

GPIB Analyzer User Manual

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National Instruments Corporate Headquarters

6504 Bridge Point Parkway

Austin, TX 78730-5039

(512) 794-0100

Technical support fax: (800) 328-2203

(512) 794-5678

Branch Offices:

Australia 03 9 879 9422, Austria 0662 45 79 90 0, Belgium 02 757 00 20,

Canada (Ontario) 519 622 9310, Canada (Québec) 514 694 8521,

Denmark 45 76 26 00, Finland 90 527 2321, France 1 48 14 24 24,

Germany 089 741 31 30, Hong Kong 2645 3186, Italy 02 48301892,

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Netherlands 0348 433466, Norway 32 84 84 00, Singapore 2265886,

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About This Manual

This manual contains instructions to help you use the National Instruments GPIB analyzer software for Windows. The analyzer software is intended for use with Windows version 3.1 or higher. This manual assumes that you are already familiar with Windows.

Organization of This Manual

This manual is organized as follows:

- Chapter 1, *Introduction*, gives an overview of the GPIB analyzer.
- Chapter 2, *GPIB Analyzer Windows*, describes each of the windows in the GPIB analyzer program.
- Chapter 3, *How To*, describes how to accomplish specific tasks within the GPIB analyzer application.
- Chapter 4, *Tutorial*, contains a hands-on tutorial to help you practice using the different features of the GPIB analyzer.
- Chapter 5, *Examples*, contains several case scenario examples to show you how you might use the analyzer to solve your IEEE 488 problems.
- Appendix A, *Common Questions*, answers common questions about the GPIB analyzer.
- Appendix B, *Keyboard Commands*, lists keyboard shortcuts that you can use within the GPIB analyzer.
- Appendix C, *Capture Display Mnemonics*, explains the mnemonics that appear in the capture display of the GPIB analyzer.
- Appendix D, *Customer Communication*, contains forms you can use to request help from National Instruments or to comment on our products and manuals.
- The *Glossary* contains an alphabetical list and a description 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 menus, menu items, or dialog box buttons or options.
<i>bold italic</i>	Bold italic text denotes a note, caution, or warning.
bold monospace	Bold text in this font denotes the messages and responses that the computer automatically prints to the screen.
<i>italic</i>	Italic text denotes emphasis, a cross reference, or an introduction to a key concept.
monospace	Text in this font denotes text or characters that are to be literally input from the keyboard, sections of code, programming examples, and syntax examples. This font is also used for the proper names of disk drives, directories, programs, subprograms, subroutines, device names, functions, variables, field names and filenames.
< >	Angle brackets enclose the name of a key on the keyboard—for example, <PageDown>.

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

Related Documentation

The following documents contain information that you may find helpful as you read this manual.

- ANSI/IEEE Standard 488.1-1987, *IEEE Standard Digital Interface for Programmable Instrumentation*
- ANSI/IEEE Standard 488.2-1992, *IEEE Standard Codes, Formats, Protocols, and Common Commands*
- *Microsoft Windows User's Guide*, Microsoft Corporation

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 D, *Customer Communication*, at the end of this manual.

Chapter 1

Introduction

This chapter gives an overview of the GPIB analyzer.

GPIB Analyzer Overview

The GPIB analyzer is an application that you can use for testing, debugging, and analysis. It can monitor, capture, and participate in bus activity on the GPIB. You can use the GPIB analyzer to test and debug your own applications by monitoring and capturing GPIB activity while your application is running. The analyzer also has tools to help you analyze the data that you capture. Analyzing this data can help you solve many of the difficulties associated with GPIB communication, such as addressing inconsistencies, protocol violations, and simple bus timeout conditions.

Online Help

The GPIB analyzer program includes an online help system, which you can access while running the analyzer by pressing <F1> or using the **Help** menu. The online help contains basically the same information as this user manual.

Windows of the Analyzer

The analyzer, created with the National Instruments LabWindows[®]/CVI development environment, consists of several major windows.

- Main window Contains all other windows of the GPIB analyzer.
- Action window Contains three controls: Capture, Capture & Trigger, and Off.
- Settings window Displays settings the analyzer uses for capturing and triggering, and allows you to change settings.
- Capture Display window Displays captured GPIB events.
- Bus Monitor window Displays the real-time status of each of the GPIB data and control lines, and allows you to change the state of the lines.
- Find window Specifies criteria to search for in a capture display.

Monitoring GPIB Activity with the GPIB Analyzer

With the GPIB analyzer, you can monitor the status of all the GPIB lines. When monitoring the GPIB, you can toggle switches to manually assert or unassert signal lines at any time to perform tasks such as stepping through the states of the source or acceptor handshake. You can also choose to manually accept one byte at a time.

Capturing Data with the GPIB Analyzer

The analyzer can capture and display data, including any combination of the following GPIB events: data transfers, command transfers, control line transitions, handshake line transitions, and parallel poll responses. You can participate in handshaking or do a non-intrusive capture.

You might want to capture and display data based on a specific bus event without knowing when the event might occur. In this case, you can specify a trigger condition and capture any number of events before and after the trigger condition occurs. The capture operation proceeds according to how you set the capture settings in the Capture Settings window.

The analyzer can perform the acceptor handshake while capturing, and you can choose to time stamp each captured event relative to the previous captured event. The number of capture samples you can store is limited only by the memory available on your computer.

Analyzing Captured Data with the GPIB Analyzer

The GPIB analyzer provides several features to help you analyze data that you have captured:

- Use markers for highlighting and examining specific transactions in the captured data, and for determining elapsed time between captured events.
- Use the flexible pattern-search utility to locate specific bus patterns.
- Store captured data to disk for later review in the Capture Display window.
- Print captured data to a selected printer.

You can reload previously saved transactions for further review and analysis. You can even have multiple Capture Display windows open, so that you can analyze current bus activity in one window and the previously captured data in another window.

Installing the GPIB Analyzer

For detailed instructions on how to install the GPIB analyzer software, refer to your GPIB getting started manual.

Note: *If you already installed the NI-488.2 software for Windows, the analyzer software may already be installed on your computer.*

Starting the GPIB Analyzer

To launch the GPIB analyzer program, double-click on the **GPIB Analyzer** icon in the **GPIB Analyzer Software** group in Windows.

Chapter 2

GPIB Analyzer Windows

This chapter describes each of the windows in the GPIB analyzer program.

The analyzer consists of several major windows.

- Main window Contains all other windows of the GPIB analyzer.
- Action window Contains controls to turn capturing off and on, and to turn on both capturing and triggering.
- Settings window Displays settings the analyzer uses for capturing and triggering, and allows you to change settings.
- Capture Display window Displays captured GPIB events.
- Bus Monitor window Displays the real-time status of each of the GPIB data and control lines, and allows you to change the state of the lines.
- Find window Specifies criteria to search for in a capture display.

Main Window

The Main window contains all the windows of the GPIB analyzer. The Action window and Bus Monitor window are always open. Figure 2-1 shows the Main window.

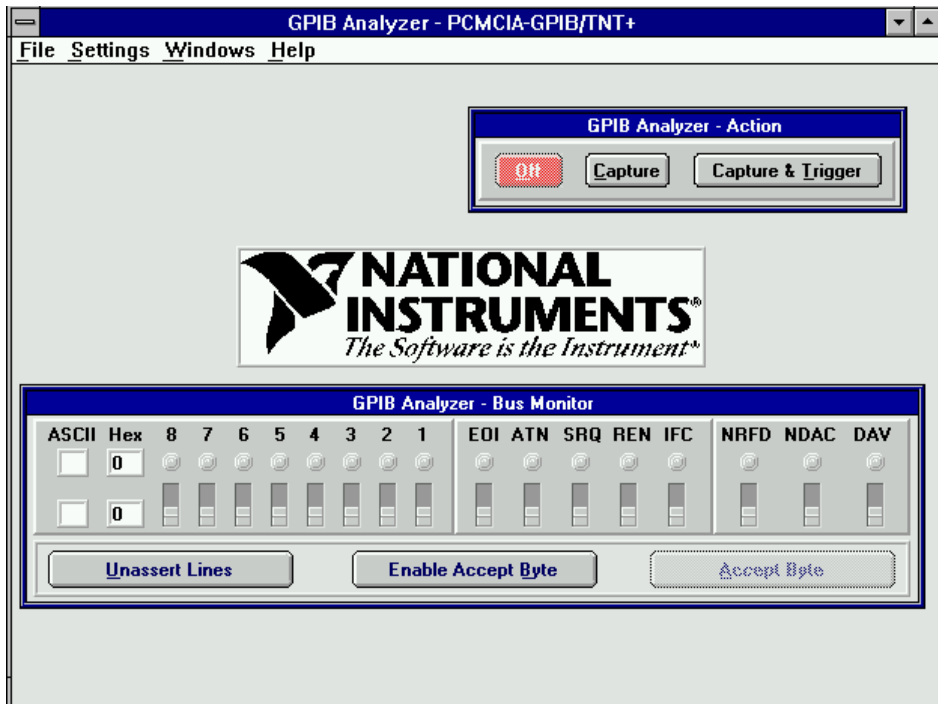


Figure 2-1. Main Window of the GPIB Analyzer

Choosing **New Capture Display** from the **File** menu opens a new, active Capture Display window. When you start capturing GPIB events by selecting one of the capture buttons in the Action window, you can view them in the active Capture Display window.

Choosing **Open Capture Display...** from the **File** menu opens a previously saved window of captured GPIB events as an inactive display. Filenames for GPIB analyzer capture files typically use the .CAP extension.

Choosing **Exit** from the **File** menu closes the GPIB Analyzer application. The analyzer prompts you to save any Capture Display window that contains unsaved GPIB events. The current settings, as specified in the Settings window, are saved automatically, and they are automatically loaded the next time you open the GPIB analyzer.

Choosing **Change Settings...** from the **Settings** menu opens the Settings window so that you can change the settings used for capturing GPIB events and triggering on specific GPIB events.

Choosing **Load Settings...** from the **Settings** menu opens a file of previously saved settings to be used for capturing GPIB events and triggering on specific GPIB events. Filenames for GPIB analyzer settings typically use the `.SET` extension.

Choosing **Save Settings As...** from the **Settings** menu allows you to save the current settings, as specified in the Settings window. Whenever possible, use the `.SET` extension for GPIB analyzer settings filenames.

The **Windows** menu lists all of the currently open GPIB analyzer windows. When you select a window from this menu, it is brought to the front.

The **Help** menu accesses the online help system for the GPIB Analyzer. It also accesses information about the analyzer software, such as version number and hardware configuration.

Action Window

The Action window contains controls you can use to turn capturing off and on, and to turn on both capturing and triggering. The Action window is automatically open when you start the GPIB analyzer. Figure 2-2 shows the Action window.

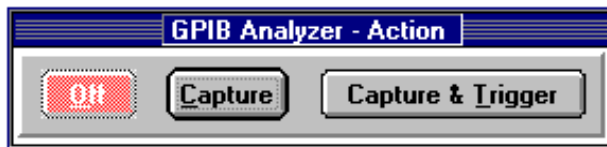


Figure 2-2. Action Window

Clicking the **Off** button causes the analyzer to stop capturing GPIB events and stop looking for trigger conditions.

Clicking the **Capture** button causes the analyzer to begin capturing GPIB events into all active Capture Display windows. The analyzer captures data according to the current configuration in the Settings window, but it does not look for any trigger condition.

Clicking on the **Capture & Trigger** button causes the analyzer to begin capturing data into all active Capture Display windows and to look for trigger conditions. The analyzer captures data and looks for trigger conditions as specified in the Settings window.

Bus Monitor Window

The Bus Monitor window allows you to monitor and control each of the 16 GPIB signal lines. It also allows you to accept one GPIB byte at a time. The Bus Monitor window is automatically open when you start the GPIB analyzer. Figure 2-3 shows the Bus Monitor window.

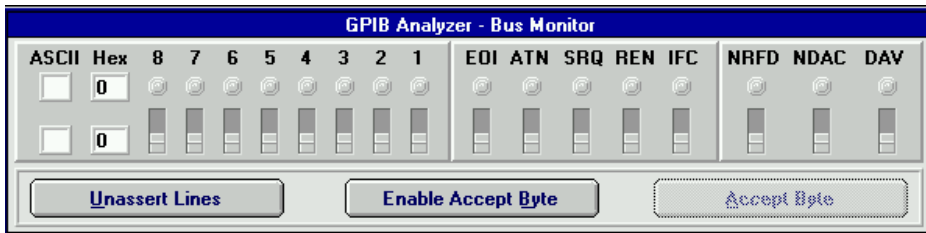


Figure 2-3. Bus Monitor Window

The **ASCII** box on the top row displays the current value of the GPIB data lines (8-1) in ASCII format. You can enter a printable ASCII character in the **ASCII** box on the bottom row to change the settings of the data lines.

The **Hex** box on the top row displays the current value of the GPIB data lines (8-1) in hexadecimal format. You can enter a one-digit or two-digit hexadecimal value in the **Hex** box on the bottom row to change the settings of the data lines.

The current value of each GPIB data line is displayed by the LEDs labeled **8** to **1** (where 8 is the most significant bit). The current value of the GPIB control and handshake lines is displayed by the LEDs labeled **EOI** through **DAV**. You can monitor these lines, or you can assert/unassert them by moving the toggle switches. A line is asserted by the Bus Monitor when the toggle switch is in the up position. If the LED for a particular line is on and the switch for that line is off (down position), the line is asserted, but not by the Bus Monitor.

Clicking on the **Unassert Lines** button moves all of the toggle switches to the down position and disables the **Accept Byte** button.

Clicking on the **Enable Accept Byte** button prepares the analyzer to accept either GPIB data or command bytes, one byte at a time, and changes the button title to **Disable Accept Byte**. The analyzer unasserts NRFD and asserts NDAC. When another GPIB device on the bus asserts the DAV signal, click on the **Accept Byte** button to automatically accept the byte and prepare to accept the next byte. Enabling this feature disables the manual toggle switches for the NRFD and NDAC lines. When you are finished accepting data, click on the **Disable Accept Byte** button to release control of the handshaking lines.

Clicking on the **Accept Byte** button causes the analyzer to examine the state of the DAV line to determine whether another GPIB device is trying to source a byte. If DAV is

unasserted, clicking on **Accept Byte** has no effect because no data is available to be accepted. If DAV is asserted, clicking on **Accept Byte** accepts a single byte of GPIB data by automatically toggling NRFD and NDAC in the proper sequence. Before you can use this button, you must click on the **Enable Accept Byte** button in this window.

Settings Window

The Settings window displays the configuration used by the GPIB analyzer for capturing and triggering. The settings only apply to active Capture Display windows when the control in the Action window is set to **Capture** or **Capture & Trigger**. You cannot change the settings in this window unless capturing is turned off.

To open the Settings window, choose **Change Settings...** from the **Settings** menu in the Main window. Figure 2-4 shows the Settings window.

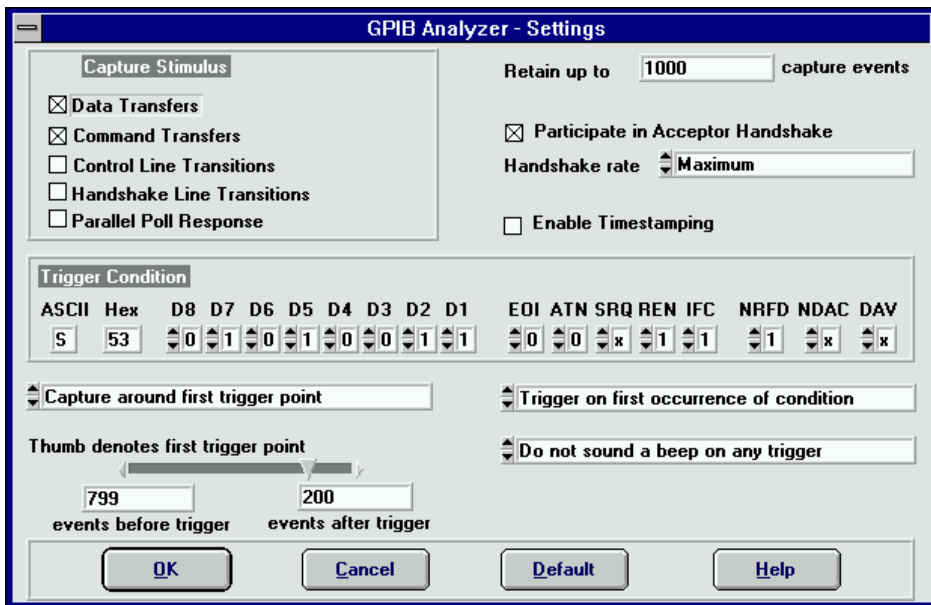


Figure 2-4. Settings Window

Buffer, Handshaking, and Timestamping Controls

The **Retain up to ? capture events** field specifies the number of captured GPIB events that can be kept in the memory buffer at one time. Once the buffer becomes full, the oldest GPIB events are discarded to make space for new events.

Selecting the **Participate in Acceptor Handshake** checkbox causes the GPIB analyzer to participate in acceptor handshaking on the GPIB. You can use this feature to slow down GPIB transfers to a particular rate or to avoid overflow errors.

The **Handshake rate** field is used to select the rate at which the GPIB analyzer accepts data and command bytes. It is disabled unless the **Participate in Acceptor Handshake** box is checked. The **Maximum** option allows the analyzer to accept bytes at the fastest rate possible without causing overflow errors. The other numeric options slow down all GPIB transfers to a rate no greater than the rate specified.

Selecting the **Enable Timestamping** checkbox causes the GPIB analyzer to place a timestamp on every GPIB event that it captures, starting with a timestamp of zero.

Capture Stimulus Checkboxes

Selecting the **Data Transfers** checkbox causes the GPIB analyzer to capture all data bytes transferred on the GPIB. Both IEEE 488 and HS488 data transfers are captured.

Selecting the **Command Transfers** checkbox causes the GPIB analyzer to capture all GPIB command bytes transferred on the GPIB.

Selecting the **Control Line Transitions** checkbox causes the GPIB analyzer to capture all transitions of the GPIB control lines. The control lines are used to manage the GPIB interface system.

Selecting the **Handshake Line Transitions** checkbox causes the GPIB analyzer to capture all transitions of the GPIB handshake lines. The handshake lines are used to transfer GPIB data and command bytes. Because this selection causes a large amount of GPIB events to be captured, you should select it only when you need to debug a problem with the handshaking of a particular GPIB device. Because some handshake line transitions may fall within the 50 ns resolution of the analyzer, they might be captured and displayed as a single event when you check this box.

Selecting the **Parallel Poll Responses** checkbox causes the GPIB analyzer to capture all GPIB parallel poll responses. To delimit the beginning of a GPIB parallel poll, the analyzer captures the assertion of ATN and EOI. The next capture, after 2 μ s, denotes the beginning of the parallel poll response. The analyzer then captures data each time the response on a GPIB data line changes. To delimit the end of a GPIB parallel poll, the analyzer captures when ATN and EOI are unasserted.

For more information about setting the capture stimulus, refer to *Configure Capture Settings* in Chapter 3, *How To*.

Trigger Condition Boxes

The **ASCII** text box is used to enter a printable ASCII character into the eight data line list boxes (**D8-D1**) to the right of this field. The value is used as a trigger condition when you select **Capture & Trigger** in the Action window. You must enter values for the control lines and handshake lines separately.

The **Hex** text box is used to enter a one-digit or two-digit hexadecimal value into the eight data line list boxes (**D8-D1**) to the right of this field. The value is used as a trigger condition when you select **Capture & Trigger** in the Action window. You must enter values for the control lines and handshake lines separately.

The list boxes **D8** through **DAV** specify the desired state of all GPIB lines for the trigger condition when you select **Capture & Trigger** in the Action window. Each switch has three possible states: 0 is unasserted, 1 is asserted, and X is don't care, which means the line can be asserted or unasserted.

Trigger Settings

The **Capture around first trigger point** list box specifies whether to stop or continue the capture, based on the trigger point. The **Capture around first trigger point** setting captures a certain number of events before and after the trigger point, depending on the placement of the thumb bar below this field. After the specified number of events are captured, capturing stops, and the Action window selection changes to **Off**. Even if multiple triggers occur, only the first trigger is used as the point to capture around. **Capture indefinitely after trigger point** disables the thumb bar below this field and allows the oldest captured events to be discarded once the buffer becomes full.

The thumb bar selects the position of the trigger point within a capture. You can also use the **events before trigger** and **events after trigger** boxes below this field to enter the desired values.

The **events before trigger** field specifies the number of GPIB events to be captured before the trigger condition occurs. When you enter a number into this field, the value in the **events after trigger** field automatically changes so that the total number of captured events will fit into the buffer.

The **events after trigger** field specifies the number of GPIB events to be captured after the trigger condition occurs. When you enter a number into this field, the value in the **events before trigger** field automatically changes so that the total number of captured events will fit into the buffer.

The **Trigger on first occurrence of condition** field selects how trigger points should be indicated in the Capture Display window. If **Trigger on first occurrence of condition** is selected, only the first occurrence of the specified GPIB event is treated as a trigger point. If **Trigger on all occurrences of condition** is selected, every occurrence of the specified event is considered a trigger point. Trigger points are enclosed in a dotted rectangle to distinguish them from other GPIB events.

The **Do not sound a beep on any trigger** field specifies whether the GPIB analyzer sounds a system beep at the first trigger event, all trigger events, or not at all.

For more information about setting the trigger conditions, refer to *Set Trigger Conditions* in Chapter 3, *How To*.

Buttons

Clicking on the **OK** button registers the changes made to the settings in this window, and then closes the window. These settings are used the next time you choose the **Capture** or **Capture & Trigger** button in the Action window. If you want to save these settings to a file for later use, choose **Save Settings As...** in the **Settings** menu of the Main window.

Clicking on the **Cancel** button cancels the changes made to the settings in this window, and then closes the window.

Clicking on the **Default** button changes all of the settings in this window to match the default values, without closing the window. If you want to register the default values, click on the **OK** button after clicking on **Default**.

Capture Display Window

The Capture Display window shows the captured GPIB events. You can have more than one Capture Display window open at one time, and the capture display can be either active or inactive. Active capture displays show GPIB events as they are being captured. Inactive capture displays show previously captured events statically, so that they are unaffected by newly captured GPIB events.

To open an active Capture Display window, choose **New Capture Display** from the **File** menu in the Main window. To open a Capture Display window showing previously saved GPIB events, choose **Open Capture File...** from the **File** menu in the Main window. Figure 2-5 shows an example of an inactive Capture Display window.

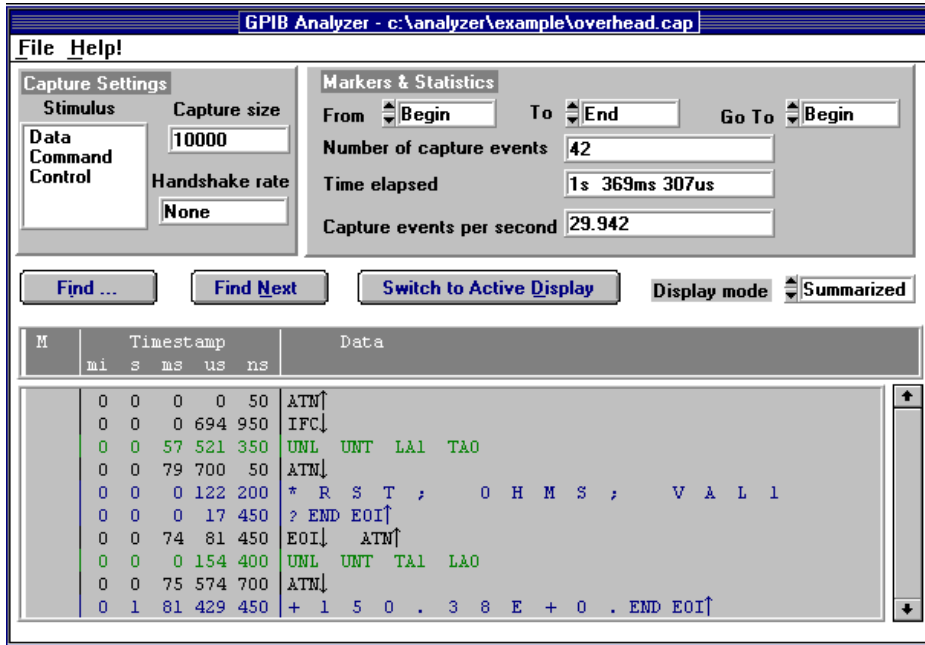


Figure 2-5. Capture Display Window

Menus

Choosing **Save As...** from the **File** menu allows you to save the GPIB events in the capture display to a file. Both inactive and active (if capturing is turned off) files can be saved. Whenever possible, use the .CAP extension for GPIB analyzer capture files.

Choosing **Print...** from the **File** menu allows you to print the contents of an inactive capture display to a selected printer.

Choosing **Export...** from the **File** menu allows you to save the GPIB events in an inactive capture display in an ASCII text file, which can be imported into other applications such as word processors. You cannot import the ASCII file back into the GPIB analyzer.

Choosing **Close...** from the **File** menu allows you to close the Capture Display window. The analyzer program prompts you to save any unsaved GPIB events.

The **Help** menu accesses the online help system for the GPIB analyzer.

Capture Settings

The **Stimulus** field lists the **Capture Stimulus** (from the Settings window) used when the GPIB events in the capture display were captured.

The **Capture size** field lists the value of the **Retain up to ? capture events** field (from the Settings window) used when the GPIB events in the capture display were captured.

The **Handshake rate** field lists the value of the **Handshake rate** (from the Settings window) used when the GPIB events in the capture display were captured. If the **Participate in Acceptor Handshake** checkbox was not selected in the Settings window, this field displays **None**.

Markers & Statistics

The **From** box is used to select the beginning marker used to calculate the statistics shown below this field, such as the number of events captured between selected markers, the time elapsed between selected markers, and the number of capture events per second.

The **To** box is used to select the ending marker used to calculate the statistics shown below this field, such as the number of events captured between selected markers, the time elapsed between selected markers, and the number of capture events per second.

The **Go To** field allows you to go to a particular marker in the capture display.

The **Number of capture events** statistic displays the number of GPIB capture events contained between the markers indicated in the **From** and **To** entries above, including the markers themselves.

The **Time elapsed** statistic displays the elapsed time between the markers indicated in the **From** and **To** entries above.

The **Capture events per second** statistic displays the rate at which the indicated GPIB events occurred, which is determined by dividing the time elapsed by the number of events minus one.

Buttons and Display Mode

Clicking on the **Find...** button opens the Find window, which is used to specify search criteria for finding a particular GPIB event in an inactive capture display.

Clicking on the **Find Next** button causes the analyzer to search for the next occurrence of your search criteria in the capture display. This button is disabled if you have not yet entered your search criteria in the Find window.

Clicking on the **Switch to Active/Inactive Display** button switches you between active and inactive capture display modes. Active capture displays show GPIB events as they are being captured. Inactive displays show previously captured GPIB events. With inactive displays, you can place markers, view statistics about the captured GPIB events, and search for specific GPIB events. Switching from inactive to active erases all captured GPIB events and markers, but the analyzer prompts you to save your data before switching to active display.

The **Display mode** box shows the display mode used for the captured GPIB events. With detailed display mode, captured GPIB events are shown one per line. In summarized display mode, multiple events can be shown on each line. Line transitions are displayed on separate lines, but data and command transfers are grouped on the same line. In both display modes, data transfers are shown in blue, command transfers are shown in green, and control line transitions, handshake line transitions, and parallel poll responses are all shown in black.

Display Fields

The dark column heading field under the buttons and **Display mode** box shows the titles of the columns of data in the capture display field.

The capture display field shows captured GPIB events, markers, timestamps, and helpful mnemonics. It can also show control line and handshake line transitions. If the line name is followed by an up arrow, the line went from unasserted to asserted. If the line name is followed by a down arrow, the line went from asserted to unasserted. This field might also display an overflow error message if the FIFO is full and events are lost.

For specific information about how to interpret the capture display, refer to the section *Read the Capture Display* in Chapter 3, *How To*, or Appendix C, *Capture Display Mnemonics*.

Find Window

The Find window allows you to specify criteria and search for a specific GPIB event in a capture display.

To open the Find window, click on the **Find** button in the Capture Display window. Figure 2-6 shows a sample Find window.

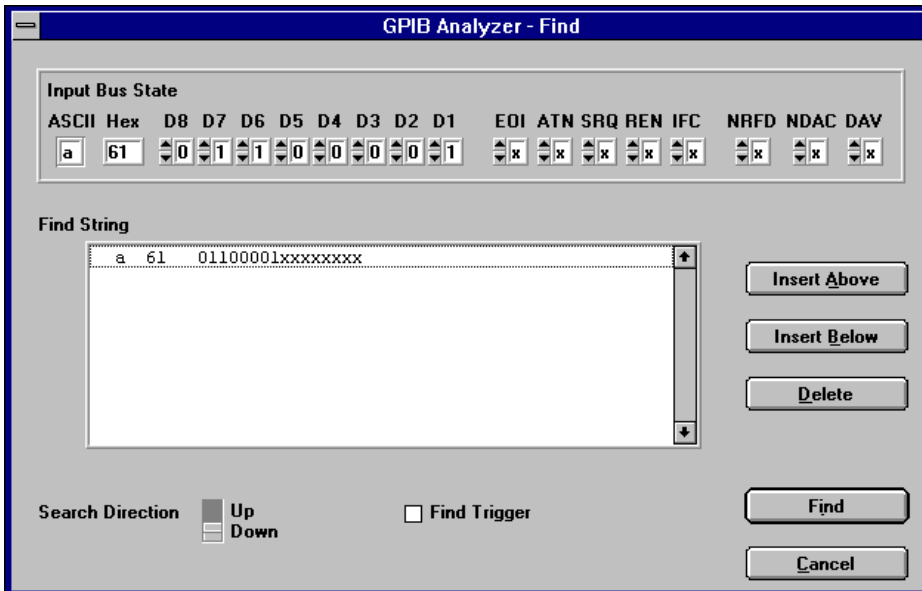


Figure 2-6. Find Window

Input Bus State

The **ASCII** field displays the current search value of the GPIB data lines (**D8-D1**) in ASCII format. You can enter a printable ASCII key sequence in this field to change the search criteria for the data lines.

The **Hex** field displays the current search value of the GPIB data lines (**D8-D1**) in hexadecimal format. You can enter a one-digit or two-digit hexadecimal value in this field to change the search criteria for the data lines.

The current search value of each GPIB data line is displayed by the list boxes labeled **D8** to **D1** (where 8 is the most significant bit). The current search value of the GPIB control and handshake lines is displayed by the list boxes labeled **EOI** through **DAV**. You can assert/unassert the lines by moving the toggle switches. Each switch has three possible states: 0 is unasserted, 1 is asserted, and X is don't care, which means the line can be asserted or unasserted.

Find Specifications

The **Find String** field shows the entered search criteria as a string of GPIB bus states. If you click on a specific bus state, that bus state is highlighted. It appears in the **Input Bus State** field and can be changed there. When a bus state is highlighted, you can use the **Insert Above** or **Insert Below** buttons to insert a new GPIB bus state, which appears with don't care (X) bits until you highlight the bus state and change it. You can also delete a bus state using the **Delete** button.

The **Search Direction** switch specifies the direction to search from the current cursor position in the capture display.

Selecting the **Find Trigger** checkbox causes the search to locate the nearest trigger condition in the capture display.

Buttons

Clicking on the **Insert Above** button inserts a new GPIB bus state above the highlighted bus state. Newly inserted bus states are initialized to don't care (X) bits until you change them.

Clicking on the **Insert Below** button inserts a new GPIB bus state below the highlighted bus state. Newly inserted bus states are initialized to don't care (X) bits until you change them.

Clicking on the **Delete** button deletes the highlighted bus state from the search criteria.

Clicking on the **Find** button registers the search criteria and closes the Find window. When you return to the capture display, the cursor will be on the nearest GPIB event matching the search criteria.

Clicking on the **Cancel** button cancels the search criteria and closes the Find window.

Chapter 3

How To

This chapter describes how to accomplish specific tasks within the GPIB analyzer application.

Start and Stop

To begin capturing data, first choose the capture settings and trigger conditions you want to use from the Settings window. If an active capture display is not already open, choose to open a new Capture Display window using the **File** menu of the Main window. Then click on the **Capture** or **Capture & Trigger** button in the Action window to begin capturing and displaying data. You can also use the <F6> or <F7> keyboard commands. To stop capturing new data, click on the **Off** button in the Action window or press <F5>.

To exit the GPIB analyzer, choose **Exit** from the **File** menu in the Main window. The program prompts you to save any Capture Display window that contains unsaved GPIB events. The current capture and trigger settings are automatically saved and will be loaded the next time you open the analyzer.

Monitor or Participate in GPIB Activity

View/Change the State of GPIB Lines

You can view or change the state of the GPIB data and control lines within the Bus Monitor window. The LEDs show the current state of the GPIB lines. The toggle switches show whether the lines are asserted by the Bus Monitor.

To assert a value on the GPIB data lines (**8-1**), you can enter a printable ASCII value in the **ASCII** box on the bottom row, enter a one-digit or two-digit hexadecimal value in the **Hex** box on the bottom row, or manually toggle the data line switches. A line is asserted when the switch is in the up position and shows a binary value of 1. After you set your data lines to the desired positions, use the **DAV** switch to source the data byte on the bus.

To change the GPIB control lines (EOI, ATN, SRQ, REN, and IFC) and handshake lines (NRFD, NDAC, and DAV), change the position of the toggle switches. A line is asserted when the switch is in the up position and shows a binary value of 1.

To accept a byte of data on the bus, use the **NRFD** and **NDAC** switches or use the **Accept Byte** button, which automatically toggles these switches in the correct sequence.

If you are using the Bus Monitor to assert GPIB lines, do not use the NI-488.2 `ibfind` function. This function will unassert the lines on the bus, even though the switches in the Bus Monitor window show that the lines are asserted. If you encounter this problem, click on the **Unassert Lines** button and avoid using the `ibfind` function.

Accept a Single Byte

To accept a single byte of data on the GPIB, first click on the **Enable Accept Byte** button in the Bus Monitor window. Then click on the **Accept Byte** button in the Bus Monitor window. This action automatically toggles the NRFD and NDAC lines in the correct handshaking sequence to accept a single byte. If you disable the Accept Byte feature, you can control the NRFD and NDAC lines manually using the toggle switches in the Bus Monitor window.

If you try to accept a byte when no GPIB device is currently trying to source a byte (DAV unasserted), then toggling the handshake lines or clicking on **Accept Byte** has no effect.

Capture and Display Data

To capture and display new data, first select the capture settings and trigger conditions you want using the Settings window. If an active capture display is not already open, choose to open a new Capture Display window using the **File** menu of the Main window. When you are ready to begin the capture, click on the **Capture** or **Capture & Trigger** button in the Action window. You can also use the <F6> or <F7> keyboard commands to start your capture. If you want to monitor GPIB activity while running another GPIB application, start your application after you begin the capture.

Capture displays can be active or inactive. Active displays have the title “Active Capture Display: X” and show GPIB events as they are being captured. Inactive displays show previously captured events and allow you to analyze the data. You can switch back and forth between active and inactive by clicking on the **Switch to Active/Inactive Display** button in the Capture Display window.

To open a Capture Display window showing previously saved GPIB events, choose **Open Capture File...** from the **File** menu in the Main window.

Note the following capabilities concerning the capture display:

- You can switch from **Capture** to **Capture & Trigger** during the capture without losing data.
- The maximum rate at which the analyzer can capture GPIB events is once every 50 ns.
- You can view more than one capture display at a time.

Configure Capture Settings

To configure the capture settings, first make sure that capturing is turned off in the Action window. Then open the Settings window by selecting **Change Settings...** from the Main window **Settings** menu, and select the configuration that you want to use. When you are finished making changes, click on **OK** in the Settings window. You can also save and reload your capture settings.

Capture Stimulus Choices

You may want to limit your capture stimulus to certain types of events. You can capture any combination of data transfers, command transfers, control line transitions, handshake line transitions, and parallel poll responses. You might want to choose only the types of events you need, to avoid overflow errors. In particular, capturing handshake line transitions causes a high volume of capture events and takes more processor time. In the **Capture Stimulus** section of the Settings window, select the checkboxes for the types of events you want to capture.

Buffer Setting

In the Settings window, you can set the **Retain up to ? capture events** option to specify the maximum number of capture events that are retained in the buffer. When the buffer becomes full, the oldest GPIB events are discarded to make room for new events.

Handshake Settings

If you want to slow down GPIB transfers, select the **Participate in Acceptor Handshake** checkbox and choose a rate with the **Handshake rate** field.

Timestamping Feature

If you want to use the timestamping feature, select the **Enable Timestamping** checkbox in the Settings window.

Set Trigger Conditions

To set the trigger conditions for your capture, first make sure that capturing is turned off in the Action window. Then set the criteria in the **Trigger Condition** section of the Settings window.

In the **Trigger Condition** section of the Settings window, enter the bus state you want to trigger on using the **ASCII** box, **Hex** box, or individual switches for each line. If you want to set a trigger condition for a data byte, set the data lines to that byte, ATN to unasserted (0), DAV to asserted (1), NDAC to 1, NRFD to 0, and all other lines to don't care (X). If you want to set a trigger condition for a command byte, set the data lines to that byte, ATN to asserted (1), DAV to asserted (1), NDAC to 1, NRFD to 0, and all other lines to don't care (X). If you want to set the trigger condition for any control line or handshake line event, set the line to that state and set all other lines to don't care (X).

Use the fields in the Settings window under the **Trigger Condition** section to set the other trigger condition options.

When you are finished making changes, click on **OK** in the Settings window. You can also save and reload your trigger settings. To trigger on a certain event that you have specified, choose **Capture & Trigger** in the Action window.

Timestamp Capture Events

To enable timestamping, select the **Enable Timestamping** checkbox in the Settings window. Timestamping shows you the elapsed time from the first GPIB event on the previous line to the first GPIB event on the timestamped line. The timestamp information appears in the timestamp column of the capture display. Timestamping allows you to calculate statistics in the Capture Display window.

Do a Non-Intrusive Capture

To prevent the GPIB analyzer from participating in acceptor handshaking, unselect the **Participate in Acceptor Handshake** checkbox in the Settings window. If this checkbox is selected, the analyzer participates in all acceptor handshaking that occurs on the GPIB. You might want to select this checkbox to slow down the GPIB transfers or to avoid overflow errors.

Avoid Overflow Errors

An overflow error occurs when the FIFO hardware buffer fills up with GPIB events faster than the software can receive them. If this happens, an error message with asterisks and the word “OVERFLOW” appears in the capture display. If an overflow error occurs, one or more GPIB events have been lost. You can usually avoid overflow errors by making one of the following changes:

- Select the **Participate in Acceptor Handshake** checkbox in the Settings window, and set the **Handshaking rate** to Maximum. This configuration causes the analyzer to hold off when the FIFO is almost full. It prevents high speed GPIB data transfers when the FIFO is almost full, which can be a common cause of overflow errors.
- Unselect the **Handshake Line Transitions** checkbox in the Settings window. If this option is selected, you might capture up to six times as many GPIB events as choosing to capture only data and command transfers. This high volume of events is likely to cause overflow errors.
- Unselect the **Enable Timestamping** checkbox in the Settings window. If you do not need to see the timestamping information, disabling this option can reduce the amount of data transferred from the FIFO and reduce the possibility for overflow errors.

- Unselect the **Control Line Transitions** checkbox in the Settings window. Some GPIB devices may toggle the control lines incorrectly, and overflow errors could result.
- Close all active capture displays while capturing. The analyzer captures GPIB events more efficiently if they do not need to be displayed immediately.
- Increase the **Retain up to ? capture events** value in the Settings window. This field specifies the maximum number of capture events retained in the capture buffer.

Save and Reload Capture/Trigger Settings

The analyzer uses the current capture and trigger settings until you change them again and automatically saves them when you exit the analyzer program. If you want to save the current settings for later use before you try new settings, select **Save Settings As...** from the **Settings** menu in the Main window. Whenever possible, use the `.SET` extension for analyzer settings files.

If you want to load a file of previously saved settings, select **Load Settings...** from the **Settings** menu in the Main window. Then choose **Change Settings...** from the same menu to view or change those settings.

Analyze Captured Data

After you have captured GPIB events, you are ready to read and interpret the capture display, calculate statistics, search for capture events, print the file, or save the file.

Read the Capture Display

You can view the captured GPIB events in either detailed display mode or summarized display mode. With detailed display mode, captured GPIB events are shown one per line. In summarized display mode, multiple events can be shown on each line. Line transitions are displayed on separate lines, but data and command transfers are grouped on the same line. In either display mode, lines are colored based on the type of event captured. Table 3-1 lists the display colors.

Table 3-1. Colors in the Capture Display Window

Type of Event	Color
Data transfers	Blue
Command transfers	Green
Control line transitions	Black
Handshake line transitions	Black
Parallel poll responses	Black
Trigger event	Dotted box

Timestamp Column

In detailed mode, where each line can correspond to only one capture event, the timestamp value represents the time elapsed between the event on that line and the previous event. So if you want to determine the time elapsed between the capture of the first event and the fifth event, add up the timestamp values on the second, third, fourth, and fifth lines.

In summarized mode, where more than one event can be present on a line, the timestamp value represents the time elapsed between the first event on that line and the first event on the previous line.

The timestamp column in the capture display shows the timestamp in minutes, seconds, milliseconds, microseconds, and nanoseconds. If the timestamp exceeds 60 minutes, the timestamp is shown in hours, minutes, and seconds. The abbreviations used for the various time scales are listed in Table 3-2. The smallest resolution possible for any timestamp is 50 ns.

Table 3-2. Timestamp Abbreviations in the Capture Display Window

Time Unit	Abbreviation
Nanoseconds	ns
Microseconds	us
Milliseconds	ms
Seconds	s
Minutes	mi
Hours	hr

Mnemonics Column

Various mnemonics appear in the right column of the capture display to provide a quick interpretation of the captured GPIB events. The column may also show line transitions. If the line name is followed by an up arrow, the line transition occurred from unasserted to asserted. If the line name is followed by a down arrow, the transition occurred from asserted to unasserted. Note that if the analyzer is capturing handshake line transitions, the assertion of DAV represents a GPIB data byte or command byte. For a detailed list of the mnemonics and their meanings, refer to Appendix C, *Capture Display Mnemonics*.

Search for a Capture Event

To search for a specific GPIB event within a capture display, first make sure that you have switched to an inactive Capture Display window. Then click on the **Find** button in that window. Clicking on the **Find** button opens the Find window. Use the Find window to enter your search criteria, or a string of events to search for, and then click on the **Find** button in that window. This action automatically closes the Find window and returns you to the nearest GPIB event in the Capture Display window that matches your criteria. To find the next occurrence of that event, click on the **Find Next** button.

Mark Capture Events to Show Statistics

You can add markers only to inactive Capture Display windows. All inactive capture displays contain at least two markers: begin and end. If you click once on an event in the capture display, a cursor appears there. To add a permanent marker to a line, double-click on that line. The first marker you set is labeled M0 in the marker column of the capture display. The next appears as M1, and so on. To delete a marker, double-click on the GPIB event again.

If you are using summarized display mode, you might have more than one marker for each line. In this case, the letter “M” appears in the marker column. You can click on the “M” several times to see each marker for that line.

Print and Save

To print the contents of an inactive Capture Display window, choose the **Print** command from the **File** menu in the Capture Display window. You can also print only selected capture events in an inactive display.

Both inactive and active (if capturing is turned off) capture displays can be saved to a file. To save the data in a Capture Display window, choose **Save As...** from the **File** menu in the Capture Display window. Whenever possible, use the .CAP extension for saving capture display files. Captured data is saved in an analyzer-specific format and can be reopened as an inactive capture display.

You can also export an inactive capture display to another application, such as a word processor. Choosing **Export...** from the **File** menu of the Capture Display window saves the data as an ASCII text file that you can open in another program. You can save captured data as text in both detailed and summarized formats.

Chapter 4

Tutorial

This chapter contains a hands-on tutorial to help you practice using the different features of the GPIB analyzer.

Before you start the tutorial, check the following:

- Make sure that the NI-488.2 software, GPIB analyzer software, and GPIB analyzer hardware are installed on your computer. For installation instructions, refer to your getting started manual.
- Disconnect all GPIB cables from your GPIB hardware.

Part 1: Capture and View New Data

1. Open the GPIB analyzer. To open the analyzer application in Windows 95, click the **Start** button and select **Programs**. From this list, select the **GPIB Analyzer for Windows 95** folder. In this folder, select the **GPIB Analyzer**.

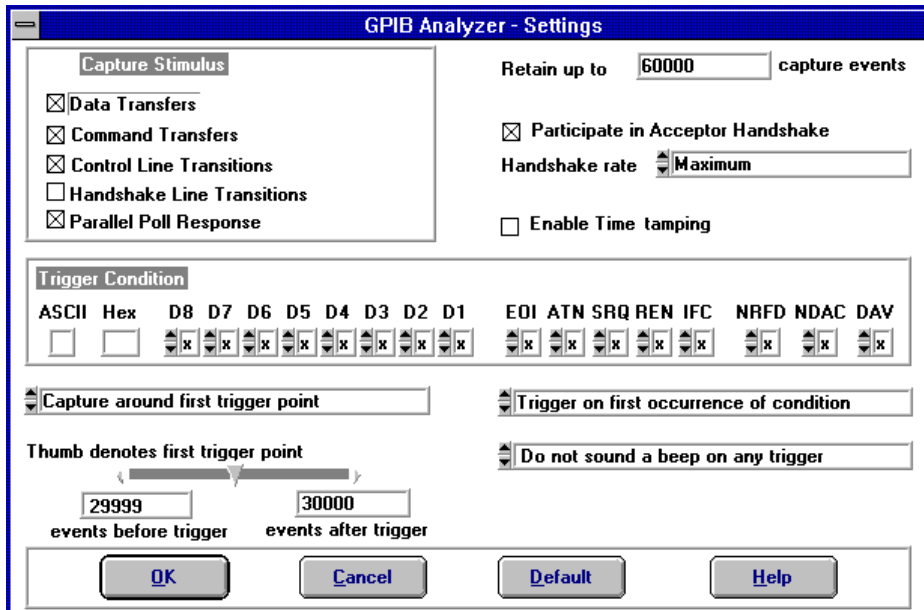
To open the analyzer application in Windows 3.1, double-click on the **GPIB Analyzer** icon, which is located in the **GPIB Analyzer Software** group in the **Program Manager**.

When you open the analyzer application, you will see the Main window, which contains the Bus Monitor window and Action window. A new Capture Display window also opens.

2. From the **Settings** menu, choose **Change Settings** to access the Settings window.
3. Click on the **Default** button to reset the screen to the default settings.
4. In the **Capture Stimulus** section, choose to capture the following stimuli: data transfers, command transfers, control line transitions, and parallel poll responses. Do not select handshake line transitions.
5. Click in the **Retain up to ? capture events** box and change the setting to 60,000 capture events.

You do not need to change the trigger pattern for this part of the tutorial. Since you are not yet looking for a specific trigger pattern, the other trigger settings will have no effect.

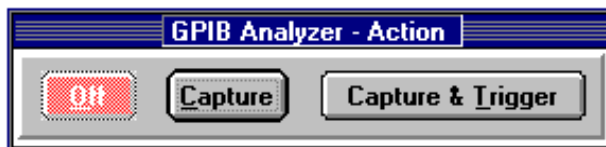
The Settings window should now look like the following screen.



- Click on **OK** to use these settings.

You could save these settings to use at a later time. To save them, you would choose **Save Settings As...** from the **Settings** menu in the Main window. To retrieve the settings, you would choose **Load Settings** from the same menu.

- If you cannot see the Action window, bring it to the front by choosing **Action window** from the **Windows** menu of the Main window. A picture of the Action window follows.



- Click on the **Capture** button in the Action window. The analyzer is ready to capture GPIB events.
- Open the Interactive Control utility. If you are using Windows 95, do not quit the analyzer program, but click the **Start** button, select the **Programs** menu, and open the **NI-488.2M Software for Windows 95** folder. Then select the **Win32 Interactive Control utility**.

- Change the display mode from detailed to summarized by clicking on the arrow beside the **Display Mode** box. Summarized display mode is often easier to read if you do not need to see one event per line, but it does not show as much information.

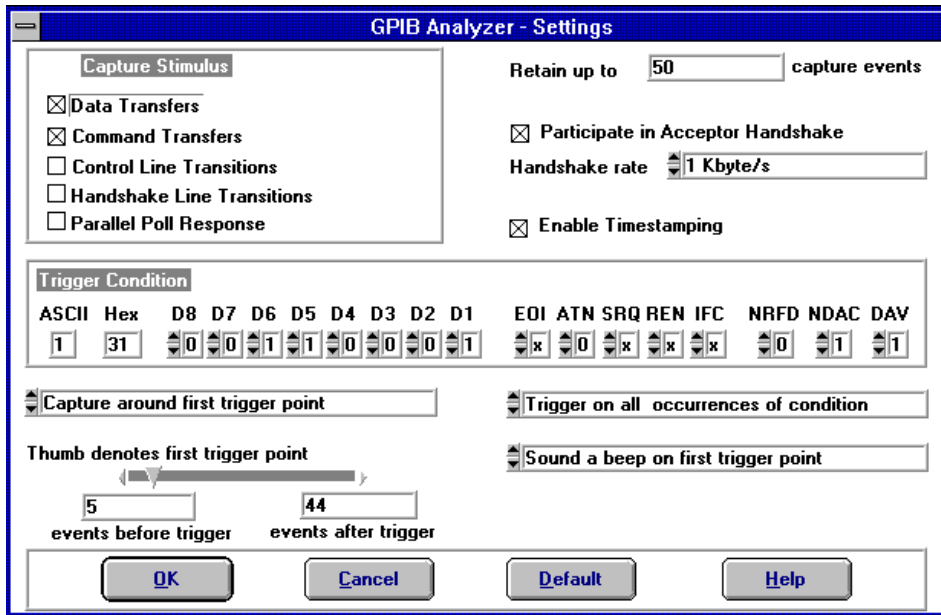
Part 2: Capture and View New Data with a Trigger Condition

- From the **Settings** menu in the Main window, choose **Change Settings** to bring up the Settings window.
- In the **Capture Stimulus** section, choose to capture data transfers and command transfers. Unselect the checkboxes for the other types of transfers. This will restrict the analyzer to capture only data and command transfer events on the bus.
- Click on “Maximum” in the **Handshake rate** box to see your choices. Then click on the 1 Kbyte/s option. This handshake rate will slow down the GPIB transfers.



- Choose to retain up to 50 capture events.
- Select the **Enable Timestamping** box to turn on the timestamping feature.
- In the **Trigger Condition** section, enter “1” in the **ASCII** box and notice the corresponding changes in the **Hex** box and the **D8-D1** toggle switch boxes.
- Use the toggle switches to set the ATN line to 0, NRFD to 0, NDAC to 1, and DAV to 1. Leave the EOI, SRQ, REN, and IFC lines set as don’t care (X).
- Make sure **Capture around first trigger point** shows up as the current setting. This option stops the capture when a certain number of events have been captured after the trigger point. It allows you to specify how many events to capture before and after the trigger point.
- Move the thumb bar pointer so that the capture file will show 5 events before the trigger point and 44 events after the trigger point.
- Click in the box with the words **Trigger on first occurrence of condition** to see your choices. Select **Trigger on all occurrences of condition**. This option captures and displays all occurrences of the trigger condition.
- Click in the box with the words **Do not sound a beep on any trigger** to see your choices, then select **Sound a beep on first trigger point**.

The Settings window should look like the following screen.



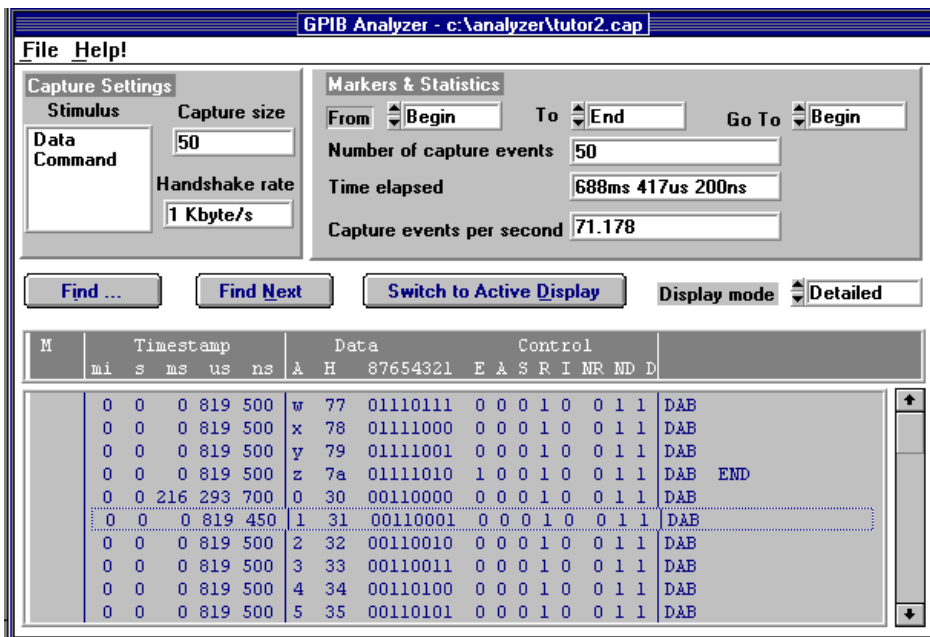
12. Click on **OK** to use these settings.
13. Bring the Action window to the front by choosing **Action window** from the **Windows** menu. Click on the **Capture & Trigger** button. The analyzer is ready to capture data and look for the trigger condition specified in the Settings window.
14. Bring the Capture Display window to the front, and notice that the changes you made in the Settings window are shown in the Capture Settings section since you clicked on **Capture & Trigger**.
15. Open the Interactive Control utility. If you are using Windows 95, do not quit the analyzer program, but click the **Start** button, select the **Programs** menu, and open the **NI-488.2M Software for Windows 95** folder. Then select the **Win32 Interactive Control utility**.

If you are using Windows 3.1, do not quit the analyzer program, but switch to the **Program Manager** and open the **Win16 Interactive Control utility** by double-clicking on its icon in the **NI-488.2 Software** group.

16. At the prompt, enter `$ c:\gpibanlz\tutorial.txt` to run the tutorial script again. (The path to the file may be different if you did not use the default installation for the analyzer software.) Wait until the script has executed. The NI-488.2 commands in this script file write data on the GPIB, and the analyzer portion of the GPIB hardware captures the data.

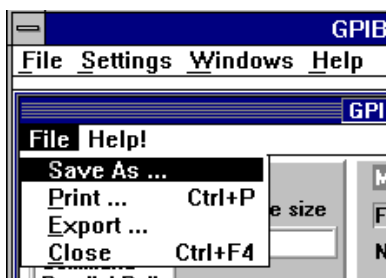
17. At the `:` prompt, type `quit` and press `<Enter>` to exit the interactive control utility. Switch back to the analyzer program.
18. Click on **Off** in the Action window, then bring the active Capture Display window to the front.
19. Click on **Switch to Inactive Display**, and choose detailed display mode. Scroll to the top of the display file.

The Capture Display window should look something like the following screen.



The trigger points are enclosed in dotted boxes and the display shows five events before the first trigger point.

20. Choose **Save As...** from the **File** menu in the Capture Display window, which is shown in the following picture.



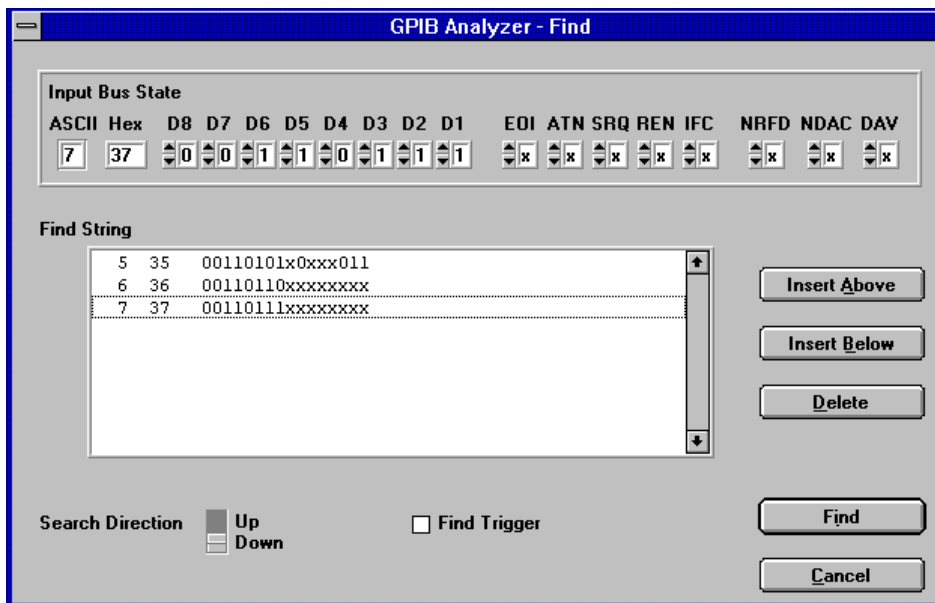
21. Enter `tutor2.cap` as the filename and click on **Save**. Notice that `tutor2.cap` appears on the title bar of the Capture Display window.
22. From the **File** menu in the Main window, choose **Exit** to quit the analyzer application.

Part 3: Search for Data in a Capture Display

1. Open the GPIB analyzer application.
2. From the **File** menu of the Main window, choose **Open Capture File**.
3. In the dialog box, enter `tutor2.cap` to retrieve the capture file that you saved in part 2 of this tutorial, and click on **OK**. The capture file is automatically opened as an inactive display.
4. Click on the **Find...** button in the Capture Display window to bring up the Find window.
5. Select the **Find Trigger** checkbox to search for the captured trigger event, ASCII 1, which was the trigger point specified in part 2 of this tutorial. The trigger pattern appears in the **Input Bus State** field and the **Find String** field.
6. Click on **Find** to start the search. The result will be highlighted as shown in following screen. ASCII 1 appears in the “A” column of the highlighted row.

M	Timestamp					Data										Control								
	mi	s	ms	us	ns	A	H	8	7	6	5	4	3	2	1	E	A	S	R	I	NR	MD	D	
	0	0	0	819	500	w	77	0	1	1	0	1	1	1	1	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	x	78	0	1	1	1	0	0	0	1	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	y	79	0	1	1	1	0	0	1	0	0	0	1	0	0	1	1	1	DAB
	0	0	0	819	500	z	7a	0	1	1	1	0	1	0	1	0	0	0	1	0	0	1	1	DAB
	0	0	216	293	700	0	30	0	0	1	1	0	0	0	1	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	450	1	31	0	0	1	1	0	0	0	1	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	2	32	0	0	1	1	0	0	0	1	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	3	33	0	0	1	1	0	0	0	1	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	4	34	0	0	1	1	0	0	0	1	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	5	35	0	0	1	1	0	1	0	1	0	0	0	1	0	0	1	1	DAB

7. Click on the **Find...** button again to return to the Find window.
8. Unselect the **Find Trigger** checkbox.
9. In the **Input Bus State** section, enter “5” in the **ASCII** box.
10. Click on **Find** to locate the search pattern.
11. Return to the Find window and choose **Insert Below** to enter another pattern in the Input Bus State.
12. Enter “6” in the **ASCII** box to indicate the second pattern in the search.
13. Insert another line below, but this time enter “7”. These characters form a string that the analyzer will search for in the capture file. The Find window should look like the following screen.



14. Click **Find** to search for the string “567”.

15. The first character of the search string, “5”, will be highlighted as shown in the following screen.

The screenshot shows the GPIB Analyzer interface with the following settings and data:

Capture Settings:
 Stimulus: Data Command
 Capture size: 50
 Handshake rate: 1 Kbyte/s

Markers & Statistics:
 From: Begin To: End Go To: Cursor
 Number of capture events: 50
 Time elapsed: 688ms 417us 200ns
 Capture events per second: 71.178

Buttons: Find ..., Find Next, Switch to Active Display, Display mode: Detailed

M	Timestamp					Data		Control									
	mi	s	ms	us	ns	A	H	87654321	E	A	S	R	I	NR	ND	D	
	0	0	0	819	450	1	31	00110001	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	2	32	00110010	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	3	33	00110011	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	4	34	00110100	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	5	35	00110101	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	6	36	00110110	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	7	37	00110111	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	8	38	00111000	0	0	0	1	0	0	1	1	DAB
	0	0	0	819	500	9	39	00111001	1	0	0	1	0	0	1	1	DAB END
	0	0	221	256	650	A	41	01000001	0	0	0	1	0	0	1	1	DAB

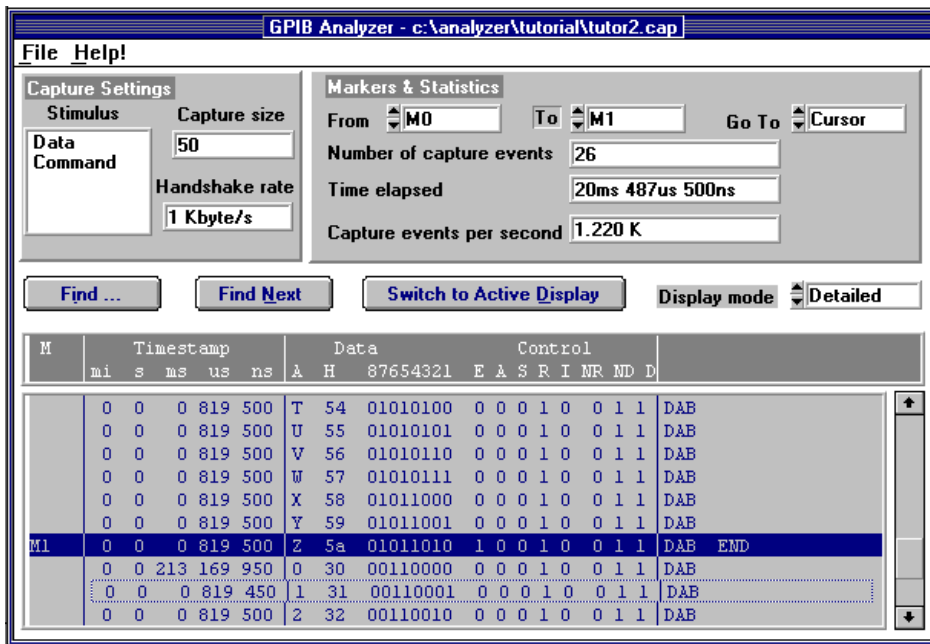
16. Click on the **Find Next** button to continue your search. The next successful search result will be highlighted.

Part 4: Show Statistics for Captured Data

Use the `tutor2.cap` capture file that you obtained in part 2 of this tutorial.

- In the Capture Display window create a marker at the line containing the ASCII character “A” by double-clicking on that line. The marker M0 appears in the marker column of that line.
- Create another marker at the line containing the letter “Z”. M1 appears in the marker column of that line.
- Click on the word **Begin** in the **From** list box to see your choices, then select **M0**, the marker for the letter “A”.
- Choose **M1** for the **To** list box.

The analyzer calculates and displays statistics as shown in the following screen.



The capture display statistics show the total number of captured events from marker M0 to marker M1. The **Time elapsed** statistic shows you the total time to transfer this block of data. The **Capture events per second** box shows system performance during this period of time.

5. Choose M0 in the **Go To** list box to highlight the line with the letter "A" again.

Part 5: Print and Export a Capture File

This part of the tutorial is continued from part 4. Use the `tutor2.cap` capture file that you used in part 4.

1. Choose **Print...** from the **File** menu of the Capture Display window.
2. In the print dialog box, select M0 for the **From Marker** and M1 for the **To Marker**.
3. Click on **OK**. The portion of the capture display from M0 to M1 will be printed. If you want to print the entire capture display, choose Begin for the **From Marker** and End for the **To Marker**.
4. Save the capture file as ASCII text by choosing **Export...** from the **File** menu in the Capture Display window.

5. Enter `sample.txt` in the export dialog box, and click on **Save**. You can view the exported file in a text editor, but you cannot import it back to the analyzer.
6. From the **File** menu in the Main window, choose **Exit** to quit the analyzer application.

Chapter 5

Examples

This chapter contains several case scenario examples to show you how you might use the analyzer to solve your IEEE 488 problems.

Example 1: Slow Communication

Description of Problem

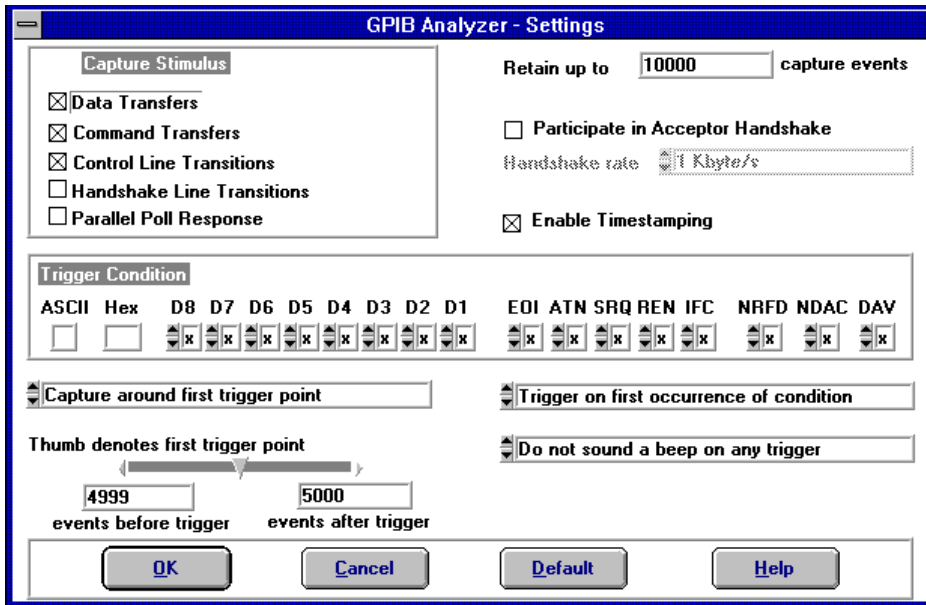
A technician is running a GPIB application program in which an AT-GPIB/TNT+ board is communicating with a multimeter. In the application, the Controller instructs the instrument to reset to its default settings, measure Ohms, and return a reading. The application seems to be running slowly, and the technician wants to determine the cause of the slow performance.

Setting up the GPIB Analyzer

By using the timestamping feature of the GPIB analyzer, the technician can determine what is causing the application to run slowly. In the Settings window of the GPIB analyzer, he chooses the following settings:

- Capture data transfers, command transfers, and control line transitions
- Retain 10,000 events
- Timestamping feature enabled
- Do not participate in acceptor handshake

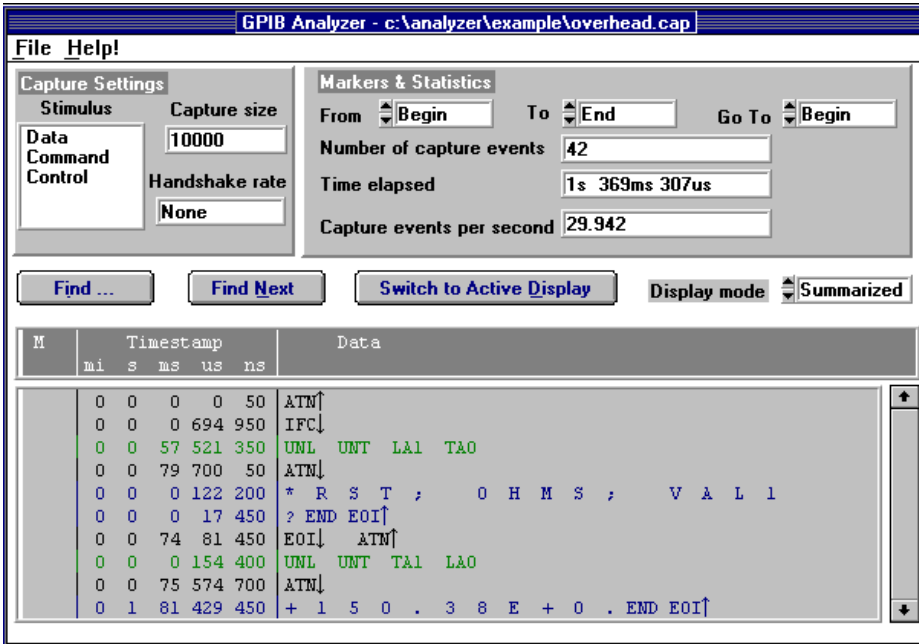
The Settings window looks like the following screen.



The technician chooses **Capture** in the Action window and runs his application program. After the program executes, he switches back to the analyzer and chooses **Off** in the Action window.

Reading the Capture Display

The following picture shows the resulting capture display.



The technician has chosen summarized display mode. In the capture display, he sees the string “RST; OHMS; VAL1?”, which instructs the multimeter to reset, measure Ohms, and send a reading to the Controller. The next string, “+150.38E+0” is the reading from the device. The technician switches back to detailed display, and after he places the markers in the capture display, he selects various markers in the **From** and **To** list boxes. For example, he calculates the time the device takes to start sending its measurement, which is 1 s, 81 ms, 429 μs, and 450 ns. The statistics that the technician sees reveal that the system performance is satisfactory, but the instrument is slow in returning a measurement.

Example 2: A Service Request Problem

Description of Problem

A test engineer has a GPIB system with two GPIB devices connected. The engineer expects that when a device requests service, it asserts the SRQ line. He has specified in his application program that when SRQ is asserted, the Controller serial polls the active devices to determine which device is requesting service and then takes the appropriate action. In this particular program, the time between the device asserting SRQ and the device receiving service is too long, so the engineer wants to check the SRQ and serial poll response of his system.

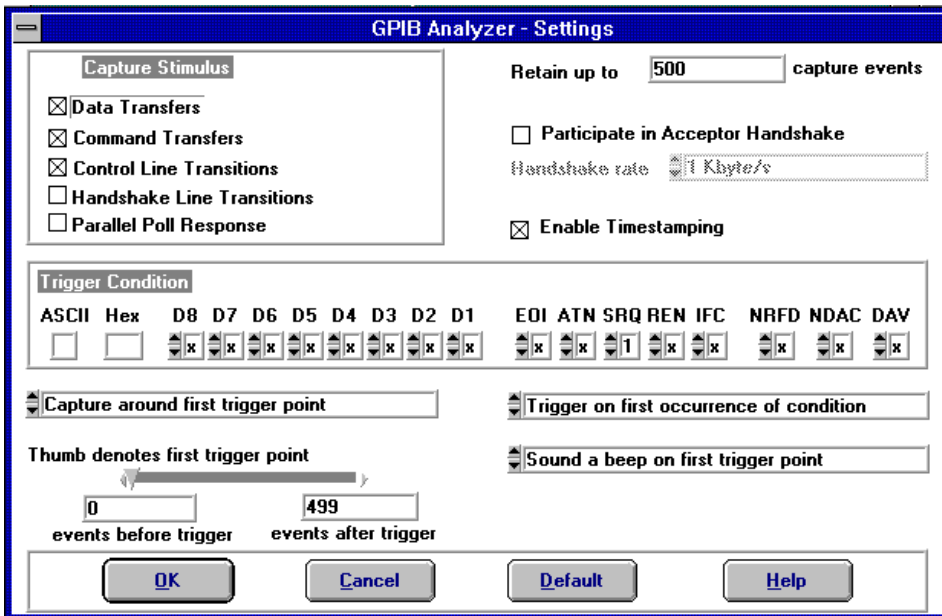
Setting up the GPIB Analyzer

By using the timestamping feature of the GPIB analyzer, the engineer is able to view the service request process and measure response times. He configures the analyzer to trigger at the assertion of SRQ and to capture GPIB events afterwards. By observing the captured events with timestamping information, he learns more about the sequence of events during a serial poll of his system.

In the Settings window of the GPIB analyzer, the engineer chooses the following settings:

- Capture data transfers, command transfers, and control line transitions
- Capture 500 events after the trigger point
- Trigger condition set to SRQ asserted (SRQ = 1) and all other lines equal to “X”
- Timestamping feature enabled
- Capture around the first trigger point

The Settings window looks like the following screen.



The engineer chooses **Capture & Trigger** in the Action window and runs his application program.

Reading the Capture Display

The following picture shows the resulting capture display.

The screenshot shows the GPIB Analyzer software interface. The title bar reads "GPIB Analyzer - c:\analyzer\example\srq.cap". The interface is divided into several sections:

- File Help!**: Standard menu options.
- Capture Settings**: Includes "Stimulus" (Data Command Control), "Capture size" (100), and "Handshake rate" (Maximum).
- Markers & Statistics**: Shows "From" (M0), "To" (M1), "Go To" (M0), "Number of capture events" (6), "Time elapsed" (851ms 449us 200ns), and "Capture events per second" (5.872).
- Find ...**, **Find Next**, **Switch to Active Display**, and **Display mode** (Detailed).
- Table Headers**: M, Timestamp (mi s ms us ns), Data (A H 87654321 E A S R I NR ND D), Control.
- Table Content**:

M	Timestamp	Data	Control
	mi s ms us ns	A H 87654321	E A S R I NR ND D
M0	-- -- --	5f 01011111	0 1 1 0 0 0 1 0
	0 0 474 196 300	0 00000000	0 0 1 0 0 0 1 0
	0 0 198 167 100	5f 01011111	0 0 1 0 1 0 1 0
	0 0 0 0 50	5f 01011111	0 1 1 0 1 0 1 0
	0 0 0 693 550	5f 01011111	0 1 1 0 0 0 1 0
M1	0 0 0 178 392 200	? 3f 00111111	0 1 1 0 0 0 1 1
	0 0 0 10 400	20 00100000	0 1 1 0 0 0 1 1
	0 0 0 2 600	18 00011000	0 1 1 0 0 0 1 1
	0 0 0 407 200	A 41 01000001	0 1 1 0 0 0 1 1
	0 0 0 178 550	A 41 01000001	0 0 1 0 0 0 1 0
	0 0 103 3 40	0 00000000	0 0 1 0 0 0 1 1
	0 0 0 123 700	0 00000000	0 1 1 0 0 1 1 0
	0 0 0 227 0	E 42 01000010	0 1 1 0 0 0 1 1
	0 0 0 191 350	B 42 01000010	0 0 1 0 0 0 1 0
	0 0 0 0 200	@ 40 01000000	0 0 0 0 0 1 1 0
	0 0 0 1 50	@ 40 01000000	0 0 0 0 0 0 1 1
	0 0 0 209 450	@ 40 01000000	0 1 0 0 0 1 1 0
	0 0 0 242 800	19 00011001	0 1 0 0 0 0 1 1

Annotations on the left side of the table:

- Device 1 Response Time**: Points to the line with timestamp 0 0 103 3 40.
- Device 2 Response Time**: Points to the line with timestamp 0 0 0 1 50.

The marker M0 appears on the first line, which shows the assertion of the SRQ line. The engineer places a marker M1 where the Controller starts the serial poll by sending the Unlisten command (UNL). By choosing M0 in the **From** list box and M1 in the **To** list box to calculate the **Time elapsed** statistic, he sees that the Controller takes 851 ms, 449 μ s, and 200 ns to respond to the serial poll.

The Controller sends its listener address (LA0 in this case) and the serial poll (SPE). The Controller sends TA1 so that the first device can talk, then unasserts ATN and reads the status byte (0x00) from the device. By reading the timestamp information on the line where the first device sends 0x00, the engineer knows that the device takes 103 ms, 3 μ s, and 40 ns to send its status byte.

Because the first device is not the one requesting service, the Controller addresses the second device to talk. The Controller then reads the device's status byte (0x40), which indicates that it is requesting service. By reading the timestamp information on the line where the second device sends 0x40, the engineer sees that the device takes only 1 μ s and 50 ns to send its status byte.

Because the response time of the second device polled is shorter than the first device, the engineer changes his application so that the Controller always polls the faster device first. If the faster device is the one requesting service, the Controller will not need to poll the slower device.

Example 3: Device Not Responding

Description of Problem

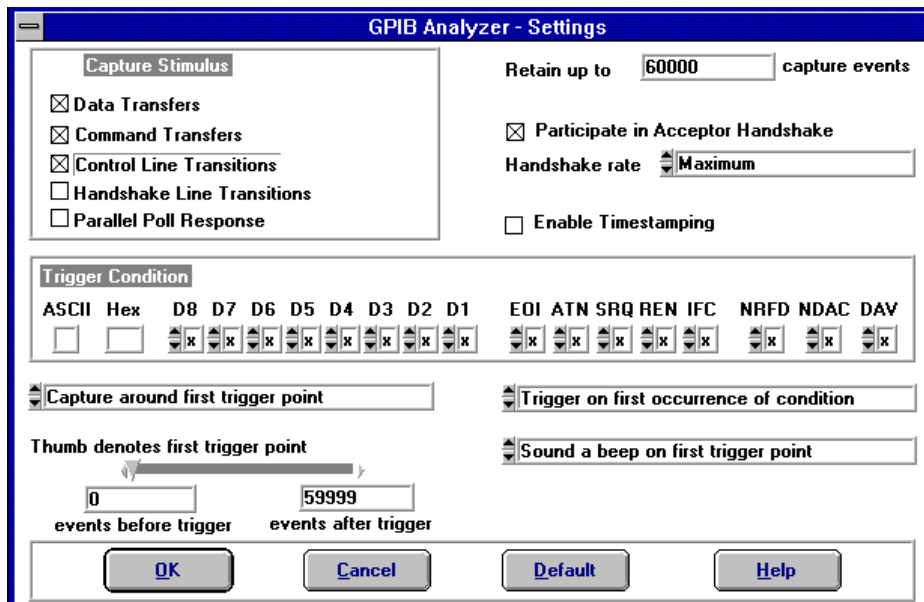
A programmer has written a GPIB application program, but her device is not responding to the program.

Setting up the GPIB Analyzer

The programmer configures the analyzer so that she can check for communication problems. In the Settings window of the GPIB analyzer, she chooses the following settings:

- Capture data transfers, command transfers, and control line transitions
- Retain 60,000 events
- Participate in handshaking and transfer rate set to maximum
- Timestamping disabled

The Settings window looks like the following screen.



The programmer chooses **Capture** in the Action window and captures the sequence of events on the bus. She then clicks on **Off** in the Action window of the analyzer.

Reading the Capture Display

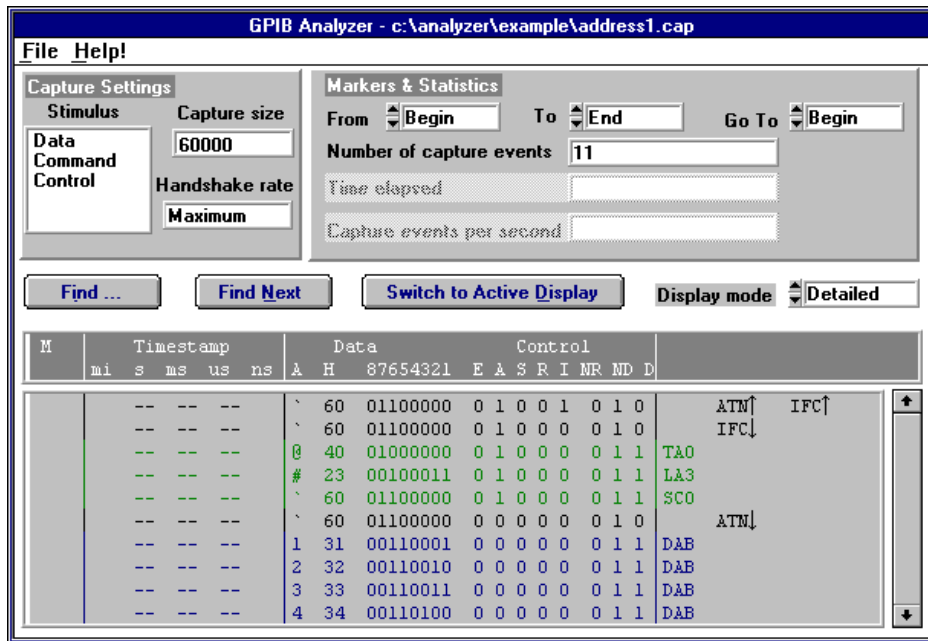
The resulting capture display looks like the following screen.

The screenshot shows the GPIB Analyzer software interface. The title bar reads "GPIB Analyzer - c:\analyzer\example\address2.cap". The interface is divided into several sections:

- File Help!**: Menu options.
- Capture Settings**: Includes "Stimulus" (Data, Command, Control), "Capture size" (60000), and "Handshake rate" (Maximum).
- Markers & Statistics**: Includes "From" (Begin), "To" (End), "Go To" (Begin), "Number of capture events" (8), "Time elapsed", and "Capture events per second".
- Buttons**: "Find ...", "Find Next", "Switch to Active Display", and "Display mode" (Detailed).
- Table**: A table with columns for Marker (M), Timestamp (mi, s, ms, us, ns), Data (A, H, 87654321), and Control (E, A, S, R, I, NR, ND, D). The table contains several rows of data, with one row highlighted in green and labeled "M0".

M	Timestamp					Data			Control								
	mi	s	ms	us	ns	A	H	87654321	E	A	S	R	I	NR	ND	D	
	--	--	--	--	--	0	00000000	0	0	0	0	0	0	1	0		
	--	--	--	--	--	0	00000000	0	0	0	0	1	0	0	0		IFC↑
	--	--	--	--	--	#	23	00100011	0	1	0	0	1	0	0		ATM↑
	--	--	--	--	--	#	23	00100011	0	1	0	0	0	0	1		IFC↓
	--	--	--	--	--	?	3F	00111111	0	1	0	0	0	0	1		UML
	--	--	--	--	--	@	40	01000000	0	1	0	0	0	0	1		TAO
M0	--	--	--	--	--	#	23	00100011	0	1	0	0	0	0	1		LA3
	--	--	--	--	--	#	23	00100011	0	0	0	0	0	0	1		ATM↓

In this example, the Controller does not seem to be sending any data bytes. In her application program, the programmer set up the device to have primary address 3 and secondary address 96. She notices, however, that at the line containing the marker M0, the Controller configures the device to be a Listener at primary address 3 with no secondary address. The device is not responding because the Controller is not addressing it correctly. The programmer corrects her application and runs the capture again. The Controller can now write to the device, and the capture display looks like the following screen.



Example 4: Timeout Error During a Read

Description of Problem

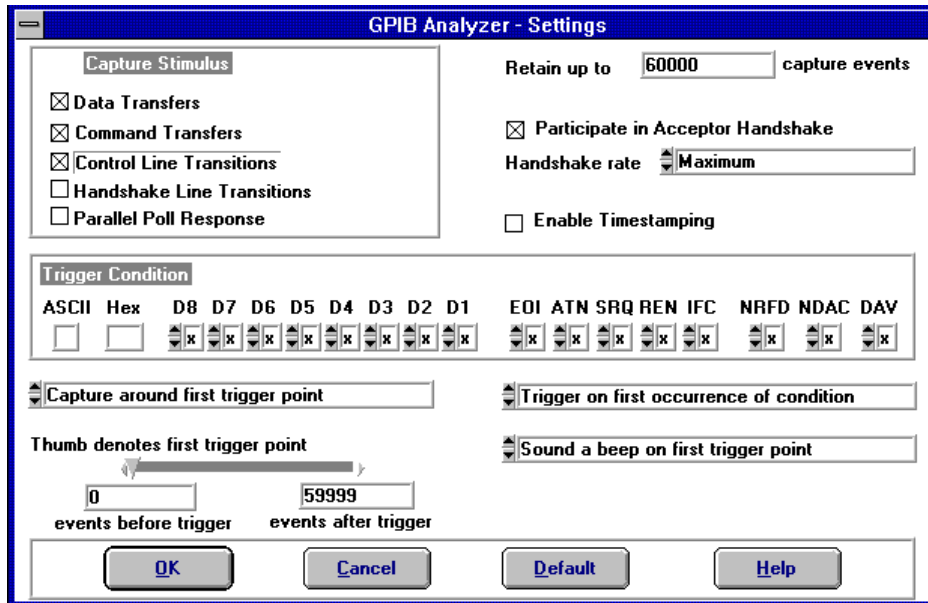
A programmer's application returns a timeout error while waiting to receive data from a device.

Setting up the GPIB Analyzer

The programmer configures the analyzer so that he can examine the GPIB activity during a read from the device. In the Settings window of the GPIB analyzer, he chooses the following settings:

- Capture data transfers, command transfers, and control line transitions
- Retain 60,000 events
- Participate in handshaking and transfer rate set to maximum
- Timestamping disabled

The Settings window looks like the following screen.



The programmer chooses **Capture** in the Action window and captures the sequence of events as the device sends data on the bus. He then clicks on **Off** in the Action window of the analyzer.

Reading the Capture Display

The resulting capture display looks like the following screen.

The screenshot shows the GPIB Analyzer software interface. The title bar reads "GPIB Analyzer - c:\analyzer\example\leoi.cap:2". The interface is divided into several sections:

- File Help!**: A menu bar at the top.
- Capture Settings**: Includes "Stimulus" (Data Command Control), "Capture size" (60000), and "Handshake rate" (Maximum).
- Markers & Statistics**: Includes "From" (Begin), "To" (End), "Go To" (End), "Number of capture events" (12), "Time elapsed", and "Capture events per second".
- Buttons**: "Find ...", "Find Next", "Switch to Active Display", and "Display mode" (Detailed).
- Data Table**: A table with columns for M, Timestamp (mi, s, ms, us, ns), Data (A, H, 87654321), Control (E, A, S, R, I, NR, ND, D), and a description column.

M	Timestamp					Data		Control												
	mi	s	ms	us	ns	A	H	8	7	6	5	4	3	2	1	NR	ND	D		
	--	--	--	--	--	v	76	01110110	0	1	0	0	0	0	0	0	0	0	0	ATN↑
	--	--	--	--	--	20	00100000	0	1	0	0	0	0	0	1	1			LA0	
	--	--	--	--	--	A	41	01000001	0	1	0	0	0	0	0	1	1			TA1
	--	--	--	--	--	A	41	01000001	0	0	0	0	0	0	0	1	0			ATN↓
	--	--	--	--	--	+	2b	00101011	0	0	0	0	0	0	0	1	1			DAB
	--	--	--	--	--	1	31	00110001	0	0	0	0	0	0	0	1	1			DAB
	--	--	--	--	--	5	35	00110101	0	0	0	0	0	0	0	1	1			DAB
	--	--	--	--	--	.	2e	00101110	0	0	0	0	0	0	0	1	1			DAB
	--	--	--	--	--	2	32	00110010	0	0	0	0	0	0	0	1	1			DAB
	--	--	--	--	--	v	76	01110110	1	0	0	0	0	0	0	1	1			DAB EOI↑

This capture display shows that the device asserts EOI with the last byte. The programmer remembers that he set up his application to expect an End-of-String character to terminate the data transfer from the device. He changes the program so that it expects the assertion of EOI to terminate the data transfer. The application then runs without an error.

Appendix A

Common Questions

This appendix answers common questions about the GPIB analyzer.

Why can't I use the analyzer to monitor a GPIB application which uses the NI-488.2 `ibln` or `FindLstn` command?

You can use the analyzer to monitor an application with these commands, but you cannot select **Participate in Acceptor Handshaking** in the Settings window. Selecting this feature asserts/unasserts the NDAC and NRFD lines in response to the Talker's assertion/unassertion of DAV in the GPIB handshake sequence. Therefore, when you run an application that executes a `FindLstn` or `ibln` command, all possible GPIB addresses are returned.

How does selecting "Participate in Acceptor Handshake" in the Settings window affect the GPIB?

When **Participate in Acceptor Handshake** is selected, the analyzer circuitry behaves like a GPIB Listener for the duration of the capture and participates in acceptor handshaking on the GPIB. You can use this feature to slow down GPIB transfers to a particular rate and to avoid overflow errors.

How do I choose a handshake rate? What does "Maximum" mean?

You can use the handshake rate to slow down the transfer rate on the GPIB while debugging timing-related problems. Choosing a particular handshake rate guarantees that the transfer rate on the bus will be less than or equal to that rate. Choosing the **Maximum** rate causes the analyzer to respond as a Listener as fast as it can without causing overflow errors.

How do I define a trigger point to capture a command byte such as TA0?

In the Settings window, set the data lines of the trigger condition by entering either the ASCII or hex equivalent of TA0 or set each of the data lines independently to represent TA0. Set the ATN, DAV, and NDAC lines to 1. Set NRFD to 0. The remainder of the control lines should be set to X. This state of the handshake lines is necessary to guarantee that valid data is present on the data lines.

What do the rows of lights and switches in the Bus Monitor window represent?

The LEDs represent the state of the bus lines at all times. The toggle switches represent the assertion of lines from within the Bus Monitor window of the analyzer. So if the LED for a particular line is on, and the switch for that line is off (down position), the line is asserted, but not by the Bus Monitor.

What is the difference between an active and inactive Capture Display window?

Active capture displays show GPIB events as they are being captured. In other words, active capture displays are windows into the single capture buffer used to store new GPIB events. Inactive capture displays show previously captured GPIB events statically, so that they are unaffected by newly-captured GPIB events. You must make the capture display inactive if you want to use the search or print features.

What do the “Capture Settings” in the Capture Display window mean?

The **Capture Settings** section of the Capture Display window shows the capture settings that were used when the data in the window was captured. They help you interpret the captured data in the Capture Display window. They are not necessarily the same as the current capture settings.

How do I use the timestamping information in detailed display mode and summarized display mode?

In detailed display mode, where each line can correspond to only one capture event, the timestamp value represents the time elapsed between the event on that line and the previous event. So if you want to determine the time elapsed between the capture of the first event and the fifth event, add up the timestamp values on the second, third, fourth, and fifth lines.

In summarized display mode, where more than one event can be present on a line, the timestamp value represents the time elapsed between the first event on that line and the first event on the previous line.

How can I prevent overflow errors?

For detailed information about avoiding overflow errors, refer to the *Avoid Overflow Errors* section in Chapter 3, *How To*.

What information should I have before I call National Instruments?

Before you call National Instruments, make sure you have filled out the configuration form in Appendix D, *Customer Communication*.

Appendix B

Keyboard Commands

This appendix lists keyboard shortcuts that you can use within the GPIB analyzer.

You can use the following keyboard commands from anywhere in the GPIB analyzer application.

<Alt-F4>	Exit the GPIB analyzer
<Ctrl-F4>	Close the current window
<Ctrl-Esc>	Switch to another application
<F1>	Access online help system
<Ctrl-N>	Bring up a new Capture Display Window
<Ctrl-O>	Open a capture file as a Capture Display Window
<Ctrl-T>	Change the settings
<Ctrl-S>	Save the foremost Capture Display Window
<Ctrl-P>	Print the foremost Capture Display Window
<F5>	Turn off capture and trigger
<F6>	Start capture
<F7>	Start capture and trigger

You can use the following keyboard commands to move the cursor and make selections.

<Tab>	Move to the next control item
<Shift-Tab>	Move to the previous control item
<Space>	Select (equivalent to mouse click except in open list box)
<Down Arrow>	Next value of selection (wrap if needed)
<Up Arrow>	Previous value of selection (wrap if needed)
<Enter>	Enter selection if inside list or text entry box; if button is selected, then choose it
<Esc>	Exit without making changes if inside list or text entry box
<Alt-mnemonic>	Selects the corresponding menu or option in the foremost window
<Alt-Space>	Activates control menu
<Alt>	Activates menu bar

You can use the following keyboard commands with menus.

<Left Arrow>	Previous menu (wrap if needed)
<Right Arrow>	Next menu (wrap if needed)
<Up Arrow>	Move up one item (wrap if needed)
<Down Arrow>	Open menu if not open; move down one item
<Mnemonic>	Open menu if not open using underlined character; select item in menu using underlined character
<Enter>	Choose selected menu item
<Esc>	Close menu if open; deactivate menu bar

Appendix C

Capture Display Mnemonics

This appendix explains the mnemonics that appear in the capture display of the GPIB analyzer.

DAB GPIB data byte captured using the data transfer or handshake line transition.

GPIB command bytes captured using the command transfer or handshake line transition:

ACG	Addressed command group.
CFE	Configuration enable.
DCL	Device clear.
GET	Group execute trigger.
GTL	Go to local.
LA0-LA31	Listen addresses 0-30.
LLO	Local lock out.
PPC	Parallel poll configure.
PPU	Parallel poll unconfigure.
SC0-SC30	Secondary command 0-30*.
SDC	Selected device clear.
SPD	Serial poll disable.
SPE	Serial poll enable.
TCT	Take control.
TA0-TA30	Talk addresses 0-30.
UCG	Universal command group.
UNL	Unlisten.
UNT	Untalk.

GPIB parallel poll responses captured using the parallel poll response capture stimulus:

PP-B	Parallel poll is beginning.
PP-E	Parallel poll is ending.
PP-R	Parallel poll response (occurs between PP-B and PP-E).

* If SC appears after a talk or listen address, it is a secondary address. If it appears after a parallel poll configure, it is either a parallel poll enable (PPE) or a parallel poll disable (PPD) command. If it appears after configuration enable (CFE), it is the cable length for HS488.

Appendix D

Customer Communication

For your convenience, this appendix contains forms to help you gather the information necessary to help us solve technical problems you might have as well as a form you can use to comment on the product documentation. Filling out a copy of the *Technical Support Form* before contacting National Instruments helps us help you better and faster.

National Instruments provides comprehensive technical assistance around the world. In the U.S. and Canada, applications engineers are available Monday through Friday from 8:00 a.m. to 6:00 p.m. (central time). In other countries, contact the nearest branch office. You may fax questions to us at any time.

Corporate Headquarters

(512) 795-8248

Technical support fax: (800) 328-2203
(512) 794-5678

Branch Offices	Phone Number	Fax Number
Australia	03 9 879 9422	03 9 879 9179
Austria	0662 45 79 90 0	0662 45 79 90 19
Belgium	02 757 00 20	02 757 03 11
Canada (Ontario)	519 622 9310	519 622 9311
Canada (Quebec)	514 694 8521	514 694 4399
Denmark	45 76 26 00	45 76 71 11
Finland	90 527 2321	90 502 2930
France	1 48 14 24 24	1 48 14 24 14
Germany	089 741 31 30	089 714 60 35
Hong Kong	2645 3186	2686 8505
Italy	02 48301892	02 48301915
Japan	03 5472 2970	03 5472 2977
Korea	02 596 7456	02 596 7455
Mexico	95 800 010 0793	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
U.K.	01635 523545	01635 523154

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 _____

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 _____

(continues)

The problem is _____

List any error messages _____

The following steps will reproduce the problem _____

GPIB 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

- GPIB Hardware Product and Revision _____
- GPIB Analyzer Software Revision _____
- NI-488.2 Software Revision Number on Distribution Disk(s) _____
- Programming Language Interface Revision _____
- Information from `ni -pnp /v` _____
- Board Settings

	Base I/O Address	Interrupt Level	DMA Channel
gpib0	_____	_____	_____
gpib1	_____	_____	_____
gpib2	_____	_____	_____
gpib3	_____	_____	_____

Other Products

- Computer Make and Model _____
- Microprocessor _____
- Clock Frequency _____
- Type of Monitor Card Installed _____
- Windows Version _____

- Application Programming Language (BASICA, Microsoft C, and so on) _____

- Intel Plug and Play Software Installed (yes or no) _____
- Other Boards in System _____
- Base I/O Address of Other Boards _____
- Interrupt Level of Other Boards _____
- DMA Channels of Other Boards _____

Glossary

Prefix	Meaning	Value
n-	nano-	10^{-9}
μ -	micro-	10^{-6}
m-	milli-	10^{-3}
k-	kilo-	10^3
M-	mega-	10^6

ASCII	American Standard Code for Information Interchange
DIO	digital input/output
EOI	end or identify
EOS	End-of-String
GPIB	General Purpose Interface Bus
hex	hexadecimal
HS488	high speed IEEE 488 transfers
IEEE	Institute of Electrical and Electronic Engineers
LED	light-emitting diode
m	meters
s	seconds

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