GPIB-410
User Manual

March 1994 Edition

Part Number 320053-01

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About This Manual

This manual contains the information you need to configure and install the GPIB-410. It also contains a brief tutorial to get you started and a few examples to show how the GPIB-410 operates.

This manual is applicable to:

- Revision C of the GPIB-410 software
- Revision B.2 or higher and Revision C of the GPIB-410 hardware

Refer to Appendix H for a description of the differences between software revisions. Refer to Appendix C for a description of the differences between hardware Revision B.2 or higher and Revision C.

Organization of This Manual

This manual is organized as follows:

- Chapter 1, *Introduction*, contains a list of the kit contents and optional equipment and the steps for unpacking your GPIB-410 interface board. It also contains general information about the GPIB-410 and lists the specifications of the hardware and software.
- Chapter 2, *Hardware and Software Installation*, contains the steps for installing your hardware and software.
- Chapter 3, *Software Overview*, contains general information about the GPIB-410 software, including an introduction to the two windows of operation (monitor and analyzer). There is also an overview of the menu screens and operational modes, and the input conventions used in the software.
- Chapter 4, *Software Reference*, contains reference material for the GPIB-410 software. It contains information about the Monitor window and the various screens of the Analyzer window, and their respective input fields.

- Appendix A, *Tutorial*, contains examples that guide you through step-by-step demonstrations of some fundamental capabilities of the GPIB-410.

- Appendix B, *Multiline Interface Messages*, contains an interface message reference list, which describes the mnemonics and messages that correspond to the interface functions.

- Appendix C, *Hardware and Software Configuration*, describes how to reconfigure the GPIB-410 hardware and software.

- Appendix D, *Common Problems*, contains possible causes for common problems encountered when operating the GPIB-410.

- Appendix E, *Using the Pattern Generator*, describes the Interface Bus Pattern Generating Language (IBPGL) and syntax conventions for data/command strings.

- Appendix F, *GPIB410.PAT Source Listing*, contains a source listing of the IBPGL example program, `GPIB410.PAT`.

- Appendix G, *Saving and Viewing Capture Information on Disk*, describes saving and viewing capture buffers on disk. Also included is a description of the `FMT410` utility.

- Appendix H, *Differences Between Software Revisions*, describes the differences between major software revisions.

- Appendix I, *Customer Communication*, contains forms for you to complete to facilitate communication with National Instruments concerning our products.

- The *Index* contains an alphabetical list of key terms and topics used in this manual, including the page where each one can be found.

Conventions Used in This Manual

The following conventions are used to distinguish elements of text throughout this manual:

italic	Italic text denotes emphasis, a cross reference, or an introduction to a key concept.
`monospace`	Lowercase 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, paths, directories, programs, subprograms, subroutines, device names, functions, variables, filenames, and extensions, and for statements and comments taken from program code.
`bold monospace`	Bold lowercase text in this font denotes the messages and responses that the computer automatically prints to the screen.
`italic monospace`	Italic lowercase text in this font denotes that you must supply the appropriate words or values in the place of these items.
<>	Angle brackets enclose the name of a key on the keyboard–for example, <PgDn>.
-	A hyphen between two or more key names enclosed in angle brackets denotes that you should simultaneously press the named keys–for example, <Ctrl-Alt-Del>.
<Ctrl>	Key names are capitalized.

Abbreviations

The following are the abbreviations for units of measure used in this manual:

A	ampere
C	Celsius
°	degree
Hz	hertz
hex	hexadecimal
in.	inch
K	kilobytes
KHz	kilohertz
MHz	megahertz
nsec	nanosecond
%	percent
V	volt

Acronyms

The following acronyms are used in this manual:

ANSI	American National Standards Institute
ASCII	American Standard Code for Information Interchange
BNC	referring to a coaxial connector
DMA	direct memory access
FIFO	first in, first out (referring to a memory buffer)
GPIB	General Purpose Interface (IEEE-488) Bus
IEEE-488	Institute of Electrical and Electronic Engineers Standard 488-1978, which defines the GPIB
I/O	input/output
IRQ	interrupt request line
LED	light-emitting diode
PIO	programmed I/O
RAM	random-access memory
ROM	read-only memory

Related Document

The following document contains information that you may find helpful as you read this manual:

ANSI/IEEE Std 488-1978, *IEEE Standard Digital Interface for Programmable Instrumentation*

Customer Communication

We appreciate communicating with the people who use our products. We are also very interested in hearing about the applications you develop using our products. To make it easy for you to communicate with us, this manual contains forms for you to complete. These forms are located in Appendix I, *Customer Communication*, at the back of this manual.

Chapter 1
Introduction

This chapter contains a list of the kit contents and optional equipment and the steps for unpacking your GPIB-410 interface board. It also contains general information about the GPIB-410 and lists the specifications of the hardware and software.

The National Instruments GPIB-410 interface board (shown in Figure 1-1) transforms a personal computer into a sophisticated IEEE-488 bus monitor and analyzer. The GPIB-410 has low-level testing and debugging capabilities as well as high-level analysis tools.

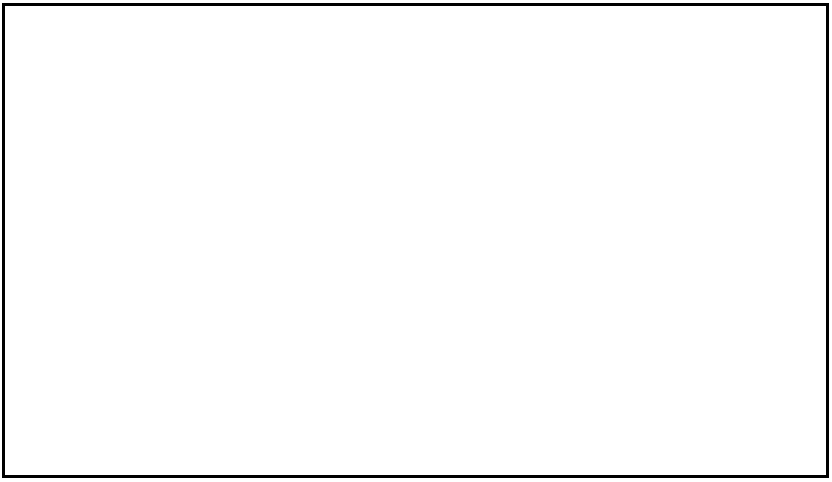


Figure 1-1. GPIB-410 Interface Board

The GPIB-410 displays the complete status of the GPIB on the screen at all times. With sixteen simulated LEDs, one for each GPIB signal, you receive real-time, visual information about GPIB activity.

You can use the GPIB-410 to directly interact with the GPIB through the PC keyboard. The sixteen simulated switches can be toggled on and off from the keyboard to assert or unassert each GPIB signal. This low-

level control is useful for manually debugging GPIB activity. In addition, these switches can be manipulated automatically at high speed by the *Pattern Generator* utility when real-time testing and simulation are required.

The GPIB-410 has high-level GPIB analysis tools. It can capture large amounts of information from the GPIB at full speed, without interfering with GPIB activity. This capture of GPIB status can be related to specific user-selectable GPIB events, a user-selectable internal clock rate, or an external clock input. This information is then interpreted in a high-level format. You can browse or pattern search through the captured data directly on the screen, log it to a disk, and obtain a printed output copy. With multiple-level triggering, you can trigger on a pattern or sequence of patterns on the GPIB. This triggering feature is useful in focusing on a particular range of activity for capture.

What Your Kit Contains

Your kit should contain the following components:

Component	Part Number
GPIB-410 Interface Board	180280-01
BNC I/O Panel with Two Input/Output Cables	180285-01
5.25 in. Distribution Disk for GPIB-410 GPIB Monitor/Analyzer Software or 3.5 in. Distribution Disk for GPIB-410 GPIB Monitor/Analyzer Software	420302-10 422302-10
GPIB-410 User Manual	320053-01

Make sure each of these items is in your kit. If any item is missing, contact National Instruments.

Optional Equipment

Equipment	Part Number
Single-Shielded GPIB Cables:	
Type X1 Cable – 1 m	763001-01
Type X1 Cable – 2 m	763001-02
Type X1 Cable – 4 m	763001-03
Double-Shielded GPIB Cables:	
Type X2 Cable – 1 m	763061-01
Type X2 Cable – 2 m	763061-02
Type X2 Cable – 4 m	763061-03

Unpacking Your GPIB-410

Follow these steps when unpacking your GPIB-410:

1. Verify that the pieces contained in the package you received match the kit parts list given earlier in this chapter. Do not remove the board from its plastic bag at this point.

2. Your GPIB-410 board is shipped packaged in an antistatic plastic bag to prevent electrostatic damage to the board. Several components on the board can be damaged by electrostatic discharge. To avoid such damage in handling the board, touch the plastic bag to a metal part of your computer chassis before removing the board from the bag.

3. Remove the board from the bag and inspect the board for loose components or any other sign of damage. Notify National Instruments if the board appears damaged in any way. *Do not* install a damaged board into your computer.

Hardware Specifications

The GPIB-410 hardware is a full-sized printed circuit board that fits into a PC expansion slot.

Board Size	13.25 in. x 3.75 in.
Maximum Power Consumption	0.6 A at 5 V
Temperature Range	
Operating	0° to 50° C
Storage	-62° to 71° C
Relative Humidity	
Operating	10% to 90% non-condensing
Storage	0% to 100% non-condensing
Maximum Bus Sampling Rate	1.8 MHz

Software Specifications

The GPIB-410 software is supplied on one double-sided/double-density diskette. The software runs on the IBM Personal Computer or any IBM compatible computer. You must have MS-DOS Version 3.00 or higher and at least 128K of RAM (256K of RAM recommended).

Chapter 2
Hardware and Software Installation

This chapter contains the steps for installing your hardware and software.

Install your GPIB-410 using the following steps:

1. Configure the hardware.
2. Install the hardware.
3. Review the files on the distribution diskette.
4. Run the hardware diagnostics.

These steps are described in detail in the remainder of this chapter.

Step 1 – Configure the Hardware

The GPIB-410 hardware is configured at the factory. Verify that the settings of the GPIB-410 do not conflict with another board in your system. The factory configuration parameters are as follows:

- The GPIB-410 occupies 32 contiguous bytes of I/O space. The base address of this 32-byte block of addresses can be any multiple of 20 hex, ranging from 000 hex to 3E0 hex. The GPIB-410 is configured at the factory with a base address of 300 hex, therefore occupying addresses 300 to 31F hex of your PC I/O space. If another board in your system uses one or more of these addresses, refer to Appendix C to change the GPIB-410 base address and to match the software configuration to the new address.
- The GPIB-410 uses DMA channel 1 on your PC for high-speed data transfers. If another board is already using DMA channel 1, refer to Appendix C to change the GPIB-410 DMA channel and to match the software configuration to the new channel.
- The GPIB-410 uses Interrupt Line 7 of the PC I/O channel. If another board is already using Interrupt Line 7, refer to Appendix C

to change the GPIB-410 Interrupt Line and to match the software configuration to the new interrupt selection.

If the GPIB-410 factory configurations do not conflict with other boards in your system, you are ready to proceed with the installation.

Step 2 – Install the Hardware

The GPIB-410 package includes a BNC I/O panel with two input/output cables. You use the BNC I/O panel and cables if you want to sample the GPIB using an external clock signal, or if you want the pulse output signals generated by the trigger mechanism to be sent to an external device.

Use the following steps to install the GPIB-410. Omit steps 8 through 11 if you do not plan to use the BNC I/O panel and cables. Consult the user or technical reference manual of your personal computer for specific instructions and warnings.

1. Turn off your computer and unplug the power cord.

2. Remove the top cover or access port to the I/O channel.

3. Remove the expansion slot cover on the back panel of the computer.

4. Select an open expansion slot (the GPIB-410 requires one full-length slot).

   Note: The GPIB-410 cannot be installed in slot J8 of the IBM Personal Computer XT if DMA is used.

5. Locate the metal bracket that covers the cut-out in the back panel of the PC chassis for the slot that you have selected. Using a screwdriver, remove and save the bracket-retaining screw. Remove the bracket.

6. Insert the GPIB-410 in an unused slot. The GPIB-410 comes with a plastic card guide. Install the card guide (if one is not already installed) for the slot that will hold the GPIB-410. Line up the GPIB-410 with the IEEE-488 connector near the cut-out on the back panel. Lower the end with the bracket and the IEEE-488

connector until the IEEE-488 connector is sticking out of the cut-out. Slowly push down on the front of the GPIB-410 until the card is level again. Lower the card until its edge connector is resting on the expansion slot receptacle. Using an evenly distributed pressure, press the GPIB-410 straight down until it seats in the expansion slot.

7. Re-install the bracket-retaining screw to secure the GPIB-410 to the back-panel rail.

8. If you wish to install the BNC I/O panel and cables for *BNC trigger output* and *BNC external clock input*, you must locate another open expansion slot for the panel. This panel does not require a full-length slot.

9. Locate and remove the bracket that covers the cut-out in the back panel for the slot you have selected.

10. Install the GPIB-410 BNC I/O panel into this slot and re-install the bracket-retaining screw to secure it to the back panel rail.

11. Connect the cables from the BNC I/O panel to the round RF connectors on the GPIB-410. Match the connector labeled TRIG OUT (J2) on the GPIB-410 to the BNC connector labeled TRIG OUT. Match the connector labeled CLK IN (J3) on the GPIB-410 to the BNC connector labeled CLK IN. Figure 2-1 shows the BNC I/O panel and cables connected to the GPIB-410 interface board.

12. Replace the top cover and/or expansion slot cover, plug in the power cord, and power up the computer.

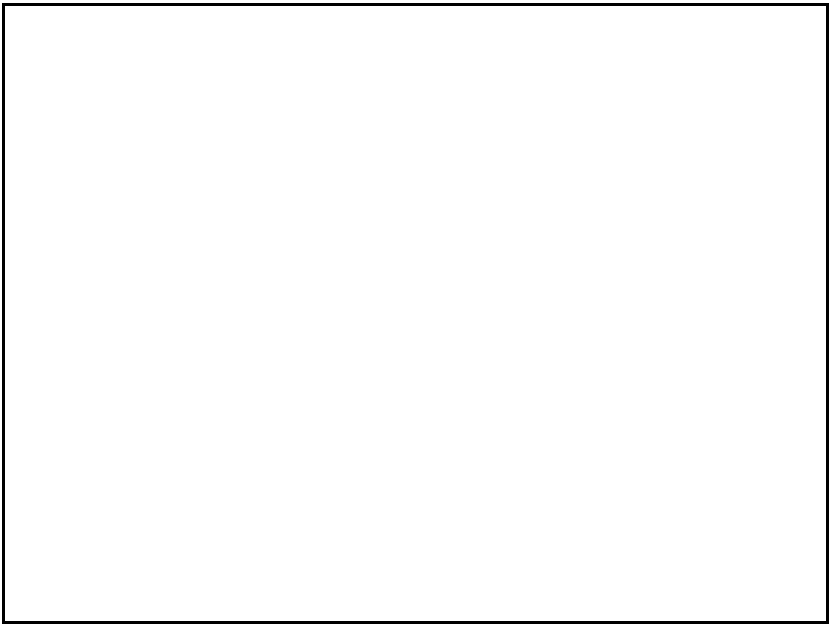


Figure 2-1. BNC I/O Panel and Cables Connected to the GPIB-410 Interface Board Installed in an IBM Compatible Computer

Step 3 – Review the Files on the Distribution Diskette

The GPIB-410 package contains the *Distribution Disk for GPIB-410 GPIB Monitor/Analyzer Software*, (hereafter referred to as the distribution diskette). Verify that your distribution diskette contains the following files:

- `README` Diskette inventory and manual additions
- `GPIB410.EXE` Interactive driver program
- `GPIB410.HLP` Help text file for driver program
- `GPIB410.CFG` Default configuration file for driver program

- `GPIB410.CAP` Default capture file for saved capture buffer
- `GPIB410.PAT` Example pattern command file
- `FMT410.EXE` Capture file format utility
- `DIAG410.EXE` Hardware diagnostic utility

Before using the GPIB-410 software, copy all files on the distribution diskette to a backup diskette or to a suitable directory on your computer's hard disk. Put the original distribution diskette away in a safe place. Use the files on the backup diskette or in the hard disk directory to run the GPIB-410 software.

Step 4 – Run the Hardware Diagnostics

Run the hardware diagnostics by entering the following command.

```
diag410          <Enter>
```

Carefully follow the instructions on the screen. If you changed any of the hardware configuration settings when you installed the interface board, refer to the notes you made in Appendix C and enter the new settings when the program prompts you to do so. To accept the default selection for any setting, just press <Enter>.

The diagnostic tests take several seconds to complete. If they complete successfully, proceed to Chapter 3, *Software Overview*. Otherwise, recheck the configuration and installation of the hardware and run the tests again.

Chapter 3
Software Overview

This chapter contains general information about the GPIB-410 software, including an introduction to the two windows of operation (*monitor* and *analyzer*). There is also an overview of the menu screens and operation modes, and the input conventions used throughout the software.

To become familiar with the windows and menus of the GPIB-410 software, start the GPIB-410 program by entering the following command.

```
gpib410          <Enter>
```

The *Monitor/Analyzer Main Menu* screen is the first screen to appear. Notice that the screen is divided into two windows: the monitor and the analyzer. An example of this screen is shown in Figure 3-1.

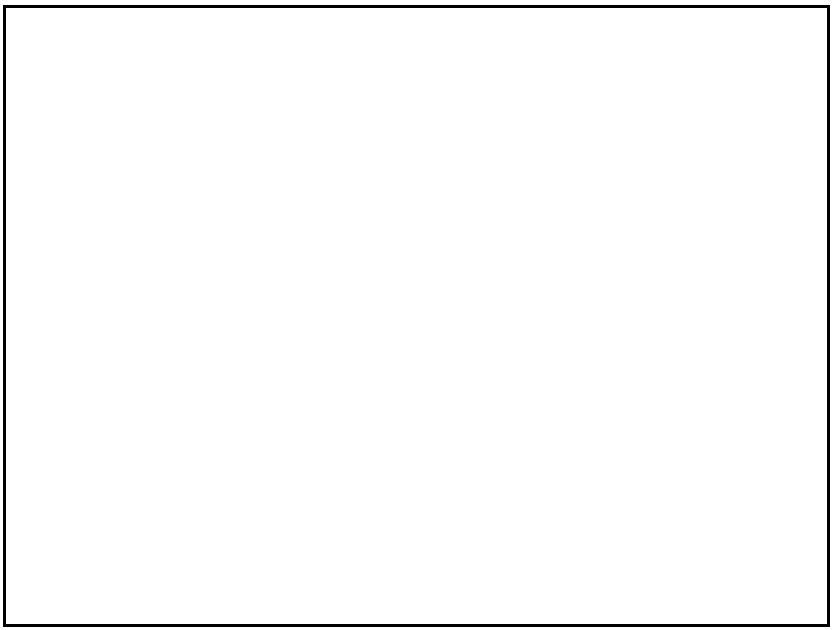


Figure 3-1. Monitor/Analyzer Main Menu Screen

The monitor window, shown in Figure 3-2, occupies the top quarter of the Monitor/Analyzer screen and is visible at all times. The analyzer window, shown in Figure 3-3, occupies the bottom three-quarters of the screen. The contents of the analyzer window vary depending on the menu screen selected. The two windows operate independently of one another.

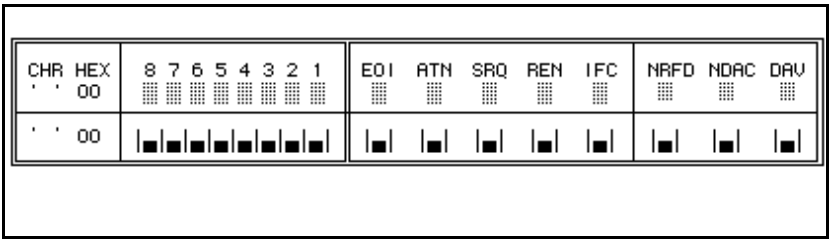


Figure 3-2. Monitor Window

Figure 3-3. Analyzer Window

The Monitor Window

The monitor window graphically displays the current state of the GPIB through simulated LED indicators. Each LED has a corresponding toggle switch through which you can assert the associated signal on the bus. In addition, the status of the eight bus data lines is indicated in both character and hexadecimal formats.

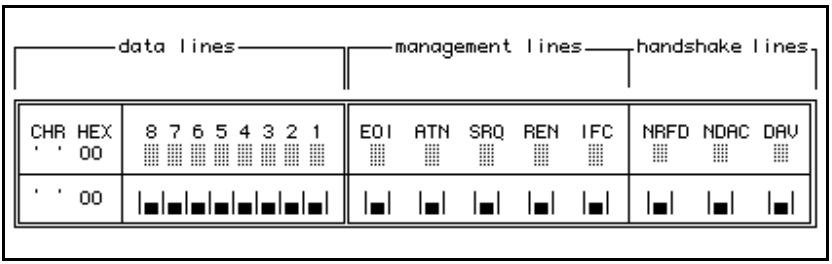


Figure 3-4. GPIB Status Indicators

The following list shows how the LEDs and switches appear when they are on and off.

LED (on) Switch (on)

LED (off) Switch (off)

As shown in Figure 3-4, the top half of the monitor window displays the current value of each signal on the GPIB. If the GPIB signal is asserted, the LED is on. If the GPIB signal is not asserted, the LED is off. The bottom half of the monitor window displays the current user switch selection for asserting or unasserting GPIB signals. If the switch is on (or up), the GPIB-410 is currently asserting that signal on the GPIB.

The Analyzer Window

The analyzer window is divided into the following four areas:

- The title/status bar
- The general information display
- The help/error bar
- The function key line

These four areas are illustrated in Figure 3-5.

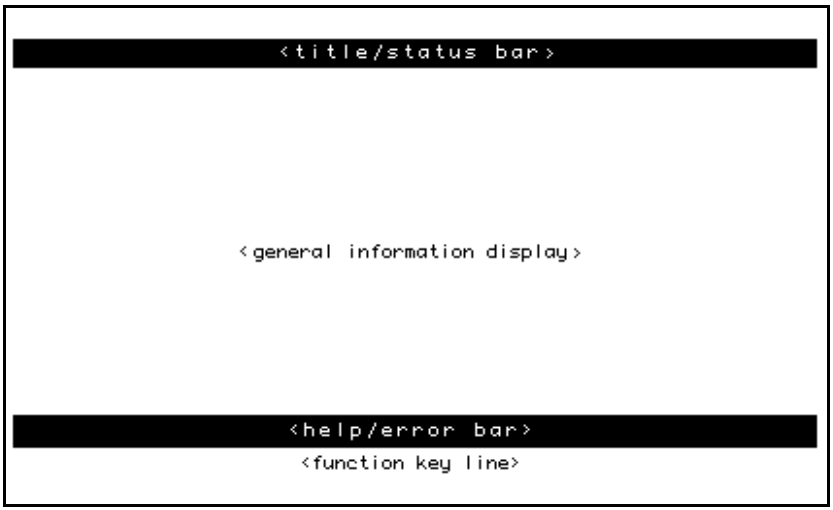


Figure 3-5. Format of the Analyzer Window

The *title/status bar* contains the name of the current menu screen and shows all enabled GPIB-410 operational modes.

The *general information display* contains menus, input fields, or other textual information.

The *help/error bar* indicates the keys to use for the currently selected menu field or the range of values allowed for data entry. This bar also displays error information and other status messages in response to various operations.

The *function key line* contains Main Menu and Help screen function keys and additional function keys enabled for the particular screen displayed.

Screens of the Analyzer Window

Five primary screens can be selected from the Main Menu (<F2>). These screens are selected by pressing <F3>, <F4>, <F5>, <F6>, or <F7>.

- <F3> – Capture Settings Screen
- <F4> – Trigger Specification Screen
- <F5> – Capture Display Screen
- <F6> – Pattern Generator Screen
- <F7> – Configuration Settings Screen

Note: You can return to the Main Menu from any of these screens by pressing <F2>, or proceed to another primary screen by pressing the function key of that screen.

In addition to the five primary screens, there are two auxiliary screens that are selected by pressing <F1> or <Esc>.

- <F1> – Help Utility Screen
- <Esc> – Program Exit Screen

Capture Settings Screen

<F3> selects the Capture Settings screen. Use this screen to indicate the method of capturing and the amount of data you wish to capture. Capturing involves sampling the GPIB at specified time intervals or on

the occurrence of specified events and saving the status of the signal lines at that moment in time. Captured status information in memory can be viewed using the Capture Display screen. Appendix G contains information on saving and viewing capture information on disk.

Trigger Specification Screen

<F4> selects the Trigger Specification screen. Use this screen to specify a pattern, or series of patterns, that you wish to detect on the GPIB, and the action you wish to take once the pattern or series has occurred.

Capture Display Screen

<F5> selects the Capture Display screen. Use this screen to monitor a capture operation while it is still in progress or to review and analyze the contents of the capture buffer after the capture has terminated.

Pattern Generator Screen

<F6> selects the Pattern Generator screen. Use this screen to specify a sequence of patterns that you wish to output to the GPIB at high speed. These patterns can be specified either interactively on the screen or in a previously prepared command file on disk. Appendixes E and F contain additional information on using the Pattern Generator.

Configuration Settings Screen

<F7> selects the Configuration Settings screen. Use this screen to change installation- and performance-related parameters, as necessary, for correct operation of the GPIB-410 software.

Note: If you have changed any of the switches or jumpers on the interface board, make the changes to this screen to reflect those changes (the hardware and software settings must match). Appendix C contains additional information on configuring your hardware.

Help Utility Screen

<F1> selects the Help Utility screen. Use this screen to obtain information about a particular primary screen or one of its input fields. You can only exit the Help screen by typing <F1>.

To select a field for help, use the cursor control keys (that is, the arrow keys) to highlight the field, then press <F1>. Once the Help screen appears, use <PgDn> or the down arrow key to read the information. If you would like to read something that has already scrolled off the screen, press <F1> twice to exit and re-activate the Help screen.

Program Exit Screen

<Esc> selects the Program Exit screen. Use this screen to specify whether to save the current state of the software upon termination of the `GPIB410` program. You can only terminate the `GPIB410` program when the Program Exit screen is active.

Operational Modes and Functions

The various operational modes and functions of the GPIB-410 are activated by pressing the following keys.

- <Alt-C> – Capture (toggles on and off)
- <Alt-E> – Capture Echo (toggles on and off)
- <Alt-R> – Recapture
- <Alt-T> – Trigger (toggles on and off)
- <Alt-G> – Generate (toggles on and off)
- <Alt-M> – Monitor Input (toggles on and off)
- <Alt-A> – Acceptor Handshaker (toggles on and off)
- <Alt-S> – Source Handshaker (toggles on and off)
- <Alt-D> – DOS Shell
- <Alt-I> – DOS Shell + Icon

<Alt-C> Capture

Use this mode to capture the status of the GPIB as directed by the parameters defined on the Capture Settings screen. Pressing <Alt-C> when a capture is in progress terminates the capture. When this mode is active, `CAP` is displayed in the Title/Status bar and `C` is displayed in the DOS shell icon. This mode cannot be enabled when triggering is enabled.

<Alt-E> Capture Echo

Use this mode along with the Capture Display screen to view up to the last sixteen capture samples while a capture operation is still in progress. If a capture is not already in progress when this mode is enabled, one will be started. Disabling this mode will not stop the current capture operation. This mode is most suitable for low-speed,

limited activity situations. When this mode is active, a blinking CAP is displayed in the Title/Status bar and C is displayed in the DOS shell icon.

<Alt-R> Recapture

Use this function to *recapture* the results of the last successful capture operation after the Capture Display screen has been cleared. An error is signaled if any portion of the previous capture has been overwritten by a subsequent capture. This function can also be used to recover the results of an untriggered background capture (see Chapter 4, *The Trigger Specification Screen*). This function executes quickly and does not have an indicator in the Title/Status bar.

<Alt-T> Trigger

Use this mode to wait for the pattern sequence defined on the Trigger Specification screen to occur on the GPIB. When this mode is active, TRG is displayed in the Title/Status bar and T is displayed in the DOS shell icon. This mode cannot be enabled when capturing is enabled.

<Alt-G> Generate

Use this mode to output a sequence of data/control patterns onto the GPIB as specified on the Pattern Generator screen. When this mode is active, GEN is displayed in the Title/Status bar and G is displayed in the DOS shell icon. This mode cannot be enabled when the Source Handshaker is enabled.

<Alt-M> Monitor Input

Use this mode to direct subsequent input into the upper window of the screen so that you can manipulate the individual lines of the GPIB. When this mode is active, MON is displayed in the Title/Status bar. In addition to <Alt-M>, pressing the function key of the currently displayed primary screen also deactivates this mode. This mode is temporarily disabled when the Pattern Generator is enabled.

<Alt-A> Acceptor Handshaker

Use this mode when you want the GPIB-410 to perform a dummy acceptor handshake automatically whenever the DAV line is asserted. The accepted data or command bytes are not saved unless capturing is also enabled (use <Alt-C>). When this mode is active, `ACP` is displayed in the Title/Status bar and `A` is displayed in the DOS shell icon.

<Alt-S> Source Handshaker

Use this mode when you want the GPIB-410 to perform a dummy source handshake automatically whenever the NRFD line is unasserted. The handshake is performed regardless of the current state of the other GPIB lines. When this mode is active, `SRC` is displayed in the Title/Status bar and `S` is displayed in the DOS shell icon. This mode cannot be enabled when the Pattern Generator is enabled.

<Alt-D> DOS Shell

Use this function to escape to DOS temporarily without terminating the `GPIB410` program. All enabled operational modes remain active while the main program is suspended. To exit the shell and return control to the `GPIB410` program, type `EXIT` at the DOS prompt.

<Alt-I> DOS Shell + Icon

Use this function to escape to DOS temporarily without terminating the `GPIB410` program. During operation of the shell, a GPIB-410 icon is displayed in the upper right-hand corner of the screen showing the operational modes in effect and the current state of the GPIB signal lines. The layout of the icon signal lines is the same as that shown in the monitor window. All enabled operational modes remain active while the main program is suspended. To exit the shell and return control to the `GPIB410` program, type `EXIT` at the DOS prompt. See Figure 3-6 for an example of this mode of operation.

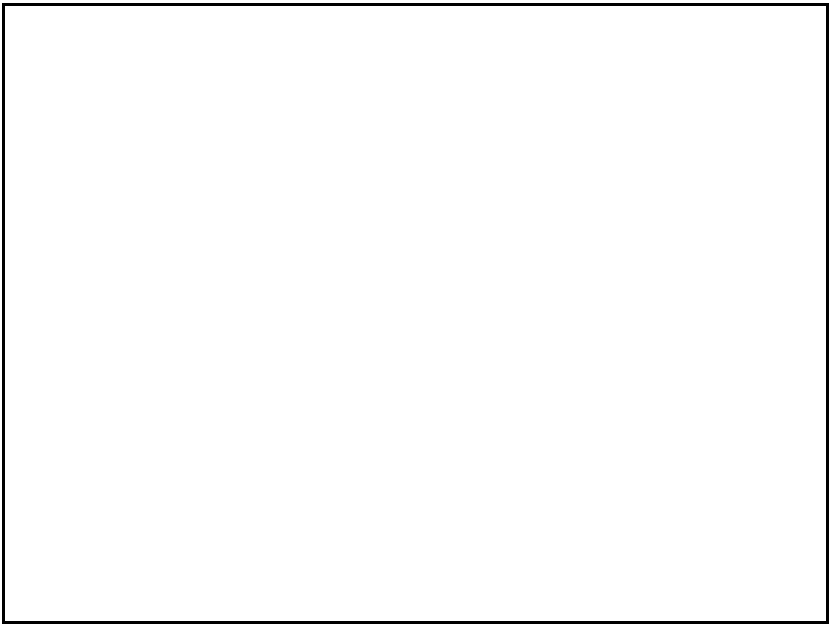


Figure 3-6. DOS Shell with GPIB-410 Icon

General Input Conventions

The GPIB-410 software has three types of input fields. They are *Direct Input*, *Option Ring*, and *Key Select*. Each of these types of fields is described in detail later in this chapter.

To modify or get help on a particular field, it must be selected. The software is always operating in one of two input modes, *monitor* or *analyzer*. When Monitor Input mode is enabled, only those fields in the monitor window can be selected. When Monitor Input mode is not enabled, the software is operating in Analyzer Input mode and the fields in the lower portion of the screen can be selected. Type <Alt-M> to move into and out of Monitor Input mode.

Regardless of the input mode selected, other operational modes can also temporarily inhibit selection of certain input fields.

To select a field, enable the appropriate input mode and use the cursor control keys to point to that field. Depending on its type, a selected field is indicated by some kind of key prompt and/or highlighting. For example,
±yes is a selected option ring. To modify the contents of the field, use the keys indicated by the prompt (in the preceding example, <+> or <->) and refer to the information contained in the Help/Error bar for assistance.

Each of the three types of input fields is described in detail in the following sections.

Direct Input Fields

Information in these fields is simply typed in from the computer keyboard. The information is then verified for correctness when the field is de-selected. A selected direct input field is distinguished by the presence of a block cursor superimposed over one of the characters in the field. There are two types of direct input fields: *Text* and *Numeric*.

- *Text* fields are used for inputting text, such as file names. Most inline editing functions are supported, including delete, backspace, tab, and left and right cursoring. In addition, typing <SpaceBar> or <Alt-B> clears all characters to blanks from the current cursor position to the rightmost position in the field.

- *Numeric* fields are used for inputting numbers in decimal or hexadecimal. Numbers are entered calculator-style, with old digits shifting to the left as new ones are entered, while the cursor remains stationary at the rightmost position. This field supports the use of the delete key (<Del>), which shifts a zero (0) in from the left, and the <SpaceBar>, which clears all digits in the field to zero (0).

Option Ring Fields

These fields present a "ring" of options from which one is selected by using the indicated keys. A selected option ring is distinguished by a blinking single character prompt at the beginning of the field. The prompt also designates which keys are used in the selection process.

- The <+> and <-> keys

  or

- The left and right cursor control keys (the arrow keys)

Some option rings contain options which include sub-fields. These fields can be of any of the three basic input types and only appear when the associated option is active. A sub-field is automatically selected whenever its parent field is selected, thus, you can modify the value of either field by using the indicated keys.

Changing the value of the parent field causes the sub-field of the deactivated option to be erased.

Key Select Fields

These fields present a grouping of several related fields, each of which is a small option ring. A selected Key Select field is distinguished by the presence of an individual key prompt either above or beside each component field. Press the key indicated by each prompt to modify the value of the associated component field.

Key Select fields are used primarily to manipulate the individual lines or bits of the GPIB. These GPIB fields support the following additional functions:

- <Ins> - Use this key to enter any 8-bit ASCII character or hexadecimal value directly into the data portion of the GPIB, for example, type

  <Ins>a to insert the pattern `0 1 1 0 0 0 0 1`

  <Ins><Ins>35 to insert the pattern `0 0 1 1 0 1 0 1`

- <SpaceBar> - Use this key to reset all component fields to their original *off* or *null* position.

Chapter 4
Software Reference

This chapter contains reference material for the GPIB-410 software. It contains information about the Monitor window and the various screens of the Analyzer window, and their respective input fields.

The Monitor Window

This window shows the current state of the sixteen GPIB signal lines and indicates which of those lines, if any, are being asserted by the GPIB-410. The window is always present at the top of the screen and is divided into four sections (see Figure 4-1).

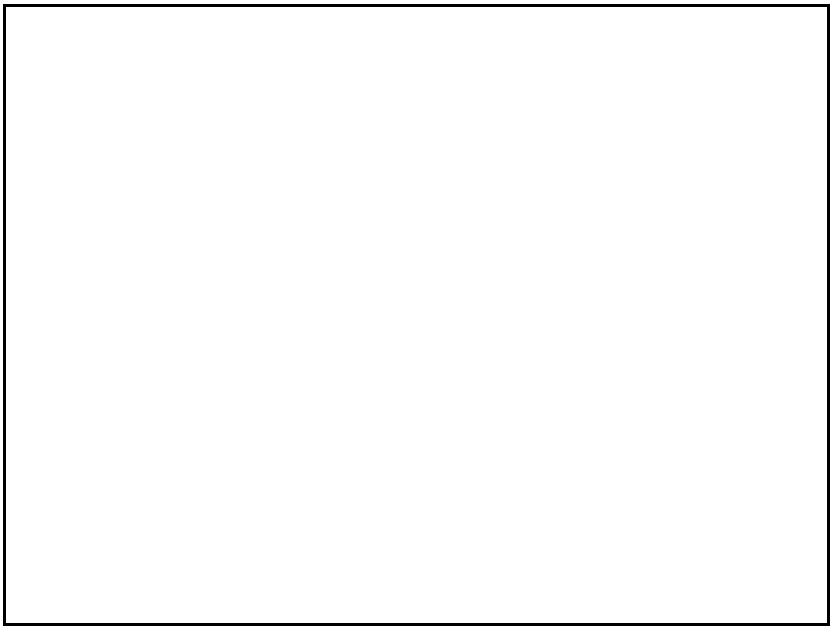
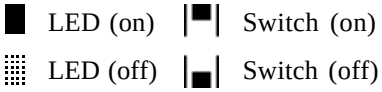


Figure 4-1. Monitor Window at the Top of the Screen

The two left-most sections of the Monitor window display the contents of the eight data lines in character, hexadecimal, and binary format. The two right-most sections display the contents of the eight control lines in binary format. The lower portion of each section contains corresponding user input fields, which are selectable using the left and right cursor control keys.

The binary indicators and fields are displayed graphically as simulated LEDs and toggle switches, as shown below.



Each LED indicates whether the corresponding signal is asserted or unasserted on the bus. Each switch indicates whether the corresponding signal is asserted or unasserted by the GPIB-410. You can change the settings of the switches only when Monitor Input mode is active, indicated by `MON` in the Title/Status bar. Press <Alt-M> to enable or disable Monitor Input mode.

Lines that you assert by setting the corresponding switches to ON remain asserted in between separate invocations of Monitor Input mode, unless they are changed during operation of the Pattern Generator.

Note: Monitor input is temporarily disabled when the Pattern Generator is running and during access to the Help utility.

When any field of the Monitor window is active, pressing function key <F10> performs one cycle of the acceptor handshake in response to the assertion of DAV. Before using this function, you must initialize the handshake by pressing <F10>–this asserts NDAC and puts the GPIB-410 in the Acceptor Ready State (ACRS). After that, each time you press <F10> in response to DAV, the GPIB-410 executes one cycle of the acceptor handshake, returning to ACRS when DAV becomes unasserted.

The Monitor Window contains the following fields from left to right.

- `Data Line Input, (Character)`
- `Data Line Input, (Hexadecimal)`
- `Data and Control Line Input, (Binary)`

Data Line Input (Character)

Use this field to assert any ASCII character onto the GPIB data lines. Each character entered is asserted immediately onto the bus and the Monitor window indicators are adjusted accordingly. Only the data lines are affected by this operation–no source handshaking is performed.

Data Line Input (Hexadecimal)

Use this field to assert any one-byte hexadecimal value onto the GPIB data lines, four bits at a time. Each hex digit entered is asserted immediately onto the bus and the Monitor window indicators are adjusted accordingly. Only the data lines are affected by this operation–no source handshaking is performed.

Data and Control Line Input (Binary)

Use this field to assert any combination of the sixteen GPIB signal lines. Each line is controlled by a simulated toggle switch indicator which can be turned on or off by pressing the indicated key.

As indicated when this field is selected, the topmost row of letters on the keyboard manipulates the eight bus data lines and the next row of letters manipulates the eight bus control lines. Use the Insert key (<Ins>) to place a single 8-bit ASCII or 2-digit hexadecimal value directly onto the data lines of the bus.

The Capture Settings Screen

This screen shows the controlling parameters in effect during a capture operation (see Figure 4-2).

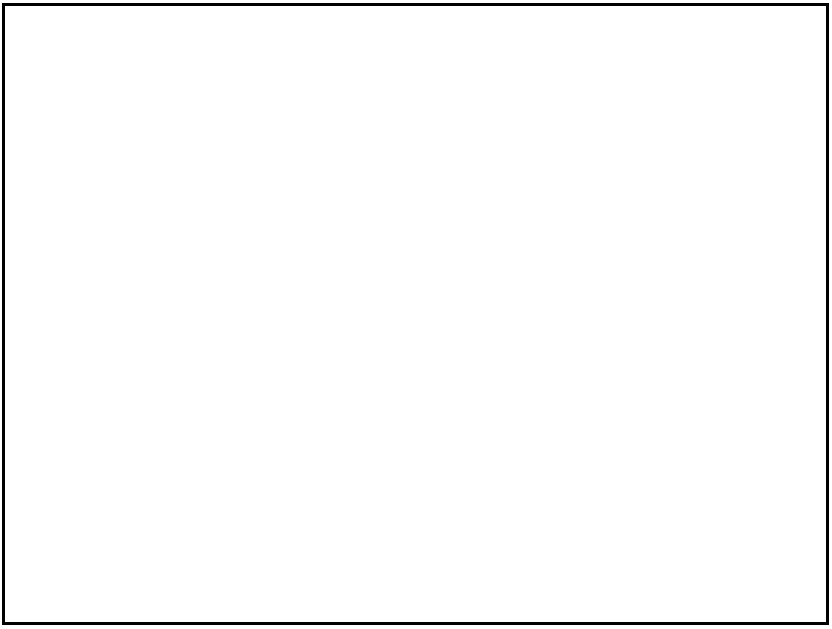


Figure 4-2. Capture Settings Screen

When accessing this screen, no input fields can be selected when the following operational modes are enabled:

- Capture
- Trigger (with background capture)
- Monitor Input

To start a capture operation type <Alt-C>. When capturing is enabled, `CAP` is displayed in the Title/Status bar and `C` is displayed in the DOS shell icon.

Capturing remains enabled until one of the following conditions occurs.

- You type <Alt-C> again.
- The capture buffer fills up and the software is configured to stop capturing on this occurrence.
- An excessive number of status entries are lost or missed by the GPIB-410 hardware due to a sustained high-speed sampling rate.

After capturing terminates, use the Capture Display screen to view and analyze the contents of the capture buffer. To save the contents of the capture buffer to a file on disk, use the `Capture Write` function <Alt-W>. To reload the contents of a previously saved file back into the capture buffer, use the `Capture Load` function <Alt-L>.

The Capture Settings screen contains the following fields.

- `Capture stimulus`
- `Participate in handshake`
- `Buffer Setup: Maximum capacity`
- `Buffer Setup: Action when buffer full`
- `Buffer Setup: Auto-write each pass`
- `File Setup: Buffer range for <Alt-W>`
- `File Setup: Capture file name`

Capture Stimulus

Use this field to specify when or how often to save the status of the GPIB signal lines during a capture operation. There are three options.

- SELECTED GPIB EVENTS
- INTERNAL CLOCK PULSE
- EXTERNAL CLOCK PULSE

Each of the above options is described in the following paragraphs.

- SELECTED GPIB EVENTS. This option causes the GPIB-410 to sample the bus on each occurrence of any selected *event*. The effective sampling rate under this option varies and depends on which events are enabled and the amount of activity on the bus. Any combination of the following seven events can be selected by turning on the • indicator.

DATA transfer	Defined as the (initial) assertion of DAV while ATN is unasserted.
COMMAND transfer	Defined as the (initial) assertion of DAV while ATN is asserted.
IDY response	Defined as the state of the bus lines at the end of a parallel poll–ATN and EOI asserted.
IFC status	Defined as the state of the bus lines at the end of an interface clear–IFC asserted.
REN transition	Defined as the (initial) assertion or unassertion of REN.
SRQ transition	Defined as the (initial) assertion or unassertion of SRQ.
ATN transition	Defined as the (initial) assertion or unassertion of ATN.

- INTERNAL CLOCK PULSE. This option causes the GPIB-410 to sample the bus at regular, fixed time intervals. Samples are taken regardless of the type or amount of activity occurring on the bus. Any one of the following sixteen sample intervals can be selected.

0.56 usec	8.96 usec	143.36 usec	2.30 msec
1.12 usec	17.92 usec	286.72 usec	4.60 msec
2.24 usec	35.84 usec	573.44 usec	9.20 msec
4.48 usec	71.68 usec	1.15 msec	18.40 msec

- EXTERNAL CLOCK PULSE. This option causes the GPIB-410 to sample the bus on each occurrence of an external clock pulse. The pulse must be supplied by an external device through the CLK input port of the GPIB-410. The actual sampling rate with this option can be fixed or varying, depending on the nature of the external clock input.

Participate in Handshake

Use this field to specify whether the GPIB-410 should perform the acceptor handshake when capturing data or command transfers. There are two options:

- `yes` (perform handshaking)
- `no` (do *not* perform handshaking)

Selecting `yes` causes the GPIB-410 to perform the acceptor handshake *only* when a data or command byte is transferred on the GPIB *and* that type of transfer is also a selected capture event. Performing the handshake helps prevent capture loss during periods of sustained high-speed transfers. Selecting `no` disables participation in the handshake and therefore prevents the GPIB-410 from interfering with the bus activity being captured.

This handshake feature is independent of the ACP handshaker <Alt-A>.

Buffer Setup: Maximum Capacity

Use this field to allocate a fixed amount of memory in which to store captured bus samples. (One bus sample requires two bytes of memory.) The capture buffer is defined in terms of the maximum number of 2-byte entries that can be made in it while capturing is in progress. Subject to the memory limitations of your computer, any size from 16 to 65535 entries can be entered (default = 256 entries).

If the software is unable to allocate a buffer of the requested size, an error is returned and the size of the largest buffer available is displayed in this field.

Warning: Resizing the capture buffer can cause existing buffer entries to be lost or truncated.

Buffer Setup: Action When Buffer Full

Use this field to specify the action to be taken when the capture buffer fills to capacity while capturing. There are two options.

- `stop capture` (single-pass)
- `reset and continue` (multi-pass)

Selecting the *multi-pass* option causes the GPIB-410 to begin entering new capture samples at the beginning of the buffer each time the buffer fills up. Previous buffer entries are overwritten. This cyclical action continues indefinitely until you stop the capture by typing <Alt-C>, at which point the buffer is "unwound" so that the most recently captured samples can be reviewed in chronological order.

Buffer Setup: Auto-Write Each Pass

Use this field to specify whether to save the results of the next capture operation automatically to a file on disk. There are two options.

- `yes` (write each buffer pass to disk)
- `no` (do *not* write to disk)

Selecting `yes` causes the results of future capture operations to be written to the specified file whenever the capture buffer is full or capturing is stopped. To implement a continuous capture operation to disk, combine this option with a circular buffer by configuring the following fields on the capture settings screen as shown.

```
Action when buffer full ... reset and continue
Auto-write each pass ..... yes
Capture file name ......... filename.cap
```

Note: Selecting `yes` for the `Auto-write each pass` field does not cause the *current* contents of the capture buffer to be saved to disk–you must explicitly type <Alt-W> to do this.

File Setup: Buffer Range for <Alt-W>

Use this field to specify the portion of the capture buffer to be written to disk when you type <Alt-W>. There are two options.

- `entire buffer`
- `cursor-to-cursor`

Selecting `entire buffer` causes all entries in the capture buffer to be written to the target capture file when you type <Alt-W>. Selecting

`cursor-to-cursor` causes only those entries falling on or between the positional cursors `1` and `2` (see Capture Display Screen) to be written to the file. The cursors can be in any order.

File Setup: Capture File Name

Use this field to enter the pathname of a file on disk to be *written from* or *loaded into* the capture buffer. You can enter any valid DOS pathname, including a drive specification, up to 47 characters in length (default = `GPIB410.CAP`). This file is used by the following functions.

- `Capture Write` <Alt-W>
- `Capture Load` <Alt-L>
- `Capture Auto-Write`

If the file is written from the capture buffer, the existing contents of the file are discarded. If the file is loaded into the capture buffer, the file must contain valid GPIB-410 capture data.

Warning: The `Capture Auto-Write` function, when enabled, overwrites this file immediately as soon as a capture operation is started. The existing contents are lost regardless of whether new capture data is subsequently written to the file.

GPIB-410 capture files are stored in binary format. To view or print the contents of a capture file from a DOS shell, use the `FMT410` utility documented in Appendix G, *Saving and Viewing Capture Information on Disk.*

The Trigger Specification Screen

This screen shows the sequence of patterns composing the Trigger Specification and the action to be performed once the sequence has been satisfied (see Figure 4-3).

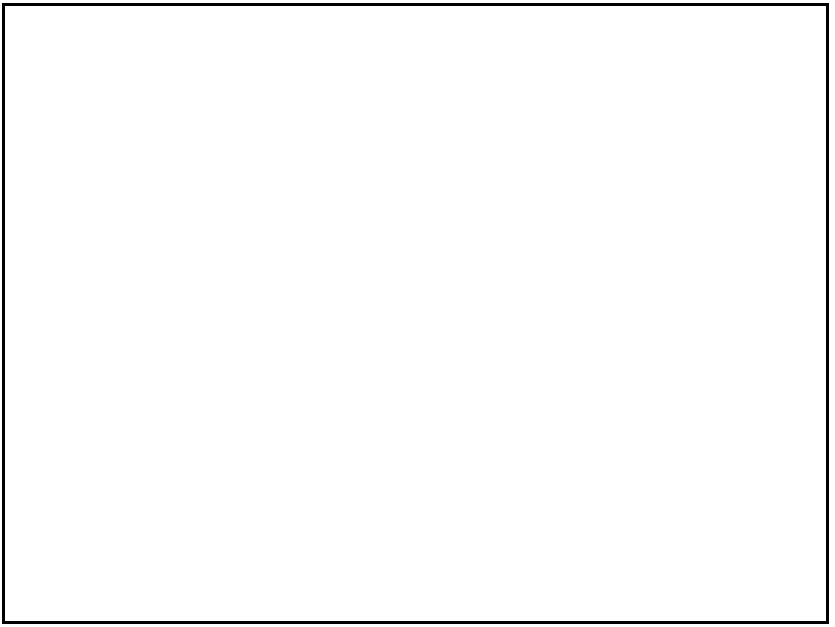


Figure 4-3. Trigger Specification Screen

When accessing this screen, no input fields can be selected when the following operational modes are enabled.

- Trigger
- Monitor Input

Up to nine patterns can be specified in the pattern sequence. Use function keys <F8>, <F9>, and <F10> to insert, append, and delete patterns, respectively. Deleted patterns are pushed back on a stack of unused patterns used by the insert and append functions, thus making it easy to re-arrange patterns in the sequence.

To arm the Trigger, type <Alt-T>. When triggering is enabled, `TRG` is displayed in the Title/Status bar and `T` is displayed in the DOS shell icon. Triggering remains enabled until one of the following conditions occurs.

- You type <Alt-T> again.
- The last pattern in the pattern sequence is matched.

If the entire pattern sequence is satisfied before triggering is disabled, the selected trigger action is taken. While the GPIB-410 waits for a particular pattern to occur the pattern label is highlighted.

Keep the following points in mind when defining the Trigger Spec.

- The GPIB-410 hardware can detect only one trigger pattern at a time without reprogramming.

- The multi-pattern, repeating trigger capability of the GPIB-410 is implemented in software. If two events matching consecutive patterns occur within a sufficiently small time interval, it is possible the second event will be missed.

- If the selected trigger action is `TRIGGER with position: TTTTT`, *background* capturing may be started when the trigger is armed. If so, following satisfaction of the pattern sequence there is a brief capture adjustment period, during which time it is possible that some capture entries may be missed or lost.

- The likelihood of losing trigger or capture events can be reduced or eliminated by configuring the GPIB-410 to participate in the acceptor handshake while capturing (see Capture Settings screen) or by enabling the "dummy" ACP handshaker <Alt-A>.

- For triggering a capture operation, the following Trigger Spec is the least dependent on software intervention and the most efficient.

```
1 WAIT FOR <single trigger pattern> 0001 time

   then

   TRIGGER with position:  T
```

The Trigger Specification screen contains the following fields.

- `Data/Control Specification`

- `Trigger Repeat Factor`

- `Pulse Output Port Option`
- `Trigger Action`

Data/Control Specification (Trigger Pattern)

Use this field to specify a 16-bit pattern that you want the GPIB-410 to later *wait for* on the bus. The ordering of the signal lines in the pattern is identical to that shown in the Monitor window.

Construct the trigger pattern by pressing the indicated letter keys to select a `0`, `1`, or `X` ("don't care") condition for each signal line. As indicated on the screen, the topmost row of letters on the keyboard manipulates the data portion of the pattern and the next row of letters manipulates the control portion. Use the Insert key (<Ins>) to place a single 8-bit ASCII or 2-digit hexadecimal value directly into the data portion of the pattern.

Pattern Repetition Factor

Use this field to enter a repetition factor for the associated trigger pattern. This value specifies how many distinct times a pattern must occur on the bus before the pattern is considered *satisfied*. Only when a pattern is satisfied will the software move on to the next pattern in the sequence.

Valid repetition factors range from 1 to 9999 (default = 1).

Pulse Output Port

Use this field to specify whether to send a pulse to the TRG output port of the GPIB-410 each time the trigger pattern is matched. There are two options.

- `PULSE`
- `NO PULSE`

Selecting PULSE causes a pulse to be sent each time the pattern occurs on the bus. The number of pulses output per pattern is equal to the pattern repetition factor.

Trigger Action

Use this field to specify the action to be taken once the trigger pattern sequence has been satisfied. There are three options.

- TRIGGER with position:
- GO TO *label*
- STOP and sound speaker

Each of the above options is described in the following paragraphs.

- TRIGGER WITH POSITION:

  This option causes the GPIB-410 to trigger a capture operation. Use the adjacent sub-field to specify the relative position of the trigger point T among the captured data. Any one of five positions can be selected.

  ```
  TRIGGER with position:      T
  ```

  If the T is placed in the left-most position, capturing does not begin until the Trigger Spec is *satisfied*. Placing the T in any other position causes background capturing to begin as soon as the trigger is *armed*. In either case, when the trigger occurs the next capture entry is marked as the trigger point and any previous entries in the buffer are realigned so as to position the trigger point as requested. Foreground capturing then proceeds according to the options selected on the Capture Settings screen.

- GO TO *label*

  This option causes the GPIB-410 to repeat the pattern sequence from the pattern specified by *label* each time the end of the sequence is reached. This looping action continues until you disarm the trigger by typing <Alt-T>. Any visible pattern label from 1 to 9 can be selected as the loop target.

  This option is useful when you wish to repeat indefinitely a pattern sequence producing one or more pulses on the TRG output port of the GPIB-410.

- STOP AND SOUND SPEAKER

  This option causes the GPIB-410 to "beep" when the pattern sequence is satisfied.

The Capture Display Screen

This screen shows the current contents of the capture buffer defined on the Capture Settings screen (see Figure 4-4).

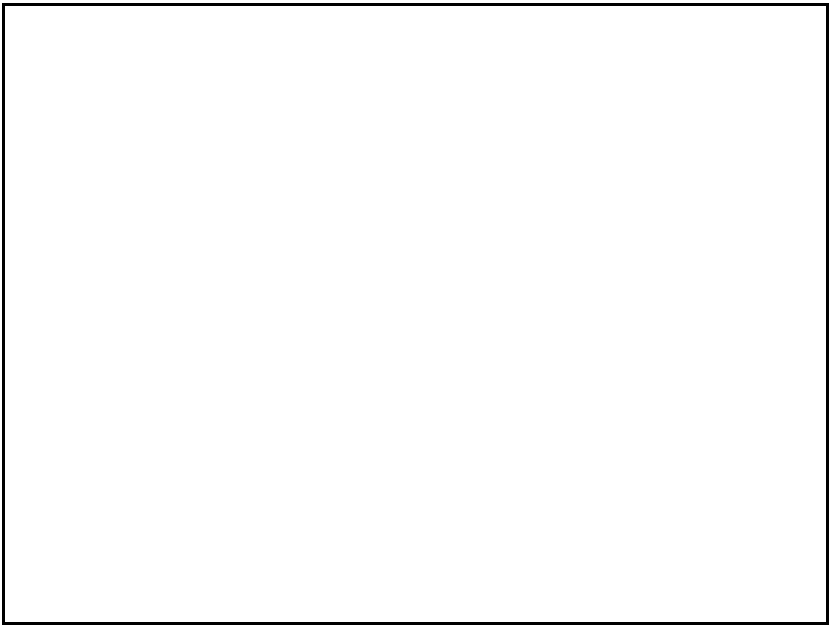


Figure 4-4. Capture Display Screen

Input to this screen is disabled when the capture buffer is empty. Input to this screen is also disabled when the following operational modes are enabled.

- Capture

- Trigger (with background capture)
- Monitor Input

Display Window Layout

Up to sixteen buffer entries, one per line, can be viewed in the display window at one time. When capturing is complete, two cursors are provided for scrolling through the buffer and examining the individual entries. Entries generally can be described as falling into one of the following three categories.

Category	Example
Data transfer	`'5' 35 00110101 00010 011 DAB`
Control line event	`'A' 41 01000001 01010 010 ATN^`
Command transfer	`'_' 5F 01011111 01010 011 UNT`

The fields, columns, and indicators of the display window are described in the following paragraphs.

- `C◊`

  This column displays two numeric flags, `1` and `2`, that label and distinguish the positional cursors. A blinking flag indicates the *currently active cursor*–this cursor is always visible within the display window. To activate the inactive cursor, use function key <F9>. The header at the top of this column changes to `C_` when the keyboard `Scroll Lock` feature is active (see *Using the Display Window* later in this section).

  This column is empty during Capture Echo operation.

- `ΔC:`

  This field displays the relative offset of the currently active cursor from the inactive cursor. This value is useful in determining the distance between two points in the buffer. The (unlabeled) column

directly above this field displays the relative offset of each buffer entry from either the capture trigger point or the beginning of the buffer, whichever is appropriate.

Use <Alt-H> to toggle the numeric base of all offsets from decimal to hex. The default display base is decimal.

This field and column are empty during Capture Echo operation.

- « DATA »

  These columns display the data portion of each buffer entry. The left column contains the ASCII and hex representations and the right column contains the corresponding binary representation. Only the lower seven bits of each data value are used in determining ASCII representations. Characters whose upper bit is set to one are shown in high intensity.

- « CONTROL »

  These columns display the control portion of each buffer entry. The left column contains the binary values of the five bus management lines and the right column contains the binary values of the three bus handshake lines. The ordering of these lines is the same as that shown in the right half of the Monitor window.

- Pg#

  This indicator is present when an oversized capture file is partially loaded and available for paging. # equals the offset of the currently loaded *page*. File pages start at zero and are equal in size to the currently defined capture buffer.

- Up or down arrow indicators are present in the status bars when the capture buffer contains more entries beyond the indicated display window boundaries.

- Up or down triangle indicators are present in the status bars when a loaded capture file contains more pages beyond the indicated capture buffer boundaries.

- The large section on the right of the window describes each buffer entry using typical IEEE-488 mnemonics. The first column within this section is reserved for mnemonic interpretation of the eight bus

data lines. The remaining space on each line is used to flag pulses or state transitions occurring on the five bus management lines from entry to entry.

The GPIB-410 software uses the following IEEE-488 mnemonics.

ACG	addressed command group	PPU	parallel poll unconfigure
ATN	attention	REN	remote enable
DAB	data byte	SC#	secondary command group (# = 0 to 31)
DCL	device clear		
EOI	end or identify	SDC	selected device clear
GET	group execute trigger	SPD	serial poll disable
GTL	go to local	SPE	serial poll enable
IFC	interface clear	SRQ	service request
LA#	listen address group (# = 0 to 30)	TCT	take control
		TA#	talk address group (# = 0 to 30)
LLO	local lock out		
PPC	parallel poll configure	UCG	universal command group
PPE	parallel poll enable	UNL	unlisten
PPD	parallel poll disable	UNT	untalk

Appendix B, *Multiline Interface Messages*, contains a listing of all IEEE-488 mnemonics and their ASCII equivalents. For a complete listing and detailed explanation of all IEEE-488 mnemonics, refer to the ANSI/IEEE publication *IEEE Standard Digital Interface for Programmable Instrumentation*.

A line mnemonic followed by an up arrow indicates that the corresponding line was asserted since the last entry was made; a down arrow indicates that the line was unasserted since the last entry was made. A mnemonic by itself indicates a pulse or other isolated event occurred on the corresponding line. All transitions and pulses within an entry are flagged regardless of the event that actually caused the capture.

An entry labeled `** OVERFLOW **` indicates that one or more capture events were missed or lost between that entry and the entry preceding it. Such breaks in capture continuity usually occur during periods of sustained high-speed sampling rates with GPIB-410 handshaking disabled, or when two capture events occur within 500 nsec of each other.

Using the Display Window

- Use <Home>, <End>, <PgUp>, <PgDn>, or the up or down cursor control keys to move the currently active cursor up or down in the capture buffer. By default, the cursor moves independently of the display window, dragging the window behind whenever scrolling into the upper or lower window boundary. To lock the relative position of the cursor within the window so that the two always move in unison, activate the keyboard `Scroll Lock` feature.

- Use <Ctrl-Home>, <Ctrl-End>, <Ctrl-PgUp>, and <Ctrl-PgDn> to page through a partially loaded capture file. These keys are only active when a loaded capture file exceeds the size of the current capture buffer.

- The default displacement for any move or paging operation is one. To override this displacement, type in any positive numeric value before pressing the control key. For example, type `500` and press the up arrow key to move the cursor back 500 entries in the buffer. Before the control key is pressed, the new displacement appears briefly in the Title/Status bar and can be edited just as any other numeric input field (see General Input Conventions in Chapter 3, *Software Overview*.)

- To locate entries matching a specific pattern or class of patterns within the buffer, use the *Set Search Pattern* function key <F10> and the left and right cursor control keys. Additional information on using the search utility is contained in the following section.

Using the Search Utility

Press function key <F10> to display the search pattern definition window, shown in FIgure 4-5.

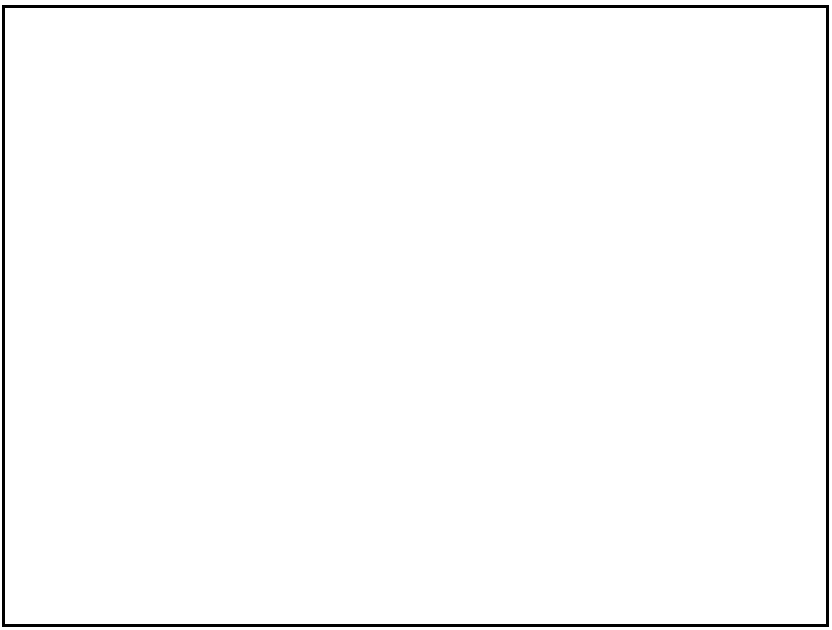


Figure 4-5. Search Pattern Definition Window

Use the pattern definition field to specify a 16-bit pattern for which you want the GPIB-410 to search for in the capture buffer. The ordering of the signal lines in the pattern is identical to that shown in the Monitor window.

Construct the search pattern by pressing the indicated letter keys to select a `0`, `1`, or `x` ("don't care") condition for each bit position of a captured status. The topmost row of letters on the keyboard manipulates the data portion of the pattern and the next row of letters manipulates the control portion. Use the Insert key (<Ins>) to place a single 8-bit ASCII or 2-digit hexadecimal value directly into the data portion of the pattern.

Once a pattern is constructed, use the left and right cursor control keys to search up or down in the buffer from the currently active cursor position. Use the <Ctrl> left and right cursor control keys to search for an entry which does *not* match the pattern. When a [non-]matching entry is found, the currently active cursor is moved to the position of that entry. If the end of the buffer is reached while searching in either direction, the GPIB-410 loops around and continues the search from the other end of the buffer. If no pattern is found, an error message is displayed in the help/error bar and the currently active cursor remains unchanged.

The search pattern definition window does not have to be visible to perform a search operation. Pressing the left or right arrow key whenever the Capture Display screen is active and captured data is present initiates a search for the most recently defined pattern.

The Pattern Generator Screen

This screen shows the controlling parameters in effect during a pattern generation sequence (see Figure 4-6).

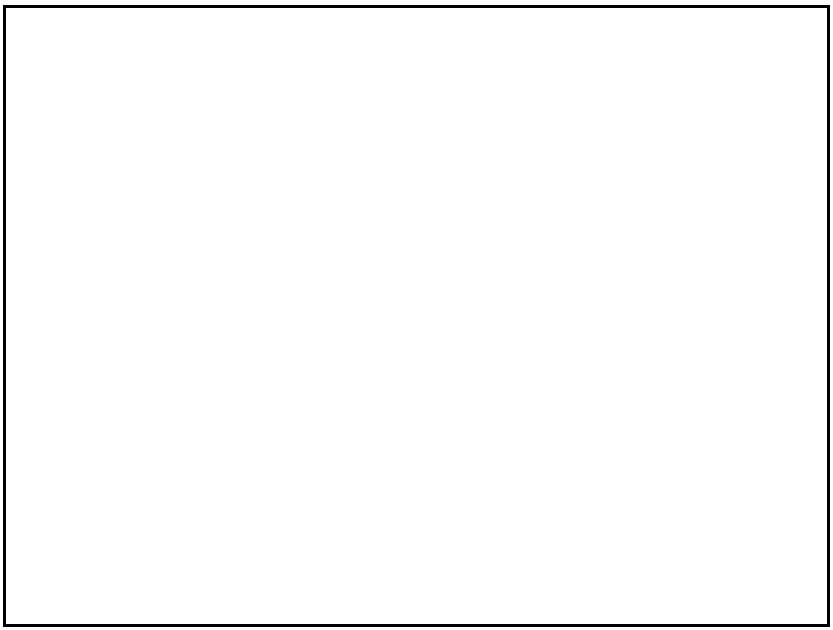


Figure 4-6. Pattern Generator Screen

When accessing this screen, no input fields can be selected when the following operational modes are enabled.

- Generate
- Monitor Input

To start the Pattern Generator type <Alt-G>. When generating is enabled `GEN` is displayed in the Title/Status bar and `G` is displayed in the DOS shell icon. Generating remains enabled until one of the following conditions occurs.

- You type <Alt-G> again.
- The specified pattern sequence runs to completion.

While generating is enabled the toggle switches in the Monitor window may move or flicker rapidly as patterns are output to the bus. If activity on the GPIB should hang during this sequence, the switches will contain the last pattern output. Direct manipulation of the Monitor switches is not possible while generating is enabled.

Note: During high-speed DMA operation, you may notice a discrepancy between toggle switch settings and the corresponding status indicators. This is normal.

For command file operation, use the load function <Alt-L> to preload or reload the specified command file. The use of this function is optional–when the Pattern Generator is enabled, it will scan and load the command file automatically if it is not already loaded. If any errors are encountered in the command file during the loading process, they are written to the file `GPIB410.ERR` in the current working directory.

The Pattern Generator screen contains the following fields.

- `No. of times to execute`
- `Clear switches when done`
- `Send EOI with last byte`
- `Pattern Buffer source`

No. of Times to Execute

Use this field to enter a repetition factor for pattern generation. This value specifies how many times the pattern buffer is output to the GPIB each time you enable the Pattern Generator.

Valid repetition factors range from 1 to 65535 (default = 1).

Example: If the Pattern Buffer source is `INPUT WINDOW` and the window contains the string "abcde", entering the value 4 in this field and typing <Alt-G> causes the sequence "abcdeabcdeabcdeabcde" to be output to the GPIB.

Clear Switches When Done

Use this field to specify whether to reset all switches in the Monitor window to OFF at the end of a pattern generation sequence. There are two options.

- `yes` (clear all switches)
- `no` (leave switches as last set)

Selecting `yes` causes the GPIB-410 to stop asserting all lines on the GPIB after the Pattern Generator successfully completes its output. If a DOS shell is active when the Pattern Generator completes, asserted lines are not cleared until you exit the shell and return to the `GPIB410` program.

Selecting `no` causes the lines asserted by the last pattern placed on the bus to remain asserted until you explicitly clear them in the Monitor window or you start the Pattern Generator again.

Send EOI with Last Byte

Use this field to specify whether to assert the EOI line with the last byte output at the end of a pattern generation sequence. This field is valid for `INPUT WINDOW` operation only. There are two options

- `yes` (send EOI)

- `no` (do *not* send EOI)

Selecting `yes` causes the GPIB-410 to send EOI with the last byte in the pattern buffer during execution of the *final pass* through the buffer. Selecting `no` disables the sending of EOI.

Pattern Buffer Source

Use this field to specify the source of the 16-bit pattern sequence to be output during execution of the Pattern Generator. The pattern buffer containing the sequence is created and loaded from the specified source when you type <Alt-G>. There are two options.

- `COMMAND FILE`
- `INPUT WINDOW`

Each of the above options is described in the following paragraphs.

- `COMMAND FILE`

  This option causes the GPIB-410 to use commands in a previously prepared file on disk to construct the patterns in the pattern buffer. The commands in the file are written in the National Instruments Interface Bus Pattern Generating Language (IBPGL), which is described in detail in Appendix E.

  Use the associated sub-field to enter the command file pathname.

- `INPUT WINDOW`

  This option causes the GPIB-410 to combine the bytes of the input window sub-field with the Monitor window switch settings to construct the patterns in the pattern buffer. When you enable the Pattern Generator, the input window contents are output to the GPIB (using the source handshake) as either data or commands, depending on the state of the Monitor ATN switch.

  You can enter up to 75 characters or other byte values in the input window. Use the following escape sequences to specify non-ASCII or non-printable codes within the string.

`\n`	ASCII linefeed
`\r`	ASCII carriage return
`\t`	ASCII horizontal tab
`\"`	ASCII double quote
`\\`	ASCII backslash
`\x`*`NN`*	Any two-digit hexadecimal number (*N* = 0-9, A-F)
`\`*`MMM`*	Any of the following GPIB mnemonics:

DCL (0x14)	PPC (0x05)	SPE (0x18)
GET (0x08)	PPU (0x15)	TCT (0x09)
GTL (0x01)	SDC (0x04)	UNL (0x3F)
LLO (0x11)	SPD (0x19)	UNT (0x5F)
NUL (0x00)		

<Alt-P>	Insert an ASCII '+' into the Input Window
<Alt-N>	Insert an ASCII '-' into the Input Window

Note: The last two escapes are necessary because the <+> and <-> keys are used to select the options of the `Pattern Buffer Source` field, which is the `INPUT WINDOW` parent field. For more information, refer to Appendix E.

The Configuration Settings Screen

This screen shows the general installation and performance related parameters of the GPIB-410 (see Figure 4-7).

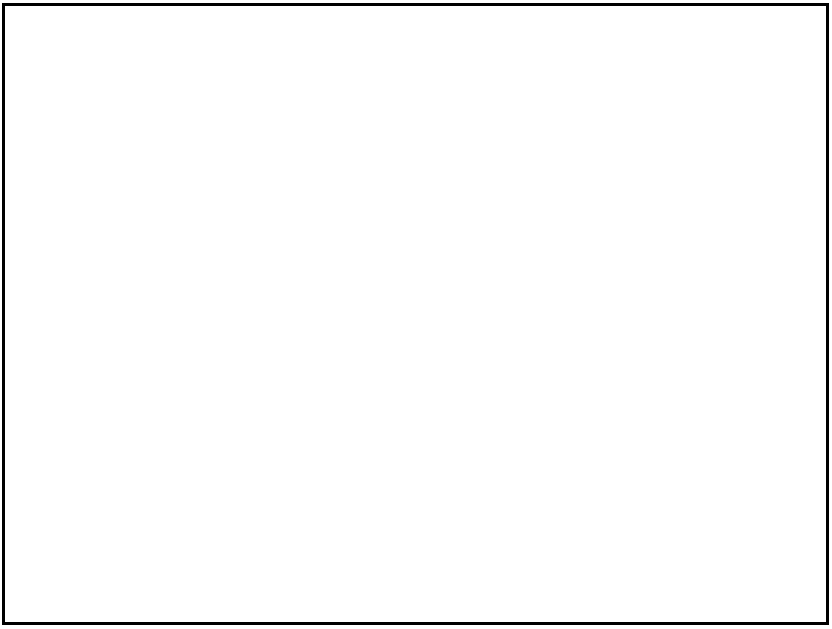


Figure 4-7. Configuration Settings Screen

When accessing this screen, no input fields can be selected when the following operational modes are enabled.

- Capture
- Trigger
- Generate
- Monitor Input
- ACP Handshaker
- SRC Handshaker

Notice that some of the parameters shown on this screen must match corresponding settings on the GPIB-410 hardware. If you change any of the default hardware settings, remember to change the software settings as well.

The Configuration Settings screen contains the following fields.

- Computer display mode
- Computer keyboard mode
- Computer speaker mode
- Base I/O address
- Input DMA channel
- Output DMA channel
- Interrupt jumper setting
- Status refresh rate
- Acceptor handshake rate
- Source handshake rate
- Help file name

Computer Display Mode

Use this field to specify the most appropriate output mode for your computer display hardware. There are six options.

- Monochrome (ROM BIOS)
- Monochrome (Synchronized Direct)
- Monochrome (High-Speed Direct)
- Color (ROM BIOS)
- Color (Synchronized Direct)
- Color (High-Speed Direct)

In most cases, the software determines the appropriate display mode automatically and sets this field accordingly. If, for some reason, the default selection is unsatisfactory, use the information in the following paragraphs to make an alternate selection.

Any of the Monochrome options should work satisfactorily on most monitors, both monochrome and color. You can select one of the Color options only if you have a display adapter that supports color output.

Selecting one of the `ROM BIOS` options causes all screen output to be directed through the built-in video services of the host PC. Using ROM BIOS calls is the most "well-behaved" manner of writing information to the computer screen, but it is also the slowest. You should select one of these options only if you intend to run the GPIB-410 software under one of the windowing software packages available commercially for DOS applications.

Note: The GPIB-410 software has not been tested nor determined to be fully functional under any particular windowing environment.

Selecting one of the `Direct` output options causes most screen output to be written directly to the display memory of the host PC. Using one of these techniques results in much faster screen updates and can also improve overall program performance. For most display hardware in use today, the `High-Speed Direct` options work satisfactorily.

Some older video adapters, such as the IBM Color Graphics Adapter (CGA) and its compatibles, produce an annoying snow-like effect on the screen when display memory is written to directly. This problem can be reduced or eliminated by synchronizing all screen output with the horizontal and vertical retrace cycles of the CRT Controller hardware. If you observe this problem when using one of the `High-Speed Direct` options, you should select the corresponding `Synchronized Direct` option instead. Although output using this technique is slightly slower than that of the high-speed option, it is typically only noticeable on slower machines.

Computer Keyboard Mode

Use this field to specify the keyboard layout of the host PC. There are six options.

- `U.S. English`
- `U.K. English`
- `French`
- `German`
- `Italian`
- `Spanish`

The information in this field determines which set of keys the software uses for all GPIB key select fields (for example, the Monitor window toggle switches).

Computer Speaker Mode

Use this field to enable or disable use of the computer speaker. There are two options.

- `Audible`
- `Silent`

Selecting `Audible` enables the GPIB-410 to "beep" whenever an error or other important event occurs during operation. Selecting `Silent` inhibits this feature of the software and may result in a slight performance gain under some operating conditions.

Base I/O Address

Use this field to enter the port address of the GPIB-410 interface board. This value must match the setting configured in the address switches on the interface board itself. Valid port addresses range from 000 to 3E0 hex in multiples of 20 hex (default = 300 hex).

A good way to test if the value contained in this field is correct is to examine the sixteen GPIB indicators in the Monitor window. If all of the indicators are on, or if they repeatedly flicker on and off in an irregular manner, the base I/O address setting is probably incorrect. Power down your computer, verify the switch settings on the interface board, and try again.

Warning: Attempting to operate some functions of the GPIB-410 software with an address already in use by another device may crash your system or have other unpredictable effects.

Input DMA Channel

Use this field to specify the method by which captured data is unloaded from the onboard memory of the GPIB-410 into the system memory of the host PC. There are four options.

- `(DMA) 1` (default)
- `(DMA) 2`

- (DMA) 3
- (PIO) NONE

Any one of the valid DMA channels can be selected if the channel is not already in use by another device. The value selected must match the input DMA channel jumper setting (C#) on the GPIB-410 interface board. It is permissible to set the input and output DMA channels to the same value provided capturing and generating are never used at the same time.

Warning: Attempting to perform a capture operation with a DMA channel already in use by another device may crash your system or have other unpredictable effects.

If there is no unused DMA channel available on your computer, you can select programmed I/O (PIO) operation by setting this field to NONE. However, because PIO greatly reduces the performance of most capture operations, it is recommended that this option be used only when absolutely necessary.

Output DMA Channel

Use this field to specify the method by which user-defined pattern buffers are loaded from system memory into the drive latches of the GPIB-410. There are four options.

- (DMA) 1
- (DMA) 2
- (DMA) 3
- (PIO) NONE (default)

Any one of the valid DMA channels can be selected if the channel is not already in use by another device. The value selected must match the output DMA channel jumper setting (S#) on the GPIB-410 interface board. It is permissible to set the input and output DMA channels to the same value if capturing and generating are never used at the same time.

Warning: Attempting to operate the Pattern Generator with a DMA channel already in use by another device may crash your system or have other unpredictable effects.

If there is no unused DMA channel available on your computer, select programmed I/O (PIO) operation by setting this field to NONE.

Interrupt Jumper Setting

Use this field to specify the interrupt level used by the GPIB-410 interface board. There are six options.

- 2
- 3
- 4
- 5
- 6
- 7 (default)

Any one of the valid levels can be selected if the level is not already in use by another device. The value selected must match the interrupt jumper setting on the interface board itself.

Warning: Attempting to operate some functions of the GPIB-410 software with an interrupt level already in use by another device may crash your system or have other unpredictable effects.

Status Refresh Rate

Use this field to specify the maximum frequency at which the Monitor window and DOS icon status indicators are updated. There are six options.

- 1 Hz
- 3 Hz
- 6 Hz
- 9 Hz
- 18 Hz
- MAXIMUM (default)

Selecting one of the five numeric options guarantees that the status indicators are updated at the specified rate regardless of most other activity in the system (with the exception of disk I/O), but can have a negative impact on overall performance. Selecting MAXIMUM instructs

the software to update the indicators as often as possible, but not at the expense of other more important activities.

MAXIMUM is usually satisfactory, but can sometimes result in indicator "freeze up" during processor-intensive activities. For the DOS icon indicators, MAXIMUM and 18 Hz are equivalent.

Acceptor Handshake Rate

Use this field to specify the speed of the GPIB-410 acceptor handshake functions. The value selected applies to both the <Alt-A> ACP handshaker and the optional handshake used during the capture of data and command transfers. There are 25 options.

60 Hz	400 Hz	4 KHz	40 KHz	400 KHz
80 Hz	500 Hz	5 KHz	50 KHz	500 KHz
100 Hz	1 KHz	10 KHz	100 KHz	700 KHz
200 Hz	2 KHz	20 KHz	200 KHz	900 KHz
300 Hz	3 KHz	30 KHz	300 KHz	MAXIMUM

Selecting one of the numeric options programs the GPIB-410 hardware to regulate the acceptor handshake to an approximation of the requested speed. Selecting MAXIMUM disables the hardware timers and allows the handshake to proceed at the fastest rate possible.

Note: Because of other configuration variables such as host processor speed and DMA vs. PIO capture operation, the actual acceptor handshake rate observed may be less than requested.

Source Handshake Rate

Use this field to specify the speed of the GPIB-410 source handshake functions. The value selected applies to both the <Alt-S> SRC handshaker and the handshake used during pattern generation sequences. There are 25 options.

60 Hz	400 Hz	4 KHz	40 KHz	400 KHz
80 Hz	500 Hz	5 KHz	50 KHz	500 KHz
100 Hz	1 KHz	10 KHz	100 KHz	700 KHz
200 Hz	2 KHz	20 KHz	200 KHz	900 KHz
300 Hz	3 KHz	30 KHz	300 KHz	MAXIMUM

Selecting one of the numeric options programs the GPIB-410 hardware to regulate the source handshake to an approximation of the requested speed. Selecting `MAXIMUM` disables the hardware timers and allows the handshake to proceed at the fastest rate possible.

Note: Because of other configuration variables such as host processor speed and DMA vs. PIO Pattern Generator operation, the actual source handshake rate observed may be less than requested.

Help File Name

Use this field to enter the full pathname of the GPIB-410 help text file. You can enter any valid DOS pathname, including a drive specification, up to 47 characters in length (default = `\GPIB410.HLP`).

Program Exit Screen

Use this screen to specify whether to save the current state of the software upon termination of the `GPIB410` program (see Figure 4-8).

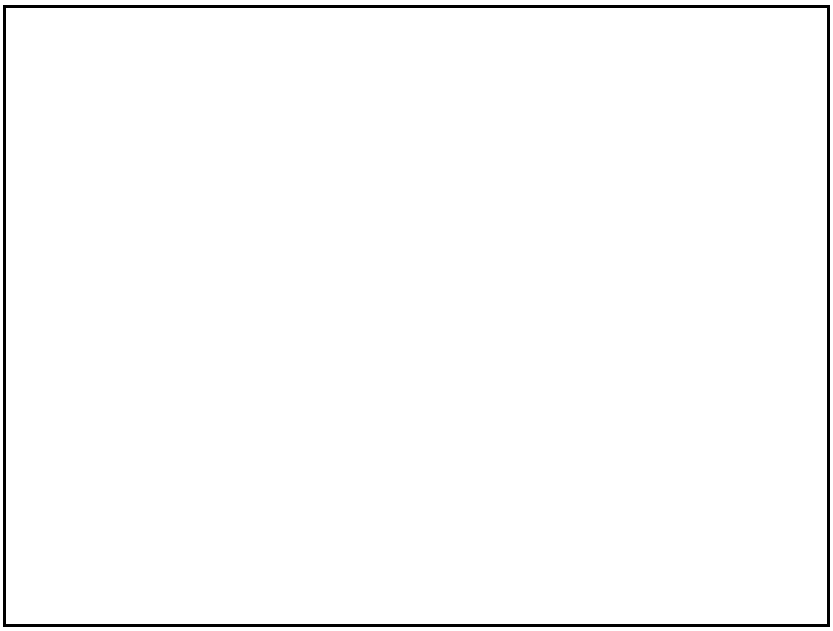


Figure 4-8. Program Exit Screen

You can only terminate the `GPIB410` program when the Program Exit screen is active. This screen contains one field.

- `Save Current Configuration Before Exiting?`

Save Current Configuration Before Exiting?

Use this field to specify whether to save to disk the current state of the GPIB-410 software before you exit. There are two options.

- `yes` (save configuration to disk)
- `no` (do *not* save configuration)

Selecting `yes` causes the field contents of the following screens to be saved to the indicated file upon program exit.

- Capture Settings Screen
- Trigger Specification Screen
- Pattern Generator Screen
- Configuration Settings Screen

Press <Esc> while the Program Exit Screen is active to execute the selected option and exit the program. Press any other screen function key to abort the exit sequence and go to that screen.

Note: The default configuration file pathname is `\GPIB410.CFG`. The software automatically searches for this file on program startup and, if found, loads its contents. If you use a different configuration file pathname, you must explicitly name the file on the DOS command line to reload when you later restart the program, for example,

```
A>gpib410 myfile.cfg.
```

Appendix A
Tutorial

This chapter contains examples that guide you through step-by-step demonstrations of some fundamental capabilities of the GPIB-410. These examples assume the following:

- No devices are connected to the GPIB-410 interface board.
- No input fields have been changed other than those on the Configuration Settings screen.
- The selected keyboard layout type is *U.S. English*.

When the hardware and software are installed, step through the following examples.

Example 1 – Capturing Data From the GPIB

This example takes you through the basic procedures to set up and execute a data capture of GPIB states. In addition, you use the GPIB-410 monitor to manipulate the GPIB.

1. If you are already running the `GPIB410` program, press <F2> to go to the Main Menu screen. Otherwise, start up the `GPIB410` program by entering the following command.

   ```
   gpib410          <Enter>
   ```

The Main Menu screen appears as shown in Figure A-1.

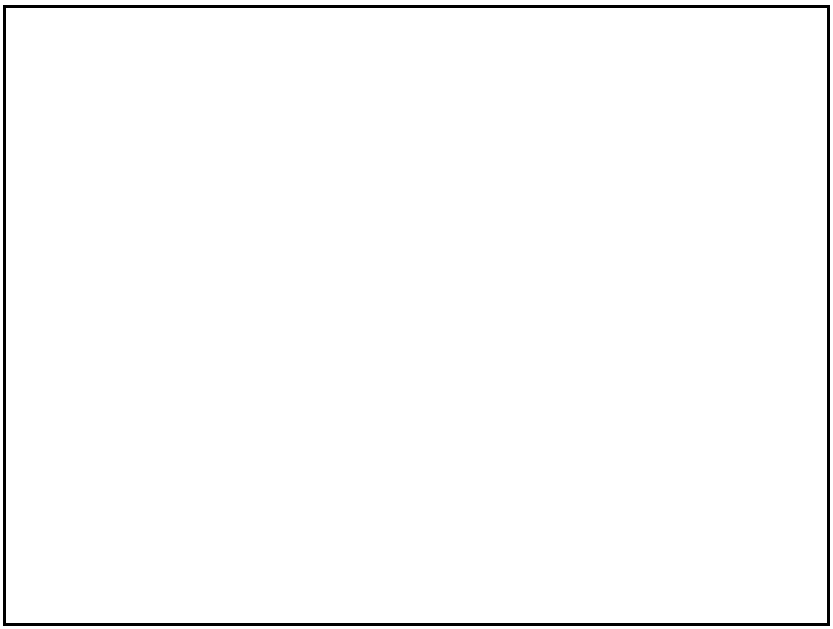


Figure A-1. Main Screen

Notice that the GPIB-410 monitor LEDs are not lit, indicating that there is no activity on the GPIB.

2. Press <F3> to select the Capture Settings screen as shown in Figure A-2.

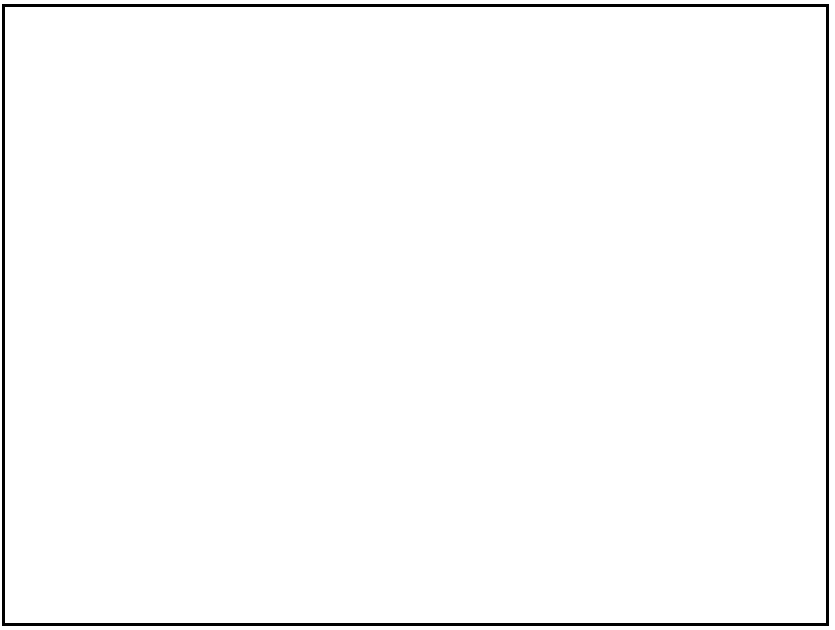


Figure A-2. Capture Settings Screen

Press <Enter> or the down arrow key until the `Maximum capacity` field is highlighted. This field indicates the maximum number of capture samples that can be stored in PC memory at one time. Enter the value 16.

For the other fields on the Capture Settings screen, the default values are used for this example. Later, you can change any of these settings, but, for now, leave them as they are. The relevant settings are summarized as follows.

- The GPIB-410 is set to capture any of the seven GPIB events listed on the screen, including data and command transfers (`xfers`) and ATN transitions.

- The GPIB-410 is set to participate in the handshake during capture.
- The next capture operation will stop when the capture buffer is full and the buffer will not be automatically written to the disk.

3. Press <F2> to return to the Main Menu. Enable the capturing by pressing <Alt-C>. `CAP` appears on the right side of the title/status bar. NDAC also becomes asserted on the GPIB-410 monitor because the GPIB-410 is participating in the GPIB handshake as a Listener. Switch to Monitor Input Mode by pressing <Alt-M>. `MON` appears beside `CAP` in the title/status bar. The menu screen appears as follows:

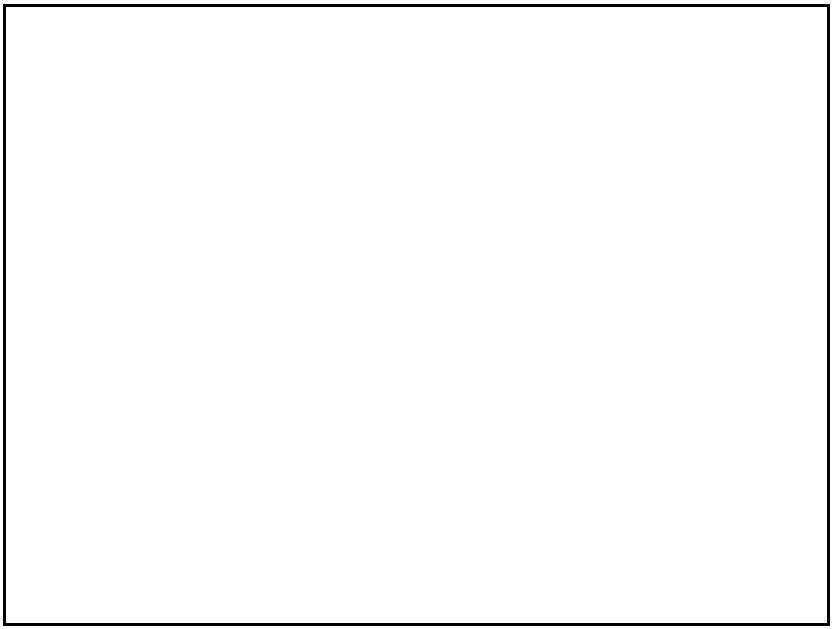
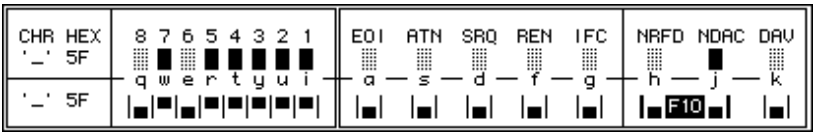


Figure A-3. Main Menu Screen with Monitor Input and Capturing Enabled

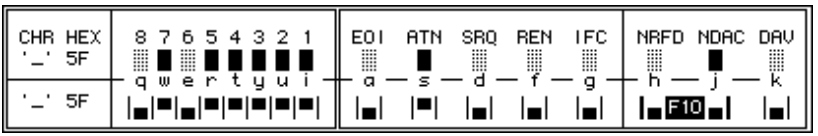
The GPIB-410 is now waiting for any of the selected GPIB events to occur so that samples can be taken.

4. Control the GPIB by manipulating the monitor to simulate bus activity. Initially, set up the data lines to the pattern 01011111 by pressing the keys <w>, <r>, <t>, <y>, <u>, and <i>. This data pattern represents an ASCII underscore (_). Alternatively, you can press <Ins> once to get the prompt `<<<character>>>` above the data line switches and then type an underscore. Notice that the ASCII underscore is also the GPIB Untalk (UNT) command. (If you are unfamiliar with the IEEE-488 command set, refer to Appendix B for a complete listing of the multiline interface messages and their ASCII equivalents.) At this point, the monitor window appears as follows:



Press <k> twice for a data transfer handshake. This causes the DAV line to toggle up and down one time.

Next, set ATN true by pressing <s>. The monitor window appears as follows:



Toggle the DAV line twice more by pressing <k> four times.

Now, set ATN false by pressing <s> again. Toggle DAV by pressing <k> an even number of times until you hear a beep and CAP is no longer displayed in the title/status bar. This indicates that the capture buffer is full and that the capture is complete. At this point, the DAV switch should be down and the DAV LED should be off.

5. Press <F5> twice to activate the Capture Display screen to view the data that was just captured. The screen will look similar to Figure A-4:

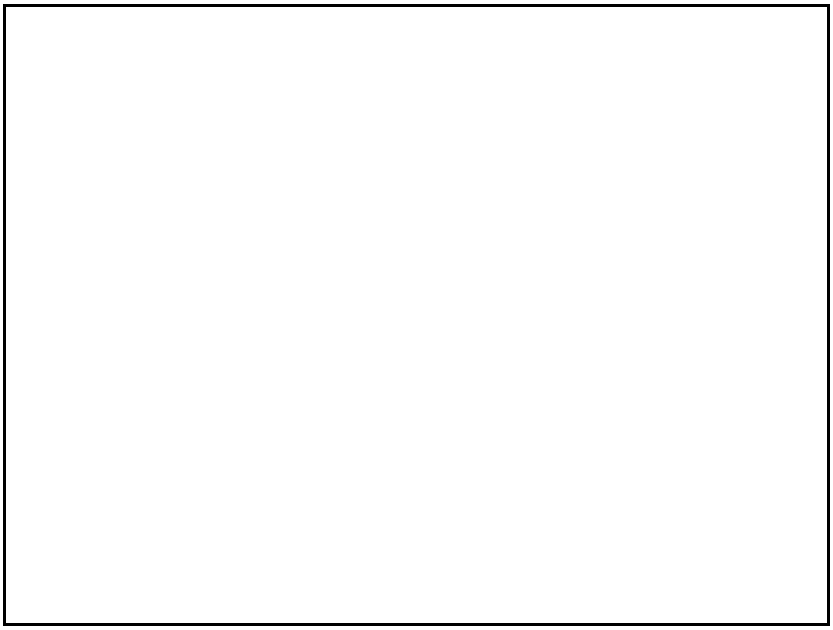


Figure A-4. Capture Display Screen

Two command transfers, 12 data transfers, and two ATN transitions have been captured. Notice that the comment field identifies the ATN transitions and identifies the Command data pattern as the Untalk (UNT) command. Refer to Chapter 4 for a description of the fields and functions of the Capture Display screen.

Use the up arrow key and down arrow key to move the cursors through the data display. <F9> can be used to change the currently active cursor. Notice that the ΔC field on the help/error bar changes as the cursors are moved to reflect the current number of samples from cursor to cursor.

6. Notice that some of the switches in the monitor are still asserted. Press <Alt-M> to enter Monitor Input mode once again, then press <SpaceBar> to reset all of the switches. At this point, you may like to

try completing steps 3 through 5 again while you are still on the Capture Display screen. This time, instead of pressing <Alt-C> to initiate the capture, press <Alt-E> to enable Capture Echo mode so that you can see the captured samples as they are acquired.

7. Press <F2> to return to the Main Menu.

Example 2 – Triggering and Pattern Generating

In this example, triggering is used with the pattern generator to capture data from the GPIB based on trigger criteria. The same capture settings are used as before, but you must go to the Trigger Specification screen to set up the *Trigger Spec*.

1. Before proceeding to the Trigger Specification screen, press <F6> to select the Pattern Generator screen as shown in Figure A-5.

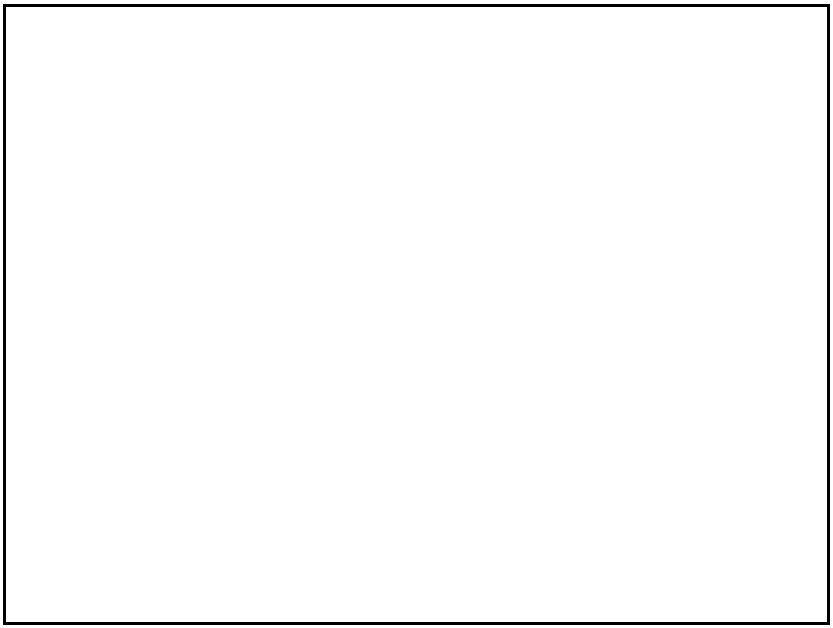


Figure A-5. Pattern Generator Screen

The default values for the Pattern Generator are used for this example. Later, you can experiment with any of these settings, but, for now, leave them as they are. The current settings are summarized as follows:

- The GPIB-410 is set to output the contents of the pattern buffer one time.
- The monitor switches will not be reset to off when the next pattern generation competes.
- EOI will not be sent with the last byte output in the sequence.
- The source of the contents of the pattern buffer to be output is defined as the command file `GPIB410.PAT`.

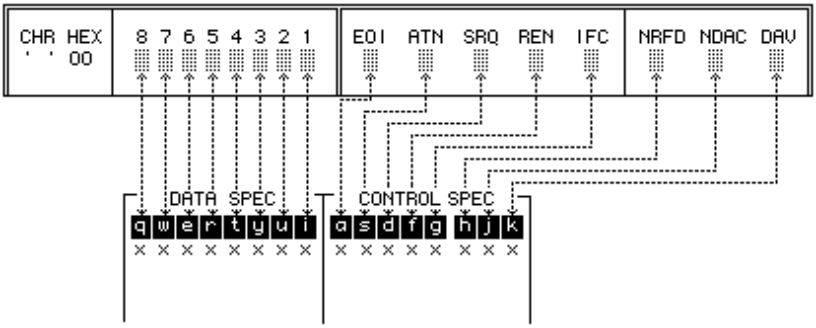
Before proceeding, examine the contents of the file `GPIB410.PAT` by turning to Appendix F, *GPIB410.PAT Source Listing*. This file, written in IBPGL, defines a sequence of 16-bit patterns that are loaded into memory prior to execution of the Pattern Generator. This area of memory, referred to as the *pattern buffer*, is analogous to the *capture buffer* used for capturing, except that its size is determined automatically by the GPIB-410 software. After the buffer has been loaded, the Pattern Generator can be executed any number of times without reloading until a new filename is specified.

The commands in `GPIB410.PAT` are straightforward and commented. For a complete description of the IBPGL command set and syntax, refer to Appendix E. Notice in the listing that the *set* and *handshake* commands are used to simulate addressing and data transfer activity between the GPIB-410 and three imaginary devices. For the purposes of this example, the GPIB-410 will be playing the role of all GPIB Listeners as well as the GPIB Talker.

2. Press <F4> to select the Trigger Specification screen. This screen defines up to nine sequential patterns, collectively referred to as the *Trigger Spec*, which the GPIB-410 should *wait for* before performing the indicated action at the bottom of the screen. Only one pattern is required in the Trigger Spec for this example.

   In constructing a trigger pattern, you must specify a *0*, *1*, or *x* (for "don't care") condition for each signal line. This is done by pressing the letter key indicated above the line you wish to set until the appropriate selection appears.

Notice that *q* through *i* on the Trigger Spec correspond to the data lines *8* through *1* in the Monitor window. Similarly, the characters *a* through *g* correspond to EOI, ATN, SRQ, REN, and IFC, respectively, and *h* through *k* correspond to the three handshake lines NRFD, NDAC, and DAV. As discussed in Chapter 3 under *General Input Conventions*, <Ins> can also be used for setting the eight data lines of a pattern when a specific data value is desired.



For this example, set the Trigger Spec to trigger when listen address 23 hex is detected as a valid command byte on the GPIB. As you may recall from examining `GPIB410.PAT`, this is the address of the imaginary third device targeted to receive a message. First, press <Ins> once to get the flashing character prompt, then press <Ins> once more to get the prompt for hexadecimal input. Enter the number 23. The binary value 00100011 is inserted into the Data Spec and the individual letter prompts reappear. Now, press the <s> key twice or until an 1 appears in the ATN position, then do the same with the <k> key for the DAV position. The rest of the lines are left as "don't care". Your screen should look like Figure A-6.

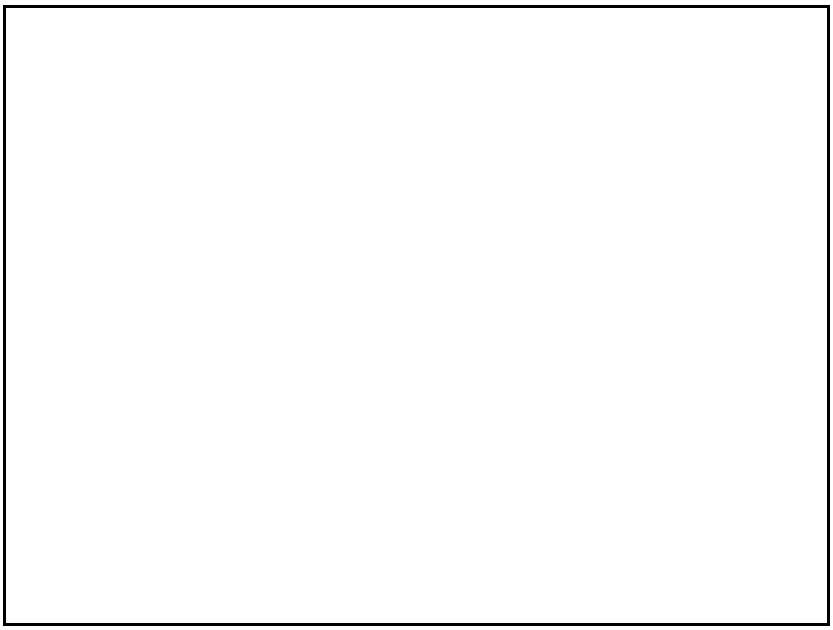


Figure A-6. Trigger Specification Screen

The settings used for this example are summarized as follows:

- The trigger sequence consists of just one GPIB pattern occurring one time, with no output pulse to be sent to the TRG OUT connector.

- The trigger action specified is `TRIGGER with position: TTTTT` and the trigger point is positioned at the center of the capture buffer (noted by the `T`). This configuration means that the GPIB-410 will trigger the capture mechanism at the moment that the Trigger Spec is satisfied so that the capture operation can be adjusted accordingly (more on this in step 3).

3. Press <F2> to return to the Main Menu screen. Press <Alt-T> to enable the Trigger Mechanism. The TRG indicator appears in the title/status bar and your screen looks like Figure A-7.

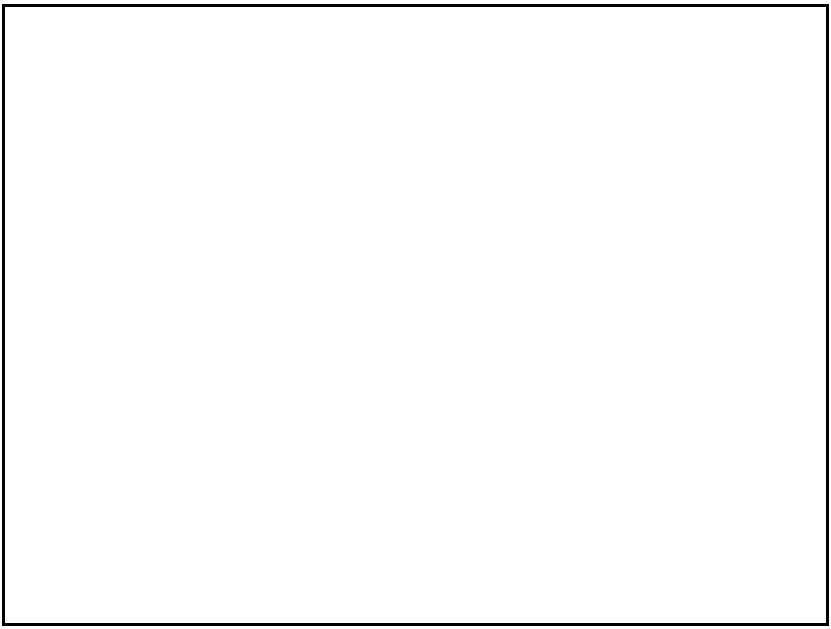


Figure A-7. Main Menu Screen with Trigger Enabled

The trigger is now armed and waiting for the trigger pattern to occur. During this time, *background* capturing is also running and ready to store pre-trigger capture samples into memory. If the capture buffer fills up before the trigger occurs, the GPIB-410 automatically loops around and reuses the buffer. When the trigger pattern is detected on the bus, the GPIB-410 marks the next capture sample as the *trigger point* and realigns any existing entries in the buffer so as to position the trigger point as requested.

4. When you enable the Pattern Generator, you will observe several things occurring within a short period of time. First, the GEN indicator appears in the title/status bar to indicate that the Pattern Generator is enabled. This occurrence is quickly followed by the appearance of a

LOADING message in the help/error bar at the bottom of the screen, during which time the software parses the GPIB410.PAT file and builds the pattern buffer in memory. When this operation completes, the LOADING indicator is erased and the pattern generation sequence begins.

In rapid succession, you will hear three beeps, possibly accompanied by a brief flurry of activity on the GPIB monitor indicators. The first beep signals the detection of the trigger pattern on the GPIB, and you may also notice the TRG indicator change to read CAP. Immediately following, you hear a second beep which signals the completion of the capture operation and the CAP indicator disappears. Finally, a third beep indicates that the pattern buffer is successfully output.

When you are ready to continue, press <Alt-G> to start the Pattern Generator.

5. When all of the operations are complete and the status indicators are turned off, press <F5> to select the Capture Display screen and view the captured data. The results should look similar to Figure A-8.

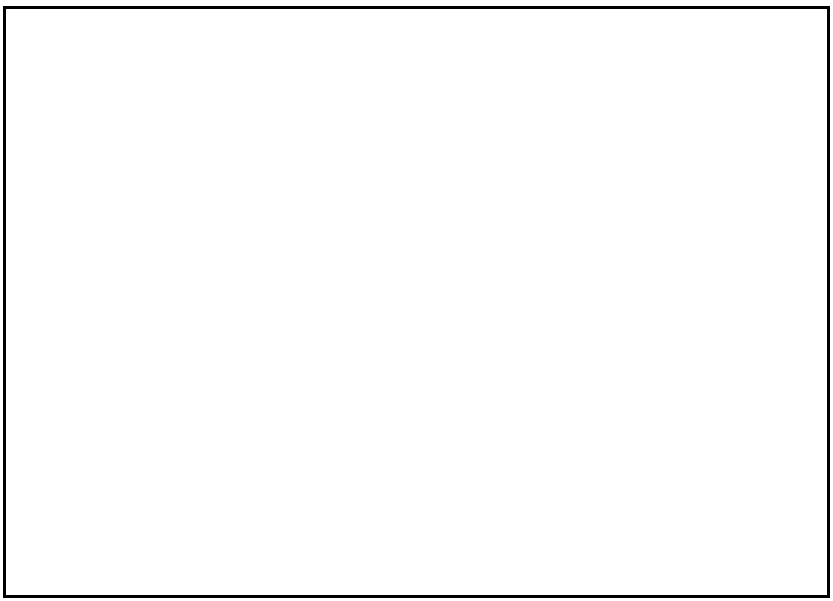


Figure A-8. Captured Data Including Trigger Point

The data is displayed in the capture buffer with respect to the trigger event which is the listen address 23 hex, or ASCII #. Following the trigger point, a drop in the ATN line and the beginning of the message to Device 3 can be seen. Notice that the trigger event is centered within the sixteen captured events as specified on the Trigger Specification screen. The two cursors `1` and `2` (far left column) provided for scrolling through the buffer are initially positioned at the trigger event. For more information on the Capture Display screen, refer to Chapter 4.

At this point, you may wish to experiment by increasing the size of the capture buffer so that more samples are retained either side of the trigger point, and then running through the <Alt-T>/<Alt-G> sequence again. If you make the buffer large enough (for example, 1,000 entries), you can capture the entire sequence of patterns output by the Pattern Generator. Notice, however, that if the capture buffer is larger than the total number of patterns generated, the buffer will never fill up and you will have to manually halt the capture at the end of the pattern generation sequence to view the captured patterns. To do this, type <Alt-C>.

This concludes the tutorial examples. Press <F2> to return to the Main Menu screen, or press <Esc> twice to exit the `GPIB410` program.

Appendix B
Multiline Interface Messages

This appendix contains an interface message reference list, which describes the mnemonics and messages that correspond to the interface functions. These multiline interface messages are sent and received with ATN TRUE.

For more information on these messages, refer to the IEEE-488 Std. 488-1978, *IEEE Standard Digital Interface for Programmable Instrumentation*.

Multiline Interface Messages

Hex	Oct	Dec	ASCII	Msg	Hex	Oct	Dec	ASCII	Msg
00	000	0	NUL		20	040	32	SP	MLA0
01	001	1	SOH	GTL	21	041	33	!	MLA1
02	002	2	STX		22	042	34	"	MLA2
03	003	3	ETX		23	043	35	#	MLA3
04	004	4	EOT	SDC	24	044	36	$	MLA4
05	005	5	ENQ	PPC	25	045	37	%	MLA5
06	006	6	ACK		26	046	38	&	MLA6
07	007	7	BEL		27	047	39	'	MLA7
08	010	8	BS	GET	28	050	40	(	MLA8
09	011	9	HT	TCT	29	051	41	)	MLA9
0A	012	10	LF		2A	052	42	*	MLA10
0B	013	11	VT		2B	053	43	+	MLA11
0C	014	12	FF		2C	054	44	,	MLA12
0D	015	13	CR		2D	055	45	-	MLA13
0E	016	14	SO		2E	056	46	.	MLA14
0F	017	15	SI		2F	057	47	/	MLA15
10	020	16	DLE		30	060	48	0	MLA16
11	021	17	DC1	LLO	31	061	49	1	MLA17
12	022	18	DC2		32	062	50	2	MLA18
13	023	19	DC3		33	063	51	3	MLA19
14	024	20	DC4	DCL	34	064	52	4	MLA20
15	025	21	NAK	PPU	35	065	53	5	MLA21
16	026	22	SYN		36	066	54	6	MLA22
17	027	23	ETB		37	067	55	7	MLA23
18	030	24	CAN	SPE	38	070	56	8	MLA24
19	031	25	EM	SPD	39	071	57	9	MLA25
1A	032	26	SUB		3A	072	58	:	MLA26
1B	033	27	ESC		3B	073	59	;	MLA27
1C	034	28	FS		3C	074	60	<	MLA28
1D	035	29	GS		3D	075	61	=	MLA29
1E	036	30	RS		3E	076	62	>	MLA30
1F	037	31	US		3F	077	63	?	UNL

Message Definitions

DCL Device Clear
GET Group Execute Trigger
GTL Go To Local
LLO Local Lockout
MLA My Listen Address
MSA My Secondary Address
MTA My Talk Address
PPC Parallel Poll Configure
PPD Parallel Poll Disable

Multiline Interface Messages

Hex	Oct	Dec	ASCII	Msg	Hex	Oct	Dec	ASCII	Msg
40	100	64	@	MTA0	60	140	96	`	MSA0,PPE
41	101	65	A	MTA1	61	141	97	a	MSA1,PPE
42	102	66	B	MTA2	62	142	98	b	MSA2,PPE
43	103	67	C	MTA3	63	143	99	c	MSA3,PPE
44	104	68	D	MTA4	64	144	100	d	MSA4,PPE
45	105	69	E	MTA5	65	145	101	e	MSA5,PPE
46	106	70	F	MTA6	66	146	102	f	MSA6,PPE
47	107	71	G	MTA7	67	147	103	g	MSA7,PPE
48	110	72	H	MTA8	68	150	104	h	MSA8,PPE
49	111	73	I	MTA9	69	151	105	i	MSA9,PPE
4A	112	74	J	MTA10	6A	152	106	j	MSA10,PPE
4B	113	75	K	MTA11	6B	153	107	k	MSA11,PPE
4C	114	76	L	MTA12	6C	154	108	l	MSA12,PPE
4D	115	77	M	MTA13	6D	155	109	m	MSA13,PPE
4E	116	78	N	MTA14	6E	156	110	n	MSA14,PPE
4F	117	79	O	MTA15	6F	157	111	o	MSA15,PPE
50	120	80	P	MTA16	70	160	112	p	MSA16,PPD
51	121	81	Q	MTA17	71	161	113	q	MSA17,PPD
52	122	82	R	MTA18	72	162	114	r	MSA18,PPD
53	123	83	S	MTA19	73	163	115	s	MSA19,PPD
54	124	84	T	MTA20	74	164	116	t	MSA20,PPD
55	125	85	U	MTA21	75	165	117	u	MSA21,PPD
56	126	86	V	MTA22	76	166	118	v	MSA22,PPD
57	127	87	W	MTA23	77	167	119	w	MSA23,PPD
58	130	88	X	MTA24	78	170	120	x	MSA24,PPD
59	131	89	Y	MTA25	79	171	121	y	MSA25,PPD
5A	132	90	Z	MTA26	7A	172	122	z	MSA26,PPD
5B	133	91	[	MTA27	7B	173	123	{	MSA27,PPD
5C	134	92	\	MTA28	7C	174	124	|	MSA28,PPD
5D	135	93	]	MTA29	7D	175	125	}	MSA29,PPD
5E	136	94	^	MTA30	7E	176	126	~	MSA30,PPD
5F	137	95	_	UNT	7F	177	127	DEL	

PPE	Parallel Poll Enable	SPE	Serial Poll Enable
PPU	Parallel Poll Unconfigure	TCT	Take Control
SDC	Selected Device Clear	UNL	Unlisten
SPD	Serial Poll Disable	UNT	Untalk

Appendix C
Hardware and Software Configuration

This appendix describes how to reconfigure the GPIB-410 hardware and software configurations. There are two different revisions of hardware: Revision B.2 or higher and Revision C. Refer to the appropriate section of this appendix for the revision of hardware you are using.

Hardware – Revision B.2 or Higher

This section describes how to reconfigure the GPIB-410 hardware (Revision B.2 or higher) configuration. If you change any hardware settings, make note of them in the spaces provided later in this appendix as you will use them to reconfigure the software.

Figure C-1 shows the portion of the parts locator diagram with the base I/O address switches (U49), the DMA channel jumpers (W1 and W2), and the interrupt jumpers (W3).

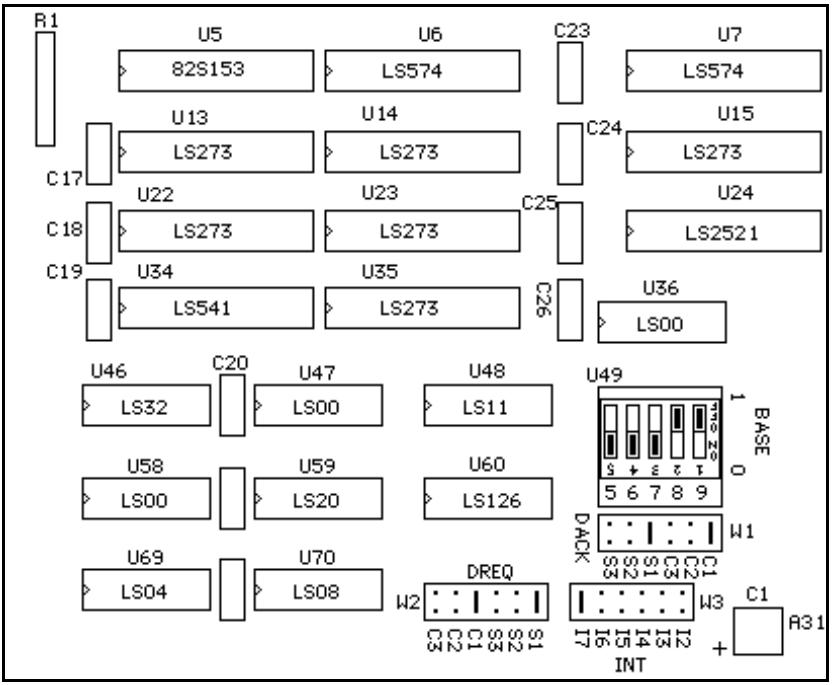


Figure C-1. GPIB-410 Parts Locator Diagram (Rev. B.2 or Higher)

Base I/O Address Configuration

The GPIB-410 is addressed as an I/O port and decodes the lower ten address lines of the PC I/O channel.

The base I/O address for the GPIB-410 is determined by the switches at position U49 on the interface board. The switches are set at the factory for the I/O port address 300 hex. This is used as the default base I/O address value by the GPIB-410 software. The GPIB-410 occupies 32 contiguous bytes of I/O space. The base address of this 32-byte block of addresses can be any multiple of 20 hex ranging from 000 hex to 3E0

hex (for example, a base address of 300 hex would occupy the addresses 300 to 31F hex on the interface board).

Note: Check to see that this address is not already used by equipment installed in the IBM Personal Computer. This address does not conflict with any of the addresses listed as used or reserved in the *IBM Personal Computer Technical Reference Manual*; however, interfaces manufactured by companies other than IBM may use this address.

Each switch in U49 corresponds to one of the address lines 9 through 5. The address line number is printed next to the corresponding switch on the interface board. Press the side marked 0 to select a binary value of 0 for the corresponding address bit. Press the side marked 1 to select a binary value of 1 for the corresponding address bit. Figure C-2 shows the default configuration 300 hex.

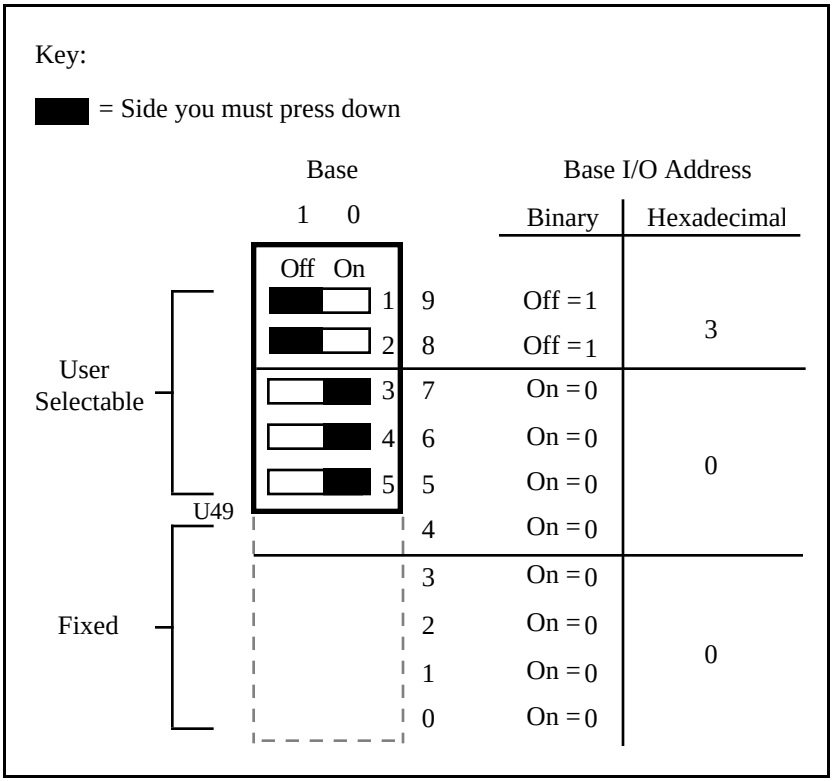


Figure C-2. Base I/O Address 300 Hex (Rev. B.2 or Higher)

To change the base I/O address, remove the plastic cover on U49, press each switch to the desired position, check each switch to make sure it is pressed all the way, and replace the plastic cover.

DMA Channel Configuration

The DMA channel used by the GPIB-410 is selected by jumpers on two rows of pins located near the I/O slot edge connector on the GPIB-410 (W1 and W2 in Figure C-1). The GPIB-410 is set to use DMA channel 1.

Note: Check that this DMA channel is not used by equipment already installed in the PC. If a peripheral uses DMA channel 1, you must change the DMA channel used by the GPIB-410.

DMA channel 2 is used by the floppy disk Controller in the IBM Personal Computer and the IBM Personal Computer XT. DMA channel 3 is used by the fixed disk Controller in the IBM Personal Computer XT. The software can be configured for programmed I/O (PIO) if no DMA channel is available. Configuration jumpers should remain as they are configured by the factory if PIO is selected.

Each DMA channel consists of two signal lines as shown in Table C-1:

Table C-1. DMA Channels for the GPIB-410 (Rev. B.2 or Higher)

DMA Channel	Signal Lines	
	DMA Acknowledge	DMA Request
1	DACK1	DREQ1
2	DACK2	DREQ2
3	DACK3	DREQ3

Two jumpers must be installed to select a DMA channel. The DMA Acknowledge (DACK) and DMA Request (DREQ) lines selected must have the same number suffix for proper operation.

Figure C-3 shows the jumper placement for the factory default DMA channel 1. Figure C-4 shows the jumper placement to select DMA channel 2 and DMA channel 3.

Note: The pins S1 through S3 are used by the GPIB-410 software (Revision B or higher) for the pattern generator. Refer to the section *Hardware - Revision C*, later in this chapter, for a discussion of DMA channel configuration for both capturing and sourcing.

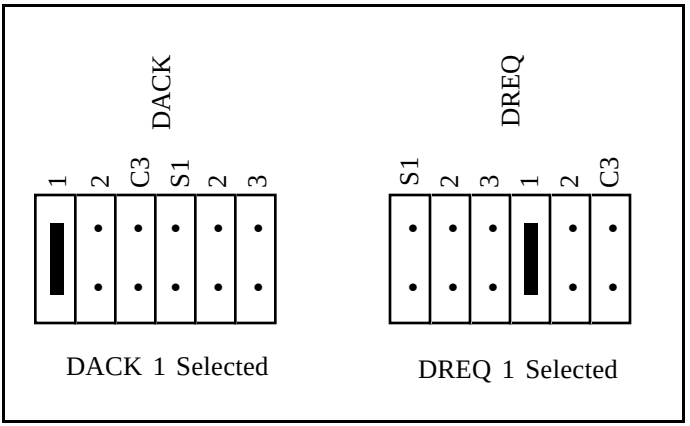


Figure C-3. Factory Default DMA Channel 1 (Rev. B.2 or Higher)

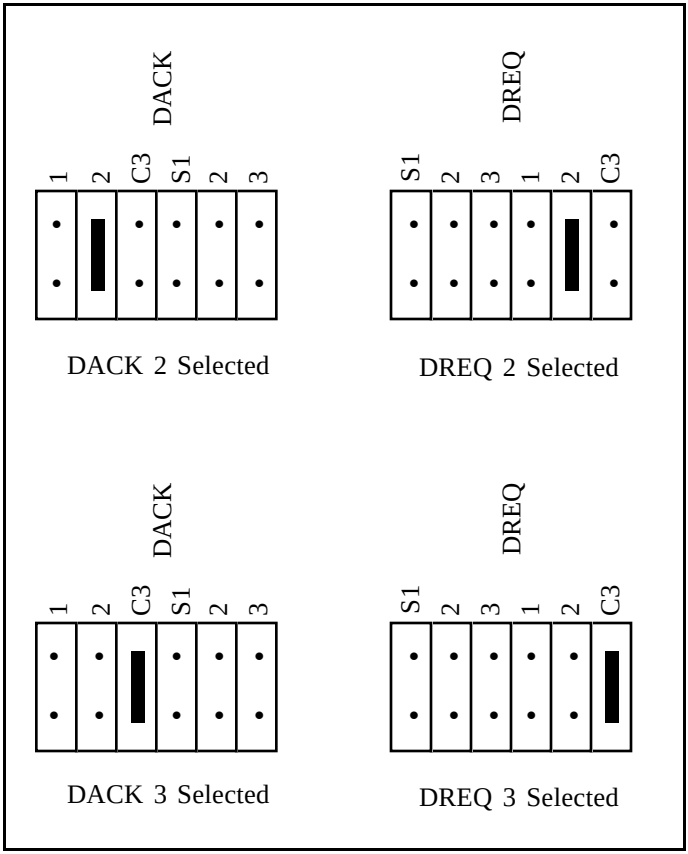


Figure C-4. DMA Channel Jumper Settings for DMA Channels 2 and 3 (Rev. B.2 or Higher)

Interrupt Selection

The GPIB-410 is configured to use Interrupt Request (IRQ) Line 7. One jumper and six dual wire wrap posts are used to select the interrupt line. The interrupt jumper array (W3) is located on the interface board with lines I2 through I7. Figure C-5 shows the factory configuration for IRQ Line 7. Figure C-6 shows the selection of IRQ Lines 6 and 2.

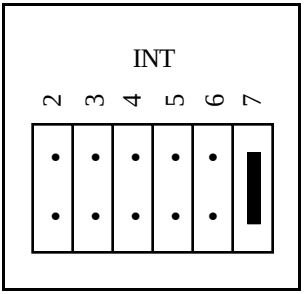


Figure C-5. Factory Default IRQ Line 7 Selected (Rev. B.2 or Higher)

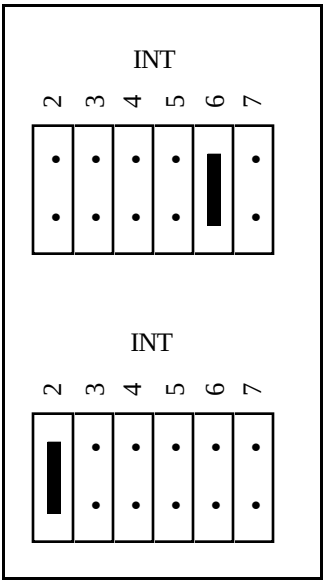


Figure C-6. IRQ Lines 6 and 2 Selected (Rev. B.2 or Higher)

In the space provided here, record the new settings of the base I/O address, the DMA channel, and the IRQ line so that you will have them handy when you install the software.

GPIB-410	**New Setting**
Base I/O Address:	_____
DMA Channel:	_____
Interrupt Request Line:	_____

Hardware – Revision C

Figure C-7 shows the parts locator diagram with the base I/O address switches (U65), the DMA channel jumpers, and the interrupt jumpers. If you change any hardware settings, make note of them in the spaces provided later in this appendix, as you will use them to reconfigure the software.

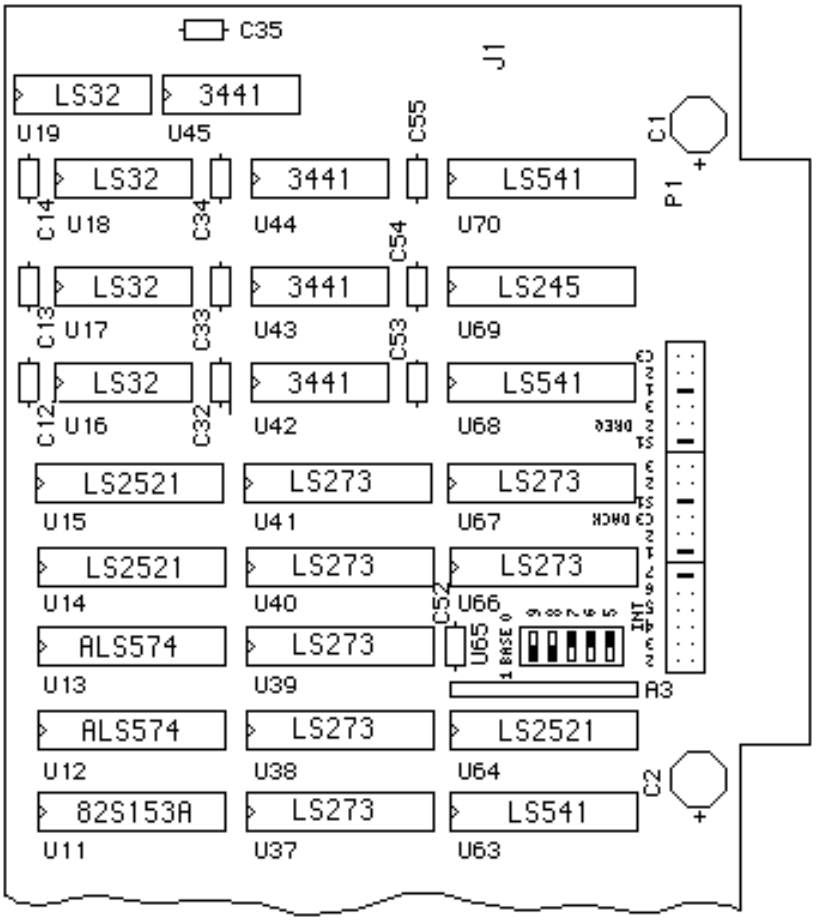


Figure C-7. GPIB-410 Parts Locator Diagram (Rev. C)

Base I/O Address Configuration

The GPIB-410 is addressed as an I/O port and decodes the lower ten address lines of the PC I/O channel.

The base I/O address for the GPIB-410 is determined by the switches at position U65 on the interface board. The switches are set at the factory for the I/O port address 300 hex. This is used as the default base I/O address value by the GPIB-410 software. The GPIB-410 occupies 32 contiguous bytes of I/O space. The base address of this 32-byte block of addresses can be any multiple of 20 hex ranging from 000 hex to 3E0 hex (for example, a base address of 300 hex would occupy the addresses 300 to 31F hex on the interface board).

Note: Check to see that this address is not already used by equipment installed in the IBM Personal Computer. This address does not conflict with any of the addresses listed as used or reserved in the *IBM Personal Computer Technical Reference Manual*; however, interfaces manufactured by companies other than IBM may use this address.

Each switch in U65 corresponds to one of the address lines 9 through 5. The address line number is printed next to the corresponding switch on the interface board. Press the side marked `0` to select a binary value of 0 for the corresponding address bit. Press the side marked `1` to select a binary value of 1 for the corresponding address bit. Figure C-8 shows the default configuration 300 hex.

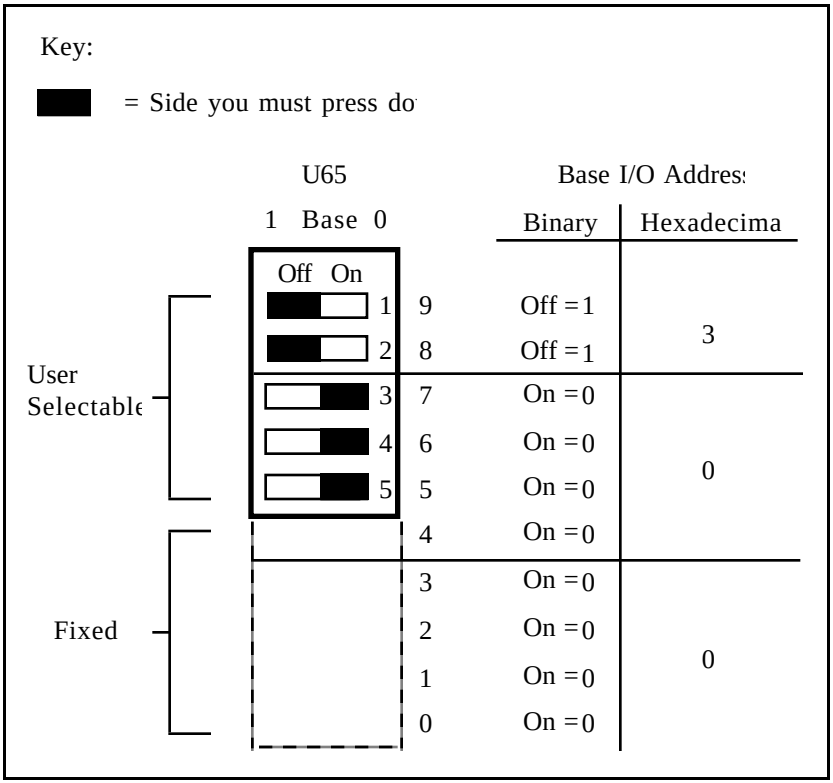


Figure C-8. Base I/O Address 300 Hex (Rev. C)

To change the base I/O address, remove the plastic cover on U65, press each switch to the desired position, check each switch to make sure it is pressed all the way, and replace the plastic cover.

DMA Channel Configuration

The DMA channel(s) used by the GPIB-410 is selected by jumpers on a row of pins located near the I/O slot edge connector on the GPIB-410. The GPIB-410 is set to use DMA channel 1.

Note: Check that this DMA channel is not used by equipment already installed in the PC. If a peripheral uses DMA channel 1 you must change the DMA channel used by the GPIB-410.

DMA channel 2 is used by the floppy disk Controller in the IBM Personal Computer and the IBM Personal Computer XT. DMA channel 3 is used by the fixed disk Controller in the IBM Personal Computer XT. The software may be configured for programmed I/O (PIO) if no DMA channel is available. Configuration jumpers should remain as they are configured by the factory if PIO is selected.

Each DMA channel consists of two signal lines as shown in Table C-2.

Table C-2. DMA Channels for the GPIB-410 (Rev. C)

DMA Channel	Signal Lines	
	DMA Acknowledge	DMA Request
1	DACK1	DREQ1
2	DACK2	DREQ2
3	DACK3	DREQ3

Two jumpers must be installed to select a DMA channel. The DMA Acknowledge (DACK) and DMA Request (DREQ) lines selected must have the same number suffix for proper operation.

Pins C1 through C3 select the DMA channel used when capturing data with the GPIB-410. Pins S1 through S3 select the DMA channel used when the GPIB-410 is sourcing data (pattern generator).

If your system has two DMA channels available for use (for example, channels 1 and 3), you can assign the capture and source circuitry to

separate channels for simultaneous DMA operation of both. However, if your system has only one available channel, both jumpers must be set to that channel for DMA operation of capturing or sourcing, but not both at the same time.

Figure C-9 shows DMA channel 1 selected for both capturing and sourcing (that is, input and output). Notice that with this configuration, DMA may not be used by the capture circuitry and pattern generator at the same time. This is the factory default configuration. Figure C-10 shows DMA channel 1 selected for capturing and DMA channel 3 selected for sourcing. Figure
C-11 shows DMA channel 1 selected for capturing with no DMA channel selected for sourcing. Programmed I/O must be used in this case.

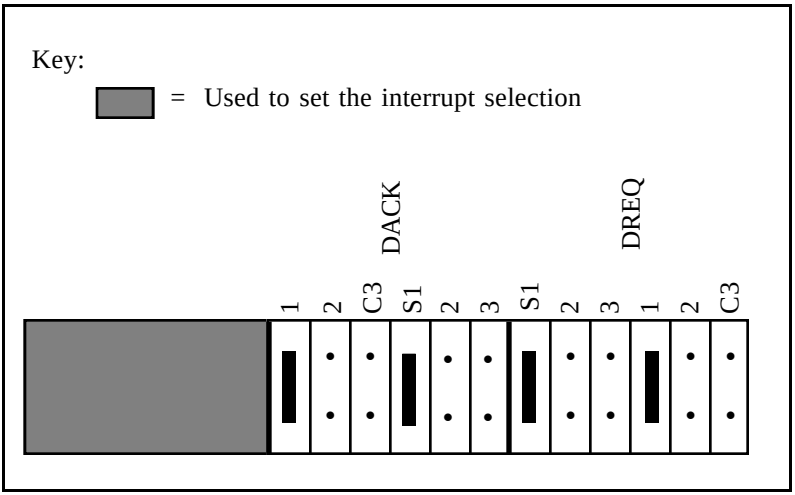


Figure C-9. Factory Default DMA Channel 1 (Rev. C)

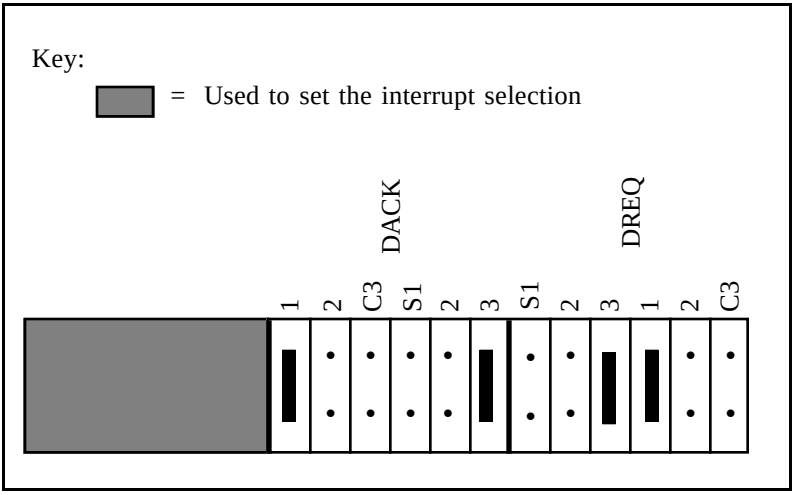


Figure C-10. DMA Channel 1 for Capturing and DMA Channel 3 for Sourcing (Rev. C)

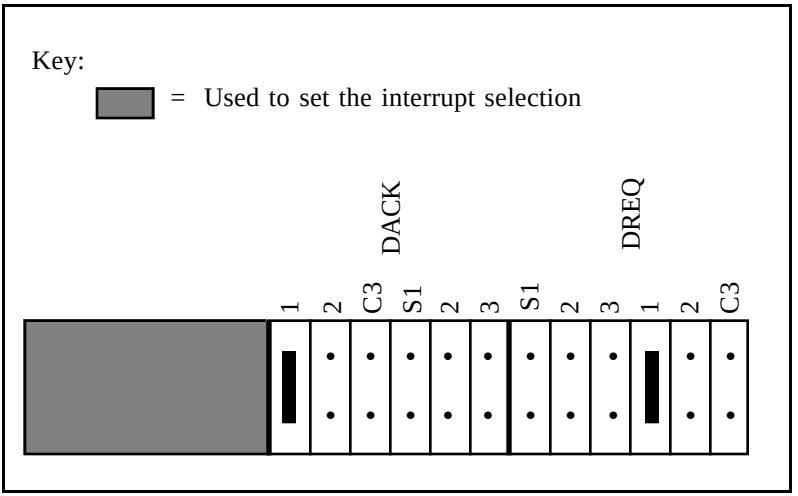


Figure C-11. DMA Channel 1 for Capturing and no DMA Channel for Sourcing (Rev. C)

Interrupt Selection

The GPIB-410 is configured to use Interrupt Request (IRQ) Line 7. One jumper and six dual wire wrap posts are used to select the interrupt line. The interrupt jumper array is located on the interface board with lines I2 through I7. Figure C-12 shows the factory configuration for Interrupt Line 7. Figure C-13 shows Interrupt Lines 6 and 2.

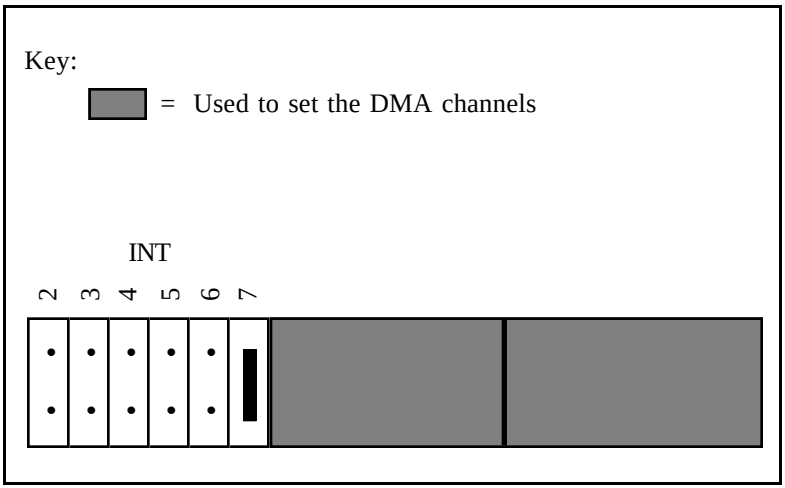


Figure C-12. Factory Default IRQ Line 7 Selected (Rev. C)

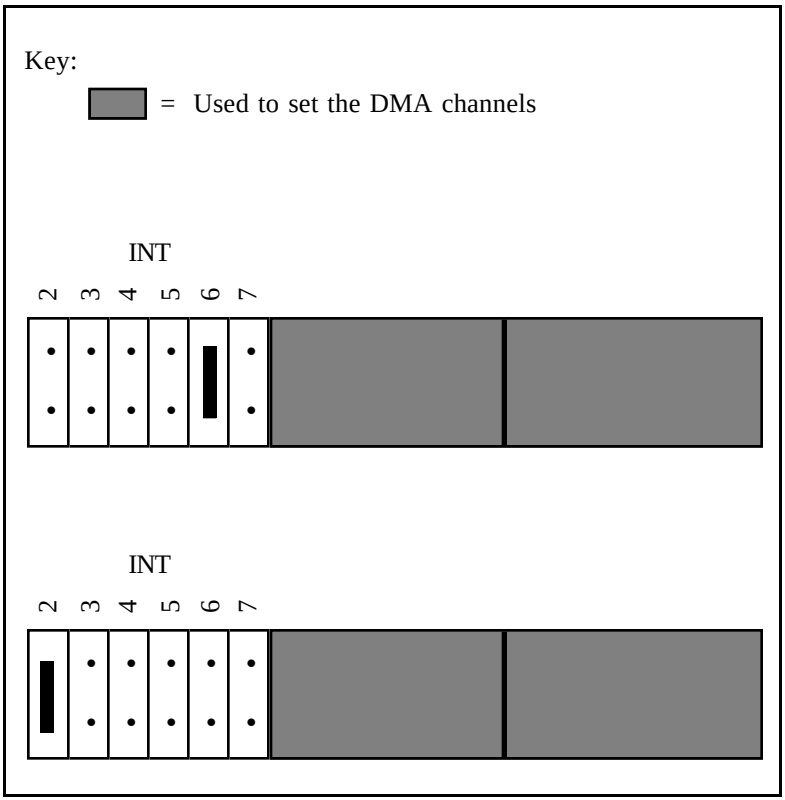


Figure C-13. IRQ Lines 6 and 2 Selected (Rev. C)

In the space provided here, record the new settings of the base I/O address, the DMA channel, and the IRQ line so that you will have them handy when you install the software.

GPIB-410	**New Setting**
Base I/O Address:	_____
DMA Channel:	_____
Interrupt Request Line:	_____

Software Configuration

If you change the hardware settings of the GPIB-410, you must match the software settings to the new hardware settings.

If you have not already done so, start up the `GPIB410` program by entering the following command.

```
gpib410          <Enter>
```

Press <F7> to access the Configuration Settings screen (see Figure C-14).

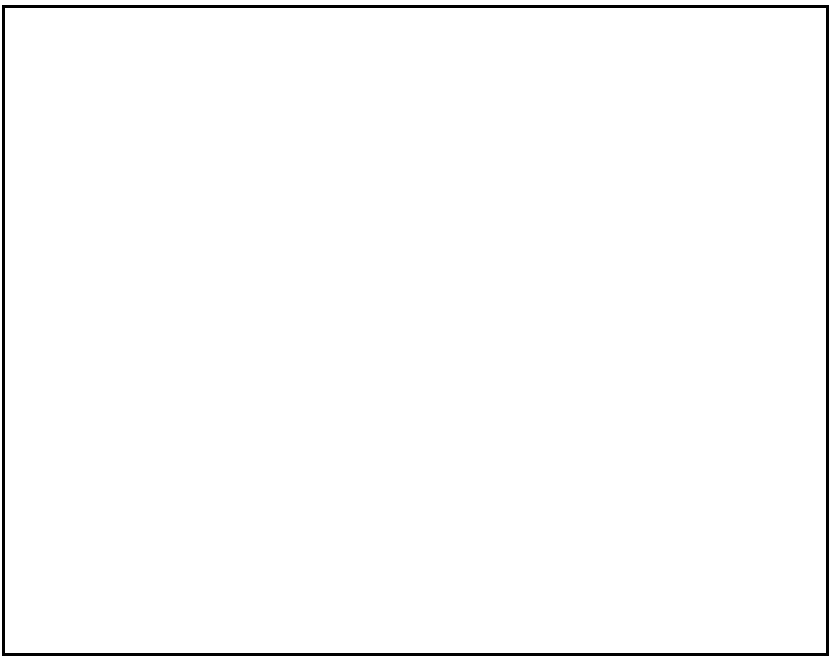


Figure C-14. Configuration Settings Screen

Scroll through the fields on this screen using the up or down arrow keys. The field you select becomes highlighted. Instructions for changing this field appear in the help/error bar.

When you exit the `GPIB410` program, be sure to save the new settings in the default configuration file `\GPIB410.CFG`. For more information on the Configuration Settings screen and the fields it contains, refer to Chapter 4, *Software Reference*.

Appendix D
Common Problems

This appendix contains possible causes for common problems encountered when operating the GPIB-410.

Problem: The capture operation does not terminate, even though enough capture events have occurred to fill up the capture buffer.

Possible Cause:

- The `Action when buffer full` field on the Capture Settings screen is set to `reset and continue`. Change this value to `stop capture`.
- The value contained in the Interrupt Jumper Setting field on the Configuration Settings screen does not match the actual jumper setting on the interface board. Check the hardware configuration and enter the proper value.

Problem: There are no highlighted cursors present on the Capture Display screen.

Possible Cause:

- The capture buffer is empty. There must be data displayed on the screen and capturing must be OFF for the cursors to be visible.
- The contrast on your display is set too low. Adjust the contrast until the highlighted cursors appear.

Problem: None of the input fields on the Capture, Trigger, Pattern Generator, or Configuration Settings screens are highlighted (no cursor present).

Possible Cause:

- One or more operational modes are enabled which depend on information contained in these screens (look for the appropriate indicator in the title/status bar). You are not able to make changes to these screens while one of these modes is active.

- Monitor Input Mode is enabled (look for `MON` in the title/status bar), meaning user input is currently directed into the upper window of the screen. To redirect input into the lower window once again, press <Alt-M> or the function key associated with the primary screen currently displayed in the analyzer window.

- The contrast on your display is set too low. Adjust the contrast until the highlighted cursor appears.

Problem: There is no indication that the final trigger pattern was matched (there was no beep and the `TRG` indicator in the title/status bar is still present), even though the required pattern has already appeared a sufficient number of times on the bus.

Possible Cause:

- The GPIB-410 software does not acknowledge the occurrence of the final pattern in a trigger sequence involving a capture until the next capture of an enabled GPIB event occurs. Thus, if the final trigger pattern does not correspond to any of the enabled GPIB events on the Capture Settings screen *and* no events are captured following the final occurrence of this pattern, completion of the trigger sequence may never be indicated to the user.

- The value contained in the Interrupt Jumper Setting field on the Configuration Settings screen does not match the actual jumper setting on the interface board. Check the hardware configuration and enter the proper value.

Problem: The system crashes when any of the operational modes on the Main Menu screen are enabled. A restart is necessary to proceed.

Possible Cause:

- The values selected for the Input DMA channel, Interrupt jumper setting, or Base I/O address on the Configuration Settings screen do not match the actual settings on the interface board, or the values selected are in use by another device. Check the choices made and try again.

Problem: The title/status bar is blank and/or the entire screen is faint or coarse, making it difficult to read.

Possible Cause:

- Your computer contains a color graphics controller card connected to a monochrome display. Go to the Configuration Settings screen (<F7>) and change the computer display mode field from `Color` to one of the `Monochrome` options by using <+> or <->. Press <Enter> after you have made this change.

  Alternatively, you can specify monochrome operation at program start-up by specifying `-m` in the DOS command line as follows:

  ```
  gpib410 -m        <Enter>
  ```

Problem: The DOS Shell functions <Alt-D> and <Alt-I> are not able to find, load, or run the file `COMMAND.COM`.

Possible Cause:

- The correct pathname of `COMMAND.COM` is not contained in the DOS environment variable `COMSPEC`. You must set this variable accordingly so that the GPIB-410 software can find the file on disk.

- `COMMAND.COM` contained on the currently active boot disk has an incorrect version number. You must use the same DOS version of `COMMAND.COM` that you used when you first started the system.

- There is insufficient memory available to load `COMMAND.COM`. Try reducing the size of the capture buffer defined on the Capture Settings screen and try again.

Appendix E
Using the Pattern Generator

This appendix describes the Interface Bus Pattern Generating Language (IBPGL) and syntax conventions for data/command strings.

Using the Pattern Generator is an alternative means of manipulating the switches of the GPIB-410 Monitor window. It is faster and more accurate than toggling the switches by hand, and the patterns created can be repeated many times.

There are two methods for specifying output patterns. The first and most flexible method is to use a text editor to create a file of commands that describes a sequence of actions to be performed on the GPIB. These actions are then translated into a stream of patterns by the GPIB-410 and output to the bus. The second method, though more limited, can be used while the GPIB-410 software is running. Using the interactive input window on the Pattern Generator screen, you can enter a string of data or command bytes that can then be output to the bus using the source handshake protocol.

The Command File Method

Pattern command files are created using the National Instruments Interface Bus Pattern Generating Language (IBPGL). Developed specifically for use with the GPIB-410 Pattern Generator, IBPGL is a simple, easy-to-use language designed for specifying arbitrary patterns to be placed on the GPIB. IBPGL is a compiled language in that its commands are used to describe a sequence of 16-bit patterns that are constructed and loaded into memory prior to execution of the Pattern Generator.

IBPGL consists of only five commands. Generally, each command can be classified by function as one of the following two types.

- Pattern creation
- Execution control

Pattern creation commands add one or more patterns to the *pattern buffer* for eventual output by the Pattern Generator. Because these

commands specify patterns in terms of changes to the current state of the GPIB, as opposed to completely redefining that state with a new 16-bit value, each new pattern is constructed by modifying the last pattern placed in the buffer. Unless the state of an individual signal line is explicitly changed by a particular command, its state remains constant from the previous pattern to the current one.

Execution control commands create no new patterns, but are used to alter the manner in which the pattern buffer is output to the GPIB.

Regardless of type, each command has the following syntax.

```
[ n * ] command arguments...
```

- The expression `n *` specifies an optional repetition factor `n` which may precede any command. The value of `n` must be an integer constant in the range 1 to 65535. If `n *` is omitted, the default repetition factor is 1.

- The expression `command` is one of the five command keywords described under the *IBPGL Command Description* section later in this chapter.

- The expression `arguments...` specifies a variable list of arguments that are determined by the selected `command`.

IBPGL Command Descriptions

(1) SET *line_mask...*

This command is used to selectively change the state of any combination of GPIB signal lines. It causes exactly one new pattern (two bytes) to be placed into the pattern buffer. In the above command line, the expression *line_mask* has the following syntax:

```
operator line_mnemonic...
```

- The expression `operator` can be the symbol `+` or `-`. The `+` operator causes each of the GPIB signal lines specified in the expression `line_mnemonic...` to be set to 1 (on). The `-` operator causes each of the GPIB signal lines specified in the expression `line_mnemonic...` to be set to 0 (off).

- The expression *line_mnemonic* can be any of the following terms:

D1	D5	EOI	IFC
D2	D6	ATN	NRFD
D3	D7	SRQ	NDAC
D4	D8	REN	DAV

DATA	(specifies all 8 data lines)
CONTROL	(specifies all 8 control lines)
ALL	(specifies all 16 signal lines)

  Any number of the above terms can be included in the expression *line_mnemonic...*, although no specific signal line should be mentioned more than once. In general, the SET command requires at least one *operator* followed by at least one *line_mnemonic*.

  Examples of SET:

  a.
  ```
  set + atn - nrfd ndac  ; assert ATN,
                         ; clear NRFD/NDAC
  ```

  b.
  ```
  set + data             ; assert all data
                         ; lines
  ```

  c.
  ```
  set - all + atn ren    ; clear all lines,
                         ; assert ATN/REN
  ```

  As the last example implies, ordering is important when any of the composite references DATA, CONTROL, or ALL are used along with references to specific signal lines. If the expression had been written like the following example, the net result would be the clearing of all lines in the pattern to zero.

  ```
  set + atn ren - all
  ```

(2) HANDSHAKE *string*

This command is used to source handshake the specified string of bytes onto the GPIB. These bytes are interpreted as either *data* or *commands*, depending on the state of the ATN line. The number of new patterns placed into the pattern buffer by this command equals the number of bytes specified in the expression *string*. The syntax

for *string* is identical to that described later for text in the Interactive Input Window, except that here the text must be enclosed in double quotes (for example, `"this is a valid handshake string"`). Notice that unlike the SET command, which simply causes a static pattern to be placed onto the GPIB, patterns specified using the HANDSHAKE command cause one cycle of the source handshake to be executed as each pattern is output to the bus. Thus, the HANDSHAKE command is roughly equivalent to a sequence of several SET commands for each byte in *string*, as illustrated below:

```
handshake "a"
```

is conceptually similar to

```
set - data dav + d7 d6 d1
    implicit wait for NRFD to be cleared
set + dav
    implicit wait for NDAC to be cleared
set - dav
```

As indicated in the illustration, the DAV line is automatically set to 0 at the beginning of any HANDSHAKE command. DAV is the only control line affected by this command.

Examples of HANDSHAKE:

a. `handshake "abcdefghijklmnopqrstuvwxyz\r\n"`

b. `handshake "\x41\x42\x43\x44\x4A\x4B\x4C\x4D"`

c. `handshake "\UNT\UNL\x41\TCT"`

(3) INCLUDE *filename*

This command is used to include the contents of another command file in line with the contents of the current command file. Files *included* in this manner may also contain INCLUDE commands. The number of new patterns placed into the pattern buffer by this command depends on the number and type of commands contained in the included file. The term *filename* must be a valid DOS pathname of 47 characters or less.

Examples of INCLUDE:

a. `include myfile.pat`

b. `include a:\tmp\test3.pat`

(4) PAUSE [*n*]

This command is used to suspend output of the pattern buffer for approximately *n* msec before proceeding. If specified, the value *n* must be an integer in the range 1 to 65,535. If *n* is omitted, its value defaults to 1,000. Because this function relies on the built-in timer interrupt of the host PC system, pause intervals that do not correspond to an integral number of timer *ticks* are rounded to the nearest integral value. Timer ticks occur approximately once every 55 msec.

Examples of PAUSE:

a. `pause 50 ; pause for 50 msec`

b. `pause ; pause for 1 sec`

c. `pause 3000 ; pause for 3 sec`

(5) {
command
command
:
}

This command is used to group together a sequence of one or more commands into one *compound* command, much like similar constructs found in C or Pascal. The command is initiated by the symbol "{" on the first line of the sequence and terminated by the symbol "}" on the last line. The commands to be grouped are placed on intervening lines, one per line, with optional indentation for clarity. This command is used for the purpose of applying a single repetition factor to an entire sequence of commands - in other words, it is used to create a loop.

Example of { ... }:

```
5 * {
   set + atn
   handshake "?0123456789"
   set - all
}
```

During execution, the above sequence of 13 patterns will be output to the GPIB five times.

IBPGL Tips and Techniques

Any of the named commands can be abbreviated to as few as one letter if desired (that is, S, H, I, and P). The maximum active line length is 79 characters, and comments can be included on any line by preceding them with a semicolon (;).

HANDSHAKE commands containing lengthy text strings that cannot fit on one line can be broken down into several shorter HANDSHAKE commands yielding the same results. For example, the sequence of commands:

```
handshake "abcd"
handshake "1234"
handshake "efgh"
```

is equivalent to the single command:

```
handshake "abcd1234efgh"
```

Unlike the above two sequences of commands, some sequences that may appear to be identical actually yield slightly different results. For example, consider the following two commands:

```
20 * handshake "a"

handshake "aaaaaaaaaaaaaaaaaaaa"
```

Though each command will result in the letter "a" being output to the bus 20 times, the second command produces faster output than the first. This is especially true if the Pattern Generator is using DMA. The

reason for this is that repetition factors do not insert extra patterns into the pattern buffer, but merely instruct the GPIB-410 to output a fixed portion of the buffer more than once. This fact should also be kept in mind when a repetition factor is applied to a block of commands.

The Input Window Method

Using the interactive input window is a quick and easy means of source handshaking a unique string of up to 75 bytes onto the GPIB without creating a pattern command file. You can repeat the string automatically up to 65,535 times and you can optionally send EOI along with the last byte in the output sequence.

Outputting bytes through the input window is roughly equivalent to executing a command file that contains only HANDSHAKE commands. Unlike a command file, however, the input window works in conjunction with the current monitor switch settings. Thus, for example, bytes can be sent out as either *data* or *commands*, depending on the state of the ATN switch in the monitor window.

The syntax for the data/command strings specified in the input window (as well as the HANDSHAKE command) has several escape sequences for including special 8-bit codes that are not conveniently entered as standard ASCII characters. These escape sequences are initiated with a backslash (\) followed by one or three alphanumeric characters as shown in the following list:

`\n`	ASCII linefeed
`\r`	ASCII carriage return
`\t`	ASCII horizontal tab
`\"`	ASCII double quote
`\\`	ASCII backslash
`\x`*`NN`*	Any 2-digit hexadecimal number (*N* = 0 through 9, A through F)

MMM Any of the GPIB mnemonics shown here (caps required):

DCL (0x14)	PPC (0x05)	SPE (0x18)
GET (0x08)	PPU (0x15)	TCT (0x09)
GTL (0x01)	SDC (0x04)	UNL (0x3F)
LLO (0x11)	SPD (0x19)	UNT (0x5F)
NUL (0x00)		

In addition to the above escape sequences, two others are provided for entering the ASCII characters '+' and '-'. They are as follows:

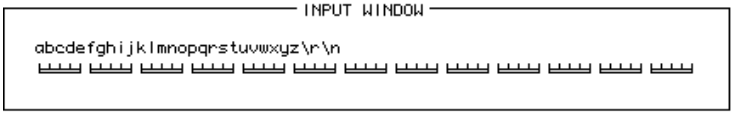
<Alt-P> Insert an ASCII '+' into the Input Window

<Alt-N> Insert an ASCII '-' into the Input Window

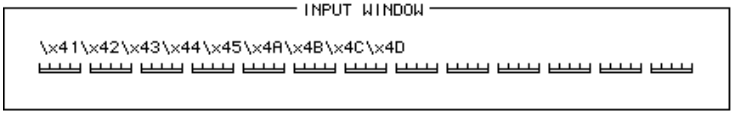
These two escape sequences are necessary because <+> and <-> on the keyboard are used to select the options in the Pattern Buffer Source field, which is the Input Window parent field.

Examples of Input Window strings:

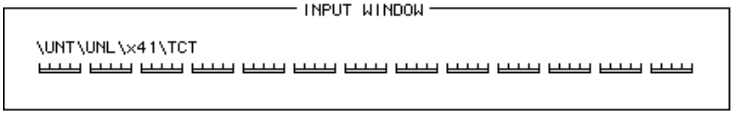
(a.)



(b.)



(c.)



Appendix F
GPIB410.PAT Source Listing

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This information not available in PDF version of this document.

Appendix G
Saving and Viewing Capture Information on Disk

This appendix describes saving and viewing capture buffers on disk. Also included is a description of the FMT410 utility.

The following two functions are available on the Capture Settings screen for saving captured status information to a file on disk.

- The Auto-write function
- The Immediate Write function

The Auto-write function is used while capturing is enabled to save the contents of the GPIB-410 capture buffer automatically each time the buffer is full or when the capture operation is terminated. The pathname of the file to receive this information is specified in the field at the bottom of the Capture Settings screen. This function is useful when you want to capture and retain more status entries than will fit in the capture buffer at one time. *Before* you initiate any capture activity that you wish to save, you must enable this function by selecting yes in the Auto-write each pass field on the screen.

The Immediate Write function, which is activated by pressing <Alt-W>, saves the *current* contents of the capture buffer to the specified file on disk. This function is used to save captured status information after the capture activity has already completed. In addition, by using the Buffer range for <Alt-W> field, you can elect to save the contents of the entire buffer or just a portion of it.

With either of the above techniques, information is saved to the capture file in exactly the same manner. If the specified file already exists, it is overwritten when the write operation is initiated. Otherwise, it is created.

The saved block, or *table*, of status entries is preceded in the file by a binary header that contains information about the size of the table and the configuration of the GPIB-410 software at the moment that the capture was started. Like the header, the capture table is also stored in binary to reduce the size of the overall file, as well as improve the speed and efficiency of the write operations. The size in bytes of the table is equal to the total number of entries saved times two. *Data* bytes

are positioned at even offsets from the beginning of the table, while *control* bytes are positioned at odd offsets.

The following two techniques are available for retrieving captured data from a file on disk.

- The `Capture Load` function, <Alt-L>
- The `FMT410` utility

The `Capture Load` function loads back into the capture buffer the file specified on the Capture Settings screen. To load the specified file, press <Alt-L>. Once the file is loaded, all of the standard editing features of the Capture Display screen can be used.

To format the contents of capture files into a more familiar ASCII form for viewing or printing outside of the `GPIB410` program, use the `FMT410` utility. The syntax used to start `FMT410` is as follows:

`FMT410 [`*`flags...`*`] [`*`filename`*`]`

The *`flags`* shown in the above line are optional; they are described later in this appendix. These flags are used to tailor the output of `FMT410` to specific needs or situations. In most cases, however, no flags are necessary and only a filename must be specified. To format any capture file, enter the following command.

`fmt410` *`filename`* <Enter>

The expression *`filename`* can be any valid DOS pathname, including an optional drive specification, of 47 characters or less. To format the default capture file `GPIB410.CAP`, enter the following command.

`fmt410` <Enter>

The `FMT410` utility directs its output to the computer display by default. Output can be redirected to a file or printer by using the DOS redirection operator `>`. Listed below are a few examples.

Example 1: `fmt410 mydata.cap > mydata.fmt`

Example 2: `fmt410 mydata.cap > lpt1`

Example 3: `fmt410 > prn`

To accomodate a wide variety of printers, only standard ASCII characters are used in `FMT410` output. For each capture table, information is displayed from the associated header, followed by the table of saved status entries. The format of the entries table is similar to that of the Capture Display screen (see Figure G-1).

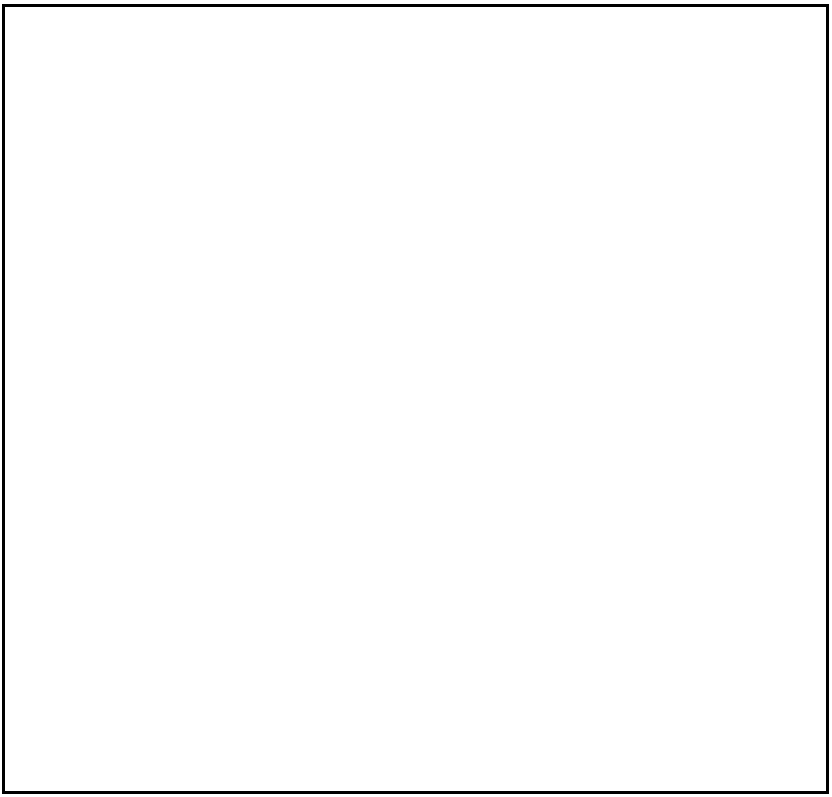

Figure G-1. FMT410 Output Listing

Unlike the file in the previous example, some capture files may contain thousands of status entries. As `FMT410` translates each 2-byte entry into a 60- to 80-byte line of ASCII text, the quantity of output can add up quickly. To alleviate this problem, the run-time flags in Table G-1 are used to condense or eliminate portions of `FMT410` output if desired.

Table G-1. Run-Time Flags

Flag	Description
-t*number*	Output only the capture table indicated by *number*. If *number* is omitted, the number of tables contained in the file is shown on the screen. This flag is used with Revision A capture files, which may contain more than one capture table. Revision B and C GPIB-410 software only store one capture table per file.
-i*number*	Begin output range at index *number*. Default range begins at index 0 of each capture table.
-c*number*	Limit output range to count of *number* entries. Default range extends to the end of each capture table.
-f*option...*	Modify formatted output of each capture table.
p	Do not format position display column.
b	Do not format data/control binary display columns.
r	Do not format remarks display column.
h	Format control column in hexadecimal.
-x*option...*	Extract capture information without headers or formatting. If this flag is specified, all **-f** options are ignored.
e	Extract all data/control entries in output range.
d	Extract only valid data bytes in output range. If the *e* option is specified, also extract the accompanying control bytes.
c	Extract only valid command bytes in output range. If the *e* option is specified, also extract the accompanying control bytes.
-h *or* **-?**	Display an online help screen describing each of the above flags.

Flags can be specified in any order. This is also true of the options that follow them. If two or more flags are specified that are redundant or conflicting, the flag specified last takes precedence. There must not be any spaces between a flag and its option(s).

The following examples are possible flag combinations. These examples assume that the file `GPIB410.CAP` exists and contains the information shown in the complete table in Figure G-1. If you enter the following command, the output looks like the listing shown in Figure G-2.

```
fmt410 -i5 -fpb        <Enter>
```

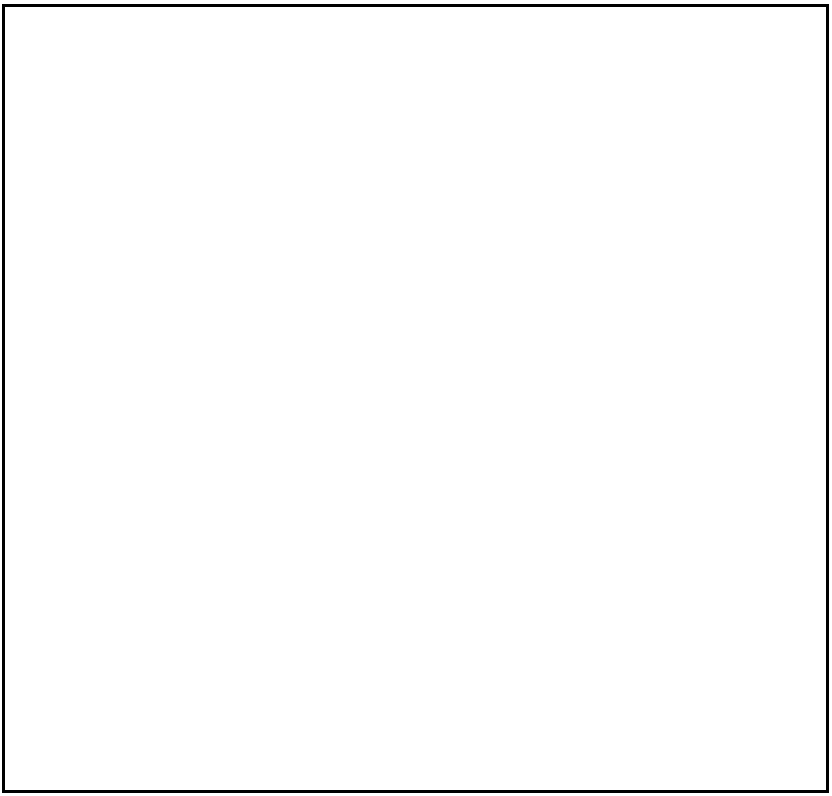

Figure G-2. Abbreviated FMT410 Output Listing

If you enter the following command:

```
fmt410 -xdc        <Enter>
```

the output appears as follows:

```
s.
?#DEV3 me
```

Appendix H
Differences between Software Revisions

This appendix describes the differences between the major software revisions.

The Revision B release of the GPIB-410 software was a functional superset of the Revision A release. In addition to enhanced functionality in several areas of operation, minor improvements to the user interface were also made. Likewise, the Revision C release builds upon the functionality of Revision B.

Note: Capture and configuration file formats are compatible across all revisions of the software.

Important Differences

Users already familiar with Revision A and Revision B will find that the original screens and functions operate in the same manner as before, with the following important exceptions:

- The Immediate Write function, <Alt-W>, which was formerly included in the list of functions on the Main Menu screen in Revision A, is a local function on the Capture Settings screen in Revision B and Revision C.

- In Revision B and Revision C, both the Immediate Write function and the Auto-write function *overwrite* previous information in the selected capture file whenever a new write operation is initiated. This approach differs from that of Revision A, wherein existing capture files were *appended* to with each new write operation.

- In Revision A and Revision B, Monitor Input mode can be exited by pressing the function key of any analyzer screen. In Revision C, Monitor Input mode can be exited only by pressing <Alt-M>, <Esc>, or the function key of the *currently displayed* analyzer screen.

Feature Highlights

Some of the new functions included in the Revision B release are as follows:

- Pattern Generator – a convenient, low-level utility for placing a sequence of 16-bit patterns onto the GPIB at high speeds.
- Variable Speed Handshaker fields – can vary the speed of the built-in source and acceptor handshakers of the GPIB-410 hardware.
- Capture Buffer Search function – can search for a specific pattern or class of patterns.
- Auto Accept-a-Byte function – can perform one cycle of the acceptor handshake with a single keystroke.
- Improved `FMT410` utility – can tailor capture file output to specific needs and situations.

Some of the new functions included in the Revision C release are as follows:

- Background Operation - you can exit to DOS temporarily without terminating the GPIB410 program. During DOS operation, an optional GPIB-410 icon can be displayed on the screen showing the operational modes in effect and the current state of the GPIB signal lines. All enabled modes remain active while the main program is suspended.
- Capture Echo mode - can display captured data on the screen as it is being captured.
- Data Recapture function - can recover the results of the last successful capture operation after the Capture Display screen has been cleared.
- Capture File Load function - can load capture files stored on disk back into the capture buffer for display and analysis.
- Improved Capture Display Screen - supports flexible cursor positioning while scrolling through the data, expanded device addressing information in the mnemonics display column, and buffer offsets formatted in either decimal or hexadecimal.

Appendix I
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.

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

Branch Offices	**Phone Number**	**Fax Number**
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Austria	(0662) 435986	(0662) 437010-19
Belgium	02/757.00.20	02/757.03.11
Denmark	45 76 26 00	45 76 71 11
Finland	(90) 527 2321	(90) 502 2930
France	(1) 48 14 24 00	(1) 48 14 24 14
Germany	089/741 31 30	089/714 60 35
Italy	02/48301892	02/48301915
Japan	(03) 3788-1921	(03) 3788-1923
Mexico	95 800 010 0793	95 800 010 0793
Netherlands	03480-33466	03480-30673
Norway	32-848400	32-848600
Singapore	2265886	2265887
Spain	(91) 640 0085	(91) 640 0533
Sweden	08-730 49 70	08-730 43 70
Switzerland	056/20 51 51	056/20 51 55
Taiwan	02 377 1200	02 737 4644
U.K.	0635 523545	0635 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 _____M

Display adapter _____

Mouse _____yes _____no

Other adapters installed _____

Hard disk capacity _____M Brand _____

Instruments used _____

National Instruments hardware product model_____

Revision _____

Configuration _____

(continues)

National Instruments software product _____

Version _____

Configuration _____

The problem is _____

_____

_____

_____

_____

_____

_____

_____

List any error messages _____

_____

_____

_____

_____

_____

_____

_____

The following steps will reproduce the problem_____

_____

_____

_____

_____

_____

_____

GPIB-410 Hardware and Software Configuration Form

Record the settings and revisions of your hardware and software on the line located to the right of each item. Complete 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.

National Instruments Products

- GPIB-410 Software Revision Number on Disk: _____
  (Disk Label: *Distribution Diskette for GPIB-410 GPIB Monitor/ Analyzer Software*
- Interrupt Level of GPIB-410: _____
- DMA Channel of GPIB-410: _____
- Base I/O Address of GPIB-410: _____

Other Products

- Computer Make and Model: _____
- Other Boards in System: _____
- Base I/O Address of Other Boards: _____
- DMA Channel of Other Boards: _____
- Interrupt Level of Other Boards: _____

Documentation Comment Form

National Instruments encourages you to comment on the documentation supplied with our products. This information helps us provide quality products to meet your needs.

Title: **GPIB-410 User Manual**

Edition Date: **March 1994**

Part Number: **320053-01**

Please comment on the completeness, clarity, and organization of the manual.

(continues)

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 _____

Title _____

Company _____

Address _____

_____

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