User's Manual

3488 Mode Supplement

This manual describes the Agilent 3499A/B/C Switch/Control System when used in the 3488 mode of operation. This manual is a supplement to the Agilent 3499A/B/C Switch/Control System User's Manual (shipped with the instrument).

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Agilent 3499A/B/C Switch/Control System

Agilent 3499A/B/C at a Glance

The Agilent Technologies 3499A/B/C Switch/Control System provides a convenient mechanical and programming environment for a variety of plug-in modules. With appropriate plug-in modules, the Switch/Control System provides high density/high speed switching and digital I/O capability.

Switch/Control System Features

- Intuitive and easy-to-use user interface

- GPIB (IEEE 488) or RS-232 interface control

- External triggering capability

- Built-in 4-bit digital I/O port

- Store and recall up to 50 customized instrument setups

- SCPI (Standard Commands for Programmable Instruments) compatibility

- Relay cycle count information for preventive maintenance

- Downloadable firmware upgrades

Agilent 3499A Features

- Five plug-in slots

- Full rack width

Agilent 3499B Features

- Two plug-in slots

- Half rack width

Agilent 3499C Features

- Nine plug-in slots

- Full rack width

Note: *Unless otherwise indicated, this manual applies to all Serial Numbers.*

Plug-in Modules at a Glance

The Agilent 3499A/B/C mainframes support a variety of plug-in modules to make test system configuration easy.

Multiplexer Modules

N2260A 40-Channel MUX Module (armature relays)
N2266A 40-Channel MUX Module (reed relays)
N2270A 10-Channel High Voltage MUX Module
44470A 10-Channel MUX Module
44470D 20-Channel MUX Module

General Purpose Relay Modules

N2261A 40-Channel GP Relay Module
N2267A 8-Channel High Current GP Module
44471A 10-Channel GP Relay Module
44471D 20-Channel GP Relay Module
44477A 7-Channel Form-C Relay Module

Matrix Modules

N2262A 4 x 8 Matrix Module
44473A 4 x 4 Matrix Module

High Frequency Switching Modules

N2268A 50Ω 3.5GHz Dual 4-to-1 MUX Module
N2272A 1 GHz RF 1-to-9 MUX Module[1]
N2276A/B Dual 1-to-6 (4) Microwave MUX/Attenuator Module[1]
44472A Dual 4-Channel VHF Switch Module
44478A/B 50Ω/75Ω 1.3 GHz Multiplexer
44476A 3-Channel 18 GHz Switch Module
44476B 2-Channel Microwave Switch Module

Optical Switch Modules

N2280A Optical Switch Quad 1-to-2 MUX Module
N2281A Optical Switch Dual 1-to-4 MUX Module
N2282A Optical Switch 1-to-8 MUX Module[1]

Digital I/O Modules

N2263A 32-Bit Digital I/O Module
44474A 16-Bit Digital I/O Module

Multifunction/Special Purpose Modules

N2264A 12-Channel GP & 3-Channel High-current GP & 16-Bit Digital I/O
N2265A 4 x 4 Matrix & 16-Bit Digital I/O Module
44475A Breadboard Module

[1] These modules are NOT supported in the 3488 Mode of operation.

The Front Panel at a Glance
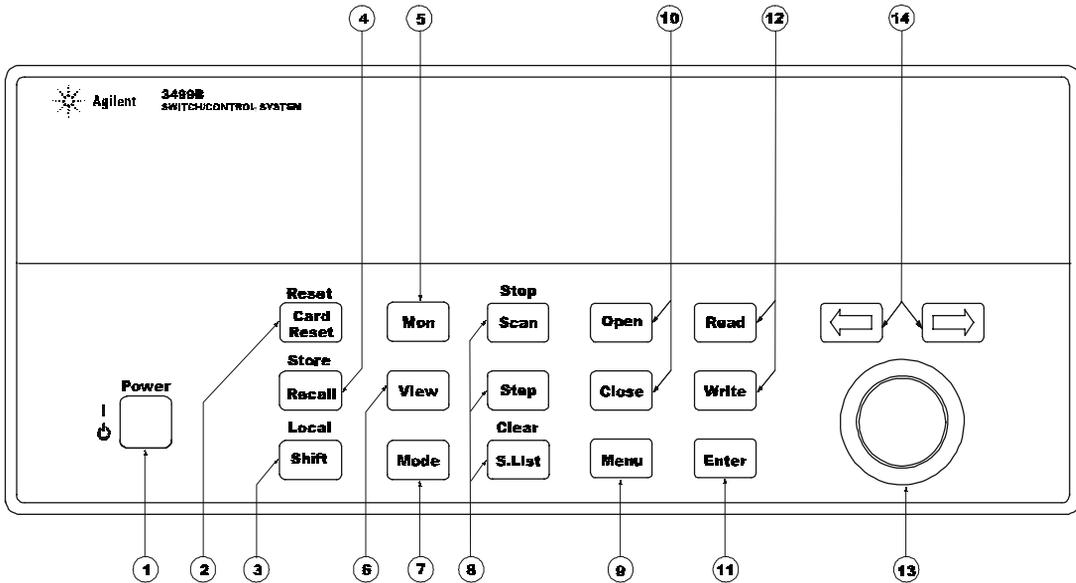
|	
1. Power On/Standby	**8. Scan Keys** (see page 78)
2. Reset Module/Instrument	**9. Main Menu**
3. Shift/Local	**10. Open/Close Relay Channels**
4. Store/Recall Instrument State	**11. Enter a Value/Confirm Selection**
5. Monitor Channel/Port/Module	**12. Read/Write Digital I/O Ports**
6. View Menu	**13. Knob**
7. Mode Menu	**14. Navigation Arrow Keys**

Note The front panel shown above is the Agilent 3499B. The 3499A and 3499C front panels are similar and have identical functionality.

The Display at a Glance
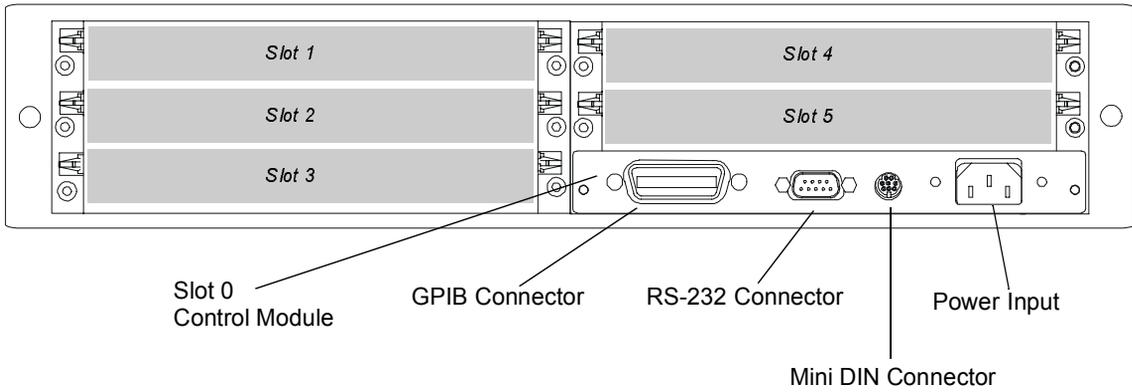
Channel/Slot Number
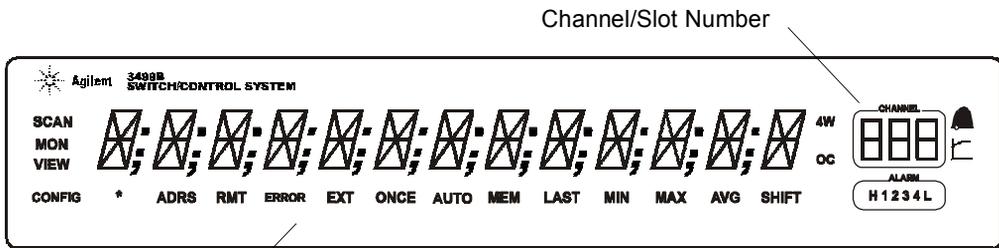
Annunciators

The display is divided into several areas. The channel and slot number is always displayed on the right corner of the display. The main area, which is in the center of the display, is primarily used to display channel status (open or closed), information messages, menu items, prompt information, error messages, and so on. Around the display are annunciators to indicate various states of the instrument operation. The annunciators are summarized below.

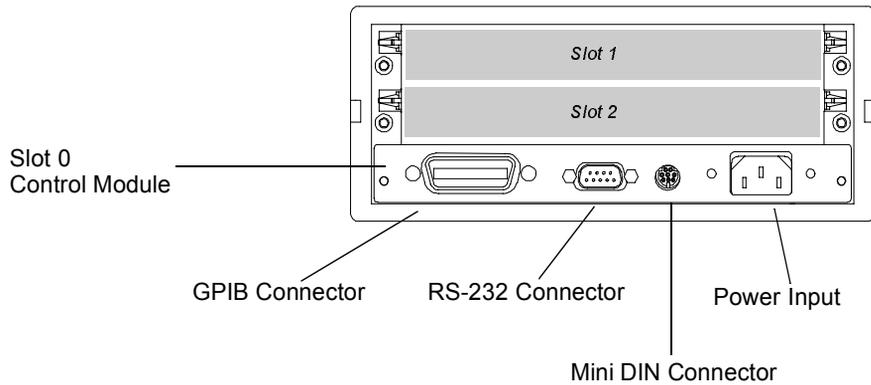| Annunciator	Indication
SCAN	Scan is initiated.
MON	Instrument is in monitor mode.
VIEW	Scan list, errors or relay cycle counts are being viewed.
CONFIG	Any configuration key has been pressed.
*	Instrument is advancing a scan step.
ADRS	Instrument is active on the remote interface.
RMT	Instrument is in remote mode.
ERROR	Error queue is not empty.
EXT	Scan is waiting for external trigger source.
SHIFT	Shift key has been pressed.

Other annunciators in the display are not used in the Agilent 3499A/B/C system.

The Rear Panel at a Glance

The figure below shows the Agilent 3499A rear panel.

Slot 1	Slot 4
Slot 2	Slot 5
Slot 3	

Slot 0 Control Module
GPIB Connector
RS-232 Connector
Power Input
Mini DIN Connector

The figure below shows the Agilent 3499B rear panel.

Slot 1
Slot 2

Slot 0 Control Module
GPIB Connector
RS-232 Connector
Power Input
Mini DIN Connector

The figure below shows the Agilent 3499C rear panel.
Option FP1 (1-slot) and FP2 (2-slot) filler panels can be ordered to cover
any unused slots.
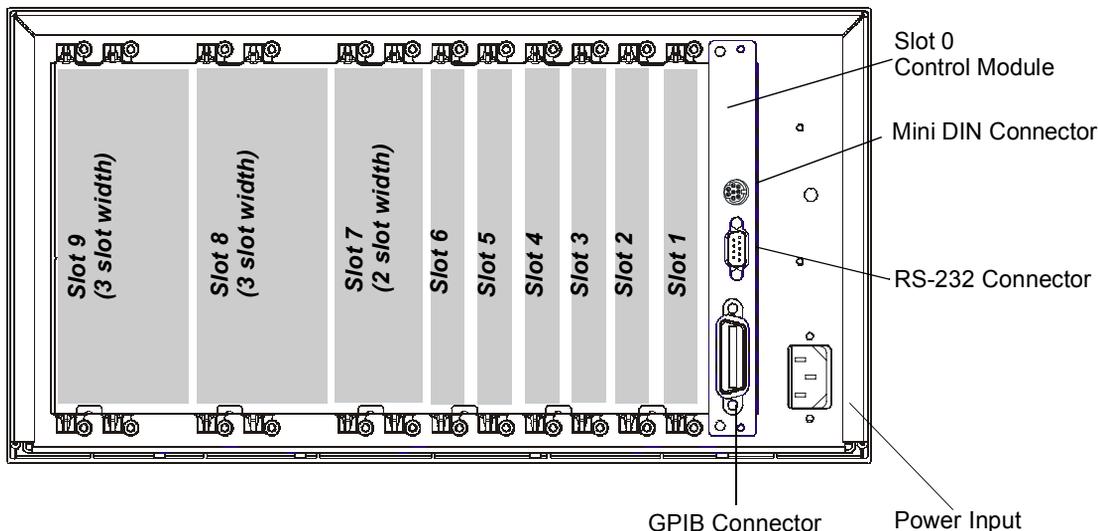
WARNING   *For protection from electrical shock, the power cord ground must not be
           defeated.*

The Mini DIN Connector

The rear panel mini DIN connector is used to make connections to
external triggers and the built-in digital I/O port. An Agilent N2289A
cable (mini DIN to D9) can be ordered to assist connections to external
devices. The figure below shows the pins used in the mini DIN connector.

	Pins	Description
	1	DIO 091
Mini DIN	2	DIO 092
Connector	3	DIO 093
	4	DIO 094
	5	GROUND (TRIG)
	6	GROUND (DIO)
	7	Ext.Trig.In
	8	Ext.Trig.Out
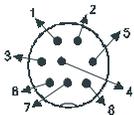
In This Book

Quick Start Chapter 1 prepares the switch/control system for use and helps you get familiar with a few of its front-panel features.

Front-Panel Menu Operation Chapter 2 introduces you to the front-panel menu and describes some of the switch/control system's menu features.

System Overview Chapter 3 gives an overview of a switch/control system, describes how parts of the system work together, and describes the channel addressing scheme used.

Features and Functions Chapter 4 gives a detailed description of the switch/control system's capabilities and operation. This chapter is useful for operating the switch/control system from the front panel or the remote interface.

Remote Interface Reference Chapter 5 contains the 3488 mode language reference used to program the switch/control system over a remote interface.

Error Messages Chapter 6 lists the error messages that may appear as you are working with the instrument.

Application Programs Chapter 7 contains several remote interface application programs to help you develop programs for your switch/control system.

Note This manual does not describe the plug-in modules except in a general way. Use the Agilent 3499A/B/C User's Manual (shipped with the instrument) for complete details.

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Contents

Quick Start

1

Quick Start

This chapter describes the procedure to install the plug-in modules into an Agilent 3499A/B/C mainframe and mount the mainframe onto a system rack. The basic operations of the Agilent 3499A/B/C Switch/Control System is also described. The chapter contents include:

- To Prepare the Instrument for Use, on page 13
- To Install a Module in the 3499A/B/C, on page 15
- Basic Operation, on page 17
- To Rack Mount the 3499A/B/C, on page 21

To Prepare the Instrument for Use

1 Check the list of supplied items

Verify that you have received the following items with your Agilent 3499A/B/C mainframe:

❑ One power cord;

❑ This *User's Manual*;

❑ One *Quick Reference Guide*;

❑ One Tie Down Clip 03499-21002 (for Agilent 3499B only);

❑ Any plug-in modules that you ordered are delivered in separate shipping containers.

2 Connect the power cord and turn on the instrument

1. Connect the 3499A/B/C to an AC power source with the supplied power cord.

2. Push the **Power** switch located on the lower left side of the front panel.

3. On power-up, every segment in the display will light up briefly, including all annunciators. Following this "starburst" display, the internal self-test will begin.

4. If the self-test passes[1], the default system mode and the GPIB address are displayed, together with a "beep" sound. Then the display shows the instrument model number and the active slot (slot 0).

```
SCPI  GPIB  9
```

```
3499                  0
```

[1] If the self-test failed, the failure will be displayed on the front panel. For details of all self-test errors, refer to "Error Messages" starting on page 135.

1

When shipped from the factory, the SCPI mode and the GPIB interface address of "9" are used. Slot 0 refers to the built-in controller board of the switch/control system.

If the Instrument Does Not Turn On

1. Verify that the power cord is firmly plugged into the power receptacle on the rear panel of the 3499A/B/C.

2. Make sure that the power source the 3499A/B/C is plugged into is energized.

3. Verify that the 3499A/B/C is turned on.

Note   If the 3499A/B/C DOES NOT turn on after you perform the above procedure, contact your nearest Agilent Service Center (see page 8).

To Install a Module in the 3499A/B/C

The plug-in modules you ordered were not installed in the mainframe. The figure on page 16 shows how to install a plug-in module into the 3499B mainframe. Other mainframes use similar procedures.

WARNING   *Disconnect the power cord from the rear panel of the mainframe prior to installing or removing any modules.*

Caution   Use anti-static procedures when configuring, installing or removing any plug-in modules. To prevent contamination to the modules that could degrade performance, handle the modules by the side edges or shields only. Do not touch the board surfaces or components.

Each plug-in module may have terminal block(s) and/or the cables for wiring to external circuits. These terminations are also shipped separately.

For more details about terminal blocks, cables, and connections, see the Agilent 3499A/B/C User's Manual (shipped with the instrument)

Module Removal

To remove a plug-in module from the Agilent 3499A/B/C mainframe, reverse the procedures shown on page 16.

1

STEP 1

1. Face the mainframe rear panel toward you.
2. Select a slot in which the module is to be installed.

STEP 2

1. Hold the sides of the module, component side **down**, by the metal shields.
2. Insert the module into the slot guides and slide the module toward the front of the instrument.
3. Push firmly until the module "snaps" into place.
4. Push both plastic levers inward to lock the module.

STEP 3 (for modules with terminal blocks)

1. Wire the screw terminal block (module dependent).
2. Attach the screw terminal block to the plug-in module.

STEP 4 (for modules with terminal blocks)

1. Push firmly until the terminal block "snaps" into place.
2. Secure the screw terminal block with the two screws (Torque < 8 in-lbs).

Module installation

16

Basic Operation

An Agilent 3499A/B/C Switch/Control System can be easily operated from the front-panel, or programmed with SCPI commands over the remote interface.

The following sections are only intended to show the basic front-panel operation. For detailed front-panel operation, refer to the "Front-Panel Operation" chapter on page 25. For more information about programming the instrument, refer to the "Remote Interface Reference" chapter on page 99.

Channel Addressing

A channel refers to an individual relay on a switching module, or an individual bit/port on a digital I/O module. The channel address is in the form of *snn*, where *s* represents slot number and *nn* represents a channel number.

For all mainframes, slot 0 refers to the 3499 controller board. Valid slot numbers are:

|	
3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

The channel number, *nn*, is plug-in module dependent. For additional information about channel numbers of individual plug-in modules, refer to the table beginning on page 67.

1

To Select a Slot and Channel

When the instrument is first turned on, the display shows the model number and the slot number of the controller board.

```
3499                    0
```
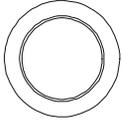
Use the knob to select a channel on the active slot. For example, with the display shown above, turning the knob to the right will select the first of the individual built-in digital I/O ports.

```
DIN                   090
```

The "DIN" indicates the port is set for a digital input operation. As the knob is turned, the additional ports are displayed followed by any installed plug-in modules.

If you have installed one or more plug-in modules, you can select the module by pressing the right arrow key. For example, if an N2260A (40-channel MUX module) is installed in slot 1, pressing the right arrow key will show the module name and slot number.

```
N2260A                  1
```
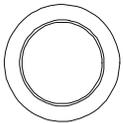
Turning the knob will then step through the individual channels on that module.

```
MUX        OPEN   100
```

18
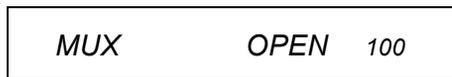
To Open or Close a Channel

When a channel is selected, you can open or close the channel using the front panel keys. For example, with an N2260A 40-channel MUX installed in slot 1, select channel 00 as described on the previous page.

> *MUX   OPEN   100*

Close

Press the **CLOSE** key to close the channel.

> *MUX   CLOSED 100*

Open

Press the **OPEN** key to open the channel

> *MUX   OPEN   100*

In this manner, you can select and control as many channels as you need. The N2260A has 40 channels numbered 0 through 39 (in slot 1, 100 through 139). You may also select additional plug-in modules and channels by turning the knob.

1

To Open All Channels on a Module

You can open individual channels on a module one at a time as described above. There are times, however, when it would be more expedient to open all channels on a module at once.

Use the arrow keys to select the module to work with. You cannot have an individual channel selected for this operation. For example, select the module in slot 1 (using the N2260A as an example) to show a display similar to this:

N2260A	1

Press and hold the card reset key. When you first press the key, the display shows:

HOLD TO RESET

When the card has been reset, the display briefly shows:

RESET CARD

and then returns to:

N2260A	1

To Reset All Modules

You can reset all channels on all modules in the mainframe at once. Press the shift key and then press and hold the reset key. The display shows:

HOLD TO RESET

When the mainframe has been reset, the display will briefly show the reset and then return to the slot or channel display.

RESET . . .

20

To Rack Mount the 3499A/B/C

You can mount the Agilent 3499A/B/C on a standard 19-inch EIA rack cabinet with the optional rack-mounting kits. The instructions and mounting hardware are included with each rack-mounting kit.

Agilent 3499A

To rack mount a 3499A, the full-rack-width mainframe, order either:

- Rack-mount kit with handles, part number 5183-7170, or

- Rack-mount kit without handles, part number 5183-7171.
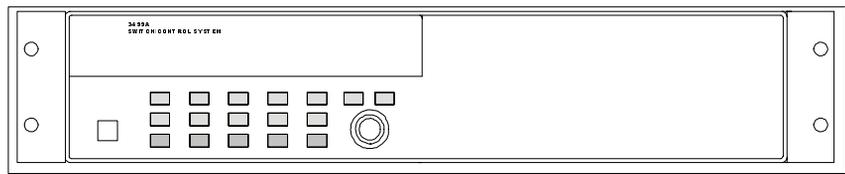
To Rack Mount an Agilent 3499A

1

Agilent 3499B

To rack mount a single 3499B, order either:

- Adapter kit, part number 5183-7172
  (includes the flange and filler panel).

Flange   **Filler Panel**
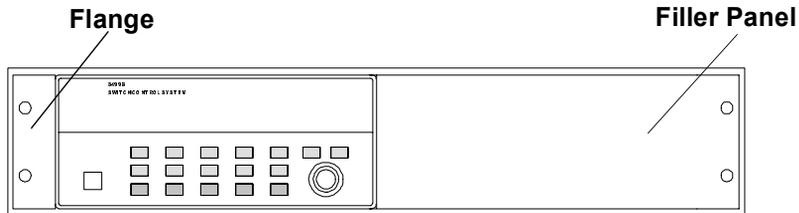
To Rack Mount a Single Agilent 3499B with Adapter kit 5183-7172

   OR

- A Support Shelf, part number 5063-9255,

- A slide kit, part number 1494-0015,

- And a filler panel, part number 5002-3999.
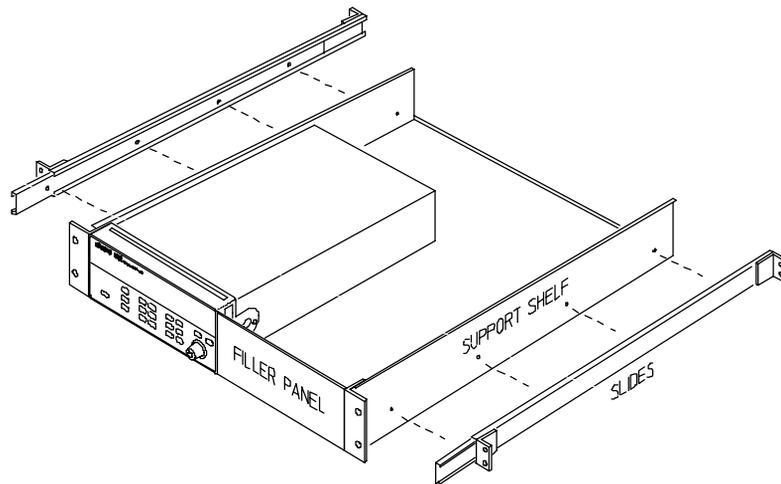
To Rack Mount a Single Agilent 3499B on a support shelf

To rack mount two Agilent 3499B's side-by-side (or any System II instrument next to an Agilent 3499B), order:

- A Support Shelf, part number 5063-9255,

- And a slide kit, part number 1494-0015.

To Rack Mount Two Agilent 3499B's Side-by-side

1
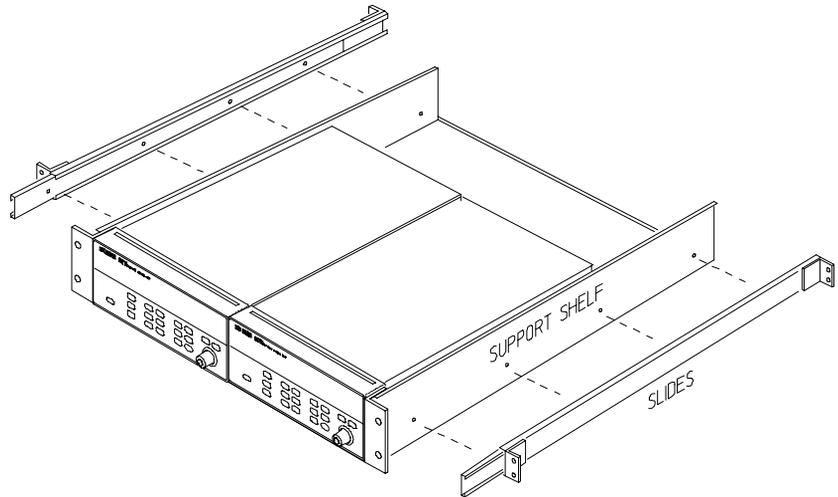
Agilent 3499C

To rack mount an Agilent 3499C, order either:

- Adapter kit without handles, part number 5063-9216, or

- Adapter kit with handles, part number 5063-9223.

Adapter kit
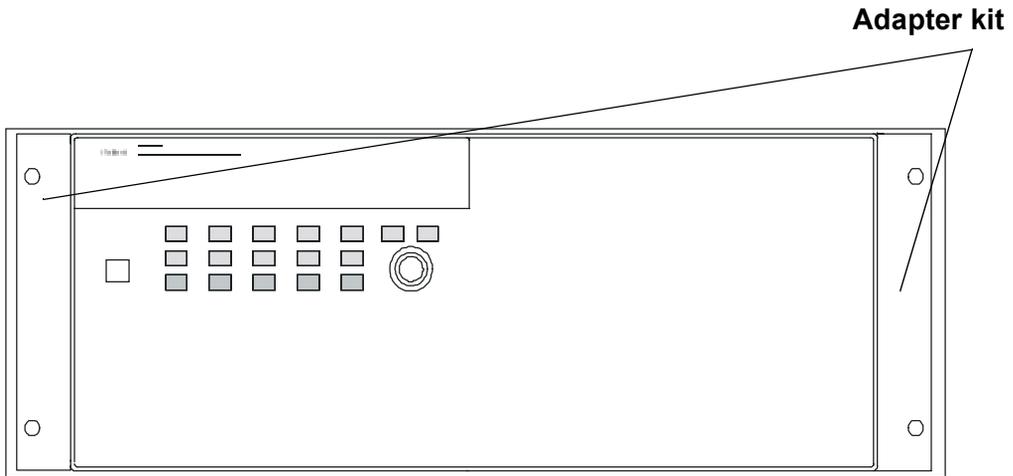
To Rack Mount an Agilent 3499C

Filler Panels

Order filler panels to cover any unused slots in an Agilent 3499A/B/C.

- 1-slot filler panel, part number 03499-00023 (option FP1)

- 2-slot filler panel, part number 03499-00024 (option FP2)

2

Front-Panel Operation

Front-Panel Operation

The Agilent 3499A/B/C mainframes all operate the same from the front-panel. This chapter does not give a detailed description of every possible front-panel operation. It does, however, give you a good overview of the front-panel menus and front-panel keys. See the "Features and Functions" chapter on page 73 for additional discussions of the instrument's capabilities and operation. This chapter contents include:

- To Power On the Instrument, on page 27
- To Select the System Mode, on page 27
- To Monitor a Channel or a Slot, on page 28
- To Use a Digital I/O Port, on page 30
- To View Instrument Errors, on page 35
- Scanning Operation, on page 37
- To Pair Two Modules Together, on page 40
- To Configure for External Trigger, on page 41
- To Configure the Power-on State, on page 43
- To Configure the Remote Interface, on page 45
- To Perform a Self-test, on page 47
- To Query the Firmware Revision, on page 48
- To Query the Serial Number, on page 49
- Local/Remote Control, on page 50

The following conventions are used for the front-panel operation.

- All keys on the front-panel keyboard are expressed in bold font and normally associated with a "press". For example, press **Mon**.
- All the front panel display annunciators are expressed in bold font followed by an "annunciator". For example, **MON** annunciator.
- The information shown on the front panel display is enclosed within a pair of quotation marks.

2

To Power On the Instrument

To power on the instrument, press the **power** switch on the front panel. If the instrument is powered up for the first time, the instrument will use the factory default settings as shown on page 71. Otherwise, the instrument will power on to the state specified. Refer to "To Configure the Power-on State", on page 43 for more details.

To Select the System Mode

The instrument can be operated in either SCPI mode or 3488A mode (except Firmware REV 3.0, see page page 55 for more details). When shipped from the factory, the instrument is set to the SCPI mode. Perform the following procedure to select the desired system mode for the instrument before any operation.

1. Press **Menu**, the **CONFIG** annunciator lights up. Turn the knob until "SYSTEM MODE" is displayed, then press **Enter**.

   ┌─────────────────────────┐
   │   │
   │   *SYSTEM MODE*   │
   │   │
   └─────────────────────────┘

2. Turn the knob until the desired system mode (i.e. 3488A MODE) is displayed, then press **Enter**.

   ┌─────────────────────────┐
   │   │
   │   *HP 3488A MODE*   │
   │   │
   └─────────────────────────┘

3. The instrument will be reset if the system mode has been changed. Otherwise, it retains the current mode and you can press **Menu** again to exit this operation.

Note   Switching between SCPI mode and 3488A mode will reset the instrument to the factory default settings, except the GPIB address which will retain its last setting.

This manual describes programming in the 3488 mode. For information about the SCPI programming mode please refer to the User's Manual shipped with the Agilent 3499A/B/C

2

To Monitor a Channel or a Slot

You can continuously monitor the current status of a particular switching channel, a digital I/O port, or an entire plug-in module. Monitoring from the front panel is especially useful when developing and debugging remote interface commands.

Mon

1. Press the monitor key, the **MON** annunciator lights up to indicate the instrument is in the monitoring state.

2. Select the slot or the channel/port to be monitored. The displayed information depends on the selected module type. Typical displays are shown in the table on page 76.

Enter

3. If only part of the channel status on the module can be displayed at one time, press **Enter** to display the next part.

    For multiplexer modules and GP Relay modules, 10 channels can be displayed at one time; for matrix modules, one Row or one Column can be displayed at one time; for digital I/O modules, two 8-bit ports can be displayed at one time. For multifunction modules, the first function on the module is displayed, then the next.

Mon

4. Press the monitor key again to end monitoring (the **MON** annunciator turns off).

Note   The built-in digital I/O bits/port (on the controller module) can be monitored either individually as bit channels (numbered *091* through *094*) or as a 4-bit port (numbered *090*). However, the individual bit channels on a digital I/O or multifunction module (with a DIO function) cannot be monitored.

.

Display	Description
1:0,,,,,,6,,,9, *2*	The display for a multiplexer or a GP relay module. This display indicates that the monitored module is in Slot 2 and channels 10, 16, and 19 are closed.
ROW 3:,1,,3,,,6,7 *3* *0;,,3,COL 3,* *3*	The display for a matrix module. The top is the row information, indicating that the relays on Row 3, Columns 1, 3, 6 and 7 of the module (in Slot 3) are closed. The lower display is the column information, indicating that relays on column 3, row 0 and 3 are closed.
00:H255 L254. *4*	The display for a digital I/O module. The first 2 digits on the left ("00" in this case) represents the "L" 8-bit port address. Adding one to this value, the "H" 8-bit port address is obtained. Data with a trailing decimal point indicates that the last operation on that port was a WRITE, data without a trailing decimal point indicates that the last operation on that port was a READ. This display shows that the data last read from Port 401 is 255 and the data last written to Port 400 is 254.
DIO 12 *090* *DOUT 0* *091*	The top display is for the built-in digital I/O Port *090* (control module) and the data from the last operation. The lower display indicates that data last written to the bit channel 091 is 0.
ROW 0:,1,,3, *5* *00:H255 L254.* *5*	For a multifunction module, the first function on the module is displayed, then the next. This display is an example of a multifunction module with matrix and DIO functions (in slot 5).

2

To Use a Digital I/O Port

You can work with a digital I/O module as a port (all eight bits) or as individual bits.

Reading a Digital I/O Port

You can read data from the built-in 4-bit digital I/O port, or any one of the 8-bit ports on a digital I/O or multifunction module (with a DIO function). You can read the entire port (all bits) when you select the slot (for example, the built-in port is channel 090). Alternately, you can read an individual bit by selecting the channel (for example the first bit in the built-in port is channel 091).

Perform the following procedure to read from a port:

1. Select a digital I/O port. Use the knob to select the slot and channel number. The channel number is in the form of *snn*, where *s* is the slot number and *nn* is the channel number.

`Read`

2. Read the data read from the selected port. For example, the display below shows the data read from port 401.

```
DIN              255  401
```
Decimal format (default)

```
DIN         11111111  401
```
Binary format

The data display format of individual 8-bit ports can be specified either in binary or decimal formats (as described on page 33). Once specified, the format applies to all input and output operations on the same port.

2

Writing to a Digital I/O Port

You can write data to the built-in digital I/O port (numbered *090*) or to one of the built-in digital I/O port bits (numbered *091* through *094*), or any one of the 8-bit ports on a digital I/O or multifunction module (with a DIO function). To write to a port:

1. Select a digital I/O port. Use the knob to select the slot and channel number. The channel number is in the form of *snn*, where *s* is the slot number and *nn* is the channel number. In the display, "DIN" indicates that the last operation on the port was a READ, and "DOUT", a WRITE.

<div style="border:1px solid black; padding:10px;">

DIN   *401*
</div>

Write

2. Press the **Write** key. "DOUT" is displayed to indicate the port is now an output port. The current port value is displayed.

<div style="border:1px solid black; padding:10px;">

DOUT   *255 401*
</div>

⬅️➡️

3. Edit the value. Use the arrow keys to select the to-be-edited bit (the digit to be edited is set to half bright in the display).

◯

Turn the knob to modify the value. Use the arrow keys to select the next digit and the knob to modify its value.

<div style="border:1px solid black; padding:10px;">

DOUT   *254 401*
</div>

Enter

4. When the value is the one desired, press **Enter** to output the data to the selected port.

5. Press **Write** again to cancel the current write operation.

Note   Data display format of individual 8-bit ports can be specified either in binary or decimal values (refer to the procedure on page 33). Once specified, the format applies to all input and output operations on the same port.

To Configure a Digital I/O Module

Digital I/O modules can be configured for handshake modes and control line, flag line, and I/O line polarity. Use the **Mode** menu to configure digital I/O parameters. See "Digital I/O Operation" on page 84 for detailed descriptions of the operating modes. Only plug-in modules can be configured this way, the built-in digital I/O port (control module) can only be configured at the port level (see page 33).

The following procedure configures a plug-in digital I/O module to use a two line digital handshake mode (mode 5) for data transfers.

1. Select the slot in which a digital I/O or multifunction module is installed. The channel number is in the form of *snn*, where *s* is the slot number and *nn* is the channel number.

```
N2263A                    4
```

2. Press the **Mode** key. The **CONFIG** annunciator lights up in the display and the first-level menu is shown.

```
CONFIG DIO              4
```

3. Press **Enter** to begin the configuration. The display shows the second-level menu choice.

```
MODE 1                  4
```
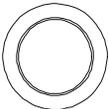
4. Turn the knob until the desired flow control mode (i.e., MODE 5) is displayed. The displayed mode is half-bright.

```
MODE 5                  4
```

2

Enter

5. Press **Enter** to select the new mode. The display changes to show the next menu level.

> *CONT POL POS   4*

Mode

6. You may change other configuration parameters as desired using the same procedure. When all desired configurations have been made, press the **Mode** key to exit the configuration menu. The **CONFIG** annunciator turns off.

To Configure a DIO Port

You can configure an individual digital I/O port to change the data polarity and the display format. The following procedure changes the built-in digital I/O port to display in binary number format.

1. Select a digital I/O port (i.e., port 090). The channel number is in the form of *snn*, where *s* is the slot number and *nn* is the channel number.

> *DIN   090*

Mode

2. Press the **Mode** key. The **CONFIG** annunciator lights up in the display. The first level menu is shown:

> *DATA POLARITY   090*

3. Turn the knob to select the second menu level

> *DISP FORMAT   090*

Enter

4. Press **Enter** to select the format parameter.

> *DECIMAL   090*

2
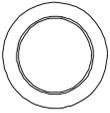
5. Turn the knob until the desired data display format (i.e., BINARY) is
   displayed.

   | BINARY   090 |

6. Press **Enter** to make the change and return to the first level of the
   Mode menu.

   | DISP FORMAT   401 |

Mode

7. Press **Mode** again to exit the current configuration, the **CONFIG**
   annunciator turns off.

Note   Once you have selected the data display format for a port, it applies to
                  both input and output operations on that port.

To View Instrument Errors

You can view errors from the front panel. This feature is especially useful when developing remote instrument control. If an error occurs, the **ERROR** annunciator in the display will light. Errors are stored in the error queue in the order they occur. You read the errors in the same order. After all errors have been read, the queue is empty and the **ERROR** annunciator turns off. To view instrument errors:

`View`

1. Press the **View** key. The **VIEW** annunciator lights up and the display shows the first menu level.

```
ERROR              0
```

`Enter`

2. Press **Enter** to view the first error.

    a. If no error is in the error queue (the **ERROR** annunciator is off), the display shows "NO ERROR" and then automatically returns to the first level of the View menu.

```
NO ERROR           0
```

```
ERROR              0
```

    b. If there are errors (the **ERROR** annunciator is on), the first error in the error queue is displayed.

```
01:ERR -109
```

`⟶`

    Press the right arrow key to scroll the display to show the entire error message.

```
MISSING PARAMETER
```

2

2

3. Turn the knob to view other errors in the error queue (if any).

Enter

4. Press **Enter** to return to the first level of the View menu, the **ERROR** annunciator turns off.

View

5. Press **View** again to exit the View menu operation, the **VIEW** annunciator turns off.

Note   All errors are cleared, and the **ERROR** annunciator turns off, once the error queue is viewed. See the "Error Messages" chapter on page 135 for a complete list of error messages.

2

Scanning Operation

The instrument allows you to combine an external measurement device such as a Digital Multimeter (DMM) with multiplexer channels to create a *scan*. During a scan, the instrument closes the configured multiplexer channels one at a time to allow a measurement to be made on that channel.

Before initiating a scan, a scan *list* must be set up. You can also specify an arm source, a trigger source, and the number of sweeps (a sweep is one pass through the scan list) to control the scan process. All these can be done from the **S.List** menu. The procedure in this chapter describes a simple scan from the front panel. For more information about scanning and using the parameters to control a scan, see page 78.

To Create a Scan List

S.List

1. Press the **S.List** key to enter the scan list menu. The **CONFIG** annunciator lights up and the first level of the menu is displayed.

```
ADD TO SCAN          101
```

Enter

2. Press **Enter** to begin the channel selection.

```
SELECT               101
```
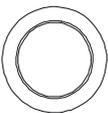
3. Turn the knob to select the first channel for the list (e.g., 103).

```
SELECT               103
```

Enter

4. Press **Enter** to add the channel into the scan list. The starburst character lights in the display to indicate the channel is now a part of the scan list.

```
SELECT          *    103
```

2

S.List

5. Repeat step 3 and 4 to add additional channels to the list.

6. When the desired channels have been added, press the **S.List** key again to return to the first level of the menu.

```
ADD TO SCAN          107
```

S.List

7. Press **S.List** again to exit the menu. The **CONFIG** annunciator turns off.

To Perform Scanning

After the scan configuration is complete, the actual scan can be performed.

Step

1. Press the Step key to close the first channel in the scan list.

Step

2. Press the Step key again to open the first channel and close the next channel in the list.

Scan

This procedure shows a simple way to scan, one channel at a time for each press of a front panel key. You can also press the **Scan** key to scan all channels in the list according to the various scan parameters set. In the default parameter state, pressing the **Scan** key will cause all the channels in the list to cycle through at the maximum possible speed. While this occurs, the **SCAN** annunciator is lighted. For details about the scan parameters, see page 78.

To Clear a Scan List

You can clear a scan list once it has been configured.

Clear

Shift   S.List

1. Press the **Shift** key and then the **S.List** key. The display will briefly show:

```
CLR SCAN LIST         101
```

and then return to normal operation.

2

To View a Scan List

You can view which channels are included in a scan list. This example
assumes that channels 103 through 107 are included in the scan list.

View

1. Press the **View** key. The **VIEW** annunciator lights up and the display
    shows the first level menu.

    ┌─────────────────────────────────┐
    │ *ERROR*   *101*   │
    └─────────────────────────────────┘
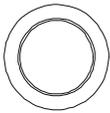
2. Turn the knob until "SCAN LIST" is displayed.

    ┌─────────────────────────────────┐
    │ *SCAN LIST*   *101*   │
    └─────────────────────────────────┘

Enter

3. Press **Enter**. The first channel in the scan list is displayed on the
    channel area.

    ┌─────────────────────────────────┐
    │ *001 OF 005*   *103*   │
    └─────────────────────────────────┘
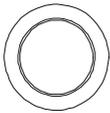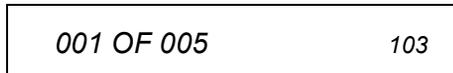
    Turn the knob to view other channels in the scan list.
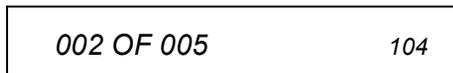
    ┌─────────────────────────────────┐
    │ *002 OF 005*   *104*   │
    └─────────────────────────────────┘

Enter

4. Press **Enter** to return to the first level of the View menu.

    ┌─────────────────────────────────┐
    │ *SCAN LIST*   *107*   │
    └─────────────────────────────────┘
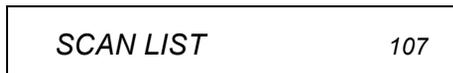
View

5. Press **View** again to exit the View menu. The **VIEW** annunciator
    turns off.

2

To Pair Two Modules Together

You can pair two modules together so that they operate as a single unit. The two modules to be paired must be identical (that is, they must have the same model number) and be installed in the same mainframe. When two modules are paired together, any operation on a channel of one module will be duplicated on the corresponding channel of the other module. The example below pairs modules installed in slots 2 and 5.

Menu

1. Press the **Menu** key. The **CONFIG** annunciator lights up and "**CARD PAIR**" is displayed.
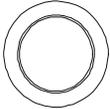
Enter

2. Press **Enter**.

When "FIRST SLOT x" is displayed, turn the knob to select the first slot to be paired (i.e., Slot 2).

   FIRST SLOT 2
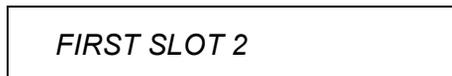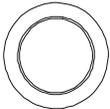
Enter

3. Press **Enter.**

When "SECOND SLOT x" is displayed, turn the knob to select the second slot to be paired (i.e., Slot 5) .

   SECOND SLOT 5

Enter

4. Press **Enter** to return to the first level of the Menu menu.

   CARD PAIR

Menu

5. Press **Menu** again to exit the Menu menu. The **CONFIG** annunciator turns off.

2

To Configure for External Trigger

You can use one of two modules for an external trigger. The built-in rear panel TRIG IN and TRIG OUT pair (on the control module) or the EI (External Increment) and the CC (Channel Closed) pair on a 44474A module. Only one pair can be used at a time. You can specify which pair to use and whether a trigger out pulse is sent out when a relay is closed during scanning operations. Refer to "Scanning" on page 78 for more details.

Menu

1. Press the **Menu** key. The **CONFIG** annunciator lights up and the display shows the first level menu.

   CARD PAIR
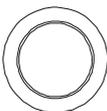
2. Turn the knob to show the second menu item, "CONF EXT TRIG".

   CONF EXT TRIG

Enter

3. Press **Enter**. The display shows the next level menu.

   TRIG SLOT 0

2
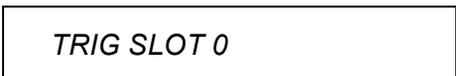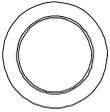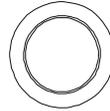
Enter

4. Turn the knob to select the slot for the external trigger. Slot 0 (control module) is the built-in external trigger (available at the rear panel mini DIN connector, see page 7). If a 44474A is not installed, only slot 0 will be shown. Press **Enter**. The display shows the current setting for the external trigger.

DISABLE

5. Turn the knob to show the alternate choice.

ENABLE

Enter

6. Press **Enter** to accept the choice and return to the first level menu.

CONF EXT TRIG

Menu

7. Press the **Menu** key to exit the menu. The **CONFIG** annunciator turns off.

2

To Configure the Power-on State

Firmware Rev 4.0 ONLY. To read your firmware version, see the procedure on page 48. For more information about firmware revisions, see "Firmware and Control Module Description" on page 55.

An instrument with Firmware REV 4.0 or later can be set to power on to the reset state (see "Factory Default and Reset States" on page 71) or to a state previously stored in a specified memory location. The instrument will return to the specified state the next time it is turned on.

Menu
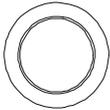
1. Press the **Menu** key. The **CONFIG** annunciator lights up and the display shows the first menu level.

   > *CARD PAIR*

2. Turn the knob until "POWER ON SET" is displayed.

   > *POWER ON SET*

Enter

3. Press **Enter** to show the second level menu.

   > *PWR ON RESET*

Enter
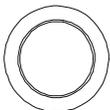
4. To set the instrument power-on to the reset state, press **Enter**. The instrument will return to the first level menu.

   Alternately, to set the instrument power-on to a stored state: Turn the knob until "USER SET UP" is displayed.

   > *USER SET UP*

Enter

5. Press **Enter** to select the stored state to use.

   > *POWER ON 05*

2
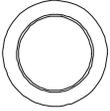
6. Turn the knob to select the desired memory location (i.e., 08).

    POWER ON 08

Enter

7. Press **Enter** to accept the stored state and return to the first level menu. More information about storing states is given on page 94 of this manual.

    POWER ON SET

Menu

8. Press the **Menu** key again to exit the Menu menu. The **CONFIG** annunciator turns off.

Note

If the instrument is set to power on to a previously stored setup that is no longer valid, it will automatically power on to the reset state and "RECALL FAILED" will be displayed.

To Configure the Remote Interface

2

In 3488 mode, the instrument can communicate with a computer over the GPIB interface. When shipped from the factory, the GPIB interface is selected and its address is set to "9".

Note   The RS-232 interface can be configured and used only in SCPI mode.

GPIB Interface

Each device on the GPIB interface must have a unique address.

- When shipped from the factory, the GPIB interface is selected and its address is set to "9". The GPIB address of the instrument can be set to any value between 0 and 30.

- The GPIB address is stored in non-volatile memory, and does not change when the instrument is turned off or reset.

- Switching between SCPI mode and 3488A mode causes the 3499A/B/C to select the GPIB interface and its address setting.

To set the GPIB interface:

Menu   1. Press the **Menu** key. The **CONFIG** annunciator lights up and the first level menu is shown.

        CARD PAIR
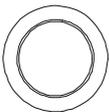
        2. Turn the knob to select "INTERFACE" in the menu.

        INTERFACE

Enter   3. Press **Enter** to show the second level menu The active interface is shown. If necessary, turn the knob until "GPIB/488" is displayed.

        GPIB/488

2

Enter

4. Press **Enter** to select the interface and show the first parameter.

ADDRESS 09
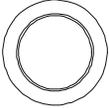
5. Turn the knob to set GPIB address (i.e., 07). Valid addresses range from 00 to 30.

ADDRESS 07

Enter

6. Press **Enter** to show the second parameter.

SRQ ON

Enter

7. Press **Enter** to enable the instrument to assert the SRQ line when powered up. If the computer is so configured, this can be used to interrupt the system computer.

To disable this feature, turn the knob to select "SRQ OFF" and press **Enter**. The instrument returns to the first level of the menu.

Menu

8. Press **Menu** again to exit the menu.The **CONFIG** annunciator turns off.

To Perform a Self-test

2

The self-test feature of the instrument provides you with a method of verifying proper instrument operation.

Menu

1. Press the **Menu** key. The **CONFIG** annunciator lights up and the first level menu is shown.

   CARD PAIR
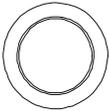
2. Turn the knob to select "SELFTEST".

   SELFTEST

Enter

3. Press **Enter**. The self test will begin. The display will briefly show a "starburst" pattern (all display segments lit). Following the pattern, the display indicates:

   TEST. . .

   while the internal tests are being performed. The self-test takes several seconds to complete.

   If the self-test is successful, "PASSED" will be displayed. Otherwise, the reason of the failure will be displayed. For details on self-test failures, refer to "The errors listed below indicate failures that may occur during a self-test (in 3488A mode)." on page 136.

   PASSED

Enter

4. Press **Enter** to return to the first level of the menu.

   SELFTEST

Menu

5. Press **Menu** again to exit the Menu menu, the **CONFIG** annunciator turns off.

2

To Query the Firmware Revision

Perform the following procedure to query the 3499A/B/C firmware and revision. For a description of the firmware and hardware revisions, see "Firmware and Control Module Description" on page 55.

Menu

1. Press the **Menu** key. The **CONFIG** annunciator lights up and the first level menu is shown.

> *CARD PAIR*
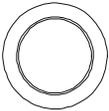
2. Turn the knob to select "REVISION INFO".

> *REVISION INFO*

Enter

3. Press **Enter**. The system firmware revision number will be displayed.

> *REVISION 4.0 2.0*

Enter

4. Press **Enter** to return to the first level of the Menu menu.

> *REVISION INFO*

Menu

5. Press **Menu** again to exit the Menu menu, the **CONFIG** annunciator turns off.

48

To Query the Serial Number

Perform the following procedure to query the 3499A/B/C serial number.

2

Menu

1. Press the **Menu** key. The **CONFIG** annunciator lights up and the first level menu is shown.

> *CARD PAIR*
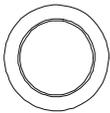
1. Turn the knob to select "SERIAL NO".

> *SERIAL NO*

Enter

2. Press **Enter**. The Agilent 3499A/B/C serial number is displayed.

> *MY12345678*

Enter

3. Press **Enter** again to return to the first level of the Menu menu.

> *SERIAL NO*

Menu

4. Press **Menu** again to exit the Menu menu, the **CONFIG** annunciator turns off.

2

Local/Remote Control

The instrument operates in two data entry modes, *local* and *remote*. In local mode, all keys on the front panel are fully functional. In *remote* mode, some front panel keys are locked (exception are: **Local, Mon, View, Enter,** the arrow keys, and the knob).

The instrument will enter the remote state upon receipt of any command over the remote interface. The **RMT** annunciator lights.

Shift

You can regain control of the front panel keys when the instrument is in remote by pressing the **Shift** (Local) key. The **RMT** annunciator turns off and the instrument return to local mode.

Note   If the front panel keys are locked through either the SYSTem:RWLock command on the RS-232 interface or a LOCAL LOCKOUT command on the GPIB interface, the local key will not function. You can restore the front panel operation by cycling power the instrument or by sending a SYSTem:LOCal command on the RS-232 interface, or a LOCAL command on the GPIB interface.

3

3

System Overview

System Overview

An Agilent 3499A/B/C Switch/Control System is composed of a mainframe and a set of Plug-in modules. This chapter provides a typical configuration of a test system using the 3499A/B/C for switching and control, followed by a description of the three mainframes and all the Plug-in modules. The following sections are included in this chapter:

- Agilent 3499A/B/C Switch/Control System, on page 53

- Mainframes Overview, on page 54

- Firmware and Control Module Description, on page 55

- 3488 Mode Differences, on page 57

- Plug-in Modules Overview, on page 58

- Channel and Slot Addressing, on page 67

- Factory Default and Reset States, on page 71

3

Agilent 3499A/B/C Switch/Control System

The Agilent 3499A/B/C Switch/Control System provides high density and high speed switching for routing test signals to and from your DUTs (devices under test) and test instruments such as external DMMs, scopes, counters, power supplies, etc. Whether you are involved in a large production test system or a small R&D bench top system, the Agilent 3499A/B/C provides an ideal combination of price/performance solution. With a wide variety of available plug-in modules, you can configure your test system much more easily and flexibly. The figure below shows the typical configuration of a test system.

3
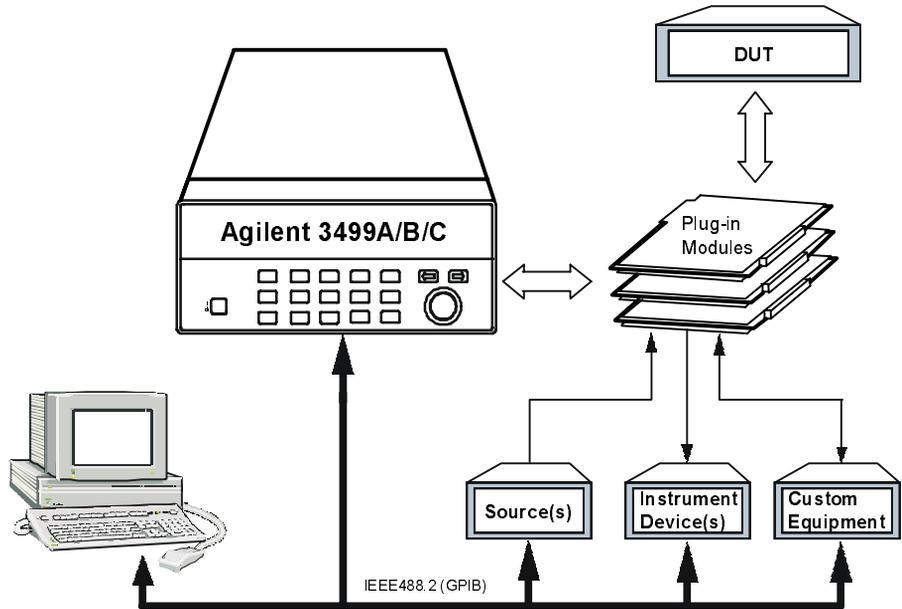
A Typical Test System

3

Mainframes Overview

Three mainframes are available:

	Slots Available	Rack Width
3499A	5	full width
3499B	2	half width
3499C	9[1]	full width

[1] The 3499C is designed to accommodate multiple width plug-in modules and has 9 logical slots but 14 mechanical slots. Slots 1 through 6 are 1-slot wide, slot 7 is 2-slots wide, and slots 8 and 9 are each 3-slots wide. See the figure on page 7 for more information.

All mainframes can be either operated from the front-panel or programed over a remote interface (GPIB or RS-232).

The mainframes can be operated in either of two system modes: SCPI mode or 3488A mode. The SCPI mode allows the full realization of performance potentials and advanced features, such as parallel operation of multiple relays on multiple modules. The 3488A mode is included for backward compatibility with the legacy Agilent 3488A system. This manual documents the 3488 mode of operation.

For information about the SCPI programming mode please refer to the User's Manual shipped with your Agilent 3499A/B/C

Firmware and Control Module Description

The Agilent 3499A/B/C and this manual support two versions of the
Agilent 3499A/B/C control module and four versions of firmware.

Firmware revisions and control module versions can be queried from the
front-panel. See page 48 for a procedure to read the revision from the
front-panel.

From the front-panel:

Control Module Revision	Firmware Revision	Typical Display
1.0	1.0	REVISION 1.0
1.0	2.0	REVISION 2.0
1.0	3.0	REVISION 3.0
2.0	4.0	REV 4.0 2.0

The table on the next page lists the differences between firmware and
control module revisions.

3

Firmware Version	Control Module Version	State Storage	Plug-in module Support	Programming Modes	Firmware Upgrade Needed?
1.0	1.0	Stored setups are cleared if power is cycled.	Must upgrade hardware and firmware.	Not Applicable	YES
2.0	1.0	Stored setups are cleared if power is cycled.	Supports all modules except: N2272A N2276A/B N2282A	Firmware Version 2.0 allows programming in both SCPI Mode and 3488A Mode.	Upgrade to Firmware Revision 3.0 ONLY if using N2272A, N2276A/B, or N2282A.
3.0	1.0	Stored setups are cleared if power is cycled.	*SCPI Mode* supports all modules. *3488A Mode* supports all modules except: N2272A, N2276A/B, or N2282A.	Firmware Version 3.0 limits programming to either SCPI Mode or 3488A Mode (not both)	Upgrade to firmware revision 4.0 ONLY if control board revision is upgraded to 2.0.
4.0[1]	2.0	Stored setups are saved. Instrument can be programmed to power up in a set state.	*SCPI Mode*: supports all modules. *3488A Mode* supports all modules except: N2272A, N2276A/B, or N2282A.	Firmware Version 4.0 allows programming in both SCPI Mode and 3488A Mode.	NO

[1] Upgrading to firmware revision 4.0 requires the control module be upgraded to revision 2.0. Control module revision 1.0 **does not** support firmware revision 4.0.

3488 Mode Differences

This manual describes using the Agilent 3499A/B/C in the 3488 mode of operation. In general, the SCPI mode of operation is recommended. All the features and functions of 3499A/B/C system and plug-in modules are supported in SCPI mode. The 3488 mode is a subset and does not support all available features.

Some of the major differences in 3488 mode of operation are summarized below:

3

• The RS-232 interface is not supported in 3488 mode. You must use the GPIB interface for remote programming.

• The 3488 mode does not provide as much control over the scanning process as SCPI mode. You cannot use the arm and trigger layers of scan control.

• The 3488 mode only provides access to the status byte register. You cannot use the Standard Event or Operation Status registers.

• With firmware revision 4.0, you can store up to 40 setups (50 setups in SCPI mode).

• Scan lists are not saved after cycling power.

• The relay cycle count feature is only available from the front-panel.

• The N2260A and N2266A can only be used in 40-channel 2-wire mode.

• The 3488 Mode does not support the following plug-in modules: N2272A, N2276A/B, or N2282A.

• Port numbering for Digital I/O modules is different.

3

Plug-in Modules Overview

The Agilent 3499A/B/C mainframes support multiple Plug-in modules, including all the existing 3488A modules (4447XX modules), as well as several new ones (N22XXX modules). Based on their functions, the modules can be divided into five classes:

- Multiplexer (MUX) modules

- General Purpose Relay (GP) modules

- Matrix modules

- Digital I/O (DIO) modules

- Multifunction modules

- Optical Modules

Note   Refer to the Agilent 3499A/B/C User's Manual (shipped with the instrument)

MUX Modules

A MUX (multiplexer) module switches one signal to multiple DUTs
(devices under test), or multiple signals to one device, one at a time.
Example applications include capacitor leakage, connector/switch
contact, and insulation resistance test systems. To expand switching
capacity or build special configurations, the multiplexer switching
modules can also be used with matrix or other switching modules. The
figure below shows a simple 1 x 4 Multiplexer.

3
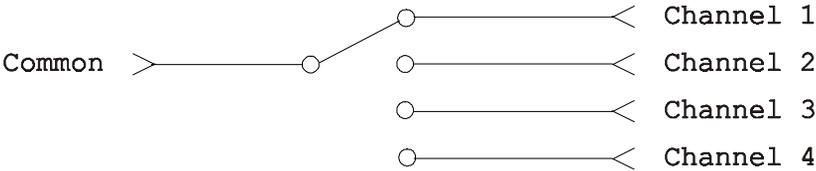
Simple Multiplexer Switching

Multiplexers are available in several types:

- *One-Wire (Single-Ended) Multiplexer* for common LO measurements

- *Two-Wire Multiplexer* for floating measurements

- *Four-Wire Multiplexer* for resistance and RTD measurements

- *Very High Frequency (VHF) / Microwave Multiplexer* for switching
  frequencies up to microwave (26.5 GHz).

The table on the next page lists the available MUX modules.

3

Model Number	Module Name	Mainframe Slots Required	Relay Type	Description
N2260A	40-Channel MUX Module	1	Latching	In 3488 mode, a 40-channel 2-wire multiplexer, switches both HI and LO inputs (200V, 1 A) with DPST relays.
N2266A	40-Channel MUX Module	1	Reed non-latching	In 3488 mode, a 40-channel 2-wire multiplexer.
N2268A	50Ω 3.5 GHz Dual 4-to-1 MUX Module	1	Latching	Consists of two independent 1-to-4 MUX switches which can switch up to 30VDC or peak AC at frequencies from DC to 3.5 GHz.
N2270A	10-Channel High Voltage MUX Module	2	Non-latching	10-channel 2-wire High Voltage MUX module with maximum switching voltage 1000V peak and maximum switching power 10W.
44470A/D	10/20-Channel MUX Module	1	Latching	The 10/20 DPST (Double-pole Single-throw) relays switch both HI and LO inputs up to 250V, 2A with low differential offsets for accurate measurements.
44472A	Dual 4-Channel VHF Switch Module	1	Latching	The two independent groups of bidirectional 1x4 switches with 50Ω characteristic impedance can be used for signals from DC to 300 MHz.
44478A/B	50Ω/75Ω 1.3 GHz Multiplexer	1	Latching	The two independent groups of bidirectional 1x4 switches with 50Ω/75Ω characteristic impedance can be used for signals from DC to 1.3 GHz.

GP Modules

The GP (General Purpose) relay modules often consist of independent latching or non-latching relays. They are useful for creating additional isolation between circuits, providing safety interlocks, actuating other relays or circuits, or building special topologies such as binary ladders and tree structures. A simple 4-channel SPST (Single-pole Single-throw) GP switch is shown below.
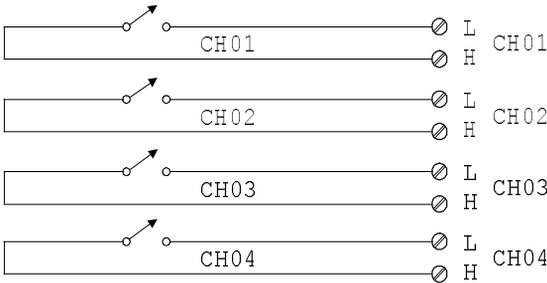
A Simple General Purpose Switch

The table below lists the available GP relay modules.

Model Number	Module Name	Mainframe Slots Required	Relay Type	Description
N2261A	40-Channel GP Relay Module	1	Latching	The 40 independent SPST relays provide quality connections for low level signals. Can also switch signals up to 200V, 1A.
N2267A	8-Channel High Current GP Module	1	Non-latching	An 8-channel High Current GP module which can switch up to 8A 250VAC or 5A 30VDC, with decreasing current to 1A at 125VDC.
44471A	10-Channel GP Relay Module	1	Latching	The 10 independent SPST (Single-pole Single-throw) relays provide quality connections for low level signals. Can also switch signals up to 250V, 2A.

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Model Number	Module Name	Mainframe Slots Required	Relay Type	Description
44471D	20-Channel GP Relay Module	1	Latching	The 20 independent SPST (Single-pole Single-throw) relays provide quality connections for low level signals. Can also switch signals up to 250V, 1A.
44475A	Breadboard Module	1	NA	Use the breadboard for custom circuits and special purpose functions in your test system.
44476A	3-Channel 18 GHz Switch Module	1	Latching	The 3 independent 50Ω SPDT (Single-pole Double-throw) coaxial switches with SMA connectors provide high isolation, low insertion loss, and low VSWR for switching signals up to 18 GHz.
44476B	2-Channel Microwave Switch Module	1	NA	Similar to the 44476A but does not have the coaxial switches installed. A variety of coaxial switches can be mounted onto the module to provide 3-, 4-, or 5-port switching up to 26.5 GHz.
44477A	7-Channel Form-C Relay Module	1	Latching	7 independent, break-before-make, SPDT Form-C relays for general purpose switching and control of external devices up to 250V, 2A.

Matrix Modules

A matrix switch is the most versatile type of system switching. Any input can be connected to any output, individually or in combination. This helps minimize the need for complex wiring, and can simplify the DUT interface. In addition, a matrix module can be used in conjunction with other modules to provide a wide variety of switching combinations. A matrix is arranged in rows and columns and a simple 4 x 4 matrix switch is shown below.
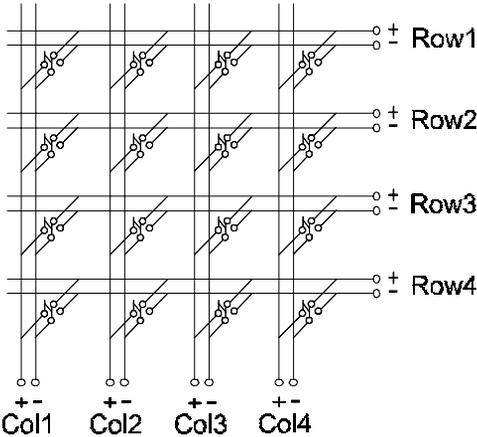
Matrix Switching

The table below lists the available matrix modules.

Model Number	Module Name	Mainframe Slots Required	Relay Type	Description
N2262A	4 x 8 Matrix Module	1	Latching	Each crosspoint or node of the 4 x 8 matrix module uses a DPST (Double-pole Single-throw) relay to switch two wires (Hi & Lo) for signals up to 200V, 1A.
44473A	4 x 4 Matrix Module	1	Latching	Each crosspoint or node of the 4 x 4 matrix module uses a DPST (Double-pole Single-throw) relay to switch two wires (Hi & Lo) for signals up to 250V, 2A.

3

Digital I/O Modules

The digital I/O modules provide high-density digital input/output capabilities in an easy-to-control form. The independent TTL-compatible inputs and outputs make it well-suited for monitoring and controlling devices compactly and cost-effectively. Typically, the digital outputs are used to provide drive for relatively high current devices such as solenoids, relays and small motors. The digital inputs are used to monitor devices such as micro-switches. A simplified schematic of a single digital input and output line is shown below.
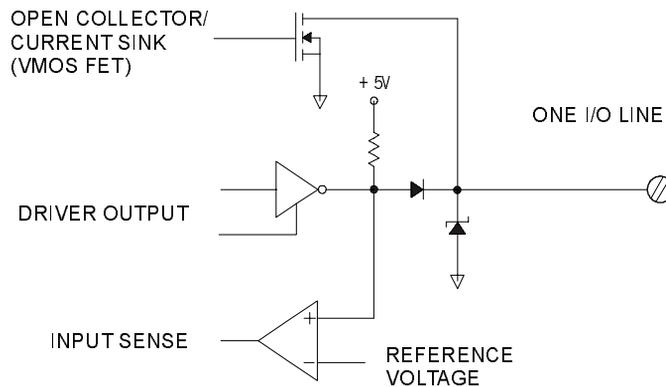
A Simple Digital I/O Circuit

The table below lists the available digital I/O modules.

Model Number	Module Name	Mainframe Slots Required	Descriptions
N2263A	32-Bit Digital I/O Module	1	The module offers 32-bidirectional I/O lines and three handshake lines for sensing and control of external devices up to 42V, 600 mA. All lines are TTL-compatible.
44474A	16-Bit Digital I/O Module	1	The module offers 16-bidirectional I/O lines and four handshake lines for sensing and control of external devices up to 30V, 125 mA. All lines are TTL-compatible.

Multifunction Modules

A multifunction module combines two or more functions such as MUX, GP, Matrix, Digital I/O or DAC onto a single module, making it possible to implement a complicated switching application with fewer modules. Therefore, the cost is reduced by minimizing the number of mainframes and modules required.

Each separate function on a multifunction module can be operated independently. For example, an Agilent N2265A can be used as both a 4 x 4 matrix module and a 16-bit digital I/O module.

The table below lists the available multifunction modules.

Model Number	Module Name	Mainframe Slots Required	Relay Type	Description
N2264A	12-Channel GP + 3-Channel High-current GP + 16-Bit Digital I/O Module	1	Non-latching	The module provides 12-channel SPST (Single-pole Single-throw) GP relays for signals up to 200 V, 1 A, 3-channel high-current GP relays for signals up to 125 V, 5 A, and 16-bit digital I/O for sensing and control of external devices up to 42 V, 600 mA.
N2265A	4 x 4 Matrix + 16-Bit Digital I/O Module	1	Latching	The module provides 4 x 4 2-wire matrix for signals up to 200V, 1A, and 16-bit digital I/O for sensing and control of external devices up to 42 V, 600 mA.

Optical Modules

The Agilent N2280A and N2281A are optical switch modules. The table below lists the information about these three optical modules.

Model Number	Module Name	Mainframe Slots Required	Relay Type	Description
N2280A	Optical Switch Quad 1-to-2 MUX Module	2	Non-latching	Four 1-to-2 Optical Switches
N2281A	Optical Switch Dual 1-to-4 MUX Module	2	Non-latching	Two 1-to-4 Optical Switches

Channel and Slot Addressing

A channel refers to an individual relay on a switching module, or an individual bit/port on a digital I/O module. The channel address is in the form of *snn*, where *s* represents slot number and *nn* represents a channel number.

For all mainframes, slot 0 refers to the 3499A/B/C control board. Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

The channel number, *nn*, is plug-in module dependent. Detailed information about channel numbers of individual plug-in modules is given below and on the following pages.

Plug-in Module	Channel Addressing *(snn)* *s* = Slot Number; *nn* = Channel Number
N2260A 40-Channel MUX Module[a]	**2-Wire Mode:** *s00, s01...s38, s39*
N2261A 40-Channel GP Relay Module	*s00, s01, s02, s03... s37, s38, s39*
N2262A 4X8 Matrix Module	Row 0, 1, 2, 3; Column 0, 1, 2, 3... 6, 7 (*s00, s01, s02... s07; s10, s11, s12... s17;* *s20, s21, s22... s27; s30, s31, s32... s37*)[b]

a. The N2260A and N2266A can be only be used as a 40-channel 2-wire MUX modulein 3488 mode.
b. A channel number on a matrix module is formed in Slot-Row-Column format, i.e., channel address s23 means row 2, column 3 in Slot s.

3

Plug-in Module	Channel Addressing *(snn)* *s* = Slot Number; *nn* = Channel Number
N2263A 32-Bit Digital I/O Module	**Individual Bits:** *s00, s01, s02... s30, s31* **8-Bit Ports:** *s00, s01, s02, s03* **16-Bit Ports:** *s04, s05* **32-Bit Port:** *s06*
N2264A 12-Channel GP Relay + 3-Channel High-current GP Relays + 16-Bit Digital I/O Module	**12 GP Relays:** *s00, s01, s02... s10, s11* **3 High-current GP Relays:** *s20, s21, s22* **16-Bit Digital I/O:** **Individual Bits:** *s30, s31, s32... s44, s45* **8-Bit Ports:** *s30, s31* **16-Bit Port:** *s32*
N2265A 4x4 Matrix + 16-Bit Digital I/O Module	**4x4 Matrix:** Row 0, 1, 2, 3; Column 0, 1, 2, 3 (*s00, s01, s02, s03; s10, s11, s12, s13;* *s20, s21, s22, s23; s30, s31, s32, s33*)[a] **16-Bit Digital I/O:** **Individual Bits:** *s40, s41, s42... s54, s55* **8-Bit Ports:** *s40, s41* **16-Bit Port:** *s42*
N2266A 40-Channel MUX Module[b]	**2-Wire Mode:** *s00, s01...s38, s39*
N2267A 8-Channel High Current GP Module	*s00, s01, s02... s07*
N2268A 50Ω 3.5 GHz Dual 4-to-1 MUX Module	*s00, s01, s02, s03; s10, s11, s12, s13*

a. A channel number on a matrix module is formed in Slot-Row-Column format, i.e., channel address s23 means row 2, column 3 in Slot s.

b. The N2260A and N2266A can only be used as a 40-channel 2-wire MUX module in 3488 mode.

Plug-in Module	Channel Addressing *(snn)* *s* = Slot Number; *nn* = Channel Number
N2270A 10-Channel HIgh Voltage MUX Module	*s00, s01, s02... s07*
N2280A Optical Switch Quad 1-to-2 MUX Module	*s00, s01; s10, s11; s20, s21; s30, s31*
N2281A Optical Switch Dual 1-to-4 MUX Module	*s00, s01, s02, s03;s10, s11, s12, s13*
4-Bit Built-in Digital I/O (slot 0 control module)	**Individual Bits:** *091, 092, 093, 094* **4-Bit Port:** *090*
44470A 10-Channel MUX Module	*s00, s01, s02, s03... s08, s09*
44470D 20-Channel MUX Module	*s00, s01, s02, s03... s18, s19*
44471A 10-Channel GP Relay Module	*s00, s01, s02, s03... s08, s09*
44471D 20-Channel GP Relay Module	*s00, s01, s02, s03... s18, s19*
44472A Dual 4-Channel VHF Module	**Group 0:** *s00, s01, s02, s03* **Group 1:** *s10, s11, s12, s13*
44473A 4x4 Matrix Module	Row: 0, 1, 2, 3; Column: 0, 1, 2, 3 (*s00, s01, s02, s03; s10, s11, s12, s13;* *s20, s21, s22, s23; s30, s31, s32, s33)*[a]

a. A channel number on a matrix module is formed in Slot-Row-Column format, i.e., channel address s23 means row 2, column 3 in Slot s.

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Plug-in Module	Channel Addressing *(snn)* *s* = Slot Number; *nn* = Channel Number
44474A 16-Bit Digital I/O Module	**Individual Bits:** *s00, s01, s02... s14, s15* **8-Bit Ports:** *s00, s01* **16-Bit Port:** *s02*
44475A Breadboard Module	N/A
44476A 3-Channel 13 GHz Microwave Switch Module	*s00, s01, s02*
44476B 2-Channel 26 GHz Microwave Switch Module	*s00, s01*
44477A 7-Channel Form-C Relay Module	*s00, s01, s02, s03, s04, s05, s06*
44478A 50 Ω 1.3 GHz MUX Module	**Group 0:** *s00, s01, s02, s03* **Group 1:** *s10, s11, s12, s13*
44478B 75 Ω 1.3 GHz MUX Module	**Group 0:** *s00, s01, s02, s03* **Group 1:** *s10, s11, s12, s13*

Factory Default and Reset States

The table on the next page shows the settings of the instrument after a reset.

- You can reset the instrument either by pressing
  Shift + **Card Reset** on the front-panel, or with a RESET command over the remote interface.

- If a module is accidentally removed or installed while the instrument power is on, the instrument will preform a reset.

3488 Mode Defaults

Item		Factory Default	Reset
Interface	GPIB/488	GPIB (Address 9)	Keep current setting[a]
	RS-232[b]		Keep current setting
System Mode	SCPI Mode	SCPI Mode	Keep current setting
	3488A Mode		Keep current setting
System-Related	Display State	On	On
	Stored State	Empty	Keep current setting
	Error Queue	Empty	Cleared
Module-Related	Switching Channels	Open	Open
	Digital I/O Ports	Input	Input
	Card Pair	None	None
Scan-Related	Scanning	None	Stop scan in progress
	Scan List	Empty	Empty
	Channel Delay (seconds)	0	0
	Trigger Out Pulse	Disabled	Disabled

a. Current setting includes the selection of the GPIB interface and its address setting.
b. RS-232 interface CANNOT be used in 3488A mode.

3

4

Features and Functions

Features and Functions

This chapter provides details about particular functions and features of the Agilent 3499A/B/C Switch/Control System. The sections in this chapter describe the features using both the front-panel and the remote interface using SCPI commands. The examples in this chapter are general. For specific procedures using the front panel refer to Chapter 2. For SCPI command information refer to Chapter 5. The following sections are included in this chapter:

- Monitoring a Channel or a Slot, on page 75
- Switching a Relay Channel, on page 77
- Scanning, on page 78
- Digital I/O Operation, on page 84
- State Storage, on page 94
- Error Conditions, on page 96
- Self-Test, on page 96
- Display Control, on page 97
- Relay Cycle Counts, on page 98

The following conventions are used for the front-panel operation.

- All keys on the front-panel keyboard are expressed in bold font and normally associated with a "press". For example, press **Mon**.
- All the front-panel display annunciators are expressed in bold font followed by an "annunciator". For example, **MON** annunciator.
- The information shown on the front-panel display is enclosed within a pair of quotation marks.
- **Shift** + **Recall**[1] indicates the sequential operation: first press **Shift**, then press **Recall**.

---

[1]   Also applicable to keys **Card Reset**, **Scan**, and **S.List**.

Monitoring a Channel or a Slot

You may need to continuously monitor the current status of a particular switching channel, a digital I/O port, or an entire plug-in module. This is especially useful when developing and debugging remote interface commands or watching for an important signal.

- To monitor a channel or a port, specify the channel or port number. To monitor a plug-in module, specify the slot number. The displayed information is module type dependent as shown on the next page.

- *Front-Panel Operation: To s*elect a channel, a digital I/O port, or a slot, press **Mon**. The **MON** annunciator lights up. Press **Mon** again to exit this state.

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| MUX   OPEN   101 | *Monitor a switching channel 101.* |

| DIN   255   400 | *Monitor a DIO Port 400.* |

| 1:0, , , , , ,6, , ,9,   2 | *Monitor a MUX or GP module.* |

| 00: H255 L254.   4 | *Monitor a DIO module.* |

If only part of the channel status on the module can be displayed at one time, press **Enter** to display the next part.

- *Remote Interface Operation*:

```
OUTPUT 709; "VIEW 103"          ! Query the state of a relay
                                  channel 103.
OUTPUT 709; "VIEW 431"          ! Query the state of a bit
                                  channel 431.
OUTPUT 709; "CMON 2"            ! Monitor the module in
                                  slot 2.
```

Example MON Display	Description
1:0,,,,,,6,,9, *2*	The display for a multiplexer or a GP relay module. This display indicates that the monitored module is in Slot 2 and channels 10, 16, and 19 are closed.
ROW 3:,1,,3,,,6,7 *3* *0;,,3,COL 3,* *3*	The display for a matrix module. The top display is the row information, indicating that the relays on Row 3, Columns 1, 3, 6 and 7 of the module (in Slot 3) are closed. The lower display is the column information, indicating that relays on column 3, row 0 and 3 are closed.
00:H255 L254. *4*	The display for a digital I/O module. The first 2 digits on the left ("00" in this case) represents the "L" 8-bit port address. Adding one to this value, the "H" 8-bit port address is obtained. Data with a trailing decimal point indicates that the last operation on that port was a WRITE, data without a trailing decimal point indicates that the last operation on that port was a READ. This display shows that the data last read from Port 401 is 255 and the data last written to Port 400 was 254.
DIO *12* *090* *DOUT* *0* *091*	The top display is for the built-in digital I/O Port *090* (controller module) and the data from the last operation. The lower display indicates that data last written to the bit channel 091 is 0.
ROW 0:,1,,3, *5* *00:H255 L254.* *5*	For a multifunction module, the first function on the module is displayed, then the next. This display is an example of a multifunction module with matrix and DIO functions (in slot 5).

Switching a Relay Channel

Switch modules can be used to route signals to and from your test system. This is achieved by closing or opening the relay channels on these modules.

- From the front-panel, you can open or close one relay channel at a time. However, over the GPIB interface, multiple relay channels can be operated by a single command if a channel list is specified. In addition, these open or closed states can be stored, and a stored channel setup can be included in a scan list (see "State Storage" on page 94).

- Whenever a switch module is reset, all of the closed relay channels on the module will be opened.

- Whenever the instrument is turned on or reset, all of the closed relay channels in the instrument will be opened.

- *Front-Panel Operation:* Select a channel, press **Open** or **Close**.

  Select a slot, press and hold **Card Reset** to open all channels on the selected module.

  Press **Shift**, then press and hold **Card Reset** to open all channels in the instrument.

- *Remote Interface Operation:* The following commands open and close multiple channels on the modules in slots 1 and 2.

  ```
  OUTPUT 709; "OPEN 101,102,207"
  ```
              ! Open multiple channels.
  ```
  OUTPUT 709; "CRESET 1"         ! Open all channels on the
  ```
               module in slot 1.
  ```
  OUTPUT 709; "CLOSE 101,102,207"
  ```
              ! Close multiple channels

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Scanning

The Agilent 3499A/B/C can scan switching channels, digital I/O bit channels, and stored channel setups in a scan list. When a scan starts, the first channel in a scan list is closed. The channel is then opened and the next channel in the list is closed. This process repeats for all channels in the scan list. You can sweep through a scan list more than once. You can also synchronize scanned channel closures with external measurement devices.

Rules for Scanning

- A scan list must be specified before initiating a scan. One or more switching channels, digital I/O bit channels, and/or previously stored channel setups can be included in a scan list. The order of the channels in the scan list determines the order of the channels to be scanned.

- If any plug-in module is installed or removed while the instrument is operating, the instrument will automatically perform a reset and the current scan list is cleared.

- If a scan list contains a non-existing channel, the scan cannot be performed and an error will occur.

- If a scan list contains a channel on a digital I/O module that is not configured to handshake mode #1 or mode #2 (see page 86), the scan cannot be performed and an error will occur.

- If a mismatch between a stored channel setup in the scan list and the current hardware configuration is found, a scan cannot be performed and an error will occur. When a stored setup is included in the scan list, the stored setup is recalled and the next channel in the scan list is switched.

- When a scan is aborted, the channel last scanned before the interruption will remain closed. Aborting a scan does not affect the present scan configuration. A scan cannot resume from where it is interrupted. To initiate a new scan, the channels in the scan list will be scanned from the beginning of the scan list.

- A scan list may contain up to 200 entries.

Creating a Scan List

Before initiating a scan, a scan list must be set up. The instrument scans the specified channels automatically in the same order of the scan list.

- The scan list is automatically cleared whenever the instrument is turned off or reset. You can also clear the scan list by pressing **Shift+S.List**.

- *Front-Panel Operation:* Press **S.List**, the **CONFIG** annunciator will light. The display will show "ADD TO SCAN". Press **Enter** to begin building the scan list. Select each desired channel and press **Enter** to add the channel to the scan list. As channels are added, an asterisk is shown in the display to indicate the channel is a part of the scan list.

ADD TO SCAN	*Press* **S.List**. *Press* **Enter**.
SELECT 101	*Select a channel to add.*
SELECT * 101	*Press* **Enter**.
SELECT 203	*Select the next channel to add.*

4

- *Remote Interface Operation:* You may use single channels, ranges of channel, or stored setups in the scan list. Set up a scan list with one command as follows:

```
10   OUTPUT 709; "SLIST 100-109 "! Create a scan list.
20   FOR I = 1 to 10
30   OUTPUT 709; "STEP"            ! Step through the scan list.
40   OUTPUT 709; "DELAY 20"        ! Add 20 ms time delay.
50   Next I
```

Note   Stored states may be used in scan lists. Stored states are discussed in more detail beginning on page 94.

Configuring a Scan

You can use delay times to control a scan.

- You can specify a *delay time* (from 0 to 99999.999 seconds, with 1 ms resolution) between when a channel is closed and when the next operation begins (and, if configured, a *trigger out pulse* is sent). The delay time can be set individually for each channel in the scan list, or one delay can be set for all channels in the scan list. Note that, even if the trigger source is set to IMMediate, the scan list will not advance until the delay time is met.

- *Front-Panel Operation:* Use the **S.List** menu to set the scan delay time as shown below.

4

DELAY TIME

Turn the knob to select DELAY TIME. Press **Enter**.

00000.0000 SECS

Use arrow keys and knob to select the delay time. Press **Enter**.

3499

Press **S.List** *to exit the menu.*

- *Remote Interface Operation:*

```
OUTPUT 709; "DELAY 2000; CHAN 101"
                              ! Set a 2 second delay time
```

Performing a Scan

Once you set up a scan list and configure the scan, the actual scan can be performed.

- If a scan list contains a non-existing channel, the scan cannot be performed and an error will occur.

- If a scan list contains a channel on a digital I/O module that does not work in Mode #1 or Mode #2, the scan cannot be performed and an error will occur (see page 86 for more information about modes).

- If a stored channel setup in the scan list does not match the current hardware configuration, the scan cannot be performed and an error will occur.

- *Front-Panel Operation:* Press **Scan** to begin the scan operation.

  Stop a scan in progress by pressing **Shift**+**Scan**. The last channel closed in the scan list will remain closed. You cannot pause and then continue a scan. You must start the scan operation over.

  Press **Step** to start and step through the channels in the scan list, one channel at a time.

- *Remote Interface Operation:* Use the STEP command to begin a scan. If you abort a scan in progress, the last channel closed in the scan list will remain closed. You cannot pause and then continue a scan. You must start the scan operation over.

  ```
  OUTPUT 709; "STEP"                    !Step into the scan list.
  ```

Using External Triggering

Two control lines are provided in the rear panel mini-DIN connector: external trigger in and external trigger out. These lines can be used individually or combined to synchronize a scan list with an external instrument (such as a DMM). The figure below shows this connection. The 3499A/B/C can be configured to output a trigger pulse to notify the external instrument whenever a channel is closed.
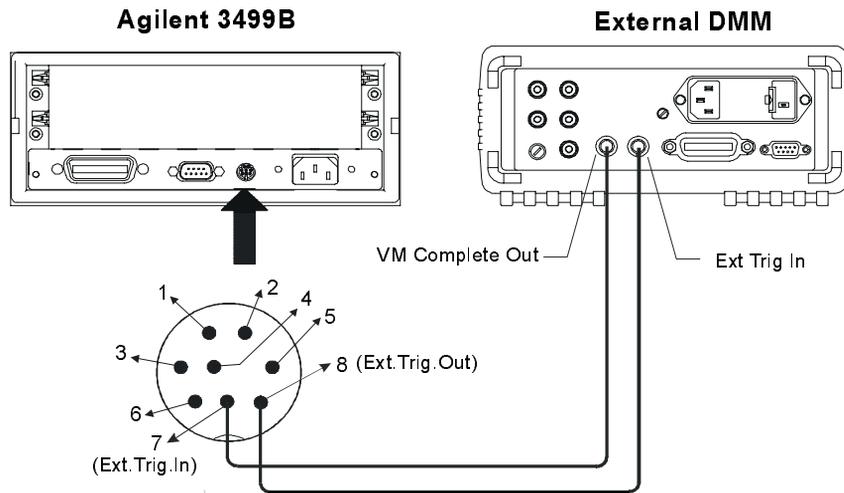
- In addition to the Ext.Trig.In and Ext.Trig.Out pair provided on the rear panel of the mainframe, the EI (external increment) and CC (channel closed) pair on a 44474A module can also be used to synchronize. Specify either Slot 0 or the slot in which a 44474A module is installed to indicate which lines are to be used.

- Both the built-in trigger lines and the EI/CC lines on the 44474A are TTL compatible.

- Once enabled, the selected trigger-in line is immediately ready to accept the trigger signal from the external instrument. Enabling or disabling a trigger source from the front-panel sets both the trigger in and trigger out functions.

- *Front-Panel Operation:* Press **Menu**, use the knob to select "CONF EXT TRIG" and press **Enter**. Select either slot 0 (built-in external trigger) or the slot where a 44474A is installed and press **Enter**. Enable or disable the pair of trigger lines and press **Enter**. Press the **Menu** key again to exit the menu.

  Press **S.List**, select "CONFIG SCAN", and configure the arm source or trigger source as either EXT or MIX.

- *Remote Interface Operation:* The following code segment will set up the 3499A/B/C to synchronize with an external instrument.

  ```
  OUTPUT 709; "DMODE 0,1,0,1"        ! Enable a trigger pulse on the
                                       rear panel Mini DIN
                                       connector.
  ```

4

Digital I/O Operation

The digital input/output is well-suited for monitoring and controlling external devices. You may use the built-in digital I/O bits or port (on the rear panel), one or more digital I/O modules, or a multifunction modules with a DIO function. In the following context, multifunction modules refer to those with a DIO function.

- The built-in digital I/O (control board) consists of four bits which can be operated either independently as four bit channels (numbered *091* through *094*) or as one 4-bit port (numbered *090*).

- The plug-in digital I/O modules and multifunction modules usually consist of several 8-, 16-, and/or 32-bit ports. These ports can be operated independently, which means one port can be used for output operation, while others can be used for input. However, all bits within a same 8-bit port are dependent. If one bit of a port is used for input or output operation, then all other bits of the same port can only be used for the same operation.

Note   For more information about a specific digital I/O module, refer to the Agilent 3499A/B/C User's Manual (shipped with the instrument)

Digital I/O Configuration

- Parameters such as flow control mode, control line polarity (PCTL), flag line polarity (PFLG), and I/O direction line polarity, are all configured for the plug-in digital I/O modules and multifunction modules. However, these DO NOT apply to the built-in 4-bit digital I/O (on the rear panel).

- The data line polarity of any 8-bit port (or the 4-bit built-in port) can be configured from the front-panel. However, using the remote interface, the data line polarity of any ports (8-, 16-, or 32-bit) can be configured.

- Data display format of any 8-bit port, binary or decimal (default), can only be specified from the front-panel. Once specified, the format applies to all input and output operations on the same port.

- When the instrument is turned on or reset, the handshake mode is set to Mode #1 and the polarities of all configured lines are positive. More information about handshake modes is given starting on page 86.

- *Front-Panel Operation:* Select a digital I/O module and press **Mode**. "CONFIG DIO" is shown in the display. Press **Enter** to show the second-level menu and begin the configuration.

Note   Be sure to select the module, not a port or bit. The options on this menu are only available when the module is selected.

N2263A 4	*Select a DIO module.*
CONFIG DIO 4	*Press* **Mode**.
MODE 1 4	*Select flow control mode. Press* **Enter**.
CONT POL POS 4	*Select the control line polarity. Press* **Enter**.
FLAG POL POS 4	*Select the flag line polarity. Press* **Enter**.
I/O POL POS 4	*Select the I/O direction line polarity. Press* **Enter**.

Press **Mode** again to exit the menu.

Configure a port. Select a digital I/O port, then press **Mode,** the **CONFIG** annunciator lights up. When "DATA POLARITY" appears in the display, press **Enter** to set data line polarity and/or use the knob to select "DISP FORMAT" and press **Enter** to set data display format for the port.

DIN 401	*or*	DIN 401	
DATA POLARITY 401		DISP FORMAT 401	
NEG POLARITY 401		BINARY 401	

• *Remote Interface Operation:* Set the flow control parameters using the following 3488 command. This example assume a digital I/O module is installed in slot 4.

```
OUTPUT 709; "DMODE 4,1,0,1"
```
! Set the flow control to Mode #1 and the polarity of all lines to default values.

About Flow Control Modes (Handshake)

Five flow control modes are available for Digital I/O operations. Some modes use one or more of the three flow control lines: I/O Direction, PFLG, and PCTL. Select the flow control you need for your digital input/output applications.
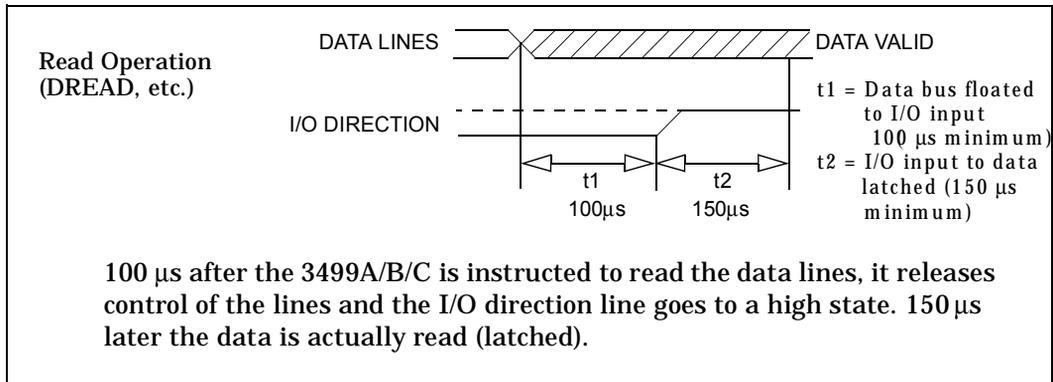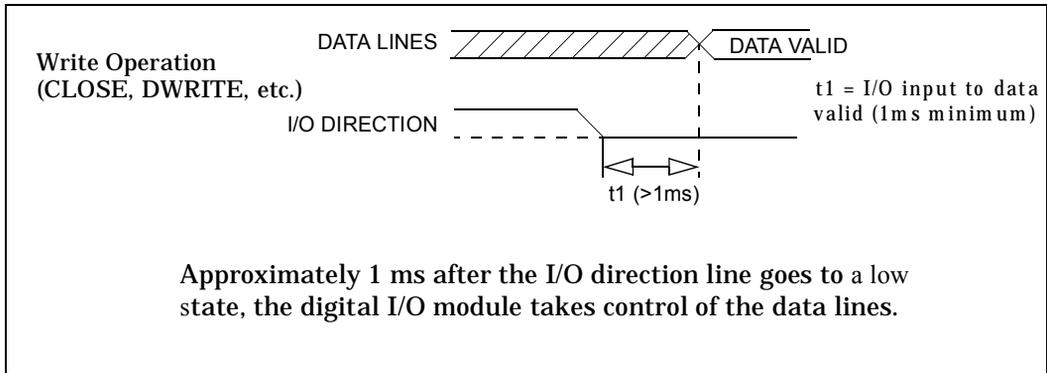
Note   The polarity of the flow control lines is assumed to be positive (the default) in the following diagrams and discussions.

Mode Number	Handshake Mode Definition	Notes
1	Static mode #1	Default handshake mode.
2	Static mode #2	Read what was written.
3	Read or Write and strobe	If you set a port to this mode, you cannot use the port in a scan list.
4	Read and write strobe	If you set a port to this mode, you cannot use the port in a scan list.
5	Full handshake	If you set a port to this mode, you cannot use the port in a scan list.

Static Mode #1

Static Mode #1 is the default mode. In this mode, data is transferred statically, there is no read or write strobe pulses or handshaking. The I/O Direction line is active and indicates direction of transfer. This is shown in the following timing diagrams.

DATA LINES /////////////// DATA VALID

Write Operation
(CLOSE, DWRITE, etc.)

t1 = I/O input to data valid (1ms minimum)

I/O DIRECTION

t1 (>1ms)

4

Approximately 1 ms after the I/O direction line goes to a low state, the digital I/O module takes control of the data lines.

DATA LINES /////////////// DATA VALID

Read Operation
(DREAD, etc.)

I/O DIRECTION

t1 = Data bus floated to I/O input 100 μs minimum)

t1   t2

100μs   150μs

t2 = I/O input to data latched (150 μs minimum)

100 μs after the 3499A/B/C is instructed to read the data lines, it releases control of the lines and the I/O direction line goes to a high state. 150 μs later the data is actually read (latched).

Static Mode #2

Static Mode #2 acts just like Mode #1 except the output lines are not disabled during an input operation. This means that if a port is written to and then read from, the data read will be that which was just written to it. It is possible, however, that external devices might load the lines and cause a false read.

Timing for the I/O direction line is as shown in Mode #1 for write operations. For read operations, the I/O direction line does not change.
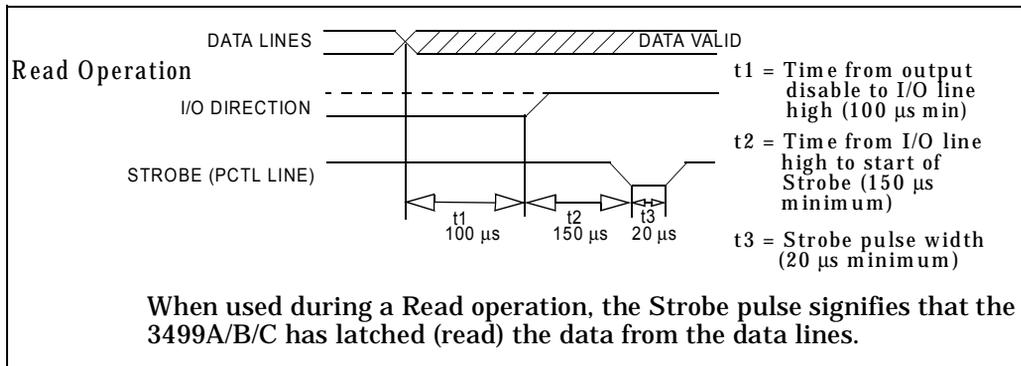
Read or Write and Strobe Mode #3

In this mode, the I/O direction line is still used to indicate direction of transfer (input or output) but the PCTL (Peripheral control) line is used to strobe the data.

During a write operation, where the 3499A/B/C writes the data to some external device, the strobe pulse signifies that the data on the 16 or 32 data I/O lines is valid. This is shown in the following timing diagram.

A Strobe pulse signifies that the data on the data lines is valid. During a write operation, the device receiving the data is triggered by the strobe.
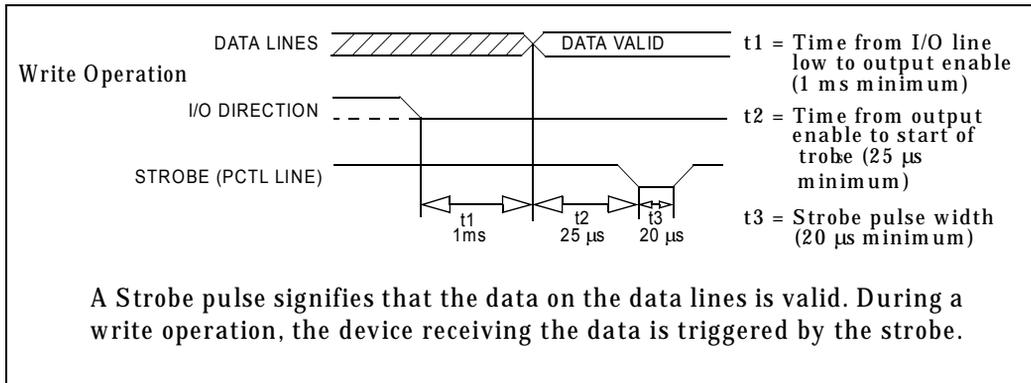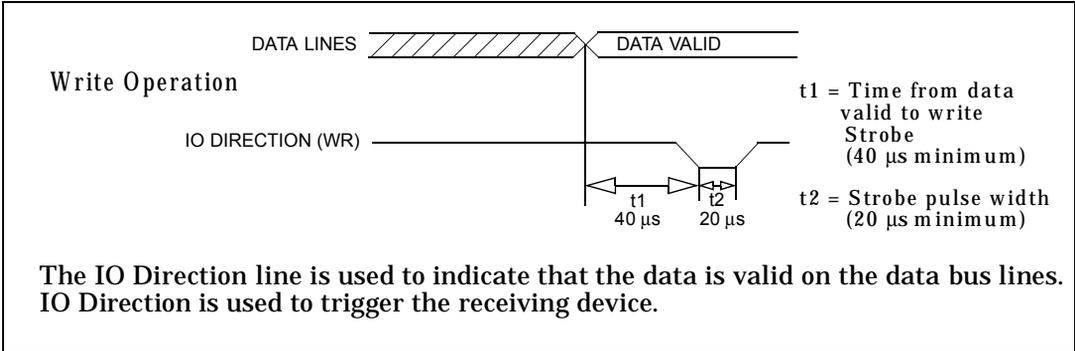
The Strobe pulse is used during a read operation to signify that the 3499A/B/C has completed the read operation. This is shown in the following diagram.
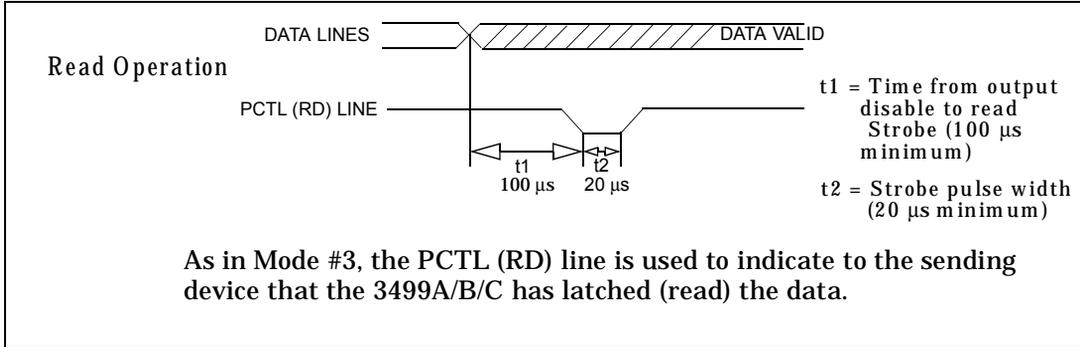

When used during a Read operation, the Strobe pulse signifies that the 3499A/B/C has latched (read) the data from the data lines.

Read and Write Strobe Mode #4
Read and Write Strobe Mode #4 uses the I/O direction line as a Strobe
pulse to indicate writing operations. The PCTL line is used to indicate
Read operations. It is thus similar to the R/W and Strobe Mode #3 except
separate control lines are used for the Strobe pulses and there is no I/O
direction line.

DATA LINES ////////// DATA VALID

Write Operation

IO DIRECTION (WR)

t1 = Time from data
valid to write
Strobe
(40 µs minimum)

t1
40 µs

t2
20 µs

t2 = Strobe pulse width
(20 µs minimum)

The IO Direction line is used to indicate that the data is valid on the data bus lines.
IO Direction is used to trigger the receiving device.

DATA LINES ////////// DATA VALID

Read Operation

PCTL (RD) LINE

t1
100 µs

t2
20 µs

t1 = Time from output
disable to read
Strobe (100 µs
minimum)

t2 = Strobe pulse width
(20 µs minimum)

As in Mode #3, the PCTL (RD) line is used to indicate to the sending
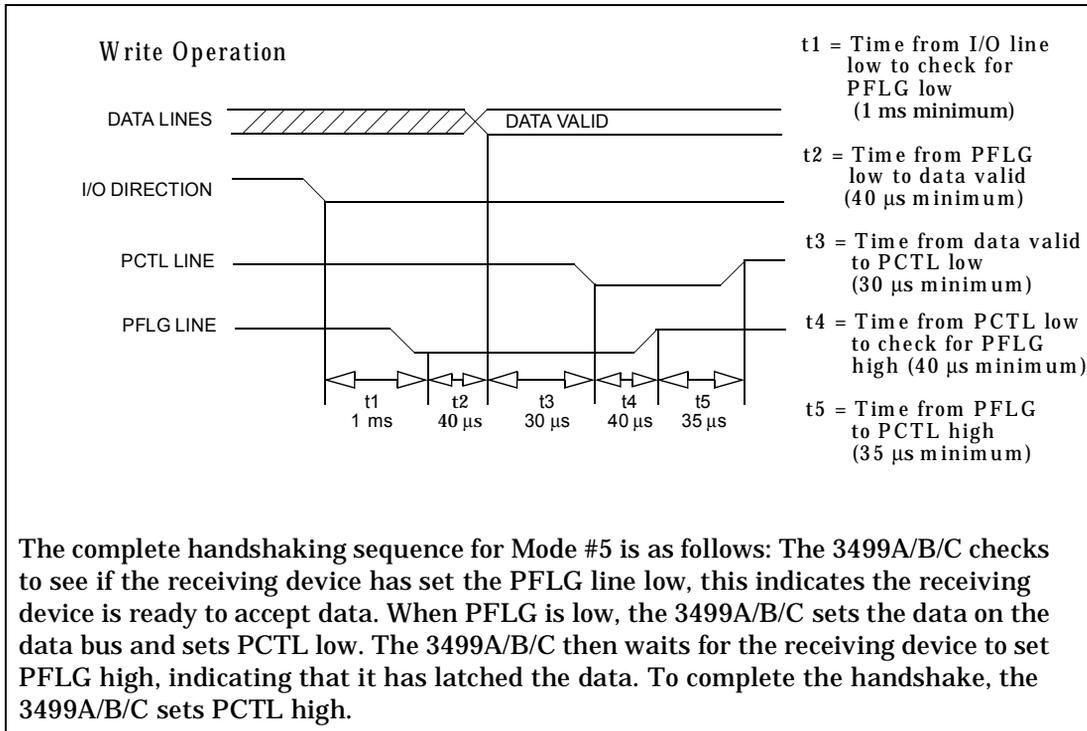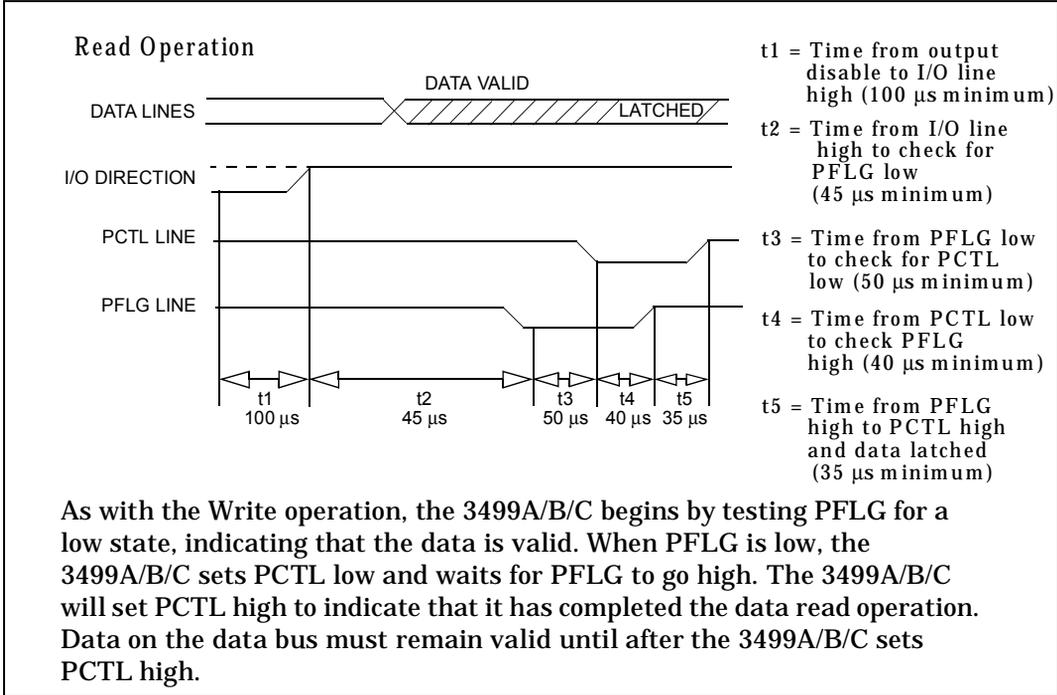device that the 3499A/B/C has latched (read) the data.

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Full Handshake Mode #5

Handshake Mode #5 provides a complete two wire handshake with a data direction line. During write operations, the PCTL line indicates that output data is valid; during read operations, it indicates that the digital I/O module (i.e. N2263A) is "ready for data". The PFLG line is used by the peripheral device to indicate "ready for data" during write operations or "data valid" for read operations.

For this discussion, write operations mean the plug-in digital I/O module is controlling the data lines. Read operations mean external devices control the data lines and the digital I/O module reads the data and controls the PCTL/RD line.

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Write Operation

DATA LINES — DATA VALID

I/O DIRECTION

PCTL LINE

PFLG LINE

t1 = Time from I/O line low to check for PFLG low (1 ms minimum)

t2 = Time from PFLG low to data valid (40 µs minimum)

t3 = Time from data valid to PCTL low (30 µs minimum)

t4 = Time from PCTL low to check for PFLG high (40 µs minimum)

t5 = Time from PFLG to PCTL high (35 µs minimum)

t1	t2	t3	t4	t5
1 ms	40 µs	30 µs	40 µs	35 µs

The complete handshaking sequence for Mode #5 is as follows: The 3499A/B/C checks to see if the receiving device has set the PFLG line low, this indicates the receiving device is ready to accept data. When PFLG is low, the 3499A/B/C sets the data on the data bus and sets PCTL low. The 3499A/B/C then waits for the receiving device to set PFLG high, indicating that it has latched the data. To complete the handshake, the 3499A/B/C sets PCTL high.

Read Operation

DATA VALID

DATA LINES   LATCHED

I/O DIRECTION

PCTL LINE

PFLG LINE

t1   t2   t3   t4   t5
100 μs   45 μs   50 μs 40 μs 35 μs

t1 = Time from output
     disable to I/O line
     high (100 μs minimum)

t2 = Time from I/O line
     high to check for
     PFLG low
     (45 μs minimum)

t3 = Time from PFLG low
     to check for PCTL
     low (50 μs minimum)

t4 = Time from PCTL low
     to check PFLG
     high (40 μs minimum)

t5 = Time from PFLG
     high to PCTL high
     and data latched
     (35 μs minimum)

4

As with the Write operation, the 3499A/B/C begins by testing PFLG for a
low state, indicating that the data is valid. When PFLG is low, the
3499A/B/C sets PCTL low and waits for PFLG to go high. The 3499A/B/C
will set PCTL high to indicate that it has completed the data read operation.
Data on the data bus must remain valid until after the 3499A/B/C sets
PCTL high.

Digital Input Operation

- From the front-panel, you can read data from the built-in digital I/O bits/port (numbered *090* through *094*) or any one of the 8-bit ports on a digital I/O module or multifunction module.

- From the remote interface, you can read data from the individual bit channels and 8-, 16-, or 32-bit ports on a digital I/O module or multifunction module, as well as from the built-in digital I/O bits/port (numbered *090* through *094*).

- Instrument reset will set all digital I/O ports in the instrument as input ports. Pressing **Card Reset** or issuing a RESET command will set all ports on the specified module as input ports (ports on other modules are not affected).

- *Front-Panel Operation:* Select an 8-bit digital I/O port, press **Read** to read the data from the port. The data can be displayed as either decimal or binary (see page 33).

- *Remote Interface Operation:* Use the following command to read an individual bit (bit 6) on a module in slot 4. A "0" (bit cleared) or a "1" (bit set) will be returned.

```
OUTPUT 709; "DREAD 402"          ! Read data from Port 402.
OUTPUT 709; "VIEW 403"           ! View a bit channel 4.
```

The range of possible returned values is shown:

Parameter	Decimal Range	Hex range
BYTE	0 to 255	00_h to FF_h
WORD	-32768 to 32767	-8000_h to $7FFF_h$
LWORD	-2^{31} to $(2^{31}-1)$	-80000000_h to $7FFFFFFF_h$

WORD values greater then 32767 and LWORD values greater then for $(2^{31}-1)$ are returned as negative numbers. These values are in 2's complement form.

Digital Output Operation

- From the front-panel, you can write data to the built-in digital I/O bits/port (numbered *090* through *094*) or any one of the 8-bit ports on a digital I/O module or multifunction module.

- From the remote interface, you can write data to individual bit channels and 8-, 16-, or 32-bit ports on a digital I/O module or multifunction module, as well as to the built-in digital I/O bits/port (numbered *090* through *094*).

- Instrument reset will set all digital I/O ports in the instrument as input ports. Pressing **Card Reset** or issuing a RESET command will set all ports on the specified module as input ports (ports on other modules are not affected).

- *Front-Panel Operation:* Select an 8-bit port, press **Write**, the data from the last operation (read or write) will be displayed. Edit the data to the desired value and press **Enter** to write the data to the port. To cancel the write operation, press **Write** again instead of **Enter**. You can edit the data in either binary or decimal form (see page 33).

- *Remote Interface Operation:*

  ```
  OUTPUT 709; "DWRITE 400,219"    ! Write 219 to 16-bit Port 404.
  OUTPUT 709; "CLOSE 401,407,411"
                                  ! Close bit channels 401, 407,
                                    and 411.
  OUTPUT 709; "OPEN 403,405,407"
                                  ! Open bit channels 403, 405,
                                    and 407.
  ```

  WORD values greater then 32767 and LWORD values greater then for $(2^{31}-1)$ are sent as negative numbers. These values are in 2's complement form.

State Storage

The 3499A/B/C provides the capability to store setups, and then recall them to put the instrument back into a known configuration. Information that can be stored includes:

- Status of all relay channels (open or closed)

- Status of digital I/O ports (input or output, flow control, etc.)

- Remote interface settings (address, baud, etc.)

Additionally, you can include a stored state in a scan list as a channel.

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Firmware Revision Differences

State storage behavior differs depending upon the firmware revision of your 3499A/B/C (see page 55).

- Firmware revision 1.0 must be upgraded. Please contact your nearest Agilent Technologies Office for details.

- Firmware revisions 2.0 and 3.0 allow up to 10 states to be stored. Firmware revision 4.0 allows up to 40 stored states.

- Stored states are lost if power is removed for firware revisions 2.0 or 3.0. Stored states are preserved when power is removed for firmware revision 4.0.

- Storage memory locations are numbered 01 to 10 for Firmware revision 2.0 and 3.0. Memory locations are number 01 to 40 for Firmware revision 4.0.

- Before recalling a stored setup, the instrument verifies that all module types and slot assignment match the setup. If a mismatch is detected, an error ("RECALL FAILED") will occur.

Firmware Revision Differences (continued)

- An instrument reset does not affect the stored instrument setup information.

- All stored setups will be cleared if the system mode is changed (for example, to SCPI mode).

- Firmware revision 3.0 allows instrument operation in *either* SCPI *or* 3488 mode, *not* both. The mode is selected when the firmware is loaded.

To Store an Instrument State

Firmware revision 2.0 and 3.0 allow up to 10 stored states. Firmware revision 4.0 allows up to 40 stored states. Set the instrument to the state you want to store.

- *Front-Panel Operation:* To store an instrument setup, press **Shift** + **Recall**, select a memory location, and press **Enter**. To cancel the store operation, press **Recall** again instead of **Enter**.

- *Remote Interface Operation:*

  OUTPUT 709; "STORE 4"   *! Store an instrument setup*

Note   Approximately 1 second is required to store an instrument setup into an Agilent 3499A/B/C with Firmware REV 4.0. To avoid errors in when programming, be sure to allow a 1 second interval between the store and recall operations.

To Recall an Instrument State

You can recall a previously stored instrument setup.

- *Front-Panel Operation:* To recall a stored setup, press **Recall**, select the memory location to be recalled, and press **Enter**. To cancel the recall operation, press **Recall** again instead of **Enter**.

- *Remote Interface Operation:*

  OUTPUT 709; "RECALL 4"   *! Recall the previously stored channel setup.*

Error Conditions

When an error occurs, the 3499A/B/C will beep and the **ERROR**
annunciator on the front-panel lights up. This indicates one or more
command syntax or hardware errors have been detected.

- The error queue will be cleared automatically once you read the
  queue, change the system mode, send the RESET command, or cycle
  power on the instrument. However, a module reset will not clear the
  error queue.

- *Front-Panel Operation:* Press **View,** select "ERROR", and press
  Enter. The sum of the values of the possible error conditions is
  displayed (refer to "Error Messages" on page 135).

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- *Remote Interface Operation:* In 3488 mode, the sum of the values of
  the possible error conditions is recorded in the error queue. For
  example, the returned value of "0003" means that both "Syntax
  Error" and "Execution Error" occurred (refer to "Error Messages" on
  page 135).

    ERROR   *! Query the error register.*

Self-Test

The 3499A/B/C can perform a self-test to verify that it is in proper
operation.

- If the self-test is successful, "PASSED" will be displayed on the front-
  panel. Otherwise, the reason of the failure will be displayed. For
  details of all self-test failures, refer to "Self Test Errors" on page 136.

- *Front-Panel Operation:* Press **Menu**, use the knob to select
  "SELFTEST", and press Enter to perform a self-test.

- *Remote Interface Operation:*

    TEST   *! Returns zero if the test is
                                          successful, or non-zero if it
                                          fails.*

Display Control

You can turn off the 3499A/B/C display (for security or increased processing speed for example). You can also write a message of up to 13 characters to the front-panel display.

Note   The display cannot be turned off from the front-panel.

- When the display is turned off, the entire front-panel display goes blank except for the **ADRS** and **RMT** annunciators (the **ERROR** annunciator will also be on if there are errors), and all keys except **Local** are locked.

- If the display is turned off, pressing **Local** causes the instrument to return to local operation, the display will be turned back on.

- The display is automatically turned on when power is cycled, or after a RESET command.

- When the display is on, you can send a message (up to 13 characters) to display on the front-panel from the remote interface. If you attempt to send more than 13 characters, only the first 13 characters can be displayed. The characters can be letters (A-Z), numbers (0-9), and some special characters (" ' space ( ) * + - , . : ; / \ ).

- *Remote Interface Operation:*

```
OUTPUT 709; "DOFF"              ! Turn off the display.
OUTPUT 709; "DON"               ! Turn on the display.
OUTPUT 709; "DISP Scan finished."
                                ! Display the message on the
                                   front panel.
```

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Relay Cycle Counts

The Agilent 3499A/B/C can read and track the relay cycle counts on some plug-in modules. This feature can be very useful in switching systems to track relay failures and predict system maintenance requirements.

- This feature is supported in 3488 Mode by the Agilent N2260A, N2261A, N2262A, N2264A, N2265A, N2266A, N2267A, N2268A, N2270A, and N2280A/81A modules.

- The cycle counts of the tree relays (*s98 & s99*) on an N2260A or N2266A can also be queried.

- *Front-Panel Operation:* Press **View**, use the knob to select "RELAY CYCLES", and press **Enter**. Turn the knob to select the relay channel of interest. The display shows the channel cycle count.

- *Remote Interface Operation:* This feature is only available from the front panel in 3488 mode.

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Remote Interface Reference

Remote Interface Reference

This chapter describes 3488 mode commands applicable to the Agilent 3499A/B/C Switch/Control System. The chapter contents include:

- Command Syntax, on page 101
- 3488 Mode Command Quick Reference, on page 102
- 3488 Mode Commands, on page 104

Note   It is highly recommended that you use SCPI commands (in SCPI mode) instead of 3488A commands (in 3488A mode). The SCPI commands allow you to use all the features of the Agilent 3499A/B/C and the plug-in modules. 3488 mode commands are a subset and are provided for legacy installations.

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Command Syntax

Throughout this manual, the following conventions are used for command syntax for remote interface programming.

- Square brackets (**[ ]**) indicate optional keywords or parameters.

- Braces (**{ }**) enclose parameter choices within a command string.

- Angle brackets (< >) enclose parameters for which you must specify a value.

- A vertical bar (|) separates multiple parameters.

Rules for Using a Channel or Scan List

Many of the SCPI commands include a channel list or scan list parameter which allows you to specify one or more channels. The channel number has the form (@*snn*), where *s* is the slot number and *nn* is the channel number. You can specify a slot, a single channel, or multiple channels as described below.

- The following command closes a single channel (channel 11) on the module installed in slot 1:

  ```
  OPEN 111
  ```

- The following command closes multiple channels on modules in slots 1 and 2:

  ```
  CLOSE 111,112,203,204
  ```

- Additional information about channel and slot numbering is given on page 67.

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3488 Mode Command Quick Reference

Command	Description	Page
CHAN	Open the last channel/bit closed and close the specified channel/bit.	104
CLOSE	Close one or more relays (channels/bits) on the plug-in modules.	105
CMON	Monitor the open/close states of a plug-in module in the specified slot.	106
CRESET	Reset one or multiple cards in the specified slot(s) to their default states.	106
CPAIR	Pair up two plug-in modules of the same type.	107
CTYPE	Query the module's identification in the specific slot.	108
DBR	Read digital I/O port.	110
DBW	Output a block of binary data to the specified digital I/O port.	112
DELAY	Insert a delay time during scanning.	113
DISP	Write a message to display.	114
DMODE	Establish the handshake mode, polarity and trigger configuration of the DIO module.	115
DOFF	Turn off the front panel display of the instrument.	117
DON	Turn on the front panel display of the instrument.	117
DREAD	Read the status of a digital I/O port as inputs.	118
DWRITE	Output a block of data to the specified digital I/O port.	120
EHALT	Enable/Disable the stop-on-error mode.	121
ERROR	Query Error register.	121
ID?	Query the instrument's identity.	121
LOCK	Activate or deactivate locking out the keyboard of the instrument.	122

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Command Summary

Command	Description	Page
MASK	Query/set the SRQ mask conditions.	122
OLAP	Enable/Disable GPIB I/O overlap mode.	123
OPEN	Open one or more relays (channels/bits) on the plug-in modules.	124
RECALL	Re-assert the channel/bit setup stored by the command STORE (1-10).	125
RESET	Reset the instrument to its power on state. All channels/bits of the plug-in modules are open, etc.	125
SLIST	Specify a sequence of channels/bits to be scanned.	126
SYSMODE	Specify a system mode (SCPI or 3488A) for the instrument.	127
SYSMODE?	Query the instrument's system mode.	127
SREAD	Read back the read-only port on a 44475A Breadboard module (for 44475A only).	128
SWRITE	Write data to the static write-only port on a 44475A Breadboard module (for 44475A only).	129
STATUS	Query the Status Byte of the 3499A/B/C.	130
STEP	Sequence through a scan list set up by SLIST.	131
STORE	Store the current of the instrument in the specified register number (1-10).	131
TEST	Cause the 3499A/B/C to perform an internal self-test.	132
VIEW	Query the state of a particular channel/bit.	133

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Command Summary

3488 Mode Commands

CHAN [<*channel_address*>]

Opens the last channel/bit closed by either STEP or CHAN command and then closes the specified channel/bit.

The *channel_address* has the form @*snn*, where *s* is the slot number and *nn* is the channel number. For all mainframes, slot 0 refers to the 3499A/B/C control board. Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

The channel number, *nn*, is plug-in module dependent. Channel numbers for plug-in modules are listed on page 70.

If no channel/bit is specified with CHAN, the 3499A/B/C will respond with the number of the last channel closed. If no channel has been closed since the last reset, then CHAN returns the number 0.

If a Scan List is in effect when CHAN is executed, the 3499A/B/C will search through the list and position the Scan List pointer to the channel specified by CHAN. If CHAN specifies a channel that is not in the Scan List, and then STEP is executed, the 3499A/B/C will open the channel closed by CHAN and go to the beginning of the Scan List.

```
OUTPUT 709; "CHAN 203"        ! Close channel 203.
OUTPUT 709; "CHAN
ENTER 709; A
DISP A
```

CLOSE *<channel_address>*[,*<channel_address>*,*<channel_address>*...]

Close one or more channels on the non digital I/O (DIO) modules. It can also be used to "clear" bits on the digital I/O modules. The CLOSE command does not open any channels/bits that were previously closed.

The *channel_address* has the form @*snn*, where *s* is the slot number and *nn* is the channel number. For all mainframes, slot 0 refers to the 3499A/ B/C control board. Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

The channel number, *nn*, is plug-in module dependent. Channel numbers for plug-in modules are listed on page 70.

Several channels or bits can be closed with one CLOSE command by separating the channel or bit addresses with a comma. If more than one channel or bit is specified, they are closed or bits "cleared" in the order listed.

When CLOSE is used with the DIO modules (44474A, N2263A, N2264A, N2265A), the DIO modules must be in either default Static Mode #1 or Static Mode #2. Using the CLOSE command in any other mode will cause an error. In these modes there is no read or write handshaking. Digital modes are described in more detail on page 86.

The bits 091-094 on the 4-bit built-in digital I/O can be also included in the *channel_address*.

All the channels/bits in the plug-in modules are opened following a reset. For the DIO modules, all bits are operating as input bits, no handshaking enabled.

OUTPUT 709; "CLOSE 102,103,212,313"
                                                ! Close the specific channels.

5

CMON *<slot>*

Causes the 3499A/B/C to monitor the individual card (module) in the specified *slot*.

The *slot* parameter is a decimal ranging from 0 to 9 (mainframe dependent). Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

Specifying 0 as the slot number turns off the monitor function. Cycling power on the instrument or resetting the modules will cancel the monitoring.

You cannot monitor the 4-bit built-in DIO, an individual DIO port, or a switching channel.

The displayed information is module dependent, refer to page 75 for more details.

```
OUTPUT 709; "CMON 2"
ENTER 709; A$
DISP A$
```

5

CRESET *<slot>*[,*<slot>*...]

Resets all channels/bits on the specified modules to their open state. Only the modules in the specified slots are affected.

The *slot* parameter is a decimal ranging from 0 to 9 (mainframe dependent). Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

Switching Modules: All the switching channels on the specific module are reset to their open state.

DIO Modules: A digital I/O module is reset to its default mode. That means the bits on the module are set to open (high impedance), and the module is in the Static Mode #1 (no handshaking).

```
OUTPUT 709; "CRESET 2"              ! Reset the module in slot 2.
```

CPAIR *<slot>,<slot>*

Pairs two of the same (type) plug-in modules (i.e. two N2261A modules). This operation will effectively assign both modules to both slot numbers so that closing/opening/scanning a channel on either one module will perform the same operation on the respective channel on the other module.

The *slot* parameter is a decimal ranging from 0 to 9 (mainframe dependent). Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

This feature is especially useful when doing 4-wire scanning with the MUX modules, such as 44470A/D, N2260A, etc.

Commands used with the CPAIR function are: CLOSE, OPEN, CRESET, CHAN, STEP, DWRITE and DREAD. Channels/bits on the paired slots can be included in a scan list.

Executing a CPAIR command cancels any previous CPAIR command that involved either of the two modules. It is possible, however, to have two sets of card pairs, e.g. Slot 1 paired with 2 and Slot 3 paired with 4.

Paired DIO Modules: Two of the same (type) DIO modules used in Mode #1 or #2 can be paired. You cannot pair DIO modules using other handshake modes (see page 86).

Executing the CPAIR command without specifying slot numbers allows you to determine which, if any, slots are paired together. Four numbers are returned separated by commas. The first two numbers specify slots in the first pair, the second two numbers specify the second pair. An inactive card pair is denoted by 0,0.

```
OUTPUT 709; "CPAIR 1,3"          ! Pair the modules in Slot 1
                                   and Slot 3.
OUTPUT 709; "CLOSE 105"          ! Close Channels 105 and 305
                                   simultaneously.
```

CTYPE *<slot>*

This query returns a string containing the module identification in the specified slot. The *slot* parameter is a decimal ranging from 0 to 9 (mainframe dependent). Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

```
OUTPUT 709; "CTYPE 3"          ! Look for the card in Slot 3.
ENTER 709;A$
DISP A$                        ! Card description will be
                                 displayed.
```

The string returned has one of the following forms:

Module	Returned String	
Empty Slot	NO CARD	00000
Mainframe	Built-in DIO	3499, Serial #
N2260A	40CH MUX	N2260A, Serial #
N2261A	40CH GP	N2261A, Serial #
N2262A	4X8 MATRIX	N2262A, Serial #
N2263A	32BIT DIO	N2263A, Serial #
N2264A	12+3 (5A) CH GP+16BIT DIO	N2264A, Serial #
N2265A	4X4 MATRIX +16BIT DIO	N2265A, Serial #
N2266A	20CH MUX	N2266A, Serial #
N2267A	8(8A)CH GP	N2267A, Serial #
N2268A	DUAL 1X4 RF MUX	N2268A
N2270A	10(1000V)CH MUX	N2270A, Serial #
N2280A	QUAD 1X2 OPTICAL	N2280A, Serial #
N2281A	DUAL 1X4 OPTICAL	N2281A, Serial #
44470A	RELAY MUX	44470[a]
44470D	RELAY MUX	44470[a]
44471A	GP RELAY	44471[b]
44471D	GP RELAY	44471[b]
44472A	VHF SW	44472[c]
44473A	MATRIX SW	44473
44474A	DIGITAL IO	44474
44475A	BREADBOARD	44475
44476A/B	GP RELAY	44471[b]
44477A	GP RELAY	44471[b]
44478A/B	VHF SW	44472[c]

a.   Both the 44470A/D return "RELAY MUX 44470". You must physically check the
     module to determine which one is present.
b.   All the 44471A/D, 44476A/B and 44477A return "GP RELAY 44471". To determine if
     the module is an 44471A/D, 44476A/B or 44477A, check the switching channels. For
     44471A/D and 44476A/B, you must physically check the modules to determine which
     one is present.
c.   Both the 44478A/B return "VHF SW 44472". You must physically check the module to
     determine which one is present.

DBR <slot><port>,[<number of times to read>]

Reads the data items according to the format setup by the slot/port
parameters and the DMODE (for polarity and handshaking) command.

The *slot* parameter is a decimal ranging from 0 to 9 (mainframe dependent). Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

The *port* parameter is a number that indicates where the data is to be read. The port is module dependent and the valid port numbers are shown below.

Model Number	4-Bit Port	8-Bit Port	16-Bit Port	32-Bit Port
4-Bit Built-in DIO	090	N/A	N/A	N/A
44474A 16-Bit DIO	N/A	s00, s01	s02	N/A
N2263A 32-Bit DIO	N/A	s00, s01, s02, s03	s04, s05	s06
N2264A Multifunction	N/A	s30, s31	s32	N/A
N2265A Multifunction	N/A	s40, s41	s42	N/A

The *number of times to read* is an integer between 1 and 32767. If more than one reading is requested, the 3499A/B/C must be in the OLAP1 mode (see page 123).

- When Slot 0 is specified, only Port 090 is valid.

- If a 16-bit port is specified, data will be sent with the high or most significant byte first. The data transfer is terminated with the 3499A/B/C setting the GPIB EOI true line concurrently with the last data byte sent.

- If a 32-bit mode (Port 06) is specified, data will be sent with the highest byte fist, then the second highest byte and so on. The data transfer is terminated with the 3499A/B/C setting the GPIB EOI true line concurrently with the last data byte sent.

```
DIM A$[30]
IOBUFFER A$
A$ = "DBR 504,1"                  ! One digital binary reading.
TRANSFER A$ TO 709 INTR
ENTER 709 USING "%,K"; B$         ! Qualifiers "%,K" set PC to
                                    concurrent EOI and last
                                    data byte.

DISP B$
```

5

DBW *<slot><port>*,#I*<block data>*

Outputs a block of data to the specified digital I/O port. When DBW is received, the 3499A/B/C will interpret the block of data to be output according to the slot/port parameters and DMODE (polarity, handshake) command.

The *slot* parameter is a decimal ranging from 0 to 9 (mainframe dependent). Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

The *port* parameter is a number that indicates where the data is to be read. The port is module dependent and the valid port numbers are shown below.

Model Number	4-Bit Port	8-Bit Port	16-Bit Port	32-Bit Port
4-Bit Built-in DIO	090	N/A	N/A	N/A
44474A 16-Bit DIO	N/A	s00, s01	s02	N/A
N2263A 32-Bit DIO	N/A	s00, s01, s02, s03	s04, s05	s06
N2264A Multifunction	N/A	s30, s31	s32	N/A
N2265A Multifunction	N/A	s40, s41	s42	N/A

In 16-bit mode, *block data* is interpreted as being the high byte first. In 32-bit mode (port 06), *block data* is interpreted as being the highest byte first, then the second highest and so on. The transfer is completed by setting the GPIB EOI line true concurrently with the last byte of data.

```
CONTROL 7,16,128              ! Set EOI true concurrent
                                with the last character sent.

DIM A$[30]
IOBUFFER A$
A$ = "CMON 5;DBW 504, #IAS"   ! Output a block of data "AS"
                                to the plug-in DIO (Port 04,
                                Slot 5).
TRANSFER A$ to 709 INTR
```

DELAY <*time in mS*>

Inserts a time delay between the time that a channel is closed and the time that the next command or Channel Closed pulse is executed.

The delay time may be a value between 0 and 32,767 mS (32 seconds) in 1 mS increments.

The delay time does not become effective until either a CHAN or a STEP is executed.

If any command is sent to the 3499A/B/C during the delay time, the command will not be executed until the delay time has completed.

For 44474A digital I/O module, a Channel Closed pulse will be sent after the delay time is complete (when External Increment enabled).

Executing DELAY with no parameters will read back the current delay time in mS.

The default delay time is "0" after an instrument power up or reset.

```
OUTPUT 709; "DELAY 2000; CHAN 101"
```
                                           ! The delay time is 2 seconds.
```
OUTPUT 709; "DELAY"
ENTER 709; A
DISP A                             ! Display the delay time.
```

5

DISP *<ASCII character string>*

Writes a message (up to 13 characters) to display on the front panel of the 3499A/B/C.

ASCII character string can be up to 13 characters. The characters supported by the 3499A/B/C are shown below

Type	Letters (Supported by 3499A/B/C)
Number	0-9
Letter	a-z; A-Z
Special Character	' (space) ( ) * + , - . / \

The lower case characters can be included in *ASCII character string,* but the characters displayed on the front panel are all uppercase.

A colon (:) or a semicolon(;) is used as the terminator to end the string. An error will occur if there are other characters following the colon or semicolon.

> OUTPUT 709; "DISP "It's a DIO" *! Display "IT'S A DIO".*

5

DMODE <*slot*>[,<*mode*>][,<*polarity*>][,<*EI*>]

Establishes the handshake mode as well as polarity of the digital I/O bits and control lines for the plug-in DIO modules. It is also used to enable/disable the External Increment (EI) and Channel Closed (CC) pulse functions for the 44474A DIO module.

The *slot* parameter is a decimal ranging from 0 to 9 (mainframe dependent). Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

The *mode* parameter can take one of the values shown in the table below. Complete descriptions of the handshake modes are given beginning on page 86.

Handshake Mode	Parameter Value
Static 1 (default) mode	1
Static 2 (read what was written) mode	2
R/W and Strobe mode	3
Read & Write Strobe mode	4
Handshake (no EI or CC) mode	5

5

Note   Only the ports including the first bit (i.e. Ports 00, 04, 06, etc.) on a digital I/O model can be set to Mode #3, #4 or #5, and the three control lines are valid for these ports. Other ports can be only in Static Mode #1 or #2, and the three control lines are invalid.

The *polarity* parameter sets the polarity of both the 16/32-bit data lines and the handshake/control lines. When the polarity of the control lines is changed by this command, the DIO modules will immediately change the states of the affected lines. For the data lines, the current state is not immediately changed, but the new polarity will be used in subsequent operations.

The *polarity* parameter is a decimal weighted sum of up to seven bits and is defined below.

Definition	Bit #	Value
Default, data lines high true (open), PCTL and PFLG low means ready, I/O Direction line high for ready.		0 = Default
1st 8-bit port polarity	0	1 = Low means positive, High means negative
2nd 8-bit port polarity	1	2 = Low means positive, High means negative
PCTL Polarity	2	4 = Low means busy, High means ready
PFLG Polarity	3	8 = Low means busy, High means ready
I/O Direction line polarity	4	16 = Low means input, High means output
3rd 8-bit port polarity	5	32 = Low means positive, High means negative
4th 8-bit port polarity	6	64 = Low means positive, High means negative

Note   If the *slot* parameter is 0, the *mode* parameter will be ignored. The polarity of the built-in DIO Port *090* is specified. In this case, the *EI* parameter is used to enable/disable the external Trig In/Out lines.

The *EI* parameter provides a method of sequencing through a scan list without system computer intervention. *EI* is enabled when set to 1 and disabled when set to 0.

The *EI* parameter is only applicable for the 4-bit built-in DIO and the 44474A plug-in module. For other DIO modules, *EI* is ignored.

When *slot* is set to 0, the EXT TRIG IN & OUT lines on the Mini_DIN connector (shown on page 7) will be enabled when *EI* = 1. Using the external increment/external triggering for a scan list is described in more detail beginning on page 82.

You can send DMODE `<slot>` with no parameters and the 3499A/B/C will respond with a display of the currently set parameters (i.e., mode, polarity, EI).

Whenever power on or reset the instrument, the DIO modules are put in Static Mode #1, with High True Logic on all lines, EI/CC are disabled.

```
OUTPUT 715; "DMODE 5,1,0,1"      ! Set the EI & CC Mode and
                                   STATIC Mode #1.
```

DOFF

Turns off the 3499A/B/C's display. This allows the instrument to operate faster because it no longer needs to update the display.

    OUTPUT 709; "DOFF"   *! Turn off the display.*

DON

Turns on the 3499A/B/C's display.

The display will be reactivated by either the DON command or pressing the **LOCAL** key. Use DON to remove a message written to the display with a DISP command.

    OUTPUT 709; "DON"   *! Turn on the display.*

5

DREAD *<slot><port>*[,*number of times to read*]

Reads the current status of the DIO modules' ports designated as inputs. The decimal value read back is equal to the decimal sum of the bit values that are set. When Slot 0 is specified, only Port 090 is valid.

The *slot* parameter is a decimal ranging from 0 to 9 (mainframe dependent). Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

The *port* parameter is a number that indicates where the data is to be read. The port is module dependent and the valid port numbers are shown below.

Model Number	4-Bit Port	8-Bit Port	16-Bit Port	32-Bit Port
4-Bit Built-in DIO	090	N/A	N/A	N/A
44474A 16-Bit DIO	N/A	s00, s01	s02	N/A
N2263A 32-Bit DIO	N/A	s00, s01, s02, s03	s04, s05	s06
N2264A Multifunction	N/A	s30, s31	s32	N/A
N2265A Multifunction	N/A	s40, s41	s42	N/A

If the DIO modules are using the Static Mode #1, this command will read the input data. The DIO modules must be using Static Mode #2 for this command to read the outputs.

The *number of times to read* parameter sets the number of times to read the port. The 3499A/B/C must be in OLAP 1 mode (see page 123) and the information is sent as a block with the readings separated by commas.If no *number of times to read* is given, the specified port will be read one time only. The maximum value of *number of times to read* is 32767.

- When reading the 4-bit built-in DIO port (Port 090), the decimal value will be between 0 and 15.

- When reading an 8-bit port, the decimal value of the bits will be between 0 and 255.

- When reading a 16-bit port, the decimal value of the 16 bits will be between –32768 and 32767. Any time the summed decimal value of the 16 bits would exceed +32768, the 2's complement form is used and expressed as a negative number.

- When reading a 32-bit port, the decimal value will be between –2147483648 and 2147483647. Any time the summed decimal value of the 32 bits would exceed +2147483647, the 2's complement form is used and expressed as a negative number.

```
DIM A$[700]
OUTPUT 709; "OLAP 1"
OUTPUT 709; "DREAD 501,100"      ! Take 100 readings.
ENTER 709; A$                    ! Enter all 100 readings.
DISP A$                          ! Display readings.
END
```

5

DWRITE `<slot><port>,<data>[,<data>...]`

Configures all or part of a DIO module to digital output ports and writes data to the DIO ports.

The *slot* parameter is a decimal ranging from 0 to 9 (mainframe dependent). Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

The *port* parameter is a number that indicates where the data is to be written. The port is module dependent and the valid port numbers are shown below.

Model Number	4-Bit Port	8-Bit Port	16-Bit Port	32-Bit Port
4-Bit Built-in DIO	090	N/A	N/A	N/A
44474A 16-Bit DIO	N/A	s00, s01	s02	N/A
N2263A 32-Bit DIO	N/A	s00, s01, s02, s03	s04, s05	s06
N2264A Multifunction	N/A	s30, s31	s32	N/A
N2265A Multifunction	N/A	s40, s41	s42	N/A

- When writing to the 4-bit built-in DIO port (Port 090), the decimal value must be between 0 and 15.

- When writing to an 8-bit port, the decimal value of the bits must be between 0 and 255.

- When writing to a 16-bit port, the decimal value of the 16 bits must be between −32768 and 32767. Any time the summed decimal value of the 16 bits would exceed +32768, the 2's complement form must be used and expressed as a negative number.

- When writing to a 32-bit port, the decimal value must be between −2147483648 and 2147483647. Any time the summed decimal value of the 32 bits would exceed +2147483647, the 2's complement form must be used and expressed as a negative number.

There is no limit to the number of data items that can be sent with the DWRITE command.

```
OUTPUT 709; "DWRITE 206, -1074267141"
```

EHALT <0 │ 1>

Enables or disables the stop-on-error mode. When enabled (EHALT 1), an error will lockup the GPIB interface (no GPIB communication). Default condition is disabled (EHALT 0), which allows GPIB communication after an error is discovered.

Note

Once the GPIB is locked up, you must reset the GPIB interface. The 3499A/B/C can be reset by either pressing the front panel local key or executing the GPIB CLEAR command.

```
OUTPUT 709; "EHALT 1"              ! Enable the stop-on-error mode.
```

ERROR

Reads the 3499A/B/C's error register. The returned decimal value is the sum of the values of the possible error conditions, as shown below:

Bit	Weighted Value	Error Condition
0	1	Syntax Error
1	2	Execution Error possible meanings include: a. Parameter out of range b. Card type mismatch c. Attempt to access a nonexistent stored state or scan list
2	4	Hardware Trigger too fast
3	8	Logical Failure
4	16	Power Supply Failure

```
OUTPUT 709; "ERROR"
OUTPUT 709; A
DISP A
```

ID?

Queries the 3499A/B/C's identity and returns a string in the form "3499A".

```
10   OUTPUT 709; "ID?"
20   ENTER 709; A$
30   DISP A$                        ! Display the returned string.
```

LOCK <0 │ 1>

Locking out the keyboard prevents the keyboard from being scanned thus permitting faster operation.

LOCK 1 locks the keyboard and LOCK 0 (default) unlocks the keyboard.

    OUTPUT 709; "LOCK 1"   *! Lockout the keyboard.*

MASK [<*decimal value*>]

Sets the SRQ mask to allow certain conditions to generate SRQ.

The *decimal value* loaded into the mask is equal to the sum of the values of the conditions that will cause an SRQ interrupt as shown below:

Mask Bit	Weighted Value	Description
0	1	End of Scan Sequence
1	2	Output available
2	4	Power-on SRQ true
3	8	Not used
4	16	Ready for instructions
5	32	Error
6		SRQ (This bit is not maskable)
7		Not used

If no value is sent with the MASK command, the 3499A/B/C will display or output the current value of its SRQ mask to the computer.

    OUTPUT 709; "MASK 8"   *! Set the mask for Front Panel*
                                    SRQ key.
    OUTPUT 709; "MASK 33"   *! Set mask for Error (32) and*
                                    End of Scan Sequence (1).
    OUTPUT 709; "MASK"
    ENTER 709; A
    DISP A   *! The current mask value is*
                                    displayed.

5

OLAP <0 │ 1>

Suspends or releases the GPIB I/O communications.

In the Overlap disabled mode (default, OLAP 0), the 3499A/B/C holds up GPIB I/O communications while it processes received messages.

When Overlap is enabled (OLAP 1), the 3499A/B/C will release the GPIB as soon as the command message is received. Overlap enabled allows faster I/O operations but does not guarantee sequential operation of other devices on the bus.

Overlap goes into effect on the first Bus communication after the OLAP message sent.

Overlap only applies to commands received, not to data sent by the 3499A/B/C.

In Overlap enabled, you should monitor Bit 4 in the 3499A/B/C Status Register to help insure sequential operation of other instruments on the GPIB interface.

OLAP 1 is necessary for multiple readings from the digital I/O modules with the DREAD and DBR commands.

Switching between OLAP 0 and OLAP 1 should have a minimum delay time of 5 seconds before sending other commands.

```
OUTPUT 709; "OLAP 1"
```

5

OPEN *<channel_address>*[,*<channel_address>*,*<channel_address>*...]

Open one or multiple channels/bits on the plug-in modules.

The *channel_address* has the form @*snn*, where *s* is the slot number and *nn* is the channel number. For all mainframes, slot 0 refers to the 3499A/B/C control board. Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

The channel number, *nn*, is plug-in module dependent. Channel numbers for plug-in modules are listed on page 70.

Several channels/bits can be opened with one OPEN command by separating the channel/bit addresses with a comma. If more than one channel/bit is specified, they are opened in the order listed. Use CARD RESET command to open all channels/bits on the modules, it is easier than listing each channel/bit.

When OPEN is used with the DIO modules (44474A, N2263A, N2264A, N2265A), the DIO modules must be in either default Static Mode #1 or Static Mode #2. Using the OPEN command in any other mode will cause an error. In these modes there is no read or write handshaking.

The bits 091-094 on the 4-bit built-in digital I/O can be also included in a *channel_address*.

All the channels in the plug-in modules are opened following a reset. For the DIO modules, all bits are operating as input bits. There is no handshaking enabled.

```
OUTPUT 709; "OPEN 103,105,113,116"
                                    ! Open channels 3, 5, 13, 16 in
                                      Slot 1.
```

RECALL <1-40>

Recalls the channel/bit setup stored by the command STORE. Only relays
and static Digital Outputs are recalled. This means that only those
channels/bits that are closed in the stored channel setup will be closed
when the channel setup is recalled.

Note   If no state has been stored in the channel setup selected, an error will
result and the 3499A/B/C will send SRQ if it was enabled (see MASK on
page 122). In this case, the 3499A/B/C remains in its previous state.

```
OUTPUT 709; "CLOSE 103,104,202,204,206; STORE 6"
OUTPUT 709; "RECALL 6"
```

RESET

Used to reset the 3499A/B/C to the power on state. Reset performs the
following:

• Identifies all plug-in modules and resets them (all relays open)

• Sets all parameters of the instrument to their default conditions. The
reset conditions are shown on page 71.

This command does not affect the GPIB settings or stored states.

Note   If RESET is executed over the remote interface, interface functions are
not affected (i.e. the 3499A/B/C will stay in Remote mode). If the front
panel **RESET** key is pressed, interface functions are reset.

```
OUTPUT 709; "RESET"
```

5

SLIST *<channel_address>*[*,<channel_address>,<channel_address>*...]

> Specifies a sequence of channels to be scanned. The sequence is specified as a list of up to 85 channel addresses (relays or digital I/O lines) and/or stored setups separated by commas. Contiguous channels may be specified by entering the first channel address and the last channel address separated by a hyphen. STEP is used to sequentially close channels in the list.
>
> The *channel_address* has the form @*snn*, where *s* is the slot number and *nn* is the channel number. For all mainframes, slot 0 refers to the 3499A/B/C control board. Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

> The channel number, *nn*, is plug-in module dependent. Channel numbers for plug-in modules are listed on page 70.
>
> The 4-bit built-in DIO bits (091-094) can be included in a scan_list.
>
> Channels may be scanned in any sequence, i.e., 309-300.
>
> Stepping beyond the last channel specified in the scan list cause a wrap-around to the first channel in the list. The number 0 can be used as a stop channel.
>
> CHAN may be used to specify a particular channel/bit to close. If CHAN is used, any channel/bit previously closed in the scan list will open and the channel/bit specified by CHAN will close. In addition, if the channel/bit closed by CHAN is specified in the scan list, subsequent scanning with the STEP command will start with that channel/bit.
>
> The commands OPEN, CLOSE, CRESET, or RECALL will have no effect on the scan list even though the states of individual channels change.
>
> Stored channel setups may be recalled as part of a scan list by specifying the register number.

5

For example, in the code below, the scan would start by closing channel 104, followed by channel 205, then recall saved setup 10, followed by channels 300, 301, 302, ... 309, and finally channel 410. The 0 channel specified at the end of the list is a stop channel, which will open the last channel closed (channel 410) without closing any other channel.

```
OUTPUT 709; "SLIST 104,10,205,300-309,410,0"
                                  ! '10' is a stored setup. '0' at
                                    the end of the list opens
                                    channel 410.

FOR I= 1 TO 15
  OUTPUT 709; "STEP"
NEXT I
```

SYSMODE <0│1│SCPI│HP3488A>

Specifies the system mode for the Agilent 3499A/B/C Switch/Control system.The 3499A/B/C can be operated in either one of the two system modes. Specifying 0│SCPI will set the instrument to SCPI mode. Specifying 1│HP3488A will set the instrument to 3488A mode.

Switching the system modes between SCPI mode and 3488A mode will cause the instrument to return to its default state, but the GPIB address and the RS-232 settings will remain at what they had been configured.

The instrument requires a minimum of 5 seconds to change modes. You should program a minimum 5 second delay before sending commands after a mode change to prevent and error.

```
OUTPUT 709; "SYSMODE HP3488A"  ! Specify the instrument
                                  system mode.
```

SYSMODE?

Queries the system mode for the Agilent 3499A/B/C Switch/Control system. The returned string will be either "SCPI" or "HP3488A", indicating the instrument's system mode.

```
OUTPUT 709; "SYSMODE HP3488A"  ! Specify the instrument's
                                  system mode.
OUTPUT 709; "SYSMODE?"         ! Query the instrument's
                                  system mode. "HP3488A"
                                  will be returned, indicating
                                  that the instrument is in
                                  3488A mode.
```

5

SREAD *<slot><register>*

Reads data from the input port on a 44475A Breadboard in the specified slot. The data read back is in the form of a decimal number which is the sum of the binary weighted values of the bits that are high (+5 volts). This command is for 44475A Breadboard only.

The *slot* parameter is a decimal ranging from 0 to 9 (mainframe dependent). Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

Two 8-bit ports are available on the 44475A Breadboard. One port is a static read only port (04), the second port is static write only (00). Static means that there is no handshaking involved in data transfers.

The *register* parameter value is 04. If a number other than 04 is used (any value between 0 and 7 will not cause an instrument error), the value 255 will be returned.

```
OUTPUT 709; "SREAD 304"        ! Breadboard in Slot 3.
ENTER 709; A
DISP A
```

5

SWRITE *<slot><register>,<data>*

Writes data to the output port on a 44475A breadboard in the specific slot. The data value is a decimal sum of the binary weighted values of the bits that are to be set high (+5 volts).

The *slot* parameter is a decimal ranging from 0 to 9 (mainframe dependent). Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

Two 8-bit ports are available on the 44475A Breadboard. One port is a static read only port (04), the second port is static write only (00). Static means that there is no handshaking involved in data transfers.

The *register* parameter value is 00. Any number between 1 and 7 may be used without causing an error, however no action will be taken by the Breadboard.

data is the binary weighted sum to write to the register. *data* can range from 0 to 255.

```
OUTPUT 709; "SWRITE 500,146"    ! Breadboard in Slot 5.
ENTER 709; A
DISP A
```

5

STATUS

Reads the 3499A/B/C's Status Byte and returns a decimal value that is the sum of the values of the individual bits that are set (condition is true).

Bit	Weighted Value	Definition
0	1	End of scan sequence
1	2	Output available
2	4	Power-on SRQ asserted
3	8	Front panel SRQ key pressed
4	16	Ready for instructions
5	32	Error
6	64	RQS
7	128	Not used

Bits 0, 2, and 3 will be cleared after the STATUS command is executed. Bit 1 will be cleared only after the data is read from the 3499A/B/C, new data is requested, or the 3499A/B/C is reset. The Ready for Instructions bit (Bit 4) will be cleared whenever the 3499A/B/C is busy executing instructions. For this reason, Bit 4 will always be clear when STATUS is executed. The Error bit (Bit 5) will only be cleared after the Error Register is read. Bit 6, RQS, will only be cleared after STATUS, if the condition that caused Bit 6 to be set is cleared.

```
OUTPUT 709; "STATUS"
ENTER 709; A
DISP A
```

5

STEP

Opens the last channel closed and close the next channel in the Scan List. If STEP is executed and no Scan List exists, the 3499A/B/C will generate an execution error.

The 3499A/B/C uses a pointer to keep track of which channel in the Scan List is currently closed. When STEP is executed, that channel is opened and the next item in the list is checked. If the next item in the list is a relay or a digital I/O line, that channel/bit is closed. If the next item in the list is a stored channel setup, that channel setup is recalled. If the next item in the list is a stop channel 0, the last channel/bit closed will be open without closing any channel/bit.

Channels that are closed by a channel setup will remain closed; they are not opened by the next execution of the STEP command.

```
10 OUTPUT 709; "SLIST 100-119; CMON 1"
20 FOR I= 1 TO 20
30 OUTPUT 709; "STEP"
40 NEXT I
```

STORE <1-40>

Records the current state of the 3499A/B/C (including the channel states, the static digital output states, etc.) in the specified register number (1-40).

Up to 40 channel/bit setups can be stored when operating the instrument in 3488A mode. Use RECALL (page 125) to restore a previously stored state.

The channel/bit setup(s) can be included in a scan list.

The states of digital I/O modules that are not using handshake modes #1 or #2 are ignored.

The channels' state will not be changed when STORE is executed.

Resetting the 3499A/B/C does not affect the stored channel/bit setup.

```
OUTPUT 709; "CLOSE103,115,203,204,205,206"
OUTPUT 709; "STORE 9"            ! Store the channel setup in
                                    Register 9.
OUTPUT 709; "RECALL 9"           ! Recall the channel setup 9.
```

5

TEST

Initiates the internal self tests and returns a number indicating the test results. A value of "+00000" returned indicates all tests have passed. Any other value indicates the instrument failed the tests as shown below:

Error Number	Description
+00001	ROM Test Failed.
+00002	GPIB Test Failed.
+00003	RS-232 Test Failed.
+00004	Front Panel Test Failed.

```
OUTPUT 709; "TEST"
ENTER 709; A
DISP A
```

5

VIEW <*channel_address*>

Shows the state, either open or closed of a particular channel or a DIO bit. The 3499A/B/C responds with the string "OPEN 1" if the specified channel/bit is open. If the specified channel/bit is closed, the 3499A/B/C responds with the string "CLOSED 0".

The *channel_address* has the form @*snn*, where *s* is the slot number and *nn* is the channel number. For all mainframes, slot 0 refers to the 3499A/B/C control board. Valid slot numbers are:

3499A	slots 0 through 5
3499B	slots 0 through 2
3499C	slots 0 through 9

The channel number, *nn*, is plug-in module dependent. Channel numbers for plug-in modules are listed on page 70.

Only one channel/bit can be "viewed" each time with this command.

VIEW can only be used to look at input bits on a digital I/O module. If an attempt is made to VIEW an output bit, the 8-bit port where the bit is located will revert to an input port.

```
OUTPUT 709; "VIEW 105"          ! View channel 5 on slot 1.
ENTER 709; A$                   ! Input the response from the
                                  3499A/B/C.
DISP A$                         ! A$ will either be "OPEN 1"
                                  or "CLOSED 0".
```

- or -

```
OUTPUT 709; "VIEW 105"          ! View channel 5 on slot1.
ENTER 709; A                    ! "A" will be either 1 or 0 (open
                                  or closed, respectively)
DISP A
```

5

5

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Error Messages

Error Messages

In 3488A mode, you can query the instrument error queue when the **ERROR** annunciator is on. The returned decimal value is the sum of the values of the possible error conditions, as shown below:

Weighted Value	Error Condition
1	Syntax Error

2	Execution Error which includes:
	    a. Parameter out of range;
	    b. Module type mismatch;
	    c. Attempt to access a nonexistent stored state
	       or scan list.

4	Hardware Trigger too fast
8	Logical Failure
16	Power Supply Failure

Note   When the error queue is empty, the string "+00000" is returned in response to a remote interface ERROR command. The mainframe display will show "0000".

Self Test Errors

The errors listed below indicate failures that may occur during a self-test (in 3488A mode).

Error Number	Description
+1	ROM test failed.
+2	GPIB test failed.
+3	RS-232 test failed.
+4	Front-panel test failed.

Note   The string "+0" returned from a TEST command indicates that all the tests have passed. In this case, "PASSED" displays on the front-panel of the instrument.

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Application Programs

Application Programs

This chapter provides example programs in Visual C++, Visual BASIC and BASIC to help you develop programs for your specific application. Chapter contents include:

- Visual C++ Example Program, on page 139

- Visual BASIC Example Program, on page 141

- BASIC Example Program, on page 143

Note   For the example programs provided in this chapter to run properly, make sure that your system has been properly setup according to the requirements of the individual example.

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Visual C++ Example Program

This example program is written in Visual C++ 6.0 and has been tested on a PC running WIN95/NT. The example uses the 3488 commands. As the example is currently written, the program requirements are:

- GPIB interface selected and set to the address of 09 from the front-panel;

- Any one of the relay modules installed in Slot 1 of the mainframe;

- A GPIB interface card installed in your PC with the VISA library.

```
#include <stdio.h>
#include <windows.h>
#include "visa.h"

#define INST_ADDR"GPIB0::9::INSTR   // 3499A/B/C GPIB address.

void main()
{
    ViSession drm;     // Session to default resource manager.
    ViSession vi;      // Session to instrument.
    ViStatus status;   // VISA function status return code.
    int i;

    /* Open the default resource manager. */
    status = viOpenDefaultRM( &drm );
    if ( status < VI_SUCCESS ) {
       printf( "VISA ERROR: viOpenDefaultRM()\n");
       exit(1);
    }

    /* Open a session to the 3499A/B/C. */
    status = viOpen( drm, INST_ADDR, VI_NULL, VI_NULL, &vi );
    if ( status < VI_SUCCESS ) {
       printf( "VISA ERROR: viOpen(). Address: %s\n",INST_ADDR);
       viClose( drm );
       exit(1);
    }

    /* Set 3499A/B/C to 3488A mode. */
    viPrintf( vi, "SYSMODE HP3488A\n" );
    Sleep( 4000 );     //Wait 4 seconds.

    /* Reset the instrument to a known state. */
    viPrintf( vi, "RESET\n" );
    Sleep( 4000 );

    /* Close channels 100 through 103. */
    viPrintf( vi, "CLOSE 100, 101, 102, 103\n");

    /* Open channels 100 through 103. */
    viPrintf( vi, "OPEN 100, 101, 102, 103\n");
```

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```
/* Create a scanlist, then set up a loop to scan through
 the channels two times. */
viPrintf( vi, "SLIST 100-103\n");
for ( i = 0; i < 8; i++ ) {
   viPrintf( vi, "STEP\n" );
   Sleep( 25 );    // Wait 25 milliseconds.
}
printf( "Scan End.\n" );

viClose( vi );    // Close session to 3499A/B/C.
viClose( drm );    // Close session to the resource manager.
}
```

Visual BASIC Example Program

This example program is written in Visual BASIC 6.0 and has been tested on a PC running WIN95/NT. The example uses the 3488 commands. As the example is currently written, the program requirements are:

- GPIB interface selected and set to the address of 09 from the front-panel;

- Any one of the relay modules installed in Slot 1 of the mainframe;

- A GPIB interface card installed in your PC with the VISA library.

```
Declare Sub Sleep Lib "Kernel32" (ByVal s As Long)
' Sleep( ) function declaration.

Sub main()

    Dim drm As Long   ' Session to default resource manager.
    Dim vi As Long    ' Session to instrument.
    Dim status As Long ' VISA function status return code
    Dim retStr As String * 128
    ' String returned from the instrument.
    Dim str As String  ' String for individual channel number.

    On Error GoTo ErrorHandler

    ' Open default resource manager.
    drm = -1
    status = viOpenDefaultRM(drm)
    If (status < VI_SUCCESS) Then GoTo VisaErrorHandler

    ' Open a session to 3499A/B/C.
    INST_ADDR = "GPIB0::9::INSTR"
    ' Set 3499A/B/C GPIB address to 9 (default).
    status = viOpen(drm, INST_ADDR, 0, 0, vi)
    If (status < VI_SUCCESS) Then GoTo VisaErrorHandler

    ' Set 3499A/B/C to 3488A mode.
    Call viVPrintf(vi, "SYSMODE HP3488A" + Chr$(10), 0)
    Call Sleep(4000)    ' Wait 4 seconds

    ' Reset the instrument to a known state.
    Call viVPrintf(vi, "RESET" + Chr$(10), 0)
    Call Sleep( 4000 )

    ' Close channels 100 through 103.
    Call viVPrintf(vi, "CLOSED 100, 101, 102, 103" + Chr$(10), 0)

    ' Open channels 100 through 103.
    Call viVPrintf(vi, "OPEN 100, 101, 102, 103" + Chr$(10), 0)
```

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```
        ' Create a scanlist, then set up a loop to scan through
        ' the channels two times.
        viVPrintf(vi, "SLIST 100-103" + Chr$(10), 0)
        ' Create a scan list including 100 through 103.
        For I = 0 To 8
            Call viVPrintf(vi, "STEP" + Chr$(10), 0)
          ' Step through the channels.
            Sleep ( 25 )    ' Wait 25 milliseconds.
        Next

        viClose (vi)    ' Close session to 3499A/B/C.
        viClose (drm)   ' Close session to the resource manager.
        End

  ErrorHandler:
        ' Display the error message
        MsgBox "''' Error : " + Error$, MB_ICON_EXCLAMATION
        If drm <> -1 Then
            viClose (drm)
        End If
        End

  VisaErrorHandler:
        Dim strVisaErr As String * 200
        Call viStatusDesc(defrm, status, strVisaErr)
        MsgBox "''' Error : " + strVisaErr
        If drm <> -1 Then
            viClose (drm)
        End If
        End

  End Sub
```

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BASIC Example Program

Sample programs in this section are written in BASIC 6.0 and have been tested on a UNIX workstation.

Requirements:

- GPIB interface selected and set to the address of 09 from the front-panel;

- Any one of the relay modules installed in Slot 1 of the mainframe;

- A GPIB interface card installed in your UNIX workstation.

```
10    ! EXAMPLE.BAS: TEST 3499A/B/C IN 3488A MODE
20    DIM Retstr$[128]! String returned from the instrument.
30    OUTPUT 709; "SYSMODE HP3488A"! Set 3499A/B/C to 3488A mode
40    WAIT 4! Wait 4 seconds.
50    OUTPUT 709; "RESET" ! Reset 3499A/B/C.
60    WAIT 4
70  ! Close channels 100 through 103.
80    OUTPUT 709; "CLOSE 100, 101, 102, 103"
90  ! Open channels 100 through 103.
100   OUTPUT 709; "OPEN 100, 101, 102, 103"
110   ! A SIMPLE SCAN.
120   OUTPUT 709; "SLIST 100-103"! Create a scan list.
130   FOR I=0 TO 8! Step through the channels two times.
140   OUTPUT 709; "STEP"
150   WAIT .025
160   NEXT I
170   Done: END
```

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