans, and pink wires carry strings. For more information about wire styles and colors, see the *G Programming Quick Reference Card*.



To wire from one terminal to another, click the Wiring tool on the first terminal, move the tool to the second terminal, and click on the second terminal. It does not matter at which terminal you start. The hot spot of the Wiring tool is the tip of the unwound wiring segment.

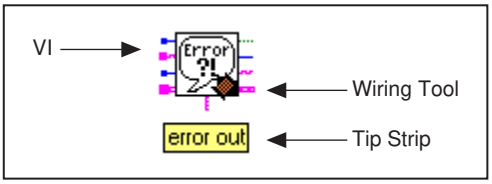
In the wiring illustrations in this section, the arrow at the end of this mouse symbol shows where to click and the number printed on the arrow indicates how many times to click the mouse button.

When the Wiring tool is over a terminal, the terminal area blinks, to indicate that clicking connects the wire to that terminal. Do not hold down the mouse button while moving the Wiring tool from one terminal to another. You can bend a wire once by moving the mouse perpendicular to the current direction. To create more bends in the wire, click the mouse button. To change the direction of the wire, press the spacebar. Click with the mouse button, to tack the wire down and move the mouse perpendicularly.



Tip Strips

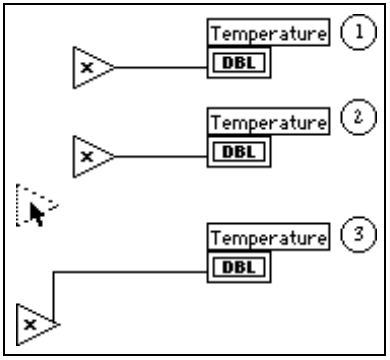
When you move the Wiring tool over the terminal of a node, a *tip strip* for that terminal pops up. Tip strips consist of small, yellow text banners that display the name of each terminal. These tip strips should help you to wire the terminals. The following illustration displays the tip strip that appears when you place the Wiring tool over an output of the Simple Error Handler VI.



Note ***When you place the Wiring tool over a node, G displays wire stubs that indicate each input and output. The wire stub has a dot at its end if it is an input to the node.***

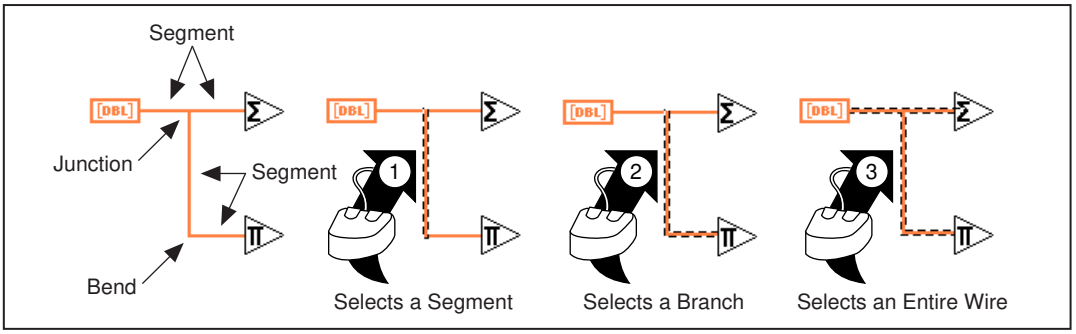
Wire Stretching

You can move wired objects individually or in groups by dragging the selected objects to a new location with the Positioning tool.



Selecting and Deleting Wires

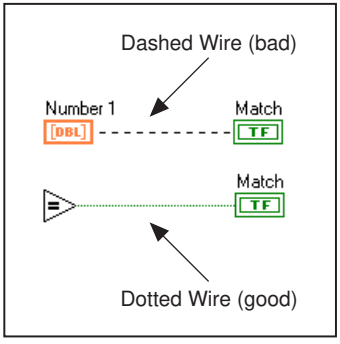
You might wire nodes incorrectly. If you do, select the wire you want to delete and then press <Delete>. A wire segment is a single horizontal or vertical piece of wire. The point where three or four wire segments join is called a *junction*. A wire branch contains all the wire segments from one junction to another, from a terminal to the next junction, or from one terminal to another if there are no junctions in between. You select a wire segment by clicking on it with the Positioning tool. Double-clicking selects a branch, and triple-clicking selects the entire wire.

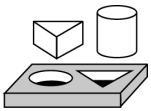


Bad Wires

A dashed wire represents a bad wire. You can get a bad wire for a number of reasons, such as connecting two controls, or connecting a source terminal to a destination terminal when the data types do not match (for instance, connecting a numeric to a Boolean). You can remove a bad wire by clicking on it with the Positioning tool and pressing <Delete>. Choosing **Edit»Remove Bad Wires** or <Ctrl-B> deletes all bad wires in the block diagram. This is a useful quick fix to try if your VI refuses to run or returns the **`Signal has Loose Ends`** error message.

Note ***Do not confuse a black, dashed wire with a dotted wire. A dotted wire represents a Boolean data type, as the following illustration shows.***





Activity 9-1. Create a VI

Your objective is to build a VI.

Imagine that you have sensors that read temperature and volume readings as voltage. You will use a VI in the `BridgeVIEW\Activity` directory to simulate the temperature and volume measurements in volts. You will write a VI to scale these measurements to degrees fahrenheit and liters, respectively.

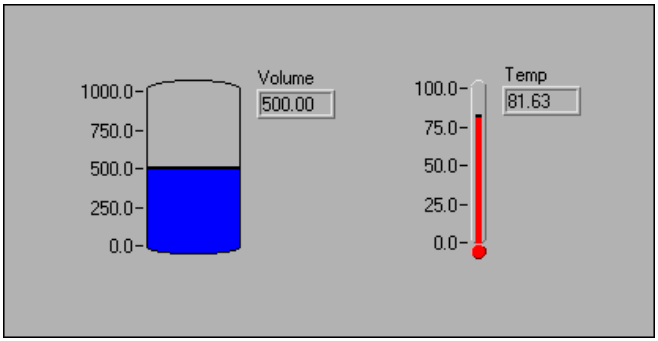
1. Open a new front panel by selecting **File»New**. If you have closed all VIs, select **New VI** from the BridgeVIEW dialog box.

☞ **Note** ***If the* Controls *palette is not visible, select* Windows»Show Controls Palette *to display the palette. You also can access the* Controls *palette by popping up in an open area of the front panel. To pop up, right-click on your mouse.***

2. Select **Tank** from **Controls»Vessels**, and place it on the front panel.
3. Type `Volume` in the label text box and click anywhere on the front panel.

☞ **Note** ***If you click outside the text box without entering text, the label disappears. To show the label again, pop up on the control and select* Show»Label.**

4. Rescale the tank indicator to display the tank volume between 0.0 and 1000.0.
   a. Using the Labeling tool, double-click on `10.0` on the tank scale to highlight it.
   b. Type `1000` in the scale and click the mouse button anywhere on the front panel. The intermediary increments are scaled automatically.
5. Place a thermometer from **Controls»Numeric** on the front panel. Label it `Temp` and rescale it to be between 0 and 100.
6. Your front panel should look like the following illustration.



7. Open the block diagram by choosing **Windows»Show Diagram**. Select the objects listed below from the **Functions** palette and place them on the block diagram.

Note *If the* **Functions** *palette is not visible, select* **Windows»Show Functions Palette** *to display the palette. You also can access the* **Functions** *palette by popping up in an open area of the block diagram.*

8. Place each of the following objects on the block diagram.

Process Monitor (**Functions»Select a VI** from the `BridgeVIEW\Activity` directory)—Simulates reading a temperature voltage and volume value from a sensor or transducer.

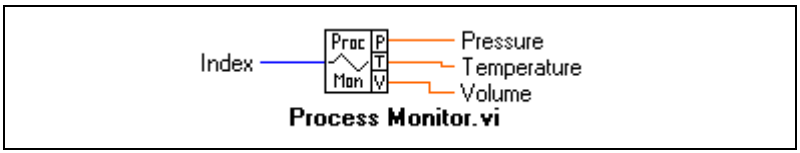
Random Number Generator (**Functions»Numeric**)—Generates a number between 0 and 1.

Multiply function (**Functions»Numeric**)—Multiplies two numbers and returns their product. In this activity, you need two of these. Drop one from the palette and copy and paste to create the other.

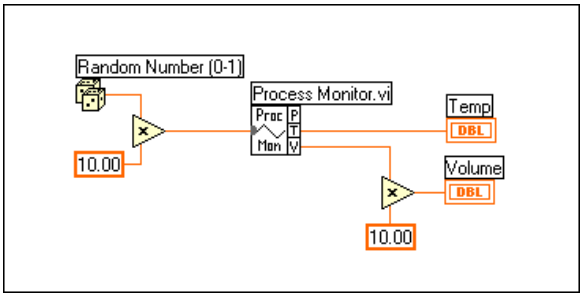
Numeric Constant (**Functions»Numeric**)—You need two of these. Drop one from the palette. Using the labeling tool, change its value to `10.00`. Copy and paste it.

Note *Another way to create a constant is to pop up on the terminal of a function or VI using the Wiring tool. Select* **Create Constant** *from the floating menu. A constant of the appropriate data type appears.*

9. To view the inputs and outputs of a function or a VI, select **Show Help** from the **Help** menu and then drag the cursor over each function and VI. The Help window for the Process Monitor VI is shown below.



10. Using the Wiring tool, wire the objects as shown.



Note ***To move objects around on the block diagram, click on the Positioning tool in the* Tools *palette.***

11. Select **File»Save** and save the VI as `Temp & Vol.vi` in the `BridgeVIEW\Activity` directory.
12. From the front panel, run the VI by clicking on the **Run** button. Notice values for Volume and Temperature are displayed on the front panel.
13. Close the VI by selecting **File»Close**.

End of Activity 9-1.

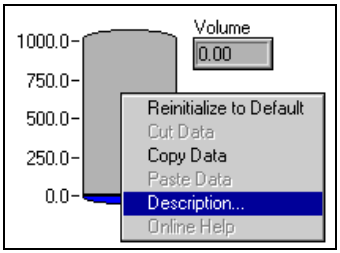
VI Documentation

You can document a VI by choosing **Windows»Show VI Info…**. Type the description of the VI in the VI Information dialog box. Then, you can recall the description by selecting **Windows»Show VI Info…** again.

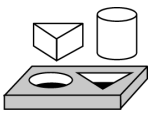
You can edit the descriptions of objects on the front panel (or their respective terminals on the block diagram) by popping up on the object and choosing **Data Operations»Description…**.

Note ***You cannot change the description of a VI or its front panel objects while the VI is running.***

The following illustration is an example pop-up menu that appears while you are running a VI. You cannot add to or change the description while running the VI, but you can view any previously entered information.



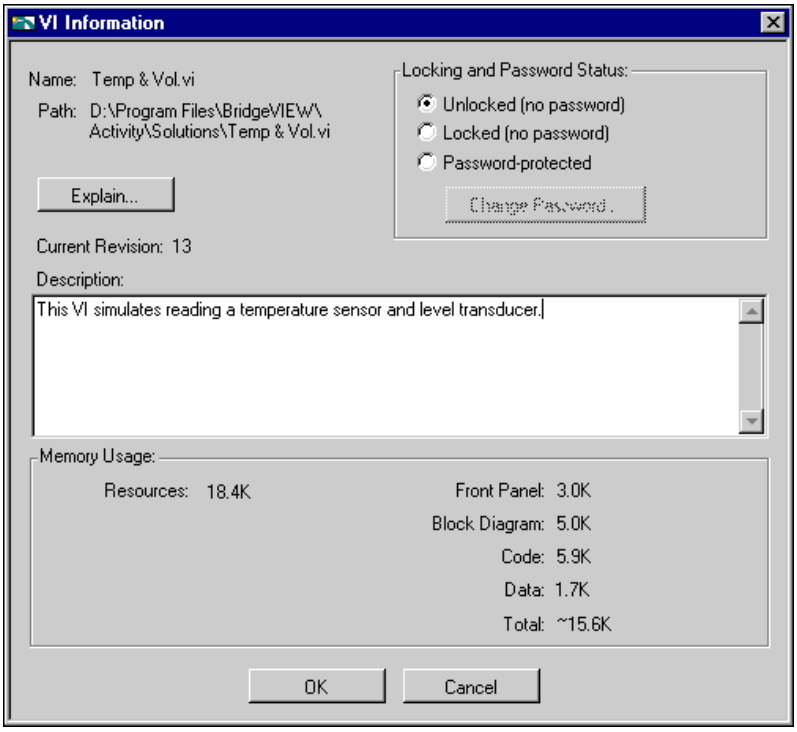
You also can view the description of a front panel object by showing the Help window (**Help»Show Help**) and moving the cursor over the object.



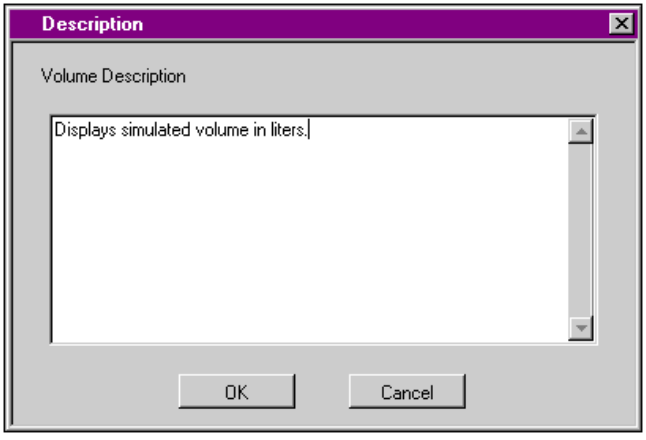
Activity 9-2. Document a VI

Your objective is to document a VI that you have created.

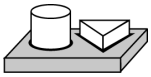
1. Open the `Temp & Vol.vi` created in Activity 9-1 from the `BridgeVIEW\Activity` directory.
2. Select **Windows»Show VI Info…**. Type the description for the VI, as shown in the following illustration, and click on **OK.**



3. Pop up on the tank and choose **Data Operations»Description…**. Type the description for the indicator, as shown in the following illustration, and click **OK**.



4. Pop up on the thermometer and choose **Data Operations» Description…**. Type in the description: `Displays simulated temperature (deg F) measurement`. Click on **OK**.
5. Select **Show Help** from the **Help** menu. Place the cursor on Volume and then on Temp. You can see the descriptions you typed in appear in the help window.
6. Save and close the VI.



End of Activity 9-2.

What is a SubVI?

A *subVI* is much like a subroutine in text-based programming languages. It is a VI that is used in the block diagram of another VI.

You can use any VI that has an icon and a connector as a subVI in another VI. In the block diagram, you select VIs to use as subVIs from **Functions»Select a VI…**. Choosing this option produces a file dialog box, from which you can select any VI in the system. If you open a VI that does not have an icon and a connector, a blank, square box appears in the calling VI's block diagram. You cannot wire to this node.

A subVI is analogous to a subroutine. A subVI node is analogous to a subroutine call. The subVI node is not the subVI itself, just as a subroutine call statement in a program is not the subroutine itself. A block diagram that contains several identical subVI nodes calls the same subVI several times.

Hierarchy Window

The Hierarchy window displays a graphical representation of the calling hierarchy for all VIs in memory, including type definitions and global variables. You use the Hierarchy window (**Project»Show VI Hierarchy**) to display the dependencies of VIs by providing information on VI callers and subVIs. This window contains a toolbar that you can use to configure several types of settings for displayed items. The following illustration shows an example of the VI hierarchy toolbar.

You can use buttons on the Hierarchy window toolbar or the **View** menu, or pop up on an empty space in the window to access the following options. For more information about the Hierarchy window see the *Using the Hierarchy Window* section in Chapter 3, *Using SubVIs*, of the *G Programming Reference Manual*.

Redraw—Rearranges nodes after successive operations on hierarchy nodes if you need to minimize line crossings and maximize symmetric aesthetics. If a focus node exists, you then scroll through the window so that the first root that shows subVIs is visible.

Switch to vertical layout—Arranges the nodes from top-to-bottom, placing roots at the top.

Switch to horizontal layout—Arranges the nodes from left-to-right, placing roots on the left side.

Include/Exclude VIs—Toggles the hierarchy graph to include VI libraries, or exclude VIs in VI libraries.

Include/Exclude global—Toggles the hierarchy graph to include or exclude global variables. Global variables store data used by several VIs.

Include/Exclude typedefs—Toggles the hierarchy graph to include or exclude typedefs. A typedef is a master copy of a custom control, which can be used by several VIs.

In addition, the View menu and pop-up menus include **Show all VIs** and **Full VI Path** in **Label** options that you cannot access on the toolbar.

As you move the Operating tool over objects in the Hierarchy window, BridgeVIEW displays the name of the VI below the VI icon.

Use the <Tab> key to toggle between the Positioning and Scroll window tools. This feature is useful for moving nodes from the Hierarchy window to the block diagram.

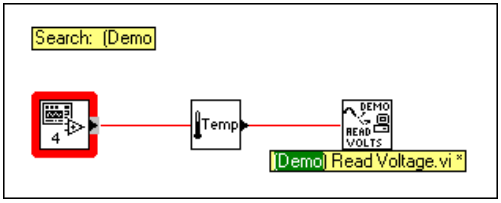
You can drag a VI or subVI node to the block diagram or copy it to the clipboard by clicking on the node. <Shift>-click on a VI or subVIs node to select multiple objects for copying to other block diagrams or front panels. Double-clicking on a VI or subVI node opens the front panel of that node.

Any VIs that contain subVIs have an arrow button next to the VI that you can use to show or hide subVIs. Clicking on the red arrow button or double-clicking on the VI itself displays the subVIs in that VI. A black arrow button on a VI node means that all subVIs are displayed. You also

can pop up on a VI or subVI node to access a menu with options, such as showing or hiding subVIs, opening the VI or subVI front panel, editing the VI icon, and so on.

Search Hierarchy

You also can search currently visible nodes in the Hierarchy window by name. You initiate the search by typing in the name of the node, anywhere on the window. As you type in the text, a search string appears, which displays the text as you type it in and concurrently searches through the hierarchy. The following illustration shows the search hierarchy.

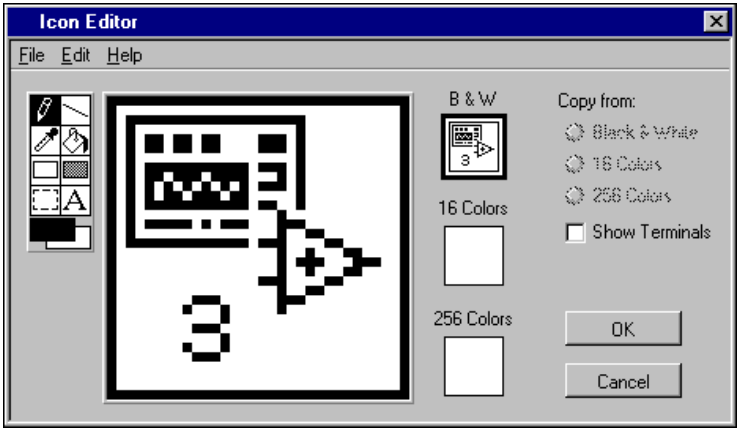


After finding the correct node, you can press <Enter> to search for the next node that matches the search string, or you can press <Shift-Enter> to find the previous node that matches the search string.

Icon and Connector

Every VI has a default icon displayed in the upper-right corner of the Front Panel and Diagram windows. For VIs, the default is the BridgeVIEW VI icon and a number indicating how many new VIs you have opened since launching BridgeVIEW. You use the Icon Editor to customize the icon by turning individual pixels on and off. To activate the Icon Editor, pop up on the default icon in the top right corner of the Panel window and select **Edit Icon**.

The following illustration shows the Icon Editor Window. You use the tools at left to create the icon design in the pixel editing area. An image of the actual icon size appears in one of the boxes to the right of the editing area.



The tools to the left of the editing area perform the following functions:

Pencil tool—Draws and erases pixel by pixel.

Line tool—Draws straight lines. Press <Shift> and then drag this tool to draw horizontal, vertical, and diagonal lines.

Color Copy tool—Copies the foreground color from an element in the icon.

Fill bucket tool—Fills an outlined area with the foreground color.

Rectangle tool—Draws a rectangular border in the foreground color. Double-click on this tool to frame the icon in the foreground color.

Filled rectangle tool—Draws a rectangle bordered with the foreground color and filled with the background color. Double-click to frame the icon in the foreground color and fill it with the background color.

Select tool—Selects an area of the icon for moving, cloning, or other changes.

Text tool—Enters text into the icon design.

Foreground/Background—Displays the current foreground and background colors. Click on each to get a color palette from which you can choose new colors.

The buttons at the right of the editing screen perform the following functions:

- **Undo**—Cancels the last operation you performed.
- **OK**—Saves your drawing as the VI icon and returns to the front panel.
- **Cancel**—Returns to the front panel without saving any changes.

Depending on the type of monitor you are using, you can design a separate icon for monochrome, 16-color, and 256-color mode. You design and save each icon version separately. The editor defaults to **Black & White**, but you can click on one of the other color options to switch modes.

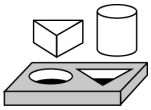
☞ **Note** ***If you design a color icon only, the icon does not show up in a subpalette of the* Functions *palette if you place the VI in the* `*.lib` *directory, nor will the icon be printed or displayed on a black and white monitor.***

The *connector* is the programmatic interface to a VI. If you use the panel controls or indicators to pass data to and from subVIs, these controls or indicators need terminals on the connector pane. You define connections by choosing the number of terminals you want for the VI and assigning a front panel control or indicator to each of those terminals.

To define a connector, select **Show Connector** from the icon pane pop-up menu on the Panel window.

The connector icon replaces the icon in the upper-right corner of the Panel window. BridgeVIEW selects a terminal pattern appropriate for your VI with terminals for controls on the left side of the connector pane, and terminals for indicators on the right. The number of terminals selected depends on the number of controls and indicators on your front panel.

Each rectangle on the connector represents a terminal area, and you can use the rectangles either for input or output from the VI. If necessary, you can select a different terminal pattern for your VI. To do this, pop up on the icon, select **Show Connector**, pop up again, and select **Patterns**.



Activity 9-3. Create an Icon and Connector

Your objective is to make an icon and connector for a VI.

To use a VI as a subVI, you must create an icon to represent it on the block diagram of another VI, and a connector pane to which you can connect inputs and outputs. BridgeVIEW provides several tools with which you can create or edit an icon for your VIs.

The icon of a VI represents it as a subVI in the block diagram of other VIs. It can be a pictorial representation of the purpose of the VI, or a textual description of the VI.

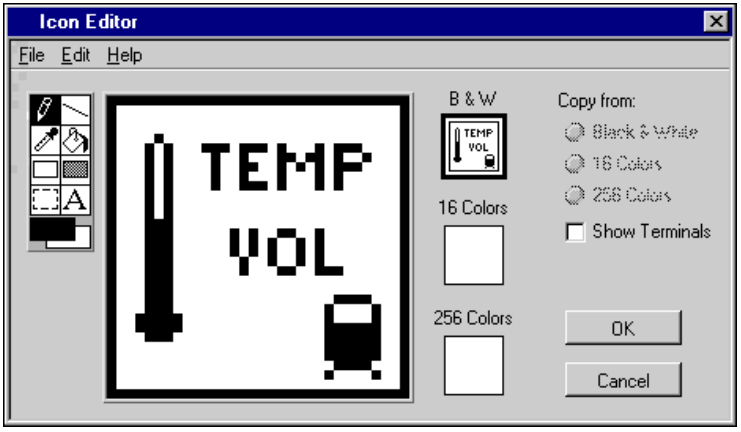
1. Open `Temp & Vol.vi` in the `BridgeVIEW\Activity` directory.
2. From the front panel, pop up on the icon in the top right corner and select **Edit Icon…**. You also can double click on the icon to invoke the icon editor.

☞ **Note** ***You only can access the icon/connector for a VI from the front panel.***

3. Erase the default icon. With the Select tool, which appears as a dotted rectangle, click and drag over the section you want to delete, and press the <Delete> key. You also can double click on the shaded rectangle in the tool box to erase the icon.

4. Draw a thermometer with the Pencil tool.

5. Create the text with the Text tool. To change the font, double-click on the Text tool. Your icon should look similar to the following illustration.

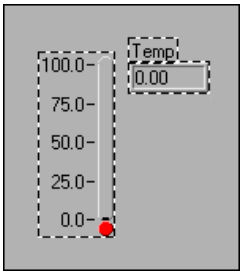


6. Close the Icon Editor by clicking on **OK**. The new icon appears in the icon pane.

7. Define the connector terminal pattern by popping up in the icon pane on the front panel and choosing **Show Connector**. By default, BridgeVIEW selects a terminal pattern based on the number of controls and indicators on the front panel. Because there are two objects on the front panel, the connector has two terminals, as shown at left.

8. Pop up on the connector pane and select **Rotate 90 Degrees**. Notice how the connector pane changes, as shown at left.
9. Assign the terminals to Temp and Volume.
   a. Click on the top terminal in the connector. The cursor automatically changes to the Wiring tool, and the terminal turns black.

   b. Click on the Temp indicator. A moving dashed line frames the indicator, as shown in the following illustration. The selected terminal changes to a color consistent with the datatype of the control/indicator selected.

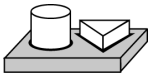


   If you click in an open area on the front panel, the dashed line disappears and the selected terminal appears dimmed, indicating that you have assigned the indicator to that terminal. If the terminal is white, you have not made the connection correctly.
   c. Repeat steps a and b to associate the bottom terminal with the Volume indicator.
   d. Pop up on the connector and select **Show Icon…**.
10. Save the VI by choosing **File»Save**.

    Now, this VI is complete and ready for use as a subVI in other VIs. The icon represents the VI in the block diagram of the calling VI. The connector (with two terminals) outputs the temperature and volume.

Note ***The connector specifies the inputs and outputs of a VI when you use it as a subVI. Remember that front panel* controls *can be used as inputs only; front panel* indicators *can be used as outputs only.***

11. Close the VI by choosing **File»Close**.

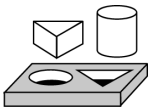


End of Activity 9-3.

Opening, Operating, and Changing SubVIs

You can open a VI used as a subVI from the block diagram of the calling VI by double-clicking on the subVI icon or by selecting **Project»This VI's SubVIs**. You will see a palette containing all the subVIs of the calling VI. Select the subVI you want to open.

Any changes you make to a subVI alter only the version in memory until you save the subVI. The changes affect all instances of the subVI and not just the node you used to edit the VI.



Activity 9-4. Call a SubVI

Your objective is to build a VI that uses the `Temp & Vol.vi` ***as a subVI.***

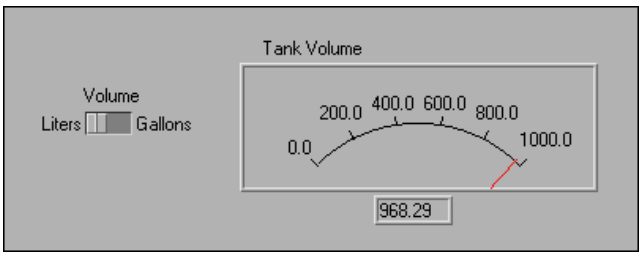
The Temp & Vol VI you built in Activity 9-1 returns a temperature and volume. You will take a volume reading and convert the value to gallons when a switch is pressed.

Front Panel

1. Open a new front panel by selecting **File»New**.

2. Select a Horizontal Switch from the **Controls»Boolean** palette and label it `volume`. Place free labels on the front panel to indicate `Liters` and `Gallons` by using the Labeling tool.

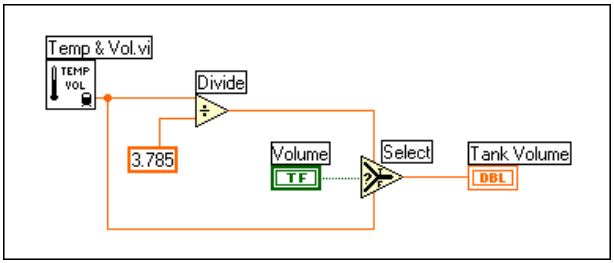
3. Select a meter from **Controls»Numeric** and place it on the front panel. Label it `Tank Volume`.



4. Change the range of the meter to accommodate values ranging between 0.0 and 1000.0. With the Operating tool, double-click on the high limit and change it from 10.0 to 1000.0. Switch to the positioning tool and resize the meter by dragging out one of the corners and expanding the control.

Block Diagram

5. Go to the block diagram by selecting **Windows»Show Diagram**.
6. Pop up in a free area of the block diagram and choose **Functions»Select a VI…**. A dialog box appears. Select `Temp & Vol.vi` in the `BridgeVIEW\Activity` directory. Click on **Open** in the dialog box. BridgeVIEW places the Temp & Vol VI on the block diagram.
7. Add the other objects to the block diagram as shown in the following illustration.



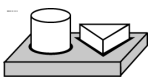
Numeric Constant (**Functions»Numeric**)—Add a numeric constant to the block diagram. Assign the value `3.785` to the constant by using the Labeling tool. This is the conversion factor for switching from liters to gallons.

Select Function (**Function»Comparison**)—Returns the value wired to the TRUE or FALSE input, depending on the Boolean input.

Divide function (**Functions»Numeric**)—Divides the value in liters by 3.785 to convert it to gallons.

8. Wire the diagram objects as shown.

9. Return to the front panel and click on the **Run** button in the toolbar. The meter shows the value in liters.
10. Click on the switch to select `Gallons` and click on the **Run** button. The meter shows the value in gallons.
11. Save the VI as `Using Temp & Vol.vi` in the `BridgeVIEW\Activity` directory.



End of Activity 9-4.

How Do You Debug a VI?

A VI cannot compile or run if it is broken. Normally, the VI is broken while you are creating or editing it, until you wire all the icons in the diagram. If it still is broken when you finish, try selecting **Remove Bad Wires** from the **Edit** menu. Often, this fixes a broken VI.

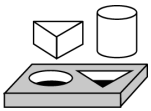
When your VI is not executable, a *broken* arrow appears instead of the **Run** button. To list the errors, click on the broken **Run** button. Click on one of the errors listed and then click on **Find** to highlight the object or terminal that reported the error.

You can animate the VI block diagram execution by clicking on the **Highlight Execution** button. Execution highlighting is commonly used with single-step mode to trace the data flow in a block diagram.

For debugging purposes, you might want to execute a block diagram node by node. This is known as single-stepping. To enable the single-step mode, click on the **Step Into** button or **Step Over** button. This action then causes the first node to blink, denoting that it is ready to execute. Then you can click on either the **Step Into** or **Step Over** button again to execute the node and proceed to the next node. If the node is a structure or VI, you can select the **Step Over** button to *execute* the node but *not single-step* through the node. For example, if the node is a subVI and you click on the **Step Over** button, you execute the subVI and proceed to the next node but cannot see how the subVI nodes execute. To single step through a structure or subVI, select the **Step Into** button.

Click on the **Step Out** button to finish execution of the block diagram nodes and/or complete single stepping. For more information about debugging, see Chapter 4, *Executing and Debugging VIs and SubVIs*, in the *G Programming Reference Manual*.

For more information about block diagrams, and the options available from the block diagram window, see the section *Block Diagram* in Chapter 2, *BridgeVIEW Environment*.

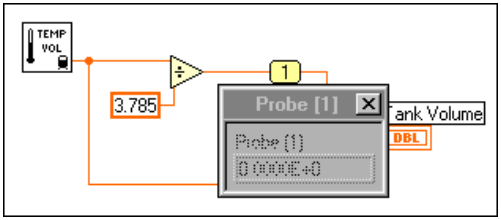


Activity 9-5. Debug a VI in BridgeVIEW

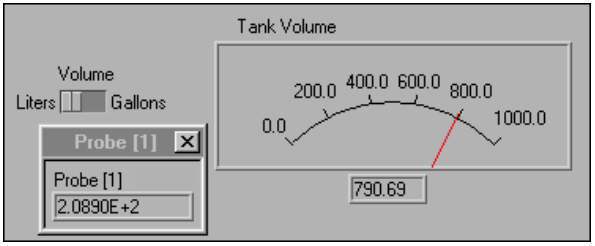
Your objective is to use the probe tool and the probe window and to examine data flow in the block diagram using the execution highlighting feature.

1. Open `Using Temp & Vol.vi` from the `BridgeVIEW\Activity` directory.
2. Select **Windows»Show Diagram**.
3. If the Tools palette is not open, select **Windows»Show Tools Palette**.

4. Select the Probe tool from the **Tools** palette. Click with the Probe tool on the wire coming out of the Divide function. A Probe window pops up with the title `Probe 1` and a yellow glyph with the number of the probe, as shown in the following illustration. The Probe window remains open, even if you switch to the front panel.



5. Return to the front panel. Move the Probe window so you can view both the probe and volume values as shown in the following illustration. Run the VI. The volume in gallons appears in the Probe window while `Tank Volume` displays the value in liters.



Note ***The volume values that appear on your screen may be different than what is shown in this illustration. Refer to the Numeric Conversion section in Chapter 11, Loops and Charts, for more information.***

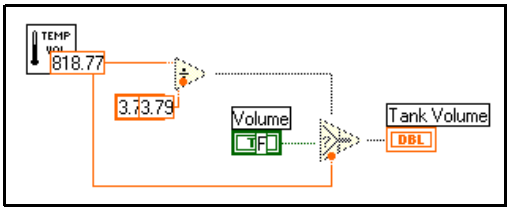
6. Close the Probe window by clicking in the close box at the top of the Probe window title bar.

   Another useful debugging technique is to examine the flow of data in the block diagram using the execution highlighting feature.

7. Return to the block diagram of the VI.

8. Begin execution highlighting by clicking on the **Highlight Execution** button, in the toolbar. The **Highlight Execution** button changes to an illuminated light bulb.

9. Click on the **Run** button to run the VI, and notice that execution highlighting animates the VI block diagram execution. Moving bubbles represent the flow of data through the VI. Also notice that data values appear on the wires and display the values contained in the wires at that time, as shown in the following block diagram, just as if you had probed the wire.

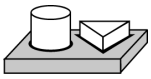


   You also can use the single stepping buttons if you want to walk through the graphical code, one step at a time.

10. Begin single-stepping by clicking on the **Step Over** button, in the toolbar.

11. Step into the Temp & Vol subVI by clicking on the **Step Into** button, in the toolbar. Clicking on this button opens the front panel and block diagram of your Temp & Vol subVI. Click on the **Step Over** button until the VI finishes executing.

12. Finish executing the block diagram by clicking on the **Step Out** button, in the toolbar. Clicking on this button completes all remaining sequences in the block diagram.



End of Activity 9-5.

10

Customizing VIs

This chapter introduces the basic concepts used for customizing VIs.

There are several ways to configure how your VIs execute. You access these options by popping up on the icon pane in the upper-right corner of the front panel and choosing **VI Setup…**.

A VI Setup dialog box appears showing setup options for execution of the VI, appearance of the panel, and documentation. You can learn how to use these options in Activity 10-1, in this chapter. For more detailed information, see Chapter 6, *Setting up VIs and SubVIs*, in the *G Programming Reference Manual*.

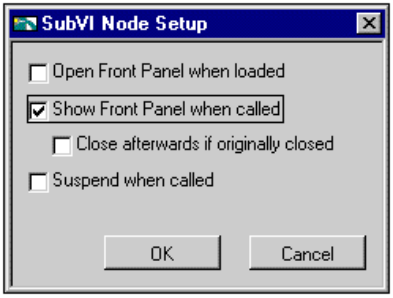
Set Window Options

The Window Options control the appearance of the VI when running. To switch from Execution Options to Window Options, click on the downward pointing arrow in the menu bar.

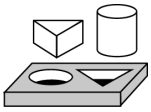
SubVI Node Setup

You also can configure how a subVI executes. The configuration options are available by popping up on the subVI icon (in the block diagram of the

calling VI), and choosing **SubVI Node Setup…**. The following illustration shows the SubVI Node Setup dialog box.



☞ **Note** ***If you select an option from the VI Setup… dialog box of a VI, the option applies to every instance of that VI. If you select an option from the SubVI Node Setup dialog box, the option applies only to that particular node.***



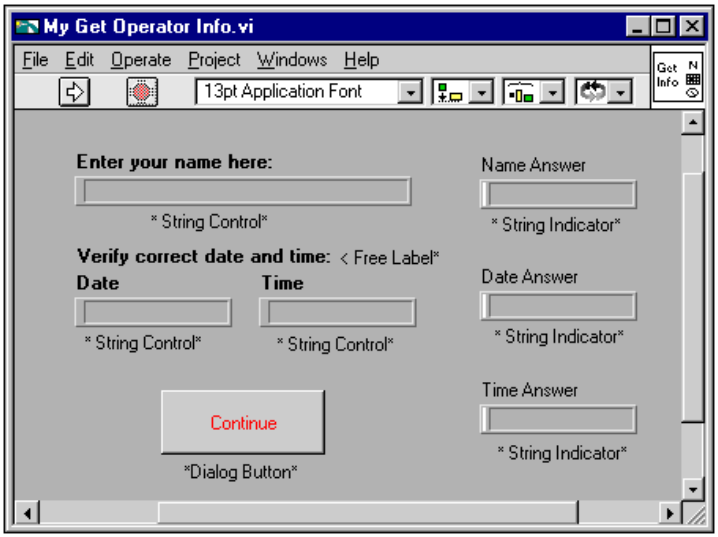
Activity 10-1. Use Setup Options for a SubVI

Your objective is to build a VI that prompts the operator to enter information.

You will create a VI that launches a dialog box to obtain information from the user upon execution. Once the user enters the information and presses a button, the dialog box disappears.

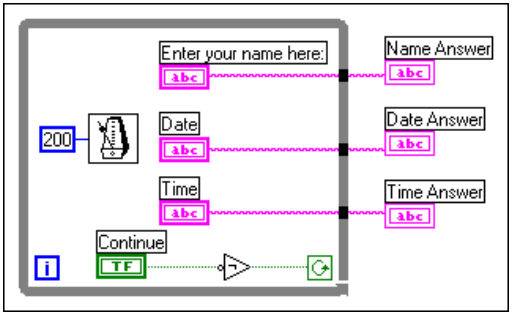
Front Panel

1. Open a new front panel and place some string controls and a button, as shown in the following illustration.

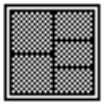


Block Diagram

2. Build the block diagram shown in the following illustration.



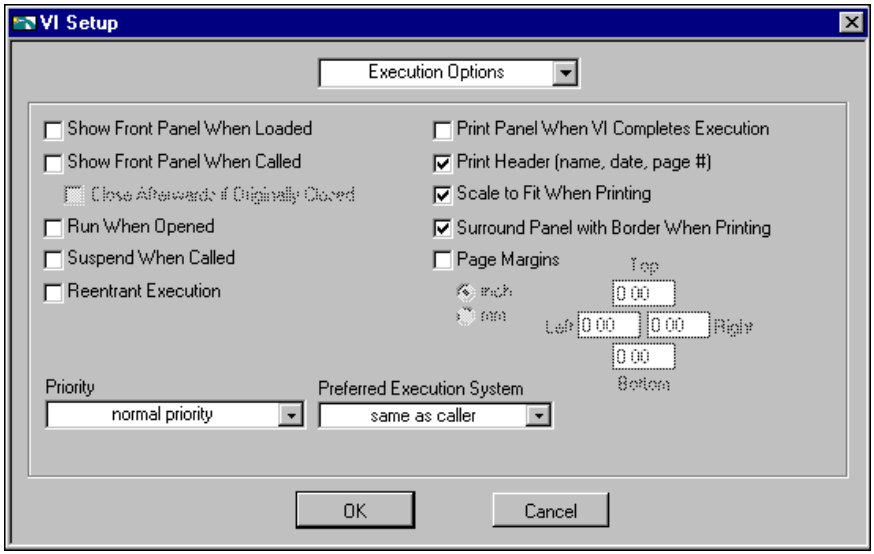
3. Create the icon for the VI as shown at left. To access the Icon Editor, pop up on the icon pane of the front panel and select **Edit Icon**.
4. Switch to the connector pane by popping up on the icon pane and selecting **Show Connector**.



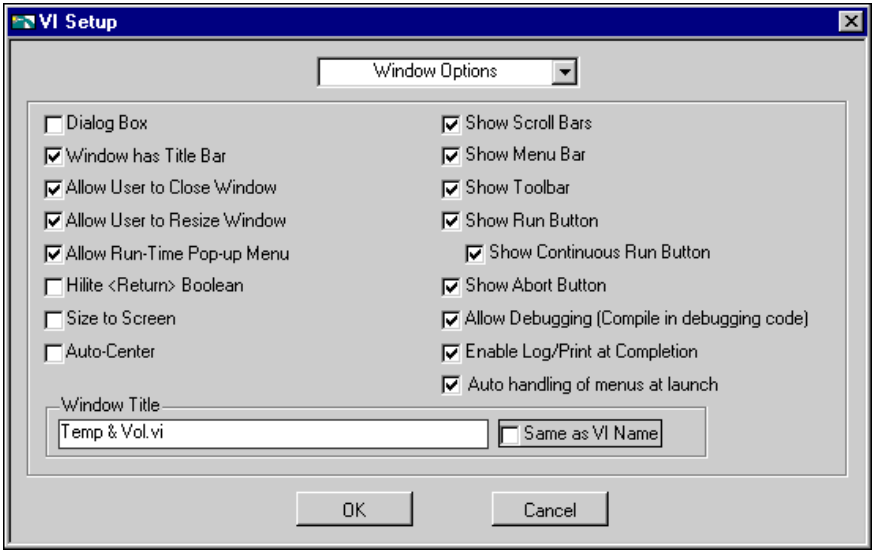
5. Build the connector. Notice that the default connector pane is not what you see illustrated to the left. To get the correct connector pane, choose **Patterns** from the pop-up menu on the connector. Choose the pattern with three inputs and two outputs. Then choose **Flip Horizontal**. Now you can connect the `Date` and `Time` controls to the two connectors on the left side of the icon, and the `Name Answer`, `Date Answer`, and `Time Answer` indicators to the three connectors on the right side of

the icon, as shown in the following illustration. After creating the connector, return to the icon display.

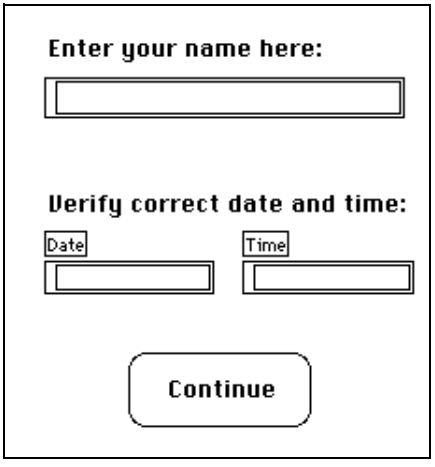
6. Save the VI as `Get Operator Info.vi` in the `BridgeVIEW\Activity` directory.
7. Now you can customize the VI with the **VI setup** options to make it look like a dialog box.
   a. Pop up on the icon and select **VI Setup**. Configure the **Execution Options** as shown in the following illustration.



b. Select **Window Options** and make the selections shown in the following illustration.



8. After you finish with the **VI Setup** options, resize the front panel as shown in the following illustration so you do not see the three string indicators.

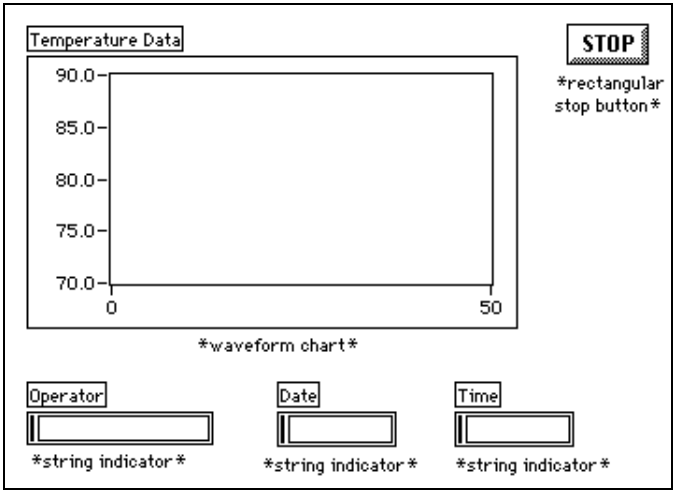


9. Save and close the VI.

   Now you will use this VI as a subVI.

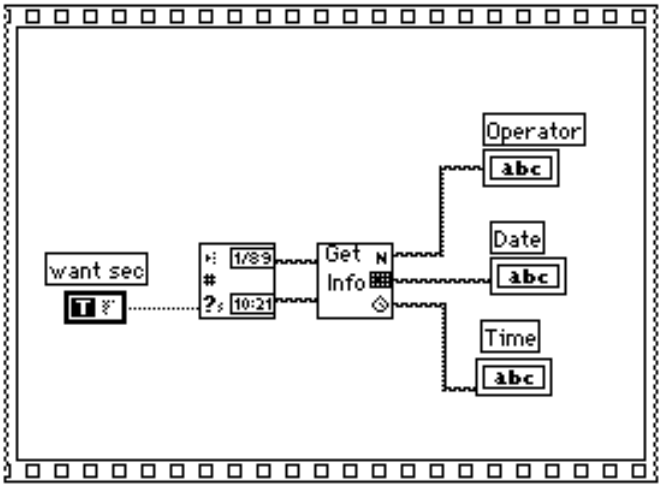
Front Panel

10. Open a new front panel.
11. Place a Waveform Chart (**Controls»Graph**) on the front panel and label it `Temperature Data`.
12. Modify the scale of the chart, so that its upper limit is set to 90.0 and its lower limit is set to 70.0. Pop up on the chart and choose **Show»Legend** to hide the legend. Pop up on the chart again and choose **Show»Palette** to hide the palette.
13. Build the rest of the front panel as shown in the following illustration.



Block Diagram

14. Create a Sequence structure and add the following to frame 0, as shown in the following illustration.



Get Date/Time String function (**Functions»Time & Dialog**)—Outputs the current date and time.

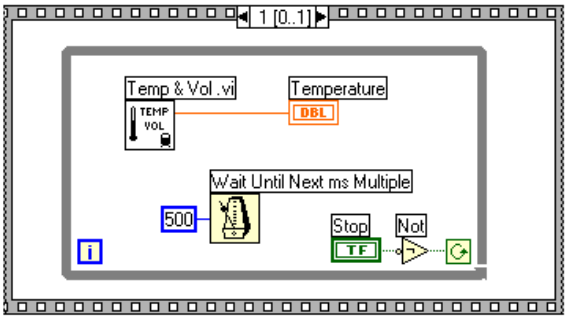
Get Operator Info VI (**Functions»Select a VI…** from the `BridgeVIEW\Activity` directory)—Pops open its front panel and prompts the user to enter a name, the date, and the time.

Boolean constant (**Functions»Boolean**)—Controls whether the input date and time string are TRUE. To set this option to TRUE, click on the constant with the Operating tool.

15. Pop up on the Sequence structure and select **Add Frame After** from the pop-up menu.

16. Place a While Loop inside frame 1 of the Sequence structure.

17. Add the objects shown in the following illustration.



Temp & Vol VI (**Functions»Select a VI…** from the `BridgeVIEW\Activity` directory)—Returns one temperature measurement from a simulated temperature sensor.

Wait Until Next ms Multiple function (**Functions»Time & Dialog**)—Causes the For Loop to execute in ms.

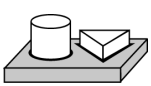
Numeric constant (**Functions»Numeric**)—You can also pop up on the Wait Until Next Tick Multiple function and select Create Constant to create automatically and wire the numeric constant. The numeric constant delays execution of the loop for 500 ms (0.5 seconds).

Not function (**Functions»Boolean**)—Inverts the value of the **STOP** button so that the While Loop executes repeatedly until you click on **STOP**.

18. Save the VI as `Pop-up Panel Demo.vi` in the `BridgeVIEW\Activity` directory.
19. Run the VI. The front panel of the Get Operator Info VI opens and prompts you to enter your name, the date, and the time. Click on the **Continue** button to return to the calling VI. Then temperature data is acquired until you click on the **STOP** button.

Note ***The front panel of the Get Operator Info VI opens because of the options you selected from the VI Setup dialog box. Do not try to open the front panel of the subVI from the block diagram of the My Pop-Up Panel Demo VI.***

20. Close all windows.



End of Activity 10-1.

11

Loops and Charts

This chapter introduces structures and explains the basic concepts of charts, the While Loop, and the For Loop. This chapter also provides activities that illustrate how to accomplish the following:

- Learn about different chart modes
- Use a While Loop and a chart
- Change the mechanical action of a Boolean switch
- Control loop timing
- Use a shift register
- Create a multiplot chart and customize your trend
- Use a For Loop

What is a Structure?

A *structure* is a program control element. Structures control the flow of data in a VI. G has five structures: the While Loop, the For Loop, the Case structure, the Sequence structure, and the Formula Node. This chapter introduces the While Loop and For Loop structures along with the chart and the shift register. The Case structure, Sequence structure, and Formula Node are explained in Chapter 12, *Case and Sequence Structures and the Formula Node*.

While and For Loops are basic structures for programming with G, so you can find them in most of the G examples as well as the activities in this manual. You also can find more information on loops in Chapter 19, *Structures*, in the *G Programming Reference Manual*.

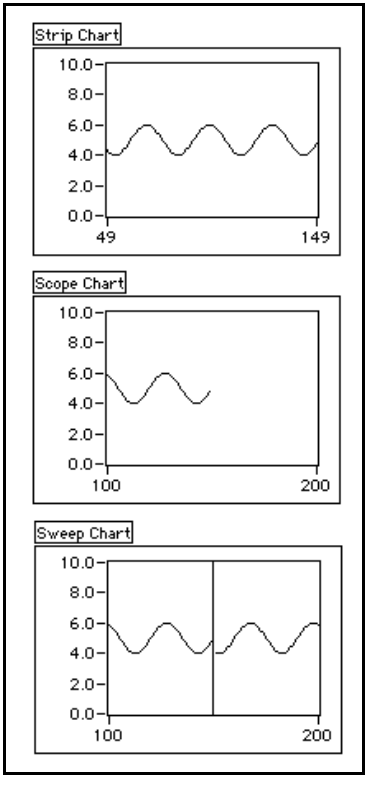
For examples of structures, see `G Examples\General\structs.llb`. For examples of charts, see `G Examples\General\Graphs\charts.llb`.

Charts

A *chart* is a numeric plotting indicator which is updated with new data periodically. You can find two types of charts in the **Controls»Graph** palette: waveform chart (or real-time trend) and intensity chart. You can customize charts to match your data display requirements or to display more information. Features available for charts include: a scrollbar, a legend, a palette, a digital display, and representation of scales with respect to time. For more information about charts, see Chapter 15, *Graph and Chart Controls and Indicators*, in your *G Programming Reference Manual*.

Chart Modes

The following illustration shows the three chart display options available from the **Data Operations»Update Mode** submenu—**Strip chart, Scope chart, and Sweep chart**. The default mode is strip chart.

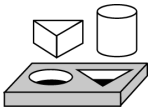


Faster Chart Updates

You can pass an array of multiple values to the chart. The chart treats these inputs as new data for a single plot. Refer to the `charts.vi` example located in `G Examples\General\Graphs\charts.llb`.

Overlaid Versus Stacked Plots

You can display multiple plots on a chart using a single vertical scale, called overlaid plots, or using multiple vertical scales, called stacked plots. Refer to the `charts.vi` example located in `G Examples\General\Graphs\charts.llb`.



Activity 11-1. Experiment with Chart Modes

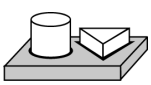
Your objective is to view a chart as your VI runs in strip chart mode, scope chart mode, and sweep chart mode.

1. Open `Charts.vi`, located in the following directory: `BridgeVIEW\Examples\G Examples\General\Graphs\charts.11b`.
2. Run the VI.

   The strip chart mode has a scaling display similar to a paper tape strip chart recorder. As each new value is received, it is plotted at the right margin and old values shift to the left.

   The scope chart mode has a retracing display similar to an oscilloscope. As the VI receives each new value, it plots the value to the right of the last value. When the plot reaches the right border of the plotting area, the VI erases the plot and begins plotting again from the left border. The scope chart is significantly faster than the strip chart because it is free of the processing overhead involved in scrolling.

   The sweep chart mode acts much like the scope chart, but it does not go blank when the data hits the right border. Instead, a moving vertical line marks the beginning of new data and moves across the display as the VI adds new data.
3. With the VI still running, pop up on any chart, and select **Update Mode**, and change the current mode to that of another chart. Notice the difference between the various charts and modes.
4. Stop and close the VI.

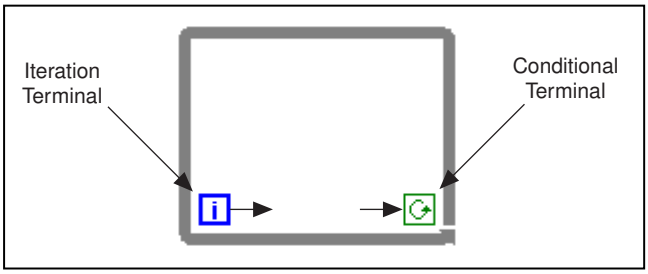


End of Activity 11-1.

While Loops

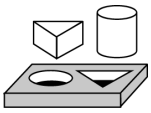
A While Loop is a structure that repeats a section of code until a condition is met. It is comparable to a Do Loop or a Repeat-Until Loop in traditional programming language.

The While Loop, shown in the following illustration, is a resizable box you use to execute the diagram inside it until the Boolean value passed to the conditional terminal (an input terminal) is FALSE. The VI checks the conditional terminal at the end of each iteration; therefore, the While Loop always executes at least once. The iteration terminal is an output numeric terminal that outputs the number of times the loop has executed. However, the iteration count always starts at zero, so if the loop runs once, the iteration terminal outputs 0.



The While Loop is equivalent to the following pseudocode:

```
Do
Execute Diagram Inside the Loop (which sets the
condition)
While Condition is TRUE
```

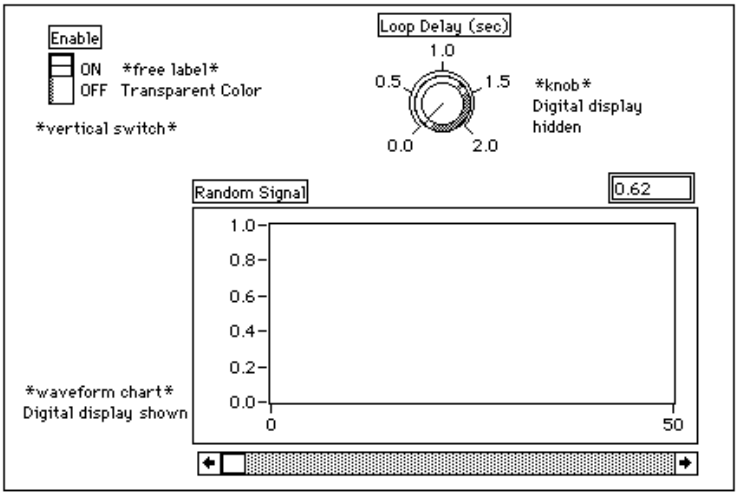


Activity 11-2. Use a While Loop and a Chart

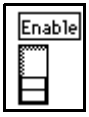
Your objective is to use a While Loop and a chart for acquiring and displaying data in real time.

You will build a VI that generates random data and displays it on a chart. A knob control on the front panel adjusts the loop rate between 0 and 2 seconds and a switch stops the VI. You will change the mechanical action of the switch so you do not have to turn on the switch each time you run the VI. Use the front panel in the following illustration to get started.

Front Panel



1. Open a new front panel by selecting **File»New**.



2. Place a Vertical Switch (**Controls»Boolean**) on the front panel. Label the switch `Enable`.

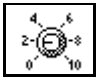
3. Use the Labeling tool to create free labels for `ON` and `OFF`. Select the Labeling tool, and type in the label text. With the Color tool, shown at left, make the border of the free label transparent by selecting the T in the bottom left corner of the **Color** palette.

4. Place a waveform chart (**Controls»Graph**) on the front panel. Label the chart `Random Signal`. The chart displays random data in real time.

☞ **Note** ***Make sure that you select a waveform chart and not a waveform graph. In the* Graph *palette, the waveform chart appears closest to the left side.***

5. Pop up on the chart and choose **Show»Palette**, and **Show»Legend** to hide the palette and legend. The digital display shows the latest value. Then pop up on the chart and choose **Show»Digital Display** and **Show»Scroll Bar**.

6. Rescale the chart from `0.0` to `1.0`. Use the Labeling tool to replace the HI limit of `10.0` with `1.0`.

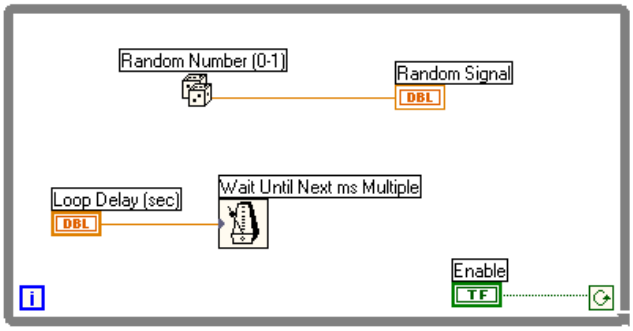


7. Place a knob (**Controls»Numeric**) on the front panel. Label the knob `Loop Delay (sec)`. This knob controls the timing of the While Loop. Pop up on the knob and deselect **Show»Digital Display** to hide the digital display.

8. Rescale the knob. Using the Labeling tool, double-click on `10.0` in the scale around the knob, and replace it with `2.0`.

Block Diagram

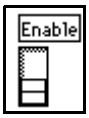
9. Open the block diagram and create the diagram in the following illustration.



a. Place the While Loop in the block diagram by selecting it from **Functions»Structures**. The While Loop is a resizable box that is not dropped on the diagram immediately. Instead, you have the chance to position and resize it. To do so, click in an area above and to the left of all the terminals. Continue holding down the mouse button and drag out a rectangle that encompasses the terminals.

b. Select the Random Number (0–1) function from **Functions» Numeric**.

c. Wire the diagram as shown in the Block Diagram, connecting the Random Number (0–1) function to the Random Signal chart terminal, and the Enable switch to the conditional terminal of the While Loop. Leave the Loop Delay terminal unwired for now.

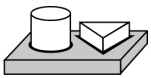


10. Return to the front panel and turn on the vertical switch by clicking on it with the Operating tool.
11. Save the VI as `Random Signal.vi` in the `BridgeVIEW\Activity` directory.
12. Run the VI.

The While Loop is an indefinite looping structure. The diagram within it executes as long as the specified condition is TRUE. In this example, as long as the switch is on (TRUE), the diagram continues to generate random numbers and display them on the chart.

13. Stop the VI by clicking on the vertical switch. Turning the switch off sends the value FALSE to the loop conditional terminal and stops the loop.
14. Scroll through the chart. Click and hold down the mouse button on either arrow in the scrollbar.
15. Clear the display buffer and reset the chart by popping up on the chart and choosing **Data Operations»Clear Chart**.

☞ **Note** ***The display buffer default size is 1,024 points. You can increase or decrease this buffer size by popping up on the chart and choosing*** **Chart History Length….** ***You only can use this feature when the VI is not running.***



End of Activity 11-2.

Mechanical Action of Boolean Switches

You might notice that each time you run the VI, you must turn on the vertical switch and then click the **Run** button in the toolbar. With G, you can modify the mechanical action of Boolean controls.

There are six possible choices for the mechanical action of a Boolean control:

- Switch When Pressed
- Switch When Released
- Switch Until Released
- Latch When Pressed
- Latch When Released
- Latch Until Released

Below are figures depicting each of these boolean switches, as well as a description of each of these mechanical actions.

Switch When Pressed action—Changes the control value each time you click on the control with the Operating tool. The action is similar to that of a ceiling light switch, and is not affected by how often the VI reads the control.

Switch When Released action—Changes the control value only after you release the mouse button, during a mouse click, within the graphical boundary of the control. The action is not affected by how often the VI reads the control. This action is similar to what happens when you click on

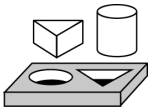
a check mark in a dialog box; it becomes highlighted but does not change until you release the mouse button.

Switch Until Released action—Changes the control value when you click on the control. It retains the new value until you release the mouse button, at which time the control reverts to its original value. The action is similar to that of a doorbell, and is not affected by how often the VI reads the control.

Latch When Pressed action—Changes the control value when you click on the control. It retains the new value until the VI reads it once, at which point the control reverts to its default value. (This action happens regardless of whether you continue to press the mouse button.) This action is similar to that of a circuit breaker and is useful for stopping While Loops or having the VI do something only once each time you set the control.

Latch When Released action—Changes the control value only after you release the mouse button. When your VI reads the value once, the control reverts to the old value. This action guarantees at least one new value. As with Switch When Released, this action is similar to the behavior of buttons in a dialog box; clicking on this action highlights the button, and releasing the mouse button latches a reading.

Latch Until Released action—Changes the control value when you click on the control. It retains the value until your VI reads the value once or until you release the mouse button, depending on which one occurs last.



Activity 11-3. Change the Mechanical Action of a Boolean Switch

Your objective is to experiment with the different mechanical actions of Boolean switches.

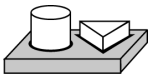
1. Open the `Random Signal.vi`, as saved in Activity 11-2, from the `BridgeVIEW\Activity` directory. The default value of the `Enable` switch is FALSE.
2. Modify the vertical switch so it is used only to stop the VI. Change the switch so that you do not need to turn on the switch each time you run the VI.
   a. Turn on the vertical switch with the Operating tool.

b. Pop up on the switch and choose **Data Operations»Make Current Value Default**. This makes the ON position the default value.

c. Pop up on the switch and choose **Mechanical Action»Latch When Pressed**.

3. Run the VI. Click on the `Enable` switch to stop the acquisition. The switch moves to the OFF position momentarily and is reset back to the ON position.
4. Save the VI.

☞ **Note** ***For your reference, BridgeVIEW contains an example that demonstrates these behaviors, called*** `Mechanical Action of Booleans.vi`***. It is located in*** `Examples\G Examples\General\Controls\booleans.llb`.

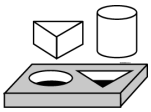


End of Activity 11-3.

Timing

When you ran the VI in the previous activity, the While Loop executed as quickly as possible. However, you can slow it down to iterate at certain intervals with the functions in the **Functions»Time & Dialog** palette.

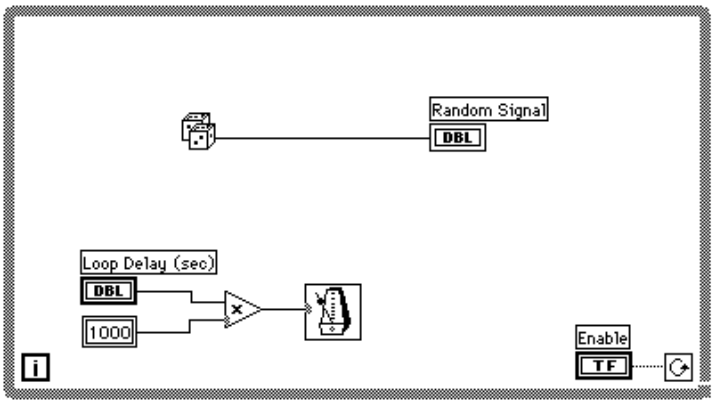
The timing functions express time in milliseconds (ms), however, your operating system might not maintain this level of timing accuracy. On Windows 95/NT, the timer has a resolution of 1 ms. This is hardware-dependent, so on slower systems, such as an 80386, you might have lower resolution timing.



Activity 11-4. Control Loop Timing

Your objective is to control loop timing and ensure that no iteration is shorter than the specified number of milliseconds.

1. Open `Random Signal.vi`, as modified and saved in Activity 11-3, from the `BridgeVIEW\Activity` directory.
2. Modify the VI to generate a new random number at a time interval specified by the knob, as shown in the following illustration.

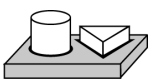


Wait Until Next ms Multiple function (**Functions»Time & Dialog**)—Multiply the knob terminal by 1,000 to convert the knob value in seconds to milliseconds. Use this value as the input to the Wait Until Next ms Multiple function.

Multiply function (**Functions»Numeric**)—The multiply function multiplies the knob value by 1000 to convert seconds to milliseconds.

Numeric constant (**Functions»Numeric**)—The numeric constant holds the constant by which you must multiply the knob value to get a quantity in milliseconds. Thus, if the knob has a value of 1.0, the loop executes once every 1000 milliseconds (once per second).

3. Run the VI. Rotate the knob to get different values for the loop delay. Notice the effects of the loop delay on the update of the `Random Signal` display.
4. Save the VI as `Random Signal with Delay.vi` in the `BridgeVIEW\Activity` directory. Close the VI.

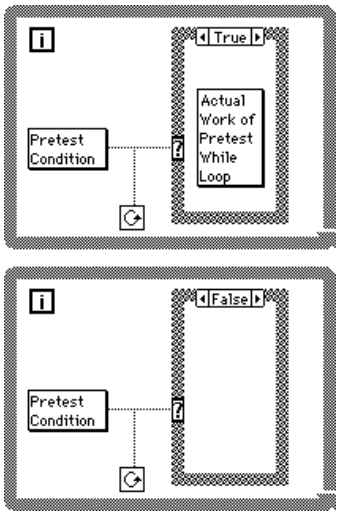


End of Activity 11-4.

Preventing Code Execution in the First Iteration

The While Loop always executes at least once, because G performs the loop test for continuation after the diagram executes. You can construct a While Loop that pretests its conditional terminal by including a Case structure inside the loop. Wire a Boolean input to the Case structure selector terminal so the subdiagram for the FALSE condition executes if the code in the While Loop should not execute. See Chapter 12, *Case and Sequence Structures and the Formula Node* for more information about using Case structures.

The subdiagram for the TRUE condition contains the work of the While Loop. The test for continuation occurs outside the Case structure, and the results are wired to the conditional terminal of the While Loop and the selector terminal of the Case structure. In the following illustration, labels represent the pretest condition.

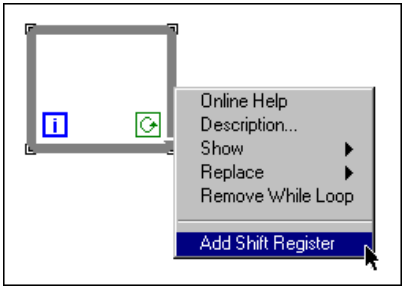


This example has the same result as the following pseudocode:

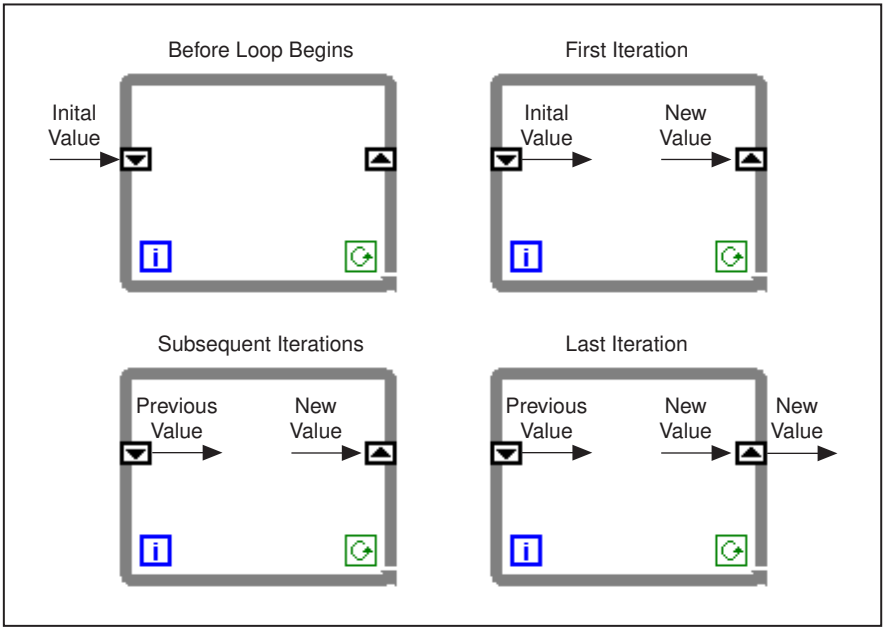
```
While (pretest condition)
Do actual work of While Loop
Loop
```

Shift Registers

Shift registers (available for While Loops and For Loops) transfer values from one loop iteration to the next. You can create a shift register by popping up on the left or right border of a loop and selecting **Add Shift Register**.

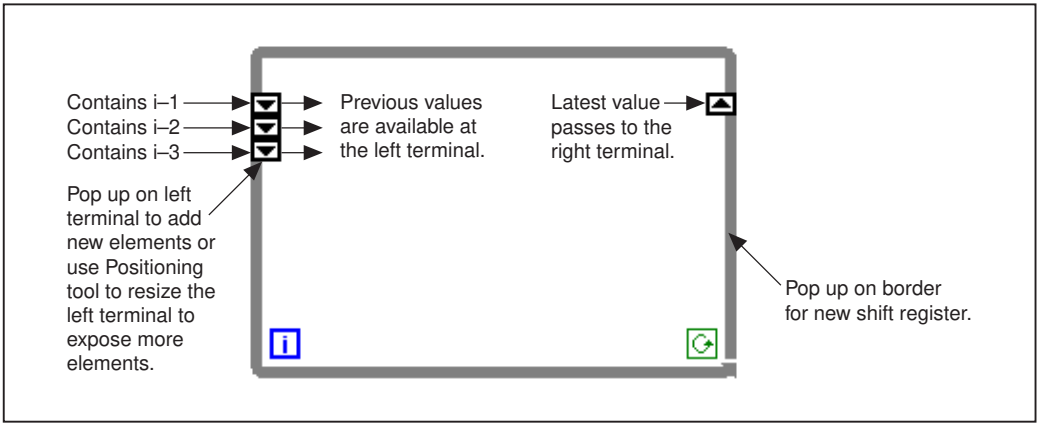


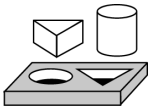
The shift register contains a pair of terminals directly opposite each other on the vertical sides of the loop border. The right terminal stores the data upon the completion of an iteration. That data shifts at the end of the iteration and appears in the left terminal at the beginning of the next iteration, as shown in the following illustration. A shift register can hold any data type—numeric, Boolean, string, array, and so on. The shift register automatically adapts to the data type of the first object you wire to the shift register.



You can configure the shift register to remember values from several previous iterations. This feature is useful for averaging data points. You create additional terminals to access values from previous iterations by popping up on the left or right terminal and choosing **Add Element**.

For example, if a shift register contains three elements in the left terminal, you can access values from the last three iterations, as shown in the following illustration.



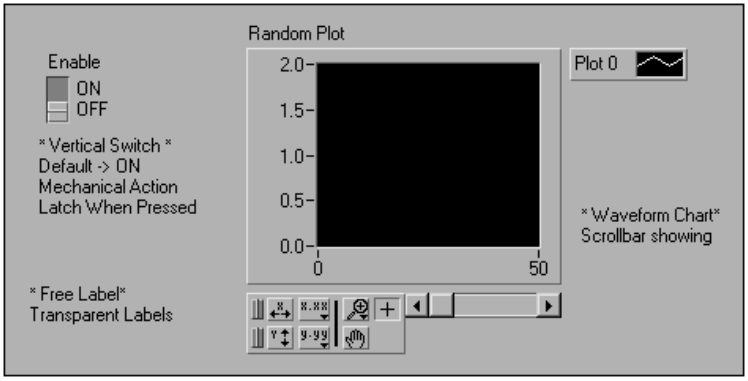


Activity 11-5. Use a Shift Register

Your objective is to build a VI that displays a running average on a chart.

Front Panel

1. Open a new front panel and create the objects as shown in the following illustration.

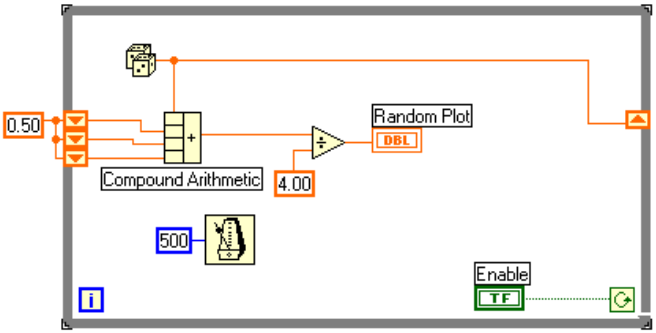


2. Change the scale of the Waveform chart to range from `0.0` to `2.0`.

3. After adding the vertical switch, pop up on it and select **Mechanical Action»Latch When Pressed** and set the ON state to be the default by choosing **Operate»Make Current Values Default**.

Block Diagram

4. Build the block diagram shown in the following illustration.



5. Add the While Loop (**Functions»Structures**) in the block diagram and create the shift register.

a. Pop up on the left or right border of the While Loop and choose **Add Shift Register**.

b. Add an extra element by popping up on the left terminal of the shift register and choosing **Add Element**. Add a third element in the same manner as the second.

Random Number (0–1) function (**Functions»Numeric**)—This function generates random data ranging between 0 and 1.

Compound Arithmetic function (**Functions»Numeric**)—In this activity, the compound arithmetic function returns the sum of random numbers from two iterations. To add more inputs, pop up on an input and choose Add Input from the pop-up menu.

Divide function (**Functions»Numeric**)—In this activity, the divide function returns the average of the last four random numbers.

Numeric Constant (**Functions»Numeric**)—During each iteration of the While Loop, the Random Number (0–1) function generates one random value. The VI adds this value to the last three values stored in the left terminals of the shift register. The Random Number (0–1) function divides the result by four to find the average of the values (the current value plus the previous three). Then the average is displayed on the waveform chart.

Wait Until Next ms Multiple function (**Functions»Time & Dialog**) —This function ensures that each iteration of the loop occurs no faster than the millisecond input. The input is 500 milliseconds for this activity. If you pop up on the icon and choose **Show»Label**, the label Wait Until Next ms Multiple appears.

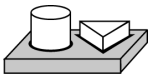
6. Pop up on the input of the Wait Until Next ms Multiple function and select **Create Constant**. A numeric constant appears and is automatically wired to the function.

7. Type `500` in the label. The numeric constant wired to the Wait Until Next ms Multiple function specifies a wait of 500 milliseconds (one half-second). Thus, the loop executes once every half-second.

   Notice that the VI initializes the shift registers with a random number. If you do not initialize the shift register terminal, it contains the default value or the last value from the previous run and the first few averages are meaningless.

8. Run the VI and observe the operation.
9. Save this VI as `Random Average.vi` in the `BridgeVIEW\Activity` directory.

Note ***Remember to initialize shift registers to avoid incorporating old or default data into your current data measurements***

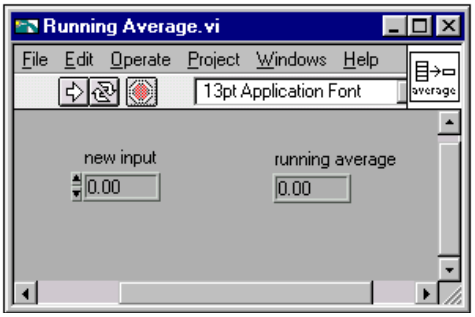


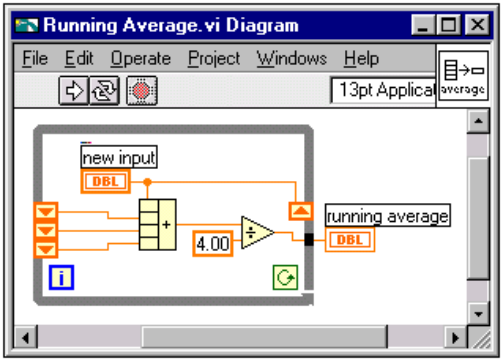
End of Activity 11-5.

Using Uninitialized Shift Registers

You initialize a shift register by wiring a value from outside a While Loop or For Loop to the left terminal of the shift register. Sometimes, however, you want to execute a VI repeatedly with a loop and a shift register, so that each time the VI executes, the initial output of the shift register is the last value from the previous execution. To do that, you must leave the left shift register terminal unwired from outside the loop. Leaving the input to the left shift register terminal unwired preserves state information between subsequent executions of a VI.

The following illustration shows an example of a subVI that calculates the running average of four data points. The VI uses an uninitialized shift register (with three additional elements) to store previous data points.





Each time the VI is called, `running average` is computed from the new input and the previous three values. Then the new value is saved into the shift register, and the previous two values are moved up in the shift register. There is no input value wired to the input side of the left shift registers, so all three values are preserved for the next execution of the VI.

Because this subVI has nothing wired to the condition terminal, it executes exactly once when called. The While Loop in this subVI is not used to loop several times, but to store values in the loop shift registers between calls.

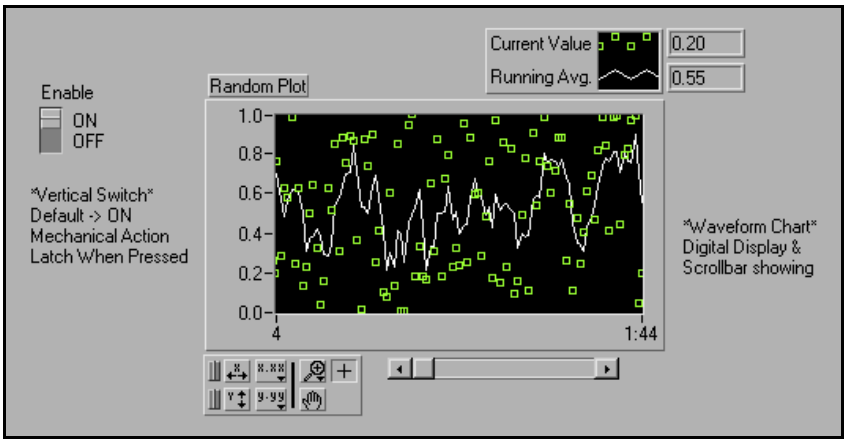
When the Running Average VI is loaded into memory, the uninitialized shift registers are set to zero automatically. If the shift registers are wired to Boolean values, the initial value is FALSE.

Activity 11-6. Create a Multiplot Chart and Customize Your Trends

Your objective is to create a chart that can accommodate more than one plot.

Front Panel

1. Open the `Random Average.vi` you created in Activity 11-5.
2. Modify the Front Panel as shown in the following illustration.



a. Using the Positioning tool, stretch the legend to include two plots.

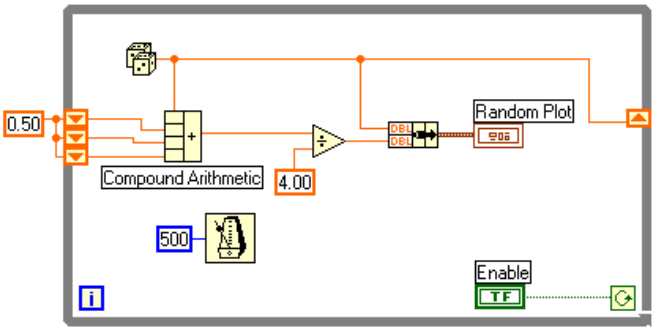
b. Show the digital display by popping up on the chart, and choosing **Show»Digital Display**. Move the legend if necessary.

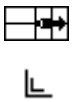
c. Rename Plot 0 to `Current Value` by double-clicking on the label with the Labeling tool and typing in the new text. You can resize the label area by dragging either of the left corners with the Positioning tool. Rename Plot 1 to `Running Avg` in the same way.

d. For the `Current Value` plot, change the interpolation to unconnected, the point style to square, and the color to green. You can change the plot style and color by popping up on the legend.

Block Diagram

3. Modify the block diagram, as shown in the following illustration, to display both the average and the current random number on the same chart.

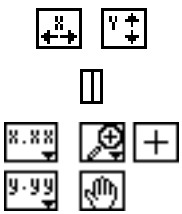




Bundle function (**Functions»Cluster**)—In this activity, the Bundle function bundles the average and current value for plotting on the chart. The bundle node appears as shown at left when you place it in the block diagram. You can add additional elements by using the Resizing cursor (accessed by placing the Positioning tool at the corner of the function) to enlarge the node.

Note ***The order of the inputs to the Bundle function determines the order of the plots on the chart. For example, if you wire the raw data to the top input of the Bundle function and the average to the bottom, the first plot corresponds to the raw data and the second plot corresponds to the average.***

4. From the front panel, run the VI. The VI displays two plots on the chart. The plots are overlaid. That is, they share the same vertical scale.
5. From the block diagram, run the VI with execution highlighting turned on to see the data in the shift registers.
6. Turn execution highlighting off. From the front panel, run the VI. While the VI is running, use the buttons from the palette to modify the chart. You can reset the chart, scale the X or Y axis, and change the display format at any time. You also can scroll to view other areas or zoom into areas of a graph or chart.



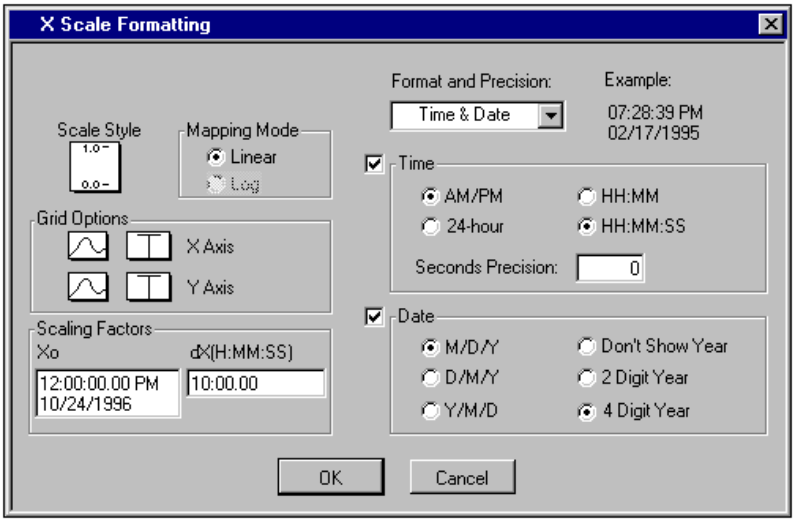
You can use the **X** and **Y** buttons to rescale the X and Y axes, respectively. If you want the graph to autoscale either of the scales continuously, click on the lock switch to the left of each button to lock on autoscaling.

You can use the other buttons to modify the axis text precision or to control the operation mode for the chart. Experiment with these

buttons to explore their operation, scroll the area displayed, or zoom in on areas of the chart.

7. Format the scales of the waveform chart to represent either absolute or relative time. To select the x scale time format, pop up on the x-scale and select **Formatting…**.

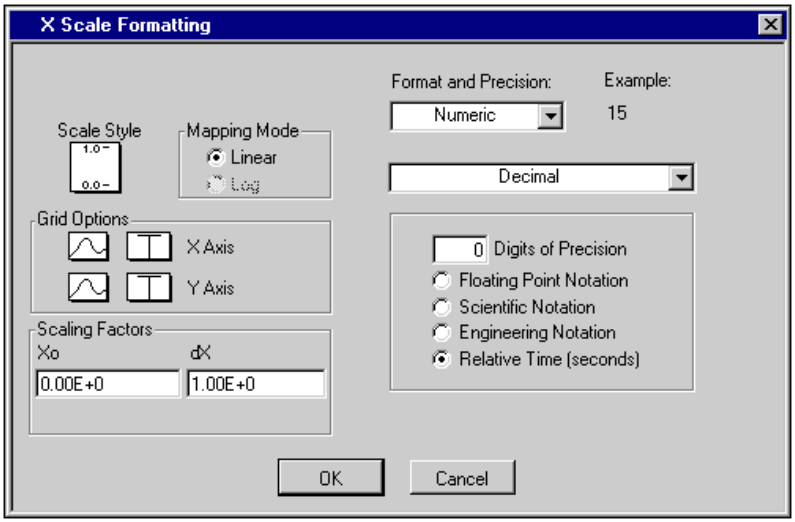
   a. Choose absolute time by selecting the **Time & Date** option from the **Format and Precision** menu ring. This changes the dialog box to the one shown below. For the waveform chart to start at a certain time and increment at certain intervals, you can edit the *Xo* and *dX* values respectively.



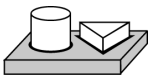
   b. Format the chart to display the data starting from noon, Oct. 24, 1996, and increment every 10 minutes, as shown above.

Note ***Modifying the axis text format often requires more physical space than was originally set aside for the axis. If you change the axis, the text may become larger than the maximum size that the waveform can correctly present. To correct this, use the Resizing cursor to make the display area of the chart smaller.***

8. To select the relative time format, select **Numeric** from the **Format and Precision** menu ring. Then you can select the **Relative Time (seconds)** option in the dialog box and represent the time in seconds. Modify the dialog box, as shown in the following illustration, and select **OK**.



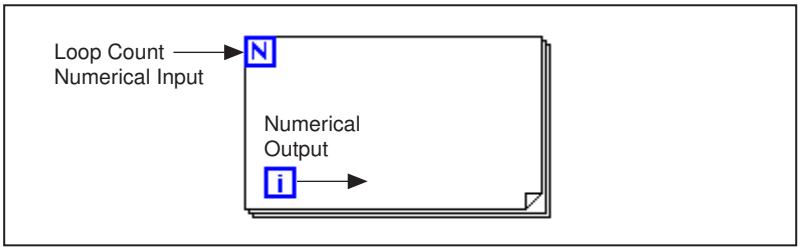
9. Run the VI.
10. Save the VI as `Multiple Random Plot.vi` in the `BridgeVIEW\Activity` directory.



End of Activity 11-6.

For Loops

A For Loop executes a section of code a defined number of times. It is resizable, and, like the While Loop, is not dropped on the block diagram immediately. Instead, a small icon representing the For Loop appears in the block diagram, and you have the opportunity to size and position it. To do so, first click in an area above and to the left of all the terminals. While holding down the mouse button, drag out a rectangle that encompasses the terminals you want to place inside the For Loop. When you release the mouse button, G creates a For Loop of the size and position you selected. You place the For Loop on the block diagram by selecting it from **Functions»Structures**.



The For Loop executes the diagram inside its border a predetermined number of times. The For Loop has two terminals, explained below.

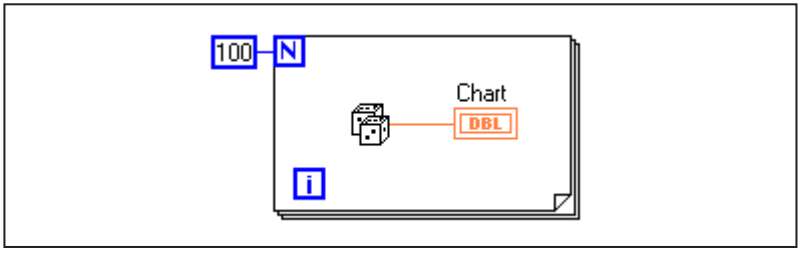
N Count terminal (an input terminal)—The count terminal specifies the number of times to execute the loop.

i Iteration terminal (an output terminal)—The iteration terminal contains the number of times the loop has executed.

The For Loop is equivalent to the following pseudocode:

```
For i = 0 to N-1
Execute Diagram Inside The Loop
```

The following illustration shows a For Loop that generates 100 random numbers and displays the points on a chart.



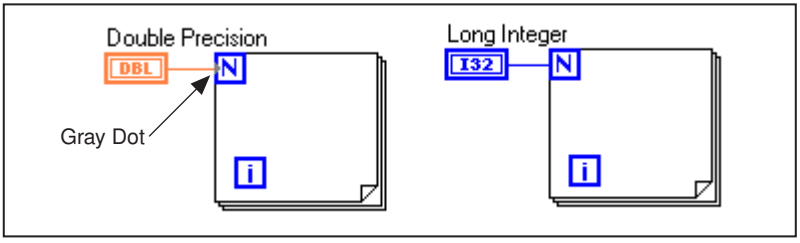
Numeric Conversion

Until now, all the numeric controls and indicators you have used have been double-precision, floating-point numbers represented with 32 bits. G, however, can represent numerics as integers (byte, word, or long) or floating-point numbers (single-, double-, or extended-precision). The default representation for a numeric is a double-precision, floating-point.

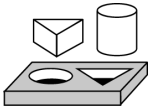
If you wire two terminals together that are of different data types, G converts one of the terminals to the same representation as the other

terminal. As a reminder, G places a gray dot, called a *coercion dot*, on the terminal where the conversion takes place.

For example, consider the For Loop count terminal. The terminal representation is a long integer. If you wire a double-precision, floating-point number to the count terminal, G converts the number to a long integer. Notice the gray dot in the count terminal of the first For Loop.



Note ***When the VI converts floating-point numbers to integers, it rounds to the nearest integer. If a number is exactly halfway between two integers, it is rounded to the nearest even integer. For example, the VI rounds 6.5 to 6, but rounds 7.5 to 8. This is an IEEE standard method for rounding numbers. See the IEEE Standard 754 for details.***

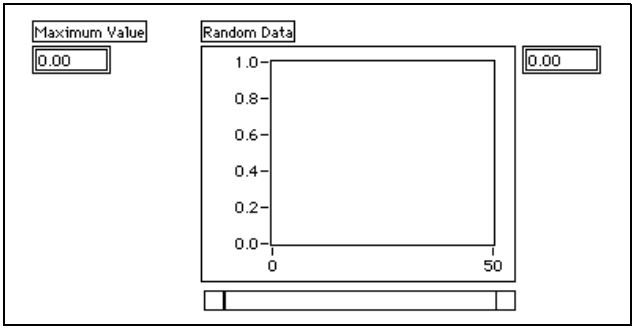


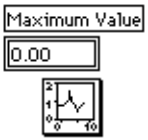
Activity 11-7. Use a For Loop

Your objective is to use a For Loop and shift registers to calculate the maximum value in a series of random numbers.

Front Panel

1. Open a new front panel and add the objects shown in the following illustration.





a. Place a digital indicator on the front panel and label it `Maximum Value`.

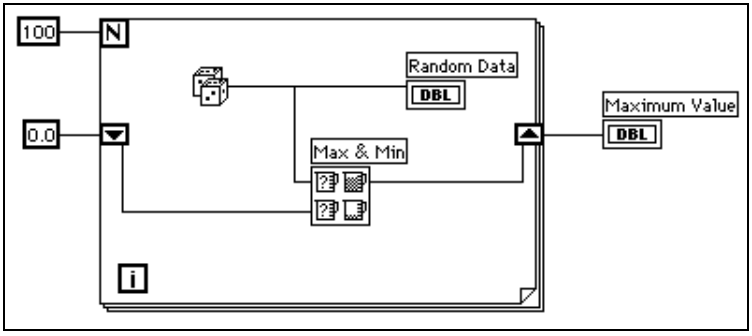
b. Place a waveform chart on the front panel and label it `Random Data`. Change the scale of the chart to range from `0.0` to `1.0`.

c. Pop up on the chart and choose **Show»Scrollbar** and **Show»Digital Display**. Pop up and hide the palette and legend.

d. Resize the scrollbar with the positioning tool.

Block Diagram

2. Open the block diagram and modify it as shown in the following illustration.



3. Place a For Loop (**Functions»Structures**) on the block diagram.

4. Add the shift register by popping up or right-clicking on the right or left border of the For Loop and choosing **Add Shift Register**.

5. Add the following objects to the block diagram.

Random Number (0–1) function (**Functions»Numeric**)—This function generates the random data.

Numeric Constant (**Functions»Numeric**)—The For Loop needs to know how many iterations to make. In this case, you execute the For Loop 100 times.

Numeric Constant (**Functions»Numeric**)—You set the initial value of the shift register to zero for this exercise because you know that the output of the random number generator is from 0.0 to 1.0.

You must know something about the data you are collecting to initialize a shift register. For example, if you initialize the shift register to 1.0, then that value is already greater than all the expected data values, and is always the maximum value. If you did not initialize the shift register, then it would contain the maximum value of a previous

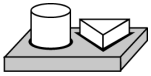
run of the VI. Therefore, you could get a maximum output value that is not related to the current set of collected data.

Max & Min function (**Functions»Comparison**)—Takes two numeric inputs and outputs the maximum value of the two in the top right corner and the minimum of the two in the bottom right corner. Because you only are interested in the maximum value for this exercise, wire only the maximum output and ignore the minimum output.

6. Wire the terminals as shown. If the Maximum Value terminal were inside the For Loop, you would see it continuously updated, but because it is outside the loop, it contains only the last calculated maximum.

☞ **Note** ***Updating indicators each time a loop iterates is time-consuming and you should try to avoid it when possible to increase execution speed.***

7. Run the VI.
8. Save the VI as `Calculate Max.vi` in the `BridgeVIEW\Activity` directory.



End of Activity 11-7.

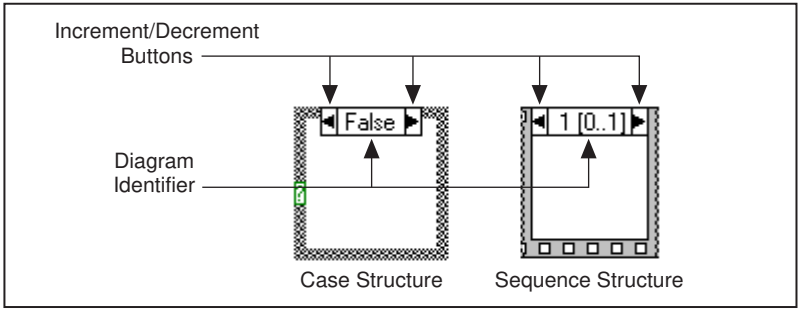
12

Case and Sequence Structures and the Formula Node

This chapter introduces the basic concepts of Case and Sequence structures and the Formula Node, and provides activities that explain the following:

- How to use the Case structure
- How to use the Sequence structure
- What sequence locals are and how to use them
- What a Formula Node is and how to use it

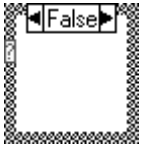
Both Case and Sequence structures can have multiple subdiagrams, configured like a deck of cards, of which only one is visible at a time. At the top of each structure border is the *subdiagram display window*, which contains a *diagram identifier* in the center and decrement and increment buttons at each side. The diagram identifier indicates which subdiagram currently is displayed. For Case structures, a diagram identifier is a list of values which select the subdiagram. For Sequence structures, a diagram identifier is the number of the frame in the sequence (0 to $n - 1$). The following illustration shows a Case structure and a Sequence structure.



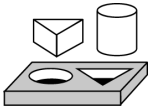
Clicking on the decrement (left) or increment (right) button displays the previous or next subdiagram, respectively. Incrementing from the last subdiagram displays the first subdiagram, and decrementing from the first subdiagram displays the last. For more information about Case and Sequence structures, refer to Chapter 19, *Structures*, in the *G Programming Reference Manual*.

Case Structure

The Case structure has two or more subdiagrams, or *cases*, exactly one of which executes when the structure executes. This depends on the value of an integer, Boolean, string, or enum value you wire to the external side of the selection terminal or *selector*. A Case structure is shown in the following illustration.



Note ***Case statements in other programming languages generally do not execute any case if a case is out of range. In G, you must either include a default case that handles out-of-range values or explicitly list every possible input value.***

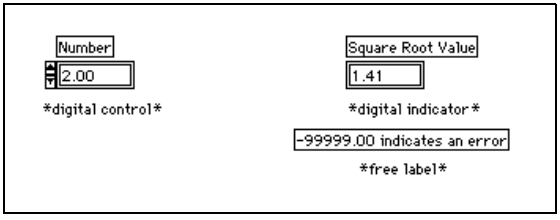


Activity 12-1. Use the Case Structure

Your objective is to build a VI that checks a number to see if it is positive. If the number is positive, the VI calculates the square root of the number; otherwise, the VI returns an error.

Front Panel

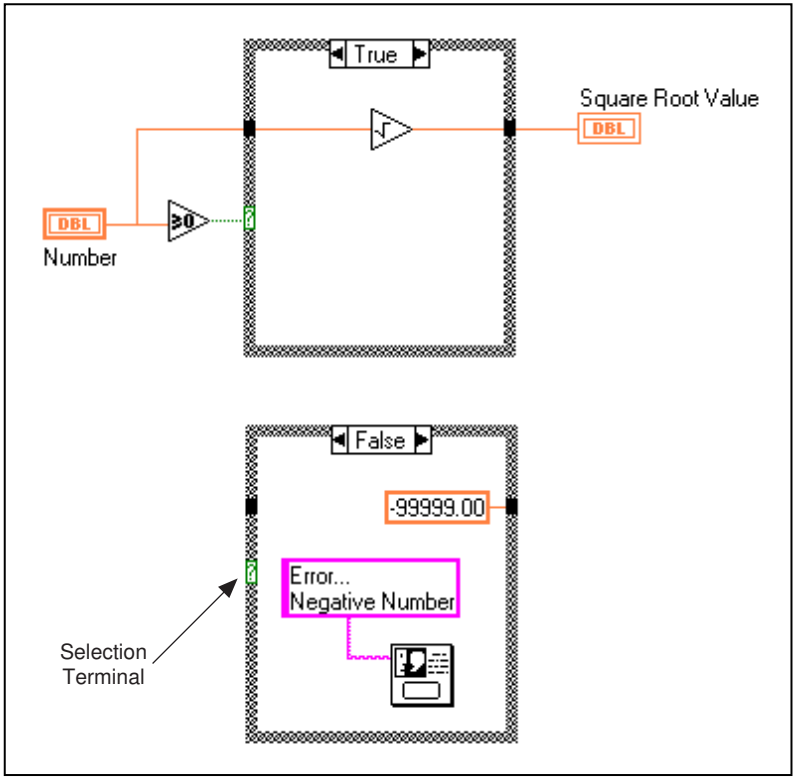
1. Open a new front panel and create the objects as shown in the following illustration.



The `Number` control supplies the number. The `Square Root Value` indicator displays the square root of the number. The free label acts as a note to the user.

Block Diagram

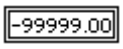
2. Build the diagram as shown in the following illustration.



3. Place a Case structure in the block diagram by selecting it from **Functions»Structures**. The Case structure is a resizable box that is not dropped on the diagram immediately. Instead, you have the chance to position it and resize it. To do so, click in an area above and to the left of all the terminals you want to be inside the Case structure. Continue holding down the mouse button and drag out a rectangle that encompasses the terminals.

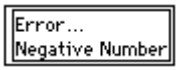
Greater Or Equal To 0? function (**Functions»Comparison**)—Returns a TRUE if the number input is greater than or equal to 0.

Square Root function (**Functions»Numeric**)—Returns the square root of the input number.



Numeric Constant (**Functions»Numeric**)—In this activity, the constant indicates the numeric value of the error.

One Button Dialog function (**Functions»Time & Dialog**)—In this activity, the function displays a dialog box that contains the message `Error...Negative Number`.



String Constant (**Functions»String**)—Enter text inside the box with the Labeling tool.

The VI executes either the TRUE case or the FALSE case. If the number is greater than or equal to zero, the VI executes the TRUE case and returns the square root of the number. The FALSE case outputs –99999.00 and displays a dialog box with the message `Error...Negative Number`.

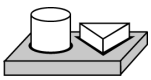
Note ***You must define the output tunnel for each case. When you create an output tunnel in one case, tunnels appear at the same position in all the other cases. Unwired tunnels appear as white squares.***

4. Return to the front panel and run the VI. Try a number greater than zero and a number less than zero by changing the value in the digital control you labeled `Number`. Notice that when you change the digital control to a negative number, BridgeVIEW displays the error message you set up in the FALSE case of the Case structure.
5. Save the VI as `Square Root.vi` in the `BridgeVIEW\Activity` directory.

VI Logic

The block diagram in this activity has the same effect as the following pseudocode in a text-based language.

```
if (Number >= 0) then
Square Root Value = SQRT(Number)
else
Square Root Value = -99999.00
Display Message "Error...Negative Number"
end if
```

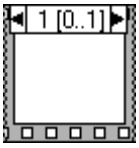


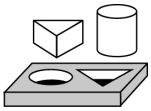
End of Activity 12-1.

Sequence Structures

The Sequence structure, which looks like frames of film, executes block diagrams sequentially. In conventional programming languages, the program statements execute in the order in which they appear. In data flow programming, a node executes when data is available at all of the node inputs, although sometimes it is necessary to execute one node before another. G uses the Sequence structure as a method to control the order in which nodes execute. G executes the diagram inside the border of Frame 0 first, it executes the diagram inside the border of Frame 1 second, and so on. As with the Case structure, only one frame is visible at a time.

A Sequence structure is shown in the following illustration.



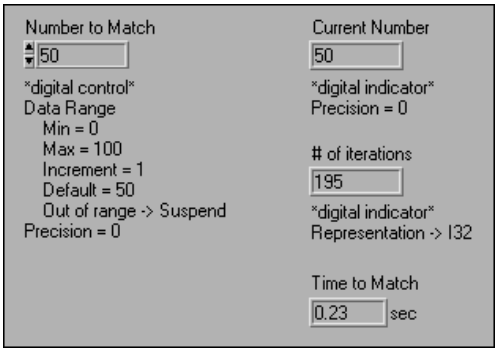


Activity 12-2. Use a Sequence Structure

Your objective is to build a VI that computes the time it takes to generate a random number that matches a given number.

Front Panel

1. Open a new front panel and build the front panel shown in the following illustration. Be sure to modify the controls and indicators as described in the text following the illustration.

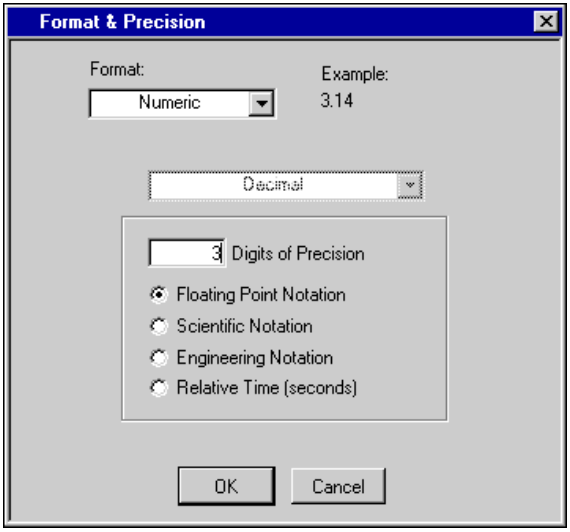


The `Number to Match` control contains the number you want to match. The `Current Number` indicator displays the current random number. The `# of iterations` indicator displays the number of iterations before a match. `Time to Match` indicates how many seconds it took to find the matching number.

Modifying the Numeric Format

By default, BridgeVIEW displays values in numeric controls in decimal notation with two decimal places (for example, 3.14). You can use the **Format & Precision…** option of a control or indicator pop-up menu to change the precision or to display the numeric controls and indicators in scientific or engineering notation. You can also use the **Format & Precision…** option to denote time and date formats for numerics.

2. Pop up on the Time to Match digital indicator and choose **Format & Precision…**. The front panel must be the active window to access the menu.
3. Enter `3` for Digits of Precision and click **OK**.

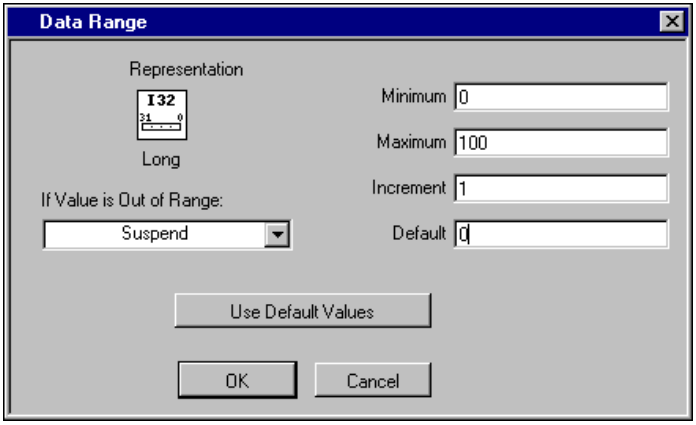


4. Pop up on the Number to Match digital control and choose **Representation»I32**.
5. Repeat Step 4 for the Current Number and the # of iterations digital indicators.

Setting the Data Range

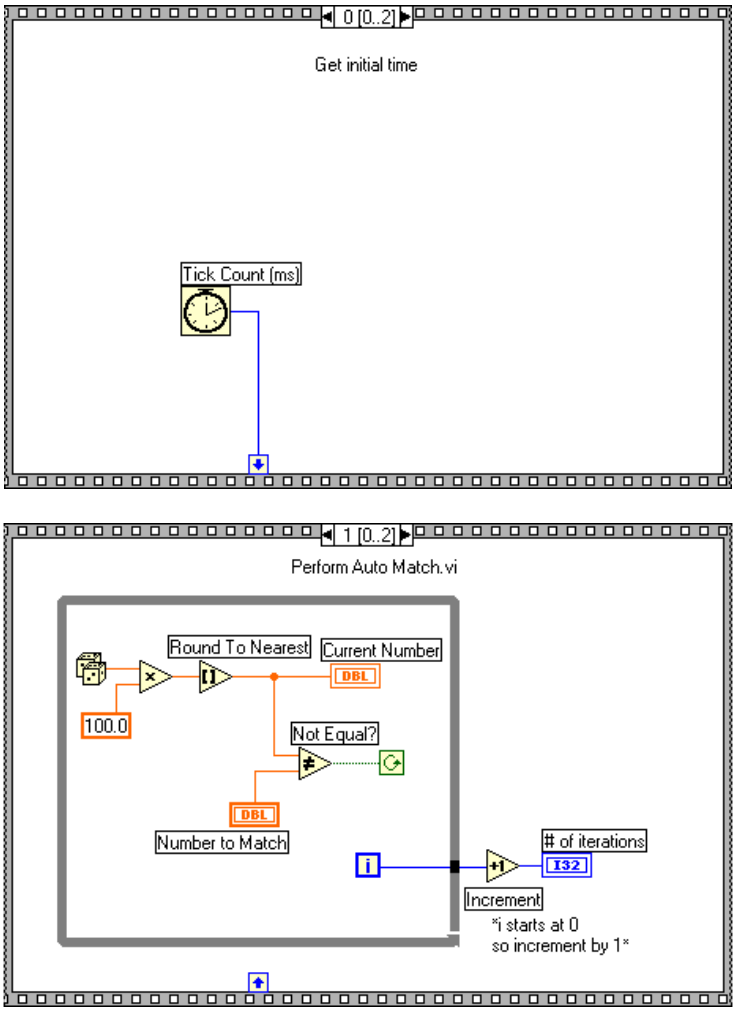
With the Data Range… option, you can prevent a user from setting a control or indicator value outside a preset range or increment. Your options are to ignore the value, coerce it to within range, or suspend execution. The range error symbol appears in place of the run button in the toolbar when a range error suspends execution. Also, a solid, dark border frames the control that is out of range.

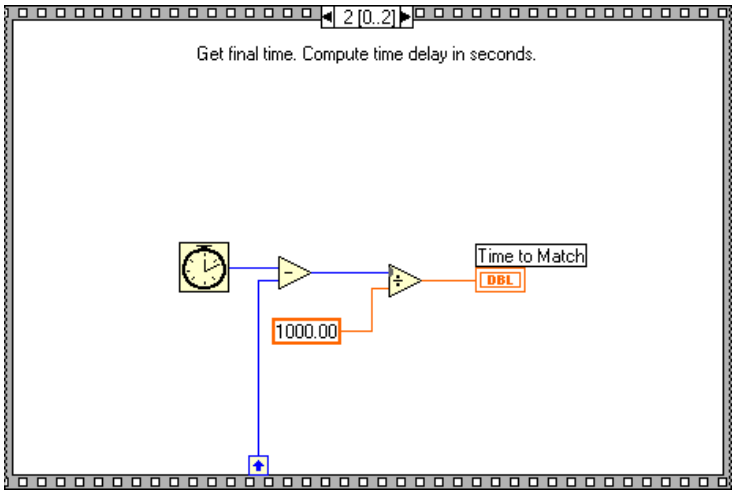
6. Pop up on the Number to Match indicator and choose **Data Range…**.
7. Fill in the dialog box as shown in the following illustration and click **OK**.

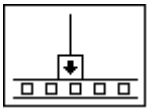


Block Diagram

8. Open the block diagram.
9. Place the Sequence structure (**Functions»Structures**) in the block diagram.
10. Enlarge the structure by dragging one corner with the Resizing cursor.
11. Create a new frame by popping up on the frame border and choose **Add Frame After**. Repeat this step to create frame 2.
12. Build the block diagram shown in the following illustrations.


0 [0..2]
Get initial time
Tick Count (ms)
1 [0..2]
Perform Auto Match.vi
Round To Nearest
Current Number
DBL
100.0
Not Equal?
DBL
Number to Match
# of iterations
I32
i
+1
Increment
*i starts at 0
so increment by 1*





Frame 0 in the previous illustration contains a small box with an arrow in it. That box is a *sequence local* variable which passes data between frames of a Sequence structure. You can create sequence locals on the border of a frame. Then, the data wired to a frame sequence local is available in subsequent frames. However, you cannot access the data in frames preceding the frame in which you created the sequence local.

13. Create the sequence local by popping up on the bottom border of Frame 0 and choosing **Add Sequence Local**.

    The sequence local appears as an empty square. The arrow inside the square appears automatically when you wire a function to the sequence local.

14. Finish the block diagram as shown in the opening illustration of the *Block Diagram* section in this activity.

Tick Count (ms) function (**Functions»Time & Dialog**)—Returns the number of milliseconds that have elapsed since power on. For this activity, you need two Tick Count functions.

Random Number (0–1) function (**Functions»Numeric**)—Returns a random number between 0 and 1.

Multiply function (**Functions»Numeric**)—In this activity, the function multiplies the random number by 100.

Numeric Constant function (**Functions»Numeric**)—In this activity, the numeric constant represents the maximum number that can be multiplied.

Round to Nearest function (**Functions»Numeric**)—In this activity, the function rounds the random number between 0 and 100 to the nearest whole number.

Not Equal? function (**Functions»Comparison**)—In this activity, the function compares the random number to the number specified in the front panel and returns a TRUE if the numbers are not equal. Otherwise, this function returns FALSE.

Increment function (**Functions»Numeric**)—In this activity, the function increments the While Loop count by 1.

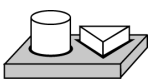
Subtract function (**Functions»Numeric**)—In this activity, the function returns the time (in milliseconds) elapsed between frame 2 and frame 0.

Divide function (**Functions»Numeric**)—In this activity, the function divides the number of milliseconds elapsed by 1,000 to convert the number to seconds.

Numeric constant (**Functions»Numeric**)—In this activity, the function converts the number from milliseconds to seconds.

In Frame 0, the Tick Count (ms) function returns the current time in milliseconds. This value is wired to the sequence local, where the value is available in subsequent frames. In Frame 1, the VI executes the While Loop as long as the number specified does not match the number that the Random Number (0–1) function returns. In Frame 2, the Tick Count (ms) function returns a new time in milliseconds. The VI subtracts the old time (passed from Frame 0 through the sequence local) from the new time to compute the time elapsed.

15. Return to the front panel and enter a number inside the `Number to Match` control and run the VI.
16. Save the VI as `Time to Match.vi` in the `BridgeVIEW\Activity` directory.



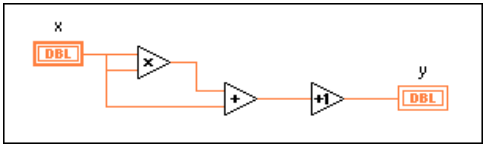
End of Activity 12-2.

Formula Node

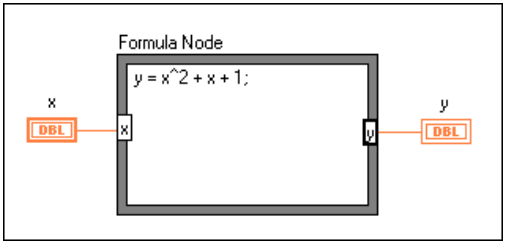
The Formula Node is a resizable box that you can use to enter formulas directly into a block diagram. You place the Formula Node on the block diagram by selecting it from **Functions»Structures**. This feature is useful when an equation has many variables or is otherwise complicated. For example, consider the equation below:

$$y = x^2 + x + 1$$

If you implement this equation using regular G arithmetic functions, the block diagram looks like the one in the following illustration.

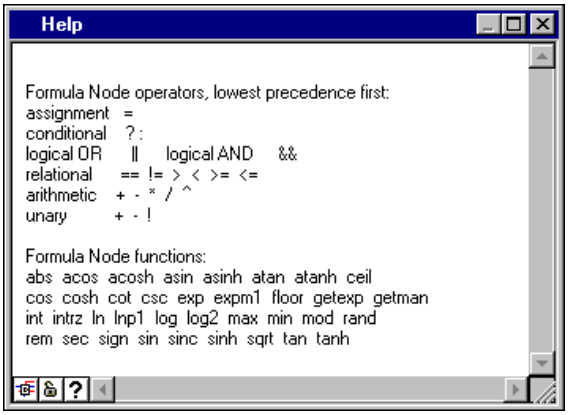


You can implement the same equation using a Formula Node, as shown in the following illustration



With the Formula Node, you can directly enter a complicated formula, or formulas, in lieu of creating block diagram subsections. You enter formulas with the Labeling tool. You create the input and output terminals of the Formula Node by popping up on the border of the node and choosing Add Input (Add Output). Type the variable name in the box. Variables are case sensitive. You enter the formula or formulas inside the box. Each formula statement must end with a semicolon (`;`).

The operators and functions available inside the Formula Node are listed in the Help window for the Formula Node, as shown in the following illustration. A semicolon terminates each formula statement.

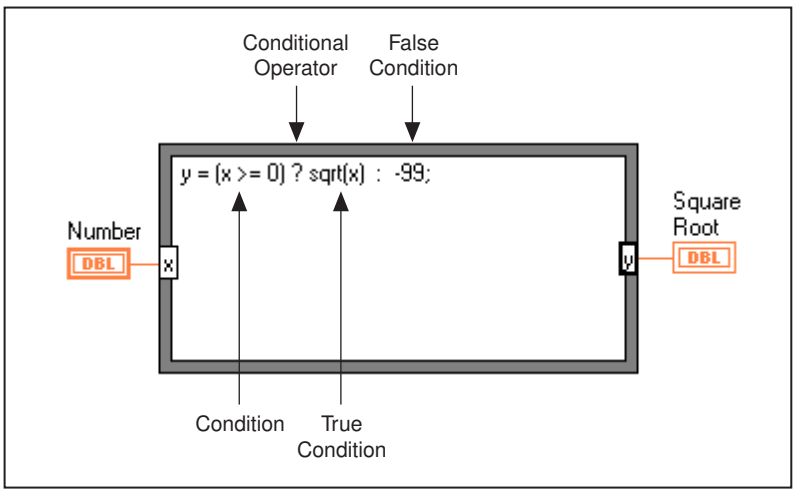


The following example shows how you can perform a conditional assignment inside a Formula Node.

Consider a code fragment that computes the square root of `x` if `x` is positive, and assigns the result to `y`. If `x` is negative, the code assigns –99 to `y`.

```
if (x >= 0) then
y = sqrt(x)
else
y = -99
end if
```

You can implement the code fragment using a Formula Node, as shown in the following illustration.



Activity 12-3. Use the Formula Node

Your objective is to build a VI that uses the Formula Node to calculate the following equations.

$$y_1 = x^3 - x^2 + 5$$

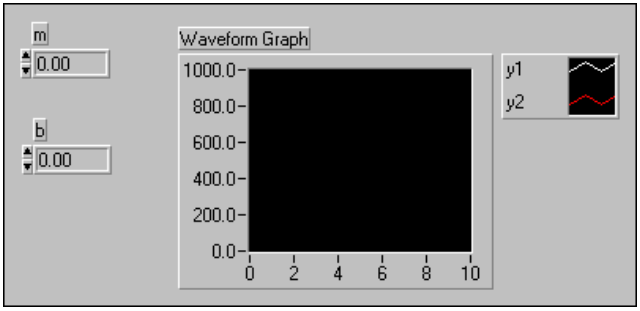
$$y_2 = m \times x + b$$

where `x` ranges from 0 to 10.

You will use only one Formula Node for both equations, and you will graph the results on the same graph. For more information on graphs, see Chapter 14, *Arrays, Clusters, and Graphs*.

Front Panel

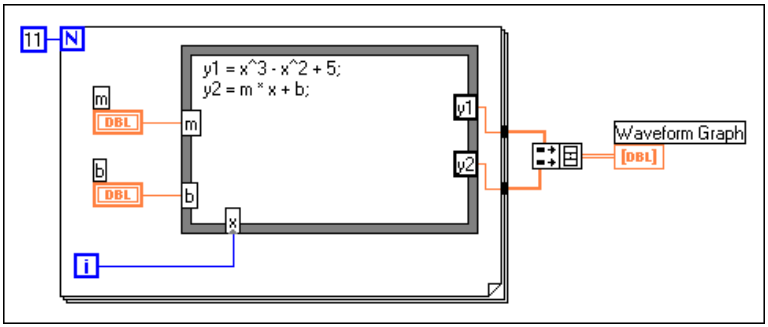
1. Open a new front panel and build the front panel shown in following illustration. The waveform graph indicator displays the plots of the equation. The VI uses the two digital controls to input the values for `m` and `b`.

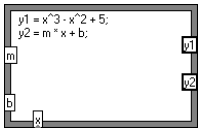


2. Create the graph legend shown in the following illustration by selecting **Show»Legend**. Use the Resizing cursor to drag the legend downward so it displays two plots. Use the Labeling tool to rename the plots. You can define the line style for each plot using the legend pop-up menu. You also can color each plot by using the Color tool on the plots legend.

Block Diagram

3. Build the block diagram shown in the following illustration.





Formula Node (**Functions»Structures**). With this node, you can enter formulas directly. Create the three input terminals by popping up on the border and choosing **Add Input**. You create the output terminal by choosing **Add Output** from the pop-up menu.

When you create an input or output terminal, you must give it a variable name. The variable name must match the one you use in the formula exactly. The names are case sensitive. That is, if you use a lowercase `a` in naming the terminal, you must use a lowercase `a` in the formula. You can enter the variable names and formula with the Labeling tool.

Note ***Although variable names are not limited in length, be aware that long names take up considerable diagram space. A semicolon (;) terminates the formula statement.***

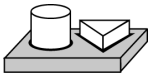
Numeric Constant (**Functions»Numeric**). You also can pop up on the count terminal and select **Create Constant** to create and wire the numeric constant automatically. The numeric constant specifies the number of For Loop iterations. If `x` range is 0 to 10 including 10, you must wire 11 to the count terminal.

Because the iteration terminal counts from 0 to 10, you use it to control the `x` value in the Formula Node.

Build Array (**Functions»Array**) puts two array inputs into the form of a multiplot graph. Create the two input terminals by using the Resizing cursor to drag one of the corners. For more information on arrays, see Chapter 14, *Arrays, Clusters, and Graphs*.

4. Return to the front panel and run the VI with different values for `m` and `b`.

5. Save the VI as `Equations.vi` in the `BridgeVIEW/Activity` directory.



End of Activity 12-3.

Artificial Data Dependency

Nodes not connected by a wire can execute in any order. Nodes do not necessarily execute in left-to-right, top-to-bottom order. A Sequence structure is one way to control execution order when natural data dependency does not exist.

Another way to control execution order is to create and artificial data dependency, a condition in which the arrival of data rather than its value triggers execution of an object. The receiver may not actually use the data internally. The advantage of artificial dependency is that all of the nodes are visible at one level, although, in some cases, the confusion created by the artificial links between the nodes can be a disadvantage.

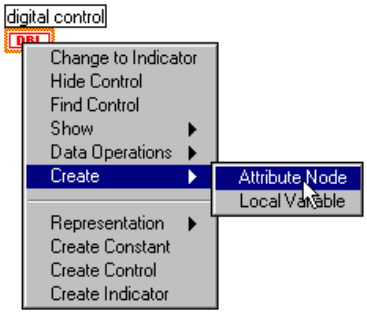
You can open the `Timing Template (data dep).vi` from `G Examples\General\structs.llb` to see how the `Timing Template` has been altered to use artificial data dependency rather than a sequence structure.

13

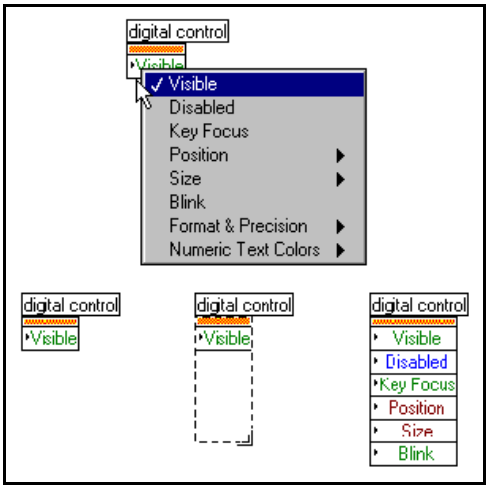
Front Panel Object Attributes

This chapter describes objects called attribute nodes, which are special block diagram nodes that control the appearance and functional characteristics of controls and indicators.

With attribute nodes, you can set attributes such as display colors, visibility, position, blinking, trend scales, and many more. To create an attribute node, select **Create»Attribute Node** from the pop-up menu of the front panel object or from the terminal in the block diagram, as shown in the following illustration.



Initially, the attribute node displays a single characteristic. You can expand the node to display multiple characteristics. To expand the node, select the attribute node with the Positioning tool. Place your cursor over the node near the bottom-right corner, and when your cursor changes to a frame drag it to create the desired number of characteristics. Then you can change attributes by clicking the node with the Operating tool and choosing the new attribute from the pop-up menu, as shown in the following illustration.



Because there are many different attributes for front panel objects, you can use the Help window to display the descriptions, data types, and acceptable values of attributes. Access the Help window by selecting **Help»Show Help**.

For more information about accessing help in BridgeVIEW, see the section *How Do You Access Online Help?* in Chapter 2, *BridgeVIEW Environment*, of this manual.

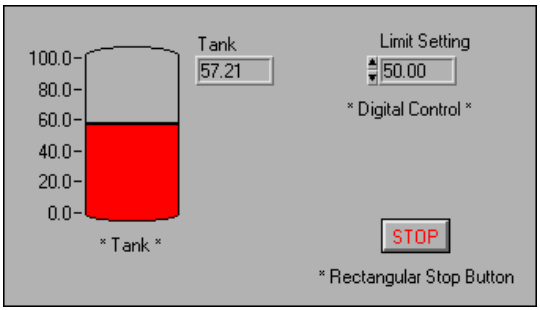
With attribute nodes, you can assign characteristics or read the current state of an attribute by popping up on the attribute and selecting **Change to Read**.

Activity 13-1. Use an Attribute Node

Your objective is to create a VI that indicates a high limit condition using attribute nodes. You will use the* Fill Color *attribute of a* `Tank indicator` *to indicate whether a randomly generated tank level has gone above the user-defined limit.

Front Panel

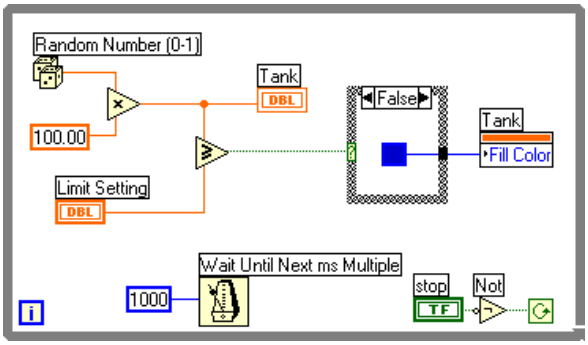
1. Open a new front panel and create it as shown in the following illustration.



2. Rescale the tank from `0.0` to `100.0`.
3. Set the default **Limit Setting** to `50.00`.

Block Diagram

4. Create the block diagram as shown below.



Not function (**Functions»Boolean**)—In this exercise, the Not function inverts the value of the **STOP** button so that the While Loop executes repeatedly until you click the **STOP** button. (The default state of the button is FALSE.)

Random Number Generator (**Functions»Numeric**)—Generates raw data between 0 and 1 to fill the tank on your front panel. You multiply this value by 100 to create a value between 0 and 100.

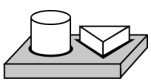
Greater or Equal? (**Functions»Comparison**)—Compares the raw data to the **Limit Setting** input. If the value is greater than or equal to the limit input, a TRUE value is passed to the Case Structure.

Attribute Node (Pop up on the Tank terminal)—Select **Create» Attribute Node** from the Tank terminal. Pop up on the attribute and choose **Select»Fill Color**.

Color Box Constant (**Functions»Numeric»Additional Numeric Constants**)—Wire this constant to define a red color to **Fill Color** in the TRUE case and a blue color in the FALSE Case. Click on the constant with the Operating tool to select the color.

Wait Until Next ms Multiple (**Functions»Time & Dialog**)—Wire a numeric constant of 1000 to execute the loop every second.

5. Run the VI. The level of the tank is compared to the **Limit Setting** control. If the tank value is greater than or equal to the **Limit Setting** value, the tank turns red. If the data falls below the limit, the tank turns blue.
6. Save the VI as `Tank Limit.vi` in the BridgeVIEW\`Activity` directory.



End of Activity 13-1.

14

Arrays, Clusters, and Graphs

This chapter introduces the basic concepts of polymorphism, arrays, clusters, and graphs and provides activities that explain auto-indexing and the Graph and Analysis VIs.

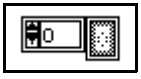
Arrays

An array is a collection of data elements that are all the same type. An array has one or more dimensions and up to $2^{31} - 1$ elements per dimension, memory permitting. You access each array element through its index. The index is in the range 0 to $n - 1$, where n is the number of elements in the array. The following 1D array of numeric values illustrates this structure. Notice that the first element has index 0, the second element has index 1, and so on.

index	0	1	2	3	4	5	6	7	8	9
10-element array	1.2	3.2	8.2	8.0	4.8	5.1	6.0	1.0	2.5	1.7

How Do You Create and Initialize Arrays?

If you need an array as a source of data in your block diagram, you can choose **Functions»Array** and then select and place the array shell on your block diagram. Using the Operating tool, you can choose a numeric constant, Boolean constant, or string constant to place inside the empty array. The following illustration shows an example array shell with a numeric constant inserted into the array shell.

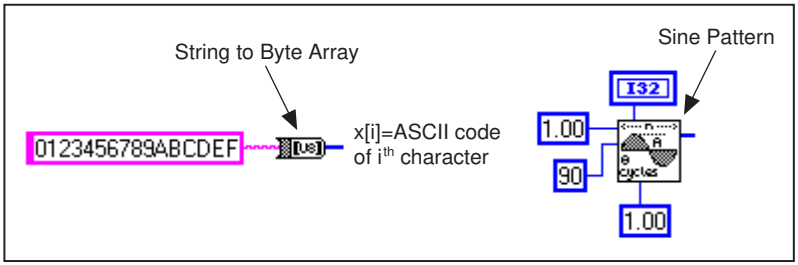


To create an array on the front panel, select **Array & Cluster** from the **Controls** palette and place the array shell on your front panel. Then select an object (numeric, for example) and place that inside the array shell. This creates an array of numerics.

Note ***You also can create an array and its corresponding control on the front panel and then copy or drag the array control to the block diagram to create a corresponding constant.***

For more information on how to create array controls and indicators on the front panel, see Chapter 14, *Array and Cluster Controls and Indicators*, in the *G Programming Reference Manual*.

There are several ways to create and initialize arrays on the block diagram. Some block diagram functions also produce arrays, as the following illustration shows.



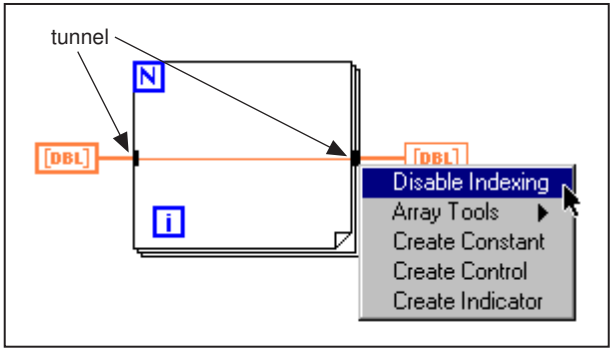
Array Controls, Constants, and Indicators

You create array controls, constants, and indicators on the front panel or block diagram by combining an array shell with a numeric, Boolean, string, or cluster. An array element cannot be another array, chart, or graph. For examples of arrays, see `G Examples\Examples\General\arrays.llb`.

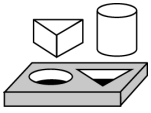
Auto-Indexing

For Loop and While Loop structures can index and accumulate arrays at their boundaries automatically. These capabilities collectively are called *auto-indexing*. When you enable auto-indexing and wire an array of any dimension from an external node to an input tunnel on the loop border, components of that array enter the loop, one at a time, starting with the first component. The loop indexes scalar elements from 1D arrays, 1D arrays from 2D arrays, and so on. The opposite action occurs at output tunnels—elements accumulate sequentially into 1D arrays, 1D arrays accumulate into 2D arrays, and so on.

Note ***Auto-indexing is the default for every array wired to a For Loop. You can disable auto-indexing by popping up on the tunnel (entry point of the input array) and selecting*** **Disable Indexing.**



By default, auto-indexing is disabled for every array wired to a While Loop. Pop up on the array tunnel of a While Loop to enable auto-indexing.



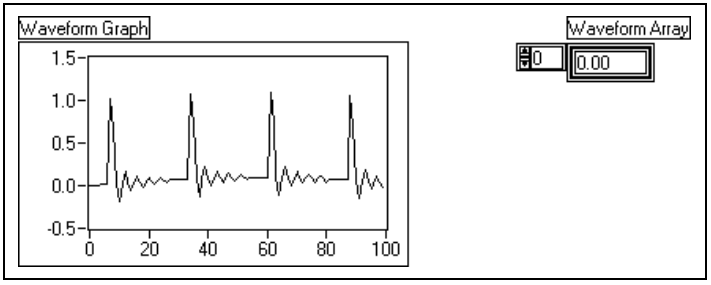
Activity 14-1. Create an Array with Auto-Indexing

Your objective is to create an array using the auto-indexing feature of a For Loop and plot the array in a waveform graph.

You will build a VI that generates an array using the Generate Waveform VI and plots the array in a waveform graph. You also will modify the VI to graph multiple plots.

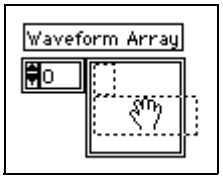
Front Panel

1. Open a new front panel.



2. Place an array shell from **Controls»Array & Cluster** in the front panel. Label the array shell `Waveform Array`.

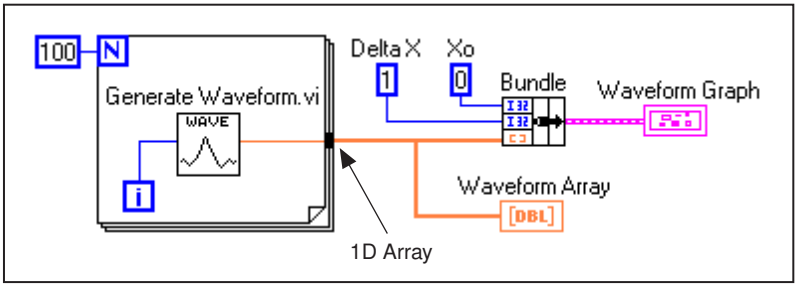
3. Place a digital indicator from **Controls»Numeric** inside the element display of the array shell, as the following illustration shows. This indicator displays the array contents.



4. Place a waveform graph from **Controls»Graph** in the front panel. Label the graph `Waveform Graph`.
5. Enlarge the graph by dragging a corner with the Resizing cursor.
6. Hide the legend and palette.
7. Disable autoscaling by popping up on the graph and deselecting **Y Scale»Autoscale Y**.
8. Use the Text tool to rescale the Y axis to range from `-0.5` to `1.5`.

Block Diagram

9. Build the block diagram shown in the following illustration.



Generate Waveform VI (**Functions»Select a VI…** from the `BridgeVIEW\Activity` directory)—Returns one point of a waveform. The VI requires a scalar index input, so wire the loop iteration terminal to this input.

Notice that the wire from the Generate Waveform VI becomes thicker as it changes to an array at the loop border.

The For Loop automatically accumulates the arrays at its boundary. This is called auto-indexing. In this case, the numeric constant wired to the loop count numeric input has the For Loop create a 100-element array (indexed 0 to 99).

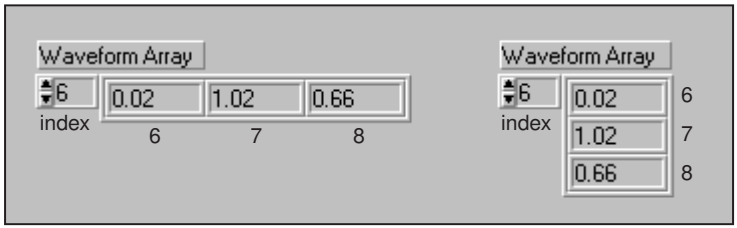
Bundle function (**Functions»Cluster**)—Assembles the plot components into a cluster. You need to resize the Bundle function icon before you can wire it properly. Place the Positioning tool on the lower-left corner of the icon. The tool transforms into the Resizing cursor shown at left. When the tool changes, click and drag down until a third input terminal appears. Now, you can continue wiring your block diagram as shown in the previous illustration.

Numeric Constant (**Functions»Numeric**)—Three numeric constants set the number of For Loop iterations, the initial X value, and the delta X value. Notice that you can pop up on the For Loop count terminal, shown at left, and select Create Constant to add and wire a numeric constant for that terminal automatically.

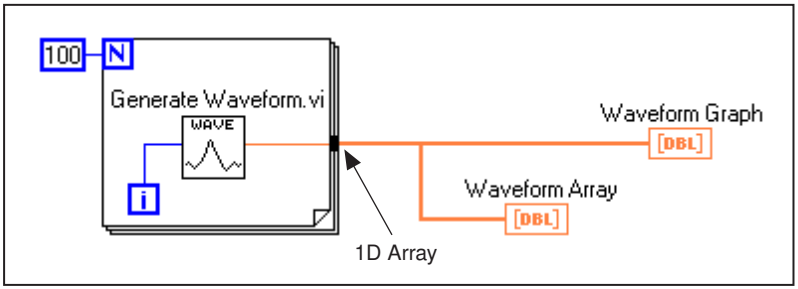
10. From the front panel, run the VI. The VI plots the auto-indexed waveform array on the waveform graph. The initial *X* value is 0 and the delta *X* value is 1.
11. Change the delta *X* value to 0.5 and the initial *X* value to 20. Run the VI again.

    Notice that the graph now displays the same 100 points of data with a starting value of 20 and a delta *X* of 0.5 for each point (see the X axis). In a timed test, this graph might correspond to 50 seconds worth of data starting at 20 seconds.
12. You can view any element in the waveform array by entering the index of that element in the index display. If you enter a number greater than the array size, the display dims, indicating that you do not have a defined element for that index.

If you want to view more than one element at a time, you can resize the array indicator. Place the Positioning tool on the lower right corner of the array. The tool transforms into the array Resizing cursor shown at left. When the tool changes, drag to the right or straight down. The array now displays several elements in ascending index order, beginning with the element corresponding to the specified index, as the following illustration shows.



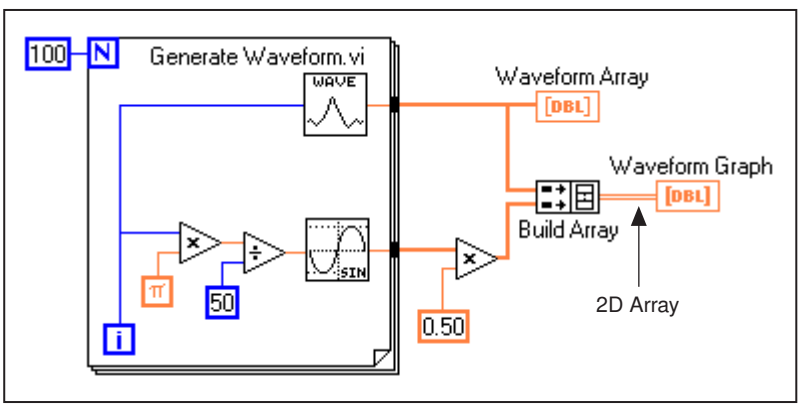
In the previous block diagram, you specified an initial *X* and a delta *X* value for the waveform. The default initial *X* value is zero and the delta *X* value is 1. So, you can wire the waveform array directly to the waveform graph terminal without the initial *X* and delta *X* specified, as the following illustration shows.



13. Return to the block diagram. Delete the Bundle function and the numeric constants wired to it. To delete the function and constants, select the function and constants with the Positioning tool then press <Delete>. Select **Edit»Remove Bad Wires**. Finish wiring the block diagram as shown in the previous illustration.
14. Run the VI. Notice that the VI plots the waveform with an initial *X* value of 0 and a delta *X* value of 1.

Multiplot Graphs

You can create multiplot waveform graphs by building an array of the data type normally passed to a single-plot graph.



15. Continue building your block diagram as shown in the preceding block diagram.

Sine function (**Functions»Numeric»Trigonometric**)—In this activity, you use the function in a For Loop to build an array of points that represents one cycle of a sine wave.

Build Array function (**Functions»Array**)—In this exercise, you use this function to create the proper data structure to plot two arrays on a waveform graph, which in this case is a 2D array. Enlarge the Build Array function to create two inputs by dragging a corner with the Positioning tool.

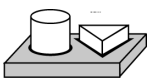
Pi constant (**Functions»Numeric»Additional Numeric Constants**)—Remember that you can find the Multiply and Divide functions in **Functions»Numeric**.

16. Switch to the front panel. Run the VI.

    Notice that the two waveforms plot on the same waveform graph. The initial *X* value defaults to 0 and the delta *X* value defaults to 1 for both data sets.

Note ***You can change the appearance of a plot on the graph by popping up in the legend for a particular plot. For example, you can change from a line graph to a bar graph by choosing*** **Common Plots»Bar Graph.**

17. Save the VI as `Graph Waveform Arrays.vi` in the `BridgeVIEW\Activity directory`.



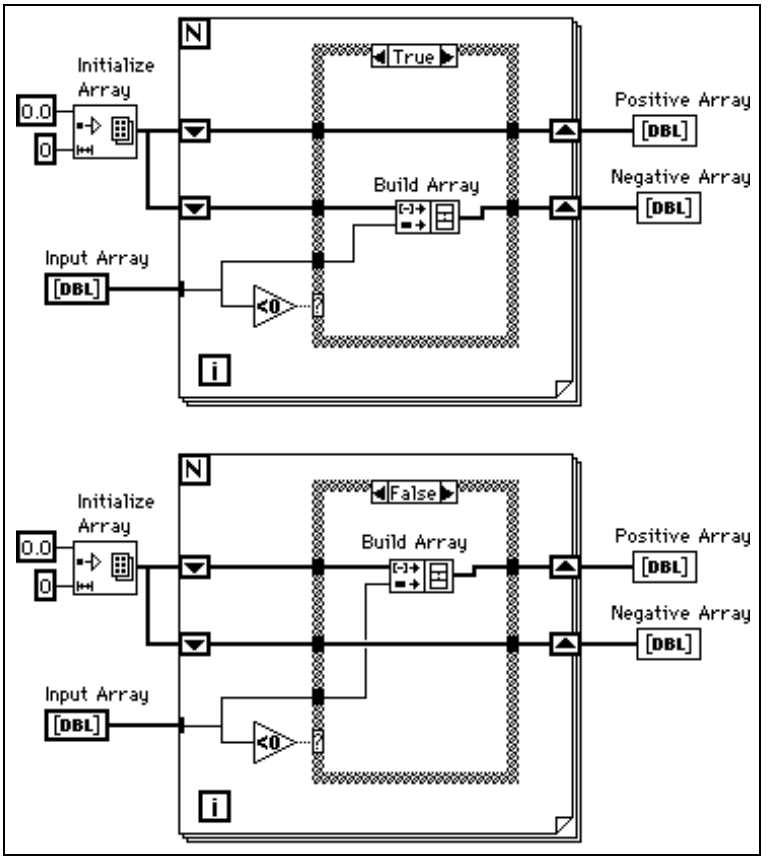
End of Activity 14-1.

In the previous example, the For Loop executed 100 times because a constant of `100` was wired to the count terminal. The following activity illustrates another means of determining how many times a loop will execute.

Activity 14-2. Use Auto-Indexing on Input Arrays

Your objective is to open and operate a VI that uses auto-indexing in a For Loop to process an array.

1. Open the Separate Array Values VI by selecting **File»Open…**. The VI is located in `Examples\G Examples\General\arrays.llb`.
2. Open the block diagram. The following illustration shows the block diagram with both TRUE and FALSE cases visible.

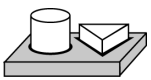


Notice that the wire from `Input Array` changes from a thick wire outside the For Loop, indicating it is an array, to a thin wire inside the loop, indicating it is a single element. The i^{th} element of the array is indexed automatically from the array during each iteration.

Using Auto-Indexing to Set the For Loop Count

Notice that the count terminal is left unwired. When you use auto-indexing on an array entering a For Loop, the loop executes according to the size of the array, eliminating the need to wire a value to the count terminal. If you use auto-indexing for more than one array, or if you set the count in addition to auto-indexing an array, the actual number of iterations is the smallest number possible.

3. Run the VI. Of the eight input values, you will see four in the Positive Array and four in the Negative Array.
4. From the block diagram, wire a constant of 5 to the count terminal of the For Loop. Run the VI. You will see three values in the Positive Array and two in the Negative Array, even though the input array still has eight elements. This demonstrates that if N is set and you are auto-indexing, the smaller number is used for the actual number of iterations of the loop.
5. Close the VI and do not save changes.

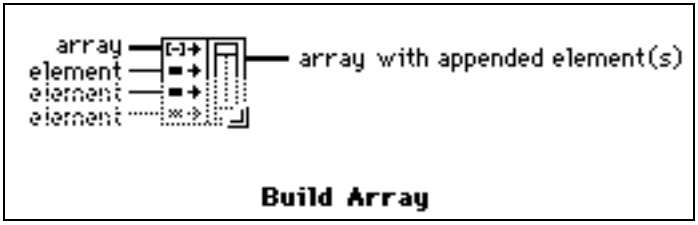


End of Activity 14-2.

Using Array Functions

G has many functions to manipulate arrays located in **Functions»Array**. These functions include Replace Array Element, Search 1D Array, Sort 1D Array, Reverse 1D Array, and Multiply Array Elements. For more information about arrays and the array functions available, refer to Chapter 14, *Array and Cluster Controls and Indicators,* in the *G Programming Reference Manual* or **Online Reference»Function and VI Reference**.

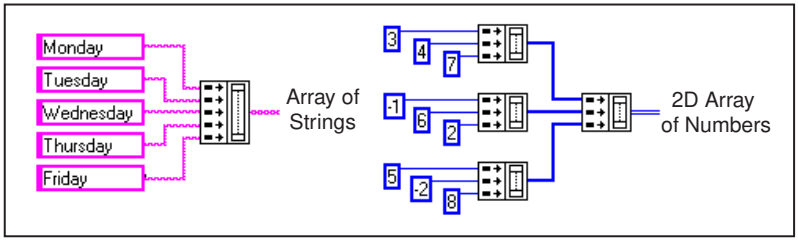
Build Array



Build Array function (**Functions»Array**)—You can use it to create an array from scalar values or from other arrays. Initially, the Build Array function appears with one scalar input.

You can add as many inputs as you need to the Build Array function, and each input can be either a scalar or an array. To add more inputs, pop up on the left side of the function and select **Add Element Input** or **Add Array Input**. You also can enlarge the Build Array node with the Resizing cursor (place the Positioning tool at the corner of an object to transform it into the Resizing cursor). You can remove inputs by shrinking the node with the Resizing cursor, or by selecting **Remove Input**.

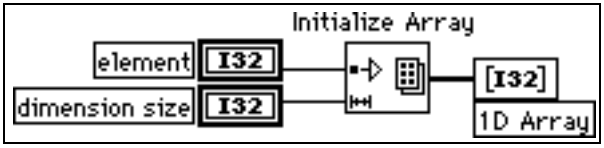
The following illustration shows two ways to create and initialize arrays with values from block diagram constants. On the left, five string constants are built into a 1D array of strings. On the right, three groups of numeric constants are built into three, 1D numeric arrays. Then, the three arrays are combined into a 2D numeric array. The result is a 3 x 3 array with the rows 3, 4, 7; –1, 6, 2; and 5, –2, 8.



You also can create an array by combining other arrays along with scalar elements. For example, suppose you have two arrays and three scalar elements that you want to combine into a new array with the order array 1, scalar 1, scalar 2, array 2, and scalar 3.

Initialize Array

Use this function to create an array whose elements all have the same value. In the following illustration, this function creates a 1D array.

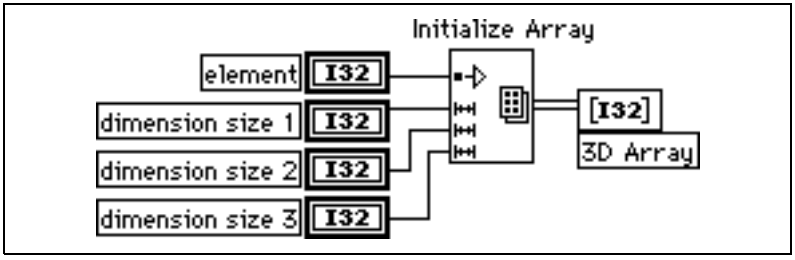


The element input determines the data type and the value of each element. The dimension size input determines the length of the array. For example,

if `element` is a long integer with the value of five and `dimension size` has a value of 100, the result is a 1D array of 100 long integers all set to five. You can wire the inputs from front panel control terminals, as shown in the preceding illustration, from block diagram constants, or from calculations on other parts of your diagram.

To create and initialize an array that has more than one dimension, pop up on the lower-left side of the function and select **Add Dimension**. You also can use the Resizing cursor to enlarge the Initialize Array node and add more dimension size inputs, one for each additional dimension. You can remove dimensions by shrinking the node by selecting Remove Dimension from the function pop-up menu or with the Resizing cursor.

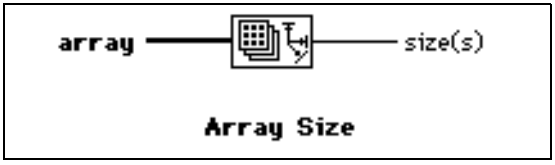
The following block diagram shows how to initialize a 3D array.

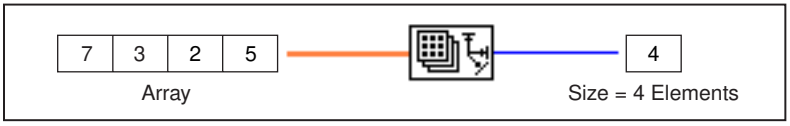


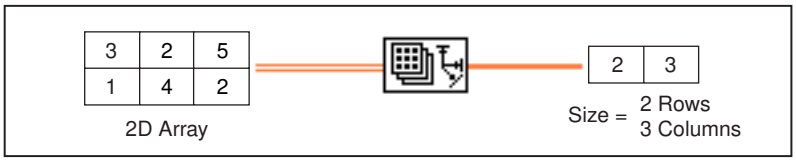
If all the dimension size inputs are zero, the function creates an empty array of the specified type and dimension.

Array Size

Array Size returns the number of elements in the input array.

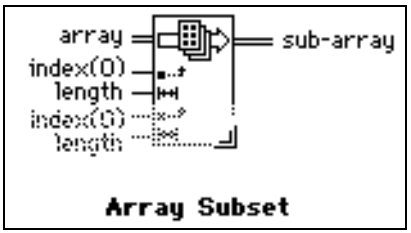




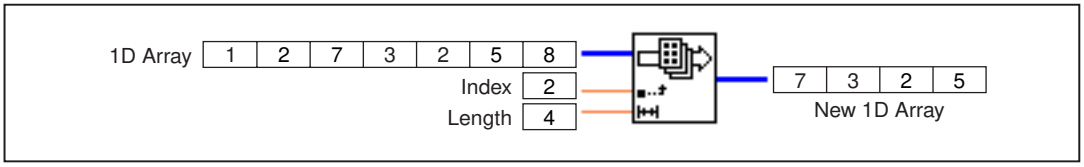


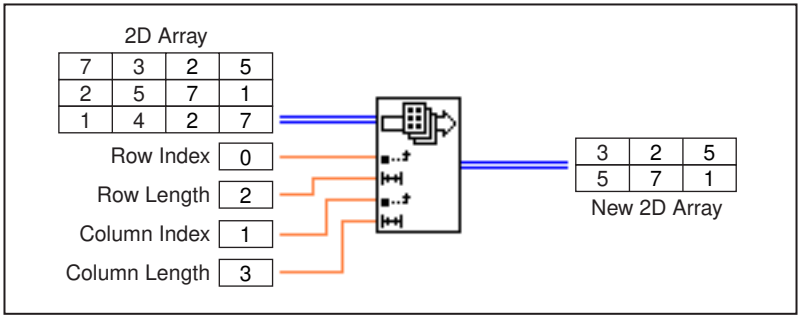
Array Subset

You can use this function to extract a portion of an array or matrix.



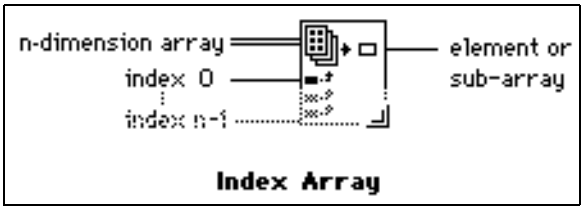
Array Subset returns a portion of an array starting at index and containing length elements. The following illustrations show examples of Array Subsets. Notice that the array index begins with 0.



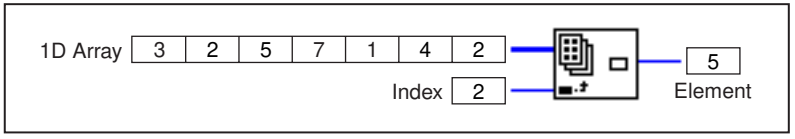


Index Array

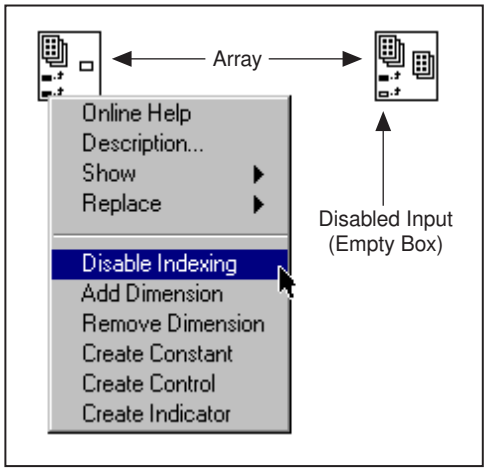
The Index Array function accesses an element of an array.



The following illustration shows an example of an Index Array function accessing the third element of an array. Notice that the index of the third element is 2 because the first element has index 0.

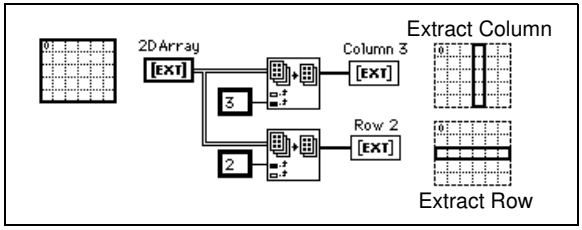


You also can use this function to slice off one or more dimensions of a multi-dimensional array to create a subarray of the original. To do this, stretch the Index Array function to include two index inputs, and select the **Disable Indexing** command on the pop-up menu of the second index terminal as shown in the following illustration. Now you have disabled the access to a specific array column. By giving it a row index, the result is an array whose elements are the elements of the specified row of the 2D array. You also can disable indexing on the row terminal.

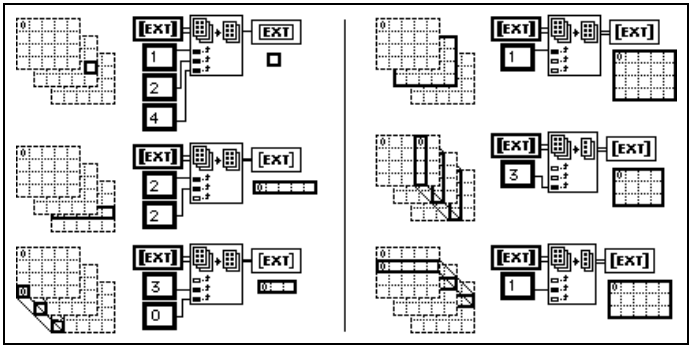


Notice that the index terminal symbol changes from a solid to an empty box when you disable indexing. To restore a disabled index, use the **Enable Indexing** command from the same menu.

You can extract subarrays along any combination of dimensions. The following illustration shows how to extract a 1D row or column arrays from a 2D array.



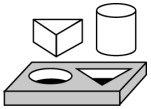
From a 3D array, you can extract a 2D array by disabling two index terminals, or a 1D array by disabling a single index terminal. The following figure shows several ways to slice a 3D array.



The following rules govern the use of the Index Array function to slice arrays:

- The dimension of the output object must equal the number of disabled index terminals. For example:
  - Zero disabled = scalar element
  - One disabled = 1D component
  - Two disabled = 2D component
- The values wired to enabled terminals must identify the output elements.

Thus, you can interpret the lower left preceding example as a command to generate a 1D array of all elements at column 0 and row 3. You can interpret the upper right example as a command to generate a 2D array of page 1. The new, 0th element is the one closest to the original, as shown in the preceding illustration.

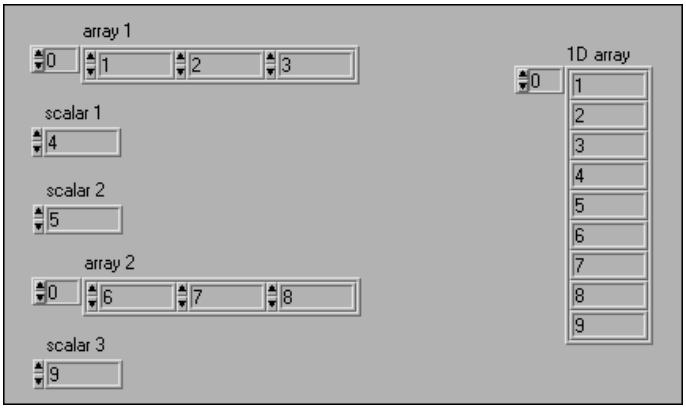


Activity 14-3. Use the Build Array Function

Your objective is to use the Build Array function to combine elements and arrays into one bigger array.

Front Panel

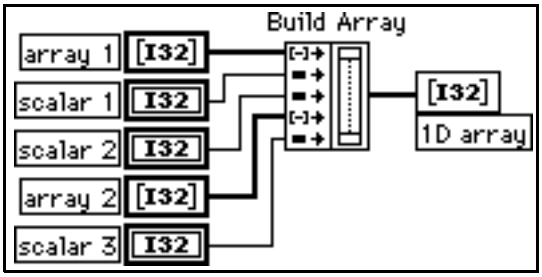
1. Create a new front panel, as shown in the following illustration.



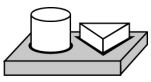
2. Place a digital control from the **Controls»Numeric** palette and label it `scalar 1`. Change its representation to `I32`.
3. Copy and paste it to create two other digital controls and label them `scalar 2` and `scalar 3`.
4. Create an array of digital controls and label it `array 1`. Copy and paste it and label it `array 2`.
5. Expand the arrays and enter the values 1 through 9 in `array 1`, `scalar 1`, `scalar 2`, `array 2`, and `scalar 3`, as shown in the illustration above.
6. Copy the array and paste it and change it to an indicator. Label it `1D array`. Expand it to show nine values.

Block Diagram

7. Place a Build Array function (**Functions»Array**) on the block diagram. Expand it with the Positioning tool to have five inputs.
8. Pop up on the first input in the Build Array node and select **Change to Array**. Do the same for the fourth input.
9. Wire the arrays and scalars to the node. The output array is a 1D array composed of the elements of `array 1` followed by `scalar 1`, `scalar 2`, and the elements of `array 2` and `scalar 3`, as the following illustration shows.



10. Run the VI. You can see the values in `scalar 1`, `scalar 2`, `scalar 3`, `array 1`, and `array 2` appear in a single 1D array.
11. Save the VI as `Build Array.vi` in the `BridgeVIEW\Activity` directory.



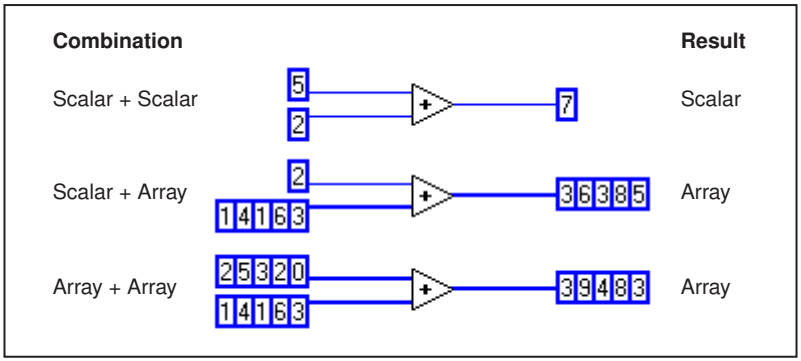
End of Activity 14-3.

Efficient Memory Usage: Minimizing Data Copies

To save memory, you can use single-precision arrays instead of double-precision arrays. For information about how memory is allocated, see the section *Monitoring Memory Usage* in Chapter 28*, Performance Issues,* in the *G Programming Reference Manual.*

What is Polymorphism?

Polymorphism is the ability of a function to adjust to input data of different types, dimensions, or representations. Most G functions are polymorphic. For example, the following illustrations show some of the polymorphic combinations of the Add function.



In the first combination, the two scalars are added together, and the result is a scalar. In the second combination, the scalar is added to each element of the array, and the result is an array. An array is a collection of data. In the third combination, each element of one array is added to the corresponding element of the other array. You also can use other combinations, such as clusters of numerics or arrays of clusters.

You can apply these principles to other G functions and data types. G functions are polymorphic to different degrees. Some functions might accept numeric and Boolean inputs, others might accept a combination of any other data types. For more information about polymorphism, see **Online Reference»Function and VI Reference**.

Clusters

A cluster is a data type that can contain data elements of different types. The cluster in the block diagram that you will build in Activity 14-4 groups related data elements from multiple places on the block diagram, reducing wire clutter. When you use clusters, your subVIs require fewer connection terminals. A cluster is analogous to a record in Pascal or a struct in C. You can think of a cluster as a bundle of wires, much like a telephone cable. Each wire in the cable would represent a different element of the cluster. The components include the initial *X* value (0), the delta *X* value (1), and the Y array (waveform data, provided by the numeric constants on the

block diagram). In G, use the Bundle function to assemble a cluster. For more information about Clusters refer to Chapter 14, *Array and Cluster Controls and Indicators*, in the *G Programming Reference Manual*.

Graphs

A *graph* is a two-dimensional display of one or more data arrays called plots. There are three types of graphs in the **Controls»Graph** palette:

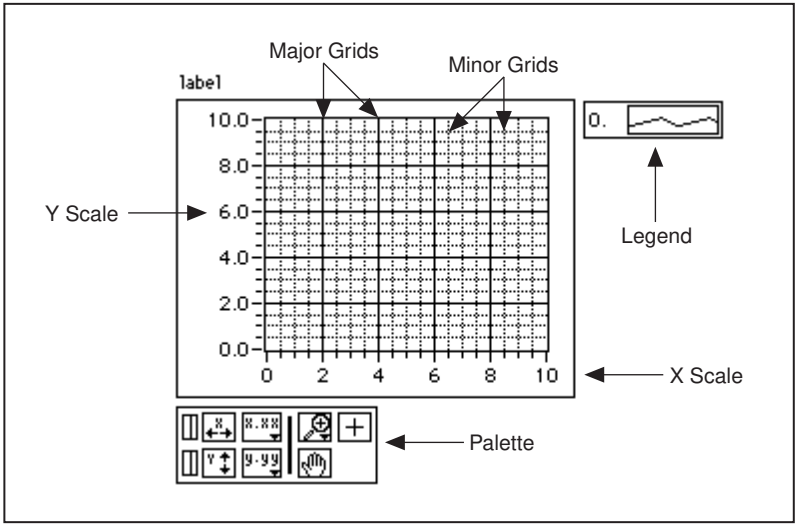
- XY graph
- Waveform graph
- Intensity graph

This palette also contains the Historical Trend, which is an XY Graph specifically configured for displaying logged data in BridgeVIEW. The difference between a graph and a chart (discussed in Chapter 10, *Loops and Charts*, in this manual) is that a graph plots data as a block, whereas a chart plots data point by point, or array by array.

For examples of graph VIs, see `Examples\G Examples\General\Graphs`.

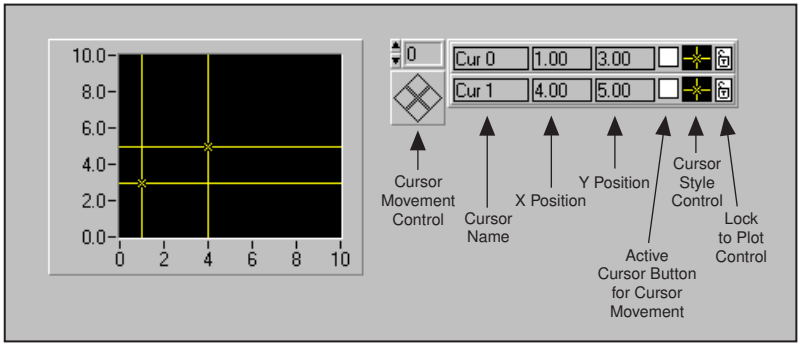
Customizing Graphs

Both waveform and XY graphs have a number of optional parts that you can show or hide using the **Show** submenu of the pop-up menu for the graph. The options include a legend, through which you can define the color and style for a given plot, a palette from which you can change scaling and format options while the VI is running, and a cursor display. The following illustration of a graph shows all of the optional components except for the cursor display.



Graph Cursors

You can place cursors and a cursor display on all the graphs in G, and you can label the cursor on the plot. You can set a cursor to lock onto a plot, and you can move multiple cursors at the same time. There is no limit to the number of cursors a graph can have. The following illustration shows a waveform graph with the cursor display.



For more detailed information on customizing graphs, see Chapter 15, *Graph and Chart Controls and Indicators*, in the *G Programming Reference Manual*.

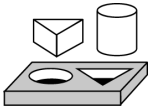
Refer to the ZoomGraph VI in `Examples\G Examples\General\Graphs\zoom.llb` for an example that reads cursor values and programmatically zooms in and out of a graph using the cursors.

Graph Axes

You can format the scales of a graph to represent either absolute or relative time. Use absolute time format to display the time, date, or both for your scale. If you do not want G to assume a date, use relative time format. To select absolute or relative time format, pop up on the chart and select the scale you want to modify. Select **Formatting…**. This enables the **Formatting** dialog box, which you can use to specify different attributes of the chart.

Data Acquisition Arrays

Data returned from a plug-in data acquisition board using the Data Acquisition VIs can be in the form of a single value, a 1D array, or a 2D array. You can find a number of graph examples located in `Examples\G Examples\General\Graphs`, which contains VIs to perform varied functions with arrays and graphs.

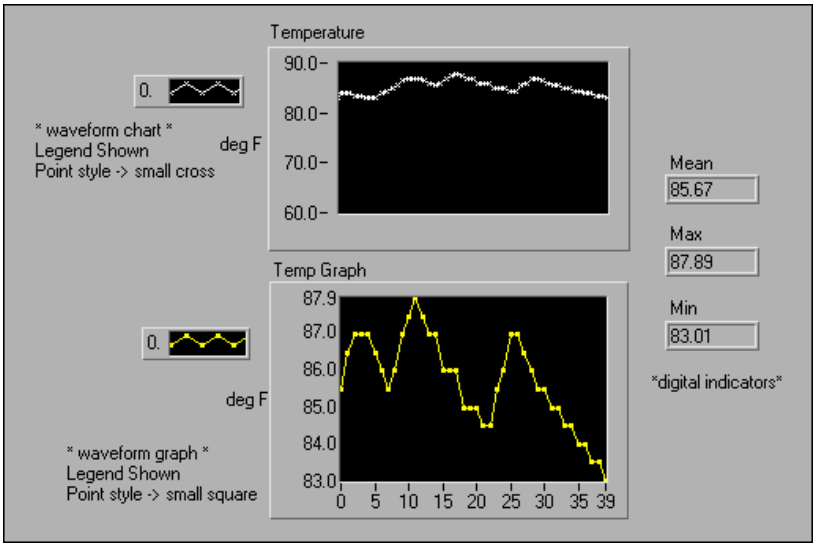


Activity 14-4. Use the Graph and Analysis VIs

Your objective is to build a VI that measures temperature and displays the values in real time. It also displays the average, maximum, and minimum temperatures.

Front Panel

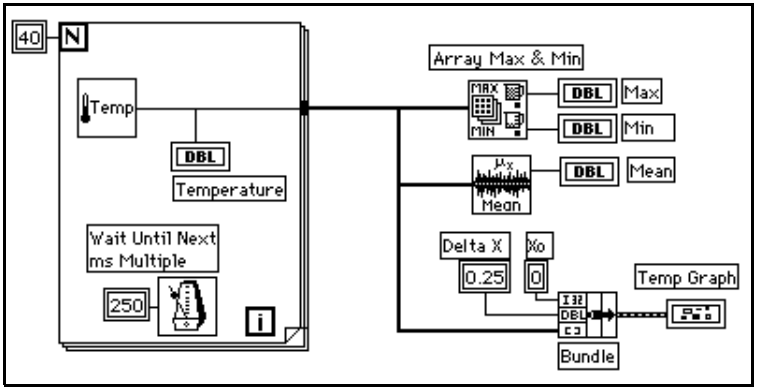
1. Create a new front panel as shown in the following illustration. You can modify the point styles of the waveform chart and waveform graph by popping up on their legends. Scale the charts as shown.



The Temperature waveform chart displays the temperature as it is acquired. After acquisition, the VI plots the data in `Temp Graph`. The `Mean`, `Max`, and `Min` digital indicators display the average, maximum, and minimum temperatures.

Block Diagram

2. Build the block diagram as shown in the following illustration:



Digital Thermometer VI (**Functions»Select a VI** from the `BridgeVIEW\Activity` directory)—Returns one temperature measurement.

Wait Until Next ms Multiple function (**Functions»Time & Dialog**)—In this exercise, this function ensures the For Loop executes every 0.25 seconds (250 ms).

Numeric constant (**Functions»Numeric**)—You also can pop up on the Wait Until Next ms Multiple function and select **Create Constant** to automatically create and wire the numeric constant.

Array Max & Min function (**Functions»Array**)—In this activity, this function returns the maximum and minimum temperature measured during the acquisition.

Mean VI (**Functions»Analysis»Probability and Statistics or Functions»Base Analysis for LabVIEW Base Package users**)—Returns the average of the temperature measurements.

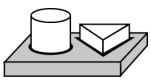
Bundle function (**Functions»Cluster**)—Assembles the plot components into a cluster. The components include the initial *X* value (0), the delta *X* value (0.25), and the Y array (temperature data). Use the Positioning tool to resize the function by dragging one of the corners.

The For Loop executes 40 times. The Wait Until Next ms Multiple function causes each iteration to take place every 250 ms. The VI stores the temperature measurements in an array created at the For Loop border (auto-indexing). After the For Loop completes execution, the array is passed on to the subVIs and `Temp Graph`.

The Array Max&Min function returns the maximum and minimum temperature. The Mean VI returns the average of the temperature measurements.

Your completed VI bundles the data array with an initial X value of 0 and a delta X value of 0.25. The VI requires a delta X value of 0.25 so that the VI plots the temperature array points every 0.25 seconds on the waveform graph.

3. Return to the front panel and run the VI.
4. Save the VI as `Temperature Analysis.vi` in the `BridgeVIEW\Activity` directory.



End of Activity 14-4.

Intensity Plots

BridgeVIEW has two methods for displaying 3D data: the intensity chart and the intensity graph. Both intensity plots accept 2D arrays of numbers, where each number is mapped to a color. You can define the color mapping interactively, using an optional color ramp scale, or programmatically, using an attribute node for the chart. For examples using the intensity chart and graph, refer to `intgraph.llb` in the `Examples\General\Graphs` directory.

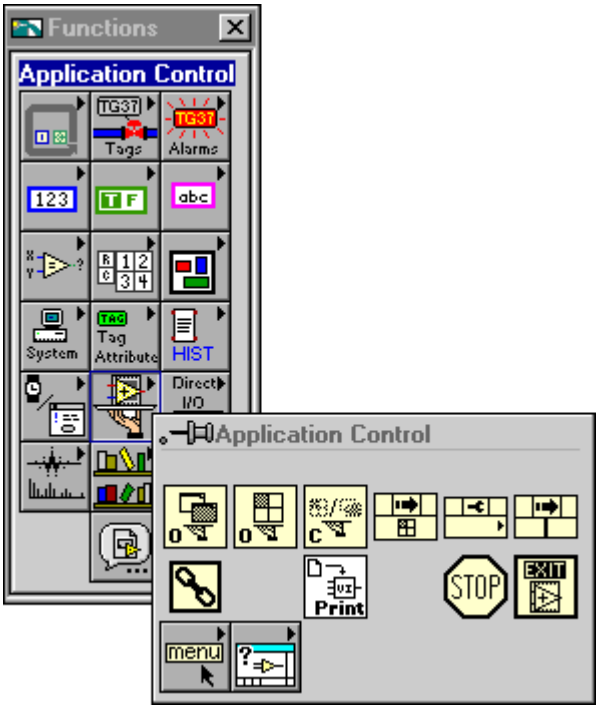
15

Application Control

This chapter introduces the VI Server and provides an activity that explains how to use it within BridgeVIEW. The VI Server allows you to control when a VI is loaded into memory, run, and unloaded from memory. The VI Server also allows you to accomplish the following dynamically:

- Control many VI properties
- Monitor the status of VI execution (running or idle)
- Monitor the status of a VI front panel (closed, open, or active)

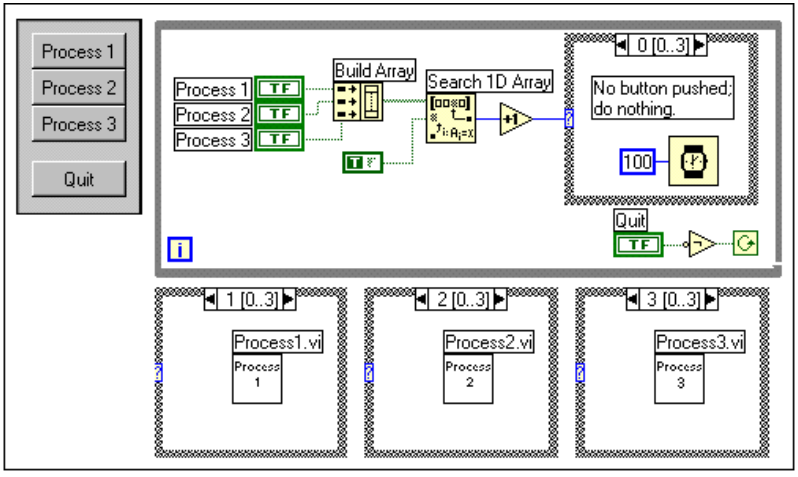
You can reach the VI Server functions through the **Functions** Palette from the Block Diagram window. The **Application Control** subpalette is shown below.



What is the VI Server?

The VI Server is a G programming mechanism that lets you programmatically control properties and the execution of VIs. You can use the VI Server to open, call, and close other VIs dynamically, and to manipulate VI properties. The VI Server is used from the Open VI Reference, Invoked Node, and Close Application or VI Reference functions in the Application Control menu. You can use the VI Server Property Node, found in **Functions»Application Control** palette, to control the opening and closing of the front panel of the called VI. You also can pass parameters to and receive data from the VIs you call dynamically. All the VI Server functions use error cluster inputs and outputs to make error handling easier. For detailed information about the Server functions, refer to the BridgeVIEW *Online Reference* by selecting **Help»Online Reference,** or by right-clicking on the VI Server function and select **Online Help**.

As you develop larger BridgeVIEW applications, you might find it inconvenient to have all of the subVIs in memory at once. For example, assume you have written a number of VIs that act as user interfaces (HMIs) for several subsystems within your process. One solution might be to have a top-level VI that has each of these subVIs in its diagram. The top-level VI serves as a menu from which you choose the subVI to run, as shown in the front panel portion of the illustration below.

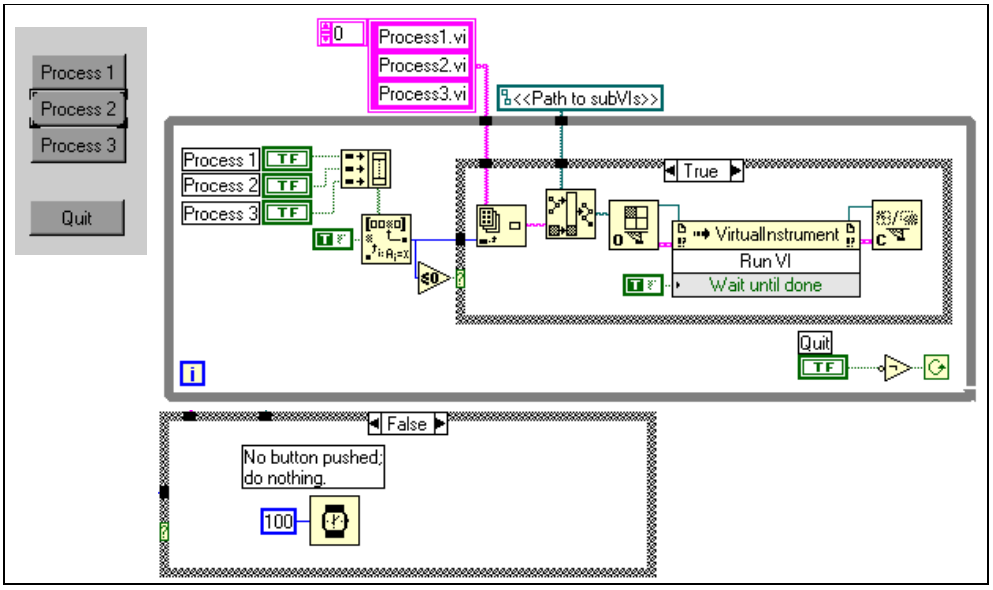


This VI contains a set of Booleans such that when the user presses a button on the front panel, the proper subVI is executed. The diagram builds an array of Booleans and checks the array for any TRUE values. The index of

the TRUE value is passed into a Case structure and each case contains the appropriate subVI, as shown in the previous illustration.

The disadvantage of the above approach is that all subVIs are in memory at all times, regardless of which ones are needed. If each subVI is large, your main menu VI might require a large amount of memory.

To avoid using so much memory, you can use the VI Server to load and execute VIs dynamically. To do this, you must know the name of the VI you want to access and its location on the computer or network. The illustration below demonstrates the same scenario described above, this time using the VI Server.



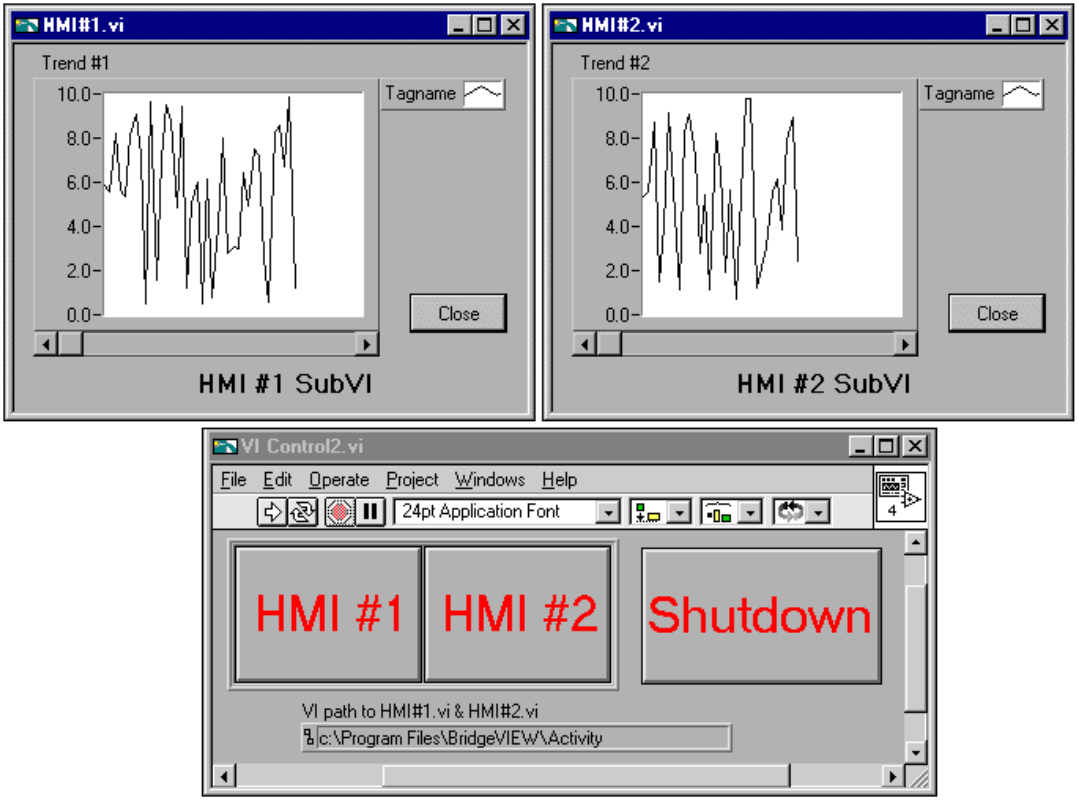
In both of the previous examples, the top-level VI stops executing until the subVI completes, which means the top-level VI stops responding to the user interface. To keep both the top-level VI and other VIs responding to the user interface at all times, you can load and run VIs dynamically as shown in Activity 15-1.

Activity 15-1. Use the VI Server

Your objective is to build a top-level VI that uses the VI Server to open, run, display, and close two other VIs. The top-level VI will load both subVIs dynamically. Then, the top-level VI will open and run the subVI chosen by the user.

Front Panel

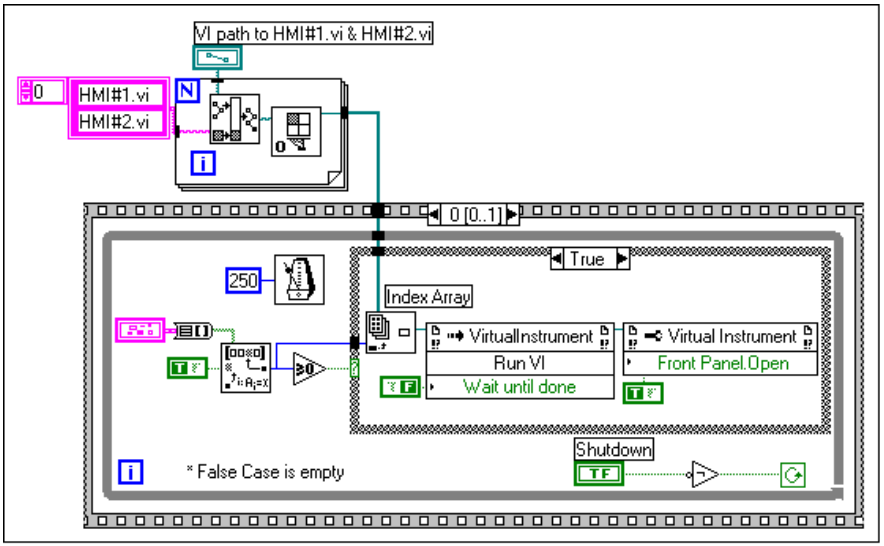
1. Open a new front panel. Place a waveform chart and label it `Trend #1`. Place a rectangular stop button and label it `Close`. Save the VI as `HMI#1.vi` in the `BridgeVIEW\Activity` directory.
2. Open a new front panel. Place a cluster with two rectangular buttons labeled `HMI#1` and `HMI#2`. Create a button and label it `Shutdown`. At the end of this exercise, you will have three front panels, which will appear as shown below.

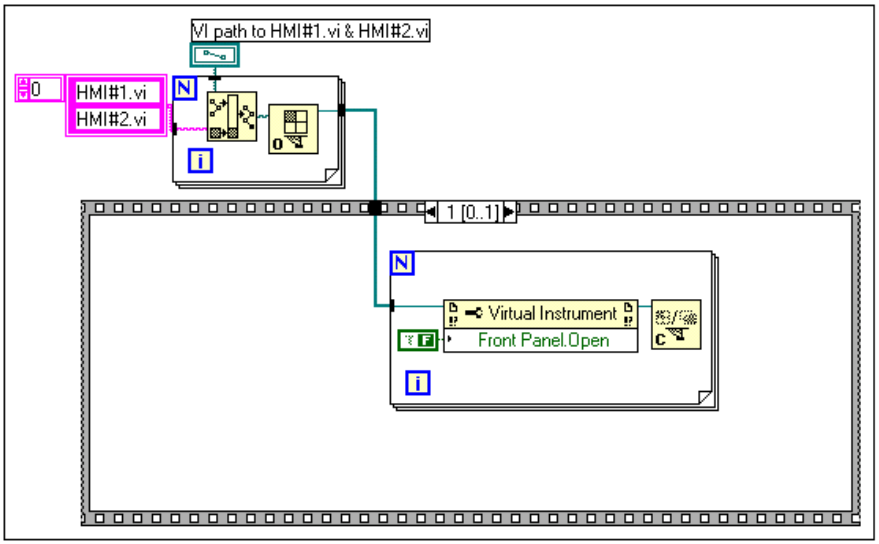


3. Save this VI as `VI Control2.vi` in the `BridgeVIEW\Activity` directory. This VI will call the HMI#1 and HMI#2 VIs.

Block Diagram

4. Build the block diagram of `VI Control2.vi`, as shown in the following illustrations.

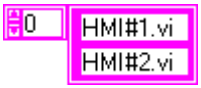




The elements of the VI are described below.

Open VI Reference (**Functions»Application Control**)—Opens the two VIs dynamically and loads them into memory.

Path Control (Right-click on the Path input of the Open VI Reference and choose **Create Control**)—Provides the path to the subVIs to be called.



Array String constant (**Functions»Array**)—Provide the name of the subVIs to be called, HMI#1.vi and HMI#2.vi.

Cluster to Array **(Functions»Cluster)**—Converts the cluster of booleans to a boolean array.

Search 1D Array (**Function»Array**)—Returns the index of the first TRUE value it finds in the Boolean array. If you did not click on a button, Search 1D array returns an index value of –1 and does nothing. If a Boolean value is pressed, it returns the index value of the respective Boolean and then runs and opens the selected subVI.

Invoke Node, Run VI method (**Functions»Application Control**)—Executes the subVI reference that is specified by the output of the Search 1D array.

Property Node, Front Panel Open Property (**Functions»Application Control**)—Displays the selected HMI subVIs front panel.

Property Node, Front Panel Open Property set to False (**Functions»Application Control)**—Uses the selected HMI subVIs front panel.

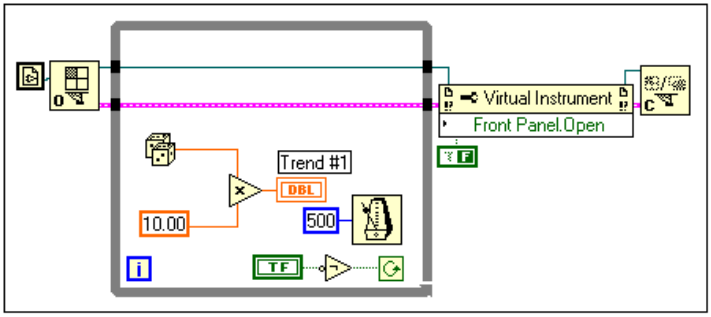
Close Application or VI Reference (**Functions»Application Control**)—Unloads the VI from memory.

Greater Than or Equal to 0 Function (**Functions»Comparison**)—Returns TRUE if the input value is greater than or equal to 0. Otherwise the function returns FALSE.

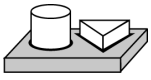
Boolean Constant (**Functions»Numeric**)—Supplies a constant TRUE or FALSE value to the Not Function, in this activity. Set this value by clicking on the **T** or **F** portion of the constant with the Operating tool. The value cannot be changed while the VI is executing.

Not Function (**Functions»Comparison**)—The node inverts the Boolean state of the While Loop.

5. Save the VI.
6. Build the block diagram of HMI#1, as shown in the following illustration.



7. Save `HMI#1.vi` Save a copy of this VI as `HMI#2.vi` in the `BridgeVIEW\Activity` directory.
8. Close `HMI#1.vi` and `HMI#2.vi`.
9. Run `VI Control2.vi`. Make sure that you have entered the correct path in the `VI path to HMI#1.vi & HMI#2.vi` section. Click on the **HMI#1** button. The front panel of `HMI#1.vi` appears. Now click on the **HMI#2** button. The front panel of `HMI#2.vi` appears.
10. Press the **Shutdown** button to close the front panels of HMI#1 and HMI#2 and stop `VI Control2.vi`.



End of Activity 15-1.

16

Program Design

Now that you are familiar with many aspects of G programming, you need to apply that knowledge to develop your own applications. This chapter suggests some techniques to use when creating programs and offers programming-style recommendations.

Use Top-Down Design

When you have a large project to manage, incorporate *top-down design*. G has an advantage over other programming languages with respect to top-down design because you can start with the final user interface then animate it.

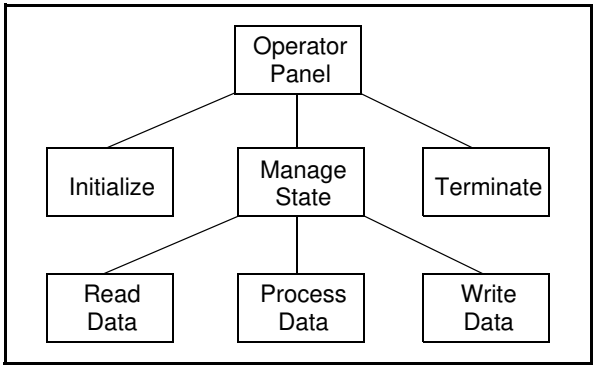
Make a List of User Requirements

Create a list of the panels with which the user can interact, the number and type of controls and indicators for these panels, the need for real-time analysis, data presentation, and so on. Next, create mock-up front panels you can show to the prospective users (or manipulate yourself, if you are the user). Think about and discuss functions and features. Use this interactive process to redesign the user interface as necessary. You might need to do some low-level research at this early stage to be certain you can meet specifications.

Design the VI Hierarchy

The power of G lies in the hierarchical nature of VIs. After you create a VI, you can use it as a subVI in the block diagram of a higher level VI. You can have an essentially unlimited number of layers in the hierarchy.

Divide the task to be accomplished into manageable, logical pieces. As the following flowchart illustrates, you can expect several major blocks in one form or another for every data acquisition system.



In some cases you might not need all these blocks or you might need different blocks. For example, some applications might include monitoring only, thus, you would not need to write data to the Real-Time Database. Alternatively, you might need additional blocks, such as blocks representing user prompts. Your main objective is to divide your programming task into high-level blocks that you can manage easily.

After you determine the high-level blocks you need, try to create a block diagram that uses those high-level blocks. For each block, create a new *stub VI* (a nonfunctional prototype representing a future subVI). For this stub VI, create an icon as well as a front panel that contains the necessary inputs and outputs. You do not have to create a block diagram for this VI yet. Instead, see if this stub VI is a necessary part of your top-level block diagram.

After you assemble a group of stub VIs, try to understand, in general terms, the function of each block and how each block provides the desired results. Ask yourself whether any given block generates information that a subsequent VI needs. If so, make certain that the sketch for your top-level block diagram contains wires to pass the data between VIs.

Try to avoid using unnecessary global variables because they hide the data dependency between VIs. Use memory tags only when you need this information in the Engine for historical logging or alarms. As your system gets larger, it becomes difficult to debug if you depend on global variables and memory tags as your method for transferring information between VIs.

Create the Program

Now you are ready to create the program in G:

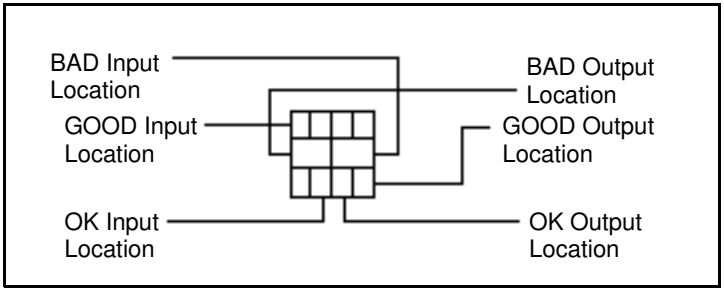
- Use a modular approach by building subVIs where you find a logical division of labor or the potential for code reuse.
- Solve your general problems along with your specific ones.
- Test your subVIs as you create them. You might need to construct higher-level test routines, but you can catch the bugs in one small module more easily than in a hierarchy of several VIs.

As you consider the details of your subVIs, you might find that your initial design is incomplete. For example, you might realize you need to transfer more information from one subVI to another. You might have to reevaluate your top-level design at this point. Using modular subVIs to accomplish specific tasks makes it easier to manage your program reorganizations.

Plan Ahead with Connector Panes

If you think that you might need to add additional inputs or outputs later on, select a connector-pane pattern with extra terminals. You can leave these extra terminals unconnected. With these extra terminals, you do not have to change the connector pane for your VI if you find you need another input or output later. This flexibility enables you to make these changes with minimal effect on your hierarchy.

When linking controls and indicators to the connector, place inputs on the left and outputs on the right. This prevents complicated, unclear wiring patterns in your VIs.

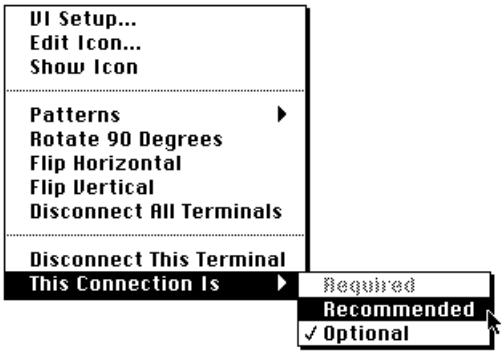


If you create a group of subVIs that are used together often, try to give the subVIs a consistent connector pane, with common inputs in the same location. You then can remember where to locate each input more easily without using the Help window. If you create a subVI that produces an

output that is used as the input to another subVI, try to align the input and output connections. This technique simplifies your wiring patterns.

SubVIs with Required Inputs

On the front panel, you can edit required inputs for subVIs by clicking the icon pane on the upper-right side of the window and choosing **Show Connector»This Connection Is**. From the submenu, choose between the **Required**, **Recommended**, or **Optional** options.
The following illustration displays the submenu options.



If you want to return to the icon pane in the front panel, pop up on the connector pane and select **Show Icon**.

Good Diagram Style

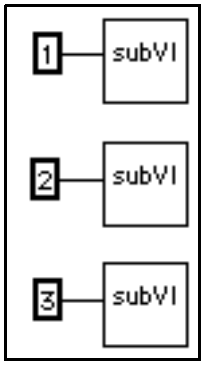
In general, avoid creating a block diagram that uses more than one or two screens of space. If a diagram becomes very large, decide whether you can reuse some components of your diagram in other VIs, or whether a section of your diagram fits together as a logical component. If so, consider dividing your diagram into subVIs.

With forethought and careful planning, it is easier to design diagrams that use subVIs to perform specific tasks. Using subVIs helps you manage changes and debug your diagrams quickly. You can determine the function of a well-structured program after only a brief examination.

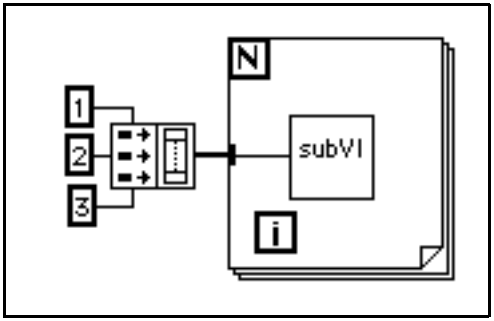
Watch for Common Operations

As you design your programs, you might find that you perform a certain operation frequently. Depending on the situation, consider using subVIs or loops to perform an action repetitively.

For example, examine the following diagram in which three similar operations run independently.



An alternative to this design is a loop, which performs the operation three times. You can build an array of the different arguments and use auto-indexing to set the correct value for each iteration of the loop.



If the array elements are constant, you can use an array constant instead of building the array on the block diagram.

Use Left-to-Right Layouts

G is designed to use a left-to-right (and sometimes top-to-bottom) layout. Organize all elements of your program in this layout when possible.

Check for Errors

When you perform any kind of I/O, consider the possibility of errors occurring. Almost all I/O functions return error information. If you use direct I/O, make sure that your program checks for errors and you handle them appropriately.

The BridgeVIEW Engine handles system events and errors reported by device servers. However, your VIs must handle any error conditions within their diagrams. For example, if a VI is unable to open a file properly, you might want the VI to halt or inform the user of the error through a dialog box. You also might want the VI to use an alternative path before alerting the user of the error. You can make these error-handling decisions in the block diagram of your VI.

The following list describes situations in which errors frequently occur:

- Incorrect initialization of communication or data that has been written to an external device improperly
- Loss of power in an external device, or a broken or improperly working external device
- Change in functionality of an application or library when upgrading operating system software

When an error occurs, you might not want certain subsequent operations to occur. For instance, if an analog output operation fails because you specify the wrong device, you might not want a subsequent analog input operation to take place.

One method for managing such a problem is to test for errors after every function and place subsequent functions inside case structures. However, this method can complicate your diagrams and ultimately hide the purpose of your application.

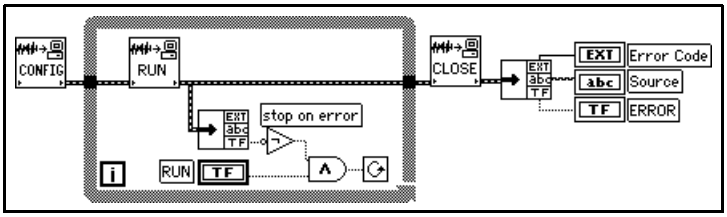
An alternative approach, which has been used successfully in a number of applications and many of the VI libraries, is to incorporate error handling in the subVIs that perform I/O. Each VI can have an error input and an error output. You can design the VI to check the error input to see if an error has occurred previously. If an error exists, you can configure the VI to do nothing and pass the error input to the error output. If no error exists, the VI can execute the operation and pass the result to the error output.

☞ **Note** ***In some cases, such as a Close operation, you might want the VI to perform the operation regardless of the error that is passed into it.***

Using the preceding technique, you can wire several VIs together, connecting error inputs and outputs to propagate errors from one VI to the next. At the end of the series of VIs, you can use the Simple Error Handler VI to display a dialog box if an error occurs. The Simple Error Handler VI is located in **Functions»Time & Dialog**. In addition to encapsulating error handling, you can use this technique to determine the order of several I/O operations.

One of the main advantages in using the error input and output clusters is that you can use them to control the execution order of dissimilar operations.

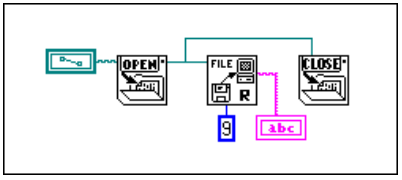
The error information generally is represented using a cluster containing a numeric error code, a string containing the name of the function that generated the error, and an error Boolean for quick testing. The following illustration shows how you can use this technique in your own applications. Notice that the While Loop stops if it detects an error.



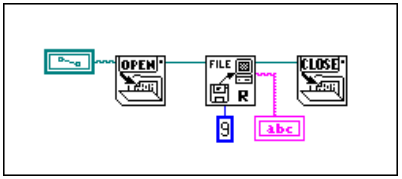
Watch Out for Missing Dependencies

Make sure that you have explicitly defined the sequence of events when necessary. Do not assume left-to-right or top-to-bottom execution when no data dependency exists.

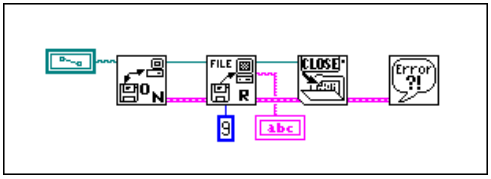
In the following example, no dependency exists between the Read File VI and the Close File VI. This program might not work as expected.



The following version of the block diagram establishes a dependency by wiring an output of the Read File VI to the Close File VI. The operation cannot end until the Close File VI receives the output of the Read File VI.



Notice that the preceding example still does not check for errors. For instance, if the file does not exist, the program does not display a warning. The following version of the block diagram illustrates one technique for handling this problem. In this example, the block diagram uses the error I/O inputs and outputs of these functions to propagate any errors to the Simple Error Handler VI.



Avoid Overuse of Sequence Structures

Because VIs can operate with a great deal of inherent parallelism, avoid using Sequence structures. Using a Sequence structure guarantees the order of execution but prohibits parallel operations. For instance, asynchronous tasks that use I/O devices (GPIB, serial ports, and data acquisition boards) can run concurrently with other operations if Sequence structures do not prevent them from doing so.

Sequence structures tend to hide parts of the program and interrupt the natural left-to-right flow of data. You do not sacrifice performance by using Sequence structures. However, when you need to sequence operations, you might consider using data flow instead. For instance, in I/O operations you might use the error I/O technique described previously to ensure that one I/O operation occurs before another.

Study the Examples

For further information about program design, you can examine the many example block diagrams included in BridgeVIEW. These sample programs provide you with insights into G programming style and technique.
To view these block diagrams, open any of the VIs in the `Examples` directory.

A

HMI Function Reference

This appendix describes error handling for BridgeVIEW VIs and contains an explanation of the VIs in the BridgeVIEW VI library. In this appendix, the VIs are arranged alphabetically, first by VI Library name (Alarms and Events, Historical Data, System, Tags, and Tag Attributes), then by VI name.

Error Handling in the BridgeVIEW VI Library

Errors that occur in the VIs in the BridgeVIEW VI Library can be handled in one of two ways: by the BridgeVIEW Engine or by each VI. The BridgeVIEW Engine handles errors for the Tags VIs and the Alarms and Events VIs. The other VIs include standard **error in** and **error out** parameters for error handling.

These two methods of error handling are described in detail below. For information about how you can handle errors in your own VIs, see the section *Check for Errors* in Chapter 16, *Program Design*.

Errors Reported by the BridgeVIEW Engine

BridgeVIEW reports error handling information for Tags VIs, Tag Attributes VIs, and Alarms and Events VIs to the system. If you try to access a tag that does not exist in the Tags VIs or the Alarms and Events VIs, the BridgeVIEW Engine reports an error. The error shows up in the BridgeVIEW Engine Manager display. For more information about the Engine Manager, see Chapter 2, *BridgeVIEW Environment*.

Errors Not Reported by the BridgeVIEW Engine

If a BridgeVIEW VI does not report to the BridgeVIEW Engine, it uses a standard control and indicator (**error in** and **error out**) to notify you that an error has occurred. The **error in** and **error out** parameters are described here.

error in (no error) is a cluster that describes the error status before this VI executes. If **error in** indicates that an error occurred before this VI was called, this VI might choose not to execute its function, but just pass the error through to its **error out** cluster. If no error has occurred, this VI executes normally and sets its own error status in **error out**. Use the error handler VIs to look up the error code and to display the corresponding error

message. Using **error in** and **error out** clusters is a convenient way to check errors and to specify execution order by wiring the error output from one subVI to the error input of the next.

status is TRUE if an error occurred before this VI was called, or FALSE if not. If **status** is TRUE, **code** is a nonzero error code. If **status** is FALSE, **code** can be 0 or a warning code.

code is the number identifying an error or warning. If **status** is TRUE, **code** is a nonzero error code. If **status** is FALSE, **code** can be 0 or a warning code. Use the error handler VIs to look up the meaning of this code and to display the corresponding error message.

source is a string that indicates the origin of the error, if any. Usually, **source** is the name of the VI in which the error occurred.

error out is a cluster that describes the error status after this VI executes. If an error occurred before this VI was called, **error out** is the same as **error in**. Otherwise, **error out** shows the error, if any, that occurred in this VI. Use the error handler VIs to look up the error code and to display the corresponding error message. Using **error in** and **error out** clusters is a convenient way to check errors and to specify execution order by wiring the error output from one subVI to the error input of the next.

status is TRUE if an error occurred, or FALSE if not. If **status** is TRUE, **code** is a nonzero error code. If **status** is FALSE, **code** can be 0 or a warning code.

code is the number identifying an error or warning. If **status** is TRUE, **code** is a nonzero error code. If **status** is FALSE, **code** can be 0 or a warning code. Use the error handler VIs to look up the meaning of this code and to display the corresponding error message.

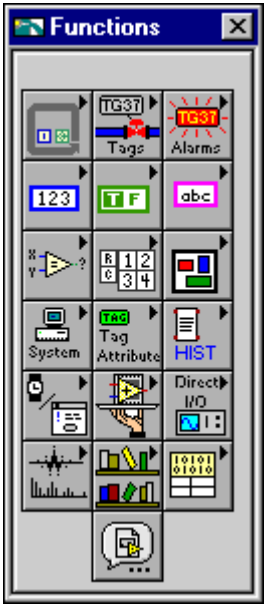
source is a string that indicates the origin of the error, if any. Usually, **source** is the name of the VI in which the error occurred.

BridgeVIEW VI Library

Many of the VIs in the BridgeVIEW VI Library are specific to BridgeVIEW, and are not part of the standard G library. These VIs include Alarms and Events VIs, Historical Data VIs, System VIs, Tags VIs, and Tag Attributes VIs. This section contains an explanation of the VIs specific to BridgeVIEW. The VIs are arranged alphabetically, first by VI palette name, then by VI name.

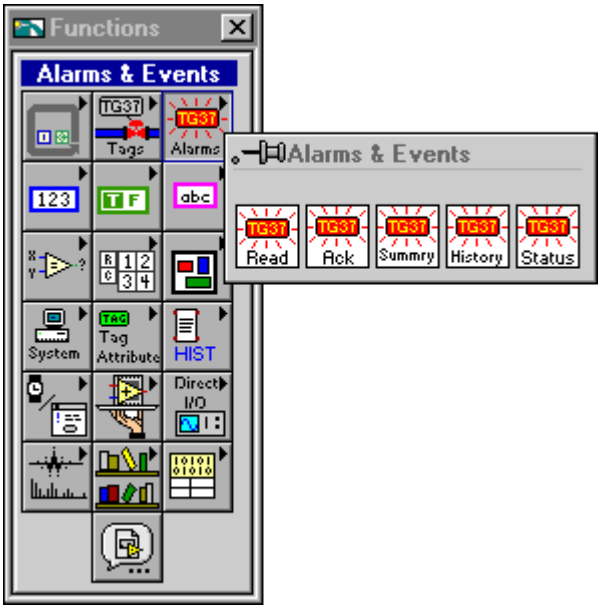
For more information about standard G VIs, refer to the BridgeVIEW *Online Reference*. Select **Help»Online Reference** and choose the topic **G Language»G Reference»G Function Reference**.

To reach the BridgeVIEW VIs, choose **Window»Show Functions Palette** from the block diagram window. The **Functions** palette is shown below.



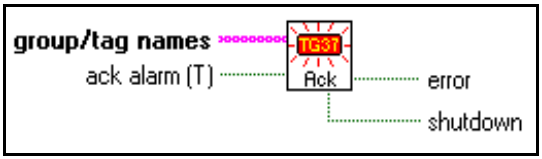
Alarms and Events VIs

Use the Alarms and Events VIs to acknowledge alarms, display alarm summary or event history information, or obtain alarm summary status information. The Alarms and Events subpalette is shown in the following illustration.



Acknowledge Alarm

Use the Acknowledge Alarm VI to acknowledge alarms on a tag or a group. Call this VI when an **Acknowledge** button is pressed in your HMI. You can call this VI multiple times from your HMI.



group/tag names is the list of tags that have alarms to be acknowledged.

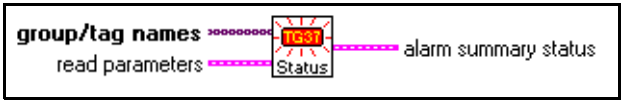
ack alarm(T) determines whether alarms on tags in **group/tag names** is acknowledged. If FALSE, this VI does nothing except return the **shutdown** status. If unwired, this input is TRUE by default. You can wire this input in your diagram so that acknowledge is called only when a front panel control is TRUE. This eliminates the need to place a case structure in your calling diagram.

error indicates that an error occurred when executing the Acknowledge Alarm VI. This is probably a result of the tag or group name not being found.

shutdown indicates that the BridgeVIEW Engine is shutting down. In this case, the Acknowledge Alarm VI returns immediately with **shutdown** TRUE. You can use **shutdown** to exit any loop that uses the Acknowledge Alarm VI.

Get Alarm Summary Status

Use the Get Alarm Summary Status VI to check the status of alarms in the BridgeVIEW system. You can call this VI multiple times from your HMI.



group/tag names determines the tags for which alarm status is to be read. Use group <ALL> to get the status of all of the tag alarms in the system.

read parameters is a cluster of parameters for filtering out the alarms for which status is checked.

- **min priority** is the minimum priority of alarms to read. If left unwired, alarms corresponding to priority level 1 and above are reported.
- **max priority** is the maximum priority of alarms to read. If left unwired, alarms corresponding to priority level 15 and below are reported.
- **filter ACK alarms?** determines whether acknowledged alarms are read.

alarm summary status contains information about the alarms currently in the BridgeVIEW system.

- **# active alarms** is the number of alarms currently in the BridgeVIEW system.
- **any alarm?** is an indication of any tag in the system that is in alarm, irrespective of its acknowledgement status.
- **# unack alarms** is the number of unacknowledged alarms in the system.
- **any unack alarm?** is an indication of any tag in the system that is in alarm and unacknowledged.

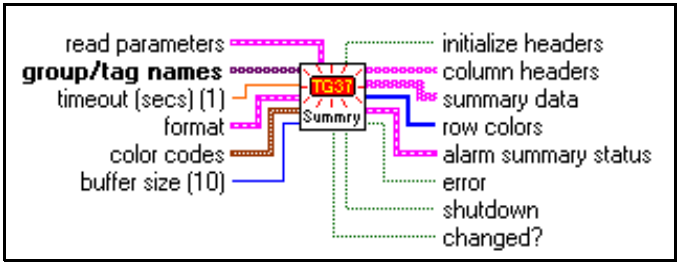
Read Alarm Summary

Use the Read Alarm Summary VI to display current alarm information for a set of tags or tag groups within a given alarm priority range. You also can filter out acknowledged alarms. This VI formats the alarm summary information for display in an Alarm Summary Display in your HMI. If you specify a **timeout** value greater than 0, this VI returns when the current alarm information changes, or the **timeout** value is exceeded, whichever occurs first. The **changed?** output alerts you as to whether the current alarm information has changed.

The **format** and **color codes** inputs determine how to format and color code summary information. The Read Alarm Summary VI returns all the information needed to update the Alarm Summary Display in your HMI. Part of the table indicator formatting is done through attribute nodes which only can exist in your diagram. The column headers display the table column header information and must be wired to your table Column Headers[] attribute if you are displaying **column headers**. This is updated when the VI is executed for the first time, or if you change the format during program operation. The **initialize headers** output is TRUE when you need to update the **column headers** attribute.

You should wire the **summary data** output directly to your Alarm Summary Display. Wire the **row colors** output to the Active Cell and Cell FG Color attributes inside of a While Loop. Wiring the Alarm Summary Display attributes like this formats the table to show different line colors for different alarm states. If you use the HMI G Wizard, this code is generated for you automatically.

The entire Alarm Summary Display, including attributes, is updated only if the current alarm information changes, and if there was no **timeout**. Table indicator updates can be slow for large tables, so it is a good idea to update the table only if **changed?** is TRUE. Notice that **changed?** is always TRUE after the first execution of the VI.



read parameters is a cluster of parameters for filtering out the alarms read.

U8

min priority is the minimum priority of alarms to read. If left unwired, alarms corresponding to priority level 1 and above are reported.

max priority is the maximum priority of alarms to read. If left unwired, alarms corresponding to priority level 15 and below are reported.

filter ACK alarms? determines whether acknowledged alarms are read.

group/tag names determines the tags for which alarm conditions are read.

timeout (secs) (1) specifies how many seconds to wait before reading the tag alarms. If **timeout** is 0, the alarms are read immediately. If it is wired, the VI waits indefinitely until a new alarm occurs or the Real-Time Database shuts down, whichever occurs first.

format allows you to compose the alarm message you want to display for the tags.

Date determines whether to display the date.

Date Format determines the format of the date, if it is selected for displaying.

Time determines whether to display the time.

Time Format determines the format of the time, if it is selected for displaying.

Tag Name determines whether to display the name of the tag in alarm.

Group Name determines whether to display the name of the group that the tag in alarm belongs to.

Alarm Value determines whether to display the value of the tag that caused the alarm.

Alarm State determines whether to display the type of alarm (HI_HI, LO, etc.).

Alarm Ack State determines whether to display the status of the user who acknowledged the alarm.

Alarm Priority determines whether to display the priority of the alarm state.

Alarm Limit determines whether to display the alarm limit.

Operator Name determines whether to display the operator name.

Alarm Message determines whether to display the user-configured alarm message. This applies to discrete tags only.

color codes is a cluster of parameters that determine the colors for the messages in the Alarm Summary Display.

event determines the color for events. The Alarm Summary Display does not include events.

ack alarm determines the color for acknowledged alarms.

unack alarm determines the color for unacknowledged alarms.

normal determines the color for tags that are currently in normal state, but have an unacknowledged alarm.

buffer size determines the number of entries to be displayed in the alarm summary display. The default setting is 10.

initialize headers is TRUE when the summary data has been read for the first time, indicating that **column headers** should be updated.

column headers represents the information displayed in the alarm summary. Wire this output to the Column Headers[] attribute of the Alarm Summary Display in your HMI.

summary data lists the alarms that currently exist is the system and have been filtered with the user specified priority and filter parameters.

row colors is an array of colors for the alarms displayed. Wire this output to the Cell FG Color attribute of the Alarm Summary Display in your HMI.

alarm summary status contains information about the alarms currently in the BridgeVIEW system.

 # active alarms is the number of alarms currently in the BridgeVIEW system.

any alarm? indicates any tag in the system that is in alarm, irrespective of its acknowledgement status.

 # unack alarms is the number of unacknowledged alarms in the system.

any unack alarm? indicates any tag in the system that is in alarm and unacknowledged.

error indicates that an error occurred when executing the Read Alarm Summary VI. It was probably a problem with the **group/tag names**.

shutdown indicates that the BridgeVIEW Engine is shutting down. In this case, the Read Alarm Summary VI returns immediately with **shutdown** TRUE. You can use **shutdown** to exit any While Loop that calls Read Alarm Summary VI.

changed? is TRUE if a new alarm was read. If **changed?** is FALSE, the Read Alarm Summary VI probably timed out before the Alarm Summary Display was updated.

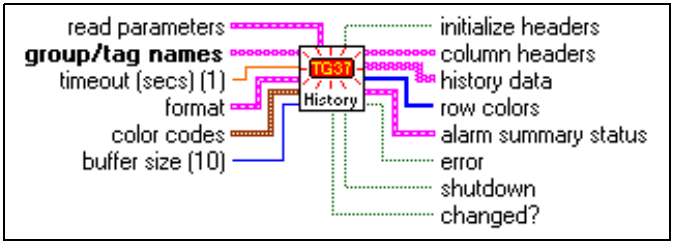
Read Event History

Use the Read Event History VI to display all the alarms and events that have occurred for a set of tags or tag groups within a given alarm priority range. You also can filter out acknowledged tags. The Read Event History VI formats the event history information for display in an Event History Display indicator in your HMI. If you specify a **timeout** value greater than 0, this VI returns when the event history information changes, or the **timeout** value is exceeded, whichever occurs first. The **changed?** output alerts you as to whether the event history information has been updated.

The **format** and **color codes** inputs tell the Read Event History VI how to format and color code event history information. The Read Event History VI returns all the information needed to update the Event History Display indicator. Part of the Event History Display indicator formatting is done through attribute nodes which only can exist in your diagram. The **column headers** display the table column header information and must be wired to your table Column Headers[] attribute if you are displaying column headers. Normally this is updated only when the VI is executed for the first time, assuming you do not change the **format** control during program operation. The **initialize headers** output is TRUE when you need to update the Column Headers attribute.

Wire the **history data** output directly to your Event History Display. Wire the **row colors** output to the Active Cell and Cell FG Color attributes inside a While Loop. Wiring the Event History Display attributes formats the table to show different line colors for different alarm states or events. You can generate this code automatically by using the HMI G Wizard.

The entire Event History Display, including attributes, is updated only if the event history information changes, and there was no timeout. Table indicator updates can be slow for large tables, so it is usually a good idea to update the table only if the **changed?** indicator is TRUE. Notice that the **changed?** indicator is always TRUE after the first execution of the VI.



read parameters is a cluster of parameters for filtering out the alarms read.

min priority is the minimum priority of alarms read. If left unwired, alarms corresponding to priority level 1 and above are reported.

max priority is the maximum priority of alarms read. If left unwired, alarms corresponding to priority level 15 and below are reported.

filter ACK alarms? determines whether acknowledged alarms are read.

group/tag names determines the tags for which alarm conditions and events are read.

timeout (secs)(1) specifies how many seconds to wait before reading the tag alarms and events. If **timeout** is 0, the alarms and events are read immediately. If it is wired, the VI waits indefinitely until a new alarm or event occurs or the Real-Time Database shuts down, whichever occurs first.

format allows you to compose the alarm message you want to display for the tags.

Date determines whether to display the date.

Date Format determines the format of the date, if it is selected for displaying.

Time determines whether to display the time.

Time Format determines the format of the time, if it is selected for displaying.

Tag Name determines whether to display the name of the tag in alarm.

Group Name determines whether to display the name of the group that the tag in alarm belongs to.

Alarm Value determines whether to display the value of the tag that caused the alarm.

Alarm State determines whether to display the type of alarm (HI_HI, LO, etc.).

Alarm Ack State determines whether to display the status of the user who acknowledged the alarm.

Alarm Priority determines whether to display the priority of the alarm state.

Alarm Limit determines whether to display the alarm limit.

Operator Name determines whether to display the operator name.

Alarm Message determines whether to display the user-configured alarm message. This applies to discrete tags only.

color codes is a cluster of parameters that determine the colors for the messages in the Alarm Summary Display.

event determines the color for events.

ack alarm determines the color for acknowledged alarms.

unack alarm determines the color for unacknowledged alarms.

normal determines the color for tags not in alarm.

buffer size determines the number of entries to be displayed in the event history display. The default setting is 10.

initialize headers is TRUE when the history data has been read for the first time, indicating that **column headers** should be updated.

column headers represents the information displayed in the event history. Wire this output to the Column Headers[] attribute of the Alarm Summary Display in your HMI.

history data is the list of alarms and events that have occurred in the system and have been filtered with the user specified read parameters.

row colors is an array of colors for the alarms and events to be displayed. Wire this output to the Cell FG Color attribute of the Event History Display in your HMI.

alarm summary status contains information about the alarms currently in the BridgeVIEW system.

 # active alarms is the number of alarms currently in the BridgeVIEW system.

any alarm? indicates any tag in the system that is in alarm, irrespective of its acknowledgement status.

 # unack alarms is the number of unacknowledged alarms in the system.

any unack alarm? indicates any tag in the system that is in alarm and unacknowledged.

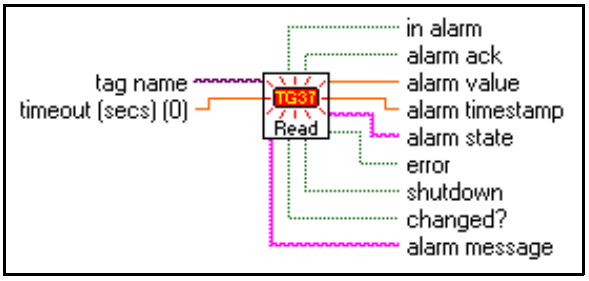
error indicates that an error occurred when executing the Read Event History VI. It was probably a problem with the **group/tag name**.

shutdown indicates that the BridgeVIEW Engine is shutting down. In this case, the Read Event History VI returns immediately with **shutdown** TRUE. You can use **shutdown** to exit any While Loop that calls the Read Event History VI.

changed? is TRUE if a new alarm or event was read. If **changed?** is FALSE, Read Event History probably timed out before the Event History Display was updated.

Read Tag Alarm

Use the Read Tag Alarm VI to read detailed alarm status for a tag from the Real-Time Database. You probably want to use the Read Tag Alarm VI in the portion of your program where you monitor alarm information for specific tags. The Read Tag Alarm VI indicates whether a tag is in alarm, which alarm state it is in, when the alarm occurred, at which value it occurred, and whether it has been acknowledged. If you specify a **timeout** value that is greater than 0, the Read Tag Alarm VI returns when the tag changes alarm state or the **timeout** is exceeded, whichever occurs first. The **changed?** indicator alerts you to whether the Read Tag Alarm VI returned a new value.



tag name is the name of the tag.

timeout (secs) (0) specifies how many seconds to wait for the tag alarm state to be updated in the Real-Time Database before reading the Real-Time Database for the latest alarm information. If **timeout** is 0, the Read Tag Alarm VI reads the Real-Time Database immediately and returns the tag alarm status without waiting. If **timeout** is –1, Read Tag Alarm waits indefinitely until the tag alarm state changes, or the Real-Time Database shuts down, whichever occurs first. If a **timeout** occurs before the value is updated, Read Tag Alarm returns the most current tag alarm state from the Real-Time Database, and **timeout** is set to TRUE. The default value is 0.

in alarm is TRUE if the tag is in alarm.

alarm ack indicates whether the tag alarm has been acknowledged. If acknowledged, **alarm ack** is TRUE.

alarm value is the tag value when it changed alarm states. Notice that the tag alarm value is updated only when the tag changes alarm states, and is not necessarily the most recent alarm value.

alarm timestamp indicates the time when the tag alarm state last changed.

alarm state indicates the name of the most recent alarm state for the tag.

error indicates that an error occurred when executing Read Alarm Tag, or that the value returned by Read Tag Alarm is not valid.

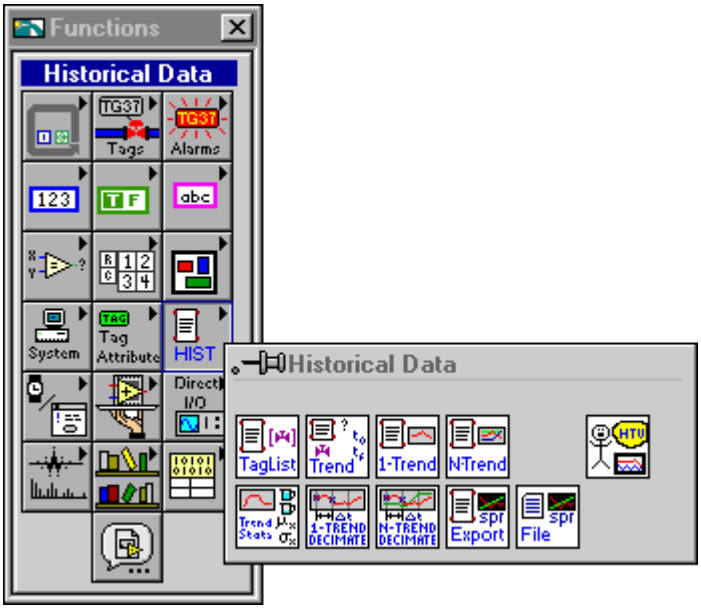
shutdown indicates that the BridgeVIEW Engine is shutting down. In this case, the Read Tag Alarm VI no longer waits for a change in the tag **alarm state** and returns immediately with both **timeout** and **shutdown** TRUE. You can use **shutdown** to exit any loop that uses the Read Tag Alarm VI.

changed? is TRUE when Read Tag Alarm returns a new alarm state from the Real-Time Database. If **changed?** is FALSE, the Read Tag Alarm VI probably timed out before the tag alarm state was updated.

alarm message is the user defined string message displayed along with the alarm notification for a discrete tag. Notice that this output is not valid for any tag type other than discrete.

Historical Data VIs

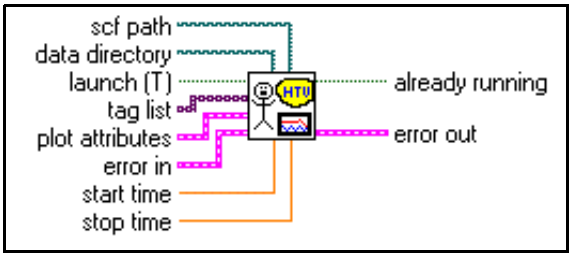
Use the Historical Data VIs to obtain or read historical data about a tag, resample trend data, compute statistical data for a historical trend, or convert historical trend data to a spreadsheet format. The Historical Data subpalette is shown below.



Call HTV

Use the Call HTV VI to include the Historical Trend Viewer (HTV) in your HMI application programmatically. Wire no inputs to launch the HTV in its default state, or wire one or more inputs to override the defaults.

If the HTV is running when this VI is called, **already running** returns TRUE and the HTV appears at the front of the screen. The inputs are not used in this case.



scf path is the path of the `.scf` file that contains configuration information for the tags to be displayed. If the Engine is running, the HTV ignores this input and uses the active `.scf` file.

data directory is the path to the directory containing the Citadel historical database files. If the Engine is running, the HTV ignores this input and uses the active Citadel data directory. If the Engine is not running and the `.scf` path is not empty, the HTV ignores this input and uses the Citadel data directory found in the `.scf` file.

launch (T) determines whether to launch the HTV. If TRUE, the Call HTV VI starts the HTV. If FALSE, the VI does nothing.

tag list is the array of tags to be displayed in the HTV.

plot attributes is a cluster of parameters to set the color, point style, and line style of the trend display.

colors is an array of colors to be used.

points is an array of points to be used. Use the position in the trend palette to determine the value for each point style. The default value is `0` (no point).

lines is an array of line styles to be used. Use the position in the trend palette to determine the value for each line style. The default value is `0` (solid line).

error in is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

start time is the time to be displayed at the beginning of the trend.

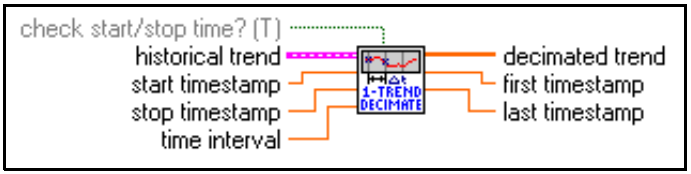
stop time is the time to be displayed at the end of the trend.

already running indicates whether the HTV is running when the Call HTV VI executes. If the HTV is running, this VI returns TRUE.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Decimate Historical Trend

Use the Decimate Historical Trend VI to take XY historical trend data, and decimate (resample) it from the **start timestamp** to the **stop timestamp**. The decimated trend output is a 1D array of the value at each time interval from the **start timestamp** to the **stop timestamp**.



check start/stop time? determines whether the requested start and stop times are checked against data available in the **historical trends** input. If this value is TRUE, the start and stop timestamps are checked against the first and last timestamp in the historical trend. A requested start/stop time out of the range of the trend is not used—the first/last timestamp in the trend is used.

historical trend is the historical trend to be decimated.

timestamp is the date and time for the **value**.

value is the value of the tag at the **timestamp**.

start timestamp is the timestamp at which the decimated trend starts. If **start timestamp** is unwired, the decimated trend output starts at the first timestamp in the **historical trend**.

stop timestamp is the desired stop time of the decimated trend. If **stop timestamp** is unwired, the decimated trend output ends at or before the last timestamp in the **historical trend**.

time interval determines the interval at which the trend is decimated or resampled. If unwired, data is extracted with the default interval of 1 second.

decimated trend is a list of **historical trend** values starting at **first timestamp**. Each trend value is **time interval** seconds apart.

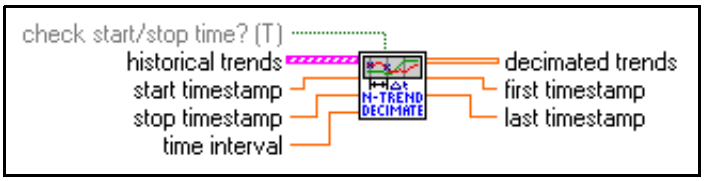
first timestamp is the actual time associated with the first point in the decimated trend.

last timestamp is the actual time associated with the last point in the decimated trend.

Decimate Historical Trends

Use the Decimate Historical Trends VI to decimate (resample) XY historical trend data over the time interval specified from **start timestamp** to **stop timestamp**. The decimated trend output is a 2D array of instantaneous values, each **time interval** seconds apart, starting at **start timestamp**. Each column in the 2D array contains one decimated trend.

If **start timestamp** is left unwired, the decimated trend values start at the first timestamp in the historical trend. If the **stop timestamp** is left unwired, the decimated trend ends at the point nearest the last timestamp in the historical trend.



check start/stop time? determines whether the requested start and stop times are checked against data available in the **historical trends** input. If this value is TRUE, the start and stop timestamps are checked against the first and last timestamp in the historical trend. A requested start/stop time out of the range of the trend is not used—the first/last timestamp in the trend is used.

To override this and use the input values regardless of the data points in the trend, set this input to FALSE.

historical trends is a set of historical trends to be decimated.

timestamp is the date and time for the value.

value is the value of the tag at the timestamp.

start timestamp is the timestamp at which the decimated trend starts. If **start timestamp** is unwired, the decimated trend output starts at the first timestamp in the historical trend.

stop timestamp is the desired stop time of the decimated trend. If **stop timestamp** is unwired, the decimated trend output ends at or before the last timestamp in the historical trend.

time interval determines the interval at which the trend is decimated or resampled. If unwired, data is extracted with the default interval of 1 second.

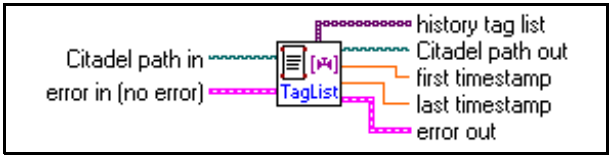
decimated trends is a list of decimated historical trends starting at **first timestamp**. Each trend value is **time interval** seconds apart.

first timestamp is the actual time associated with the first point in the decimated trend.

last timestamp is the actual time associated with the last point in the decimated trend.

Get Historical Tag List

Use the Get Historical Tag List VI to obtain the list of tags that have historical data available in the historical database.



Citadel path in is the path to the directory containing the Citadel historical database. If this path is empty, the VI attempts to use the historical data directory configured in the active `.scf` file. If this has not been configured, the VI prompts you to select a data directory.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

history tag list is the list of tag names that have historical data logged.

Citadel path out is the path to the directory containing historical data files.

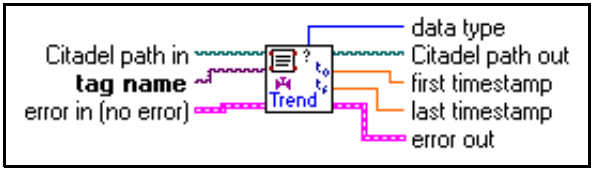
first timestamp is the date and time associated with the first data point logged in the given set of historical data files.

last timestamp is the date and time associated with the last data point logged in the given set of historical data files.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Get Historical Trend Info

Use the Get Historical Trend Info VI to obtain the first and last timestamp available in the historical database for a given tag, and the type of the tag, whether analog or discrete.



Citadel path in is the path to the directory containing the Citadel historical database. If this path is empty, the VI attempts to use the historical data directory configured in the active `.scf` file. If this has not been configured, the VI prompts you to select a data directory.

tag name is the tag about which you want to obtain historical trend information.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

data type is the type of tag, whether discrete, analog, or bit array.

Citadel path out is the path to the directory containing historical data files.

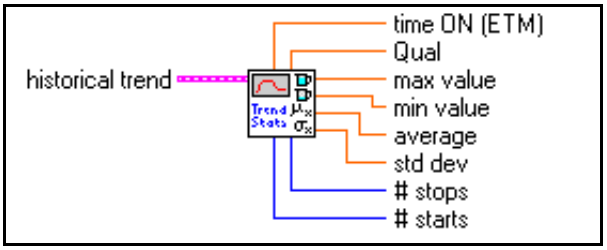
first timestamp is the date and time associated with the first value logged in the database for this tag.

last timestamp is the date and time associated with the last value logged in the database for this tag.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Historical Trend Statistics

Use the Historical Trend Statistics VI to compute statistical data for a historical trend. Statistics include minimum value, maximum value, average and standard deviations. The statistics skip invalid input points (where *value* = *NaN*). The average and standard deviation are weighted according to the time duration of each valid input point. The last point in the historical trend is not included in the average and standard deviation because the time interval associated with it is unknown.



historical trend is the tag trend data upon which statistics are computed.

timestamp is the date and time for the value.

value is the value of the tag at the timestamp.

time ON (ETM) is the amount of time for which data has known values in the trend. It is roughly the same as the amount of time historical logging was turned on for the tag.

Qual is the ratio of time the trend has known values to the total time elapsed in the trend.

max value is the maximum value in the historical trend. This output ignores invalid points (*value* = *NaN*).

min value is the minimum value in the historical trend. This output ignores invalid points (*value* = *NaN*).

average is the average for the values in the historical trend. This is a weighted average. Each point is weighted according to its time duration. **average** ignores time intervals with invalid points (*value* = *NaN*). The last point in the trend is not included in **average**, because there is no known time interval associated with it.

std dev is the standard deviation for values in the historical trend. This is a weighted standard deviation. Each point is weighted according to its time duration. **Std dev** ignores time intervals with invalid points (*value* = *NaN*).

The last point in the trend is not included in the standard deviation, because there is no known time interval associated with it.

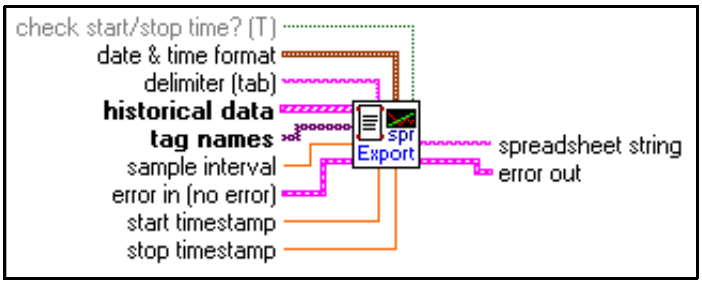
 # stops is the number of transitions from logging on to logging off in the trend.

 # starts is the number of transitions from logging off to logging on in the trend.

Historical Trends to Spreadsheet

Use the Historical Trends to Spreadsheet VI to converts a set of historical trends into the tab delimited string format, which spreadsheet programs can read. The columns created are date, time, tag name 1 value, tag name 2 value, and so on. A header is created labelling the date, time, and tag names. The output of this VI can be saved in a file, and then imported into a spreadsheet program.

You can wire in the delimiter you want. The delimiter is a tab by default. You also can override the date and time formatting by wiring in the **date & time format** cluster.



check start/stop time? determines whether the requested start and stop times are checked against data available in the **historical trends** input. By default the decimation does not start until data is available in all trends, and ends as soon as any trend has no more data. To override this behavior, set this input to FALSE.

date & time format is a cluster that contains settings used to format the date and time in the spreadsheet string.

date format (0) determines the format for the date (`MM/DD/YYYY` or `DD/MM/YYYY`).

time format determines whether a 12-hour (AM/PM) or 24-hour format is used.

delimiter (tab) is the separator used in the spreadsheet format. The default separator is a tab.

historical data is the set of historical data trends to convert to spreadsheet format.

tag names is the list of tag names corresponding to the historical trends. These tag names are used as column headers when converted into spreadsheet format.

sample interval (1 sec) determines the time interval for each historical trend. If unwired, the data is sampled at one-second intervals.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine*in this appendix.

start timestamp is the timestamp for which the spreadsheet rows start. If **start timestamp** is unwired, the spreadsheet rows start at the first timestamp in the historical data.

stop timestamp is the timestamp for which the spreadsheet rows end. If **stop timestamp** is unwired, the spreadsheet rows start at the last timestamp in the historical data.

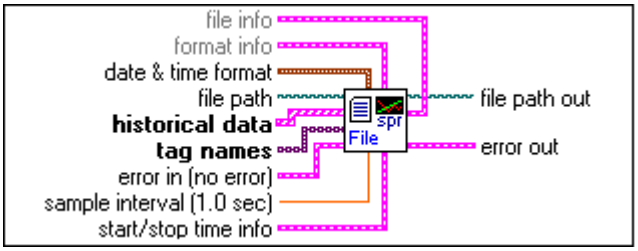
spreadsheet string contains spreadsheet formatted data that can be written to a text file. This file can be opened into spreadsheets like Excel.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Historical Trends to Spreadsheet File

This VI stores the data from a set of historical trends into a spreadsheet file format. The columns created are date, time, tag1data, tag2data, and so on. A header is created labelling the date, time, and tag names. The default delimiter is the tab character; sending a different value via the **format info** input (such as a comma) will change the character used to separate columns.

You can also override the default date and time format by wiring a different value to the **date & time format** input. To customize the file dialog behavior (if the file path input is an empty path or Not A Path), use the **file info** input.



file info describes information to customize the file prompt and creation behavior.

prompt is the messages that appears below the list of files and directories in the file dialog box.

function function is the operation to perform.

default name is the initial file name that appears in the selection box of the File dialog box.

pattern is the match pattern specification used to display only certain types of files or directories.

format info Contains spreadsheet formatting information

delimeter (tab) is the separator to be used inteh spreadsheet format. The default is a tab.

date header is the cloumn header for the date information.

time header is the column header fr the timestamp information.

date & time format is a cluster that contains settings used to format the date and time in the spreadsheet string.

date format (System default) determines the format for the date.

time format (System default) determines whether a 12-hour (AM/PM) or 24-hour format is used.

seconds format (1 sec) determines how many digits of precision are displayed for timestamps.

file path is the name of the spreadsheet file to store the historical data. If file path is empty (default value), or is Not A Path, the VI displays a file dialog box from which you can select a file. Error 43 occurs if the user cancels the dialog.

historical data is the set of historical data trends to convert to spreadsheet format.

historical trend describes historical trends for the inpout tag names, read from the **historical database**. The data in the trends start at the date and time specifiied by **start timestamp**, and end at the date and time specified by **stop timestamp**.

tag names is the list of tag names corresponding to the historical trends. These tag names are used as column headers when converted into spreadsheet format.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

sample interval (1 sec) determines the time interval for each spreadsheet row. If unwired, a spreadsheet row is created for each one-second interval.

start/stop time info describes the settings used to decimate the data for export to spreadsheet.

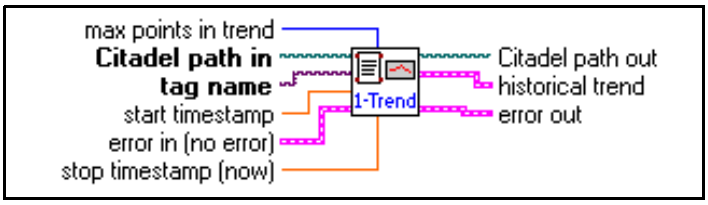
error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

file path out is the name of the spreadsheet file in which the historical date is stored.

Read Historical Trend

Use the Read Historical Trend VI to read the historical data for a given tag from user specified start and stop dates and times, up to the maximum number of points specified. If **start timestamp** and **stop timestamp** are not wired, all historical data for the tag is returned, up to the maximum points per trend specified. If **max points per trend** is left unwired, all points between the **start timestamp** and **stop timestamp** are returned.

You can use this VI to read history information for analog, discrete or bit array tags. All values are returned as floating point values.



max points in trend is the maximum number of points to read. If the value is less than zero, all points available between **start timestamp** and **stop timestamp** are returned. Otherwise, the number of points in the trend is the minimum of the actual number of data points between **start timestamp**, **stop timestamp**, and **max points in trend**.

Citadel path in is the path to the directory containing the Citadel historical database. If this path is empty, the VI attempts to use the historical data directory configured in the active `.scf` file. If this has not been configured, the VI prompts you to select a data directory.

tag name is the tag for which you want to read historical data. If the tag is not logged in the historical database, you will get an empty trend.

start timestamp is the date and time associated with the first data point to be retrieved from the historical database. If this input is unwired, the data is extracted starting at the first point available for the tag.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

stop timestamp (now) is the date and time associated with the last data point to be retrieved from the historical database. If this input is unwired, the data is extracted up to the last point available for the tag.

Citadel path out is the path to directory containing historical data files.

historical trend is the tag trend data read from the historical database, starting at the date and time specified by **start timestamp**, and stopping at the date and time specified by **stop timestamp** or up to **max points per trend**, whichever is smaller. If these **start timestamp** and **stop timestamp** values are left unwired, all the logged data up to **max points per trend** for the tag is returned.

timestamp is the date and time for **value**.

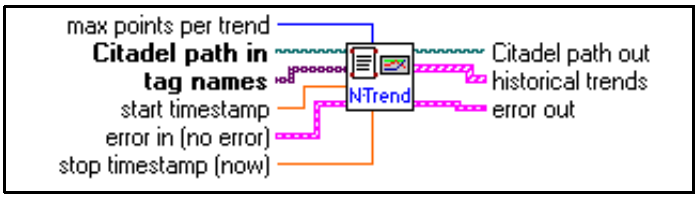
value is the value of the tag at the **timestamp**.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Read Historical Trends

Use the Read Historical Trends VI to read the historical data for a given set of tags from a user specified start and stop date and time, up to **max points per trend**. If the inputs for **start timestamp** and **stop timestamp** are not wired, all historical data for the tags is returned, up to the **max points per trend** specified. If **max points per trend** is left unwired, all points between **start timestamp** and **stop timestamp** are returned.

You can use this VI to read history information for analog, discrete or bit array tags. All values are returned as floating point values.



max points per trend is the maximum number of points to read. If the value is less than zero, all points available between **start timestamp** and **stop timestamp** are returned. Otherwise, the number of points in the trend is the minimum of the actual number of data points between **start timestamp**, **stop timestamp**, and **max points in trend**.

Citadel path in is the path to directory containing the Citadel historical database. If this path is empty, the VI prompts the user for the citadel folder path.

tag names is the list of tags for which you want to read historical data. If one or more of the tags is not logged in the historical database, you will get an empty trend for that tag.

stop timestamp (now) is the date and time associated with the last data point to be retrieved from the historical database. If this input is unwired, the data is extracted up to the last point available for the tag.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

start timestamp is the date and time associated with the first data point to be retrieved from the historical database. If this input is unwired, the data is extracted starting at the first point available for the tag.

Citadel path out is the path to directory containing the historical database.

historical trends is the tag trend data read from the historical database, starting at the date and time specified by **start timestamp**, and stopping at the date and time specified by **stop timestamp** or up to **max points per trend**, whichever is smaller. If these start and stop timestamp values are unwired, all the logged data up to **max points per trend** for the tag is returned.

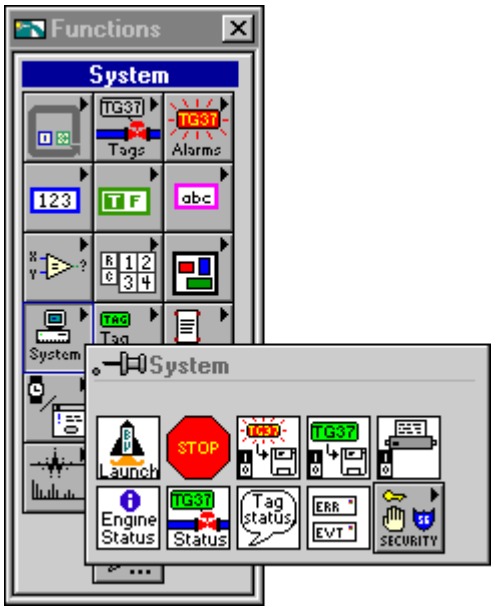
timestamp is the date and time for the value.

value is the value of the tag at the timestamp.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

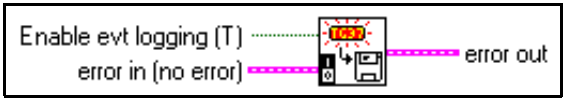
System VIs

Use the System VIs to obtain information or monitor the access level of the current operator, to launch or shut down BridgeVIEW, or to enable or disable event logging, historical data logging or printing. The System subpalette is shown below.



Enable Event Logging

Use the Enable Event Logging VI to turn on or off logging of alarms and events for all tags in the system programmatically.



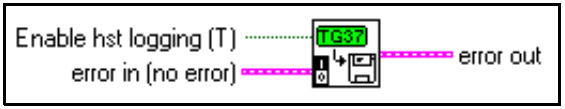
Enable evt log (T) determines whether to turn event logging on or off.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Enable Historical Data Logging

Use the Enable Historical Data Logging VI to turn on or off data logging for all tags in the system programmatically.



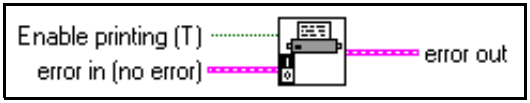
Enable hst logging (T) determines whether to turn historical data logging on or off.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Enable Printing

Use the Enable Printing VI to turn on or off printing of alarms and events for all tags in the system programmatically.



Enable printing (T) determines whether to turn printing on or off.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Engine Launch

Use the Engine Launch VI to launch the BridgeVIEW Engine programmatically. Normally the BridgeVIEW Engine is launched automatically when you execute any of the VIs that access the Real-Time Database. Use this VI if you want to control when the Engine is launched explicitly.

If **configuration file to use** is unwired, BridgeVIEW automatically uses the last configuration file you viewed or edited. Use **launch engine** to control whether the Engine is launched.

The outputs indicate whether the Engine is running already and which configuration file is being used. These outputs are valid only if **launch engine** is TRUE.

configuration file to use specifies exactly which Tag Configuration file the BridgeVIEW Engine should use. You must provide the complete path to the configuration file. If unwired, the last configuration you viewed or edited is used.

launch engine determines whether to launch the BridgeVIEW Engine, provided that it is not already running. If FALSE, the VI does nothing. If unwired, this input is TRUE by default. You can wire this input if you do or do not want to launch the Engine based on logic in your program.

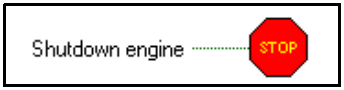
configuration file in use indicates which BridgeVIEW configuration file is currently in use.

already launched indicates whether the BridgeVIEW Engine was launched already when this VI was called. If so, the BridgeVIEW Engine is left undisturbed and this VI returns which configuration file is being used.

shutdown indicates that the BridgeVIEW Engine is shutting down. In this case, calling this VI does nothing.

Engine Shutdown

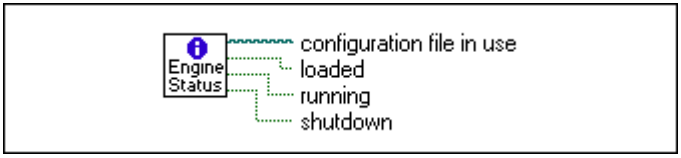
Use the Engine Shutdown VI to shut down the BridgeVIEW Engine from your HMI. You must terminate your application immediately after calling this VI. The BridgeVIEW Engine does not shut down until all VIs that are accessing the Real-Time Database finish. If you do not terminate your application, after a few seconds a dialog box prompts you to stop your application so that the BridgeVIEW Engine can complete shutdown.



Shutdown engine determines whether the BridgeVIEW Engine shuts down. If TRUE, this VI notifies the BridgeVIEW Engine to shut down. If FALSE, the VI does nothing. This parameter is TRUE by default.

Get Engine Status

Use this VI to query the BridgeVIEW engine status. The outputs indicate whether the engine is loaded, running, or shutting down, and which configuration file is being used.



configuration file in use indicates which BridgeVIEW configuration file currently is in use.

loaded indicates whether the BridgeVIEW engine currently is loaded.

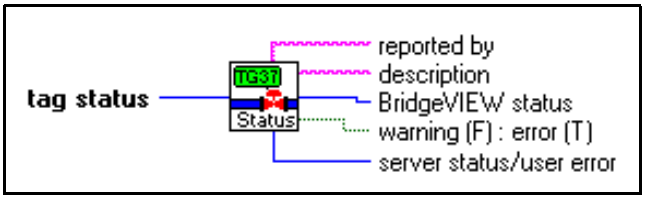
running indicates whether the BridgeVIEW engine currently is running.

shutdown indicates whether the engine has been stopped and is shutting down.

Get Tag Status Info

Use the Get Tag Status Info VI to obtain status information associated with tags. Tag status information can be broken down into two types:

- Status information from BridgeVIEW—This status can be from the Engine or a Server. It consists of details about the status and whether it is an error or warning.
- Status information from a Server—Only the status code is reported. Check your server documentation for a description of this status.



tag status can be broken down into status information from BridgeVIEW (Engine or Server), and status information from a server or a user error.

reported by indicates whether the status was reported by the BridgeVIEW Engine or a server.

description gives the details of the part of the status reported by BridgeVIEW.

BridgeVIEW status is the numeric representation of the portion of the status reported by BridgeVIEW.

warning (F): error (T) indicates if the portion of status reported by BridgeVIEW is an error (if it is negative), or a warning (if it is positive).

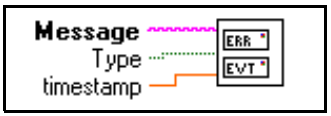
server status/user error is either the numeric value of the portion of **tag status** posted by the device server (refer to your server documentation for details on this value) or an indication of user error.

Post System Error or Event

Use this VI to post an error or event message from your HMI to the System Error/Event display on the Engine Manager. The message you post is logged to the system log file in the `BridgeVIEW\Syslog` directory. The format of the message is as follows:

```
EVENT/ERROR <date> <time> <Message>
```

The date and time represent the **timestamp** when the message is posted.



Message is the Error or Event that you want to report. The format of the message that actually is posted is as follows:

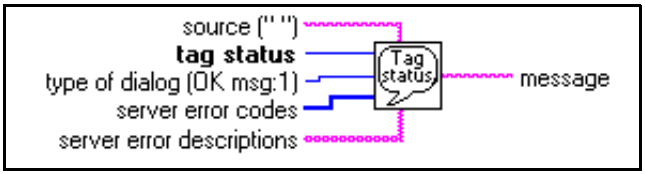
```
EVENT/ERROR <date> <time> <Message>
```

Type determines the type of message to be posted. By default, it is an error. If you are reporting an event, write a TRUE to the switch. Depending on your selection, the word EVENT or ERROR automatically is incorporated in the message that is posted.

timestamp is broken down into date and time strings and incorporated in the message that gets posted. If this input is left unwired, the current timestamp is taken and posted as a part of the message.

Tag Status Handler

Use the Tag Status Handler VI to obtain a description of the tag status, by breaking it down into warning or error conditions coming from BridgeVIEW as well as the device server. It also identifies where the error or warning occurred. The information for looking up status is derived from the inputs: **tag status**, **source**, **server error codes**, **server error descriptions**, and from an internal error description lookup that describes all the status values returned from the Engine or a Server in BridgeVIEW.



source is a string you can use to describe the VI that is the source of warning or error indicated by tag status. This is returned as a part of the **message** string if there is an error.

tag status can be broken down into status information from BridgeVIEW (Engine or Server); and status information from a server or a user error.

type of dialog (OK msg:1) determines what type of dialog box is displayed, if any. Regardless of its value, the VI returns error information and a message describing the error. According to the value, the VI does one of the following:

- Displays no dialog box. This is useful if you want to have programmatic control over how an error is handled.
- Displays a dialog box with a single **OK** button. After the user responds, the VI returns control to the main VI. This is the default setting.
- Displays a dialog box with buttons allowing the user to continue or stop. If the user cancels, the VI calls the Stop function to halt execution.

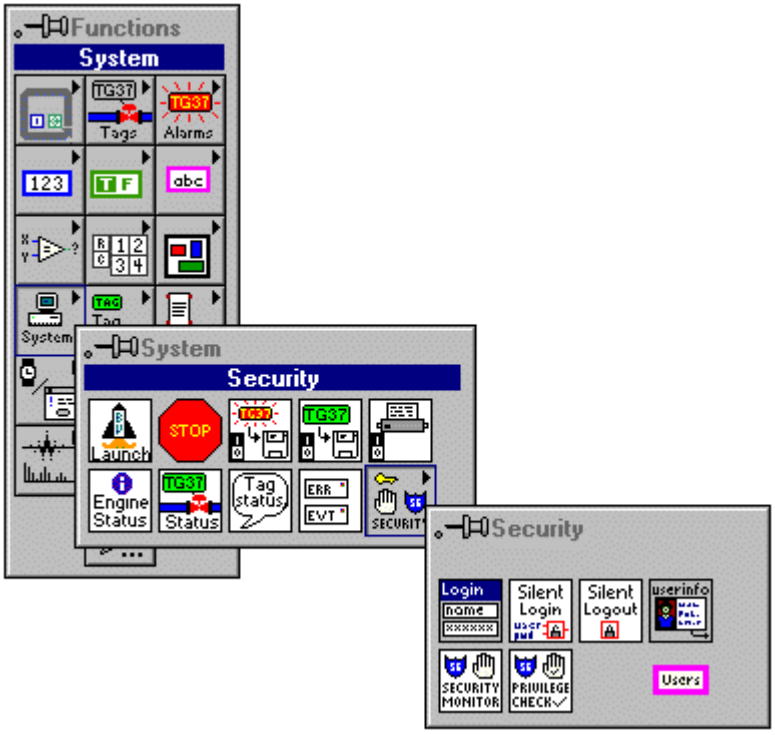
server error codes is an array of numeric error codes defined for your device server(s).

server error descriptions is an array of descriptions of server error codes. If an incoming error matches one in **server error codes**, the VI uses the corresponding description from **server error descriptions** in the message.

message describes the tag status by breaking it down into the error or warning returned by BridgeVIEW as well as the error or warning, if any,

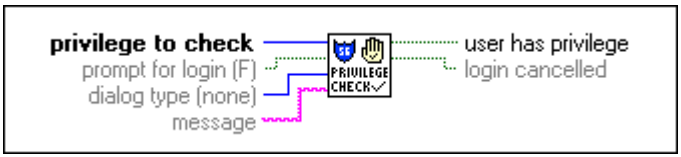
returned by the device server. The part of the message describing the server error code comes from the input you specify in **server error descriptions**. It also contains information about the source of the error.

Security VIs



Check Operator Privileges

Use this VI to check the current user's privileges and produce a Boolean output indicating if the currently logged in user has the privilege. Additional inputs can be sent to display a dialog box with a message (OK or OK/Cancel) and/or launch the login prompt if the current user does not have the requested privilege.



privilege to check inspects the privileges of the current BridgeVIEW user to see if he or she has been granted this privilege.

prompt for login (F) opens the Login dialog box if the current BridgeVIEW user does not have the requested privilege, and the input is `TRUE`.

dialog type (none) displays a dialog box if the current BridgeVIEW user does not have the requested privilege, and the message input is not empty. The type of dialog box is determined by the following input:

- **OK**—A dialog box appears displaying a message and an **OK** button. If the **prompt for login** input is `TRUE`, the login dialog box appears after the message dialog box is closed.
- **OK/Cancel**—A dialog box displaying a message and **OK** and **Cancel** buttons. If the **prompt for login** input is `TRUE`, the login dialog box appears when the **OK** button in the message dialog box is pressed.

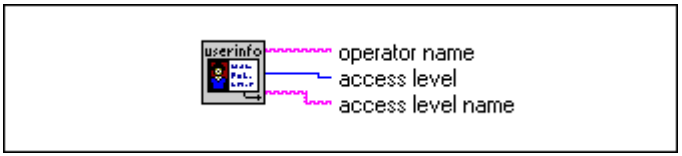
message is the message to display if the **dialog type** input is not `none`, and the current BridgeVIEW user does not have the requested privilege.

user has privilege is `TRUE` if the current BridgeVIEW user has the requested privilege.

login cancelled is `TRUE` if the current BridgeVIEW user does not have the requested privilege, prompt for login was `TRUE`, and the login dialog box was cancelled.

Get Operator Name

Use the Get Operator Name VI to obtain the current operator name, access level, and access level name.



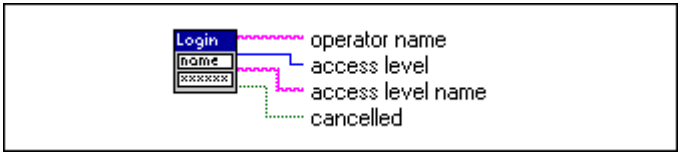
operator name is the login name of the current BridgeVIEW user.

access level is the numeric access level assigned to the current BridgeVIEW user.

access level name is a descriptive name associated with the numeric access level assigned to the current BridgeVIEW user.

Invoke Login Dialog

Use the Invoke Login Dialog VI to launch the BridgeVIEW Login dialog box. If the user selects **Cancel** in the Login dialog box, the previous user remains active.



operator name is the login name of the current BridgeVIEW user.

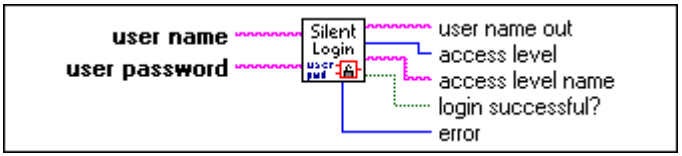
access level is the numeric access level assigned to the current BridgeVIEW user.

access level name is a descriptive name associated with the numeric access level assigned to the current BridgeVIEW user.

cancelled indicates whether the user pressed **Cancel** in the Login dialog box, aborting the login.

Programmatic Login

Use the Programmatic Login VI to programmatically log in a user.



user name is the name of the user to be logged in to BridgeVIEW.

user password is the password of the user to be logged in to BridgeVIEW.

user name out is the name of the user to be logged in to BridgeVIEW. If the login fails, this is the name of the user currently logged in to BridgeVIEW.

access level is the numeric access level assigned to the current BridgeVIEW user.

access level name is a descriptive name associated with the numeric access level assigned to the current BridgeVIEW user.

login successful? is `TRUE` if the user name and user password are correct, and the user was successfully logged into BridgeVIEW.

error is an error code that describes the result of the programmatic login and can have one of the following values.

0 Login successful (No Error)

1 Invalid Password

2 Invalid User Name

Programmatic Logout

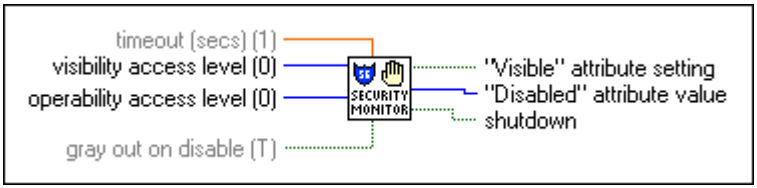
Use this VI to log out the current user, so no operator is logged into the system.

logout (T) determines if the current BridgeVIEW user should be logged out of the system. If TRUE, the current user is logged out of the BridgeVIEW system. If FALSE, the logout operation does not occur.

logout message describes the result of the logout operation.

Security Monitor

Use this VI to monitor the access level of the current BridgeVIEW operator. By default, this VI times out after one second, returning to the current operator access level. When an operator logs in, this VI returns immediately.



timeout (secs) (1) specifies how long to wait for a user to log in.

visibility access level (0) determines the value of **"Visible" attribute setting**. If the current operator access level is greater than or equal to **visibility access level**, the **"Visible" attribute setting** indicator is TRUE. Otherwise, **"Visible" attribute setting** is FALSE.

operability access level determines the value for the **"Disabled" attribute value** output. If the current operator access level is greater than or equal to **operability access level**, **"Disabled" attribute value** is `0` (enabled). Otherwise, **"Disabled" attribute value** is `1` (disabled) or `2` (grayed out), depending on the setting of the **gray out on disable** input.

gray out on disable (T) determines if the **"Disabled" attribute value** is `1` (disable) or `2` (disable and gray out) if a user access level is not greater than or equal to **operability access level**.

"Visible" attribute setting is the value to send to the **"Visible"** attribute of the control or indicator to which security is applied.

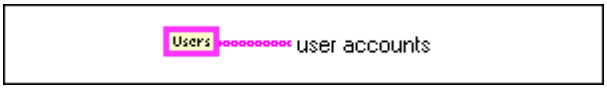
"Disabled" attribute value is the value to send to the **"Disabled"** attribute of the control or indicator to which security is applied.

shutdown indicates that the BridgeVIEW Engine is shutting down.

Note ***When you use this VI in your operator interface loops, you do not want the timeout value to be too long, or your front panel can take a long time to finish execution. Similarly, setting* timeout *to 0 seconds degrades the overall performance of your interface because this VI is called too often, too quickly.***

User Account List

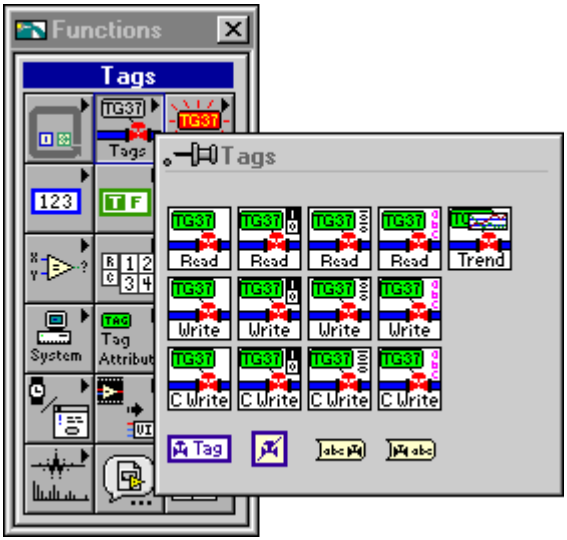
Use this VI to generate a list of BridgeVIEW user accounts.



user accounts is a list of BridgeVIEW user accounts.

Tags VIs

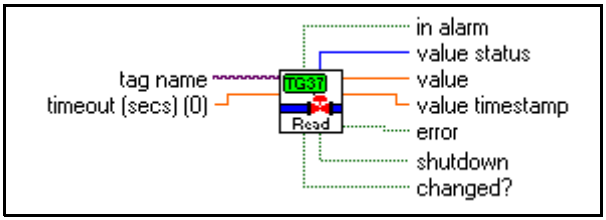
Use the Tags VIs to read the latest value for a tag, write a new value to a tag, or obtain data for a real-time trend. The Tags subpalette is shown below.



Read Tag

Use the Read Tag VI to read the latest value of a tag from the Real-Time Database. For immediate polling of the tag value, leave **timeout (secs)** unwired. To wait until the value is updated before reading it, wire a timeout value in seconds to **timeout**. The Read Tag VI returns with the most recent Real-Time Database value when it is updated, the **timeout** is exceeded, or the Real-Time Database is shutting down, whichever occurs first. Use the **changed?** output to determine whether the value changed since the last read.

Note ***Use a separate Read Tag VI for each tag you want to monitor. Do not put the Read Tag VI in a loop to read a different tag each iteration of the loop. This results in slower program performance. The Read Tag VI is designed to save information about the tag internally for efficient operation. This information is updated every time the tag name changes.***



tag name is the name of the tag.

timeout (secs) (0) specifies how many seconds to wait for the tag value to be updated in the Real-Time Database before reading the Real-Time Database for the latest value. If **timeout** is 0, the Read Tag VI reads the Real-Time Database immediately and returns the tag value without waiting. If timeout is –1, Read Tag waits indefinitely until the tag value is updated, or the Engine shuts down, whichever occurs first. If a timeout occurs before the value is updated, Read Tag returns the most recent value from the Real-Time Database, and is set to TRUE. The default value is 0.

in alarm is TRUE if the tag is in alarm.

value status returns the status of the value. If **value status** is greater than or equal to 0, the value returned by Read Tag is valid and there is a warning about the tag value. If **value status** is less than 0, either the device server has reported an error indicating there is a problem with the tag, or BridgeVIEW has reported an error indicating there is a problem using the tag.

value is the latest value of the tag read from the Real-Time Database.

value timestamp returns the timestamp for when the tag value was updated.

error indicates that an error occurred when executing the Read Tag VI, or that the **value** output returned by Read Tag is not valid. See **value status** for the specific error condition.

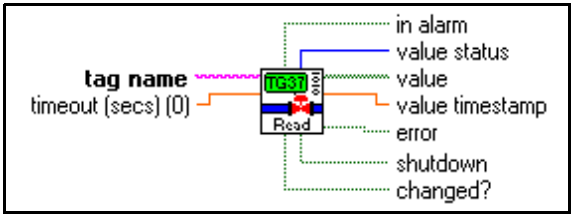
shutdown indicates that the BridgeVIEW Engine is shutting down. In this case, the Read Tag VI no longer waits for tags to be updated and returns immediately with both **timeout** and **shutdown** TRUE. You can use **shutdown** to exit any loop that uses the Read Tag VI.

changed? is TRUE when the Read Tag VI returns a new value from the Real-Time Database. If **changed?** is FALSE, the Read Tag VI probably timed out before the tag value was updated.

Read Tag (bit array)

Use the Read Tag (bit array) VI to read the latest value for a given bit array tag from the Real-Time Database. For immediate polling of the tag value, leave **timeout (secs)** unwired. To wait until the value is updated before reading it, wire a timeout value, in seconds, to the **timeout** input. The Read Tag (bit array) VI returns with the most recent Real-Time Database value when it is updated, the timeout is exceeded, or the Real-Time Database is shutting down, whichever occurs first. Use the **changed?** output to determine whether the value changed since the last read.

☞ **Note** ***Use a separate Read Tag (bit array) VI for each tag you want to monitor. Do not put the Read Tag (bit array) VI in a loop to read a different tag each iteration of the loop. This results in slower program performance. The Read Tag (bit array) VI is designed to save information about the tag internally for efficient operation. This information is updated every time the tag name changes.***



tag name is the name of the bit array tag.

timeout (secs) (0) specifies how many seconds to wait for the tag value to be updated in the Real-Time Database before reading the Real-Time Database for the latest value. If **timeout** is the default value of 0, the Read Tag (bit array) VI reads the Real-Time Database immediately and returns the tag value without waiting. If **timeout** is –1, Read Tag (bit array) waits indefinitely until the tag value is updated, or the BridgeVIEW Engine shuts down, whichever occurs first. If a timeout occurs before the value is updated, Read Tag (bit array) returns the most recent value from the Real-Time Database, and **timeout** is set to TRUE.

in alarm is TRUE if the tag is in alarm.

value status returns the status of the value. If **value status** is greater than or equal to 0, the value returned by Read Tag is valid and there is a warning about the tag value. If **value status** is less than 0, either the device server has reported an error indicating there is a problem with the tag, or BridgeVIEW has reported an error indicating there is a problem using the tag.

value is the latest bit array value of the bit array tag read from the Real-Time Database.

value timestamp returns the timestamp for when the tag value was last updated.

error indicates that an error occurred when executing the Read Tag (bit array) VI, or that the **value** output returned by Read Tag (bit array) is not valid. See **value status** for the specific error condition.

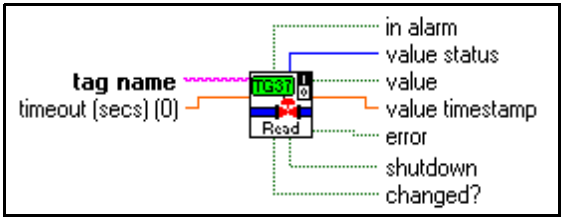
shutdown indicates that the BridgeVIEW Engine is shutting down. In this case, Read Tag (bit array) no longer waits for tags to be updated and returns immediately with both **timeout** and **shutdown** TRUE. You can use **shutdown** to exit any loop that uses Read Tag (bit array).

changed? is TRUE when Read Tag (bit array) returns a new value from the Real-Time Database. If **changed?** is FALSE, Read Tag (bit array) probably timed out before the tag value was updated.

Read Tag (discrete)

Use the Read Tag (discrete) VI to read the latest value for a given discrete (or Boolean) tag from the Real-Time Database. For immediate polling of the tag value, leave **timeout (secs)** unwired. To wait until the value is updated before reading it, wire a timeout value in seconds to **timeout**. The Read Tag (discrete) VI returns with the most recent Real-Time Database value when it is updated, the timeout is exceeded, or the Real-Time Database is shutting down, whichever occurs first. Use the **changed?** output to determine whether the value changed since the last read.

☞ **Note** ***Use a separate Read Tag (discrete) VI for each tag you want to monitor. In other words, for example, do not put the Read Tag (discrete) VI in a loop to read a different tag for each iteration of the loop. This results in slower program performance. The Read Tag(discrete) VI is designed to save information about the tag internally for efficient operation. This information is updated every time the tag name changes.***



tag name is the name of the discrete tag.

timeout (secs) (0) specifies how many seconds to wait for the tag value to be updated in the Real-Time Database before reading the Real-Time Database for the latest value. If **timeout** is 0, the Read Tag (discrete) VI reads the Real-Time Database immediately and returns the tag value without waiting. If **timeout** is –1, Read Tag (discrete) waits indefinitely until the tag value is updated, or the BridgeVIEW Engine shuts down, whichever occurs first. If a timeout occurs before the value is updated, Read Tag (discrete) returns the most recent value from the Real-Time Database, and **timeout** is set to TRUE. The default value is 0.

in alarm is TRUE if the tag is in alarm.

value status returns the status of the value. If **value status** is greater than or equal to 0, the value returned by Read Tag is valid and there is a warning about the tag value. If **value status** is less than 0, either the device server has reported an error indicating there is a problem with the tag, or BridgeVIEW has reported an error indicating there is a problem using the tag.

value is the latest value of the discrete tag read from the Real-Time Database.

value timestamp returns the timestamp for when the tag value was last updated.

error indicates that an error occurred when executing the Read Tag (discrete) VI, or that the **value** output returned by Read Tag(discrete) is not valid. See **value status** for the specific error condition.

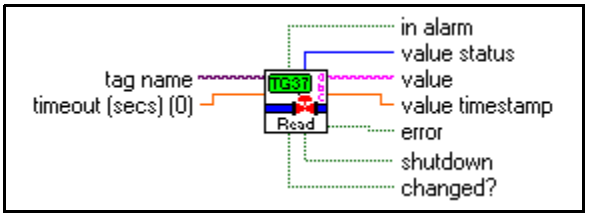
shutdown indicates that the BridgeVIEW Engine is shutting down. In this case, Read Tag (discrete) no longer waits for tags to be updated and returns immediately with both **timeout** and **shutdown** TRUE. You can use **shutdown** to exit any loop that uses Read Tag (discrete).

changed? is TRUE when Read Tag (discrete) returns a new value from the Real-Time Database. If **changed?** is FALSE, Read Tag (discrete) probably timed out before the tag value was updated.

Read Tag (string)

Use the Read Tag (string) VI to read the latest value for the tag from the Real-Time Database. If **timeout** is 0, Read Tag (string) VI returns the current Tag value and update timestamp from the Real-Time Database, otherwise the Read Tag (string) VI waits up to the specified **timeout** for the tag to be updated in the Real-Time Database, and returns the new value.

☞ **Note** ***Use a separate Read Tag (string) VI for each tag you want to monitor. Do not put the Read Tag (string) VI in a loop to read a different tag each iteration of the loop. This results in slower program performance. The Read Tag(string) VI is designed to save information about the tag internally for efficient operation. This information is updated every time the tag name changes.***



tag name is the name of the tag.

timeout (secs) (0) specifies how many seconds to wait for the tag value to be updated in the Real-Time Database before reading the Real-Time Database for the latest value. If **timeout** is the default value of 0, the Read Tag (string) VI reads the Real-Time Database immediately and returns the tag value without waiting. If **timeout** is –1, Read Tag (string) waits indefinitely until the tag value is updated, or the Real-Time Database shuts down, whichever occurs first. If a timeout occurs before the value is updated, Read Tag (string) returns the most recent value from the Real-Time Database, and **timeout** is set to TRUE.

in alarm is TRUE if the tag is in alarm.

value status returns the status of the value. If **value status** is greater than or equal to 0, the value returned by Read Tag is valid and there is a warning about the tag value. If **value status** is less than 0, either the device server has reported an error indicating there is a problem with the tag, or BridgeVIEW has reported an error indicating there is a problem using the tag.

value is the latest value of the tag read from the Real-Time Database.

value timestamp returns the timestamp for when the tag value was last updated.

error indicates that an error occurred when executing the Read Tag (string) VI, or that the **value** output returned by Read Tag(string) is not valid. See **value status** for the specific error condition.

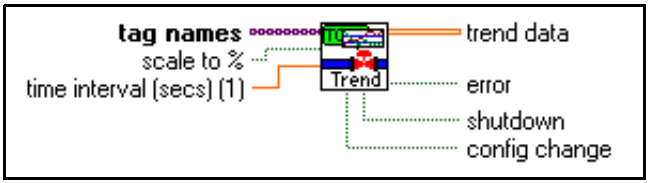
shutdown indicates that the BridgeVIEW Engine is shutting down. In this case, Read Tag (string) no longer waits for Tags to be updated and returns immediately with both **timeout** and **shutdown** TRUE. You can use **shutdown** to exit any loop that uses the Read Tag (string) VI.

changed? is TRUE when the Read Tag (string) VI returns a new value from the Real-Time Database. If **changed?** is FALSE, Read Tag (string) probably timed out before the tag value was updated.

Trend Tags

Use the Trend Tags VI to set data for a real-time trend chart in your HMI. The Trend Tags VI supports analog, discrete, and bit array tags. The Trend Tags VI formats data for one or more tags such that it can be wired directly to a trend (waveform chart). The Trend Tags VI returns after each time interval with the next set of points for the trend.

Place each Trend Tags VI in its own While Loop, assuming that each loop is running at a different time interval.



tag names is the name of each tag to be trended.

scale to % determines how the trend data is scaled. If **scale to %** is FALSE, **trend data** is in engineering units. If **scale to %** is TRUE, **trend data** is in % of full scale (0 to 100%). The default setting for **scale to %** is FALSE.

time interval (secs) (1) is the time interval in seconds for reading the tag values for the real-time trend. The default time interval is 1 second.

trend data contains the data from each tag, formatted for wiring to a waveform chart. These values are either in engineering units, or scaled, as specified by scale mode.

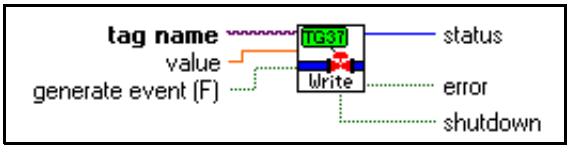
error indicates that an error occurred when executing Trend Tags, or that one or more tag values could not be accessed.

shutdown indicates that the BridgeVIEW Engine is shutting down. In this case, Trend Tags returns immediately with **shutdown** TRUE, and **trend data** might no longer be valid. You can use **shutdown** to exit any loop that uses the Trend Tags VI.

config change indicates that configuration of the Trend Tags VI has changed since the last execution. This could be because of a change in the list of tags in the trend, the **time interval** input, or the **scale to %** input. Optionally use this output to reinitialize your waveform chart because past history data will be no longer valid.

Write Tag

Use the Write Tag VI to update the Real-Time Database with a new value for memory, output, and Input/Output tags. The value also is sent to the server if it is an output or Input/Output tag. If the tag is an input only tag, the Write Tag VI causes a system error because input tags only can be updated by servers. If the tag is configured as an Input/Output tag, the tag value is passed to the server when Write Tag VI is called but not written to the RTDB. The RTDB is updated with the new value when the server polls it and passes it back to the BridgeVIEW Engine. This maintains correct time synchronization in the RTDB.



tag name is the name of the output tag.

value is the value to be written to the output tag.

generate event (F) determines whether a user change event is generated for the write operation on the tag. If the tag is configured with event logging on, this tag event can be displayed in the Event History Display in your HMI and logged to a `.evt` file. By default, **generate event** is FALSE.

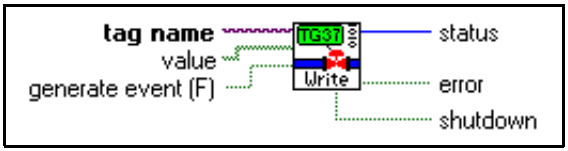
status returns the current status of the value written in the Real-Time Database. If **status** is greater than or equal to 0, the Write operation was successful. If **status** is less than 0, either the device server has reported an error indicating there is a problem with the tag, or BridgeVIEW has reported an error indicating there is a problem using the tag.

error indicates that an error occurred when executing the Write Tag VI, or that the status of the tag is bad. See **status** for the specific error condition.

shutdown indicates that the BridgeVIEW Engine is shutting down. In this case, Write Tag no longer waits for tags to be updated and returns immediately with both **timeout** and **shutdown** TRUE. You can use **shutdown** to exit any loop that uses the Write Tag VI.

Write Tag (bit array)

Use the Write Tag (bit array) VI to update the Real-Time Database with a new value for memory, output, and Input/Output tags. The value also is sent to the server if it is an output or Input/Output tag. If the tag is an input only tag, the Write Tag (bit array) VI causes a system error because input tags only can be updated by servers. If the tag is configured as an Input/Output tag, the tag value is passed to the server when Write Tag (bit array) VI is called but not written to the RTDB. The RTDB is updated with the new value when the server polls it and passes it back to the BridgeVIEW Engine. This maintains correct time synchronization in the RTDB.



tag name is the name of the output tag.

value is the value to be written to the output tag.

generate event (F) determines whether a user change event is generated for the write operation on the tag. If the tag is configured with event logging on, this tag event can be displayed in the Event History Display in your HMI and logged to a `.evt` file. By default, **generate event** is FALSE.

status returns the current status of the value written in the Real-Time Database. If **status** is greater than or equal to 0, the Write Tag (bit array) operation was successful. If **status** is less than 0, either the device server has reported an error indicating there is a problem with the tag, or BridgeVIEW has reported an error indicating there is a problem using the tag.

error indicates that an error occurred when executing the Write Tag (bit array) VI, or that the status of the tag is bad. See **status** for the specific error condition.

shutdown indicates that the BridgeVIEW Engine is shutting down. You can use **shutdown** to exit any loop that uses the Write Tag (bit array) VI.

Write Tag (discrete)

Use the Write Tag (discrete) VI to update the Real-Time Database with a new value for memory, output, and Input/Output tags. The value also is sent to the server if it is an output or Input/Output tag. If the tag is an input only tag, the Write Tag (discrete) VI causes a system error because input tags only can be updated by servers. If the tag is configured as an Input/Output tag, the tag value is passed to the server when Write Tag (discrete) VI is called but not written to the RTDB. The RTDB is updated with the new value when the server polls it and passes it back to the BridgeVIEW Engine. This maintains correct time synchronization in the RTDB.

tag name is the name of the output tag.

value is the value written to the output tag.

generate event (F) determines whether a user change event is generated for the write operation on the tag. If the tag is configured with event logging on, this tag event can be displayed in the Event History Display in your HMI and logged to a `.evt` file. By default, **generate event** is FALSE.

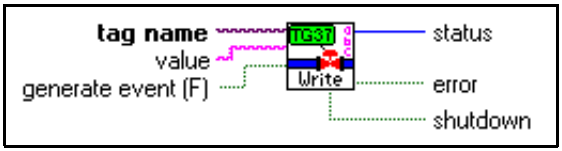
status returns the current status of the value written in the Real-Time Database. If **status** is greater than or equal to 0, the Write Tag (discrete) operation was successful. If **status** is less than 0, either the device server has reported an error indicating there is a problem with the tag, or BridgeVIEW has reported an error indicating there is a problem using the tag.

error indicates that an error occurred when executing the Write Tag (discrete) VI, or that the status of the tag is bad. See **status** for the specific error condition.

shutdown indicates that the BridgeVIEW Engine is shutting down. You can use **shutdown** to exit any loop that uses the Write Tag (discrete) VI.

Write Tag (string)

Use the Write Tag (string) VI to update the Real-Time Database with a new value for memory, output, and Input/Output tags. The value also is sent to the server if it is an output or Input/Output tag. If the tag is an input only tag, the Write Tag (string) VI causes a system error because input tags only can be updated by servers. If the tag is configured as an Input/Output tag, the tag value is passed to the server when Write Tag (string) VI is called but not written to the RTDB. The RTDB is updated with the new value when the server polls it and passes it back to the BridgeVIEW Engine. This maintains correct time synchronization in the RTDB.



tag name is the name of the output tag.

value is the value to be written to the output Tag.

generate event (F) determines whether a user change event is generated for the write operation on the tag. If the tag is configured with event logging on, this tag event can be displayed in the Event History Display in your HMI and logged to a `.evt` file. By default, **generate event** is FALSE.

status returns the current status of the value written in the Real-Time Database. If **status** is greater than or equal to 0, the Write Tag (string) operation was successful. If **status** is less than 0, either the device server has reported an error indicating there is a problem with the tag, or BridgeVIEW has reported an error indicating there is a problem using the tag.

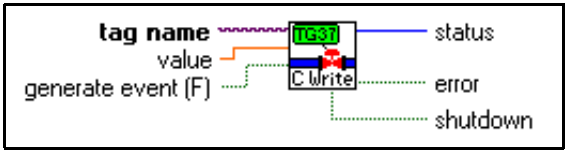
error indicates that an error occurred when executing the Write Tag (string) VI, or that the status of the tag is bad. See **status** for the specific error condition.

shutdown indicates that the BridgeVIEW Engine is shutting down. You can use **shutdown** to exit any loop that uses the Write Tag (string) VI.

Write Tag on Change

Use the Write Tag on Change VI to update the Real-Time Database with a new value for memory, output, and Input/Output tags. The value also is sent to the server if it is an output or Input/Output tag. The value is updated and sent to the server only if the tag value is different from the previous time the VI was executed. Use this VI if you do not need to pass output values to the RTDB and server unless there really is a value change. This saves you from adding code to your diagram to check value changes.

If the tag is an input only tag, Write Tag on Change VI causes a system error because input tags can only be updated by servers. If the tag is configured as an Input/Output tag, the tag value is passed to the server when Write Tag on Change VI is called but not written to the RTDB. The RTDB is updated with the new value when the server polls it and passes it back to the BridgeVIEW Engine. This maintains correct time synchronization in the RTDB.



tag name is the name of the output tag.

value is the value to be written to the output tag.

generate event (F) determines whether a user change event is generated for the write operation on the tag. If the tag is configured with event logging on, this tag event can be displayed in the Event History Display in your HMI and logged to a `.evt` file. By default, **generate event** is FALSE.

status returns the current status of the value written in the Real-Time Database. If **status** is greater than or equal to 0, the Write Tag on Change operation was successful. If **status** is less than 0, either the device server has reported an error indicating there is a problem with the tag, or BridgeVIEW has reported an error indicating there is a problem using the tag.

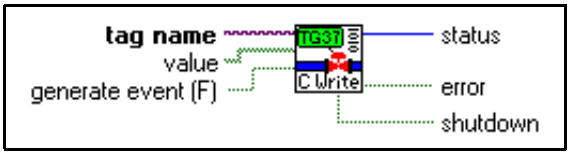
error indicates that an error occurred when executing Write Tag on Change or that the status of the tag is bad. See the **status** output for the specific error condition.

shutdown indicates that the BridgeVIEW Engine is shutting down. You can use **shutdown** to exit any loop that uses Write Tag on Change.

Write Tag on Change (bit array)

Use the Write Tag on Change (bit array) VI to update the Real-Time Database with a new value for memory, output, and Input/Output tags. The value also is sent to the server if it is an output or Input/Output tag. The value is updated and sent to the server only if the tag value is different from the previous time the VI was executed. Use this VI if you do not need to pass output values to the RTDB and server unless there really is a value change. This saves you from adding code to your diagram to check value changes.

If the tag is an input only tag, Write Tag on Change (bit array)VI causes a system error because input tags only can be updated by servers. If the tag is configured as an Input/Output tag, the tag value is passed to the server when Write Tag on Change (bit array)VI is called but not written to the RTDB. The RTDB is updated with the new value when the server polls it and passes it back to the BridgeVIEW Engine. This maintains correct time synchronization in the RTDB.



tag name is the name of the output tag.

value is the value to be written to the output tag.

generate event (F) determines whether a user change event is generated for the write operation on the tag. If the tag is configured with event logging on, this tag event can be displayed in the Event History Display in your HMI and logged to a `.evt` file. By default, **generate event** is FALSE.

status returns the current status of the value written in the Real-Time Database. If **status** is greater than or equal to 0, the Write Tag on Change (bit array) operation was successful. If **status** is less than 0, either the device server has reported an error indicating there is a problem with the tag, or BridgeVIEW has reported an error indicating there is a problem using the tag.

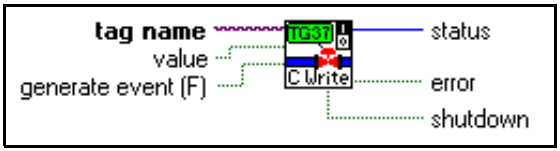
error indicates that an error occurred when executing Write Tag on Change (bit array) or that the status of the tag is bad. See the **status** output for the specific error condition.

shutdown indicates that the BridgeVIEW Engine is shutting down. You can use **shutdown** to exit any loop that uses the Write Tag on Change (bit array).

Write Tag on Change (discrete)

Use the Write Tag on Change (discrete)VI to update the Real-Time Database with a new value for memory, output, and Input/Output tags. The value also is sent to the server if it is an output or Input/Output tag. The value is updated and sent to the server only if the tag value is different from the previous time the VI was executed. Use this VI if you do not need to pass output values to the RTDB and server unless there really is a value change. This saves you from adding code to your diagram to check value changes.

If the tag is an input only tag, Write Tag on Change (discrete)VI causes a system error because input tags only can be updated by servers. If the tag is configured as an Input/Output tag, the tag value is passed to the server when Write Tag on Change (discrete)VI is called but not written to the RTDB. The RTDB is updated with the new value when the server polls it and passes it back to the BridgeVIEW Engine. This maintains correct time synchronization in the RTDB.



tag name is the name of the output tag.

value is the value to be written to the output tag.

generate event (F) determines whether a user change event is generated for the write operation on the tag. If the tag is configured with event logging on, this tag event can be displayed in the Event History Display in your HMI and logged to a `.evt` file. By default, **generate event** is FALSE.

status returns the current status of the value written in the Real-Time Database. If **status** is greater than or equal to 0, the Write Tag on Change (discrete) operation was successful. If **status** is less than 0, either the device server has reported an error indicating there is a problem with the tag, or BridgeVIEW has reported an error indicating there is a problem using the tag.

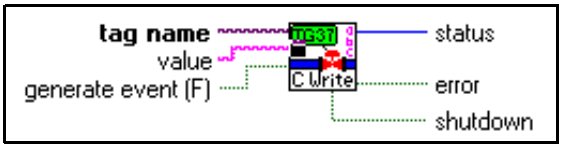
error indicates that an error occurred when executing Write Tag on Change (discrete) or that the status of the tag is bad. See the **status** output for the specific error condition.

shutdown indicates that the BridgeVIEW Engine is shutting down. In this case, Write Tag on Change (discrete) no longer waits for the tag to be updated and returns immediately with both **timeout** and **shutdown** TRUE. You can use **shutdown** to exit any loop that uses Write Tag on Change (discrete).

Write Tag on Change (string)

Use the Write Tag on Change (string) VI to update the Real-Time Database with a new value for memory, output, and Input/Output tags. The value also is sent to the server if it is an output or Input/Output tag. The value is updated and sent to the server only if the tag value is different from the previous time the VI was executed. Use this VI if you do not need to pass output values to the RTDB and server unless there really is a value change. This saves you from adding code to your diagram to check value changes.

If the tag is an input only tag, Write Tag on Change (string) VI causes a system error because input tags only can be updated by servers. If the tag is configured as an Input/Output tag, the tag value is passed to the server when Write Tag on Change (string) VI is called but not written to the RTDB. The RTDB is updated with the new value when the server polls it and passes it back to the BridgeVIEW Engine. This maintains correct time synchronization in the RTDB.



tag name is the name of the output tag.

value is the value to be written to the output tag.

generate event (F) determines whether a user change event is generated for the write operation on the tag. If the tag is configured with event logging on, this tag event can be displayed in the Event History Display in your HMI and logged to a `.evt` file. By default, **generate event** is FALSE.

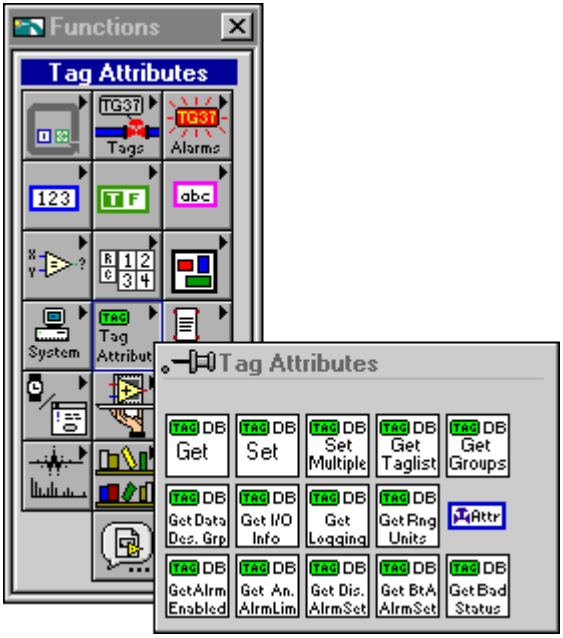
status returns the current status of the value written in the Real-Time Database. If **status** is greater than or equal to 0, the Write Tag on Change (string) operation was successful. If **status** is less than 0, either the device server has reported an error indicating there is a problem with the tag, or BridgeVIEW has reported an error indicating there is a problem using the tag.

error indicates that an error occurred when executing Write Tag on Change (string) or that the status of the tag is bad. See the **status** output for the specific error condition.

shutdown indicates that the BridgeVIEW Engine is shutting down. In this case, Write Tag on Change (string) no longer waits for the tag to be updated and returns immediately with both **timeout** and **shutdown** TRUE. You can use **shutdown** to exit any loop that uses Write Tag on Change (string).

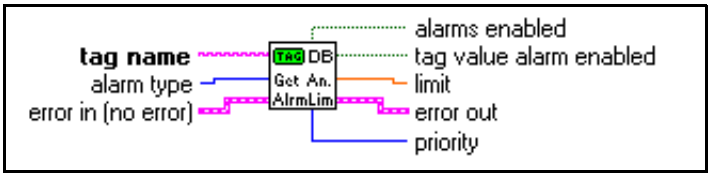
Tag Attributes VIs

Use the Tag Attributes VIs to get and set tag configuration parameters currently used by the BridgeVIEW Engine for tag processing programmatically. The Tag Attributes subpalette is shown below.



Get Analog Tag Alarm Limit

Use the Get Analog Tag Alarm Limit VI to obtain limit information for a single tag value alarm for an analog tag. Use the Alarm type input (HI_HI, HI, LO, LO_LO) to specify the desired alarm limit information.



tag name is the name of the tag about whether you want to obtain information.

alarm type determines the type of alarm for which information is queried. For analog tags, the various alarm types are HI_HI, HI, LO and LO_LO.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

alarms enabled indicates whether alarms are enabled for a tag. If TRUE, tag value alarms as well as bad status alarms are enabled for this tag, depending on the enable setting for the particular alarm types. If FALSE, all alarms are disabled for this tag, regardless of the enable settings for the particular alarm types.

tag value alarm enabled indicates whether alarms specified by **alarm type** are enabled. If FALSE, they are disabled. If TRUE, **alarm type** alarms are enabled.

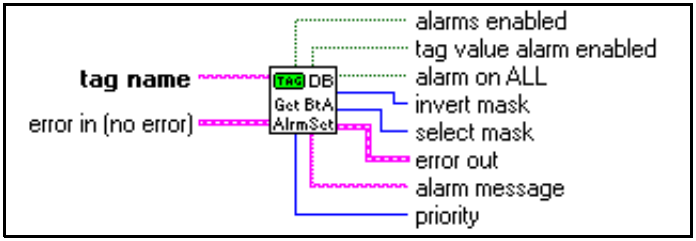
limit is the value corresponding to a given alarm type. For example, for HI_HI alarm, **limit** is the value the tag must exceed to go to the HI_HI alarm state.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

priority is the priority of the analog alarm being queried. The valid range is between 1 and 15, where 15 is the highest priority and 1 is the lowest.

Get Bit Array Tag Alarm Setting

Use the Get Bit Array Tag Alarm Setting VI to obtain alarm setting information for bit array tags.



tag name is the name of the tag about which you want to obtain information.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

alarms enabled indicates whether alarms are enabled for this tag. If TRUE, alarms are enabled for this tag. If FALSE, alarms are disabled.

tag value alarm enabled indicates whether alarms generated by changes in the value of the tag are enabled. If TRUE, alarms are enabled. If FALSE, they are disabled.

alarm on ALL indicates how many individual bits must be in alarm before the entire bit array tag is in alarm. If TRUE, an alarm is generated if all the bits are in alarm. If FALSE, an alarm is generated if any of the bits in the bit array tag are in alarm.

invert mask indicates the bits in the bit array tag that must be inverted before calculating whether the tag is in alarm. **invert mask** is represented in hexadecimal.

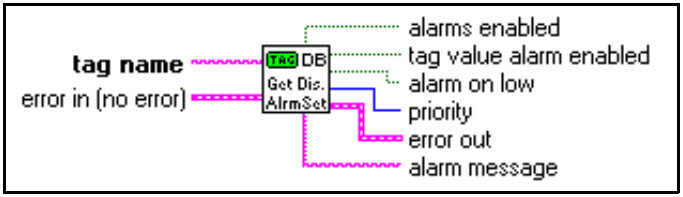
select mask indicates the bits in the bit array tag to be used for the alarm calculation.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

priority is the priority of the alarm for a bit array tag. The valid range is between 1 and 15, where 15 is the highest priority and 1 is the lowest.

Get Discrete Tag Alarm Setting

Use the Get Discrete Tag Alarm Setting VI to obtain alarm setting information for discrete tags.



tag name is the name of the tag about which you want to obtain information.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

alarms enabled indicates whether alarms are enabled for a tag. If TRUE, tag value alarms as well as bad status alarms are enabled for this tag, depending on the enable setting for the particular alarm types. If FALSE, all alarms are disabled for this tag, regardless of the enable settings for the particular alarm types.

tag value alarm enabled indicates whether alarms generated by changes in the value of the tag are enabled. If FALSE, they are disabled. If TRUE, they are enabled.

alarm on low indicates whether an alarm is generated depending on the discrete tag value. If FALSE, an alarm is generated if the discrete tag value is high. If TRUE, an alarm is generated if the discrete tag value is low.

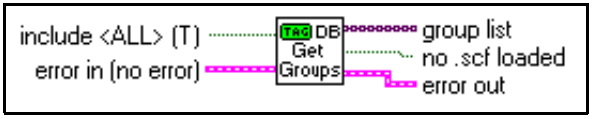
priority is the priority of the alarm for a discrete tag. The valid range is between 1 and 15, where 15 is the highest priority and 1 is the lowest.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

alarm message is the user defined string message displayed along with the alarm notification.

Get Group List

Use the Get Group List VI to returns a list of all configured groups in the system. By default, this VI includes the <ALL> group in the list.



include <ALL> (T) determines whether the <ALL> group should be included in the list. The default is TRUE.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

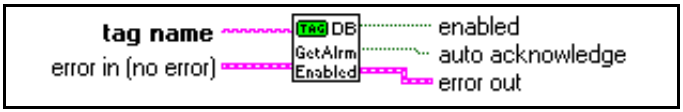
group list is the list of currently configured groups.

no .scf loaded is TRUE if there is no .scf file currently loaded in the system.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Get Tag Alarm Enabled

Use the Get Tag Alarm Enabled VI to indicate whether alarms are enabled for the tag. This VI also indicates whether alarms are acknowledged automatically when a tag previously in alarm returns to normal.



tag name is the name of the tag about which you want to obtain information.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

enabled indicates whether alarms are enabled for a tag. If TRUE, tag value alarms as well as bad status alarms are enabled for this tag, depending on the enable setting for the particular alarm types. If FALSE, all alarms are disabled for this tag, regardless of the enable settings for the particular alarm types.

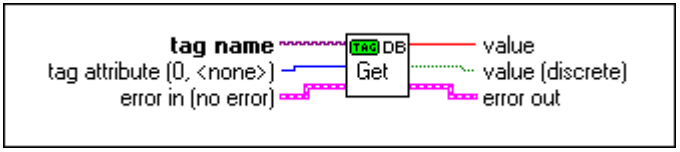
auto acknowledge indicates whether alarms are acknowledged automatically when a tag goes back to normal from an alarm state. If **auto acknowledge** is TRUE, the alarm is acknowledged automatically when the tag returns to normal. If it is FALSE, the user must acknowledge the alarm.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Get Tag Attribute

Use the Get Tag Attributes VI to obtain the value of a tag attribute. The **tag attribute** input provides a large list for selection. Each attribute is selected by specifying its numeric code. The value of the attribute selected is returned upon execution. If the attribute returns a numeric, use the **value** output. If the attribute returns a Boolean, use the **value (discrete)** output. For more information about the tag attributes you can query with this VI, refer to any of the four configuration attributes tables in the section *How Do You Configure Tags?* in Chapter 3, *Tag Configuration*, in this manual.

If the attribute returns a numeric output, **value (discrete)** returns a FALSE if the value is zero, and a TRUE if the value is nonzero. If the attribute returns a discrete output, **value** returns a 1 or 0, corresponding to TRUE or FALSE in **value (discrete)**.



tag name is the name of the tag about which you want to obtain information.

tag attribute (0, <none>) is a list of various parameters that you can query for a tag. Each attribute has a numeric code.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

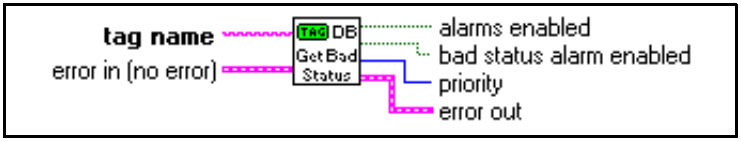
value is the numeric value of the attribute being queried. If the attribute returns a Boolean, **value** returns 1 or 0 corresponding to **value (discrete)**.

value (discrete) is the value of the Boolean attribute being queried. If the attribute returns a numeric, **value (discrete)** returns FALSE if **value** is 0, and TRUE if **value** is nonzero.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Get Tag Bad Status Alarm Info

Use the Get Tag Bad Status Alarm Info VI to determine whether alarms are enabled for the tag. This VI also returns whether the bad status alarm is enabled, and its priority.



tag name is the name of the tag about which you want to obtain information.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

alarms enabled indicates whether alarms are enabled for this tag. If TRUE, tag value alarms as well as bad status alarms are enabled for this tag, depending on the enable setting for the particular alarm types. If FALSE, all alarms are disabled for this tag, regardless of the enable settings for the particular alarm types.

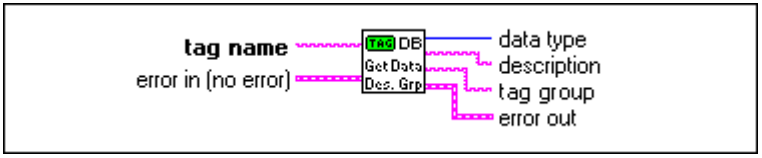
bad status alarm enabled indicates whether bad status alarms are generated for a tag if it has a bad status.

priority is the priority of the bad status alarm for a tag. The valid range is between 1 and 15, where 15 is the highest priority and 1 is the lowest.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Get Tag Description Group

Use the Get Tag Description Group VI to obtain a tag data type (analog, discrete, bit array, or string), description, and the group to which the tag belongs.



tag name is the name of the tag about which you want to obtain information.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

data type is the tag type (analog, discrete, bit array, or string).

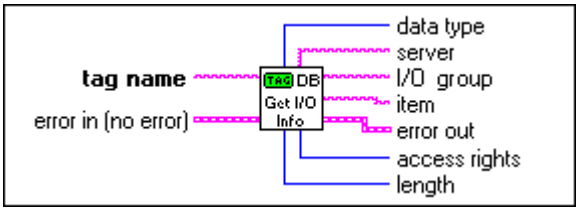
description is the user-defined description for the tag.

tag group is the tag group to which the tag belongs.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Get Tag I/O Connection Info

Use the Get Tag I/O Connection Info VI to obtain information on how the tag is connected to a real-world I/O point. Outputs include data type (analog, discrete, bit array, or string), server, I/O group, item, access rights (Memory, Input, Output, I/O), and length. For bit array tags, length is the number of discrete points in the tag. For string tags, length is the number of bytes. This output is not used for analog and discrete tags.



tag name is the name of the tag about which you want to obtain information.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

data type is the tag type (analog, discrete, string, or bit array).

server indicates the device server used for this tag. It is not applicable for memory tags, which have no servers associated with them by definition.

I/O group is the name of the I/O group the item is used with.

item is the channel, register, or item name.

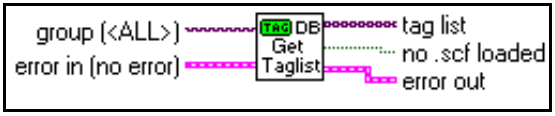
error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

access rights indicates whether the tag is a Memory, Input, Output, or Input/Output tag.

length is the maximum length for the tag. This field is applicable to bit array and string tags only. It is not used for analog or discrete tags.

Get Tag List

Use the Get Tag List VI to return a list of all tags in a group. By default, group is <ALL>, so the VI returns all configured tags.



group (<ALL>) determines what tags are in a list. The default is <ALL>, so that the VI returns all configured tags in tag list.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

tag list is the list of tags contained in group.

no .scf loaded is TRUE if there is no .scf file currently loaded in the system.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Get Tag Logging Info

Use the Get Tag Logging Info VI to determine whether a tag is configured for logging historical data or alarms and events to disk.

tag name is the name of the tag about which you want to obtain information.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

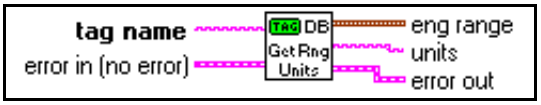
log data is TRUE if the tag is configured for logging data to the Citadel historical database.

log/print events is TRUE if events are to be logged or printed for this tag.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Get Tag Range and Units

Use the Get Tag Range and Units VI to obtain the engineering range for the tag in a cluster of **Minimum**, **Maximum**, and **Increment**. You can wire this format to a scale attribute node for a graph, slide, or vessel. **Increment** is set to 0, which means that BridgeVIEW calculates the scale increment automatically. **units** is the tag engineering units.



tag name is the name of the tag about which you want to obtain information.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

eng range is the range of the tag in engineering units. If you are plotting data on a chart, waveform graph, XY graph, slide or vessel, you can wire this output directly to the X Range (All Elements) or Y Range (All Elements) Attribute Node.

Minimum is the user defined minimum tag value.

Maximum is the user defined maximum tag value.

Increment is the delta in which the value increments. It is not a user defined value and is always 0. **Increment** determines how the chart or graph computes an increment based on the **Minimum**, **Maximum**, and the data set being plotted.

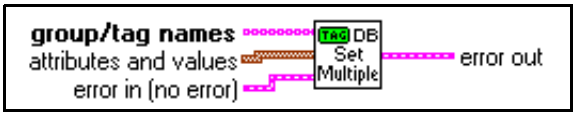
units is the name of units for engineering values. This parameter applies to analog tags only. For discrete, bit array, and string tags, **units** is an empty string.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Set Multiple Tag Attributes

Use the Set Multiple Tag Attributes VI to reconfigure several attributes for a list of tags or groups of tags programmatically. You must have the Engine running for the changes to take effect. Otherwise, this VI returns an error. For more information about the tag attributes you can change with this VI, refer to any of the five configuration attributes tables in the section *How Do You Configure Tags?* in Chapter 3, *Tag Configuration*, in this manual. Also see the *Tag Attributes VIs* section in Chapter 7, *Advanced Application Topics*.

Because the attribute value is a numeric, for discrete attributes, use 1 or 0 to represent TRUE or FALSE respectively. All the attributes are set for each tag in **group/tag name**.



group/tag names is the list of tags, or groups of tags, for which you want to set attributes.

attributes and values is a list of attributes and values to be set. You can select multiple attributes and their corresponding values, and they will be applied to all the tags. For more information about the tag attributes you can change with this VI, refer to any of the four configuration attributes tables in the section *How Do You Configure Tags?* in Chapter 3, *Tag Configuration*, in this manual.

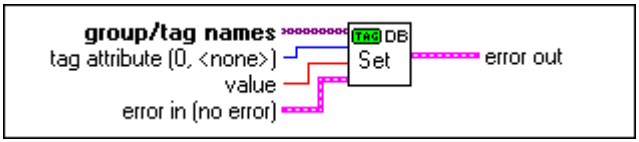
error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

Set Tag Attribute

Use the Set Tag Attribute VI to reconfigure an attribute for a list of tags or groups of tags programmatically. You must have the Engine running for the change to take effect. Otherwise, this VI returns an error. For more information about the tag attributes you can change with this VI, refer to any of the five configuration attributes tables in the section *How Do You Configure Tags?* in Chapter 3, *Tag Configuration*, in this manual. Also see the *Tag Attributes VIs* section in Chapter 7, *Advanced Application Topics*.

The **tag attribute** input provides a large list for selection.Each attribute is selected by sepcifying its numeric code. Use **value** to set the value of the attribute selected. If the attribute is a Boolean, use a 1 or 0 in **value**.



group/tag names is a list of tags or groups of tags, for which you want to set an attribute.

tag attribute (0, <none>) is the parameter to be set for each tag in **group/tag names**. For more information about the tag attributes you can change with this VI, refer to any of the four configuration attributes tables in the section *How Do You Configure Tags?* in Chapter 3, *Tag Configuration*.

value is the numeric value of the attribute being set. If the attribute is a Boolean, use 1 or 0 for **value**.

error in (no error) is a cluster that describes the error status before this VI executes. For more information about this control, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

error out is a cluster that describes the error status after this VI executes. For more information about this indicator, see the section *Errors Not Reported by the BridgeVIEW Engine* in this appendix.

B

Citadel and Open Database Connectivity

This appendix describes the Citadel database and the Open Database Connectivity (ODBC) driver, and includes a table that lists data transform commands.

The Citadel historical database includes an Open Database Connectivity (ODBC) driver. This driver enables other applications to directly retrieve data from Citadel using Structured Query Language (SQL) queries. To use the SQL ODBC interface to Citadel, you must have installed the Citadel ODBC driver from the BridgeVIEW CD.

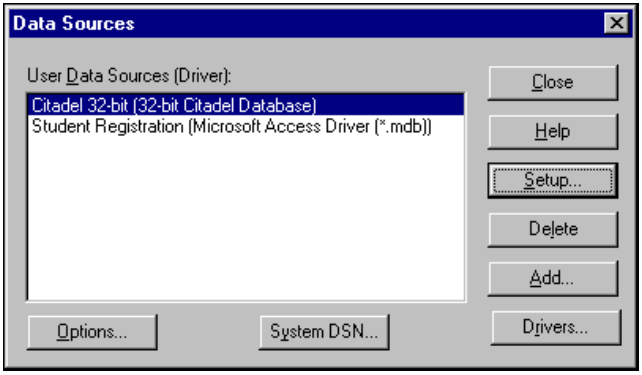
What is ODBC?

ODBC is a standard developed by Microsoft. It defines the mechanisms for accessing data resident in database management systems (DBMSs). Virtually all Windows-based applications that can retrieve data from a database supporting ODBC.

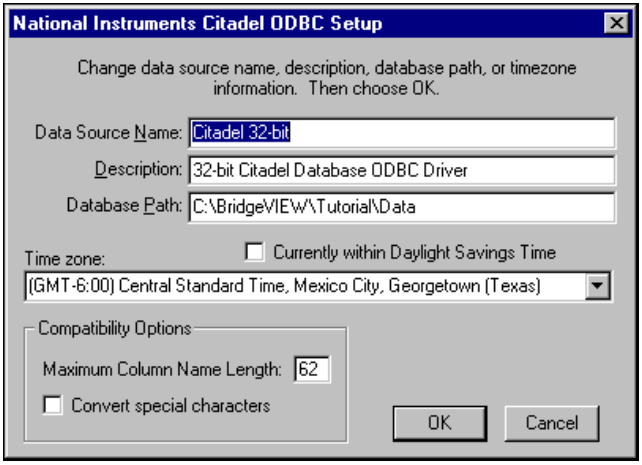
Because Citadel allows simultaneous real-time access by multiple applications, the ODBC Driver can retrieve data from the Citadel database even while BridgeVIEW is running. There is no need to interrupt data collection in order to query the database. In fact, the ODBC Driver allows multiple ODBC applications to perform SQL queries simultaneously.

Configuring the ODBC Driver

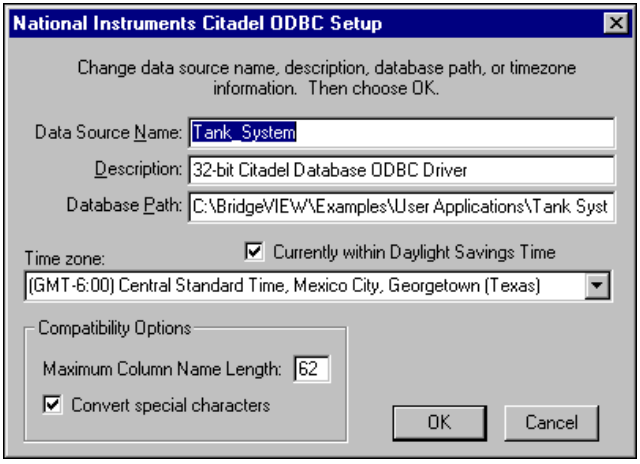
1. Shut down all applications that currently might be using ODBC. Such applications include spreadsheets, word processors, database programs, MS Query, etc. You do not need to shut down BridgeVIEW.
2. Click the **Start** button, point to Settings, then click Control Panel. Otherwise, in the Main program group, choose the Control Panel icon.
3. In the Control Panel dialog box, choose the 32-bit ODBC.
4. In the Data Sources dialog box, choose **Drivers…**.



5. Choose the Citadel driver and select **Setup…**.



6. Make changes as appropriate. Select the historical logging directory that was configured in your Tag Configuration (`*.scf`) file for each data source. For example, if you want to query the historical data created by the Tanks System example, directory, modify the database path to `C:\BridgeVIEW\Examples\User Applications\Tank System\Data`. You also can modify the name of the data source to reflect the application. An example of a modified ODBC Setup dialog box is shown below.



☞ **Note** ***Some applications are not completely ODBC compliant. If you plan to use Microsoft Query, Microsoft Access or Visual Basic, ensure*** *Maximum Column Name Length* ***does not exceed 62 characters. These packages cannot handle longer tag names. Other packages that are truly ODBC compliant should be able to handle tag names up to 126 characters long. All threads whose tag names exceed the*** *Maximum Column Name Length* ***are excluded from queries.***

If you plan to use Microsoft Access or Visual Basic, select *Convert special characters.* ***This forces BridgeVIEW tag names into a format acceptable by these applications by replacing characters within the tag names as follows:***

Original Character	Converted To
period (.)	backslash (\ )
ampersand (&)	at sign (@)
exclamation (!)	vertical bar (|)

7. Select **OK** and **CLOSE** to exit.

What is SQL?

Structured Query Language (SQL) is an industry-standard language used for retrieving, updating and managing data. You can use SQL to build queries that extract data from Citadel. Beyond simple data extraction, the Citadel ODBC driver also includes many built-in data transforms that greatly simplify statistical analysis of retrieved data.

How Do You Access Citadel Data?

The ODBC driver presents Citadel data to other applications as a *Threads* table. The table contains a field or column for each data member logged to the Citadel database.

Threads Table

The Threads table contains three fields you can use to specify query criteria and to time-stamp retrieved data: `Interval`, `LocalTime`, and `UTCTime`.

Interval allows you to specify the query value sample rate. **Interval** can range from 10ms to several years. By default, **Interval** is 1 (one day).

Remember, Citadel only logs a value when the value changes (it is event-driven). But using **Interval**, you can query Citadel for values evenly spaced over a period of time.

LocalTime and **UTCTime** indicate the time-stamps of when values are logged. Citadel actually stores the time in **UTCTime** format and derives **LocalTime** from the stored time. When you do not specify a time, Citadel assumes midnight of the current day.

The following *where clause* from a query takes advantage of **Interval** and **LocalTime** to select data over a specified time at one minute intervals. Notice that time and date formats are the same as those used in BridgeVIEW.

```
SELECT * FROM Threads
WHERE LocalTime > "12/1 10:00"
   AND LocalTime < "12/2 13:00"
   AND Interval = "1:00"
```

Data Transforms

Your queries can include special commands that perform data transforms, making it easy to manipulate and analyze historical data. The following table lists data transform commands.

Table B-1. Data Transform Commands

Data Transform Command	Description
Min{tag name}	Returns the minimum for tag name across the interval.
Max{tag name}	Returns the maximum for tag name across the interval.
Avg{tag name}	Returns the average for tag name across the interval.
StDev{tag name}	Returns the standard deviation for tag name across the interval.
Starts{tag name}	Returns the number of starts (number of transitions from OFF to ON) for tag name across the interval.
Stops{Datapoint}	Returns the number of stops (number of transitions from ON to OFF) for Datapoint across the interval.
ETM{Datapoint}	Returns the amount of time Datapoint was in the ON state across the interval.
Qual{Datapoint}	There might be gaps in the historical data threads in Citadel because of machine shutdown or BridgeVIEW shutdown. Qual returns the ratio of time for which valid data exists for a datapoint across the interval, to the length of the interval itself. Thus if valid data exists for only one-half of the interval, Qual would return 0.5.

These data transforms allow you to directly calculate and retrieve complex information from the database such as averages and standard deviations. This time saving feature eliminates the need of extracting raw data first, and then massaging it in another application to come up with the needed information.

Assume, for example, that you want to find out how many times a compressor motor started in December. You also want to know its total runtime for the month. The following query provides the answers:

```
SELECT "Starts{MotorRun}",
"ETM{MotorRun}"
FROM Threads
WHERE LocalTime >= "12/1/95"
    AND LocalTime < "1/1/96"
    AND Interval = "31"
```

SQL Examples

The following examples are typical query statements; however, your queries may be much more involved, depending on your system requirements.

- Retrieves the *most recent (current)* value of every tag logged to Citadel.

```
SELECT *
FROM Threads
```

- Retrieves the value of every tag logged today in one second increments. `Note the interval value is specified within quotation marks.`

```
SELECT *
FROM Threads
WHERE Interval="0:01"
```

- Retrieves and time-stamps the value of `Powder` in one second increments from 8:50 this morning to now. Tag names are surrounded by quotes.

```
SELECT LocalTime, "Powder"
FROM Threads
WHERE LocalTime>"8:50"
    AND Interval="0:01"
```

- Retrieves and time-stamps the value of `Liquid` input in one minute intervals for the month of October. Also indicates the input's highest occurring value within each minute.

```
SELECT LocalTime, "Liquid", "Max{Liquid}"
FROM Threads
WHERE LocalTime>"10/1/96"
    AND LocalTime<"11/1/96"
    AND Interval="1:00"
```

- Retrieves an oven's temperature set point and value at 3:00 p.m. and shows the highest, lowest, and average temperatures between 2:00 p.m. and 3:00 p.m.

```
SELECT LocalTime, "OVEN1_SP", "OVEN1_PV",
"Max{OVEN1_PV}", "Min{OVEN1_PV}", "Avg{OVEN1_PV}"
FROM Threads
WHERE  LocalTime >= "14:00"
   AND LocalTime < "15:00"
   AND Interval = "1:00:00"
```

Queries Using Specific Applications

The following sections include information on queries using specific applications.

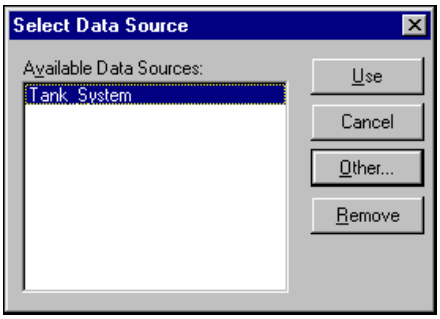
Using Microsoft Query with Citadel

Note ***The exact operation of Microsoft Query might change from version to version. Look in the online help for Microsoft Query for how to connect to an ODBC Data Source for the exact instructions for your version of Microsoft Query.***

Microsoft Query is a graphical data retrieval tool supplied with Microsoft Office and Microsoft Excel. It allows you to build your SQL statement using interactive dialog boxes. Let's step through a somewhat involved example to show you a few simple tricks.

To activate MS Query, double-click the **MS Query** icon, typically found in the MS Office program group. If you cannot find the icon, look in `C:\Program Files\Common Files\MicroSoft Shared\MSQuery\Msqry32.exe`. MS Query is not part of an MS Office standard installation, so if you do not find it on your system, install it from your MS Office disks.

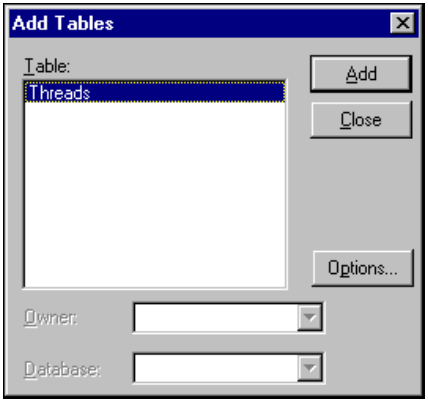
Choose **File»New Query…** to begin and select the data source you have setup for your Citadel historical directory as shown here. You might need to press **Other…** to access a list of data sources to select.



Note ***If MS Query is unable to connect to a Citadel data source, you have not yet logged data to Citadel; or the*** *Database path* ***you specified in the ODBC Setup dialog box is incorrect.***

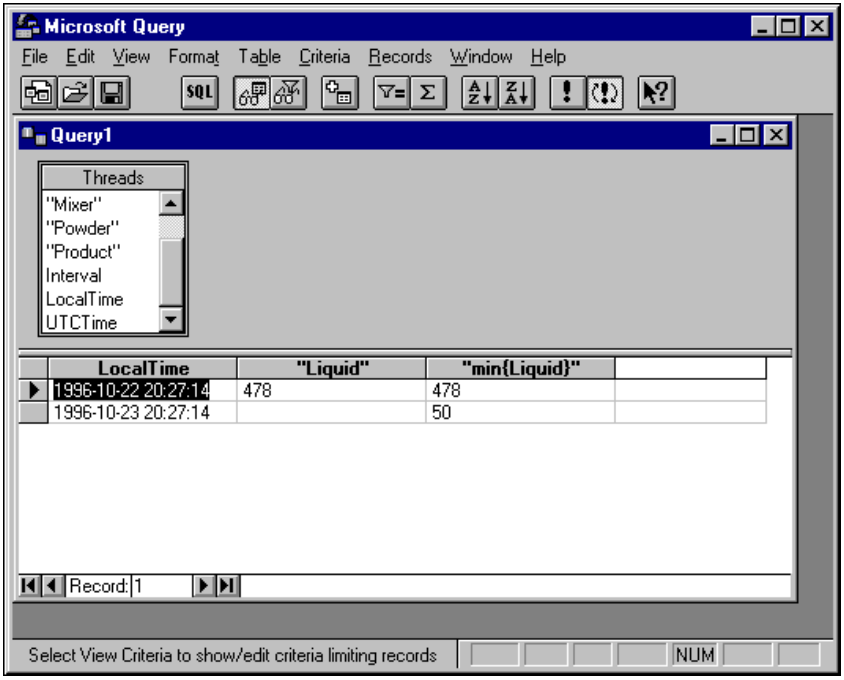
Note ***If the Citadel data source is not listed in the Select Data Source dialog box, you might not have accessed it yet. Choose*** **Other…** ***and select*** **Citadel** ***from among the ODBC data sources. If Citadel is not listed as an ODBC Data Source, you need to install it. See the*** *Configuring the ODBC Driver* ***section for more information****.*

In the Add Tables dialog box, double click **Threads**. Then close the dialog box.



MS Query presents the full Query Window with the Threads table shown. Notice the list of tag names in the Threads table. This list is a comprehensive list of all tags whose values have been logged to Citadel.

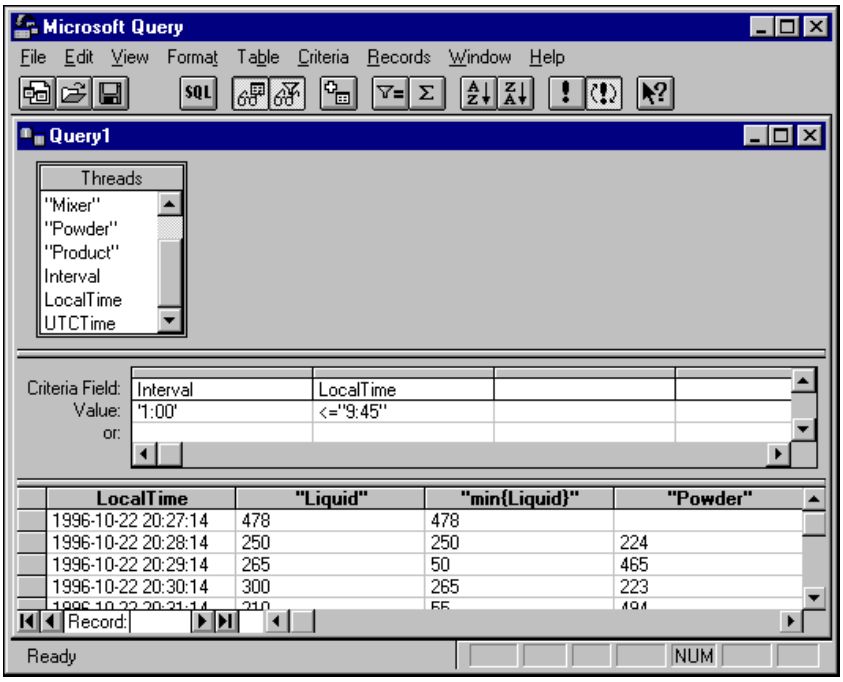
To view the value of a field, double click it or drag it to the data pane.



To view a data transform value, enter the function directly into a blank column. For example, to view the minimum value of `Liquid`, you would enter "`min{Liquid}`". Take special note of the use of quotation marks and braces.

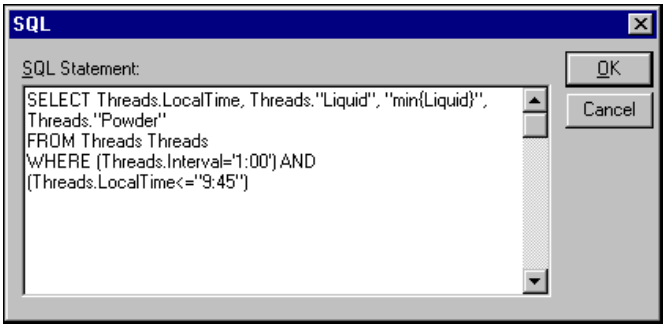
The above data set was retrieved using no specifying criteria, so the ODBC driver used the default criteria. There are several ways to specify criteria. For this example, we'll use the criteria pane. Click the **View Criteria** button.

To add a field to the criteria pane, drag it from the list of fields to the Criteria Field.



When you enter qualifying criteria values, be sure to use the syntax demonstrated in the where clauses of the SQL Examples found in this chapter. To specify a starting time of 9:45 today, for example, you would enter `>= "9:45"`.

As soon as you specify a criteria, Microsoft Query immediately retrieves the specified data. You can save your query at any stage of its development. As you build your query, the application builds an SQL statement. When you click the **SQL** button, you can view and edit the query statement, as shown in the following dialog box.

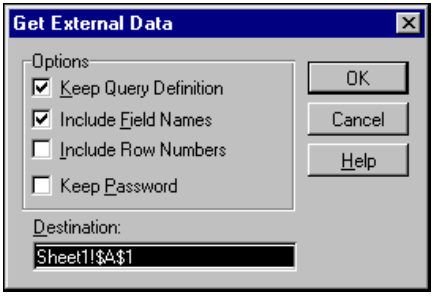


Using Microsoft Excel with Citadel

Note ***The exact operation of Microsoft Excel might change from version to version. Look in the online help for Microsoft Excel for how to connect to an ODBC Data Source for the exact instructions for your version of Microsoft Excel.***

To extract data from Citadel, activate Excel and choose **Data»Get External Data…**. This Excel command directly activates Microsoft Query. From here you can use an existing query or create a new one. See the *Using Microsoft Query with Citadel* section.

When you finish building your query, return the result set by choosing **File»Return Data to Microsoft Excel…**. Excel responds by presenting the Get External Data dialog box, enabling you to change or confirm the destination cells of the result set. If you want to update the result set later by requerying Citadel, be sure that **Keep Query Definition** remains selected. Choose **OK** to write the data into the Excel worksheet.



To update your result set, select any cell within the worksheet's result set, choose **Data»Get External Data…**, and click the **Refresh** button.

Using Microsoft Access with Citadel

The exact operation of Microsoft Access might change from version to version. Look in the online help for Microsoft Access for how to connect to an ODBC Data Source for the exact instructions for your version of Microsoft Access.

☞ **Note** ***The SQL/92 standard states that a delimited identifier is any string of not more than 128 characters enclosed in quotation marks. It further states that characters within a delimited identifier are exempt from SQL syntax checking. Unfortunately, Microsoft Access performs its own syntax checking for ODBC queries using a non-standard SQL syntax—even within delimited identifiers. For this reason, National Instruments provides a*** *Convert Special Characters* ***selection in the Citadel ODBC Setup dialog box. When selected, the ODBC driver converts the disallowed characters to something acceptable to Access, as follows:***

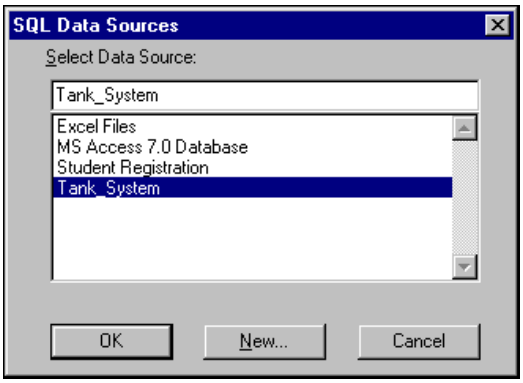
Disallowed Character	Converted To
period (.)	backslash (\ )
ampersand (&)	at sign (@)
exclamation (!)	vertical bar (|)

Therefore, Access recognizes a BridgeVIEW identifier such as Modbus1.40001 as the delimited identifier Modbus1\40001.

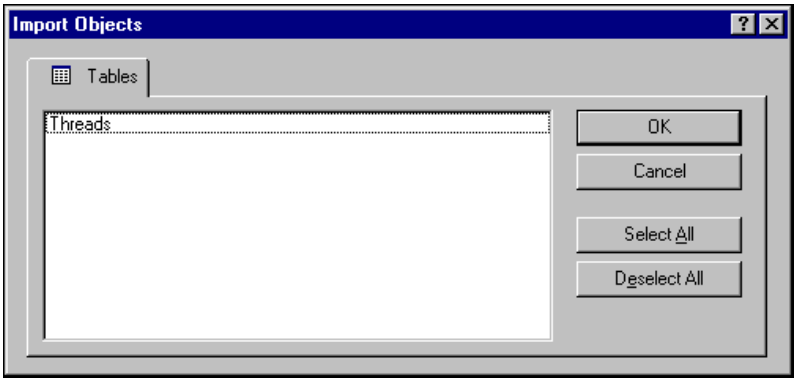
When you query Citadel data using MS Access, You must use Microsoft Access's non-standard SQL syntax in your select statement. Be sure to use the special characters that are converted for Access compatibility and double quotes around BridgeVIEW thread names. Finally, you must use square brackets [ ] around identifiers, and #'s around time stamps. For example, to retrieve LocalTime, Liquid, and Powder where LocalTime is less than 10/22/95 18:00:00, and where Interval is one second, enter:

```
SELECT LocalTime, ["Liquid"], ["Powder"]
FROM Threads
WHERE LocalTime < #10/22/96 6:00:00 PM#
   AND Interval = '0:01'
```

To query Citadel from within MS Access, open a database, select **File»Get External Data…** and then click **Import**. In the Import dialog box, in the Files of Type box, select **ODBC Databases()**. In the SQL Data Sources dialog box, choose your Citadel Data Source, as shown here.



In the Import Objects dialog box, choose **Threads**. The new table attaches to your database.



Now you can build queries in Access that extract data directly from the Citadel database.

Using Visual Basic with Citadel

The exact operation of Visual Basic might change from version to version. Look in the online help for Visual Basic for how to connect to an ODBC Data Source for the exact instructions for your version of Visual Basic.

Note ***Visual Basic software relies on Microsoft Access DLLs for performing ODBC queries. Because it uses the non-standard SQL syntax of Access, be sure that*** *Convert Special Characters* ***is selected in the Citadel ODBC Setup dialog box. See the note in the*** *Using Microsoft Access with Citadel* ***section in this appendix.***

Using the Citadel ODBC Driver in Visual Basic is the same as using any other ODBC driver. To retrieve and view data, create a Data control and at least one text control.

First place a Data control on an open form. Set its **Connect** property to `DSN=Citadel` (or the name of the Citadel data source) and double click its **Record Source** property to identify Threads as its source table.

You can leave the **Record Source** property set to Threads if you want to select all of the data for all of the threads in the Citadel database, or you can narrow your query by entering an SQL select statement in the **Record Source** property. For example, to retrieve LocalTime, Liquid, and Powder where LocalTime is greater than 10/20/95 18:00:00 and less than 18:30:00, and where Interval is one minute, enter:

```
SELECT LocalTime, ["Liquid "], ["Powder "]
FROM Threads
WHERE LocalTime > #11/20/95 6:00:00 PM#
    AND LocalTime < #11/20/95 6:30:00 PM#
    AND Interval = '1:0'
```

You must use the SQL syntax of Microsoft Access in your select statement. Also remember to use the special characters that are converted for Access compatibility and double quotes around BridgeVIEW thread names to identify them as *delimited* identifiers. Finally, Access SQL requires square brackets [ ] around identifiers, and #s around time stamps.

Now place a Text control on the form. Set its **Data Source** property to the name of your Data control—for example, Data1. Click the **Data Field** property to highlight it and then using the property sheet's drop-down combo box, select the desired field name. All logged data members should be listed including LocalTime, Interval, Liquid, etc. Repeat this step for each data member you want to display on your form.

C

Customer Communication

For your convenience, this appendix contains forms to help you gather the information necessary to help us solve your technical problems and a form you can use to comment on the product documentation. When you contact us, we need the information on the Technical Support Form and the configuration form, if your manual contains one, about your system configuration to answer your questions as quickly as possible.

National Instruments has technical assistance through electronic, fax, and telephone systems to quickly provide the information you need. Our electronic services include a bulletin board service, an FTP site, a fax-on-demand system, and e-mail support. If you have a hardware or software problem, first try the electronic support systems. If the information available on these systems does not answer your questions, we offer fax and telephone support through our technical support centers, which are staffed by applications engineers.

Electronic Services

Bulletin Board Support

National Instruments has BBS and FTP sites dedicated for 24-hour support with a collection of files and documents to answer most common customer questions. From these sites, you can also download the latest instrument drivers, updates, and example programs. For recorded instructions on how to use the bulletin board and FTP services and for BBS automated information, call 512 795 6990. You can access these services at:

United States: 512 794 5422
Up to 14,400 baud, 8 data bits, 1 stop bit, no parity

United Kingdom: 01635 551422
Up to 9,600 baud, 8 data bits, 1 stop bit, no parity

France: 01 48 65 15 59
Up to 9,600 baud, 8 data bits, 1 stop bit, no parity

FTP Support

To access our FTP site, log on to our Internet host, `ftp.natinst.com`, as `anonymous` and use your Internet address, such as `joesmith@anywhere.com`, as your password. The support files and documents are located in the `/support` directories.

Fax-on-Demand Support

Fax-on-Demand is a 24-hour information retrieval system containing a library of documents on a wide range of technical information. You can access Fax-on-Demand from a touch-tone telephone at 512 418 1111.

E-Mail Support (Currently USA Only)

You can submit technical support questions to the applications engineering team through e-mail at the Internet address listed below. Remember to include your name, address, and phone number so we can contact you with solutions and suggestions.

`support@natinst.com`

Telephone and Fax Support

National Instruments has branch offices all over the world. Use the list below to find the technical support number for your country. If there is no National Instruments office in your country, contact the source from which you purchased your software to obtain support.

Country	Telephone	Fax
Australia	03 9879 5166	03 9879 6277
Austria	0662 45 79 90 0	0662 45 79 90 19
Belgium	02 757 00 20	02 757 03 11
Brazil	011 288 3336	011 288 8528
Canada (Ontario)	905 785 0085	905 785 0086
Canada (Québec)	514 694 8521	514 694 4399
Denmark	45 76 26 00	45 76 26 02
Finland	09 725 725 11	09 725 725 55
France	01 48 14 24 24	01 48 14 24 14
Germany	089 741 31 30	089 714 60 35
Hong Kong	2645 3186	2686 8505
Israel	03 6120092	03 6120095
Italy	02 413091	02 41309215
Japan	03 5472 2970	03 5472 2977
Korea	02 596 7456	02 596 7455
Mexico	5 520 2635	5 520 3282
Netherlands	0348 433466	0348 430673
Norway	32 84 84 00	32 84 86 00
Singapore	2265886	2265887
Spain	91 640 0085	91 640 0533
Sweden	08 730 49 70	08 730 43 70
Switzerland	056 200 51 51	056 200 51 55
Taiwan	02 377 1200	02 737 4644
United Kingdom	01635 523545	01635 523154
United States	512 795 8248	512 794 5678

Technical Support Form

Photocopy this form and update it each time you make changes to your software or hardware, and use the completed copy of this form as a reference for your current configuration. Completing this form accurately before contacting National Instruments for technical support helps our applications engineers answer your questions more efficiently.

If you are using any National Instruments hardware or software products related to this problem, include the configuration forms from their user manuals. Include additional pages if necessary.

Name _____

Company _____

Address _____

_____

Fax (___) _____Phone (___) _____

Computer brand_____ Model _____Processor_____

Operating system (include version number) _____

Clock speed _____MHz RAM _____MB Display adapter _____

Mouse ___yes ___no Other adapters installed _____

Hard disk capacity _____MB Brand_____

Instruments used _____

_____

National Instruments hardware product model _____ Revision _____

Configuration _____

National Instruments software product _____ Version _____

Configuration _____

The problem is: _____

_____

_____

_____

_____

List any error messages: _____

_____

_____

The following steps reproduce the problem: _____

_____

_____

_____

_____

BridgeVIEW Hardware and Software Configuration Form

Record the settings and revisions of your hardware and software on the line to the right of each item. Complete a new copy of this form each time you revise your software or hardware configuration, and use this form as a reference for your current configuration. Completing this form accurately before contacting National Instruments for technical support helps our applications engineers answer your questions more efficiently.

National Instruments Products

DAQ hardware _____

Interrupt level of hardware _____

DMA channels of hardware _____

Base I/O address of hardware _____

Programming choice _____

BridgeVIEW version_____

Other boards in system _____

Base I/O address of other boards _____

DMA channels of other boards _____

Interrupt level of other boards _____

Other Products

Application software developer _____

Computer make and model _____

Microprocessor _____

Clock frequency or speed _____

Type of video board installed _____

Operating system version _____

Operating system mode _____

Programming language _____

Programming language version _____

Other boards in system _____

Base I/O address of other boards _____

DMA channels of other boards _____

Interrupt level of other boards _____

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Title: *BridgeVIEW™ User Manual*

Edition Date: May 1998

Part Number: 321294C-01

Please comment on the completeness, clarity, and organization of the manual.

_____

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If you find errors in the manual, please record the page numbers and describe the errors.

_____

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Thank you for your help.

Name _____

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Glossary

Prefix	Meanings	Value
m-	milli-	10^{-3}
µ-	micro-	10^{-6}
n-	nano-	10^{-9}

A

access level — Numeric value between 0 and 255 that can be used to control access to your HMI.

ACK (Acknowledge) — The sequence action that indicates recognition of a new alarm.

alarm — An abnormal process condition. In BridgeVIEW, an alarm occurs if a tag value goes out of its defined alarm limits or if a tag has bad status.

Alarm Summary — A display of tags currently in alarm, or a display of tags previously in an unacknowledged alarm state that have returned to a normal state.

analog tag — A continuous value representation of a connection to a real-world I/O point or memory variable. This type of tag can vary continuously over a range of values within a signal range.

Application Programming Interface — A specification of a set of software functions and their input and return parameters.

application software — The application created using the BridgeVIEW Development System and executed in the BridgeVIEW Run-Time System environment.

array — An ordered, indexed set of data elements of the same type.

ASCII — American Standard Code for Information Interchange.

attribute node — A special block diagram node you can use to control the appearance and functionality of controls and indicators.

B

bit array tag	A multibit value representation of a connection to a real-world I/O point or memory variable. In BridgeVIEW, this type of tag can be comprised of up to 32 discrete values.
block diagram	A pictorial description or representation of a program or algorithm. In BridgeVIEW, the block diagram, which consists of executable icons called nodes and wires that carry data between the nodes, is the source code for the VI. The block diagram resides in the Diagram window of the VI.
Boolean controls and indicators	Front panel objects used to manipulate and display or input and output Boolean (TRUE or FALSE) data. Several styles are available, such as switches, buttons and LEDs.
breakpoint	Mode that halts execution when a subVI is called. You set a breakpoint by clicking on the Breakpoint button in the execution palette.
BridgeVIEW	A program development application for real-time process monitoring and control. BridgeVIEW uses the graphical development environment called G.
BridgeVIEW Engine	The heart of the BridgeVIEW system. It maintains the Real-Time Database of all tag values and alarm states. The BV Engine runs as a separate process, independent of your HMI application.
BridgeVIEW Run-Time System	An execution environment for applications created using the BridgeVIEW Development System.
broken VI	VI that cannot be compiled or run; signified by a broken arrow in the Run button.

C

Case structure	Conditional branching control structure, which executes one and only one of its subdiagrams based on its input. It is the combination of the IF, THEN, ELSE, and CASE statements in control flow languages.
Citadel	A database for storing historical tag values.

cluster	A set of ordered, unindexed data elements of any data type including numeric, Boolean, string, array, or cluster. The elements must be all controls or all indicators.
coercion dot	A gray dot on a terminal to indicate that one of two terminals wired together has been converted to match the data type representation of the other.
connector	Part of the VI or function node that contains its input and output terminals, through which data passes to and from the node.
connector pane	Region in the upper right corner of a front panel window that displays the VI terminal pattern. It underlies the icon pane.
constant	*See* universal constant *and* user-defined constant.

D

data flow	Programming system consisting of executable nodes in which nodes execute only when they have received all required input data and produce output automatically when they have executed.
deadband	In process instrumentation, the range through which an input signal can vary, upon reversal of direction, without initiating an observable change in output signal. Deadband is usually expressed in percent of range. *See* log deadband *and* update deadband.
device	An instrument or controller that is addressable as a single entity and controls or monitors real-world I/O points. A device is often connected to the host computer through some type of communication network, or can be a plug-in device.
device server	An application that communicates with and manages a peripheral hardware device such as a Programmable Logic Control (PLC), remote I/O device or plug-in device. Device servers pass tag values to the BridgeVIEW Engine in real time.
discrete tag	A two-state (on/off) value representation of a connection to a real-world I/O point. In BridgeVIEW, this type of tag can be either a one (TRUE) or a zero (FALSE).

dynamic attributes — Tag attributes that do not require the BridgeVIEW Engine to be restarted when they are edited or reconfigured. Examples of dynamic attributes include enabling logging operations, alarm attributes, and some scaling attributes. *See also* static attributes.

E

Engine — *See* BridgeVIEW Engine.

engineering units (EU) — Terms of data measurement, as degrees Celsius, pounds, grams and so on.

error message — An indication of a software or hardware malfunction, or an unacceptable data entry attempt.

event — Something that happens to a tag in the BridgeVIEW system. Events include tags going into or out of alarm state and the user setting a tag value.

event driven programming — A method of programming whereby the program waits on an event occurring before executing one or more functions.

F

For Loop — Iterative loop structure that executes its subdiagram a set number of times. Equivalent to conventional code:
`For i = 0 to n – 1, do....`

formula node — Node that executes formulas that you enter as text. Especially useful for lengthy formulas that would be cumbersome to build in block diagram form.

frame — Subdiagram of a Sequence Structure.

free label — Label on the front panel or block diagram that does not belong to any other object.

front panel — The interactive user interface of a VI. Modeled from the front panel of physical instruments, it is composed of switches, slides, meters, graphs, charts, gauges, LEDs, and other controls and indicators.

G

G	The graphical programming language used to develop BridgeVIEW applications.
group	*See* tag group *or* I/O group.

H

Help window	Special window that displays the names and locations of the terminals for a function or subVI, the description of controls and indicators, the values of universal constants, and descriptions and data types of control attributes. The window also accesses the **Online Reference**.
historical trend	A plot of data (values versus time) showing values that were previously acquired in the system or logged to disk.
Historical Trend Viewer (HTV)	A utility that accesses historical data from the Citadel historical database.
HMI G Wizard	A utility in BridgeVIEW that automates the process of generating HMI diagram code.
Human Machine Interface (HMI)	A graphical user interface for the user to interact with the BridgeVIEW system.

I

I/O Group	A set of related server items, all of which share the same server update rate and deadband.
icon	Graphical representation of a node on a block diagram.
icon pane	Region in the upper right corner of the Panel and Diagram windows that displays the VI icon.
input tag	A tag that accepts Real-Time Database values from a device server.
Input/Output (I/O) tag	A tag that accepts Real-Time Database values from a device server and sends values to the server.

item	A channel or variable in a real-world device that is monitored or controlled by a BridgeVIEW device server.

L

LabVIEW	Laboratory Virtual Instrument Engineering Workbench. A program development application used commonly for test and measurement purposes.
log deadband	The range through which a tag value must change before it is logged to Citadel.
log resolution	The smallest change in a tag value stored in the historical database.

M

Man Machine Interface (MMI)	*See* Human Machine Interface (HMI).
MB	Megabytes of memory.
memory tag	A tag not connected to a real-world I/O point. Memory tags are used for user-defined calculations. *See also* tag and network tag.

N

network tag	A tag remotely connected to any type of tag on another BridgeVIEW Engine. *See also* tag and memory tag.

O

object	Generic term for any item on the front panel or block diagram, including controls, nodes, wires, and imported pictures.
OPC	OLE for Process Control. A COM-based standard defined by the OPC foundation that specifies how to interact with device servers. COM is a Microsoft 32-bit Windows technology.
operating tool	Tool used to enter data into controls as well as operate them. Resembles a pointing finger.

operator — The person who initiates and monitors the operation of a process.

output tag — A tag that sends values to a device server whenever it is updated in the Real-Time Database.

P

palette — A display of pictures that represent possible options.

Panel G Wizard — A utility in BridgeVIEW that automates the process of creating front panel controls.

Panel window — VI window that contains the front panel, the execution palette and the icon/connector pane.

PID — *See* Proportional Integral Derivative Control.

PLC — *See* Programmable Logic Control.

polling — A method of sequentially observing each I/O point or user interface control to determine if it is ready to receive data or request computer action.

pop up — To call up a special menu by clicking, usually on an object, with the right mouse button.

pop-up menus — Menus accessed by popping up, usually on an object. Menu options pertain to that object specifically.

positioning tool — Tool used to move and resize objects. Resembles an arrow.

Programmable Logic Control (PLC) — A device with multiple inputs and outputs that contains a program you can alter. BridgeVIEW Device Servers establish communication with PLCs.

Proportional Integral Derivative (PID) Control — A combination of proportional, integral, and derivative control actions. Refers to a control method in which the controller output is proportional to the error, its time history, and the rate at which it is changing. The error is the difference between the observed and desired values of a variable that is under control action.

pseudocode — Simplified language-independent representation of programming code.

R

range	The region between the limits within which a quantity is measured, received, or transmitted expressed by stating the lower and upper range values.
Real-Time Database (RTDB)	An in-memory snapshot of all tags in the system.
real-time trend	A plot of data (values versus time) that is updated as each new point is acquired in the Real-Time Database.
reentrant execution	Mode in which calls to multiple instances of a subVI can execute in parallel with distinct and separate data storage.
representation	Subtype of the numeric data type, of which there are signed and unsigned byte, word, and long integers, as well as single-, double-, and extended-precision floating-point numbers, both real and complex.
resizing handles	Angled handles on the corner of objects that indicate resizing points.
RTDB	*See* Real-Time Database.

S

sampling period	The time interval between observations in a periodic sampling control system.
SCADA	Supervisory Control and Data Acquisition.
sensor	A device that produces a voltage or current output representative of some physical property being measured, such as speed, temperature, or flow.
sequence local	A terminal that passes data between the frames of a Sequence Structure.
Sequence structure	Program control structure that executes its subdiagrams in numeric order. Commonly used to force nodes that are not data-dependent to execute in a desired order.
shift register	Optional mechanism in loop structures used to pass the value of a variable from one iteration of a loop to a subsequent iteration.

static attributes	Tag attributes that require the BridgeVIEW Engine to be restarted if they are edited or reconfigured. Examples of static attributes are general attributes and I/O connection attributes, such as server, device, or item. *See also* dynamic attributes.
string tag	An ASCII character representation of a connection to a real-world I/O point.
structure	Program control element, such as a Sequence, Case, For Loop, or While Loop.
subVI	A VI called on the diagram of another VI.
supervisory control	Control in which the control loops operate independently subject to intermittent corrective action.
system developer	The creator of the application software to be executed in the BridgeVIEW Run-Time System.
System errors	Errors that happen in the BridgeVIEW system, like a server going down. System errors are displayed in a dialog box, on the Engine User Interface, and also are logged in a syslog file.
System events	Events that occur in the BridgeVIEW system, like an operator logging on or a utility starting up. System events are logged in a syslog file.

T

tag	A connection to a real-world I/O point or a memory variable. Tags can be one of four data types: analog, binary, discrete, or string.
tag attributes	Parameters pertaining to a tag, like its alarm, limits, or Engineering Units. Tag attributes are configured in the Tag Configuration Editor but can be changed dynamically using the Tag Attributes VIs.
Tag Browser	A utility to view the configuration parameters of a tag, as configured in the Tag Configuration Editor.
Tag Configuration Editor	A utility to configure various parameters of a tag, such as connection information, scaling, or logging.
tag group	A set of tags primarily used for reporting and acknowledging alarms. A tag can be associated with only one tag group. All tags belong to the group `<ALL>` by default.

Tag Monitor	A utility to view the current value of a tag, along with its status and alarm state.
tag status	A variable that determines the validity of a tag value. A negative status represents an error, a positive status represents a warning, and a status of zero represents a good tag value.
terminal	Object or region on a node through which data passes.
timestamp	The exact time and date at which a tag value was sampled. Tag values are stored with their timestamps in the RTDB.
top-level VI	VI at the top of the VI hierarchy. This term distinguishes the VI from its subVIs.
trend	A view of data over time. Trends can display real-time or historical data.

U

universal constant	Uneditable block diagram object that emits a particular ASCII character or standard numeric constant, for example, π.
update deadband	The range through which a tag value must change before it is updated in the Real-Time Database.
user	*See* operator.
user-defined constant	Block diagram object that emits a value you set.

V

VI	*See* virtual instrument.
VI library	Special file that contains a collection of related VIs for a specific use.
virtual instrument	A program in the graphical programming language G; so-called because it models the appearance and function of a physical instrument.

W

While Loop	Post-iterative test loop structure that repeats a section of code until a condition is met. Comparable to a Do loop or a Repeat-Until loop in conventional programming languages
wire	Data path between nodes.
wiring tool	Tool used to define data paths between source and sink terminals.
Wizard	*See* HMI G Wizard *and* Panel G Wizard.
Wizard lock	A glyph that appears on a tag loop to indicate BridgeVIEW has protected the association between a front panel object and the automatically generated block diagram. If a Wizard lock exists on a tag loop, you cannot modify that block diagram. Once you have released the Wizard lock, the association is broken and the Wizard no longer protects that tag loop.

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