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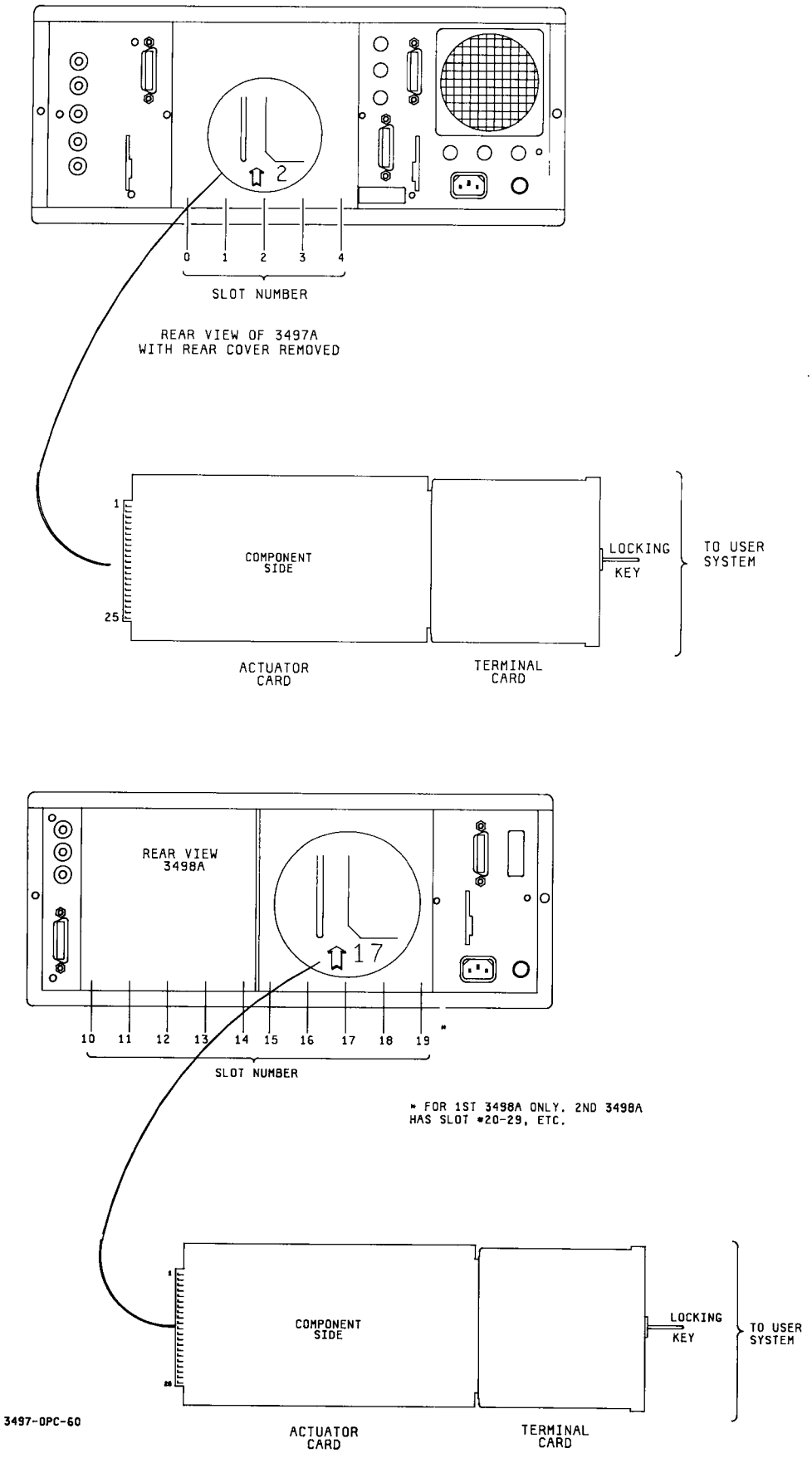


Figure 60. Installing Plug-In Assemblies (Example)

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HP-IB INSTALLATION

This part of the chapter shows how to connect the 3497A to an HP-IB bus and provides guidelines for designing an HP-IB system. This information applies only to 3497As with HP-IB capability. See RS232C Installation or RS449/423 Installation for a 3497A with RS232C or RS 449/423 capability.

NOTE

The Hewlett-Packard Interface Bus (HP-IB) is the Hewlett-Packard implementation of IEEE Standard 488-1978, "Standard Digital Interface for Programmable Instrumentation" and ANSI Standard MC 1.1.

Configuring the HP-IB

As factory configured, the 3497A is set for HP-IB address 09, TALK ONLY mode disabled and no POWER ON SRQ capability. If your operation requires a different address for the 3497A or if you need to set power-on interrupt (SRQ) or set the 3497A for TALK ONLY mode, see Changing HP-IB Addresses in the MAINFRAME CONFIGURATION part of this chapter before connecting the 3497A to the HP-IB interface bus.

After you have set the HP-IB address, TALK ONLY and POWER ON SRQ ENABLE switches as required for your operation, the next step is to connect the 3497A to the HP-IB. To do this, first decide how many instruments are going to be on the bus and their locations.

A total of 15 HP-IB compatible instruments can be connected to the bus. HP-IB cables have identical "piggy-back" connectors on both ends so that several cables can be connected to a single source. A typical HP-IB system interconnection and sample system setup is shown in Figure 61.

A good rule to follow is not to stack more than two cables on any one connector. If the stack is too large, any force on the stack can break connectors and affect HP-IB operation.

For best HP-IB performance, total cable length for the system must be less than or equal to 20 meters (65 feet). Total cable length must be less than or equal to 2 meters (6 feet) times the total number of devices connected to the HP-IB (i.e., 4 meters total for 2 instruments).

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NOTE

You can order 1 meter, 2 meter or 4 meter HP-IB cables from -hp- as optional accessories. See the Ordering and Configuration Guide in Appendix B.

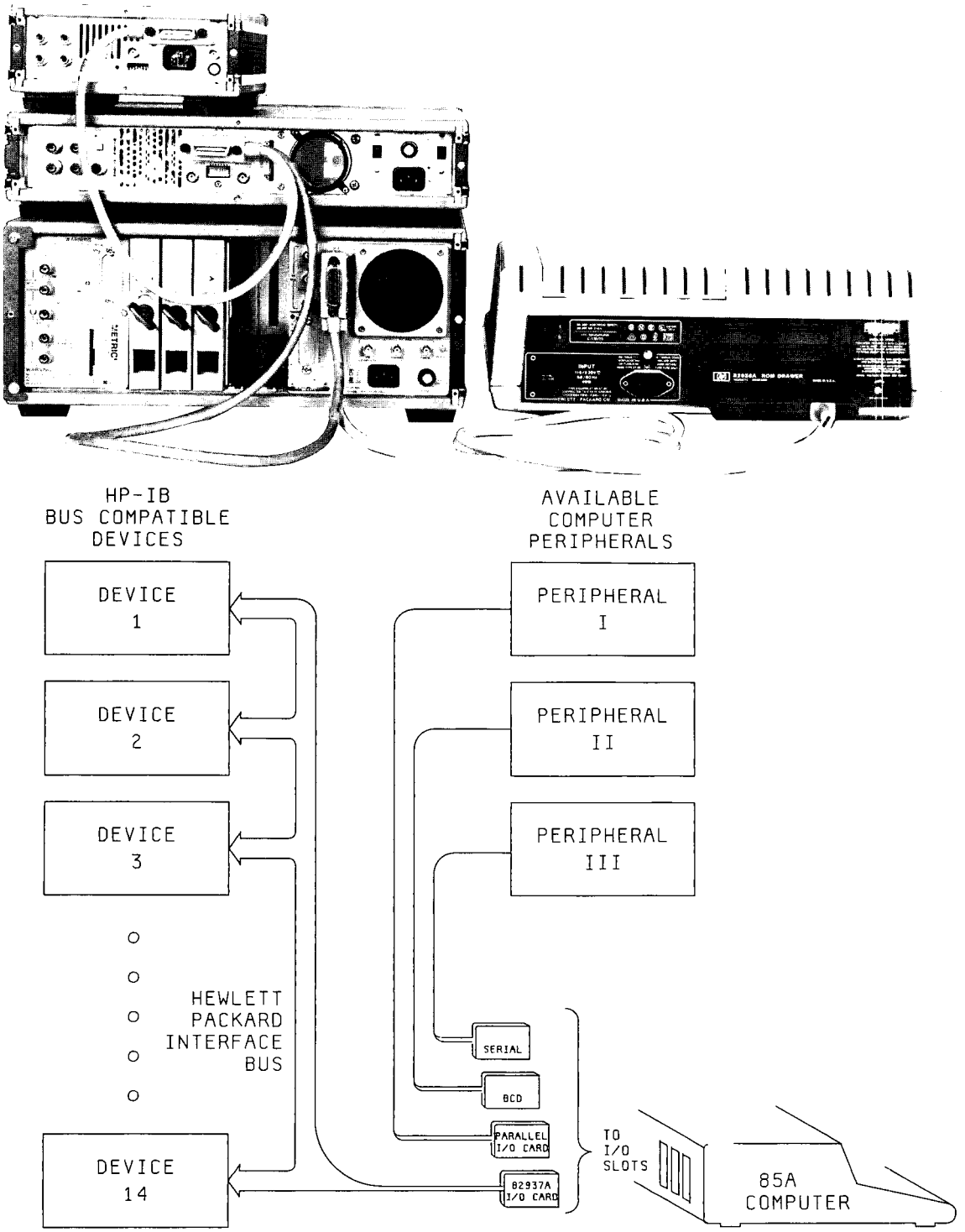


Figure 61. Typical HP-IB System Interconnection

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HP-IB Worksheet

As you are setting up your HP-IB system, you may want to use the HP-IB Worksheet shown to record the capability of each of the devices on your system. In the worksheet shown, the capabilities of the 3497A are already filled in. Refer to your controller manual(s) and device manuals for their bus message capabilities. When this worksheet is filled out, you'll have a permanent record of the device capabilities of your HP-IB system.

HP-IB WORKSHEET

DEVICE

MODEL	3497A							
ADDRESS	09							
TALK/LISTEN	T&L							

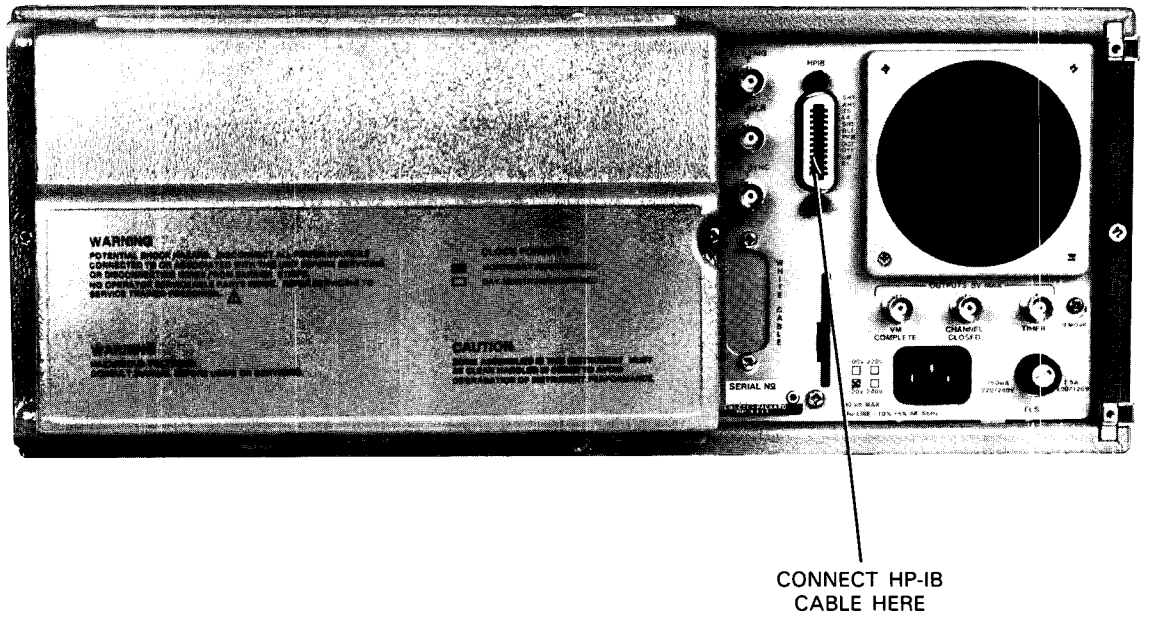
BUS MESSAGE CAPABILITY								
ABORT	N							
CLEAR	R							
DATA	S&R							
LOCAL	R							
LOCAL LOCKOUT	R							
CLEAR LOCKOUT & SET LOCAL	R							
PASS CONTROL	N							
REMOTE	R							
REQUIRE SERVICE	S							
STATUS BIT	N							
STATUS BYTE	S							
TRIGGER	R							

S = SEND ONLY R = RECEIVE ONLY S&R = SEND & RECEIVE
N = NOT IMPLEMENTED T&L = TALK & LISTEN

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Connecting the 3497A to the HP-IB

To interface the 3497A to the HP-IB, connect an appropriate HP-IB interface cable to the HP-IB connector on the 3497A rear panel, as shown in Figure 62. See your controller I/O manual for the interface cable to use.



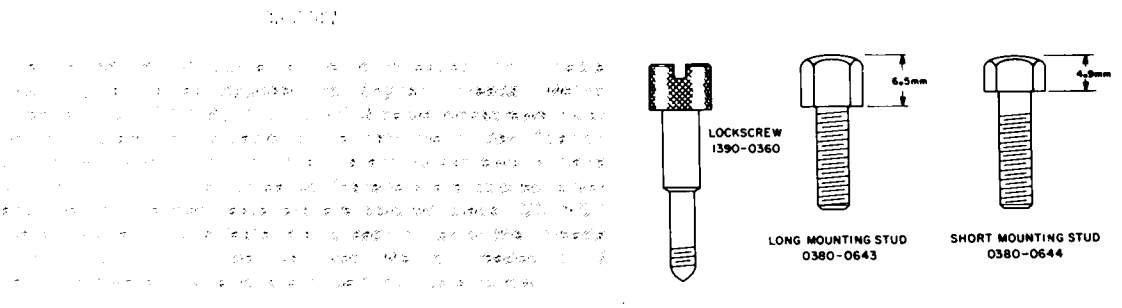


Figure 62. Connecting the 3497A to the HP-IB

3497A Device Capability

The 3497A interfaces to the HP-IB as defined by IEEE Standard 488-1978. Figure 63 shows the HP-IB connector and pin designations. The interface functional subset which the 3497A implements follows.

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3497A DEVICE CAPABILITY

SH1	Source Handshake complete capability
AH1	Acceptor Handshake complete capability
T5	Basic Talker with serial poll, talk only mode and unaddress with MLA
L4	Basic listener, unaddress when MTA
SR1	Service Request complete capability
RL1	Remote-Local complete capability
PP0	No parallel poll capability
DC1	Device Clear complete capability
DT1	Device Trigger complete capability
C0	No controller capability
E1	Open Collector Drivers

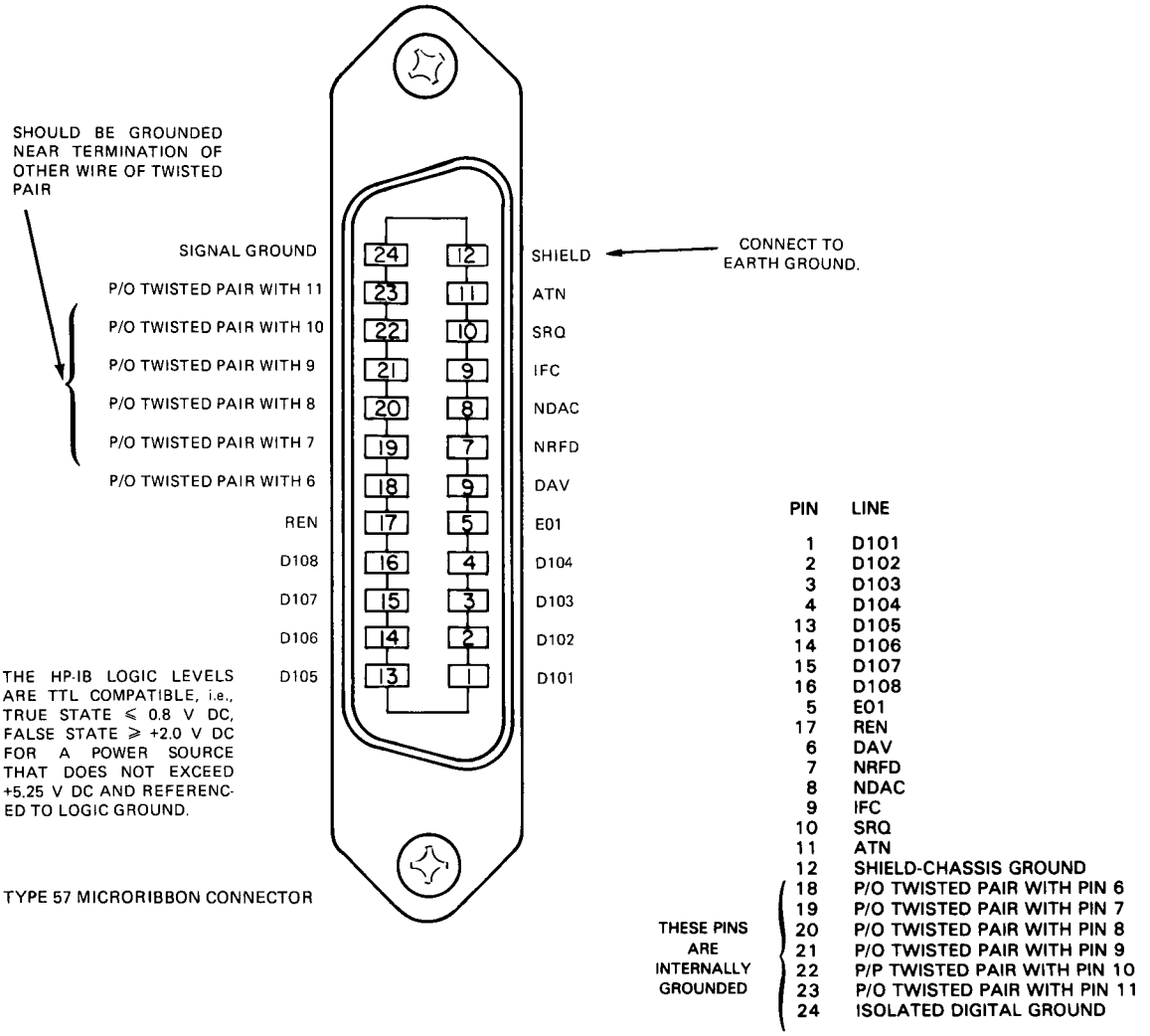


Figure 63. HP-IB Connector Pin Designators

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Checking the 3497A in the HP-IB System

After the 3497A has been connected to the HP-IB, to check its performance connect the AC power plug to the AC line and press the LINE key ON. ALLOW AT LEAST ONE HOUR OF WARM-UP TIME and then send a self-test command from your controller. A sample program in extended BASIC (applicable to -hp- 85 and similar controllers) is shown.

Following command execution, the 3497A front panel display should be as shown in Figure 59 and 8E8 (or equivalent format) should be displayed at the controller. If the self-test fails, an error message is returned and you should consult the 3497A Mainframe Installation and Service Manual for further information.

EXAMPLE - HP-IB OPERATION SELF-TEST

Program	Lines	Description
10 OUTPUT 709; "ST1"	10	Turns self-test ON.
20 ENTER 709; A 30 DISP A 40 WAIT 1000	20-30	Enters and displays 8E8 if self-test passes.
50 OUTPUT 709; "ST0"		
60 END	40-50	Waits 10 seconds and turns self-test OFF.

When the 3497A passes the self-test, it is ready for operation and can be connected to your system. When you connect your 3497A for your specific application, you may want to see Chapter 9 for example ways to make voltage, resistance, thermocouple, frequency or pressure measurements or to do control applications such as interrupts, switching and control sources.

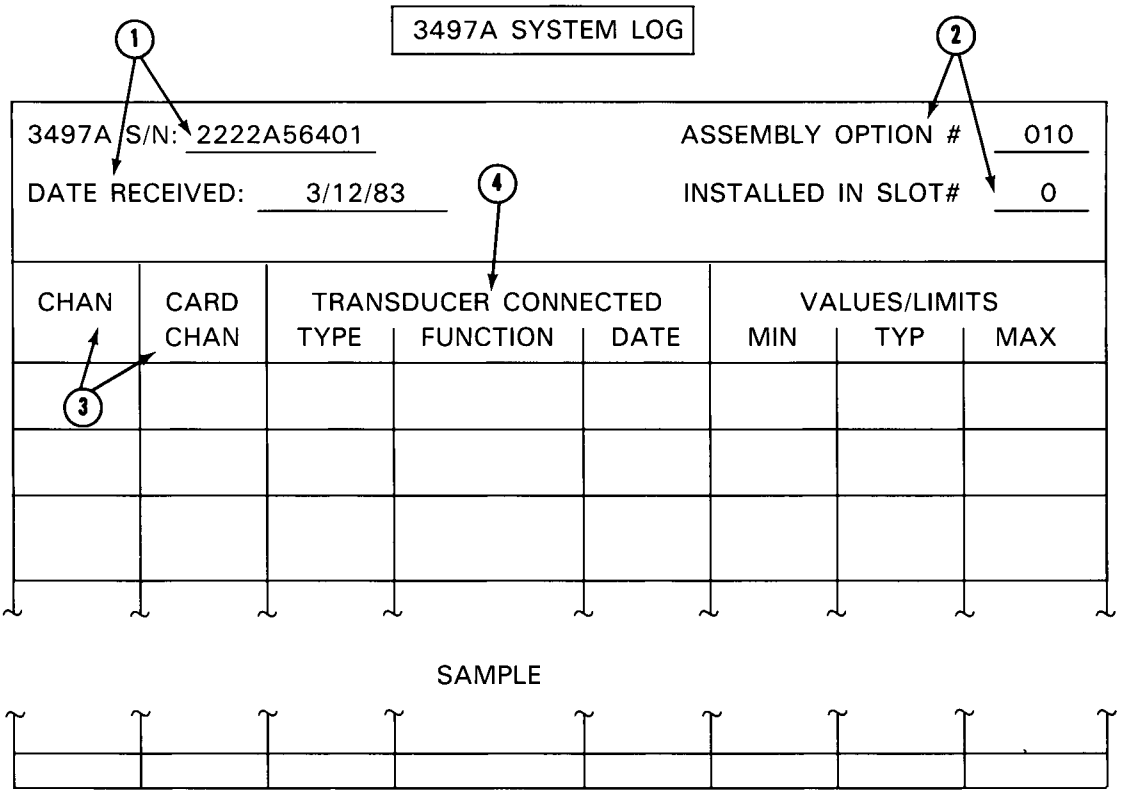
To connect your system to the 3497A, inputs must be connected to appropriate terminals on the plug-in assemblies (Options 010 through 140). Before attaching any system inputs to the assemblies, see Chapter 8 which shows how to configure each assembly for various modes of operation and operating precautions.

3497A System Log

When you are connecting your system inputs to the assemblies, you may want to complete a 3497A System Log similar to the example which follows so that you will have a permanent record of the inputs connected to each channel of the 3497A.

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A blank 3497A System Log is located in Appendix B so that you can copy it if desired. For ease of reference, we suggest that you complete a separate form for each plug-in assembly at initial installation and that all forms be filed in a folder to accompany the 3497A.



(1) Enter the 3497A serial number and the date the instrument was received.

(2) List the option number (010 through 140) of the plug-in assembly for this log and show the 3497A/3498A slot number that the assembly is installed in.

(3) For each channel used, enter the channel number and terminal connectors to which the transducer is connected. For example, with an Option 010 assembly in slot 1, channel numbers are 0 to 19. For an Option 010 assembly in any slot, terminal connectors range from A0 (H, L and G) to B9 (H, L and G). Note: CHANNEL NUMBER column not applicable for Options 050, 060, 110, 115 and 140.

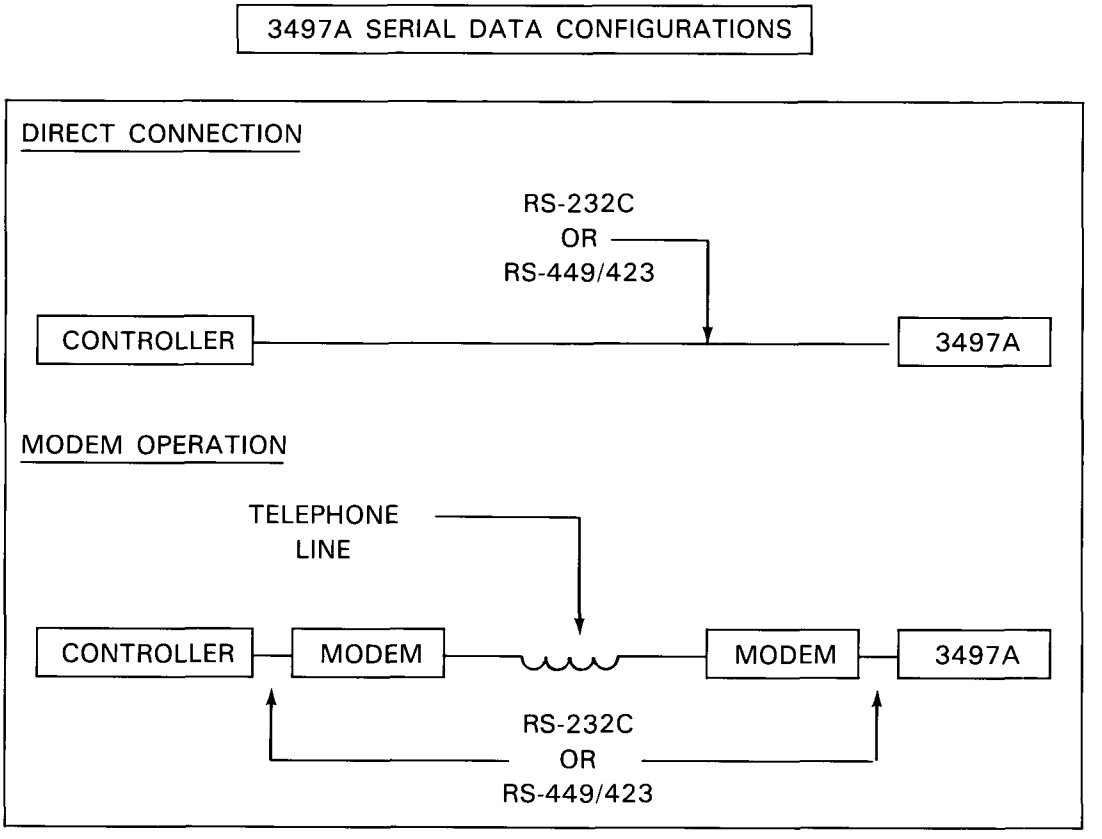
(4) For each transducer connected to a channel, list the transducer type, function and date installed. Then, list a typical measurement value for that transducer. If action is required when limits are exceeded, enter measurement limits under MAX and MIN.

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RS232C INSTALLATION

This part of the chapter provides installation guidelines for the 3497A for RS232C Serial Data operation. With Option 232, the 3497A is compatible with Electronic Industries Association (EIA) standard RS-232C and with RS449 (RS423 subset). It is also compatible with CCITT (Comite Consultatif International Telephonique et Telegraphique) standards CCITT V.24 (for RS232C) and CCITT V.10 (for RS449/423).

The 3497A can be operated from a controller in one of two ways: (1) directly connected to a controller via RS-232C or RS-449/423 or (2) connected to an asynchronous, full duplex MODEM via RS-232C or RS-449/423 for remote site operation using dedicated telephone lines, as shown.



The 3497A can operate only with asynchronous, full duplex MODEMS (data sets). The instrument has been functionally tested to operate with the following (or equivalent) MODEMS:

- Bell 103A, 212A, 103J
- Vadic 3400, 3451
- U.D.S. 103JLP
- -hp- Model 82950A MODEM Interface for the -hp- 85A

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The 3497A can be configured for a wide variety of operating conditions, depending on controller and speed requirements. The following chart shows operating conditions for the 3497A with factory preset conditions outlined. If you need to reset the 3497A for operating conditions other than factory configuration, see MAINFRAME CONFIGURATION in this chapter for details.

3497A OPERATING CONFIGURATIONS

Type of Operation	RS-449/423 Operation RS-232C Operation*
Type of Connection	Direct Connection to Controller* Connect to MODEM
Type of Handshake	ENQ/ACK DC1 ON DC1 OFF*
Speed of Operation/ # Stop Bits	Speed #Bits 19,200 1 9,600 1 4,800 1 2,400 1 1,200 1 600 1 300* 1* 110 2
Word Length & Parity	8-bit ASCII w/odd parity 7-bit ASCII w/odd parity* 8-bit ASCII w/no parity 7-bit ASCII w/even parity

* = Factory Setting

RS232C Pre-Installation Checks

Before connecting the 3497A to your controller, review the following checklist to ensure that the 3497A configuration is compatible with your controller operation.

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RS232C PRE-INSTALLATION CHECKLIST
Are the 3497A character length, parity bit, speed of operation and number of stop bits compatible with your controller?
Will ENQ/ACK or DC1 handshake be used? ENQ/ACK is implemented by software (see Chapter 4), while DC1 is set by placing the DC1 Handshake switch (S1, position #4) to the "1" position (see MAINFRAME CONFIGURATION).
Will MODEMs be used? If used, MODEMs must be asynchronous and full-duplex (preferably one of the MODEMs listed earlier in this chapter).
Is S2 set for RS232? (see MAINFRAME CONFIGURATION).
If your controller has an ECHO function, is this turned OFF? Does the controller accept CR (only) as a terminator?

Connecting the 3497A to a Controller

When the 3497A has been set for desired operation, the next step is to connect it to your controller, either by direct connection or via MODEMS.

Supplied with each 3497A Option 232 is a US MODEM cable 13222N (-hp- part number 13222-60001) for interface between the 3497A and your controller or MODEM. This cable consists of a 50-pin male connector to connect to the 3497A and a standard 25-pin RS233C male connector for connection to a MODEM or to a controller. Figure 64 shows the pin definitions for the 13222N cable.

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13222 N
(13222-60001)

Name on Hood: U.S. MODEM CABLE

Cable Length: 5 meters, 16.7 feet

Uses: 262X Terminal connection to HP 1000, 2000, 3000 Multiplexors; 103A; 202C, D, S, T; 212A and VADIC 3400 modems; Acoustic Couplers (signal compatible only). Shielded.

For HP 1000, 2000, 3000 Systems.

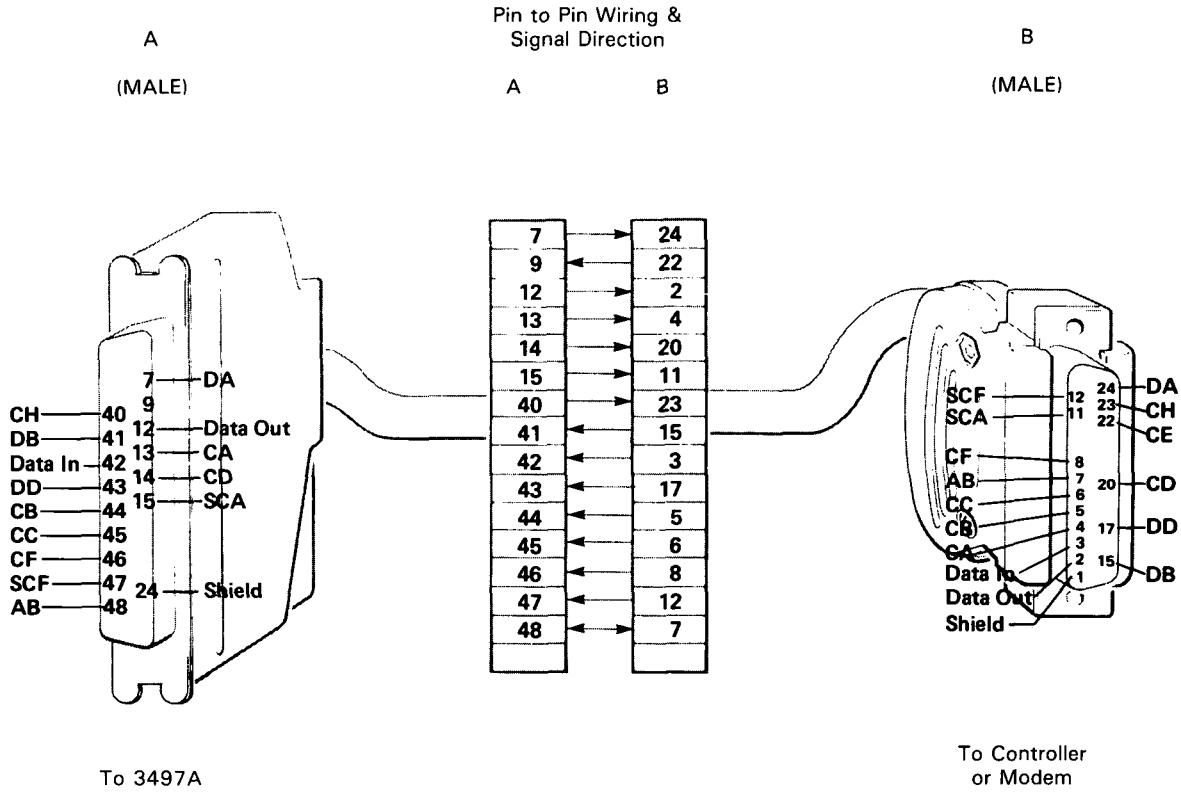


Figure 64. 13222N Pin Definitions

In general, RS232C operation limits cable length to a maximum of 50 feet (15.24 meters), depending on total load capacitance. Also, load capacitance at the interface point should not exceed 2500 pF. Longer cables may be used if total load capacitance does not exceed 2500 pF.

For any interface used, certain lines are required for connection between the 3497A and a controller (direct connection) or between the 3497A and a MODEM (MODEM Operation), as shown. Other pins, even if connected, are not monitored or controlled by the 3497A.

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RS232C OPERATION - LINES REQUIRED

LINES REQUIRED WHEN DIRECTLY CONNECTED TO A CONTROLLER
Transmitted Data Received Data Signal Ground

LINES REQUIRED WHEN CONNECTED TO A MODEM
Transmitted Data Received Data Signal Ground Data Terminal Ready Data Carrier Detect Request to Send Clear to Send Data Set Ready

To connect the interface cable to the 3497A, see Figure 65. Plug the 50-pin male connector into the female connector on the rear of the 3497A and snap the two wire clips in place to secure the connector. Then, connect the 25-pin male connector to your controller or MODEM as required. This completes the installation for RS232C operation.

WARNING

The 50-pin male connector for the 13222N cable has a metal housing which is internally connected to the cable shield. Pin 1 (Protective Ground) of the 25-pin male connector for this cable is also connected to the shield. If Pin 1 of the 25-pin male connector is connected to your controller or MODEM chassis, ensure that the chassis has an earth ground so that the exposed metal housing on the 3497A will not be at a hazardous voltage level.

NOTE

When connecting the 13222N cable, ensure that the pin connectors are correct. Pin 2 (TX Line) from the cable is an output and Pin 3 (RX Line) is an input line. At the controller or MODEM, however, pins 2 and 3 may be inputs or outputs, depending on interface specifications. These connections are shown in Figure 65.

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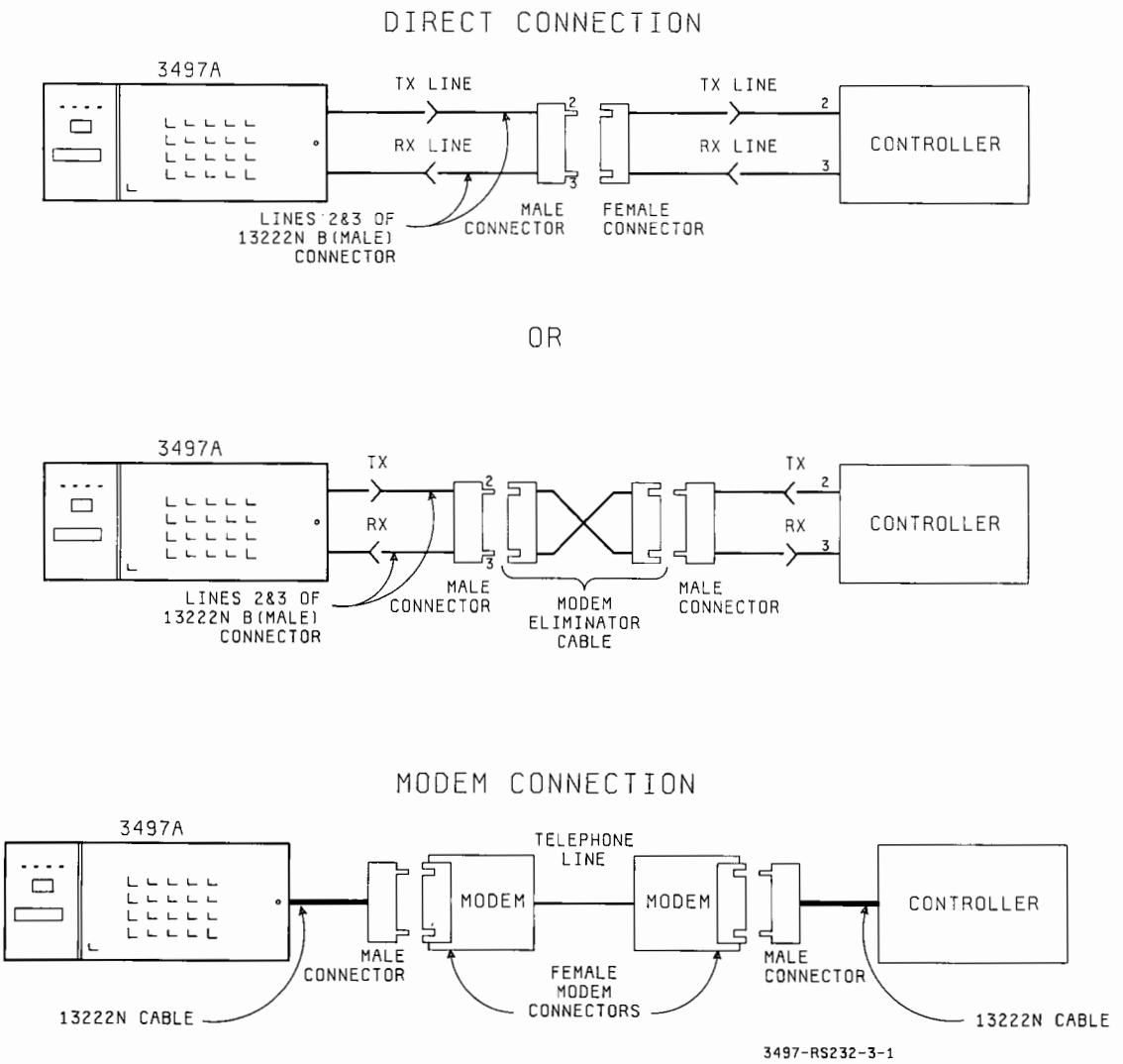


Figure 65. Connecting the 13222N Cable

Checking the 3497A For RS232C Operation

After the 3497A has been connected to your controller, perform a self-test of the 3497A to check for proper operation and to ensure that data is transferred across the interface. To do this, turn on the 3497A and enter the following program if you use a BASIC language controller or an equivalent program for other types of controllers.

At the completion of the program, if the 3497A returns 8E8 it passes the self-test and is ready for operation. If another reading is returned, refer to the 3497A Mainframe Installation and Service Manual.

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EXAMPLE - RS232C OPERATION SELF-TEST

Program	Lines	Description
10 RESET 10	10	Clears interface with ISC of 10.
20 OUTPUT 10; "ST1"		
30 ENTER USING "#,K"; A	20	Turns self-test ON.
40 DISP A		
50 OUTPUT 10; "ST0"	30-40	Displays result of self-test. 8E8 returned if self-test passes.
60 END		
	50	Turns self-test OFF.

Connecting the 3497A to Your System

When the 3497A passes the self-test, it is ready for operation and can be connected to your system. When connecting the 3497A to your system, you may want to see Chapter 9 for example ways to make voltage, resistance, thermocouple, frequency or pressure measurements or to do control applications such as interrupts, switching and control sources.

To connect your system to the 3497A, inputs must be connected to appropriate terminals on the plug-in assemblies (Options 010 through 140). Before attaching any system inputs to the assemblies, see Chapter 8 which shows how to configure each assembly for various modes of operation.

NOTE

When you are connecting your system inputs to the assemblies, you may want to complete a 3497A System Log similar to the one shown in HP-IB INSTALLATION in this chapter so that you'll have a permanent record of the inputs connected to each channel of the 3497A.

A blank 3497A System Log is located in Appendix B so that you can copy it if desired. For ease of reference, we suggest that you complete a separate form for each plug-in assembly at initial installation and that all forms be filed in a folder to accompany the 3497A.

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RS449/423 INSTALLATION

This part of the chapter provides installation guidelines for the 3497A for RS449/423 Serial Data operation. With Option 232, the 3497A is compatible with Electronic Industries Association (EIA) standard RS232C and with RS449 (RS423 subset). It is also compatible with CCITT (Comite Consultatif International Telephonique et Telegraphic) standards CCITT V.24 (for RS232C) and CCITT V.10 (for RS449/423).

Operation for RS449/423 is very similar to that for RS232C. So, for information on 3497A capabilities, operating configurations and compatible MODEMS and pre-installation checks, see RS232C INSTALLATION earlier in this chapter.

RS449 encompasses two standards for standards for voltage requirements: RS422 and RS423. RS423 is implemented by the 3497A and specifies the electrical characteristics for unbalanced voltage digital interface circuits. RS449 designates a standard 37-pin connector or an optional 9-pin connector for ''reverse channel'' or ''backward channel'' operation.

For RS-449/423 operation, the 13222N cable supplied with the 3497A cannot be used. Contact your nearest -hp- Sales and Service office if you need to order an interface cable for RS-449/423 operation.

NOTE

An overlap in values of certain parameters of RS423C and RS232C has been established so that it is possible to achieve satisfactory interoperation of RS232C and RS423 equipment. Interface circuits implemented with RS422 drivers will not directly interoperate with RS232C receivers. An important point to keep in mind when operating with RS423 and RS232C is that performance is limited to that associated with RS232C.

Connecting the 3497A to a Controller

After you have set switches S1 and S2 in the 3497A for desired operation as shown in the RS232C Pre-Installation Checklist, the next step is to determine appropriate cable connections and cable lengths for proper operation. The following chart shows the lines required for RS-449/423 operation for direct connection to your controller and for MODEM connection.

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RS449/423 OPERATION - LINES REQUIRED

LINES REQUIRED FOR DIRECT CONNECTION
Send Data Ground for Send Data Received Data Ground for Received Data Signal Ground

LINES REQUIRED FOR MODEM OPERATION
Send Data Ground for Send Data Received Data Ground for Received Data Signal Ground Terminal Ready Ground for Terminal Ready Receiver Ready Ground for Receiver Ready Request to Send Ground for Request to Send Clear to Send Ground for Clear to Send Data Mode Ground for Data Mode

Cable length limits imposed by RS449/423 operation depend on the speed of operation, as shown in Figure 66. For example, with a cable length of 4000 feet (1220 meters), maximum operating speed is 1000 bits per second. After the cable has been selected, connect the cable to the 3497A rear panel connector. This completes the installation for RS449/423 operation.

WARNING

RS449/423 does not specify either protective ground or safety ground as an interchange circuit. Thus, for RS449/423 operation, if bonding of equipment chassis is required, use a separate conductor which conforms to national or local electrical codes. In all cases, any device being interfaced should have an earth grounded chassis.

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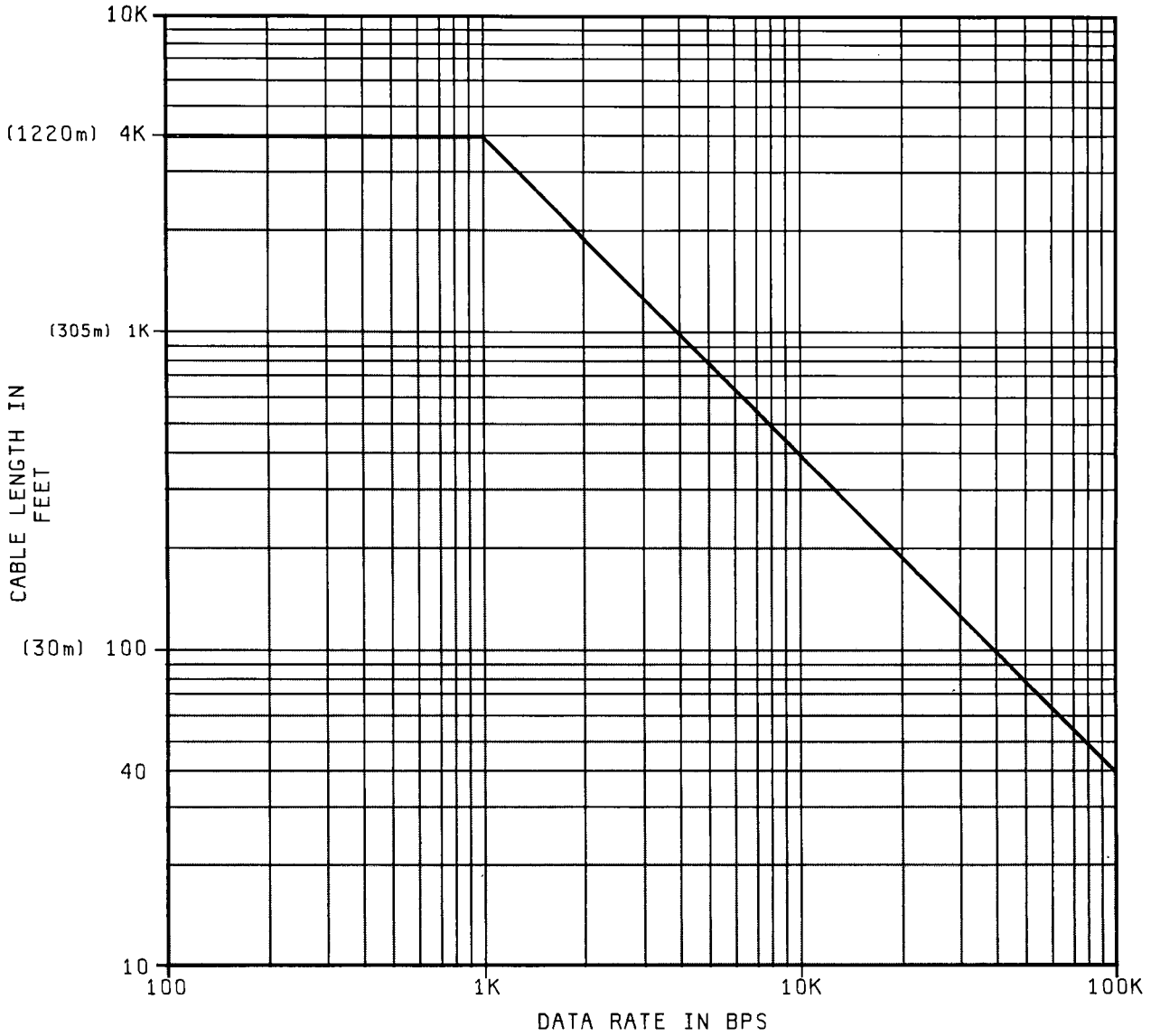


Figure 66. RS449/423 Cable Length Restrictions

Checking the 3497A For RS449/423 Operation

After the 3497A has been connected to your controller, perform a self-test of the 3497A to check for proper operation and to ensure that data is transferred across the interface. To do this, turn on the 3497A and enter the following program if you use a BASIC language controller or an equivalent program for other types of controllers.

At the completion of the program, if the 3497A returns 8E8 it passes the self-test and is ready for operation. If another reading is returned, refer to the 3497A Mainframe Installation and Service Manual.

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EXAMPLE - RS449/423 OPERATION SELF-TEST

Program	Lines	Description
10 RESET 10	10	Clears interface with ISC of 10.
20 OUTPUT 10; "ST1"		
30 ENTER USING "#,K"; A	20	Turns self-test ON
40 DISP A		
50 OUTPUT 10; "ST0"	30-40	Displays result of self-test. 8E8 returned if self-test passes.
60 END		
	50	Turns self-test OFF.

Connecting the 3497A to Your System

When the 3497A passes the self-test, it is ready for operation and can be connected to your system. When connecting the 3497A to your system, you may want to see Chapter 9 for example ways to make voltage, resistance, thermocouple, frequency or pressure measurements or to do control applications such as interrupts, switching and control sources.

To connect your system to the 3497A, inputs must be connected to appropriate terminals on the plug-in assemblies (Options 010 through 140). Before attaching any system inputs to the assemblies, see Chapter 8 which shows how to configure each assembly for various modes of operation and operating precautions.

NOTE

When you are connecting your system inputs to the assemblies, you may want to complete a 3497A System Log similar to the one shown in HP-IB INSTALLATION in this chapter so that you'll have a permanent record of the inputs connected to each channel of the 3497A.

A blank 3497A System Log is located in Appendix B so that you can copy it if desired. For ease of reference, we suggest that you complete a separate form for each plug-in assembly at initial installation and that all forms be filed in a folder to accompany the 3497A.

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MAINFRAME CONFIGURATION

When you received your new 3497A, it was factory preset for the configuration you specified. In many cases, factory settings will be correct for your application. If, however, you need to change the configuration of the 3497A mainframe, see this part of the chapter for details. If you need to change the configuration of the plug-in assemblies or the 3498A, see Chapter 8.

This part of the chapter shows how to make hardware changes to the 3497A mainframe, but does not show how to make alignments or adjustments. See the 3497A Mainframe Installation and Service Manual for this information. See the following chart to locate the specific configuration function required.

3497A MAINFRAME CONFIGURATION

FUNCTION	DESCRIPTION	PAGE
Change Analog Addresses	Change analog addressing scheme so that up to 10 channels (1/decade, 2/slot) can be closed with a single command.	356
Set Clock Format	Set real-time clock for Option 230 or 231 format.	360
Clock Battery Back-Up	Reset the 3497A so that battery back-up for the real-time clock is supplied whenever the AC power is disconnected.	362
Change Line Volts	Set the 3497A for AC line input of 100V, 120V, 220V or 240V.	363
Change HP-IB Address Switch	For a 3497A with HP-IB capability, reset the HP-IB address and set TALK ONLY and POWER ON SRQ capabilities.	363
Set Serial Data Operating Conditions	For a 3497A with Serial Data (RS-232 or RS449/423), set RS-233 or SS-449/423 operation, direct or MODEM connection to controller, handshake, speed of operation/number of stop bits, word length and parity for desired operation.	366

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Change Analog Addresses

As factory preset, a maximum of four channels can be closed simultaneously by using the AC chan#,chan#,chan#,chan# command, as long as only one channel/decade is closed (i.e. AC3,13,23,33 is a valid command, but AC3,4,5,6 is not). However, by reconfiguring the 3497A, up to 10 channels (one per decade, two per slot) can be simultaneously closed with a single AC command.

For applications which require that more than four channels be closed simultaneously, the 3497A can be reconfigured so that the two decades (A and B) in each slot can contain any century or decade addresses from 000 to 999.

For factory configuration, the 5 slots in the 3497A are assigned addresses as shown, where the first number is the ''century address'' and the second number is the ''decade'' address. Each slot is assigned 20 numbers, with the first 10 assigned to the A decade within the slot and the second ten numbers assigned to the B decade within the slot.

3497A FACTORY-SET ADDRESSES

SLOT	DECADE	ADDRESSES
0	A0	000 - 009
	B0	010 - 019
1	A1	020 - 029
	B1	030 - 039
2	A2	040 - 049
	B2	050 - 059
3	A3	060 - 069
	B3	070 - 079
4	A4	080 - 089
	B4	090 - 099

To reconfigure the analog addresses, it is necessary to remove the Inguard Controller Board from the 3497A, as shown in Figure 67.

WARNING

Before touching the 3497A, disconnect the AC line cords from the 3497A and 3498A and remove ALL external voltage sources from these instruments.

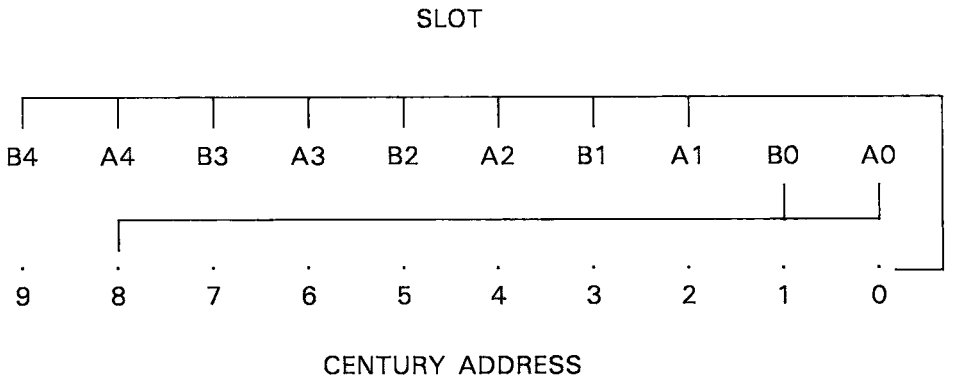
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To remove the Inguard Controller Board, first remove the protective safety cover and loosen the two fasteners on the left rear panel (as viewed from the rear of the instrument). Then pull out the Inguard Controller Board by using the plastic pull ring and position the assembly as shown in Figure 67.

As factory configured, the century address for the 3497A is set to 0 since decades A0, B0, A1, ..., B4 are all tied to the ''0'' point. To change the century address for a decade or a slot, disconnect existing jumpers to those slots and connect jumpers from decades to desired century number.

EXAMPLE - SLOT 0 SET FOR CENTURY ADDRESS ''8''

For example, to set slot 0 for century address ''8'', configure the board as shown below. Then, to address decades A and B in slot 0, the command is AC800 through AC819 (rather than AC0 through AC19 as factory preset).



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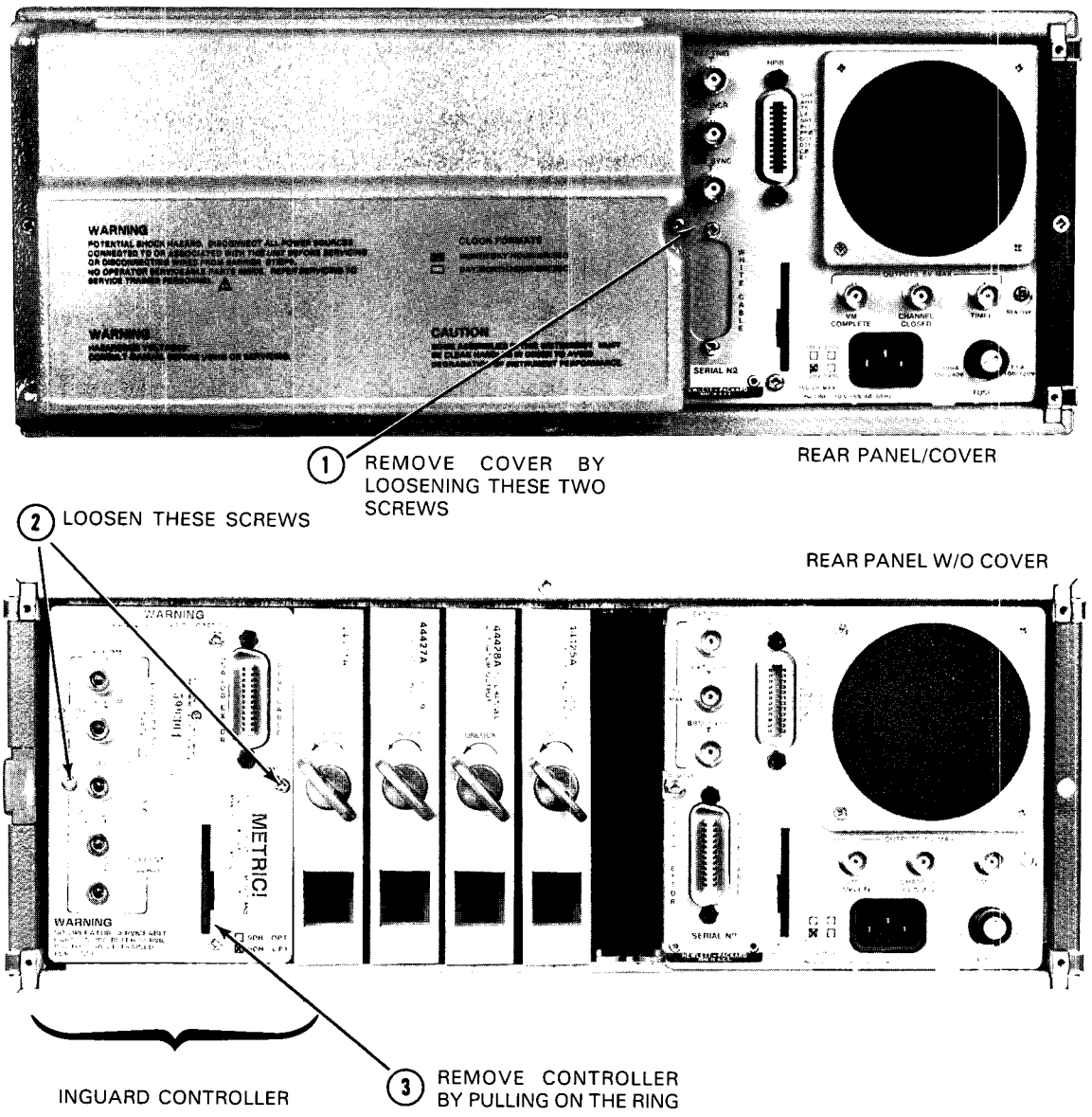
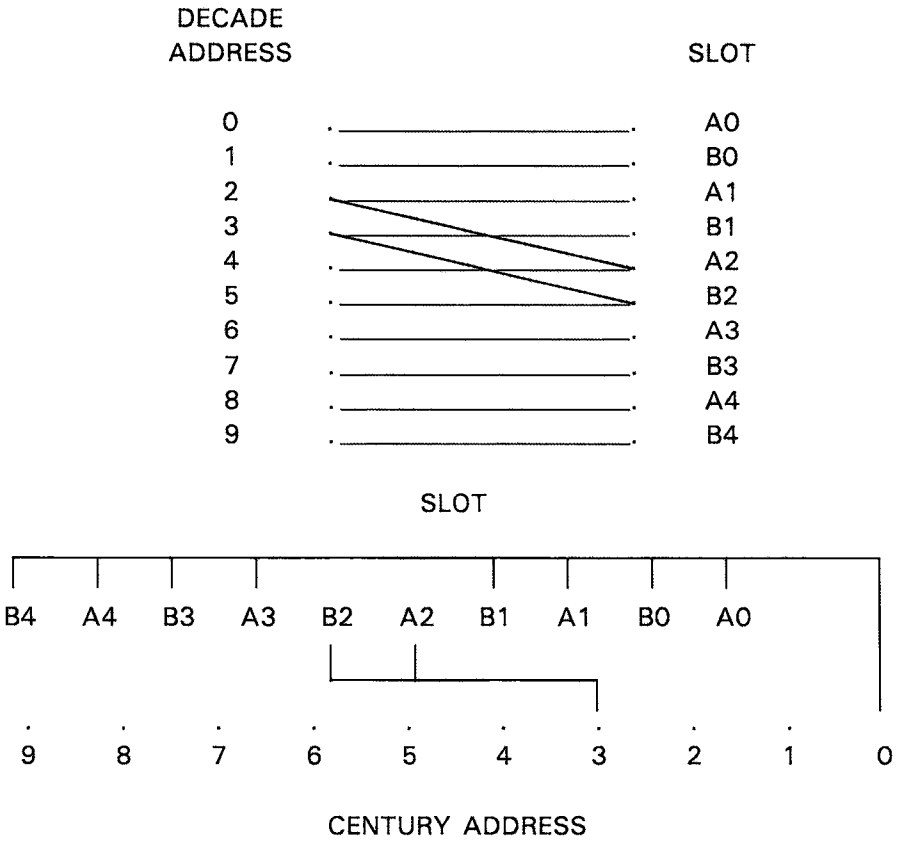


Figure 67. Century and Decade Address Jumpers

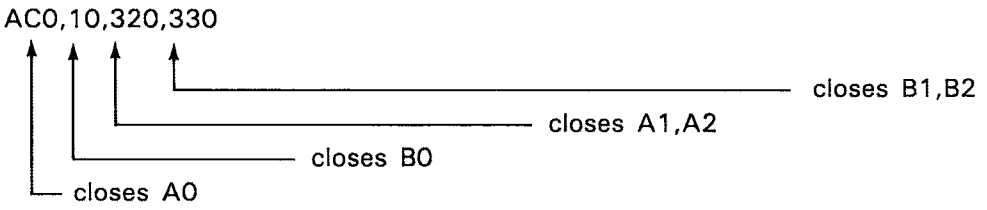
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EXAMPLE - SLOT 2 SET TO ADDRESSES 320 TO 339

To set the decade addresses, follow the same procedure as setting the century addresses. See Figure 67 for location of the decade address jumpers. For example, as factory preset, slot 2 has addresses 040 through 059. To reconfigure slot 2 for addresses 320 through 339, set the DECADE ADDRESS jumpers and the CENTURY ADDRESS jumpers as shown.



With this configuration, a single AC command can close up to six channels simultaneously. For example, AC0,10,320,330 closes six channels simultaneously, as shown.



Note that the 3497A can simultaneously close a maximum of 10 channels, regardless of type of reconfiguration used. When you have reconfigured the jumpers, replace the Inguard Controller Board and replace the protective cover.

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Set Clock Format

As specified, the 3497A real-time clock is configured for Option 230 format (Month:Day:Hour:Minute:Second) or for Option 231 format (Day:Month:Hour:Minute:Second). To reconfigure from Option 230 to 231, it is necessary to install a jumper (W1) on the Timer Board which is connected to the Outguard Controller Board in the 3497A. To install the jumper (or to remove the jumper to convert from Option 231 to 230 format), see Figure 68 and use the following procedure:

* Remove all power sources from the 3497A and 3498A and remove the AC line plug from the 3497A.

* Remove the protective cover from the 3497A rear panel. Then loosen the fastening screw on the Outguard Controller Board and remove the board by pulling on the plastic pull ring.

* Remove the Timer Board from the Outguard Controller Board by loosening the screw in the middle of the Outguard Controller Board.

* Install a jumper at W1 (for Option 231 format) or remove the jumper at W1 (for Option 230 format) on the Timer Board. See Figure 68 for W1 location.

* Reconnect the Timer Board to the Outguard Controller Board. Reinstall the Outguard Controller Board in the 3497A and replace the protective cover on the rear panel.

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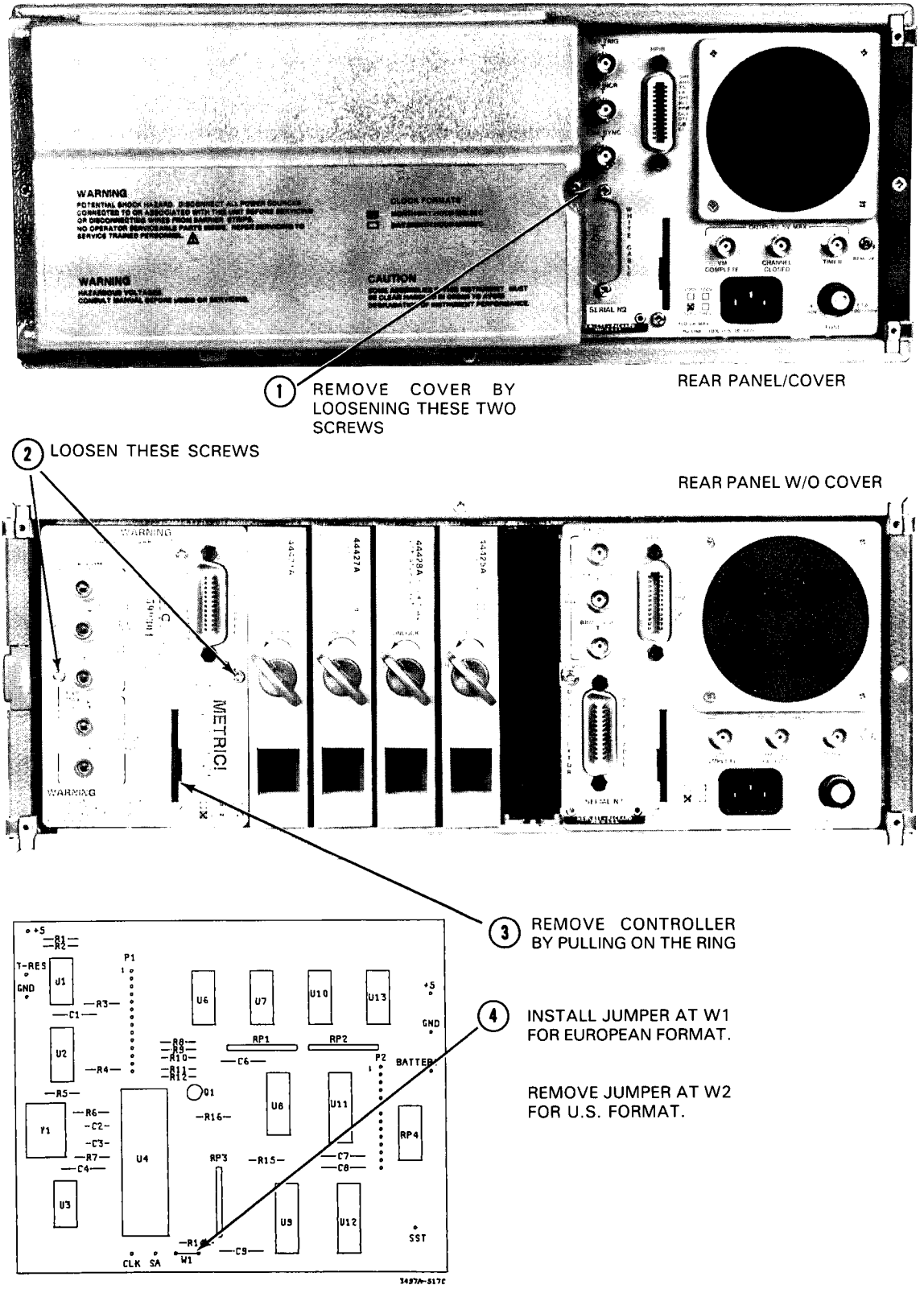


Figure 68. Setting the Clock Format

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Clock Battery Back-Up Modes

When AC power is removed from the 3497A, a 6V lead-acid battery supplies back-up power to the real-time clock. There are two modes of operation, depending on the setting of the Continuous Clock Select Plug, located on the Power Supply Board inside the 3497A behind the front panel. The two modes are:

BATTERY BACK-UP MODES

Mode 1: Plug in OFF position

Battery back-up is supplied ONLY when the LINE switch is in the ON position (factory setting).

Mode 2: Plug in ON position

Battery back-up supplied ANYTIME the AC power is disconnected, regardless of the setting of the LINE switch.

The real time clock can remain on battery power for periods greater than 24 hours. The battery is automatically on charge whenever the 3497A is operating on line power. However, if the battery is allowed to completely discharge, it will take 14 to 16 hours to fully recharge.

To change the mode of operation of battery back-up, use the following procedure:

* Remove all power sources from the 3497A and 3498A and remove the AC line plug on the 3497A.

* Loosen the screw on the right side of the 3497A front panel and swing the front panel open.

* Set the Continuous Clock Select Plug for desired operation: OFF = back-up ONLY when the LINE switch is ON; ON = back-up always. See Figure 57 for location of the plug.

* Close the front panel and tighten the screw fastener.

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Change Line Voltage Settings

The 3497A can operate from AC line voltages of 110 volts, 120 volts, 220 volts or 240 volts (-10% to +5%) at 48 - 66 Hz, 150 VA (3497A) 150 VA (3498A). To set the 3497A for one of four voltage settings, use the Line Voltage Select Switches located behind the front panel of the 3497A. To set these switches, use the following procedure:

* Remove all voltage sources from the 3497A and 3498A and remove the AC line plug from the 3497A.

* Loosen the screw on the right side of the 3497A front panel and swing the front panel open.

* Set the switches for line voltage required, as shown in Figure 57.

* Close the front panel and tighten the screw fastener.

Change HP-IB Address Select Switch

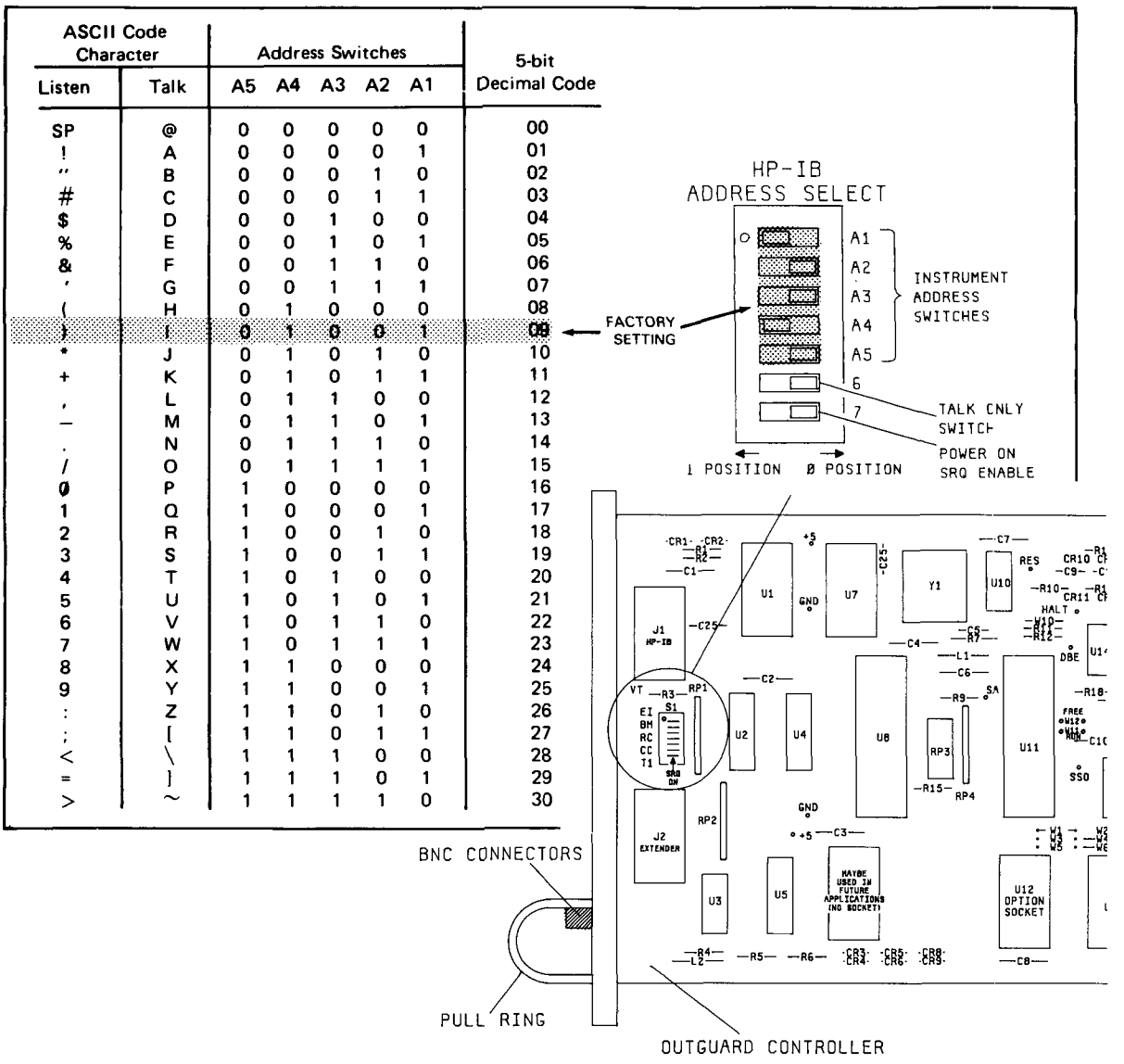
As factory preset, the 3497A with HP-IB option is set to HP-IB address of 09. If required for your application, the address of the 3497A can be changed by setting the INSTRUMENT ADDRESS switches on the 7-section HP-IB ADDRESS SELECT switch.

The HP-IB ADDRESS SELECT switch also contains the POWER ON SRQ SWITCH and the TALK ONLY switch. This part shows how to set the HP-IB addresses, how to set POWER ON SRQ and how to set the 3497A for TALK ONLY mode.

(a) Changing the HP-IB Address

The 3497A is factory preset to address setting of decimal ''09'' which corresponds to ASCII listen address of ''('' and talk address of ''I''. The 3497A may be left at its factory setting or may be changed to alternate address setting as shown in Figure 69.

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ASCII Code Character		Address Switches					5-bit Decimal Code
Listen	Talk	A5	A4	A3	A2	A1	
SP	@	0	0	0	0	0	00
!	A	0	0	0	0	1	01
"	B	0	0	0	1	0	02
#	C	0	0	0	1	1	03
$	D	0	0	1	0	0	04
%	E	0	0	1	0	1	05
&	F	0	0	1	1	0	06
'	G	0	0	1	1	1	07
(	H	0	1	0	0	0	08
)	I	0	1	0	0	1	09
*	J	0	1	0	1	0	10
+	K	0	1	0	1	1	11
,	L	0	1	1	0	0	12
-	M	0	1	1	0	1	13
.	N	0	1	1	1	0	14
/	O	0	1	1	1	1	15
0	P	1	0	0	0	0	16
1	Q	1	0	0	0	1	17
2	R	1	0	0	1	0	18
3	S	1	0	0	1	1	19
4	T	1	0	1	0	0	20
5	U	1	0	1	0	1	21
6	V	1	0	1	1	0	22
7	W	1	0	1	1	1	23
8	X	1	1	0	0	0	24
9	Y	1	1	0	0	1	25
:	Z	1	1	0	1	0	26
;	[	1	1	0	1	1	27
<	\	1	1	1	0	0	28
=	]	1	1	1	0	1	29
>	~	1	1	1	1	0	30

Figure 69. HB-IB Address Selection

To change the address of the 3497A from 09 to another value, it is necessary to remove the Outguard Controller Board. To do this, refer to Figures 69 and 70 and the following steps.

* Remove all power sources from the 3497A and 3498A and remove the AC line plug from the 3497A.

* Remove the safety cover and loosen the screw holding the Outguard Controller Board. Then, use the plastic pull ring to remove the board, as shown in Figure 70.

* From Figure 69, locate the HP-IB ADDRESS SELECT switch and set switches A1 through A5 for address required. For example, to set decimal address 10 (ASCII * and J), set A5, A3 and A1 to the "0" position and set A4 and A2 to the "1" position.

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* If you want to set the 3497A for TALK ONLY mode and/or set POWER ON SRQ, see following paragraphs. If not, replace the Outguard Controller Board and the protective cover.

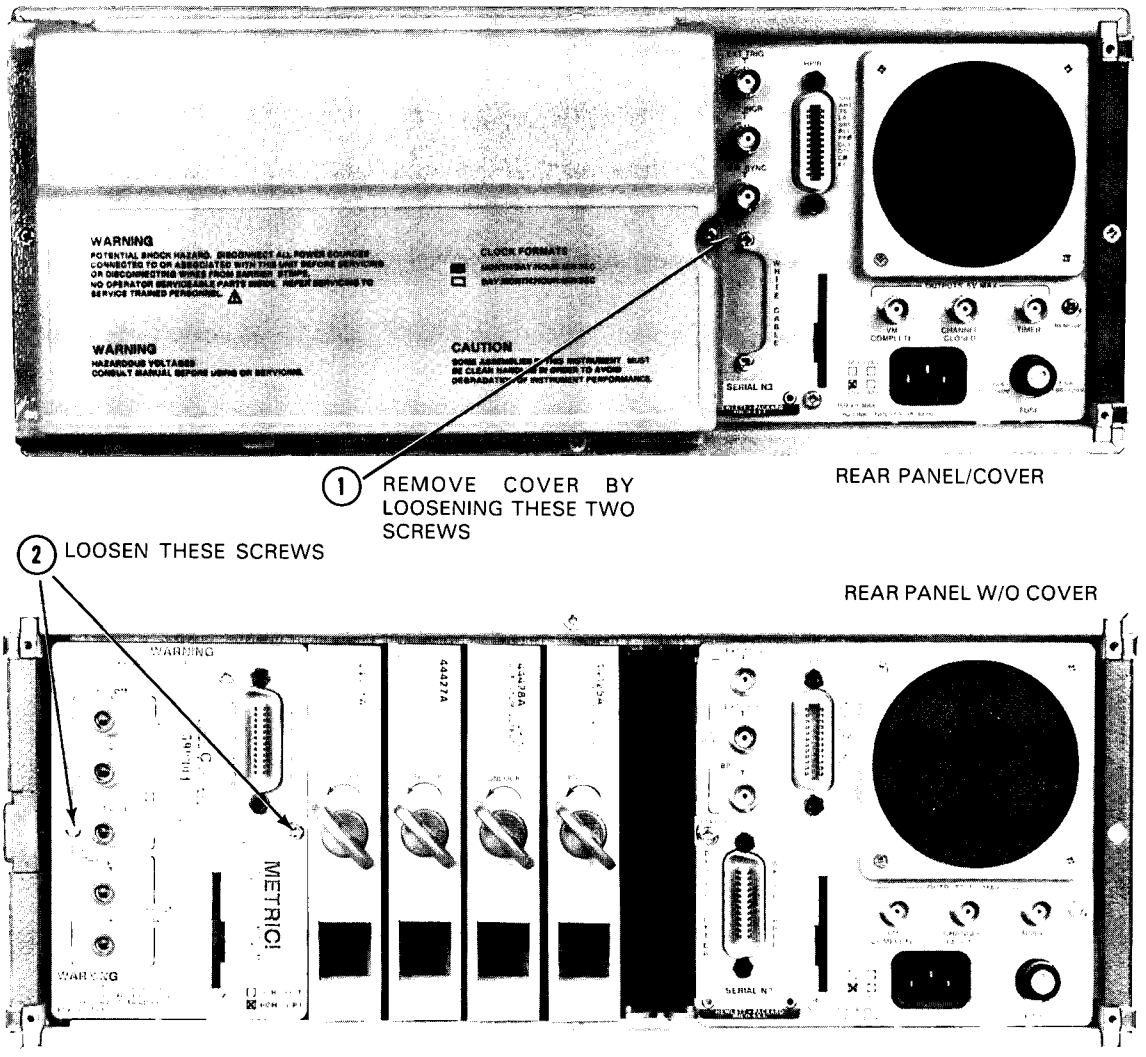


Figure 70. Removing the Outguard Controller (HP-IB)

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(b) Setting TALK ONLY Mode

Position 6 of the HP-IB ADDRESS SELECT switch is the TALK ONLY switch (see Figure 69). When the TALK ONLY switch is placed in the "1" position, the 3497A cannot be controlled from a controller and commands must be entered from the front panel.

As factory set, the TALK ONLY switch is in the "0" position (mode disabled). To enable the TALK ONLY function, follow the instructions above to remove the Outguard Controller Board. Set the TALK ONLY switch to the "1" position and replace the Outguard Controller Board and replace the protective cover.

(c) Setting POWER ON SRQ

If you want the 3497A to send a Service Request (SRQ) to the controller at power on, set the POWER ON SRQ ENABLE switch (postion 7 on the HP-IB ADDRESS SELECT switch - see Figure 69) to the "1" position. As factory set, the POWER ON SRQ function is disabled (switch position 7 set to "0").

To do this, remove the Outguard Controller as shown in Figure 70, and set switch position 7 to the "1" position. Then replace the Outguard Controller Board and the protective cover.

Set Serial Data Operating Conditions

For a 3497A with Serial Data capabilities, (Option 232), the instrument can be configured for a wide variety of operating conditions, depending on controller and speed requirements. See RS232C INSTALLATION for 3497A operating conditions and factory preset conditions.

If your application requires a setup different from the factory configuration, you can change the configuration by setting switches S1 and S2 which are located on the Outguard Controller Board inside the 3497A. Figure 71 shows the functions of each of the positions for S1 and S2.

S2 is used only for setting RS232C or RS449/423 operation. With all S2 switches set to the "1" position, the 3497A is enabled for RS449/423 operation. With S2 switches set to the "0" position (factory configuration), the 3497A is set for RS232C operation.

S1 sets Direct/MODEM connection; 7 or 8-bit operation; even, odd or no parity bit; DC1 handshake on or off; speed of operation and number of stop bits. See Figure 71 for definitions.

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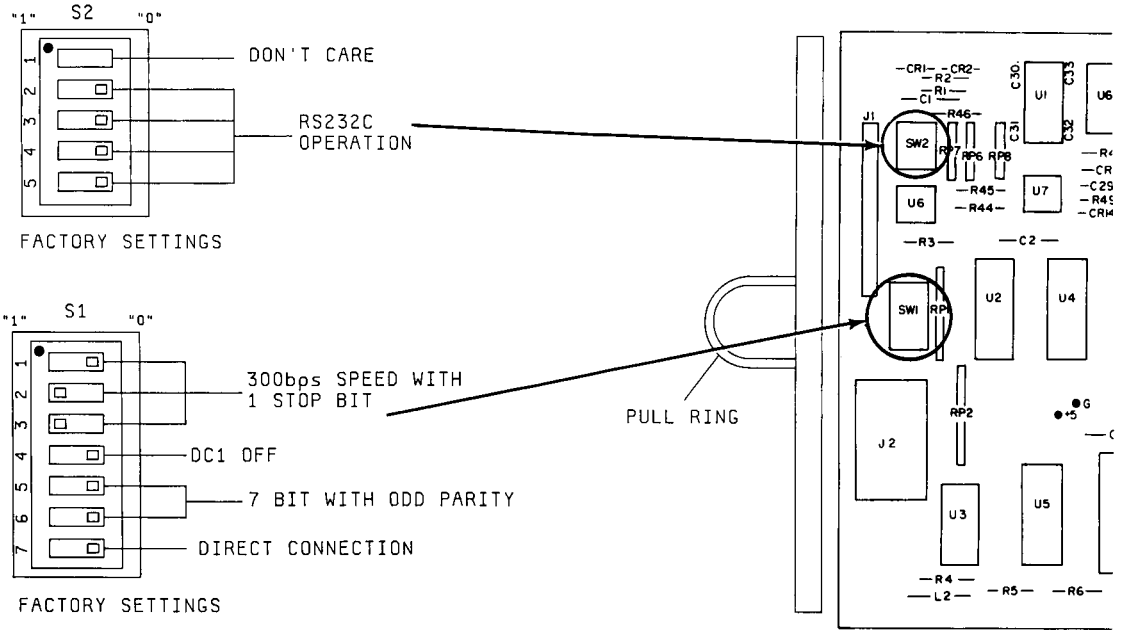


Figure 71. S1 and S2 Settings

To change the settings of S1 and S2, it is necessary to remove the Outguard Controller Board. To do this, see Figure 72 and the following steps.

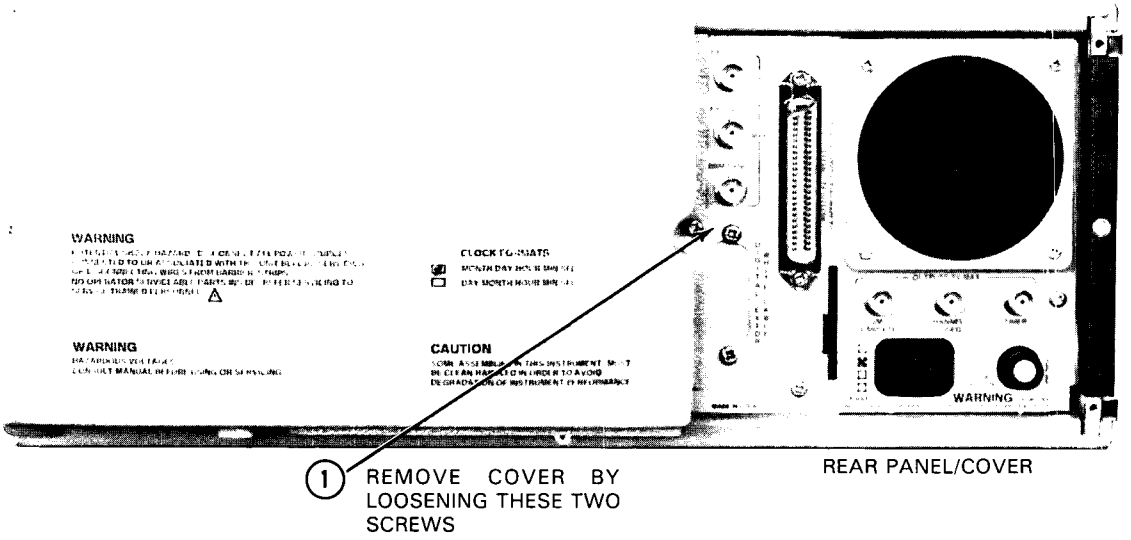
* Remove all power sources from the 3497A and 3498A and disconnect the AC power cord from the 3497A.

* Remove the safety cover from the rear panel. Loosen the screw holding the Outguard Controller Board and use the plastic pull ring to remove the board, as shown in Figure 72.

* From Figure 71, locate switches S1 and S2 on the Outguard Controller Board. Note that the ''0'' and ''1'' switch positions are not shown on the board, so orient the Outguard Controller Board as shown in Figure 71 to set the switches. A ''0'' is set when the switch is in the right-hand position and a ''1'' is set when the switch is in the left-hand position.

* Using the configuration settings in Figure 72, set S1 and S2 for desired operation. Then, replace the Outguard Controller Board and the safety cover.

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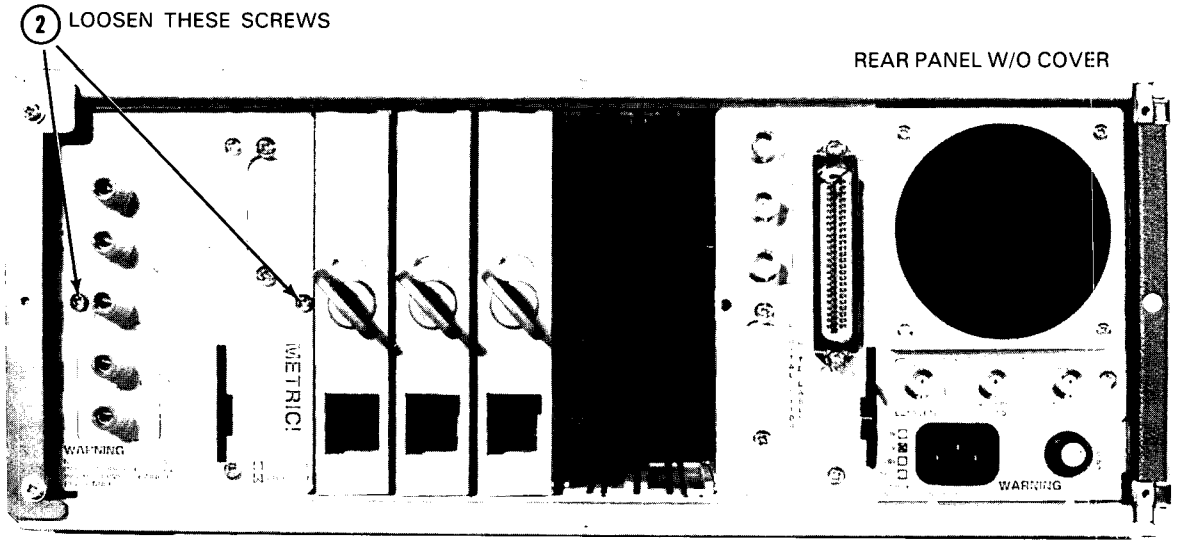


Figure 72. Removing the Outguard Controller (Serial Data)

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Chapter 8
PLUG-IN ASSEMBLY CONFIGURATION

This chapter shows how to initially inspect, install and hardware configure each of the 11 plug-in assemblies for the 3497A (Options 010 through 140) and how to inspect and install the 3498A Extender (Option 298). Information is presented by assembly option number, beginning with Option 010. For each assembly, information is divided into three parts: INTRODUCTION, INSTALLING THE ASSEMBLY and CONFIGURING THE ASSEMBLY.

- INTRODUCTION includes a description of the assembly, assembly specifications and applicable documentation for the assembly.
- INSTALLING THE ASSEMBLY shows how to initially inspect and install the assembly in the 3497A or 3498A.
- CONFIGURING THE ASSEMBLY shows hardware settings (switch and jumper settings) to configure the assembly for various operating modes.

Each assembly is factory-preset for specified operating conditions. In many cases, the factory settings will be appropriate for your application. If you need to reconfigure an assembly, see the following chart to find configuration information for specific assemblies.

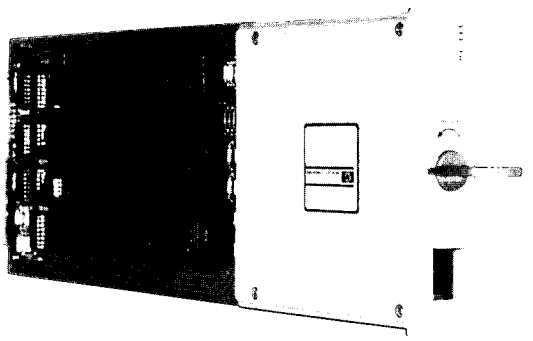
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PLUG-IN ASSEMBLY CONFIGURATION

OPTION	MODEL	ASSEMBLY TITLE	SEE PAGE
010	44421A	20 Channel Relay Multiplexer	371
020	44422A	Relay Multiplexer/Thermocouple Compensation	382
050	44425A	16 Channel Isolated Digital Input/Interrupt	399
060	44426A	100 kHz Reciprocal Counter	410
070	44427A	120 Ohm Strain Gauge/Bridge Completion	433
071	44427B	350 Ohm Strain Gauge/Bridge Completion	433
110	44428A	Actuator/Digital Output	457
115	44431A	8 Channel High Voltage Actuator	472
120	44429A	Dual Output, ±10V Voltage D/A Converter	491
130	44430A	Dual Output, 0-20 mA/4-20 mA Current D/A Converter	501
140	44432A	Breadboard Card	509
298	3498A	3498A Extender	533

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OPTION 010



20 Channel Relay Multiplexer Assembly

INTRODUCTION

Option 010 is a 20 channel analog signal multiplexer assembly which is used to switch (multiplex) signals from up to 20 channels to the 3497A DVM or to other assemblies or instruments.

Each of the 20 channels consists of three reed-actuated relays, one each for High, Low and Guard lines. The channels are organized into two decades of 10 channels and one channel can be closed in each decade. Relays can be closed in a random fashion or can be incremented between programmable limits.

Because the 20 channel relay multiplexer has low thermal offset characteristics, this assembly is ideal for precise low-level measurements of transducers and temperature measuring devices. Since two channels (one per decade) can be closed at a time, one Option 010 assembly can be used to make four-terminal resistance measurements.

Simplified Operation

As shown in Figure 73, the relay multiplexer assembly consists of a relay card and a terminal card. Inputs from system sensors, such as voltage sources, etc., are input to the terminal card connectors on channels A0 through B9 and are sent to the relays on the relay card. Each channel consists of a HIGH, LOW and GUARD line. Relays are divided into two groups (decades): A decade and B decade.

In normal operation, a close channel (AC chan#) command from the 3497A closes the relay in the channel selected and simultaneously closes the tree switch relay. When this happens, the input signal is sent to four places: the A COMMON and B COMMON connectors on the terminal card and (through the tree switch relay) to the 3497A DVM and to the rear panel (HI COM, LO COM and GUARD COM) terminals.

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For example, for an assembly in slot 0, the channel A0 address is 0, channel A1 address is 1, ... and channel B9 address is 19. Thus, the command AC0 closes the relay in channel A0 (and the tree switch) and the voltage at channel A0 is sent to the A COMMON and B COMMON terminals on the terminal card, to the rear panel connectors on the 3497A and to the DVM.

Four optional configurations are available by removing jumpers JMP1 through JMP6. For example, by removing JMP1, JMP2 and JMP3, channel inputs are not sent to the 3497A. Or, by removing JMP4, JMP5 and JMP6, the A decade outputs can be separated from the B decade outputs for four-wire ohms measurements.

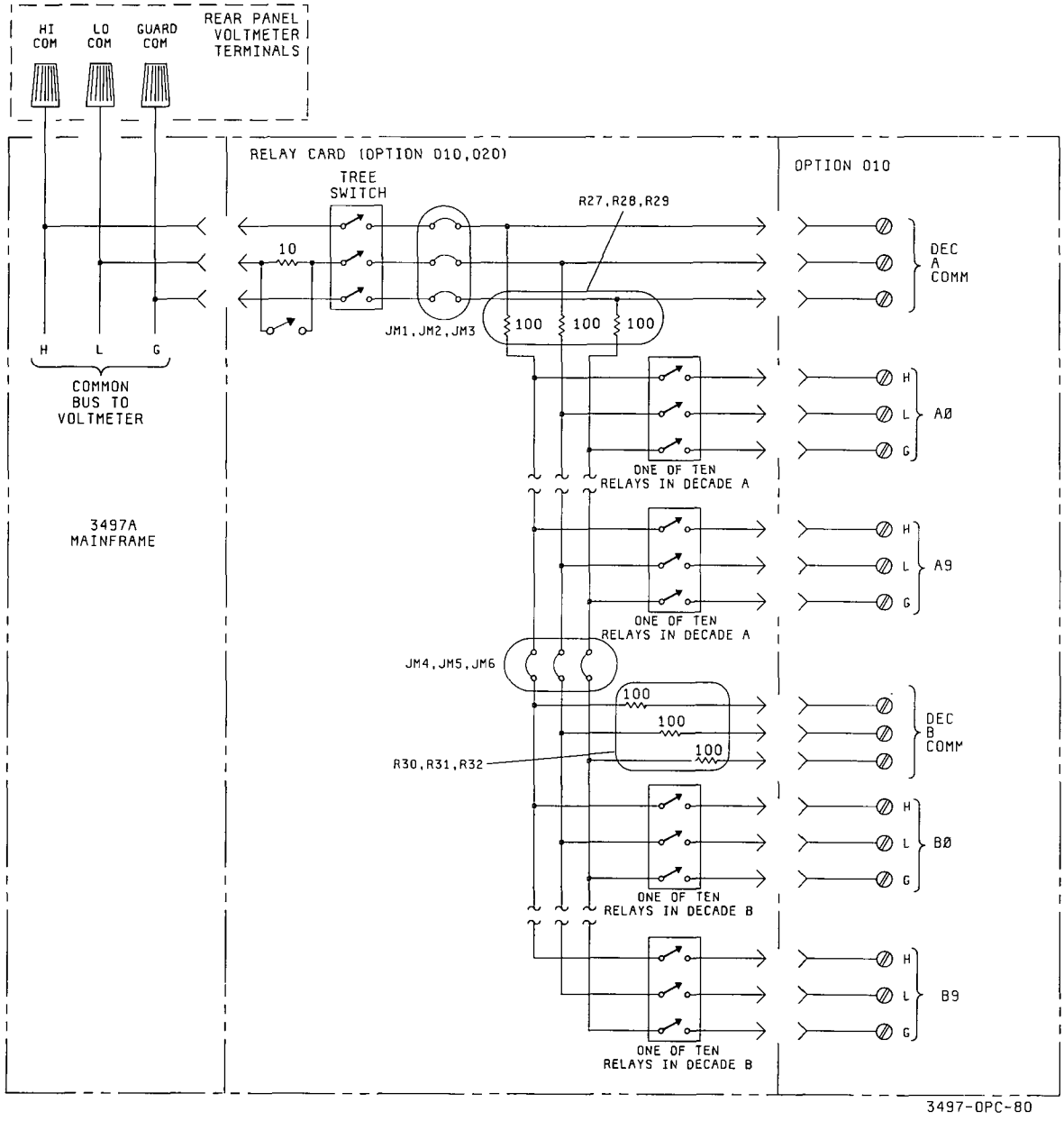


Figure 73. Option 010 - Simplified Schematic

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Specifications

Specifications for the 20 channel relay multiplexer assembly follow. Specifications are performance standards, or limits, against which the assembly may be tested.

OPTION 010
20 CHANNEL RELAY MULTIPLEXER ASSEMBLY

Input Characteristics

Maximum Input Voltage: <170V peak between any two input terminals

Maximum Current: 50 mA per channel non-inductive

Maximum Power: 1 VA per channel

Thermal Offset: Direct Switched: < 1μV Differential
Tree Switched: <2 μV Differential

Closed Channel Resistance:
In Series: 100 Ω ± 10% in High, Lo and Guard Relays
Contacts Only: <1 Ω per contact

Open Channel Isolation:

		25°C, <85% R.H. 40°C, <60% R.H.	40°C, >95% R.H.
Hi to Lo			
Option 010		$>10^{10}\Omega$	$>10^{9}\Omega$
Option 020	Open	$<10^{10}\Omega$	$>10^{9}\Omega$
	Closed	$>10^{8}\ \Omega$	$>10^{7}\Omega$
Lo to Guard		$<10^{8}\ \Omega$	$>10^{7}\Omega$
Guard to Chassis		$>10^{10}\Omega$	$>10^{9}\Omega$

Operating Characteristics

Maximum Switch Rate: Random Channels;
Using Hardware Increments: 475/second

Rated Switch Life at 1 VA: 10^{7} operations

All Relays are Break Before Make

AC Performance

High to Low Capacitance: Channel Open: < 10 pF/per channel
Channel Closed: <220 pF/per channel

Interchannel Capacitance: < 10 pF

	100 kHz	1 MHz
Frequency Response (1 MΩ Termination, 10 kHz Reference)	± .3 dB	±.5 dB
Cross Talk		
Channel to Common		
50 Ohm Termination	−70 dB	−50 dB
1M Ohm Termination	−50 dB	−40 dB
Channel to Channel		
50 Ohm Termination	−60 dB	−40 dB
1M Ohm Termination	−40 dB	−30 dB

Manual Information

This manual contains configuration and control information for this assembly. For repair and/or service information, see 3497A Plug-In Assemblies/3498A Extender Service Manual (-hp- part number 03497-90021). Assemblies manufactured after the publication date of this manual may have changes incorporated. In this case, a yellow MANUAL CHANGES sheet will accompany this manual. See Appendix B for details.

Application Note

As an aid to using the Option 010 assembly, you may want to order -hp- Application Note 123 "Floating Measurements and Guarding" (-hp- part number 5952-2153) from your nearest -hp- Sales and Service office.

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INSTALLING THE ASSEMBLY

WARNING

There is no operator installation or configuration for the relay multiplexer assembly. Only qualified, service-trained personnel should install or configure the assembly.

Initial Inspection

If you ordered the relay multiplexer assembly as Option 010, the assembly is already installed in the 3497A. If you ordered the assembly as Field Installation Kit 44421A, the shipping container should contain the relay card and a terminal card without thermocouple compensation networks.

For the field installation kit, if either card is missing or if there is mechanical damage or defect to the cards, contact your nearest -hp- Sales/Service office. They will arrange for replacement or repair at -hp- option.

If there is any damage to the shipping carton, keep the carton and notify the carrier as well as -hp-. If you return a relay card or terminal card to -hp-, follow the shipping guidelines in Appendix B.

How to Install the Relay Multiplexer Assembly

WARNING

Before touching any installed assemblies or attempting to install the relay multiplexer in the 3497A or 3498A, disconnect the power cords to the 3497A and 3498A and remove ALL voltage sources from these instruments.

The relay multiplexer assembly is not intended for outdoor use. Do not expose the assembly to rain or excessive moisture.

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Figure 74 shows how to install the assembly in the 3497A and 3498A. After taking the steps shown in the WARNING and CAUTION notes above, plug the assembly into an unused slot in the 3497A or 3498A. To minimize thermal offsets (voltage errors), it is good practice to install the assembly in slot 0 (or the leftmost slot available).

Note from Figure 74 that the temperature shield must be removed if the assembly is installed in slot 4 of a 3497A or slot 4 or 9 of a 3498A.

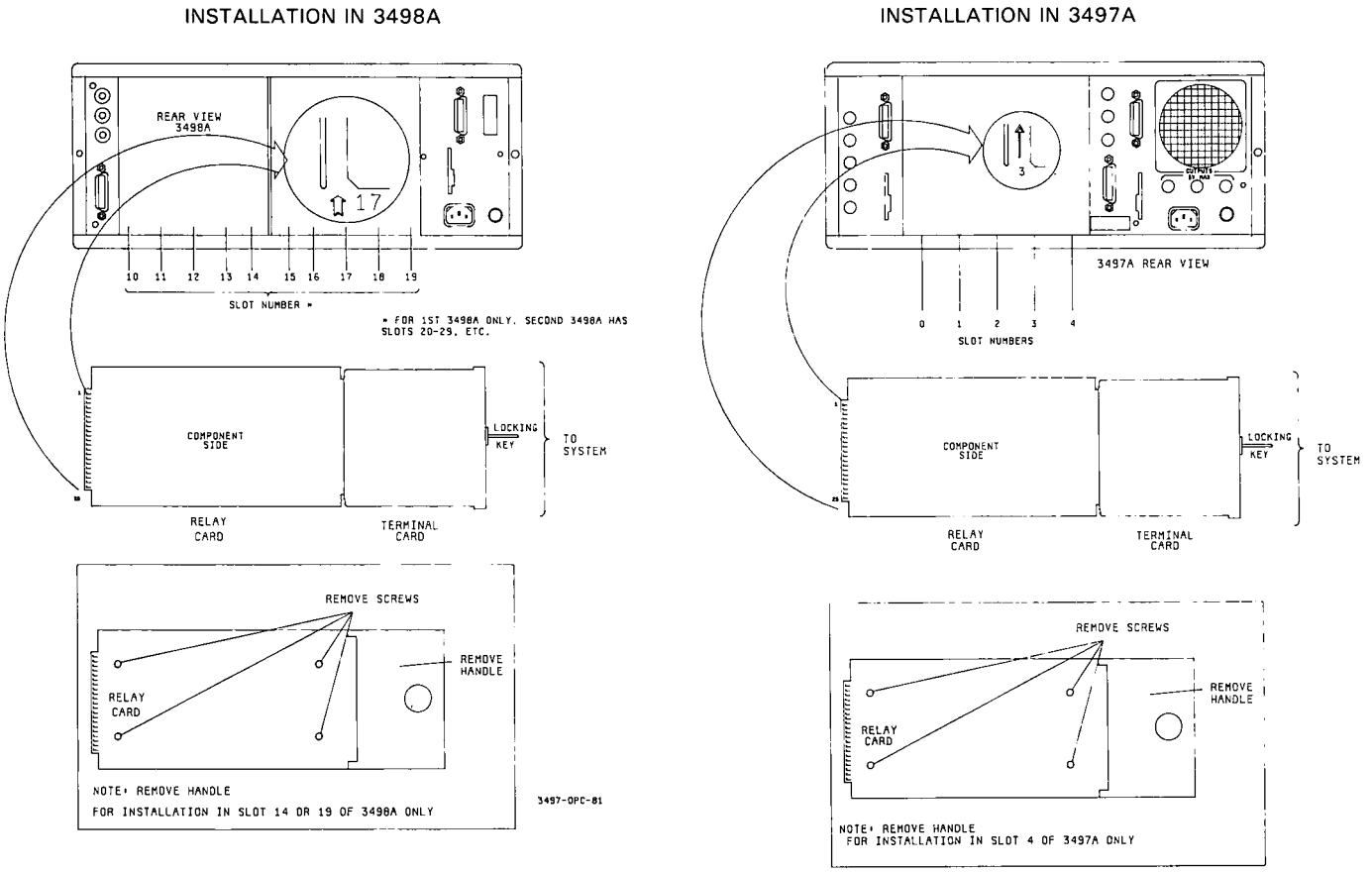


Figure 74. Option 010 - Installation in 3497A/3498A

CONFIGURING THE ASSEMBLY

Assembly configuration is divided into two parts: relay card configuration and terminal card configuration. This section shows the functions of the jumpers and resistors on the cards and their locations. See Chapter 9 for example ways that the assembly can be configured for voltage and resistance measurements.

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Relay Card Configuration

By using jumpers JMP1 through JMP6 you can configure the assembly for four modes of operation. In addition, by removing resistors R27, 28, 29 and/or R30, 31, 32 you can make accurate two-wire ohms measurements. The following chart shows the function of these components and Figure 75 shows their locations. REF refers to the numbers in Figure 75.

RELAY CARD - FUNCTIONS

REF	TITLE	FUNCTION
1	T/C COMP JUMPER	Leave set to NO T/C COMP position.
2	TREE SWITCH JUMPERS (JMP1,2,3)	Enables signals from the A decade and B decade relays to be passed to the tree switch relay. Remove these jumpers when you don't want signals input to the 3497A mainframe.
3	DECADE A TO DECADE B JUMPERS (JMP4,5,6)	These jumpers connect decade A relays output to decade B relay outputs. Remove these jumpers for four-wire ohms measurements. With jumpers removed, A decade output ONLY is available to the DVM (when tree switch is closed).
4	A DECADE SERIES RESISTORS (R27,28,29)	Provide current limiting protection for A decade. Short the resistors (by soldering across the shorting pins) when making two-wire ohms measurements on the A decade.
5	B DECADE SERIES RESISTORS (R30,31,32)	Provide current limiting protection for B decade. Short the resistors (by soldering across the shorting pins) when making two-wire ohms measurements on the B decade.

Shorting the Series Resistors

As factory configured, there are three 100 ohm resistors in series with the A decade common output (R27, R28 and R29) and three 100 ohm resistors in series with the B decade common output (R30, R31 and R32). For more accurate two-wire resistance measurements, these resistors can be shorted out.

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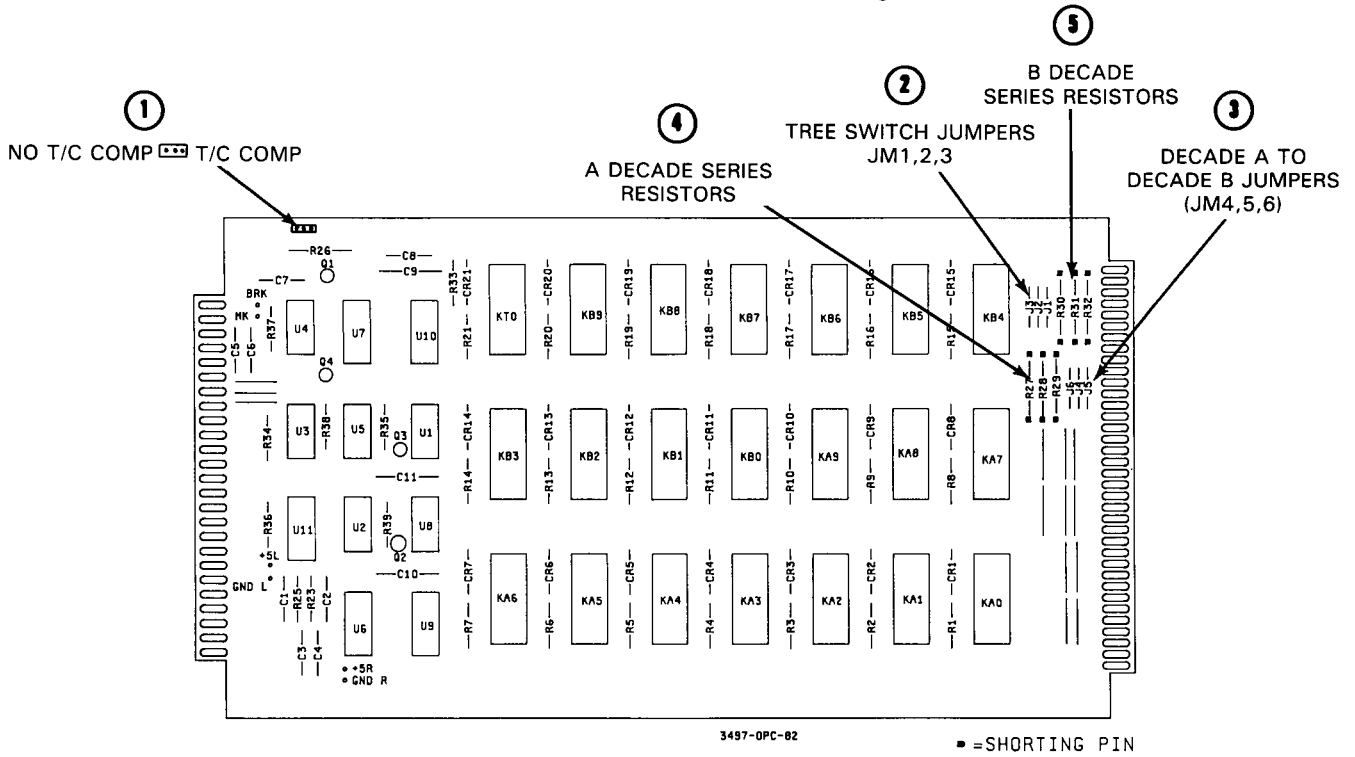


Figure 75. Option 010 - Relay Card Jumpers, Resistors

For two-wire ohms measurements on A decade channels, short out R27, R28 and R29, using the shorting pins on the relay card. For two-wire ohms measurements on B decade channels, short out R30, R31 and R32 using the shorting pins. See Figure 75 for resistor and pin locations. If the assembly is to be used in a 3498A Extender, see the following WARNING note.

WARNING

When the assembly is used in some earlier versions of the 3498A, a possible hazard may exist when making measurements in a system containing a high voltage, high power source (100 VA or above).

In these 3498As, the GUARD sheet metal may short to the chassis sheet metal because of close mechanical spacing. If the 100 ohm resistors have been shorted as previously described and this happens, a current path to ground can exist, as shown in Figure 76.

If the GUARD common line is in contact with a high voltage, high power source (100 VA or above) or could come in contact with such a source and the 100 ohm resistor (R27 or R30) in the GUARD common line has been shorted, a possible shock or fire hazard could exist.

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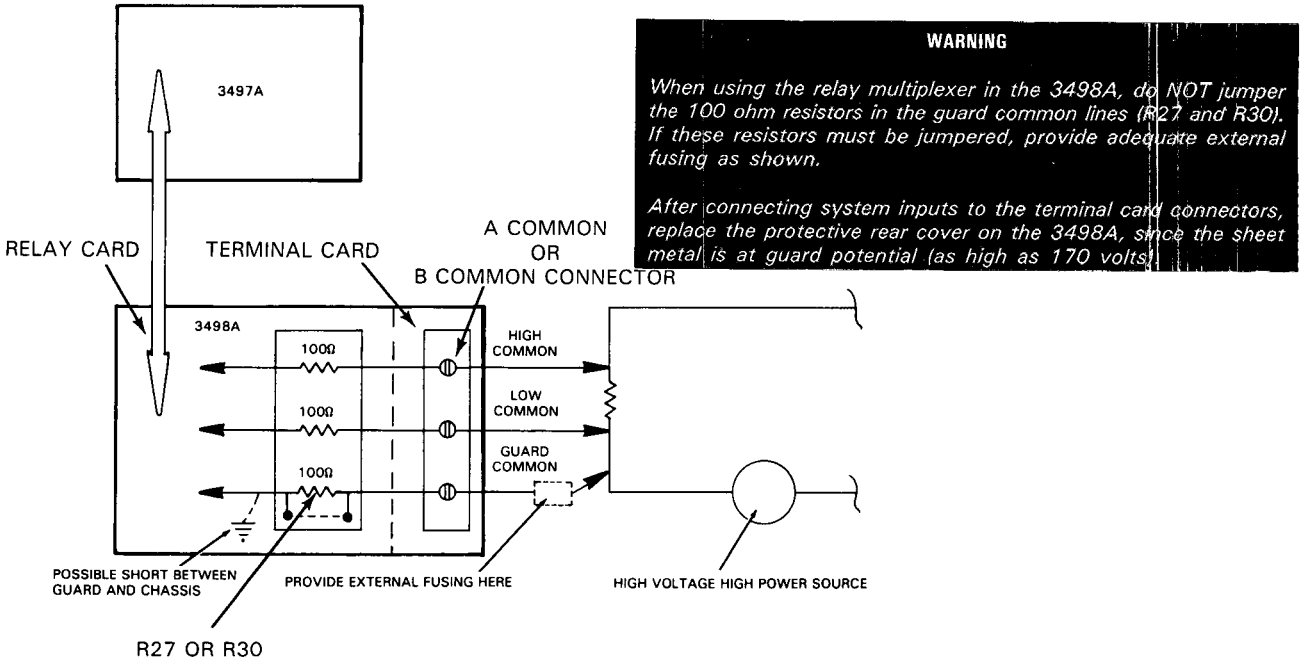
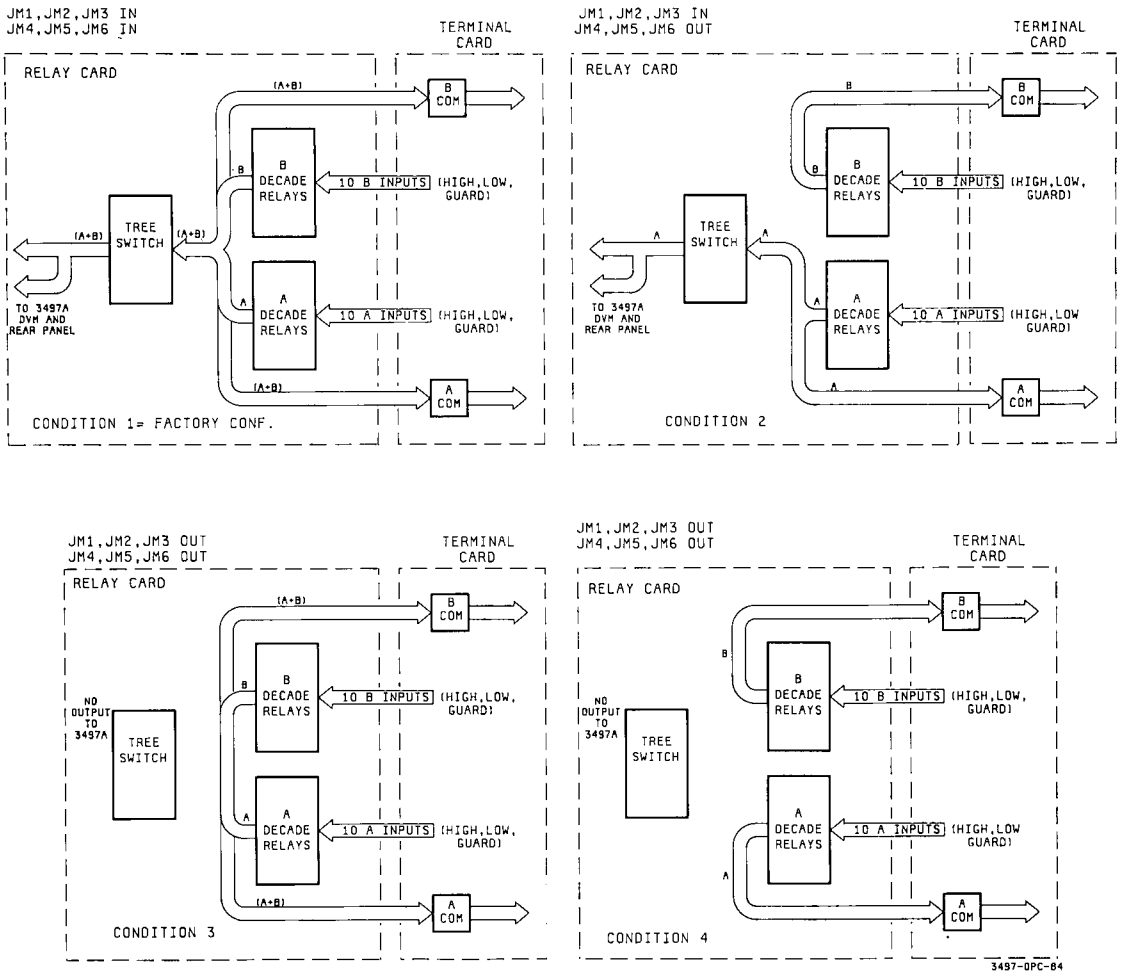


Figure 76. Option 010 - Fusing the Relay Card

Setting Jumpers JMP1 through JMP6

By removing jumpers JMP1, JMP2, JMP3 and/or JMP4, JMP5, JMP6 on the relay card, you can configure the assembly for four modes of operation. Figure 77 shows the four operating modes for the assembly and a truth table for these modes. With JMP4, JMP5 and JMP6 OUT (removed from the board), only the A decde inputs can be sent to the 3497A (i.e., an input on channel B0 through B9 can be output ONLY at the B COM terminal on the terminal card).

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Relay Multiplexer Assembly Truth Table

Jumper Position			Output To:		
Oper Cond	JM1,JM2 JM3	JM4,JM5 JM6	Term Card A Common	Term Card B Common	3497A DVM+Panel
1***	IN	IN	(A+B)*	(A+B)	(A+B)
2	IN	OUT	A**	B**	A
3	OUT	IN	(A+B)	(A+B)	—
4	OUT	OUT	A	B	—

* (A+B) = either A decade or B decade output (one of 20 channels).
** A = One of 10 A inputs; B = One of 10 B inputs.
*** Condition 1 is factory configuration.

Figure 77. Option 010 - Card Configurations and Truth Table

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Terminal Card Configuration

The terminal card provides the interface between the relay card and your system transducers. To connect your system inputs to the terminal card, see Figure 78. Note that each channel has a separate set of three connectors (HI, LO and GUARD), so three wires must be connected for each channel.

To connect your inputs, remove the terminal card cover by loosening the four screws and route wires as shown in Figure 78 to provide strain relief for the wires.

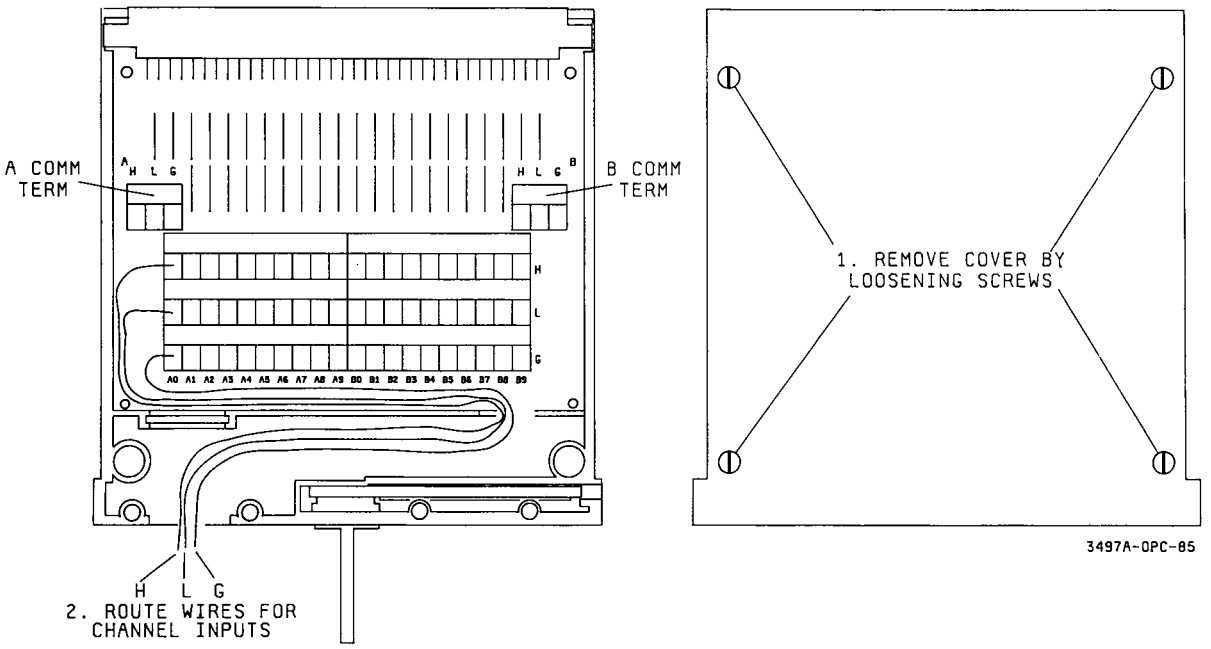


Figure 78. Option 010 - Connecting Inputs to the Assembly

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Input Signal Conditioning

You can also reconfigure the terminal card by adding customer-supplied signal conditioning elements. Figure 79 shows some example current shunt and low pass filter circuits added for input signal conditioning.

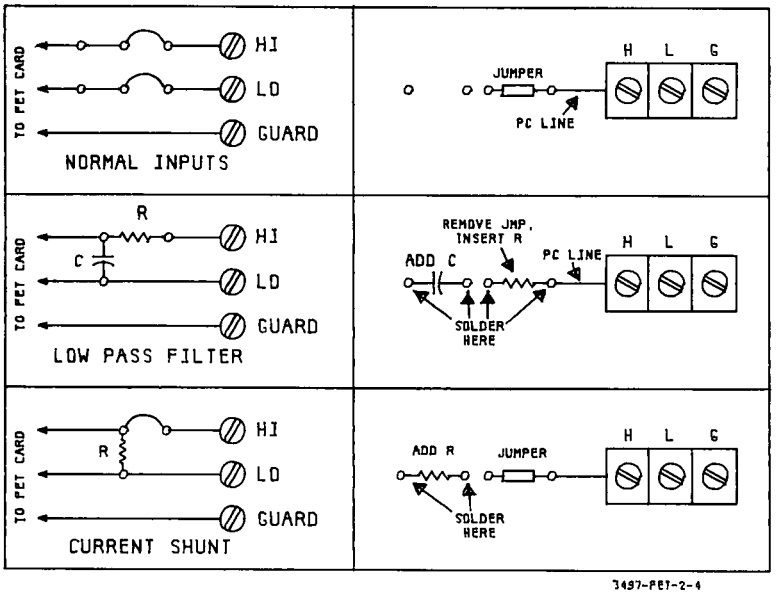
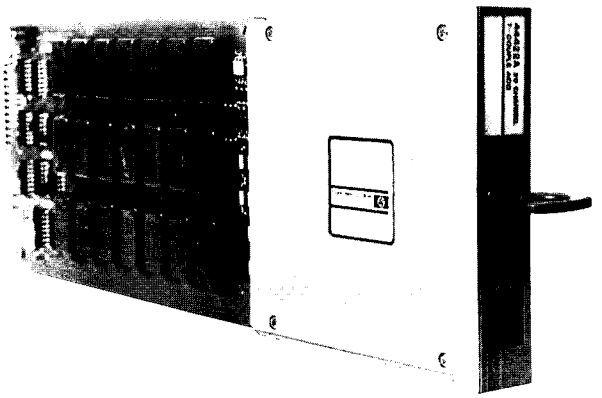


Figure 79. Option 010 - Input Signal Conditioning

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OPTION 020



Relay Multiplexer Assembly With Thermocouple Compensation

INTRODUCTION

The relay multiplexer assembly with thermocouple compensation can be used for voltage, temperature and resistance measurements, but is primarily used with thermocouples for temperature measurements. The assembly consists of a relay card and a terminal card. The terminal card, which can be disconnected from the relay card, has temperature compensation circuits for thermocouple measurements.

Description

The Option 020 assembly uses the same relay multiplexer card as the Option 010 assembly, but adds a special isothermal connector block on the terminal card to eliminate unwanted measurement errors when measuring thermocouple voltages.

Both hardware and software thermocouple compensation techniques are available. Hardware compensation can be used to measure the inputs of up to 20 thermocouples per assembly, but is limited to one thermocouple type per assembly. Software compensation can be used to measure the outputs of up to 19 thermocouples, with any mixture of thermocouples.

You can use the Option 020 assembly with hardware compensation to measure the output of up to 20 B, E, J, K, R, S or T type thermocouples (one type per assembly). You can use the assembly with software compensation to measure the output of up to 19 thermocouples (any mixture of these types).

In addition, with appropriate computer programs, you can use software compensation to determine the temperature measured by specially designed thermocouples.

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Simplified Operation

As shown in Figure 80, the assembly consists of a relay card and a terminal card. Inputs from system sensors, such as thermocouples, etc. are input to the terminals on channels A0 through B9 and sent to the relay card relays. Each channel consists of a HIGH, LOW and GUARD line. Relays are divided into two groups (decades): A Decade and B Decade.

In normal operation, an AC chan# command from the 3497A closes the relay in one of the channels and also closes the tree switch relay. When this happens, the input signal is sent through the closed relay to four places: the A COMMON and B COMMON connectors on the terminal board and (through the tree switch) to the 3497A DVM and to the rear panel (HI COM, LO COM and GUARD COM) terminals.

For example, for an assembly in slot 0, channel A0 address is 0, channel A1 address is 1, and channel B9 address is 19. Thus, AC0 closes the relay in channel A0 and the channel A0 voltage is sent to the A COMMON and B COMMON connectors on the terminal board, to the rear panel connectors on the 3497A and to the DVM.

Several optional configurations are available by removing jumpers JMP1 through JMP6. For example, by removing JM1, JM2 and JM3, channel inputs are not sent to the 3497A. Or, by removing JMP4, JMP5 and JMP6, the A Decade outputs can be separated from the B Decade outputs for 4-wire ohms measurements.

Thermocouple Compensation

Since a primary function of the assembly is temperature measurements using thermocouples, the thermocouple compensation circuits require a word of explanation. The 3497A does not directly measure temperature, but rather measures voltage generated by thermocouples. This measured voltage, which is proportional to temperature, can then be converted to an equivalent temperature by reference to standard tables or through a computer program.

The problem with this approach is that the voltage measured by the 3497A is different than the actual thermocouple voltage (due to junction voltages) unless some compensating technique is used. The Option 020 assembly has two types of thermocouple compensation techniques: software and hardware.

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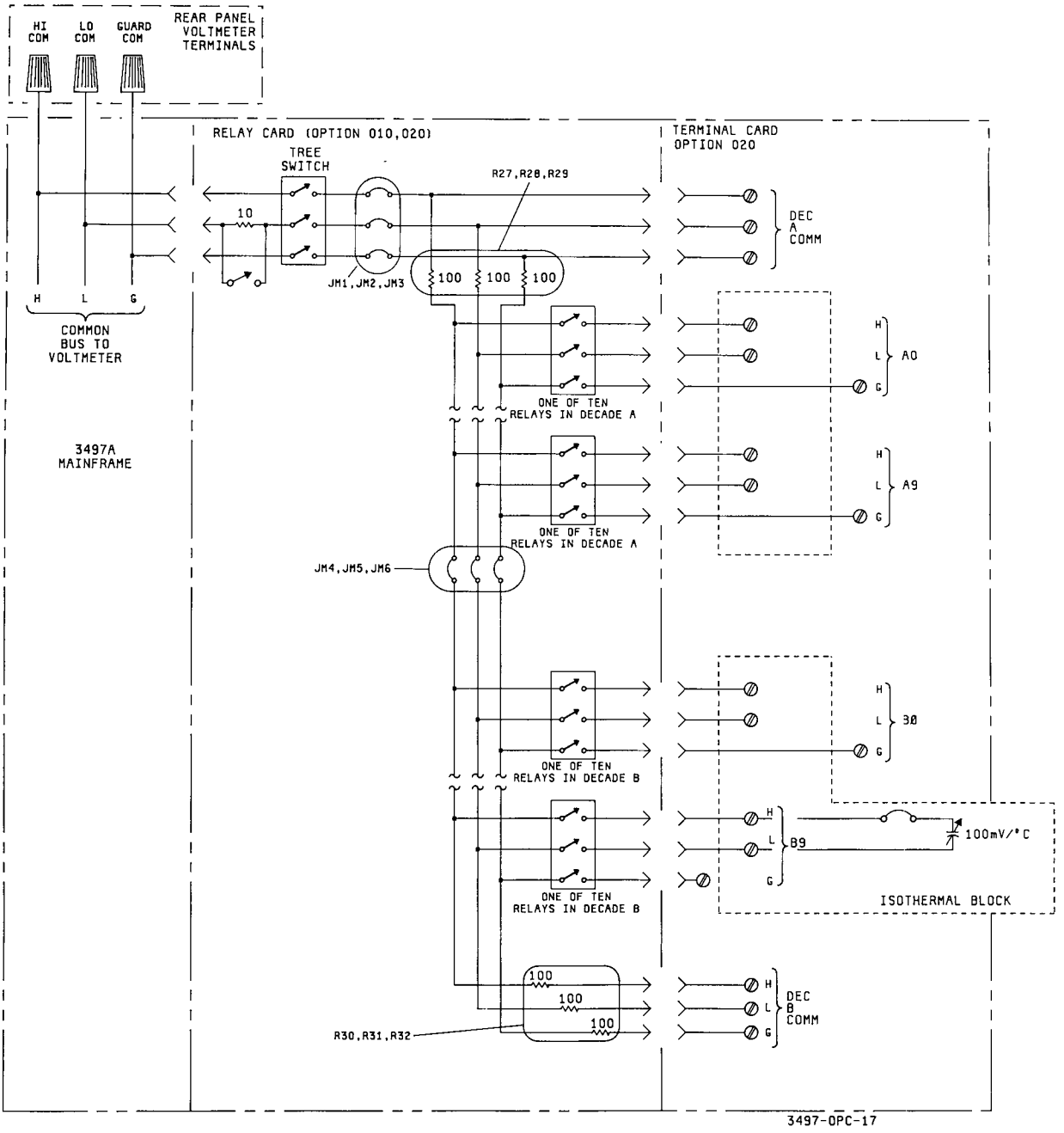


Figure 80. Option 020 - Simplified Schematic

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Software Compensation

As factory configured, the assembly is set for software compensation. With software compensation, a reference junction transducer measures the voltage of an isothermal block. The voltage measured is a function of the temperature of the block and is connected to channel B9 (channel 19) as shown in Figure 80.

Thus, with software compensation, only 19 channels are available for inputs, since the 20th channel (B9) is dedicted to the reference junction transducer circuits. However, you can use a mix of thermocouples on a single assembly.

Hardware Compensation

Software compensation has the advantage of being able to mix various types of thermocouples on a single assembly. However, the measurement process is rather slow, since the reference voltage on channel 19 should be measured frequently to avoid isothermal block temperature drift errors.

If you have only one type of thermocouple to measure, the assembly can be configured for hardware compensation and thermocouple voltages can be measured directly. With hardware compensation, the reference junction transducer is removed from the circuit and 20 channels can be used for input.

For hardware compensation, the compensation voltage is determined by two resistors installed on the terminal card, whose value is dependent on the type of thermocouple being measured. Thus, the voltage displayed on the front panel or at the controller is the true (compensated) thermocouple voltage and can be directly used with a standard look up table to determine equivalent temperature.

Specifications

Specifications for the 20 channel relay multiplexer assembly with thermocouple compensation follow. Specifications are performance standards, or limits, against which the assembly may be tested.

OPTION 020
RELAY MULTIPLEXER ASSEMBLY WITH THERMOCOUPLE COMPENSATION

Reference Junction Compensation Comparison

	Compensation Type Software	Hardware
Compatible Thermocouples	Any Mixture	One of the Following Types: B,E,J,K,R,S,T
Measurement Channels Available per Assembly	19	20
Reference Junction Compensation Accuracy (23°C ± 5°C)	1°C	

Valid for thermocouple compensation only. The total accuracy of 3497A based temperature measurement systems including compensation accuracy, 3497A scanner offsets. DVM accuracy and software accuracy is shown below.

Temperature Coefficient (0°C – 18°C, 28°C – 55°C)	.009°C/°C	
Stability	.075°C/1000 Hours	
Temperature Difference Across Isothermal Block:	< .2°C	
Software Compensation Output: (Channel B9)	100mV/0C 2.5V@25°C	
Additional In Series Resistance: (Hardware Compensation only).		10Ω

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Temperature Measurement Accuracy

For a 3497A based temperature measurement system. Includes all errors introduced by the 3497A and the HP 3054A/C Data Acquisition/Control System Software.

Input Characteristics

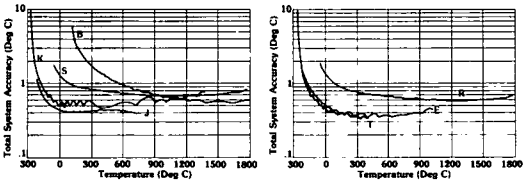
Maximum Input Voltage: < 170 V peak between any two input terminals

Maximum Current: 50 mA per channel non-inductive

Maximum Power: 1 VA per channel

Thermal Offset: Direct Switched: < 1 μV Differential
Tree Switched: < 2 μV Differential

Closed Channel Resistance:
In Series: 100 Ω ± 10% in High, Lo and Guard
Relays Contacts Only: < 1 Ω per contact



Open Channel Isolation:

		25°C, < 85% R.H. 40°C, < 60% R.H.	40°C, > 95% R.H.
Hi to Lo			
Option 010		$>10^{10}\Omega$	$>10^{9}\Omega$
Option 020	Open	$<10^{10}\Omega$	$>10^{8}\Omega$
	Closed	$>10^{8}\ \Omega$	$>10^{7}\Omega$
Lo to Guard		$<10^{8}\ \Omega$	$>10^{7}\Omega$
Guard to Chassis		$>10^{10}\Omega$	$>10^{9}\Omega$

Operating Characteristics

Maximum Switch Rate: Random Channels;
Using Hardware Increments: 475/second

Rated Switch Life at 1 VA: 10^{7} operations

All Relays are Break Before Make

AC Performance

High to Low Capacitance: Channel Open: < 10 pF/per channel
Channel Closed: <220 pF/per channel

Interchannel Capacitance: < 10 pF

	100 kHz	1 MHz
Frequency Response (1 MΩ Termination, 10 kHz Reference)	± .3 dB	± .5 dB
Cross Talk		
Channel to Common		
50 Ohm Termination	−70 dB	−50 dB
1M Ohm Termination	−50 dB	−40 dB
Channel to Channel		
50 Ohm Termination	−60 dB	−40 dB
1M Ohm Termination	−40 dB	−30 dB

Manual Information

This manual contains configuration and control information for this assembly. For repair and/or service information, see 3497A Plug-In Assemblies/3498A Extender Service Manual (-hp- part number 03497-90021). Assemblies manufactured after the publication date of this manual may have changes incorporated. In this case, a yellow MANUAL CHANGES sheet will accompany this manual. See Appendix B for details.

Application Notes

As an aid to using the Option 020 assembly, you may want to order -hp- Application Note 123 ''Floating Measurements and Guarding'' (-hp- part number 5952-2153) and -hp- Application Note 290 ''Practical Temperature Measurements'' (-hp- part number 5952-8801) from your nearest -hp- Sales and Service office.

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INSTALLING THE ASSEMBLY

WARNING

There is no operator installation or configuration for the relay multiplexer assembly. Only qualified, service-trained personnel should install or configure the assembly.

Initial Inspection

If you ordered the relay multiplexer assembly as Option 020, the assembly is already installed in the 3497A. If you ordered the assembly as Field Installation Kit 44422A, the shipping container should contain a relay card and a terminal card with thermocouple compensation networks (see Figure 80).

For the field installation kit, if either card is missing or if there is mechanical damage or defect to the cards, contact your nearest -hp- Sales/Service office. They will arrange for replacement or repair at -hp- option.

If there is any damage to the shipping carton, keep the carton and notify the carrier as well as -hp-. If you return a relay card or terminal card to -hp-, follow the shipping guidelines in Appendix B.

How to Install the Relay Multiplexer Assembly

WARNING

Before touching any installed assemblies or attempting to install the relay multiplexer in the 3497A or 3498A, disconnect the power cords to the 3497A and 3498A and remove ALL voltage sources from these instruments.

The relay multiplexer assembly is not intended for outdoor use. Do not expose the assembly to rain or excessive moisture.

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Figure 81 shows how to install the assembly in the 3497A and 3498A. After taking the steps shown in the WARNING and CAUTION notes above, plug the assembly into an unused slot in the 3497A or 3498A and turn the locking key clockwise to lock the assembly in place.

To minimize thermal offsets (voltage errors), it is good practice to install the assembly in slot 0 (or the leftmost slot available). Note that the temperature shield must be removed if the assembly is installed in slot 4 of a 3497A or slot 4 or 9 of a 3498A.

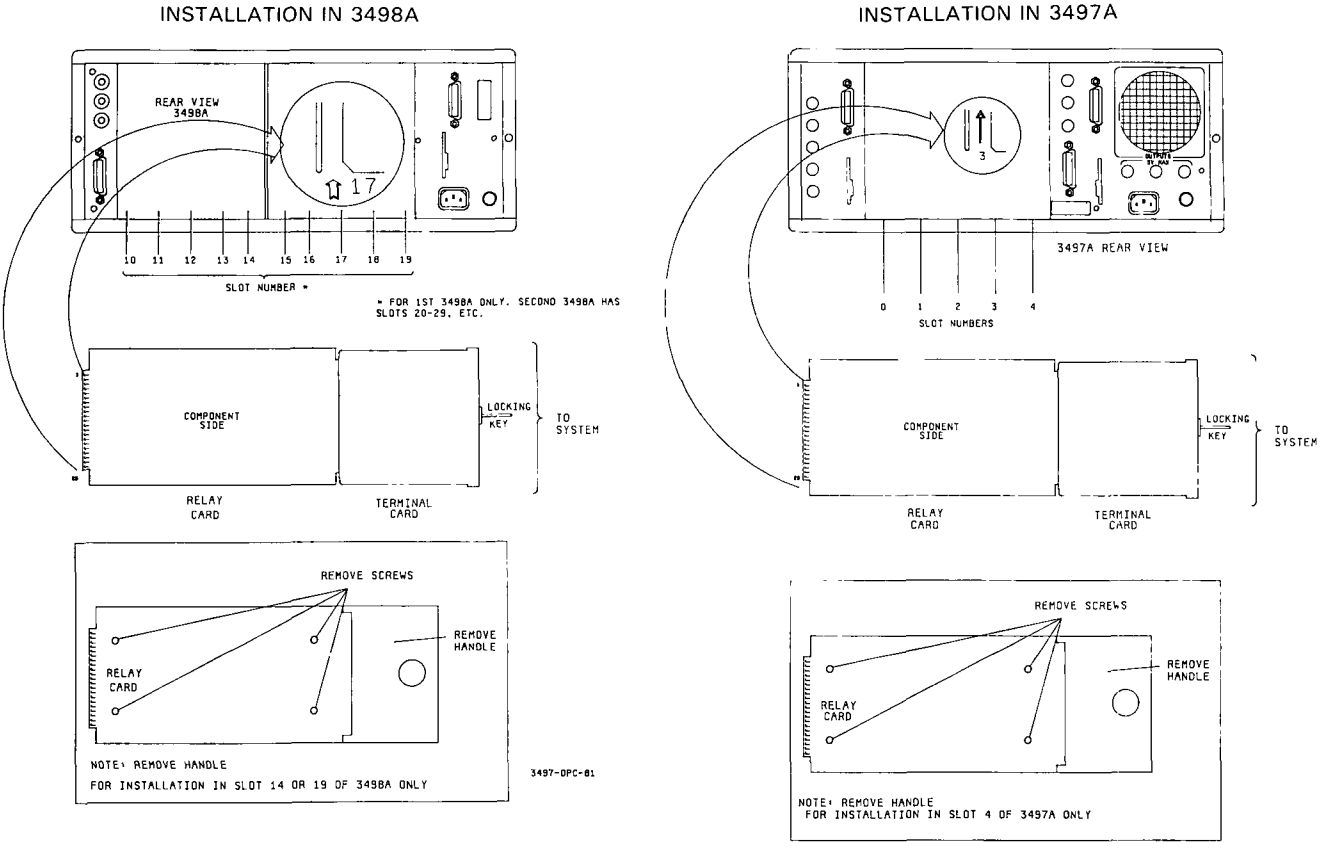


Figure 81. Option 020 - Installation in 3497A/3498A

CONFIGURING THE ASSEMBLY

Assembly configuration is divided into two parts: relay card configuration and terminal card configuration. This section shows the functions of the jumpers and resistors on the cards and their locations. See Chapter 9 for some ways that the assembly can be configured for voltage, temperature and resistance measurements.

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Relay Card Configuration

By using jumpers JMP1 through JMP6, the T/C COMP jumper and resistors R27 through R32, the relay card can be configured for a wide variety of operating modes. The following chart shows the function of each of these components and Figure 82 shows their locations.

RELAY CARD - FUNCTIONS

REF	TITLE	FUNCTION
1	T/C COMP JUMPER	Sets the assembly for hardware or software thermocouple compensation. Set to NO T/C COMP position for software compensation. Set to T/C COMP position for hardware compensation.
2	TREE SWITCH JUMPERS (JMP1,2,3)	Enables signals from the A decade and B decade relays to be passed to the tree switch relay. Remove these jumpers when you don't want signals input to the 3497A mainframe.
3	DECADE A TO DECADE B JUMPERS (JMP4,5,6)	These jumpers connect decade A relay outputs to decade B relay outputs. Remove these jumpers for four-wire ohms measurements. With jumpers removed, A decade output ONLY is available to the DVM (when tree switch is closed).
4	A DECADE SERIES RESISTORS (R27,28,29)	Provide current limiting protection for A decade. Short these resistors (by soldering the shorting pins) when making two-wire ohms measurements on the A decade.
5	B DECADE SERIES RESISTORS (R30,31,32)	Provide current limiting protection for B decade. Short these resistors (by soldering the shorting pins) when making two-wire ohms measurements on the B decade.

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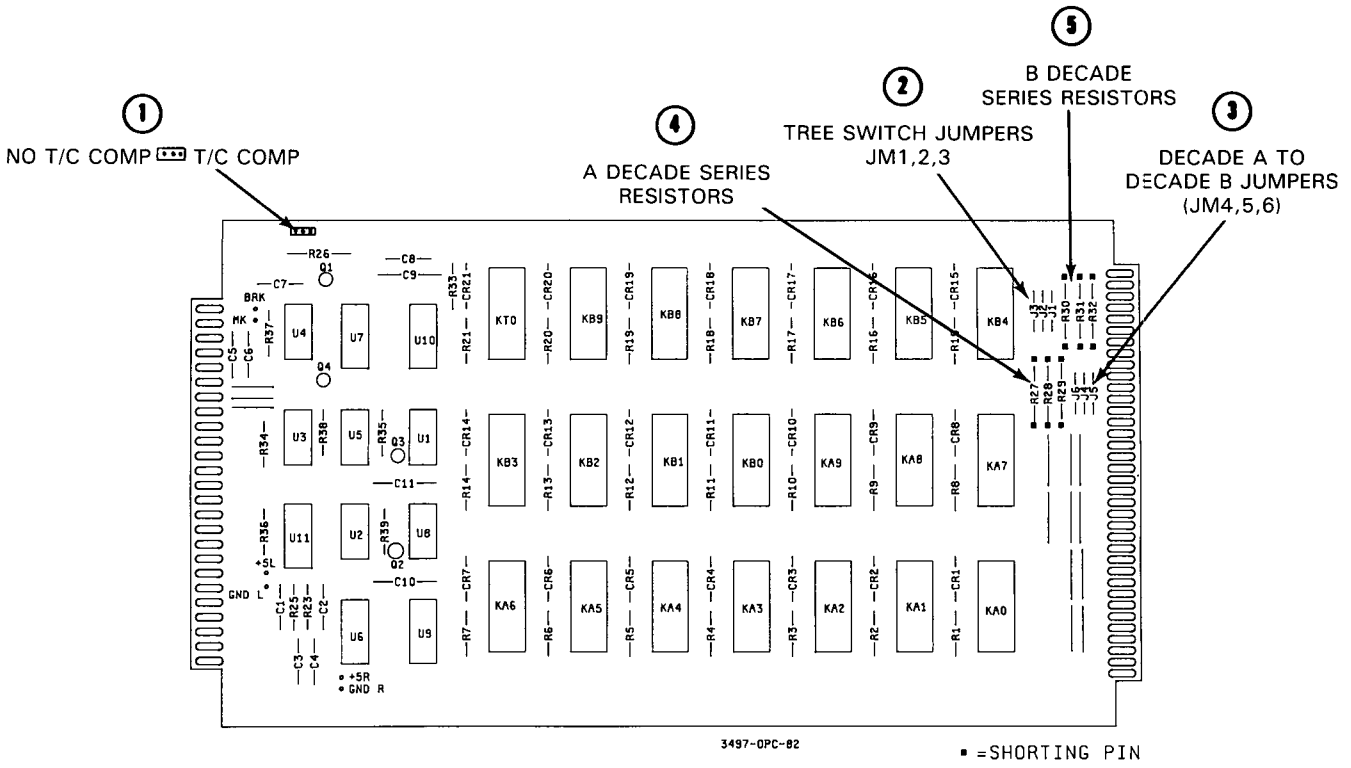


Figure 82. Option 020 - Relay Card Jumpers/Resistors

Shorting the Series Resistors

As factory configured, there are three 100 ohm resistors in series with the A decade COMMON output (R27, R28 and R29) and three 100 ohm resistors in series with the B decade COMMON output (R30, R31 and R32). For more accurate two-wire resistance measurements, these resistors can be shorted out.

For two-wire ohms measurements on A decade channels, short out R27, R28 and R29, using the shorting pins on the relay card. For two-wire ohms measurements on B channels, short out R30, R31 and R32, using the shorting pins. See Figure 82 for resistor and pin locations. If the assembly is to be used in the 3498A, see the WARNING note which follows.

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WARNING

When the assembly is used in earlier versions of the 3498A, a possible hazard may exist when making measurements in a system containing a high voltage, high power source (100 VA or above).

In these versions of the 3498A, the GUARD sheet metal may short to the chassis sheet metal because of close mechanical spacing. If the 100 ohm resistors have been shorted as described above and this happens, a current path to chassis ground can exist, as shown in Figure 83.

If the GUARD common line is in contact with a high voltage, high power source (100 VA or above) or could come in contact with such a source and the 100 ohm resistor (R27 or R30) in the GUARD COMMON line has been shorted, a possible shock or fire hazard could exist.

WARNING

When using the relay multiplexer in the 3498A, do NOT jumper the 100 ohm resistors in the guard common lines (R27 and R30). If these resistors must be jumpered, provide adequate external fusing as shown.

After connecting system inputs to the terminal card connectors, replace the protective rear cover on the 3498A, since the sheet metal is at guard potential (as high as 170 volts).

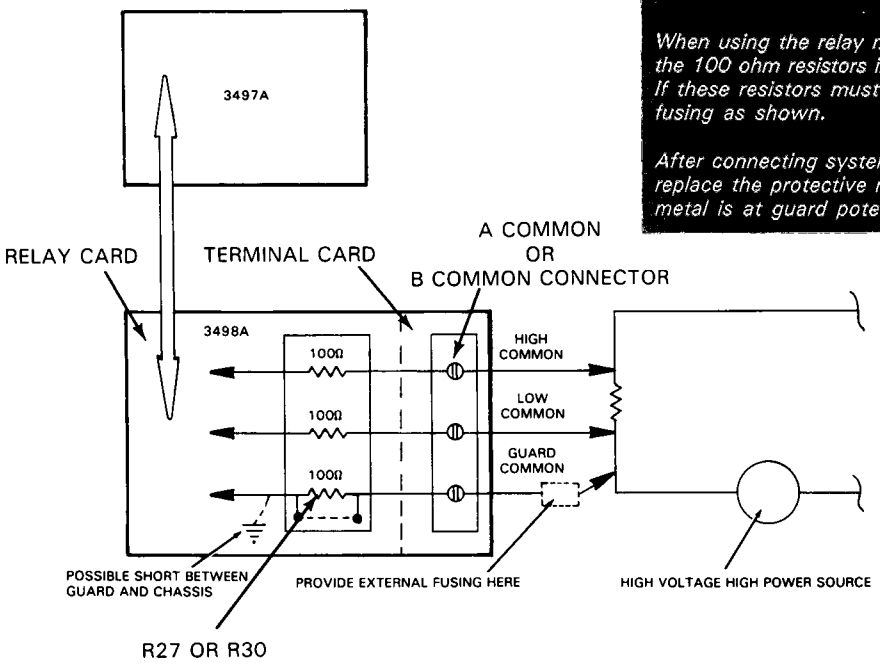


Figure 83. Option 020 - Fusing the Relay Card

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Setting Jumpers JMP1 through JMP6

By removing jumpers JMP1, JMP2, JMP3 and/or JMP4, JMP5, JMP6 on the relay card, you can configure the assembly for four modes of operation. In addition, by repositioning the T/C COMP jumper on this card, you can select hardware or software thermocouple compensation.

Figure 84 shows the four operating modes for the assembly and a truth table for these modes. Note that with JMP4, JMP5 and JMP6 OUT (removed from the board), only the A decade inputs are sent to the 3497A (i.e., an input on channel B0 through B9 can be output ONLY at the B COM terminal on the terminal board).

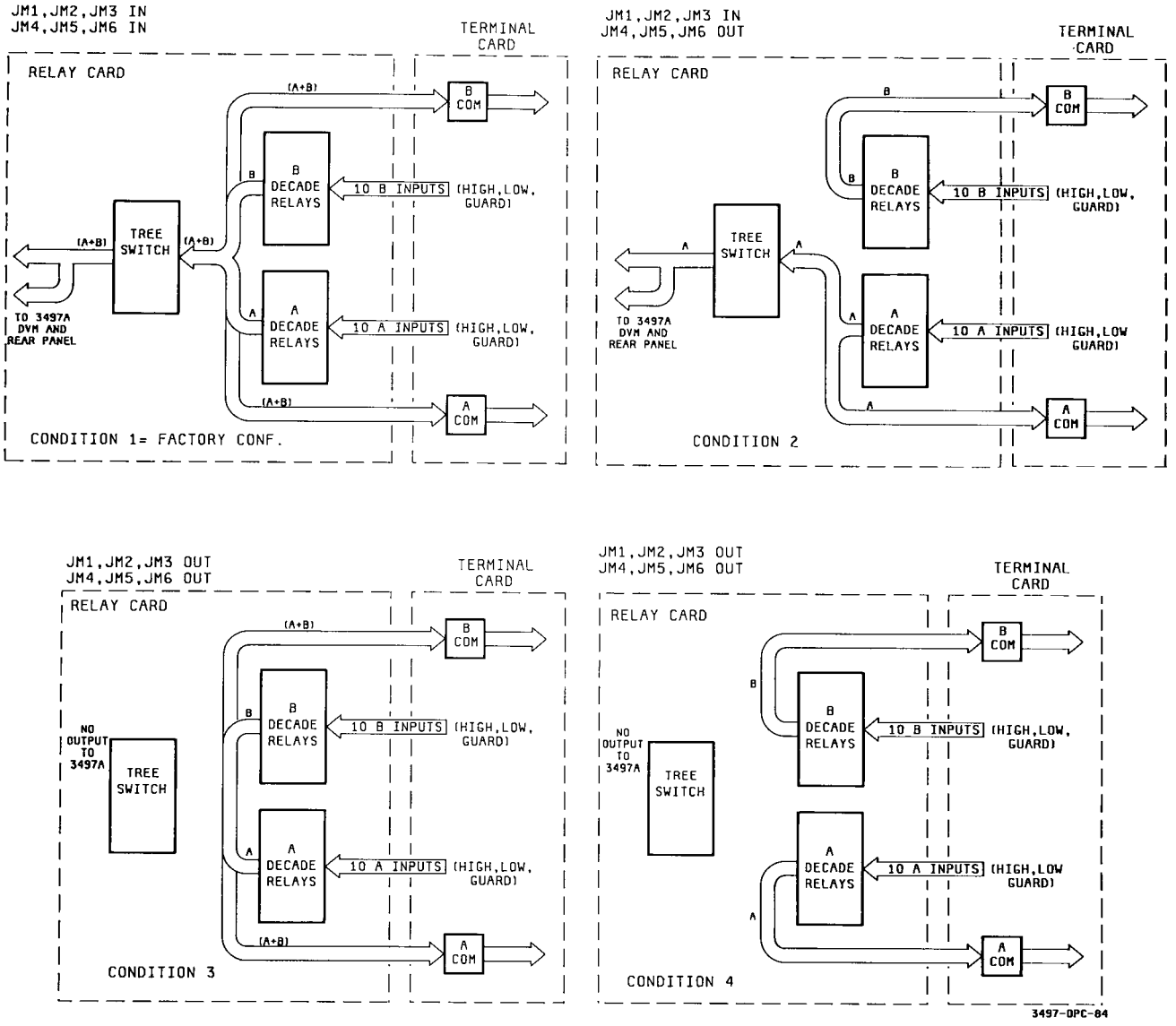


Figure 84. Option 020 - Card Configurations and Truth Table

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Relay Multiplexer Assembly Truth Table

Jumper Position			Output To:		
Oper Cond	JM1,JM2 JM3	JM4,JM5 JM6	Term Card A Common	Term Card B Common	3497A DVM+Panel
1***	IN	IN	(A+B)*	(A+B)	(A+B)
2	IN	OUT	A**	B**	A
3	OUT	IN	(A+B)	(A+B)	—
4	OUT	OUT	A	B	—

* (A+B) = either A decade or B decade output (one of 20 channels).
** A = One of 10 A inputs; B = One of 10 B inputs.
*** Condition 1 is factory configuration.

Figure 84. Option 020 - Card Configurations and Truth Table (Cont'd)

Terminal Card Configuration

The terminal card provides the interface between the relay card and your system transducers. This section shows how to set the terminal card for hardware and software compensation, how to connect signal conditioning inputs to the card and how to connect voltage and thermocouple inputs to the card.

CAUTION

To avoid equipment damage, NEVER input voltages at the 3497A rear panel terminals and at the relay multiplexer at the same time. When the tree switch and the channel relays are closed, voltages input from the rear panel are applied directly to user inputs and may damage the equipment.

Configuring for Hardware Compensation

As factory configured, the Option 020 assembly is set for software thermocouple compensation. Hardware compensation is available for J, K, T, E, R and S type thermocouples. However, only one type of thermocouple can be used per assembly. To configure the terminal card for hardware compensation, it is necessary to reconfigure terminal block J1.

As shown in Figure 85, resistors R100 and R120 must be added on J1 and the shorting jumper wire removed from J1. The value of R100 and R120 for each type of thermocouple is shown in the following table. For example, to configure the terminal card for J-type thermocouples, add R100 = 3.650 Kohm and R120 = 619 ohms and remove the shorting jumper. Note that for hardware compensation, the T/C COMP JUMPER on the relay card must be set to the T/C COMP position.

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NOTE

A kit containing resistors to configure the terminal card for J, K, T, E, R and S type thermocouples is available from -hp- (-hp- part number 03497-69541).

Thermocouple Compensation Resistors
(All values ± 1%)

Type	R120	R100
J	3.650 Kohms	691 ohms
K	3.400 Kohms	357 ohms
T	8.210 Kohms	1.24 Kohms
E	435 ohms	909 ohms
R	149.625 Kohms	2.55 Kohms
S	149.635 Kohms	2.1 Kohms

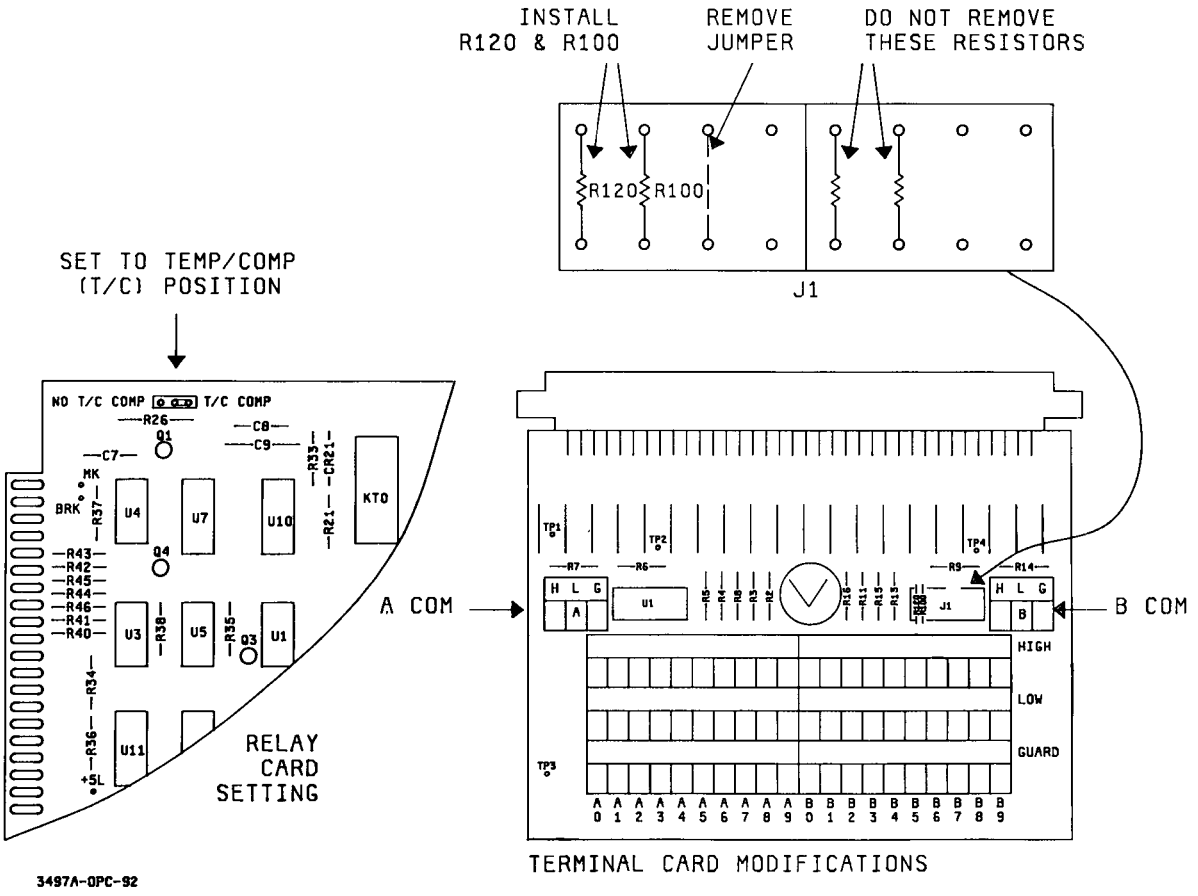


Figure 85. Option 020 · Hardware Compensation

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Configuring for Software Compensation

With hardware compensation, only one type of thermocouple can be used per assembly. If you want to mix thermocouple types on an assembly, it is necessary to use software compensation. In software compensation, channel B9 is NOT available as an input, as the voltage measured on this channel is used as the reference voltage. The assembly is factory configured for software compensation.

To reconfigure the terminal card for software compensation, see Figure 86. If resistors R100 and R120 are installed on J1, remove them and add the shorting jumper in the position shown. Also, for software compensation the T/C COMP jumper on the relay card must be set to the NO T/C COMP position.

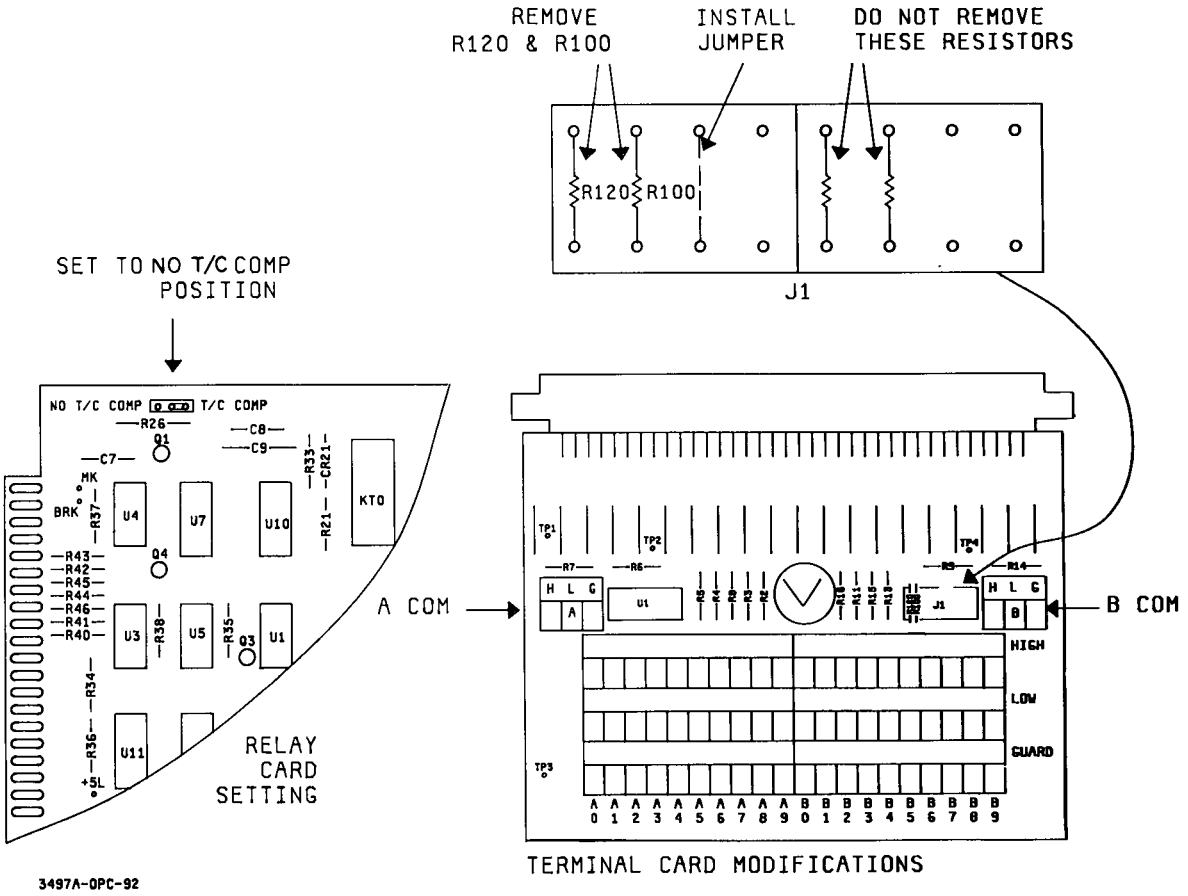


Figure 86. Option 020 - Software Compensation

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Input Signal Conditioning

You can also reconfigure the terminal card by adding customer-supplied signal conditioning elements. Figure 87 shows some example current shunt and low pass filter circuits which can be added for input signal conditioning.

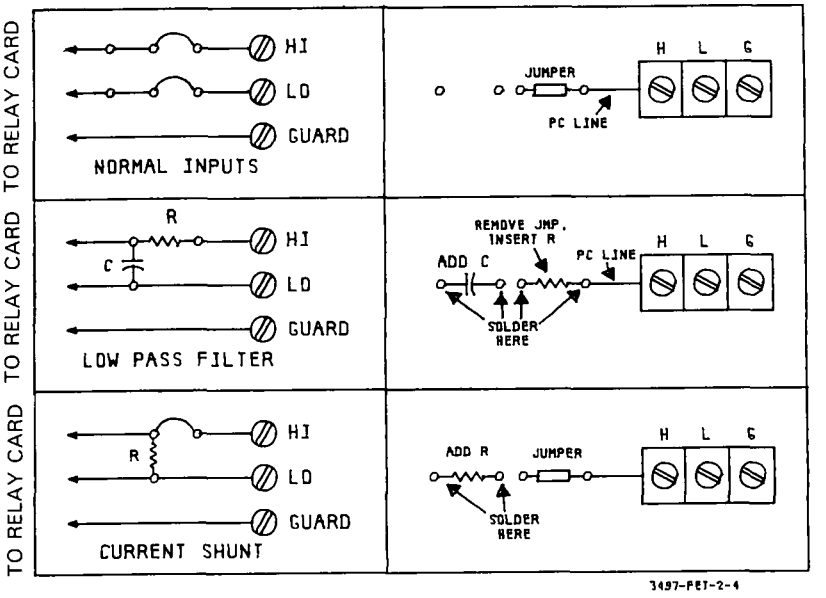


Figure 87. Option 020 · Input Signal Conditioning

Other Modifications to the Terminal Card

By adding shorting jumpers at various parts of the J1 terminal block, you can measure portions of the terminal junction temperature reference circuits on channels indicated. For example, by connecting a jumper at the right side of J1 (closest to the B COM terminal), you can use channel B8 to measure the -8V T/C reference voltage.

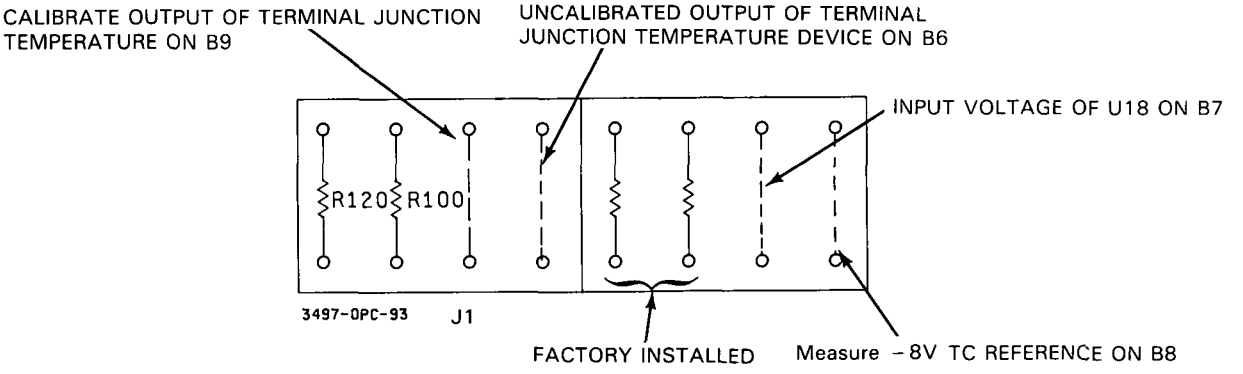


Figure 88. Option 020 · Other Terminal Card Modifications

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Connecting Thermocouples

To connect thermocouples to the terminal card, first remove the terminal card cover by loosening the four screws and then route wires as shown in Figure 89. Note that the - metal (red) lead is connected to the GUARD (G) terminal on the terminal card. Three alternate wiring possibilities are shown in Figure 89 for different types of thermocouples.

When connecting thermocouples to the terminal card, for best results consider the following suggestions. For further information on using thermocouples, see -hp- Application Note 290 ''Practical Temperature Measurements''.

GUIDELINES FOR CONNECTING THERMOCOUPLES

1. Use the largest wire possible which will not shunt heat away from the thermocouple area.
2. Use thermocouple wire which is well within its rating.
3. Avoid mechanical stress and vibration which could strain the wires.
4. For long runs, connect the shield to the GUARD terminal of the card and use twisted pair connector cables.
5. Avoid steep temperature gradients.
6. In hostile environments, use proper sheathing material to reduce adverse effects on thermocouple wires.

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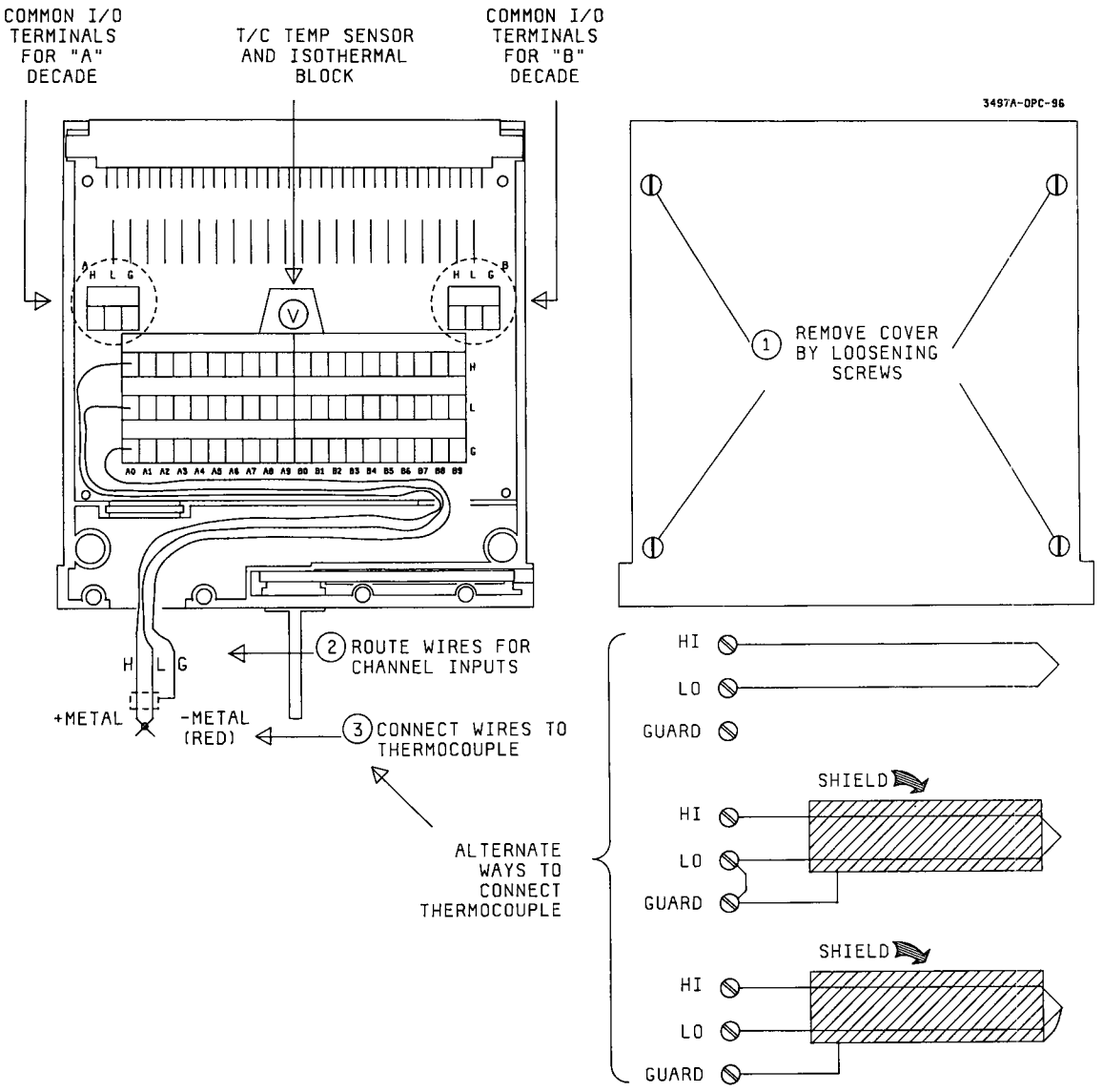
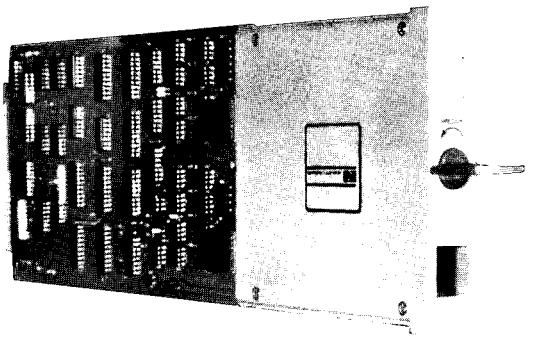


Figure 89. Option 020 - Connecting Thermocouples

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OPTION 050

16 Channel Isolated Digital Input/Interrupt Assembly



INTRODUCTION

The Option 050 assembly has two functional modes: Digital Input Mode and Interrupt Mode. In digital input mode, up to 16 digital inputs (ON, OFF; OPEN, CLOSE; etc.) can be input to the assembly. The assembly can also listen to digital data buses.

In the interrupt mode, up to eight inputs (channels 0 - 7 in the assembly) can be monitored and, when specified system conditions occur, the assembly can send a signal via the 3497A to the controller to ''interrupt'' its program and take specified action.

You can use the digital input mode to sense up to 16 lines of digital data such as the outputs of limit switches and position indicators. Use the interrupt mode to interrupt and take corrective action when immediate reaction to a level change is required or when the signal is transient (as in a momentary switch closure).

In addition, you can use the Option 050 assembly with the Actuator/Digital Output assembly (Option 110) to form an independent digital input/output port.

Description

As shown in Figure 90, the Option 050 assembly consists of a digital input card and a terminal card. The digital input card consists of 16 optically isolated input channels. Eight of the channels (0 through 7) may be used to sense interrupt conditions. In addition, optically isolated handshaking is available for each of the 16 channels to synchronize data transfer between the 3497A and an external peripheral.

The terminal card provides connectors for user inputs on each of the 16 channels and for GATE and FLAG signals used for handshaking. Each channel has a jumper to set logic levels of +5V (factory setting), +12V or +24V and the logic level network has protection against reversed connections.

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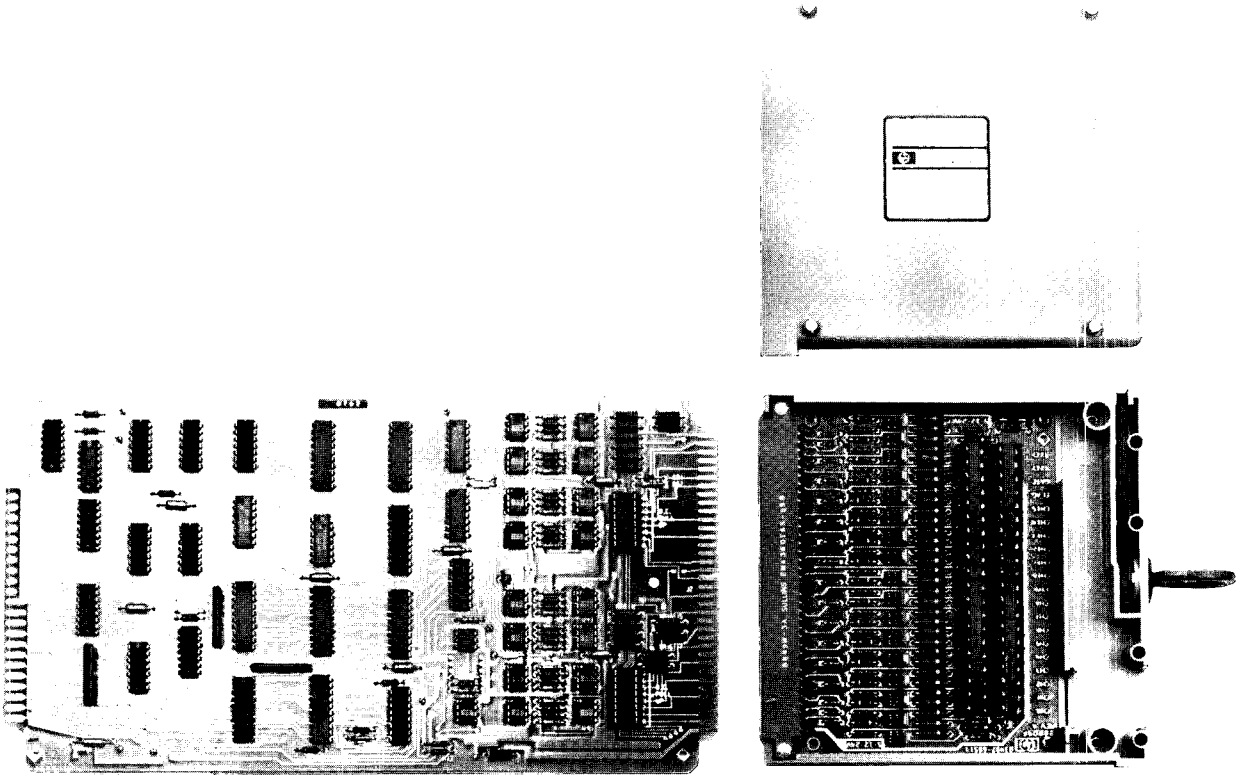


Figure 90. Option 050 - Digital Input/Interrupt Assembly

Interrupt Mode

With interrupt mode, only the first eight channels (0-7) can be used. Refer to Figure 91 which shows sample input connections to trace the sequence of operation for interrupt mode. For the inputs shown, assume that we want to interrupt the controller when the switch in channel 0 closes, but not interrupt when a switch closes in any other channel.

In the circuit of Figure 91, a switch closure causes a high-to-low transition (can be configured for low-to-high) which causes the channel bit in the input byte to be set true (''1''). In Figure 91, transitions have occurred on channels 0 and 7, so bits 0 and 7 in the input byte are set to 1.

Since interrupt is desired only for channel 0, we've set the assembly mask (not the same as the SRQ or interrupt mask in the 3497A) with a DE slot#,0 command. Since the mask bit 0 and the input byte bit 0 are both true, channel 0 of the interrupt byte is set. Note that even though bit 7 of the input byte is set by the transition of channel 7 input, bit 7 of the interrupt byte is NOT set, since the mask bit 7 is not set.

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Since a bit in the interrupt byte is set, an interrupt is sent to the 3497A mainframe and sets bit 1 in the 3497A status register. However, unless the SRQ mask (interrupt mask for Serial Data) is set for digital interrupt with an SE2 (SE102) command, an interrupt is not sent to the controller.

Thus, for an input to interrupt the controller, a two-level hierarchy of commands is required: (1) set the Option 050 assembly mask with a DE slot#,n command and (2) set the 3497A SRQ or interrupt mask with an SE2 or SE102 command.

You can monitor the status of the interrupt byte at any time (whether or not an interrupt occurs) by sending the DI slot# command. The value returned to the controller is the octal value of the true bits in the interrupt byte.

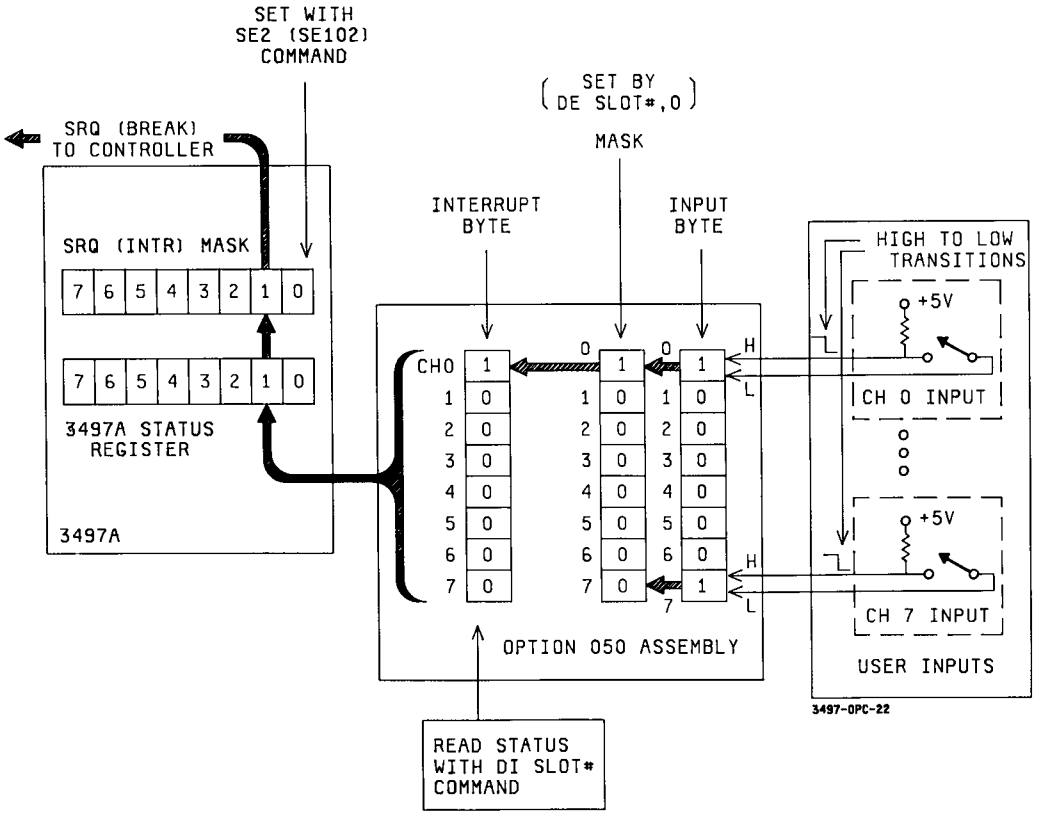


Figure 91. Option 050 - Interrupt Mode

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Digital Input Mode

The Option 050 assembly can also be used in the digital input mode to communicate with an 8-bit or 16-bit digital source at a typical maximum read rate of 400 Hz. For digital input mode operation, refer to Figure 92. As shipped from the factory, handshaking on the assembly is disabled. This means that the controller must be programmed to read input data at the appropriate time to ensure that data is valid.

By setting a jumper on the digital input card, handshaking can be enabled. Handshaking is used to verify that the 3497A responds to each data transmission, thereby synchronizing the data source with the digital input assembly.

When handshaking is enabled, the sequence is as shown in Figure 92. The 3497A initiates the sequence by signaling a READY condition on the GATE output to the data source. The READY condition occurs when a DR slot# or DL slot# command is sent and tells the source that the 3497A is ready to accept data.

When the data source has data ready (DATA STABLE), the FLAG signal transitions from low to high on the FLAG line. This action, in turn, causes the GATE output to return to the BUSY condition and data transfer occurs.

NOTE

As factory set, the 3497A responds to a low to high FLAG transition as shown. The 3497A can be jumpered to respond to a high to low FLAG transition. See CONFIGURING THE ASSEMBLY for details.

After data has been entered into the 3497A, the condition of the input byte can be read with the DR slot# or DL slot# commands. DR returns a continuous reading while DL returns a single reading/command. Note that the DR and DL commands check the status of the input byte while the DI command checks the status of the interrupt byte.

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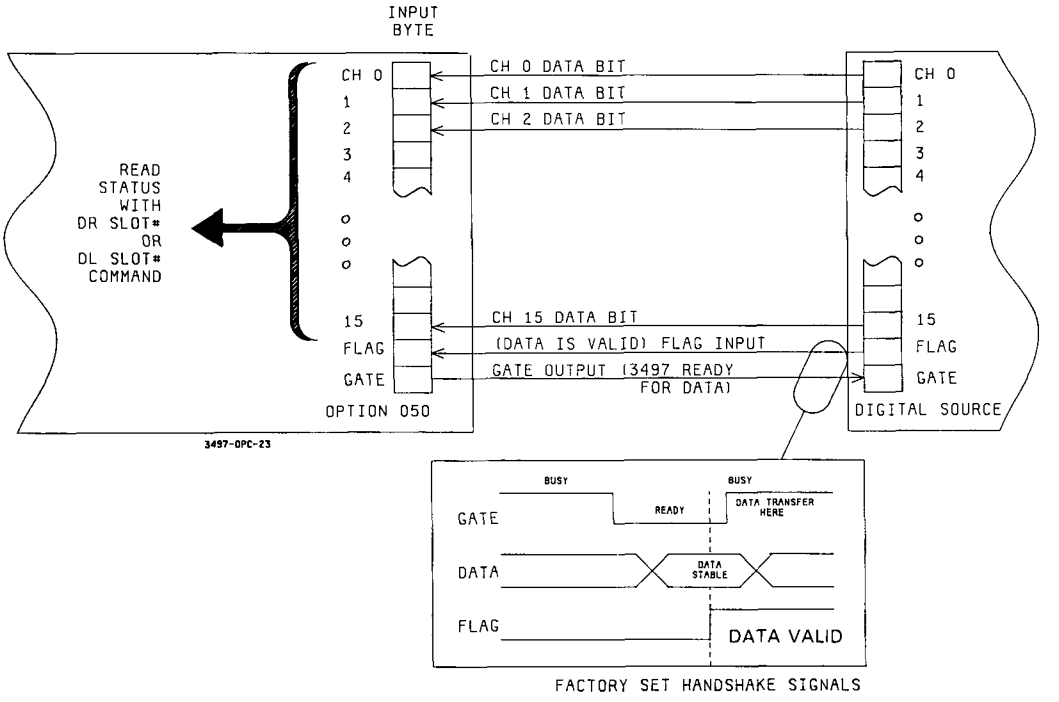


Figure 92. Option 050 - Digital Input Mode

Specifications

Specifications for the 16 Channel Isolated Digital Input/Interrupt assembly follow. Specifications are performance standards, or limits, against which the assembly may be tested.

OPTION 050
16 CHANNEL ISOLATED DIGITAL INPUT/INTERRUPT ASSEMBLY

Input Signal Characteristics

Input Level	V_{LO}(max.)	V_{HI}(min.)	Max. Input Voltage	Min. Input Current
5V	0.8V	2.4V	30V	400 μA
12V	3.0V	7.0V	42V	1 mA
24V	6.0V	13.0V	42V	2 mA

(5 volt level is standard, 12 and 24 volt levels are jumper selectable. Other voltage levels can be accepted using customer supplied resistors).

Maximum Isolation Voltage: < 170V peak between any input terminal and ground.

Digital Input Mode (Bits 0-15)

Logic Polarity: Positive True
(Negative True is jumper selectable)

Handshaking: Gate and Flag Lines are optically isolated. Gate output is open collector. Flag input is identical to input lines. Polarity of gate/flag is jumper selectable. The assembly may be configured to operate with no handshaking.

Interrupt Mode (Bits 0-7)

Minimum Pulse Width: 100 microseconds

Triggering: Each interrupt line is individually programmable for positive or negative edge triggering.

Masking: Each interupt line may be enabled or disabled using a programmable mask.

Multiple Interrupts: Multiple interrupts are latched and are dealt with at a computer dependent rate.

Interrupt Timing: The Option 050 assembly will respond to an interrupt within 1 millisecond of a programmed interrupt condition change.

Five Volt Supply: Source up to 20 mA per assembly.

Operating Consideration: Digital Interrupt (SRQ) is not available in the 3498A Extender.

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Manual Information

This manual contains configuration and control information for this assembly. For repair and/or service information, see 3497A Plug-In Assemblies/3498A Extender Service Manual (-hp- Part number 03497-90021). Assemblies manufactured after the publication date of this manual may have changes incorporated. In this case, a yellow MANUAL CHANGES sheet will accompany this manual. See Appendix B for details.

INSTALLING THE ASSEMBLY

WARNING

There is no operator installation or configuration for the Digital Input/Interrupt assembly. Only qualified, service-trained personnel should install or configure the assembly.

Initial Inspection

If you ordered the Digital Input/Interrupt assembly as Option 050, the assembly is already installed in the 3497A. If you ordered the assembly as Field Installation Kit 44425A, the shipping container should contain a digital input card and a terminal card (see Figure 90).

For the field installation kit, if either card is missing or if there is mechanical damage or defect to the cards, contact your nearest -hp- Sales/Service office. They will arrange for replacement or repair at -hp- option.

If there is any damage to the shipping carton, keep the carton and notify the carrier as well as -hp-. If you return a relay card or terminal card to -hp-, follow the shipping guidelines in Appendix B.

How to Install the Digital Input/Interrupt Assembly

WARNING

Before touching any installed assemblies or attempting to install the digital input assembly in the 3497A or 3498A, disconnect the power cords to the 3497A and 3498A and remove ALL voltage sources from these instruments.

The Digital Input/Interrupt assembly is not intended for outdoor use. Do not expose the assembly to rain or excessive moisture.

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Figure 93 shows how to install the assembly in the 3497A and 3498A. After taking the steps shown in the WARNING note above, plug the assembly into an unused slot in the 3497A or 3498A and turn the locking key clockwise to lock the assembly in place.

CAUTION

Use clean handling techniques when installing, removing or reconfiguring the digital input card. Handle the card by its edges and do not subject the components to static discharges or excessive voltages.

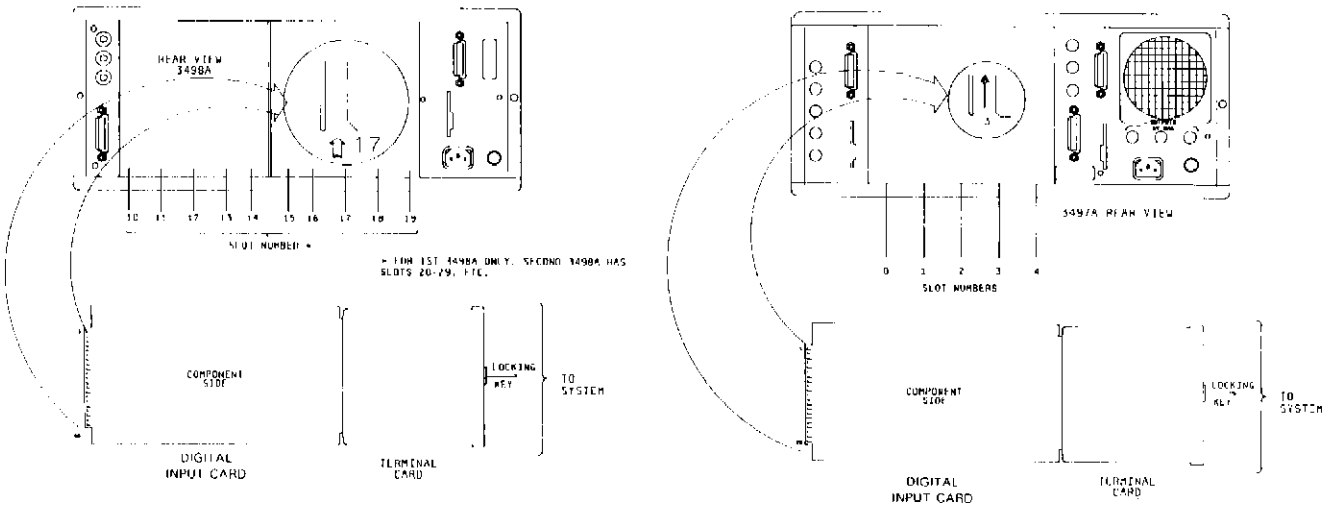


Figure 93. Option 050 - Installation in 3497A/3498A

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CONFIGURING THE ASSEMBLY

Assembly configuration is divided into two parts: digital input card configuration and terminal card configuration. This section shows the functions of the jumpers on the cards and their locations. See Chapter 9 for some ways that the assembly can be configured for interrupt applications.

Digital Input Card Configuration

By changing jumper positions and adding resistors to the digital input card, you can configure the assembly for a wide variety of operating conditions. In addition, by using the DS slot#,n (n = 0 to 377 octal) command, you can set the assembly to generate interrupts for positive (low to high) or negative (high to low) transitions from your input circuits.

To configure the digital input card for your requirements, refer to the following chart which shows the function and factory configuration for the card and see Figure 94 for location of the jumpers.

DIGITAL INPUT CARD - JUMPER FUNCTIONS

#	TITLE	REF	DESCRIPTION
1	FLAG SENSE	LFL	Sense FLAG input on high to low transition.
		HFL	Sense FLAG input on low to high transition (FACTORY SETTING).
2	INVERT LOGIC	INVT	Inverts data logic to low true (applies to DR slot# and DL slot# commands).
3	ENABLE HANDSHAKE	HS	Enables Handshake (FACTORY SETTING = NOT ENABLED).
4	OPEN COLLECTOR PULLUPS	O.C. PULLUPS	Install a 2 Kohm resistor for each channel which uses an input circuit with an open collector.*
5	GATE SENSE	HGT	High GATE: BUSY = Low, READY = High.
		LGT	Low GATE: BUSY = High, READY = Low. (FACTORY SETTING)
6	GATE, FLAG PULLUPS	GPU	GATE Pullup: Install 2 Kohm resistor if data source does not have pull up.*
		FPU	FLAG Pullup: Install 2 Kohm resistor if data source does not have pull up.*

* Must connect system grounds between data source and 3497A.

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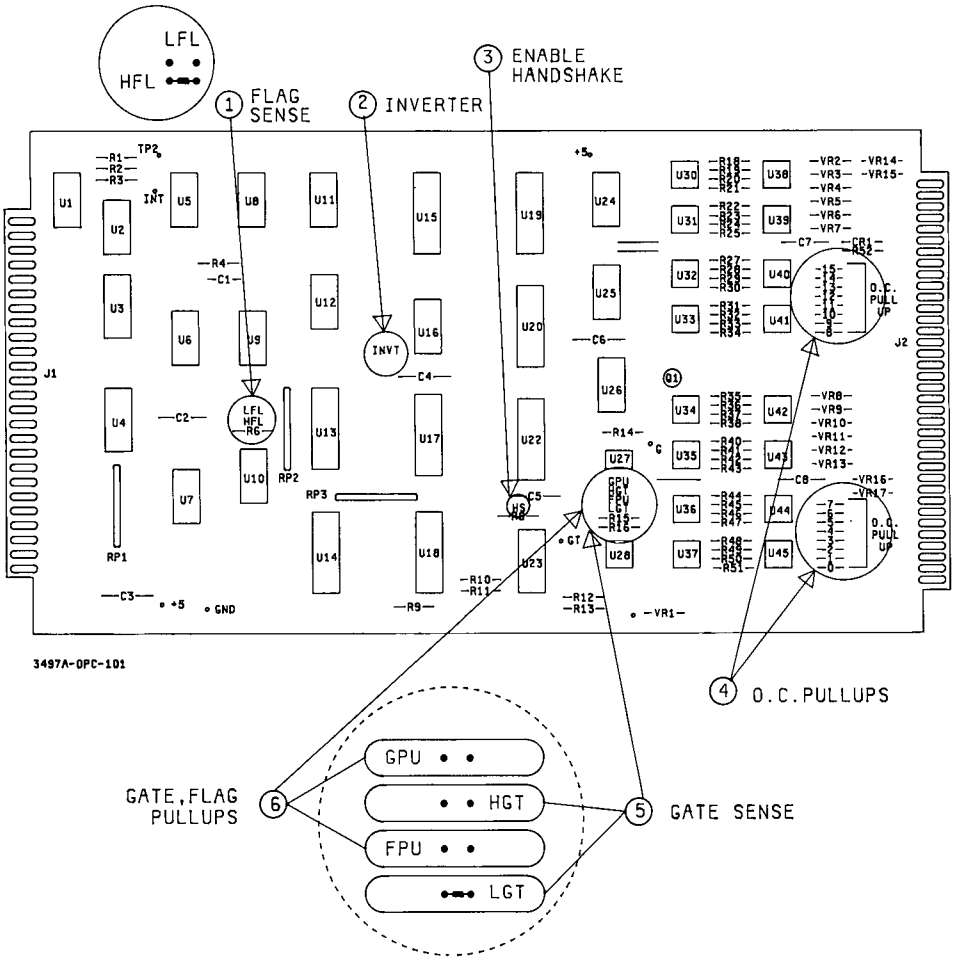


Figure 94. Option 050 - Digital Input Card Jumper Locations

Terminal Card Configuration

Each digital channel requires two inputs (HI and LO) to complete the optical isolator circuit. With this connection, each channel is isolated from the other input channels, unless common connections are made between SYSTEM GROUND on the terminal card and user SYSTEM GROUND.

When the data source or input system uses open collectors, you must connect SYSTEM GROUNDS between your system and the SYSTEM GROUND on the terminal card (as well as connecting 2 Kohm resistors).

You can select +5V (Factory Set), +12V or +24V logic level for each channel input by changing the position of the jumpers as shown in Figure 95. Note that the Chassis and Earth Ground terminals on the card are tied together to form a SYSTEM GROUND.

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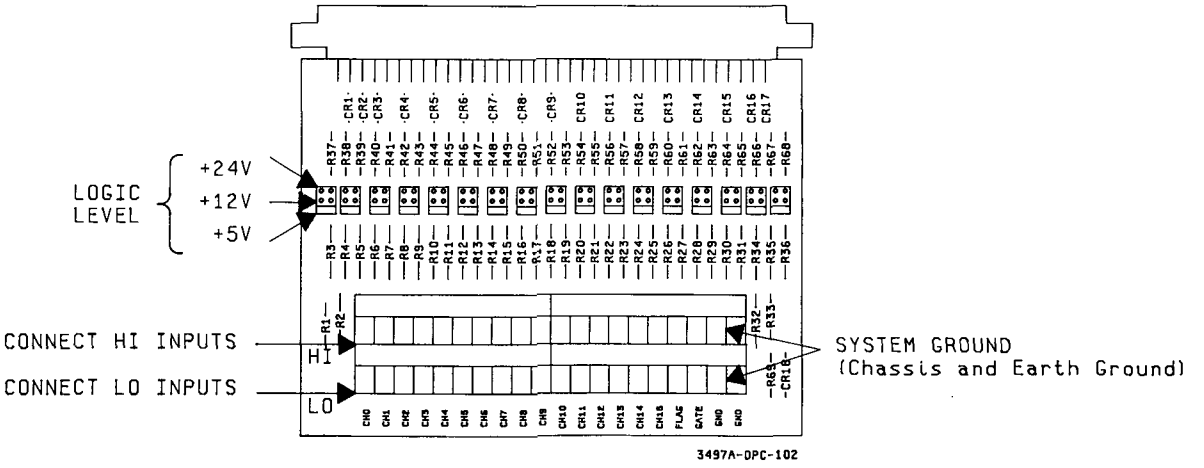


Figure 95. Option 050 - Terminal Card Connections

To connect inputs to the terminal card, remove the cover by loosening the four screws and route the wires as shown in Figure 96. Note that the FLAG and GATE connections are the same as channel inputs and must have HIGH and LOW connections. (The assembly does have protection against reversed connections). After the connections are made, replace the terminal card cover.

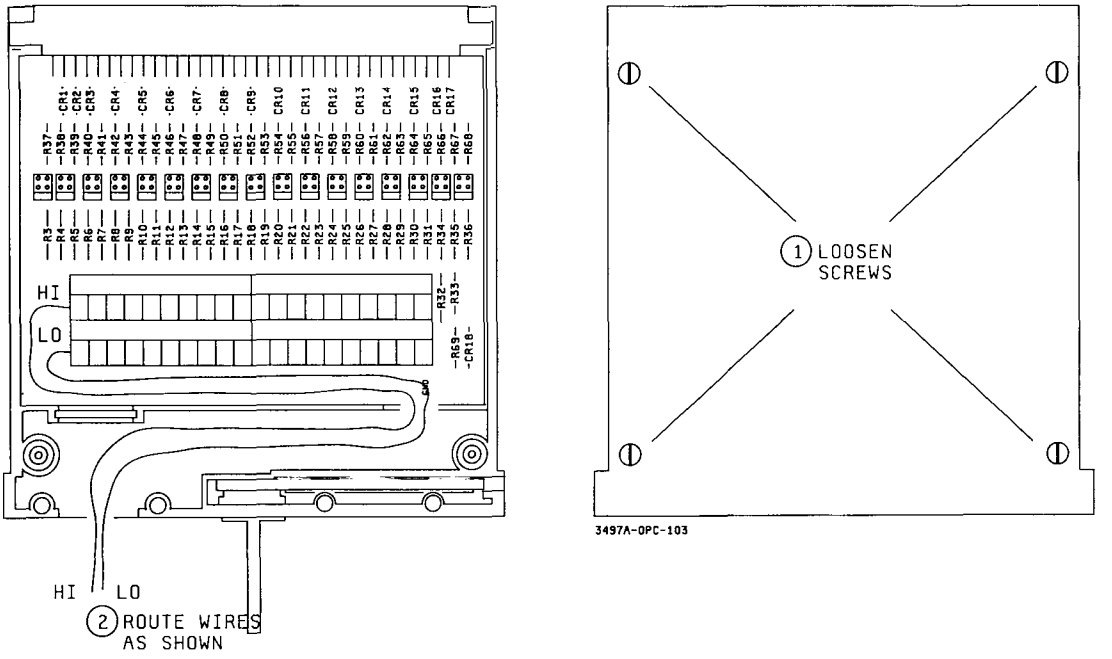


Figure 96. Option 050 - Routing Terminal Card Wiring

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Contact Closure to Ground

Another configuration which requires that SYSTEM GROUNDS be connected is for contact closure to ground. As shown in Figure 97, a contact connected to the LOW terminal of a channel is used for interrupt. Note that the SYSTEM GROUNDS are tied together at the GND terminal on the terminal board and that a 2 Kohm resistor is installed in the O. C. PULLUP block.

NOTE

To enable interrupts on channels 0-7, input signal pulse width must be greater than 100 μsec.

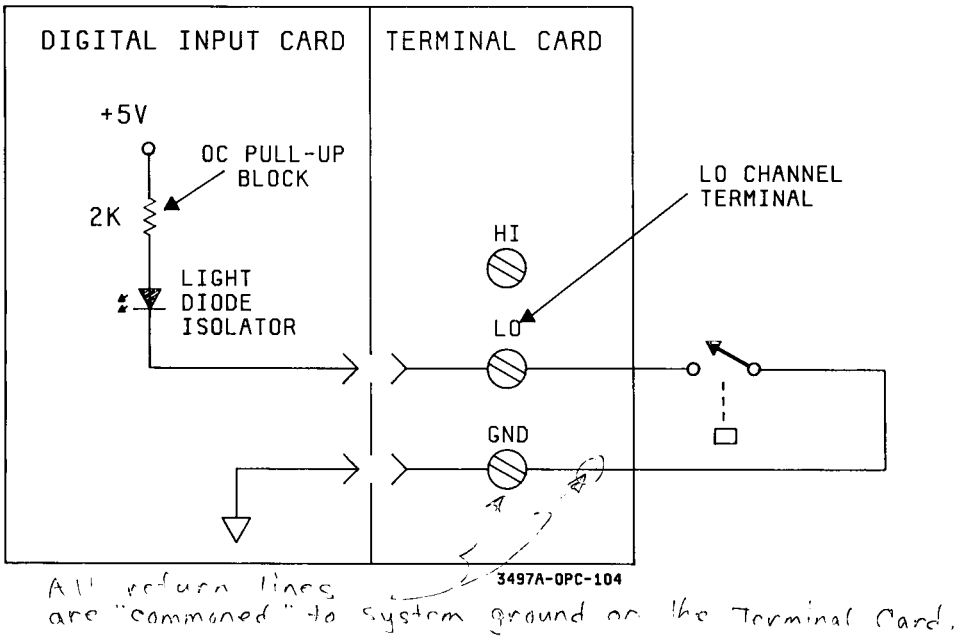
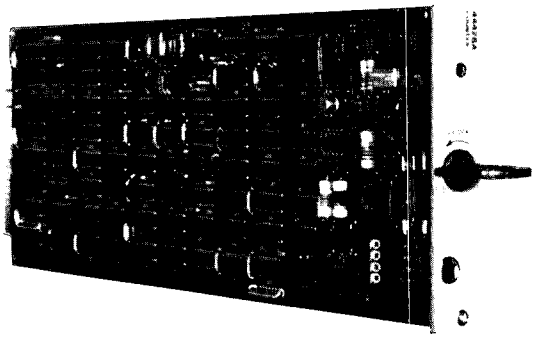


Figure 97. Option 050 - Contact Closure to Ground

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OPTION 060

100 kHz Reciprocal Counter Assembly



INTRODUCTION

Option 060 is a 100 kHz reciprocal counter which can measure the period of input signals up to 100 kHz and the pulse width of signals down to 18 usec. In addition, the counter can count up or down from a programmable start point and can output a programmable number of square wave pulses for control applications.

The counter can accept a wide variety of input signals including CMOS, open collector TTL and passive contact closures. All counter functions, interrupts and trigger modes are fully programmable. The counter can be read during a measurement or can be programmed to respond when a measurement is complete.

Description

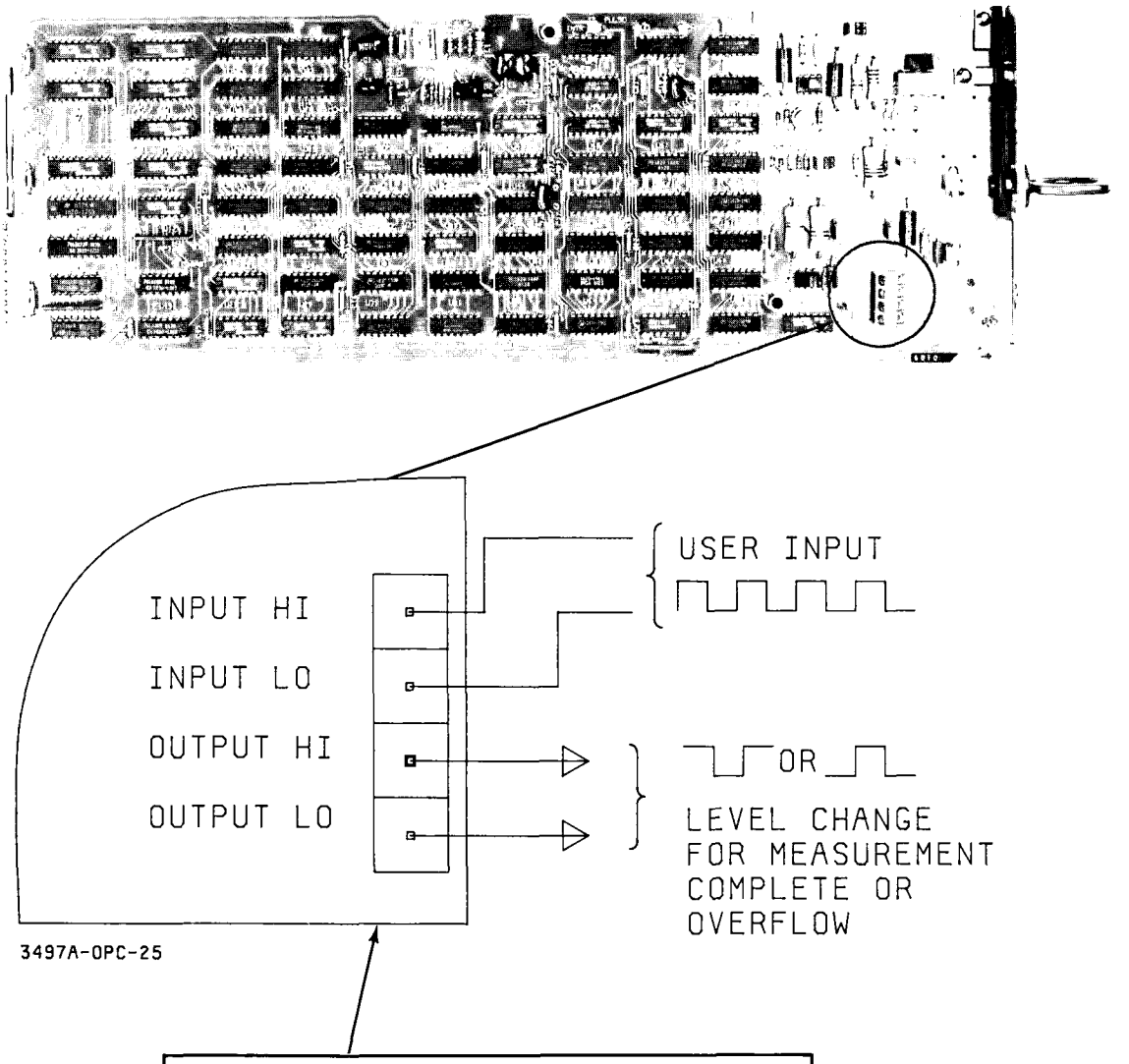
As shown in Figure 98, the assembly consists of a counter board with connector terminals for INPUT HIGH, INPUT LOW, OUTPUT HIGH and OUTPUT LOW connections. User signals are input to the INPUT HIGH and INPUT LOW connectors.

The counter can accurately measure a wide variety of input signals, as long as the signal parameters are within the limits shown in the specification table. Although square wave inputs are used for the examples in the manual, you can use other inputs such as triangle or sine wave and still achieve accurate results.

The OUTPUT HIGH and OUTPUT LOW terminals on the counter card provide a means to output a level change (programmable for high to low or low to high) whenever the counter overflows or a measurement is complete. This level change is output whenever these conditions occur and can be used to drive or control external circuits.

For example, when the counter measures more than 999999 counts (an overflow condition), a level change pulse is available at the OUTPUT HIGH terminal which can be used to signal the error to an external circuit. (Note: the terms ''overflow'' and ''measurement complete'' have different interpretations, depending on the mode of operation for the counter. See Simplified Operation for details)

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INPUT/OUTPUT TERMINALS
Use the INPUT HIGH and INPUT LOW terminals to input your system signals for count up (totalize), count down and period or pulse width measurements. Use the OUTPUT HIGH and OUTPUT LOW terminals for input to an external system. A level change is output at these terminals when a measurement is complete or when the counter overflows. You can also use the OUTPUT HIGH and OUTPUT LOW terminals to output a programmable number (0 to 499999) of square wave pulses to drive external circuitry.

Figure 98. Option 060 - 100 kHz Reciprocal Counter

NOTE

The OPTION ROM shown in Figure 98 MUST be installed in the 3497A if HP-IB option is used and the counter is ordered as a Model 44426A Field Installation Kit. See INSTALLING THE ASSEMBLY for details.

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Simplified Operation

The 100 kHz reciprocal counter has five main operational modes: count up, count down, period measurement, pulse width measurement and pulse output. Each operation is summarized, with the counter at factory settings. By using the switch and jumpers on the counter card, you can set the counter for a wide variety of configurations for each of these operations. See Figure 99 for a summary of the five modes.

Count Up

In count up, the counter counts up (totalizes) a number of input pulses (up to 999999) from a programmable start point (0 to 999999). At any time after the counter starts counting up, the totalized counts can be displayed on the front panel or sent to the controller.

If the total count in the counter exceeds 999999 counts, an overflow condition occurs and the counter generates a level change output at the OUTPUT HIGH terminal. If interrupt on overflow has been enabled, the counter sends an interrupt to the 3497A status register to set bit 1 (digital interrupt).

Count Down

In count down, the counter counts down a number of input pulses (999999 counts max) from a programmable start point (0 to 999999). The counter stops at 0 unless start point is 000000. If the start point is 0, counter ''wraps around'' and counts down from 999999 (million counts maximum).

After the counter has started the count down operation, you can display the number of remaining counts on the front panel or send this data to a controller. The counter can be programmed to send an interrupt to the 3497A when zero count is reached. Also, when a zero count is reached, a level change output is available at the OUTPUT HIGH terminal.

Period Measurement

In period measurement, the counter can measure one period or average 100 or 1000 periods of input signals which have frequencies up to 100 kHz. Input signal triggering can be selected from rising edge to rising edge or falling edge to falling edge. With appropriate settings of the counter, you can measure the periods of input signals with frequencies from 0.0001 Hz to 100 kHz (periods from 0.00001 sec to 10,000 sec).

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You can program the counter to send an interrupt to the 3497A when a measurement is complete and/or when the input signal period cannot be measured (an overflow condition). In addition, a level change is available at the OUTPUT HIGH terminal when either of these two conditions occur and (if enabled), an interrupt is sent to the 3497A status register to set bit 1 (digital interrupt).

If the input signal period can't be measured because the period is too long for the measurement range selected, a counter overflow condition occurs and a level change output and interrupt (when enabled) occurs. For example, if you tried to measure the period of 1 MHz input, an overflow condition occurs since the input period exceeds the counter limits.

Pulse Width Measurement

In pulse width measurement, the counter can measure one pulse width or average 100 or 1000 pulse widths of an input signal with pulse widths which are 18 μsec or wider. You can select input signal triggering from rising edge to falling edge or falling edge to rising edge.

You can program the counter to send an interrupt to the 3497A when a pulse width measurement is complete or when the pulse width cannot be measured by the counter (overflow condition). In addition, a level change pulse is available at the OUTPUT HIGH terminal when either of these two conditions occur and (if enabled), an interrupt is sent to the 3497A status register to set bit 1 (digital interrupt).

If the input signal period can't be measured because the pulse width is too short for the measurement range selected, a counter overflow condition occurs and a level change output and interrupt (when enabled) occurs. For example, if you tried to measure the pulse width of a 1 MHz input, an overflow condition occurs since the input pulse width exceeds the counter limits.

Pulse Output

The pulse output mode is a variation of the count down operation. In pulse output, the counter outputs a programmable number of square wave pulses (0 to 499999) at a specified frequency (0 to 1kHz). The frequency of output pulses is half the input signal frequency. The input signal must be between 0 and 2 kHz with a pulse width greater than 5 μsec.

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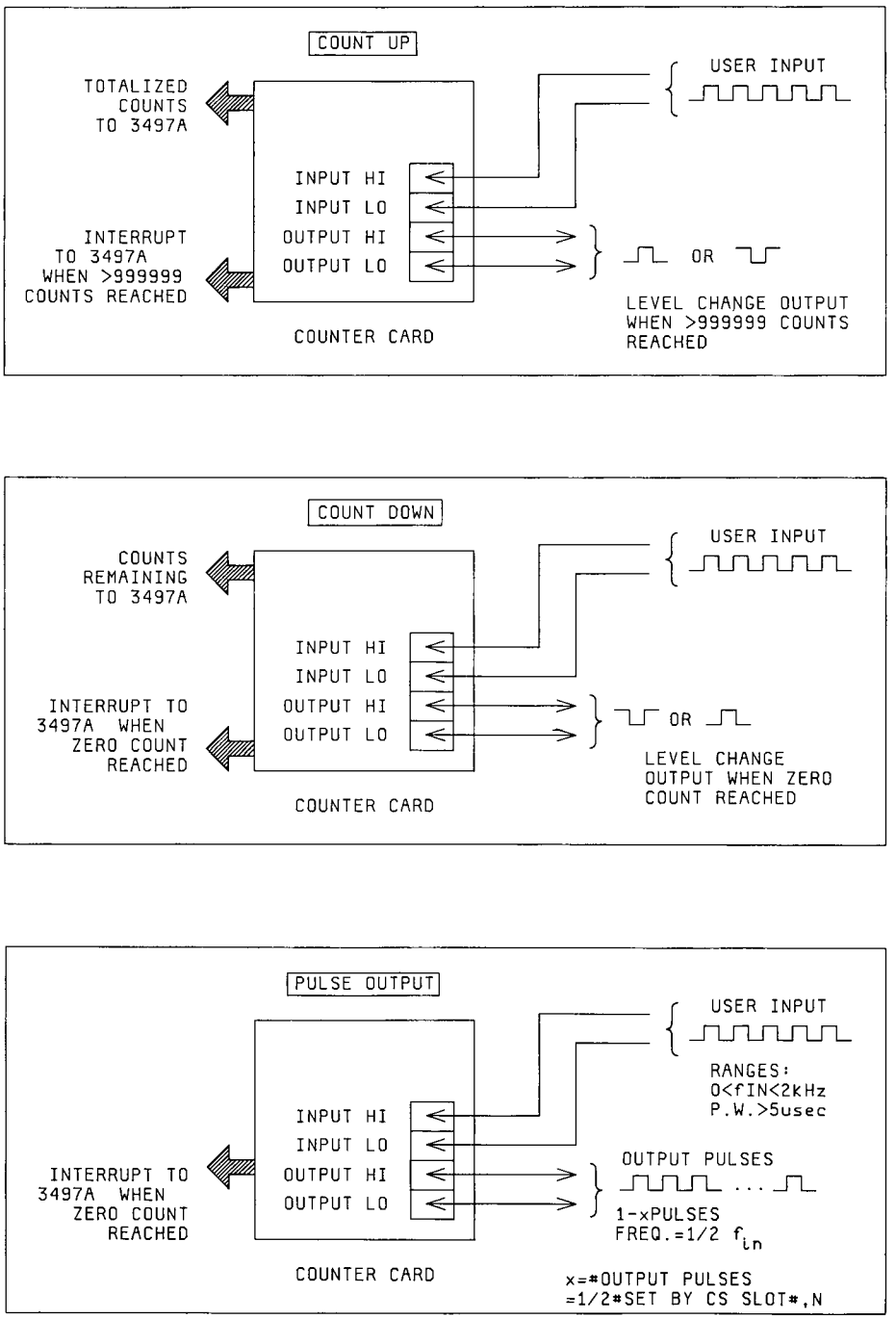


Figure 99. Option 060 - Counter Modes of Operation

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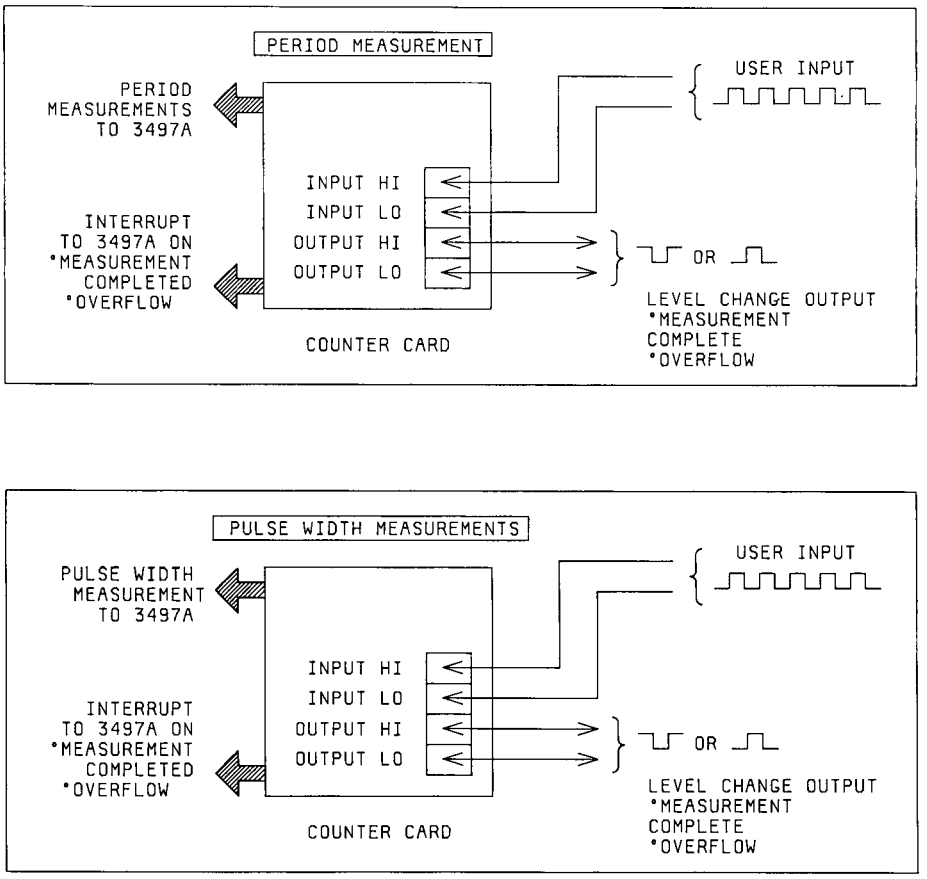


Figure 99. Option 060 - Counter Modes of Operation (Cont'd)

Specifications and General Information

Specifications and general information for the counter follow. Specifications are performance standard or limits against which the counter is tested. General information is supplied as additional information.

OPTION 060
100 kHz RECIPROCAL COUNTER ASSEMBLY

Period Mode:

Input Signal Characteristics:
Maximum Input Frequency: 100 kHz
Minimum On Time: 5 μs
Minimum Off Time: 5 μs

Range Charactristics:

Range	Least Significant Digit (LSD) HP-IB	Least Significant Digit (LSD) Display	Periods Averaged
9999.999 s	1 ms	10 ms	1
99.99999 s	10 μs	100 μs	1
0.9999999 s	100 ns	1 μs	100
.09999999 s	10 ns	1 μs	1000

Input Signal Characteristics:

Input Levels:

Input Level Range	V(Lo) (maximum) Isolated	V(Lo) (maximum) Non-iso	V(Hi) (minimum) Isolated	V(Hi) (minimum) Non-iso	Max Input Voltage
5V	1.0V	1.0V	4.2V	4.2V	±12.0V
12V	1.8V	2.7V	10.3V	8.0V	±21.0V
24V	2.6V	6.0V	18.4V	16.5V	±32.0V

Input Circuit: Switch selection of optically isolated or non-isolated input. Non-isolated input has 19.5 kΩ minimum input impedance. Non-isolated mode is standard.

Minimum Current:
Isolated: (all ranges) 8 mA
Non-isolated: 5V range: 30 μA
12V range: 250 μA
24V range: 750 μA

Input Fuse: 125 mA

Maximum Isolation Voltage: 170 V peak between any terminal and ground. Frequency ≤ 60 Hz.

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Accuracy: ±(.01% of reading + 2 LSDs + Trigger Error)

Trigger Error: Maximum Transition Time for input voltage to go from V(Lo) to V(Hi) or V(Hi) to V(Lo)

Pulse Width:

Input Signal Characteristics:
Minimum Start to Stop Time (Pulse Width): 18 μs
Minimum Stop to Start Time: 18 μs

Range Characteristics:

Range	Least Significant Digit (LSD) HP-IB	Display	Periods Averaged
9999.999 s	1 ms	10 ms	1
99.99999 s	10 μs	100 μs	1
0.9999999 s	1 μs	1 μs	100
.099999 s	1 μs	1 μs	1000

Accuracy: ±(.01% of reading + Trigger Error + 2 LSDs or 18 μs, whichever is greater)

Trigger Error: Maximum Transition Time for input voltage to go from V(Lo) to V(Hi) + V(Hi) to V(Lo)

Totalize/Down Count Mode:

Input Signal Characteristics:
Maximum Input Frequency: 100 kHz
Minimum Pulse Width: 5 μs

Range: 0 to 999,999

Preset Value Range: 0 to 999,999

General Information

Level Change Output: Level change occurs on measurement complete, overflow and zero count (down count mode only).
Output Circuit: Open Collector
Isolated mode is standard; non-isolated is jumper selectable. Interrupt mode is standard; square wave output is jumper selectable. Negative true logic is standard; positive true is jumper selectable.
Maximum Current: 1.6 mA
Maximum Voltage: 12 volts
Maximum Low Level Voltage: .65 V at 1.6 mA

Square Wave Output Operation: The output line can be configured to act as a square wave output with a frequency equal to ½ of the counter input signal. When used in the count down function with the counter input connected to the 3497A Timer output (or other external source), the counter output line can be used to output a programmable number of square wave pulses. This feature may be useful in driving devices controlled by square wave pulse trains like stepper motor controllers.
Maximum Input Frequency: 2 kHz
Maximum Output Frequency: 1 kHz (½ of input frequency)
Output Range: 0-499,999 pulses programmable

+ **5 Volt Supply:** Jumper selectable to sense contact closures and open collector outputs on the non-isolated input. May also be used to supply open collector level change output. Connected through supplied pull up resistors.

Operating consideration: Digital Interrupt (SRQ) is not available in the 3498A Extender.

Manual Information

This manual contains configuration and control information for this assembly. For repair and/or service information, see 3497A Plug-In Assemblies/3498A Extender Service Manual (-hp- part number 03497-90021). Assemblies manufactured after the publication date of this manual may have changes incorporated. In this case, a yellow MANUAL CHANGES sheet will accompany the manual. See Appendix B for details.

As shown in Figure 100, each counter has a revision letter in the upper right-hand corner of the component side of the board. This manual does NOT apply to REV A counters. If you have a REV A counter, see -hp- Model 44426A 100 kHz Reciprocal Counter Assembly Operating and Service Manual (-hp- part number 44426-90000).

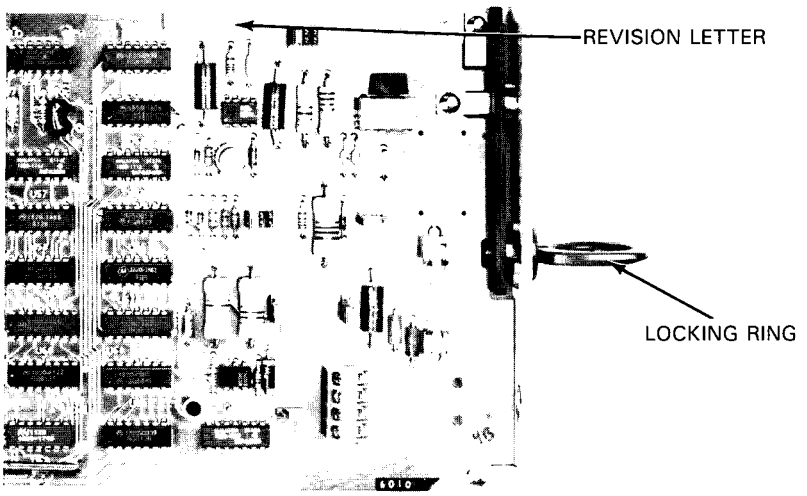


Figure 100. Option 060 - Revision Letter Location

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INSTALLING THE ASSEMBLY

WARNING

There is no operator installation or configuration for the 100 kHz counter assembly. Only qualified, service-trained personnel should install or configure the assembly.

Initial Inspection

If you ordered the 100 kHz reciprocal counter assembly as Option 060, the assembly is already installed in the 3497A. If you ordered the assembly as Field Installation Kit 44426A, the shipping container should contain a counter card and an option ROM (see Figure 98).

For the Field Installation Kit, if either item is missing or if there is mechanical damage or defect to the items, contact your nearest -hp- Sales/Service office. They will arrange for replacement or repair at -hp- option.

If there is any damage to the shipping carton, keep the carton and notify the carrier as well as -hp-. If you return a counter card or option ROM to -hp-, follow the shipping guidelines in Appendix B.

Installing the Option ROM

If you ordered the counter as Model 44426A (Field Installation Kit 44426A) AND you have a 3497A with HP-IB option, it is necessary to install the Option ROM (-hp- part number 1818-1615) onto the Outguard Controller Board in the 3497A before the counter can be operated.

If you purchased the counter as Option 060 to the 3497A (HP-IB version), the counter card and associated Option ROM are already installed. If you purchased the 3497A with Option 232 (Serial Data), an option ROM is not necessary for counter operation.

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CAUTION

The Option ROM is sensitive to electrostatic discharge. Before unpacking it or handling it, observe the following precautions:

** Reduce static build-up by using personnel grounding devices and techniques.*

** Do not place the ROM on plastic surfaces or within plastic enclosures that are not specifically designed to suppress static voltage.*

** Do not use ungrounded tools to install or remove the ROM from the socket.*

To install the Option ROM on the 3497A Outguard Controller Board, first remove all power from the 3497A and 3498A, including LINE and voltage sources connected to any installed option cards.

Next, remove the protective cover from the rear panel of the 3497A and loosen the fastener on the Outguard Controller Board (right rear panel of the 3497A as seen from the rear). Then pull out the Outguard Controller using the plastic pull ring.

Finally, position the circuit board assembly with the component side up and install the Option ROM in location U12, as shown in Figure 101. Then replace the Outguard Controller Board and the protective cover.

CAUTION

The Outguard Controller circuit board and components may be damaged by static discharge. Use clean handling techniques when installing the Option ROM.

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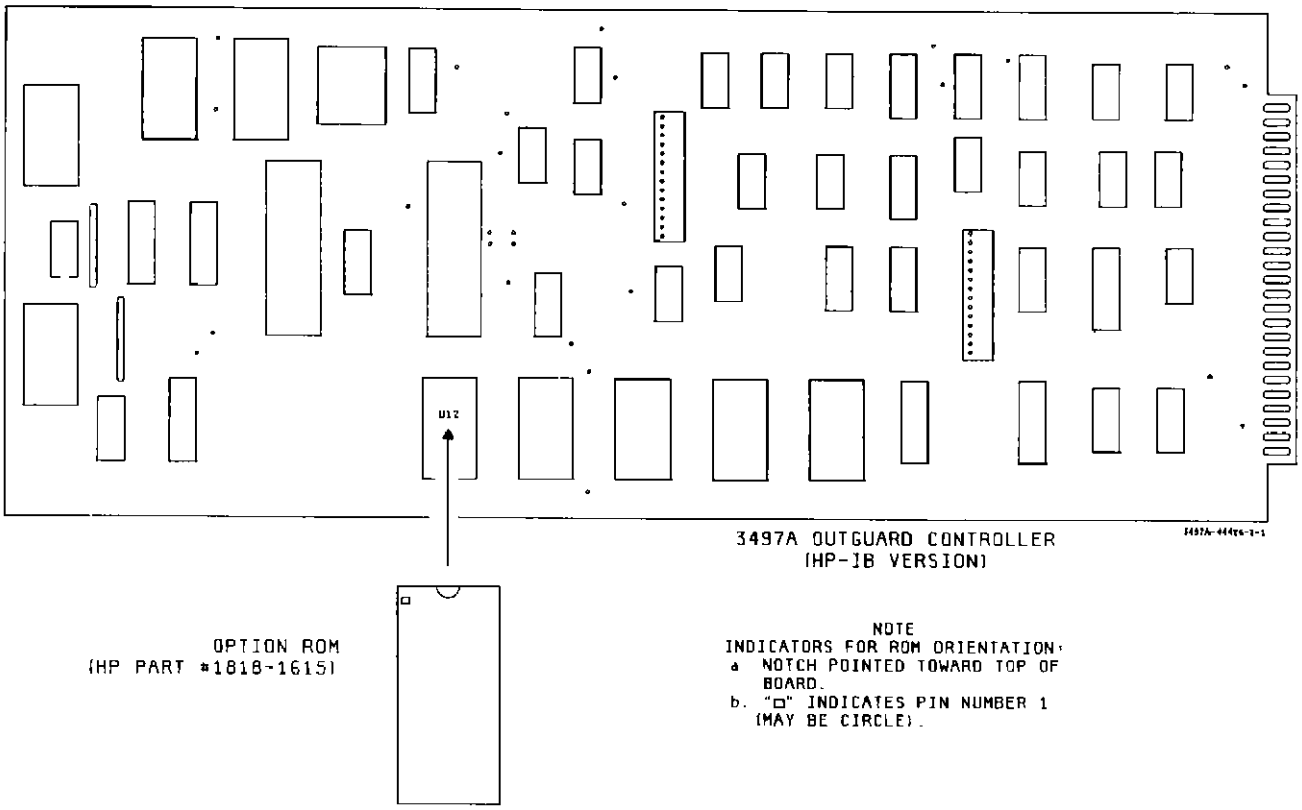


Figure 101. Option 060 - Option ROM Installation

How to Install the Counter

WARNING

Before touching any installed assemblies or attempting to install the counter assembly in the 3497A or 3498A, disconnect the power cords to the 3497A and 3498A and remove voltage sources from ALL installed assemblies.

CAUTION

Use clean handling techniques when installing, removing or reconfiguring the counter assembly. Handle the circuit board by its edges and do not subject the components to static discharges or excessive voltages.

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NOTE

To comply with Electromagnetic Interference standards, it is good practice to use shielded cable or twisted pair leads for all input and output connections to the counter. Connect shields to local earth grounds via low impedance paths.

After taking the precautions shown in the WARNING, CAUTION and NOTE above, you can install the assembly into any of the 5 slots in the 3497A or any of the 10 slots in a 3498A. To install the assembly, see Figure 102. After the assembly is installed, turn the locking key clockwise to lock the assembly into the slot.

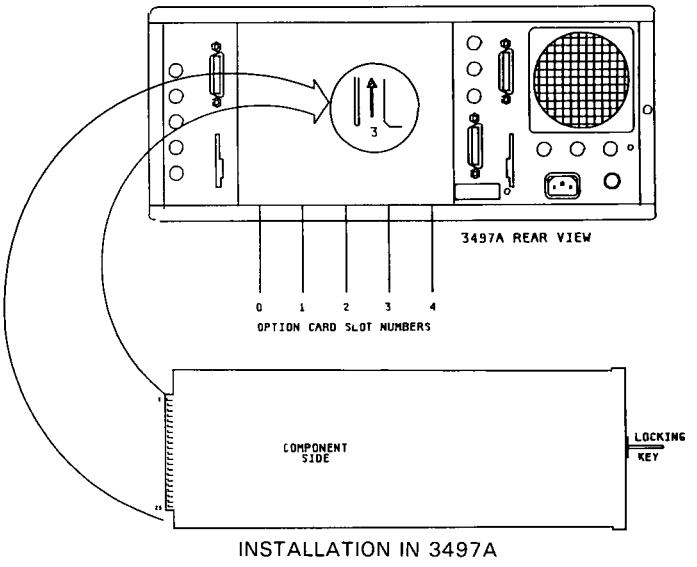


Figure 102. Option 060 - Installation in 3497A/3498A

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CONFIGURING THE ASSEMBLY

To configure the counter for your application, first determine the operation you want the counter to perform (count up, count down, period measurement, pulse width measurement or pulse output). Then, determine the parameters (voltage, current and frequency) of the input signal to the counter and the current and voltage requirements of the circuitry to be connected to the counter output terminals.

After these parameters are decided, the counter can be set for desired operation by setting switch S1 and jumpers J1 through J8. To see how this is done, we'll first cover counter configurations and show the functions of the switch and jumper functions. Then, we'll show how to set the counter input and output circuits for some sample applications.

Counter Configurations

As shown in Figure 103, we'll divide counter configurations into input circuit and output circuit configurations. For the input circuits, switch S1 selects isolated or nonisolated mode of operation. For isolated mode, jumper J4 selects +5V, +12V or +24V logic level. For nonisolated mode, jumper J3 connects an internal voltage source (called a pullup) into the counter circuits and jumper J4 selects +5V, +12V or +24V logic level.

For the output circuits, jumper J7 selects interrupt mode or pulse output mode. In the interrupt mode, an internal pullup can be added to the counter circuits by jumpers J1 and J2. The output from the OUTPUT HI terminal is a level change from high to low or low to high, as set by J8.

In pulse output mode, jumpers J1 and J2 are used to add an internal pullup (as for interrupt mode), but the output from the OUTPUT HI terminal is a pulse train with polarity set by J8.

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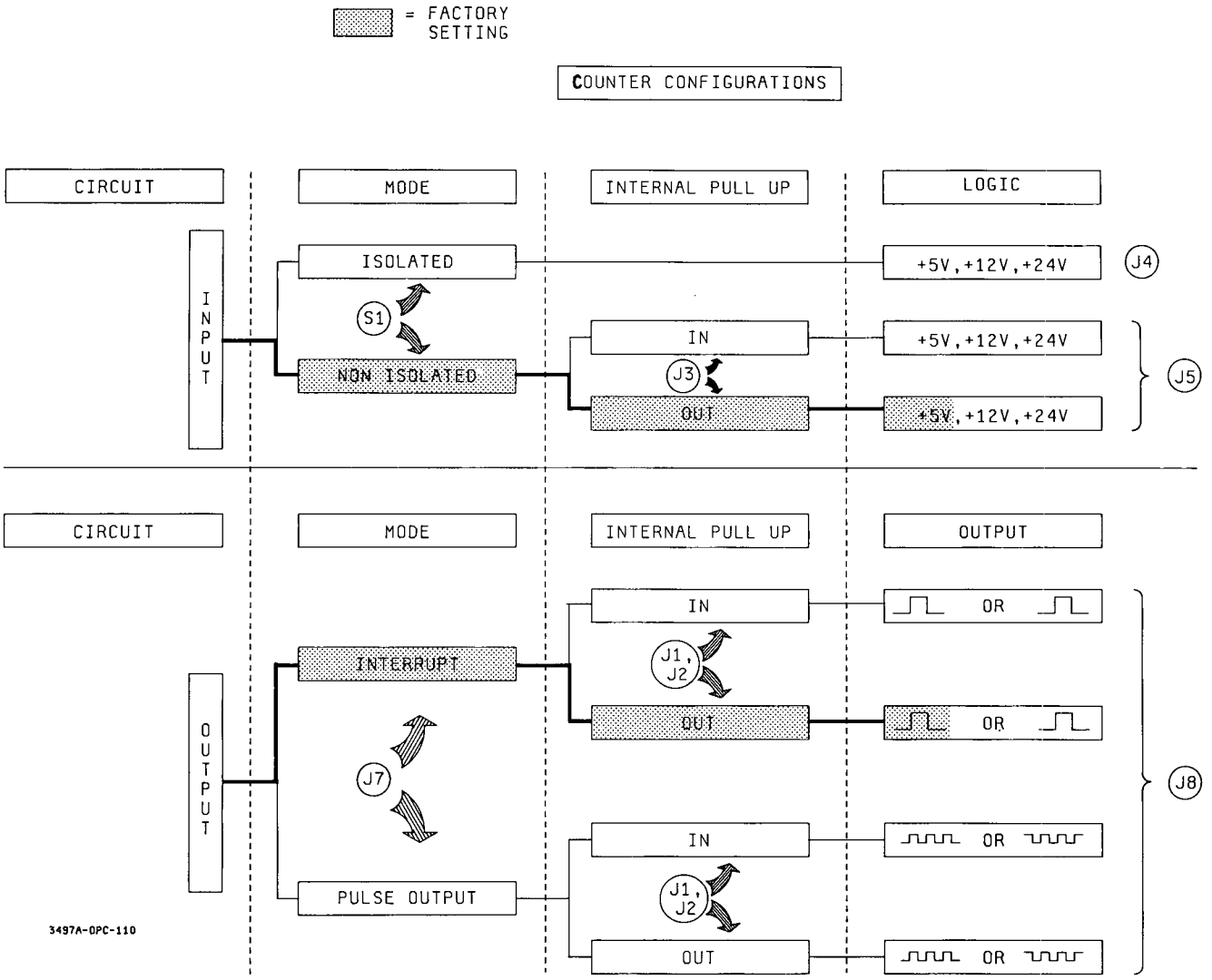


Figure 103. Option 060 - Counter Configurations

Counter Switch/Jumper Settings

As mentioned, counter configuration is set by switch S1 and jumpers J1 through J8. Figure 104 shows switch and jumper locations and factory settings and the following table describes their functions.

For example, to set the counter input circuits to nonisolated mode, internal pullup and +12v logic level, set S1 to NONISOLATED, J3 to ON and J5 to 12V. To set the output circuits for interrupt mode, isolated pullup and positive true logic, set J7 to INTR, J1 and J2 to ISOLATED and J8 to POS TRUE.

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COUNTER SWITCH/JUMPER FUNCTIONS

JUMPER/SWITCH	POSITION	FUNCTION
	INPUT CIRCUITS	
S1	ISOLATED NONISOLATED	Sets Isolated Mode. Sets Nonisolated Mode.
J3	ON (S1 NONISOLATED) OFF	Adds +5V pullup. Removes +5V pullup.
J4	5V (S1 ISOLATED) 12V 24V	Sets +5V logic level. Sets +12V logic level. Sets +24V logic level.
J5	5V (S1 NONISOLATED) 12V 24V	Sets +5V logic level. Sets +12V logic level. Sets +24V logic level.
J6*	IN OUT	Connector for input circuits. Can add signal conditioners.
	OUTPUT CIRCUITS	
J1**	ISOLATED NONISOLATED	Removes +5V pullup. Adds +5V pullup.
J2**	ISOLATED NONISOLATED	N/A Provides ground path for +5V pullup.
J7	INTERRUPT PULSE OUTPUT	Sets level change output. Sets pulse train output.
J8	POS TRUE NEG TRUE	Output starts and stops in high state. Output starts and stops in low state.

* When J6 is removed, can add one series and/or one shunt input signal conditioning element.

** J1 and J2 must be set to same position.

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Setting the Counter Input Circuits

As shown in the preceeding table, S1 and jumpers J3, J4 and J5 set the counter input circuits. Figure 105 is a simplified block diagram of the counter input circuits (for isolated mode or nonisolated mode) and associated user input signal requirements.

Switch S1 sets the mode of operation for the counter. With S1 in the ISOLATED position, the counter is in isolated mode. This means that you can use floating voltage inputs to the counter, as long as the more positive voltage is connected to INPUT HI, the voltage difference between the inputs does not exceed 32V and the low input does not exceed 170V.

With S1 in NONISOLATED position, the counter is in nonisolated mode. In this mode, the INPUT LO terminal is the same as chassis ground for all practical purposes, so you can't use floating voltages as inputs. However, your signal input current can be much smaller than for isolated mode (30 to 750 μA as opposed to 8 mA for isolated mode).

In nonisolated mode, you can use either the internal +5V voltage source on the counter (referred to as an internal pullup) or an external source voltage to drive your circuit. Jumper J3 in the ON position puts the internal pullup in the circuit and J3 in the OFF position removes it from the circuit.

For either isolated or nonisolated mode, you can select +5V, +12V or +24V logic levels for your input circuits by using J4 when S1 is in the ISOLATED position or J5 when S1 is in the NONISOLATED position.

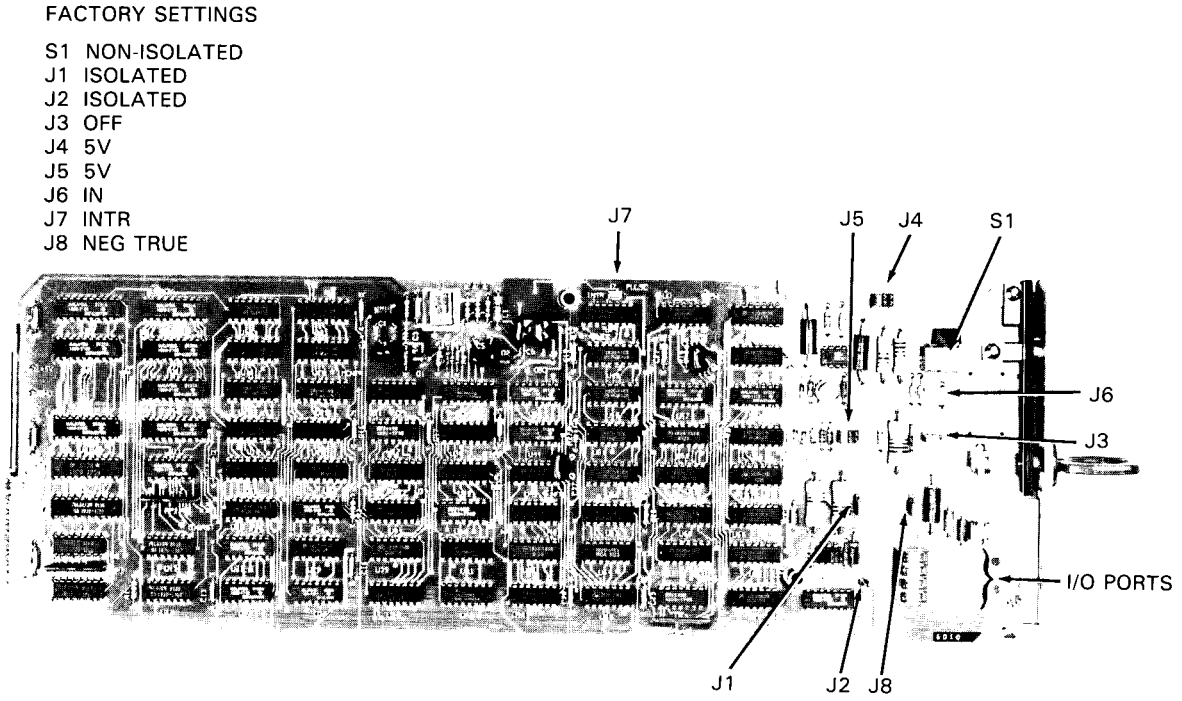


Figure 104. Option 060 - Switch/Jumper Positions

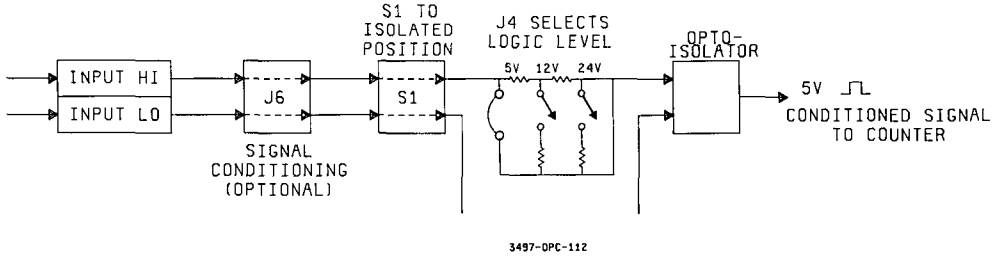
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INPUT SIGNAL LEVELS

ISOLATED MODE

Logic Level	V(Lo) (max)	V(Hi) (min)	Minimum Current	Maximum Input V
5V	1.0V	4.2V	8 mA	±12.0V
12V	1.8V	10.3V	8 mA	±21.0V
24V	2.5V	18.4V	8 mA	±32.0V

INPUT CIRCUITS-ISOLATED MODE



INPUT SIGNAL LEVELS

NON ISOLATED MODE

Logic Level	V(Lo) (max)	V(Hi) (min)	Minimum Current	Maximum Input V
5V	1.0V	4.2V	20 μA	±12.0V
12V	2.7V	8.0V	250 μA	±21.0V
24V	6.0V	16.5V	750 μA	±32.0V

INPUT CIRCUITS-NON-ISOLATED MODE

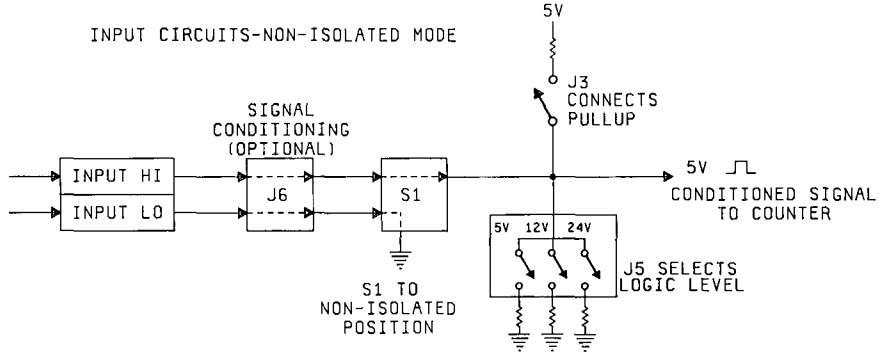


Figure 105. Option 060 - Input Circuit Signal Flow

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Isolated versus Nonisolated Inputs

Since the counter can be set for either isolated or nonisolated input mode, which is best for your application? Naturally, the choice depends on your input signal characteristics. However, some advantages and disadvantages for each mode are summarized as guidelines for your application.

ISOLATED VS NONISOLATED INPUT MODE

ISOLATED MODE
Advantages
Uses its own pullup, so external pullup not required. Floating voltages can be input and optical isolator reduces ground loops and common mode noise.
Disadvantages
Requires higher input current (8 mA minimum) than nonisolated mode.
NONISOLATED MODE
Advantages
Can use either internal or external pullup. Because of low (30-750 μA) input current requirements, may be able to use a ''totem-pole'' input and thus not require an external pullup.
Disadvantages
Uses chassis ground as low input, so floating voltages can't be input. May have higher common mode noise than isolated mode.

Input Circuit Signal Conditioning

By removing jumper J6, you can add one series and/or one shunt input signal conditioning element, as shown in Figure 106. Some applications include mechanical contact debouncing (series R, shunt C); rectification (series diode, shunt C) or adding a series resistor so that logic levels other than +5v, +12v or +24v can be used.

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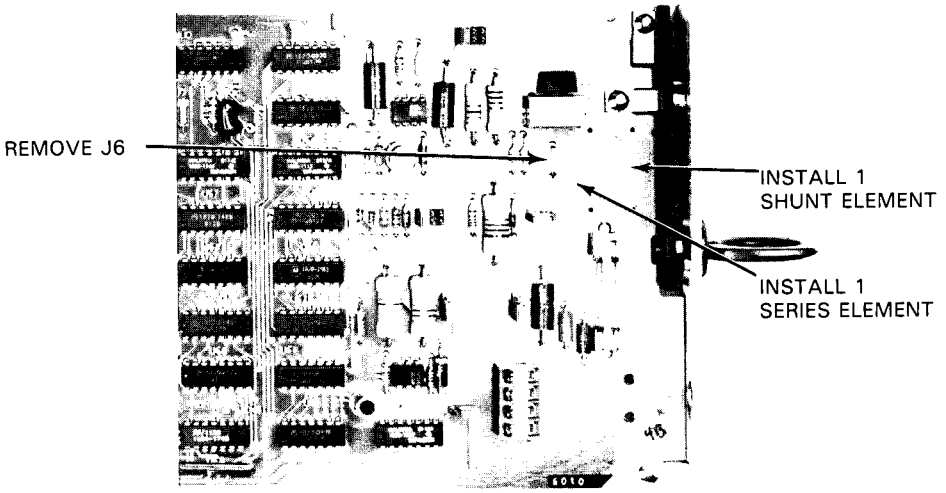
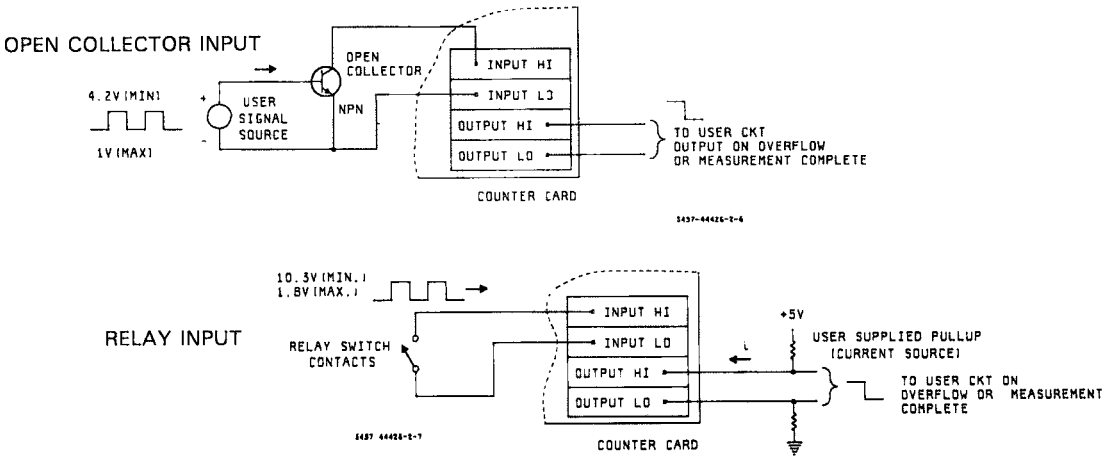


Figure 106. Option 060 - Signal Conditioning Connections

EXAMPLE - OPEN COLLECTOR INPUT CONNECTIONS

To illustrate a way that the counter input circuits can be configured, this example shows typical connections for an open collecter transistor circuit and a relay input with the counter set for nonisolated input mode (S1 in NONISOLATED position) with internal pullup (J3 in the ON position) and a +5v logic level (J5 in 5V position).

Since nonisolated input mode is used, the INPUT LO terminal is at chassis ground and floating voltages can't be input. Also, since the internal pullup is used, no external power source is required for the transistor. Finally, since +5v logic level and nonisolated mode are used, the input voltage and limits are as shown.



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Setting the Output Circuits

As noted, the counter output circuits are configured with jumpers J1,J2,J7 and J8. Figure 107 shows a simplified signal flow diagram for the counter output circuits. J7 selects either interrupt mode or pulse output mode, J7 selects positive true or negative true logic and J1,J2 allow the internal pullup to be connected into the circuit.

With J8 in the NEG TRUE position, the output starts and stops in the high state. With J8 in the POS TRUE position, the output starts and stops in the low state. The output for the interrupt mode (J7 in INTR position) is a level change for counter overflow or measurement complete conditions. The output for the pulse output mode (J7 in PULSE position) is a square wave pulse train with frequency equal to half the input frequency.

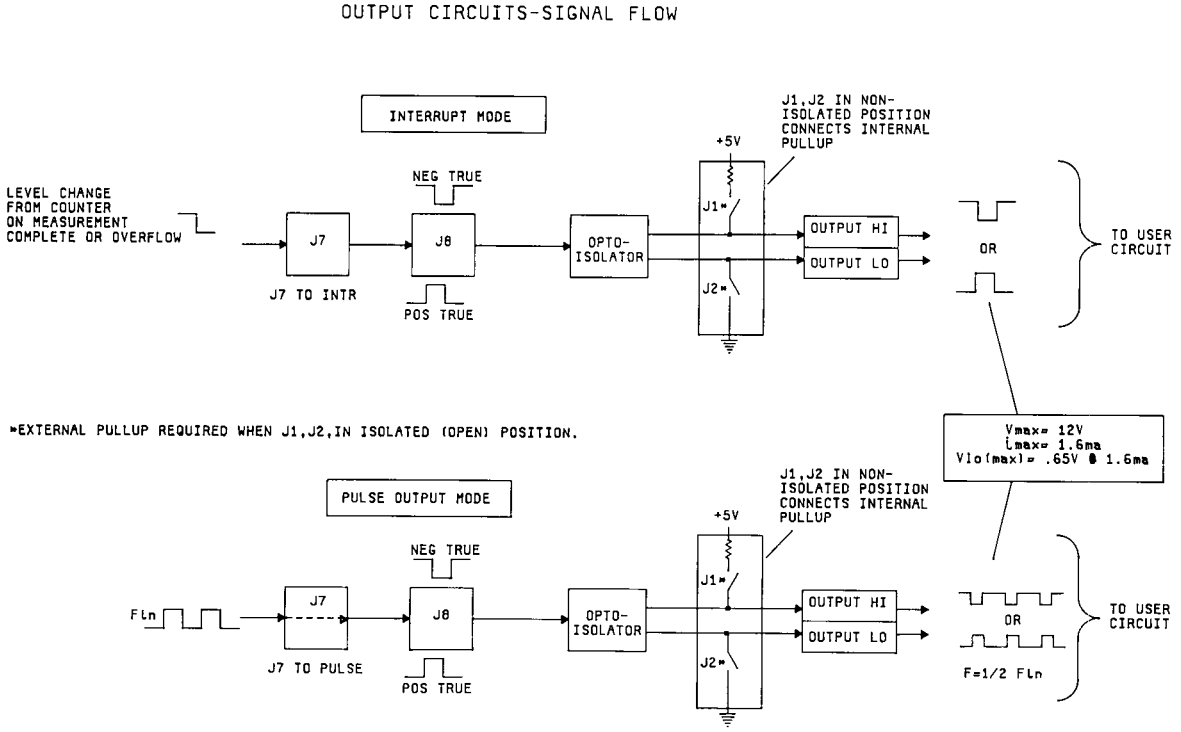


Figure 107. Option 060 - Output Circuit Signal Flow

Internal Versus External Pullup

A special consideration for the output circuits is whether to use the internal pullup or to use an external pullup. With J1 and J2 in the NONISOLATED position, the internal pullup is connected and supplies a 5 volt signal with 1.6 mA of current (maximum) to an external circuit.

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If your application requires a different logic level or more than 1.6 mA of current, you can set J1 and J2 to the ISOLATED position which removes the internal pullup from the circuit. However, you must supply a current source to the optoisolator on the card. A sample connection is shown in Figure 108. Connect + to OUTPUT HI and - to OUTPUT LO for proper operation.

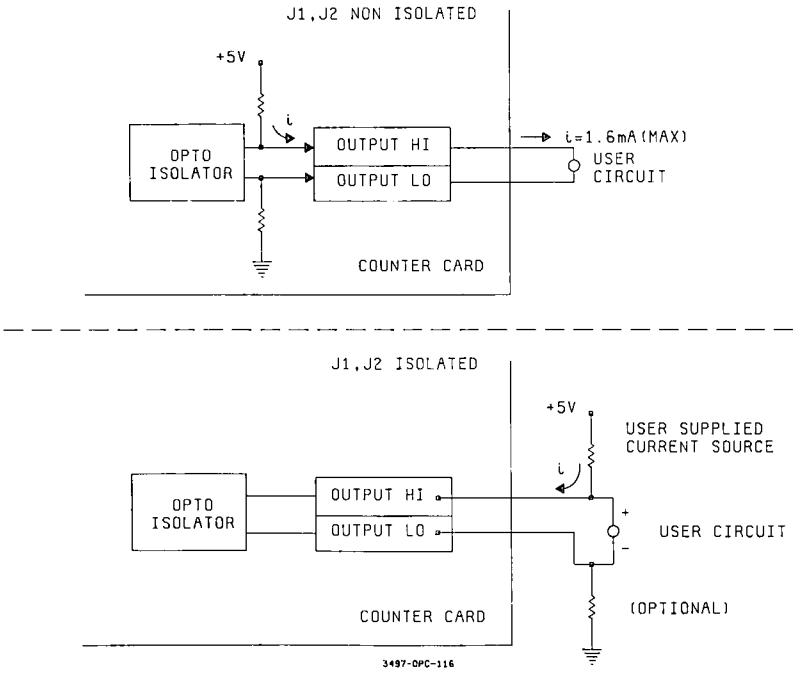


Figure 108. Option 060 - Output Circuit Pullup Configurations

To illustrate some ways that the counter can be configured, two examples follow. The first example uses an open collector input to produce a level change output for measurement complete or overflow. The second example uses a square wave input to produce a pulse train output. Although both examples show a square wave input, the counter can accurately handle a wide variety of inputs, including sine waves.

EXAMPLE - OPEN COLLECTOR INPUT/INTERRUPT OUTPUT

For this example, a 5v square wave signal is to be input to the counter through an open collector NPN transistor. From Figure 105, limits for a 5v input signal range are V(Hi) = 4.2v minimum and V(Lo) = 1.0v max for either isolated or nonisolated input mode. Since the input meets these criteria, select nonisolated input mode by setting S1 to NONISOLATED position.

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With nonisolated mode, either an internal or external pullup can be used, so set J3 to ON to connect the counter internal pullup. For the input signal used, select +5v logic level by setting J5 to 5V position.

For the output circuits, assume that a level change output from high to low is required when measurement is complete or on overflow. For this logic level change, set the output circuits to interrupt mode by setting J7 to INTR position.

We'll use the counter internal pullup for the output network and set J1 and J2 to NONISOLATED position to connect the internal pullup. For a logic level change from high to low, set J8 to NEG TRUE position. See the following diagram for a sample connection diagram and switch/jumper settings.

COUNTER SETUP

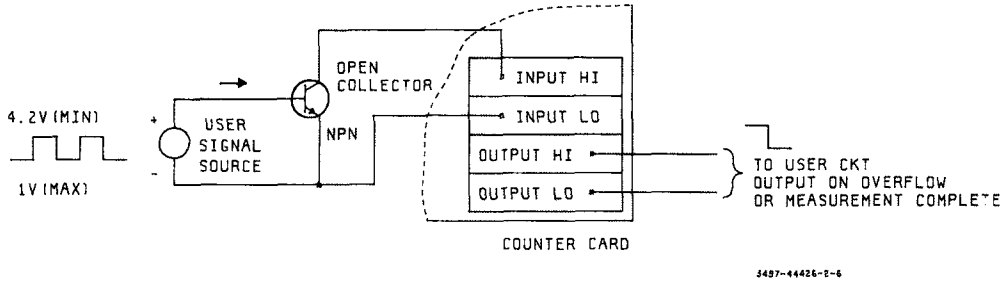
Circuit	To Select	Set
Input	Nonisolated mode	S1 to NONISOLATED
	Internal pullup	J3 to ON
	+5v Logic Level	J5 to 5V
Output	Interrupt mode	J7 to INTR
	Internal pullup	J1,J2 to NONISOLATED
	Negative True logic	J8 to NEG TRUE

SWITCH/JUMPER SETTINGS

S1	J1	J2	J3	J4	J5	J6	J7	J8
N	N	N	ON	X	5V	IN	INTR	NEG TRUE

N = NONISOLATED
X = DON'T CARE

CONNECTION DIAGRAM



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EXAMPLE - NONISOLATED INPUT/PULSE OUTPUT

For this example, we'll use a 12v square wave input to produce 100 square wave output pulses at 500 Hz. We'll set the input circuits to nonisolated mode, internal pullup and +12v logic level and set the output circuits for pulse output mode, external pullup and positive true logic.

For nonisolated mode, input signal limits for 12v logic level are V(Lo) = 2.7v maximum, V(Hi) = 8.0v minimum with 250 μA minimum current. To produce 500 Hz output pulses, the input frequency must be 1 kHz since output pulse frequency is half the input frequency. Note that for any operation with Pulse Output mode, input signal limits are f $\leq$ 2 kHz and pulse width $\geq$ 5 μsec.

Set the output circuits for pulse output (square wave) mode by setting J7 to PULSE position. For external output pullup, set J1 and J2 to ISOLATED position. For positive true logic (output starts and stops in the low state), set J8 to POS TRUE.

Since the number of output pulses is programmed using the CS slot#,n command, for 100 pulses use CS slot#,200. A sample connection diagram and jumper/switch settings follow.

COUNTER SETTINGS

Circuit	To Select	Set
Input	Nonisolated mode	S1 to NONISOLATED
	Internal pullup	J3 to ON
	+12v Logic Level	J5 to 12V
Output	Pulse Output mode	J7 to PULSE
	Isolated pullup	J1,J2 to ISOLATED
	Positive True logic	J8 to POS TRUE

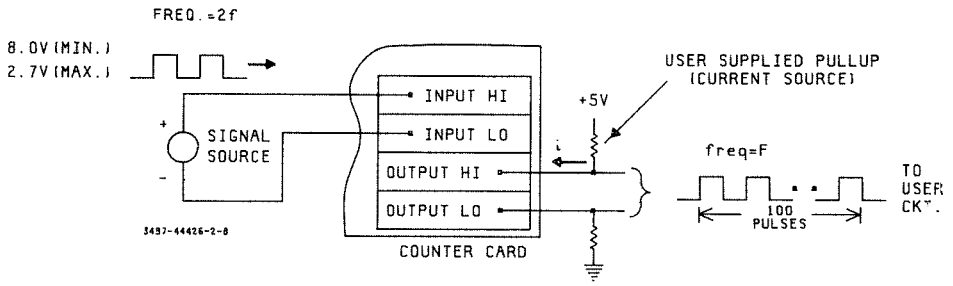
SWITCH/JUMPER SETTINGS

S1	J1	J2	J3	J4	J5	J6	J7	J8
N	I	I	ON	X	12V	IN	PULSE	POS TRUE

N = NONISOLATED
I = ISOLATED
X = DON'T CARE

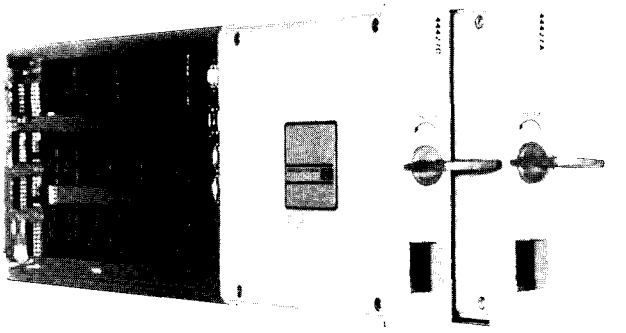
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CONNECTION DIAGRAM



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OPTIONS 070/071



120/350 Ohm Strain Gauge/ Bridge Completion Assemblies

INTRODUCTION

-hp- Model 44427A 120 Ohm Strain Gauge/Bridge Completion assembly and -hp- Model 44427B 350 Ohm Strain Gauge/Bridge Completion assembly provide bridge completion for resistance strain gauges and other resistive transducers such as RTD's and pressure sensors. You can use the assemblies to provide termination for any mixture of ¼, ½ or full bridges and can use 2 or 3-wire (plus shield) transducer connections.

Each strain gauge/bridge assembly can measure up to 10 transducers (strain gauges, RTD's, etc.) when using the internal half bridge shared by all transducers. Each 3497A can hold up to five 44427A and/or 44427B assemblies and each 3498A Extender (Option 298) can hold up to 10 assemblies.

Thus, using the 5 slots in a 3497A and 45 slots in 3498As (maximum which can be used for these assemblies), you can provide up to 500 channels for transducer measurements or up to 133 three element strain gauge rosettes. Of course, the 44427A/B can be used in the same 3497A mainframe with other 3497A assemblies for mixed measurements. For example, you could use the Option 020 thermocouple compensation assembly in one slot and an Option 070 or 071 in another slot to generate apparent strain curves.

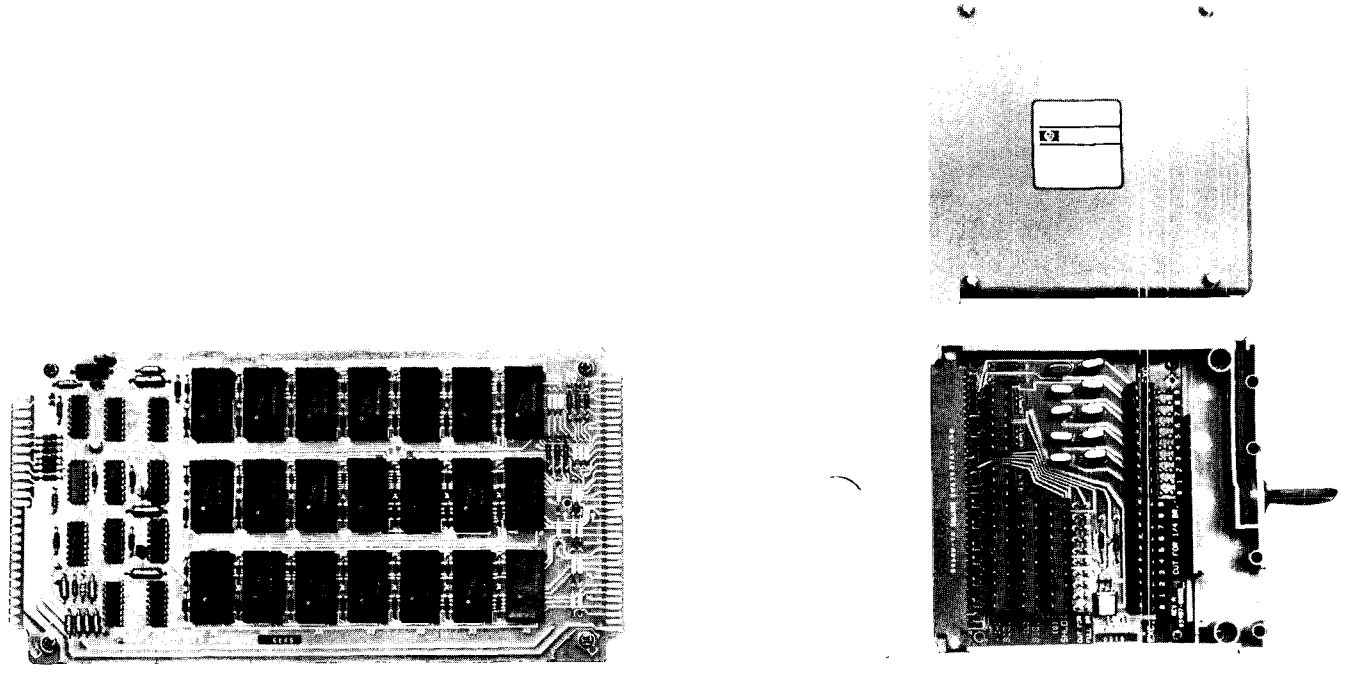
Description

As shown in Figure 109, the 44427A/B assemblies consist of a 20 channel relay card and a terminal card. The relay card is identical to that used in Options 010 and 020. The terminal card for the 120 ohm assembly (Option 070) is identical to the 350 ohm assembly (Option 071) except that Option 070 uses 120 ohm bridge termination resistors while Option 071 uses 350 ohm resistors.

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The assemblies require an external power supply for bridge excitation and a DVM (such as the internal 3497A DVM, -hp- 3456A voltmeter or equivalent DVM). Initial voltmeter readings for bridge excitation and bridge unbalance are used to solve the bridge equation, eliminating the need for any span and offset adjustments. To compute strain, the assembly should be used with a controller. Data acquisition and strain calculation can be done manually, however.

The excitation voltage, Vs, is always applied, never switched, so there are no errors due to dynamic heating and cooling of the transducer. Since the excitation voltage is measured on each assembly, measurement accuracy is independent of long term power supply voltage changes and an inexpensive supply (such as the -hp- Model 6214A or 62005A) is adequate to achieve listed specifications. The Model 6214A can provide power for 50 channels (5 assemblies) while the 62005A can power up to 80 channels.



RELAY CARD

TERMINAL CARD

Figure 109. Options 070/071 - Strain Gauge/Bridge Assemblies

Diagnostic Tests

Several diagnostic tests are available on the 44427A/B assemblies to check circuit integrity or enhance measurement accuracy. Each assembly consists of 20 channels with the first 10 channels reserved for strain gauge inputs. The remaining 10 channels (B0 through B9) can be used for measuring the excitation voltage and for diagnostic tests.

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The following chart shows the channel numbers associated with the 44427A/B assembly for each 3497A slot (for 3498A slots, add 100 to each number shown for the first 3498A, 200 to each number for the 2nd 3498A, etc). Note that for each slot, the 10 lowest numbers (the A decade) are for strain gauge measurements, channel B0 is used to measure the excitation voltage and the rest of the B decade channels are for bridge diagnostics, excitation measurements, etc.

On the terminal card, the strain gauge inputs [+(H) SIG,-(L) SIG and (G) SHLD] have designators A0 through A9, left to right. Thus, for example, a strain gauge input to terminal A0 (leftmost terminal) has channel number 0 for an assembly in slot 0, 10 for an assembly in slot 1, etc. See CONFIGURING THE ASSEMBLY for details.

STRAIN GAUGE ASSEMBLY - DIAGNOSTIC TESTS

Terminal Card Designator	Function	3497A Slot Number				
		0	1	2	3	4
			Channel Number(s)			
A0-A9	Reserved for Strain Gauge Inputs.	0-9	20-29	40-49	60-69	80-89
B0	Measure Excitation Voltage.	10	30	50	70	90
B1	Tension Shunt Calibration*	11	31	51	71	91
B2	Compression Shunt Calibration*	12	32	52	72	92
B3	Guard to Low Resistance (channel A0)*	13	33	53	73	93
B4	Guard Voltage*	14	34	54	74	94
B5-B6	Internal Half-Bridge Ratio*	15-16	35-36	55-56	75-76	95-96
B7-B9	Lead Wire Resistance (channels A7 through A9)*	17-19	37-39	57-59	77-79	97-99

* See CONFIGURING THE ASSEMBLY, Measurement Accuracy Considerations.

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Strain Gauge Measurements

The Option 070/071 assemblies allow you to determine strain of bonded resistance strain gauges by measuring voltage changes which occur between the unstrained and the strained state of the gauge. To indicate how the assemblies accomplish this, we'll summarize strain gauge measurements.

This discussion is not a comprehensive tutorial on strain gauge or bridge measurements, but is intended to show how the assemblies may be used to make these measurements. See -hp- Application Note 290-1, ''Practical Strain Gauge Measurements'' for general information on strain gauge measurements.

Strain

We'll use the term strain (ϵ) to mean the ratio of a fractional change in length to the unstrained length: $\Delta L/L$. Since the magnitude of ΔL is usually less than 1% of L, the Model 44427A/B assemblies use a Wheatstone Bridge circuit for measurement. The Gauge Factor, GF, relates a change in resistance of the gauge (ΔR) to the strain:

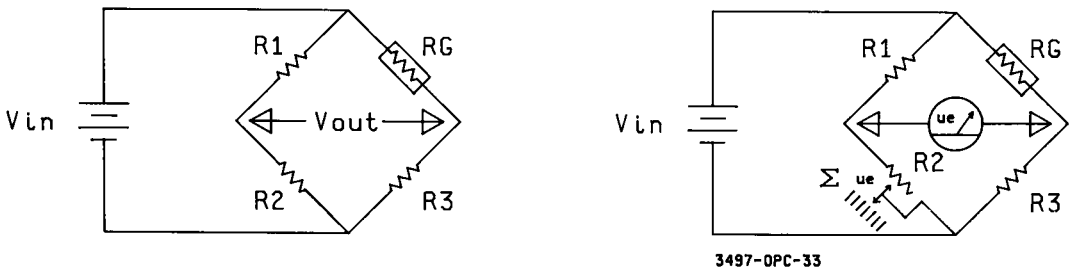
$$GF = \frac{\Delta R/R}{\Delta L/L} = \frac{\Delta R/R}{\epsilon} \qquad (1)$$

where $\Delta R/R$ is the ratio of the change in resistance (ΔR) caused by the strain to the original resistance (R) of the gauge in the unstrained state.

Unbalanced Wheatstone Bridges

As mentioned, the strain gauge assemblies use an unbalanced Wheatstone Bridge arrangement to measure voltage changes between the strained and unstrained states of strain gauges. For the (balanced) Wheatstone bridge shown in Figure 110, Vin is the input voltage to the bridge, Rg is the resistance of the strain gauge, R1, R2 and R3 are the resistances of the bridge completion resistors and Vout is the bridge output voltage.

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WHEATSTONE BRIDGE CIRCUIT

BRIDGE CIRCUIT WITH PROVISION FOR BALANCING THE BRIDGE

Figure 110. Options 070/071 - Wheatstone Bridge Circuit

A ¼ bridge configuration is shown since one arm of the bridge is an active gauge and the other arms are fixed value resistors or unstrained gauges. Ideally, the strain gauge resistance, Rg, is the only resistor in the circuit which varies. We can relate the ratio of the input voltage to the output voltage by:

$$\frac{Vout}{Vin} = \left[\frac{R3}{R3 + Rg} - \frac{R2}{R1 + R2}\right] \qquad (2)$$

Equation (2) applies to both strained and unstrained states. To measure strain, two measurements must be taken: (1) measure Vout with the gauge in the unstrained state and then (2) measure Vout with the gauge in the strained state. By combining the strained and unstrained cases, we can define a new term, Vr.

$$VR = \left[\left(\frac{Vout}{Vin}\right)_{strained} - \left(\frac{Vout}{Vin}\right)_{unstrained}\right] \qquad (3)$$

From equation (1), since strain (ϵ) = ($\Delta R/Rg$)/GF, we can write an equation for strain in terms of the gauge factor (GF) and Vr (which is derived from Vin and Vout) as follows:

$$\epsilon = \frac{-4Vr}{GF(1 + 2Vr)} \qquad (4)$$

Since the actual strain figure is quite small (on the order of 0.000200), we will express the results in $\mu\epsilon$ ($\epsilon \times 10^6$). In addition we'll assume a Gauge Factor GF = 2.

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Multichannel Bridge Measurements

The strain gauge assemblies use a bridge circuit called a ''Chevron Bridge'' for multichannel bridge measurements. Figure 111 shows the circuit setup which switches a DVM between gauges. One channel is shown as a ¼ bridge and the other as a ½ bridge (two active gauges). Resistors R1, R2 and R3 form three sides of the bridge and the excitation voltage (Vin) to the gauges is continuously applied.

To make strain gauge measurements with this circuit, the DVM is switched between points C-D, D-E, etc. and measures Vout for each channel. Although not shown in Figure 111, the DVM can also be switched to measure Vin. The procedure to measure strain with this circuit is (assuming that the Gauge Factor is known):

STRAIN GAUGE MEASUREMENTS

(1)	measure Vin and store the value.
(2)	measure Vout for channel #1 (¼ bridge in Figure 111) with the gauge unstrained.
(3)	measure Vout for channel #1 with the gauge strained.
(4)	compute strain from $\epsilon = -4Vr/GF(1 + 2Vr)$. [¼ bridge]
(5)	switch the DVM to channel #2 (shown as a ½ bridge in Figure 111) and repeat steps (2) through (4).

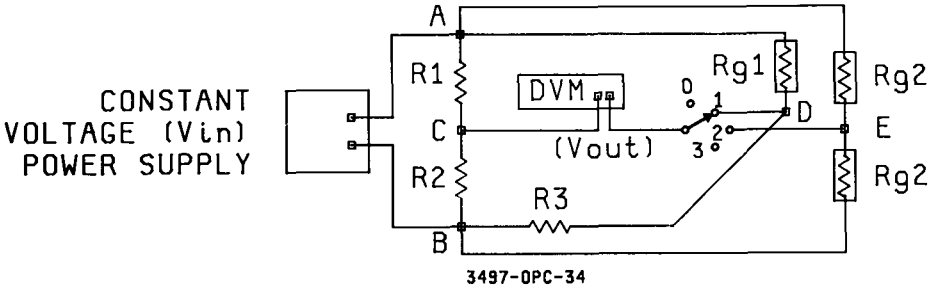


Figure 111. Option 070/071 - Bridge Circuits for Assemblies

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Specifications

Specifications for the 120/350 ohm strain gauge/bridge completion assemblies follow. Specifications are performance standards, or limits, against which the assemblies may be tested.

OPTION 070/071
120/350 OHM, STRAIN GAUGE/BRIDGE COMPLETION ASSEMBLIES

No Manual Adjustments
The assembly is used with an external supply and either the 3497A voltmeter or an external 3456A voltmeter. The initial voltmeter readings for bridge excitation and bridge unbalance are used by the system computer to solve the bridge equation, eliminating the need for any span and offset adjustments. To compute strain, this assembly must be used in conjunction with a system computer.

Bridge Excitation
The excitation voltage V_S is always applied, never switched, so there are no errors due to the dynamic heating and cooling of the gauge. Since the excitation voltage is measured on each strain gauge/bridge card, the strain accuracy is independent of long-term supply voltage changes. An inexpensive power supply, such as the HP 6214A, is adequate to achieve the accuracy specification shown. It also has enough current capability to provide power for up to 50 channels (5 cards).

Excitation Supply Requirements:
(½ bridge configuration)
V_S max: ± 5.4 volts DC
I_S: 250 mA per 10 channels (120 ohm gauges)
80 mA per 10 channels (350 ohm gauges)

General Information:

Isolation Voltage: ≥ 170 V peak between any terminal and chassis

Sensitivity vs. Supply Voltage

Bridge Type	V_S = 100 mV	V_S = 1 volt	V_S = 5 volts
Full	0.5 με	0.05 με	0.01 με
½	1 με	0.1 με	0.02 με
¼	2 με	0.2 με	0.04 με

(GF = 2, System Voltmeter = 3456A. For 3497A Voltmeter, multiply numbers by 10).

Accuracy
These specifications include all system-related errors: bridge resistor tolerance and drift, thermal offsets of bridge scanner and voltmeter, voltmeter accuracy, injected currents, self-heating of bridge resistors and system noise. The only exceptions are lead wire mismatch and the accuracy of the gauge itself. Specifications are valid for either the 3497A or the 3456A voltmeter with integration time set to one power line cycle.

Accuracy at V_S = 5 volts

Bridge Type	24 Hr. ± 1°C	90 Day 23 ± 5°C	≤90 Days 23 ± 5°C	Temperature Coefficient (0-18,28-55°C)
Full	1 με	1 με	0.04 με/Mo.	0.025 με/°C
½	4 με	5 με	0.4 με/Mo.	0.3 με/°C
¼	7 με	25 με	1.8 με/Mo.	1.8 με/°C

Accuracy At V_S = 1 Volt

Full	3 με	3.5 με	0.04 με/Mo.	0.1 με/°C
½	5 με	10 με	0.9 με/Mo.	0.4 με/°C
¼	10 με	35 με	6.8 με/Mo.	1.8 με/°C

Accuracy At V_S = 100 mV

Full	20 με	35 με	0.04 με/MO.	0.8 με/°C
½	40 με	75 με	0.9 με/Mo.	1.7 με/°C
¼	80 με	150 με	6.8 με/Mo.	3.5 με/°C

All Specifications Are ±
These figures assume a gauge factor of 2.

Maximum self-heating offset due to change in the number of gauges on one assembly: 0.3 με per gauge (V_S = + 5, R_g = 120 Ω, ¼ bridge)

Maximum self-heating offset due to .1 V change in supply voltage: 0.38 με (V_S = + 5, R_g = 120 Ω, ¼ bridge).

Manual Information

This manual contains configuration and installation information for these assemblies. For repair and/or service information, see 3497A Plug-In Assemblies/3498A Extender Service Manual (-hp- part number 03497-90021). Assemblies manufactured after the publication date of this manual may have changes incorporated. In this case, a yellow MANUAL CHANGES sheet will accompany the manual. See Appendix B for details.

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Application Note

When using the Option 070/071 assemblies, you may want to refer to -hp- Application Note 290-1 ''Practical Strain Gauge Measurements'' (-hp- part number 5952-2153) which is available from your nearest -hp- Sales and Service office.

Ordering the Terminal Card Separately

If you already have a relay assembly (such as from Option 010 or 020) or if you want to have several strain gauge terminal cards, you may order terminal cards separately by using the following part numbers:

Option 070 (120 Ohm). . . . . .-hp- part number 03497-64109
Option 071 (350 Ohm). . . . . .-hp- part number 03497-64110

INSTALLING THE ASSEMBLIES

WARNING

There is no operator installation or configuration for the strain gauge assemblies. Only qualified, service-trained personnel should install or configure the assemblies.

Initial Inspection

If you ordered a strain gauge assembly as Option 070 or 071, the assembly is already installed in the 3497A. If you ordered the assembly as Field Installation Kit 44427A or 44427B, the shipping container should contain a relay card and a terminal card with 120 ohm or 350 ohm bridge completion networks.

For the Field Installation Kit, if either card is missing or if there is mechanical damage or defect to the cards, contact your nearest -hp- Sales/Service office. They will arrange for replacement or repair at -hp- option.

If there is any damage to the shipping carton, keep the carton and notify the carrier as well as -hp-. If you return a relay card or terminal card to -hp-, follow the shipping guidelines in Appendix B.

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How to Install the Strain Gauge Assemblies

WARNING

Before touching any installed assemblies or attempting to install the strain gauge assemblies in the 3497A or 3498A, disconnect the power cords to the 3497A and 3498A and remove ALL voltage sources from these instruments.

The strain gauge assemblies are not intended for outdoor use. Do not expose the assemblies to rain or excessive moisture.

CAUTION

Use clean handling techniques when installing, removing or reconfiguring the relay card. Handle the circuit board by its edges and do not subject the components to static discharges or excessive voltages.

Should the circuit board become contaminated, promptly wash the area with isopropyl alcohol. Then rinse the area with deionized water. Let the assembly completely dry before reinserting it in the mainframe.

Figure 112 shows how to install the assembly in the 3497A and 3498A. After taking the steps shown in the WARNING and CAUTION notes above, plug the assembly into an unused slot in the 3497A or 3498A.

CONFIGURING THE ASSEMBLY

As noted, the strain gauge assemblies consist of a relay card and a terminal card. The relay card acts as a multiple channel switcher to connect the DVM to a specified channel. The terminal card provides the connections to provide excitation voltage to the strain gauges and form the bridge completion networks for voltage measurement.

To make strain gauge measurements, the relay card must be set for no thermocouple compensation. As shown in Figure 113, the jumper in the upper left-hand corner of the relay card should be set to the NO T/C COMP position.

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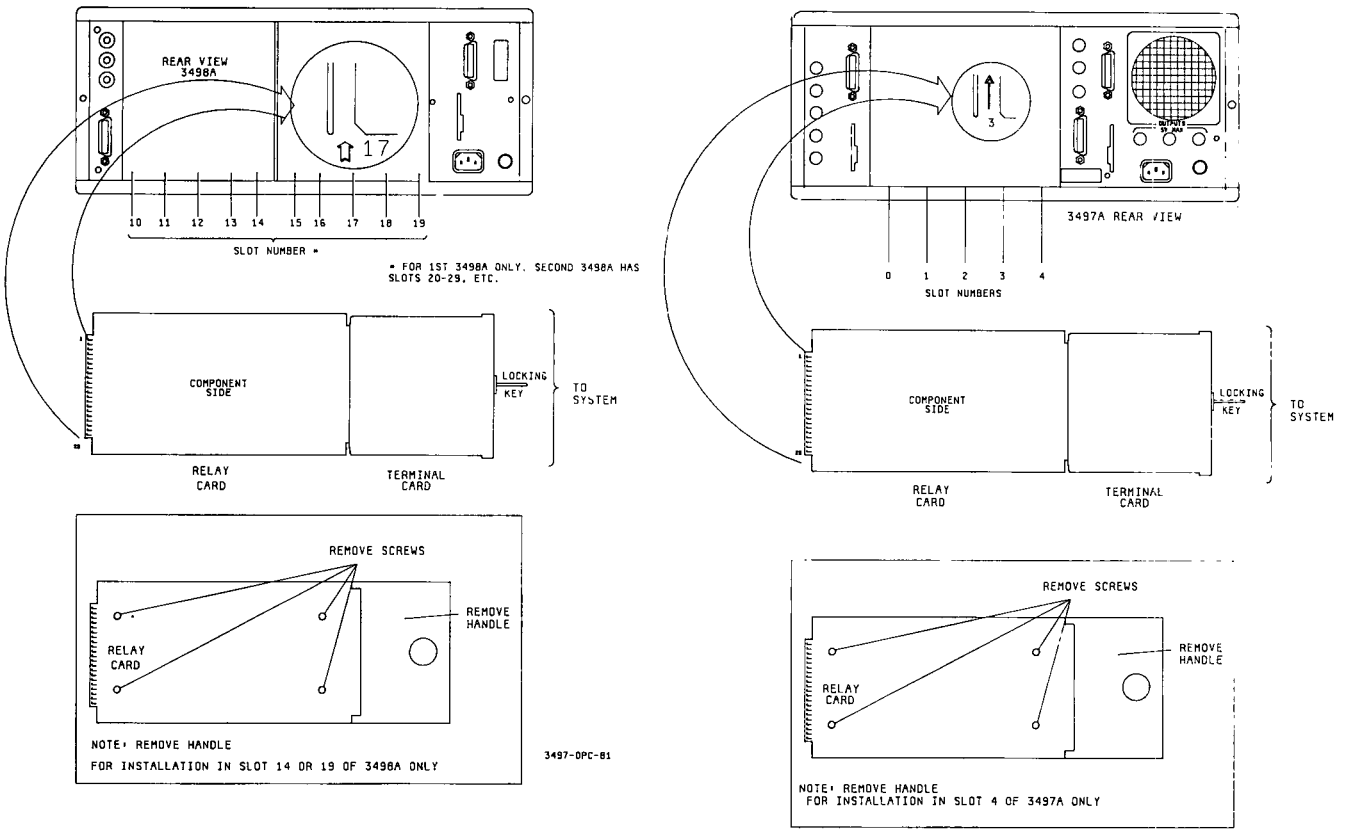


Figure 112. Options 070/071 - Installation in 3497A/3498A

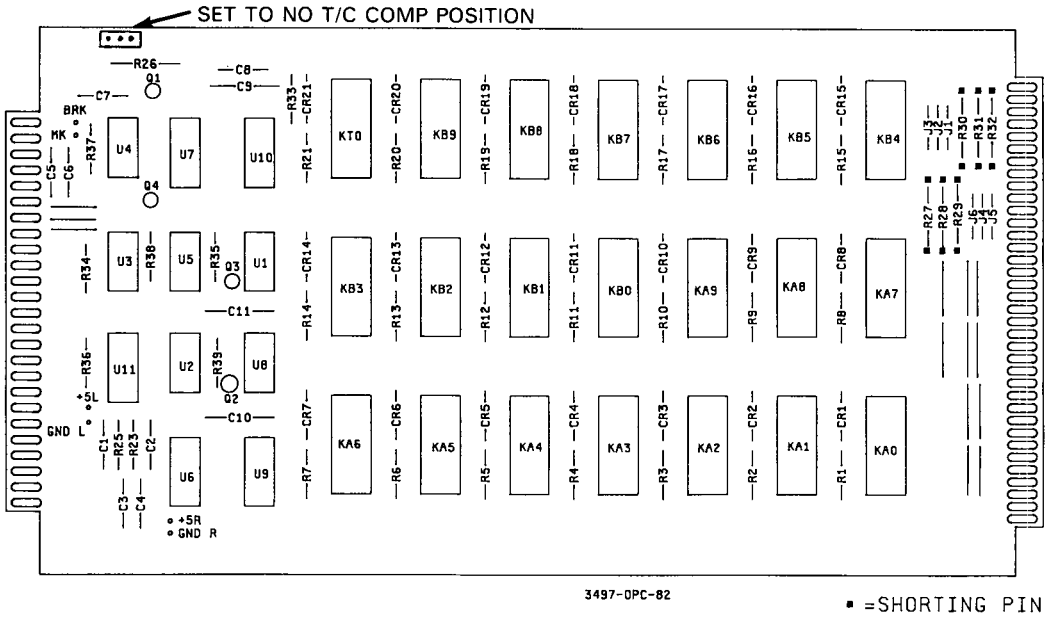
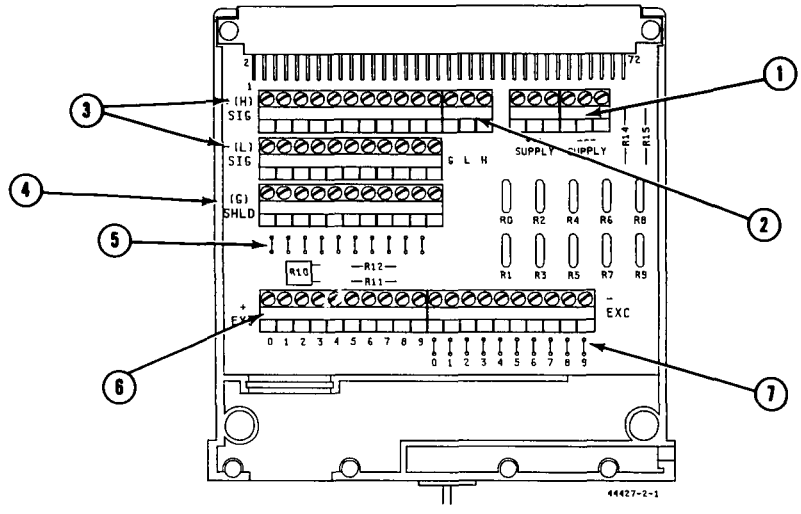


Figure 113. Options 070/071 - Relay Card T/C COMP Jumper Setting

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CONFIGURATION CONSIDERATIONS

The assembly can be configured for ¼ bridge, ½ bridge or full bridge operation. Figure 114 shows the terminal card connections and describes the functions of the connectors. Before you begin connecting strain gauges to the terminal card, you should consider three items: shielding the measurement leads; excitation supply requirements and connecting an external voltmeter.



(1) Excitation Power Supply Connections. These six connectors (three for positive and three for negative) are used for connecting the excitation supply to the terminal card. The extra connectors may be used to "Daisy Chair" the supply to other terminal cards.

(2) Common Bus Connections. High, Low, and Guard common (common to all channels after relay closure) may be accessed on these terminals. An external DVM may be connected to these terminals or to the High Common, Low Common, and Guard Common on the back panel of the 3497A.

(3) Bridge Signal Connections. The output voltage from the bridge is measured here. The relays connected to these terminals are used to switch the DVM from one bridge to the next.

(4) Bridge Shield Connections. The shield connections (Guard potential) are made on these terminals.

(5) Full Bridge Modification Jumpers. These jumpers are to be cut when using a full bridge configuration. Be sure the appropriate 1/4 bridge jumpers are in place.

(6) Excitation Connections. The excitation supply connections to the strain gage is made here. Note that the negative supply terminals are to the right of the positive terminals and have bridge label numbers below the 1/4 bridge jumpers.

(7) 1/4 Bridge Modification Jumpers. To configure a bridge for 1/4 bridge operation, cut the appropriate jumper. Be sure the appropriate Full bridge jumper is in place.

Figure 114. Options 070/071 - Terminal Card Identification

Shielding the Measurement Leads

In some cases, strain gauges are located some distance from the instrument which may cause desensitization errors due to lead resistance. For this reason, we recommend that a three-wire connection be used for ¼ bridge and ½ bridge measurements as shown in Figure 115.

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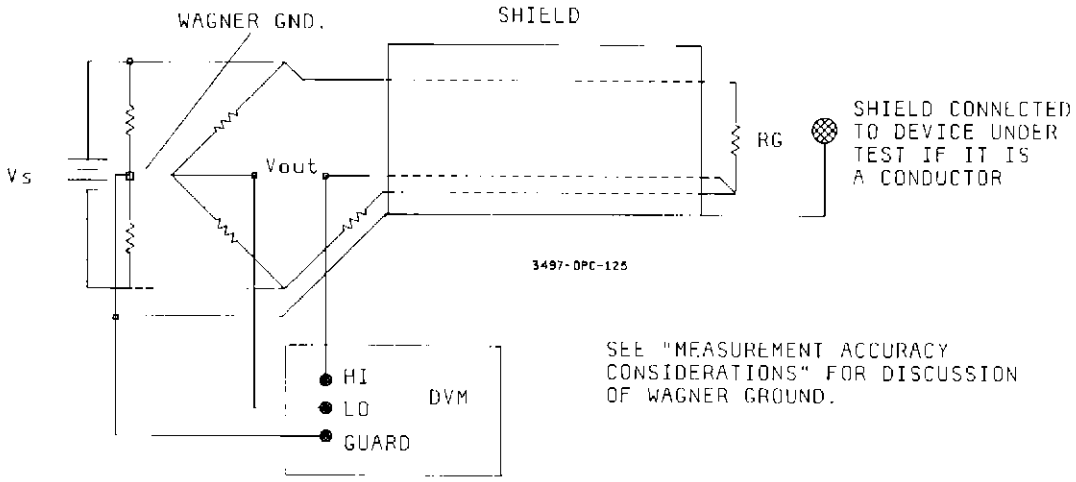


Figure 115. Options 070/071 - Connecting the Shield

Excitation Supply Requirements

The strain gauge assemblies require that an external excitation voltage source be supplied. The excitation supply (Vs) should have enough output capability to drive all connected gauges, since the assemblies switch the bridge measuring device and not the gauges. This means that the gauges are connected to Vs at all times. See the specifications table for more information.

For best common mode noise rejection, the excitation supply should drive only one assembly (10 channels) and should have floating output and low noise characteristics. One supply may be used for several assemblies if the strain gauges are mounted close to each other on the specimen being tested. If gauges are mounted some distance apart, use separate supplies.

For best results, the excitation supply voltage output should be between 0.1V and 5.4V, with less than 1 mV of noise. The supply should be linear regulated, not a switching supply.

CAUTION

Use extreme care when using power supplies with output voltages greater than 5.4V as the strain gauge and bridge resistors may be permanently damaged if exposed to over-voltage conditions.

Using an External DVM

If desired, an external voltmeter such as the -hp- Model 3456A, can be used as the DVM in place of the internal 3497A DVM. The external DVM can be connected to the HI COM, LO COM and GUARD COM terminals on the rear panel of the 3497A or to the HIGH, LOW and GUARD terminals.

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Sample Bridge Configurations

The following paragraphs describe how to configure the terminal card for sample ¼ bridge, ½ bridge, full bridge and combined bridge applications and show the equivalent circuit when the connections are made. The diagrams show Option 070 (120 ohms) but are identical for Option 071 (350 ohms).

Although the figures show only one channel connection, up to 10 bridge connections (1 per channel) can be made, and you can mix ¼ bridge, ½ bridge and full bridge arrangements on a single assembly.

¼ Bridge Configuration

Figure 116 shows a sample connection diagram and equivalent circuit for a ¼ bridge configuration with a strain gauge tied to channel 0. Note that jumpers J0 through J9 must be cut for the channels to be used for ¼ bridge circuits (i. e., cut J0 for ¼ bridge on channel 0, J0 and J1 for ¼ bridge on channels 0 and 1, etc.). Be sure to leave full bridge jumpers J10 through J19 intact.

When a relay (A0H and A0L, for example) is closed on the relay card, the DVM measures the bridge output voltage. The excitation supply, Vs, is connected internally on the terminal card to the +EXC and -EXC terminal blocks for all channels in parallel.

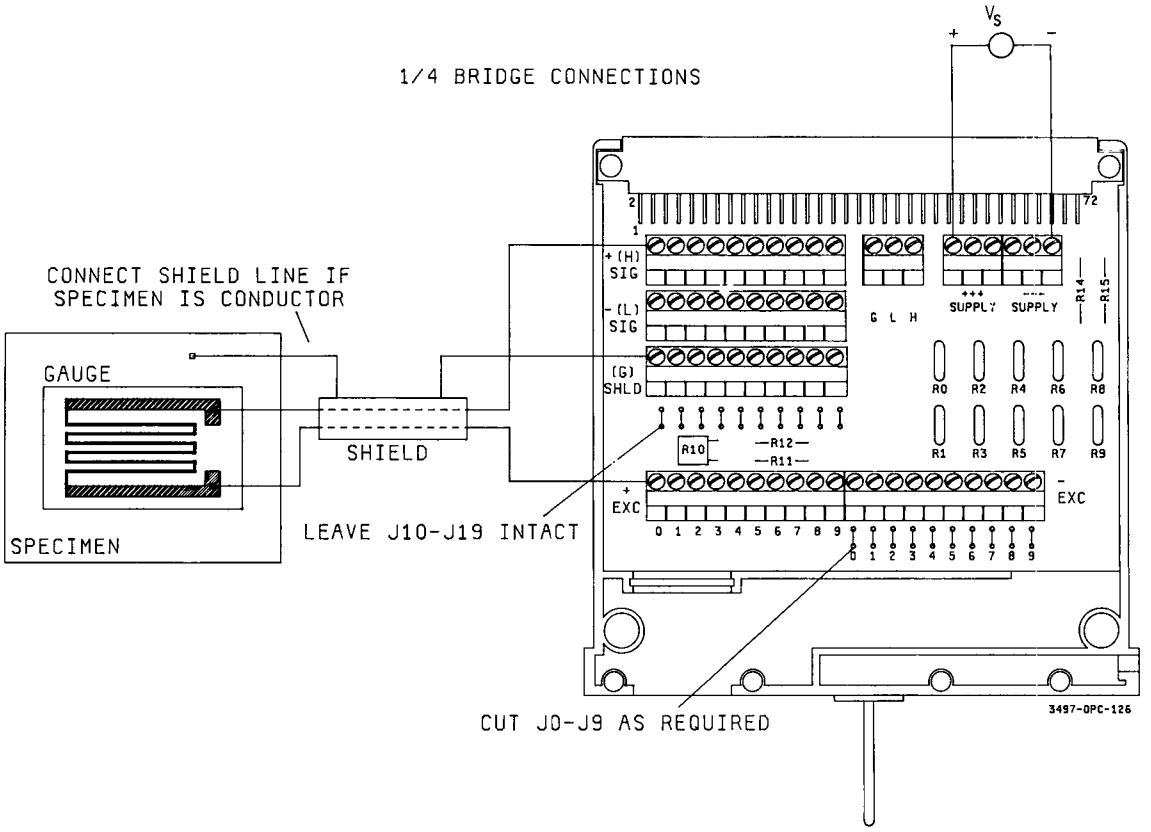
½ Bridge Configuration

Figure 117 shows a sample connection diagram and equivalent circuit for a ½ bridge configuration with strain gauges tied to channel 0. Note that jumpers J0 through J9 and jumpers J10 through J19 remain in place. Bridge completion resistors R0 through R9 are shorted by jumpers J0 through J9 (respectively) and are replaced by strain gauges RG01 (for channel 0) through RG91 (for channel 9).

Full Bridge Configuration

Figure 118 shows a sample connection diagram and equivalent circuit for a full bridge configuration with strain gauges tied to channel 0. Note that jumper J10 is cut to isolate the ½ bridge resistor R10 and R0 is shorted by jumper J0.

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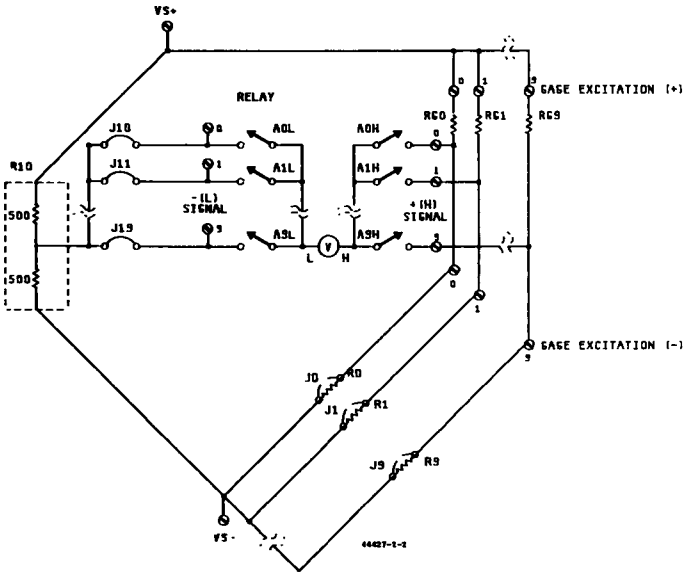


Figure 116. Options 070/071 - Sample ¼ Bridge Connections

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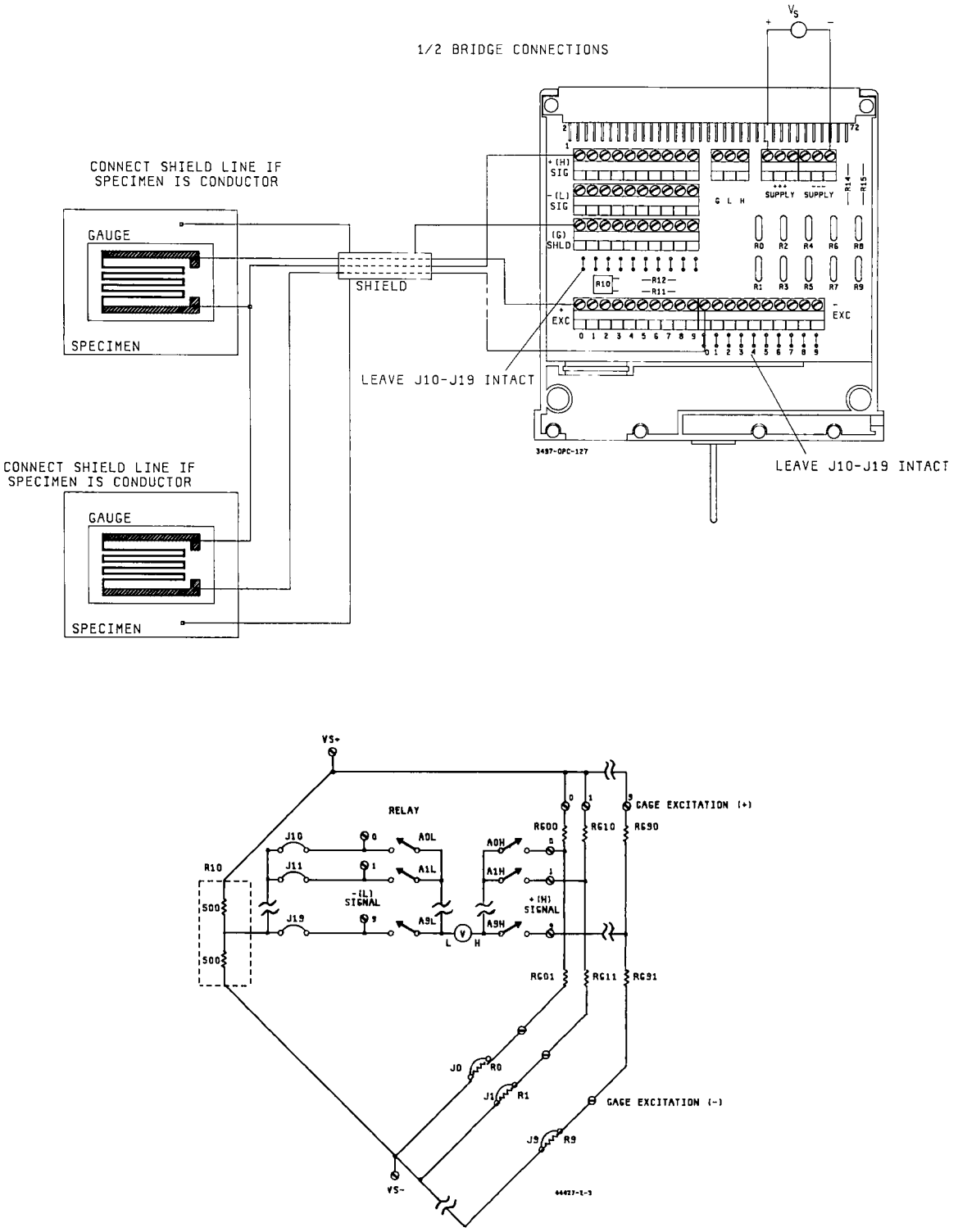


Figure 117. Options 070/071 - Sample ½ Bridge Connections

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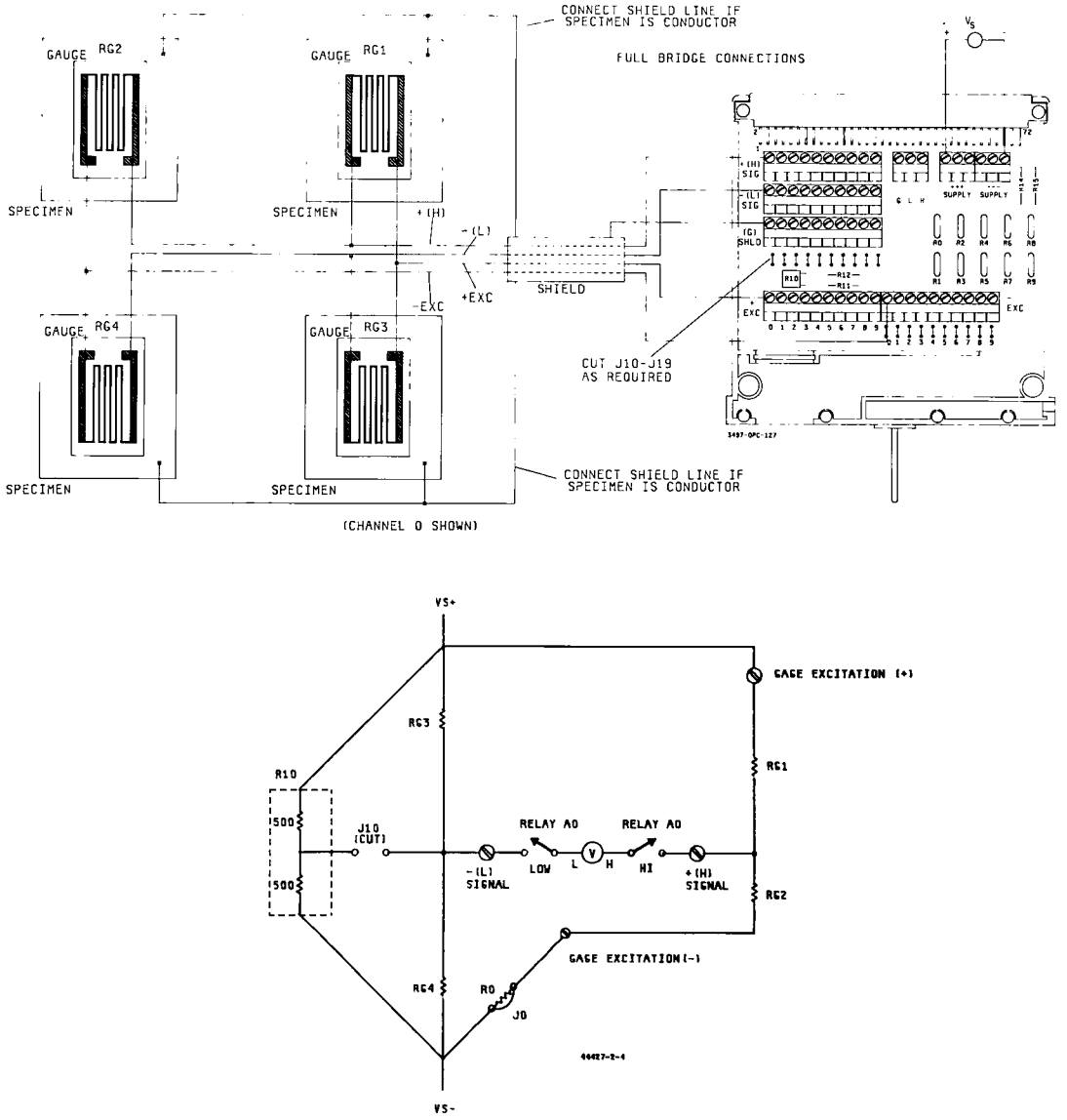


Figure 118. Options 070/071 - Sample Full Bridge Connections

Combining Bridge Configurations

You can also configure the terminal card for any combination of ¼, ½ and full bridge measurements (up to 10 bridges per assembly). Figure 119 shows an example connection with a ¼ bridge in channel 0, a ½ bridge in channel 1 and a full bridge in channel 2. The Option 070 assembly (120 ohm) is shown, but the connections are the same for the Option 071 (350 ohm) assembly. Refer to Figures 116, 117 and 118 for connection details.

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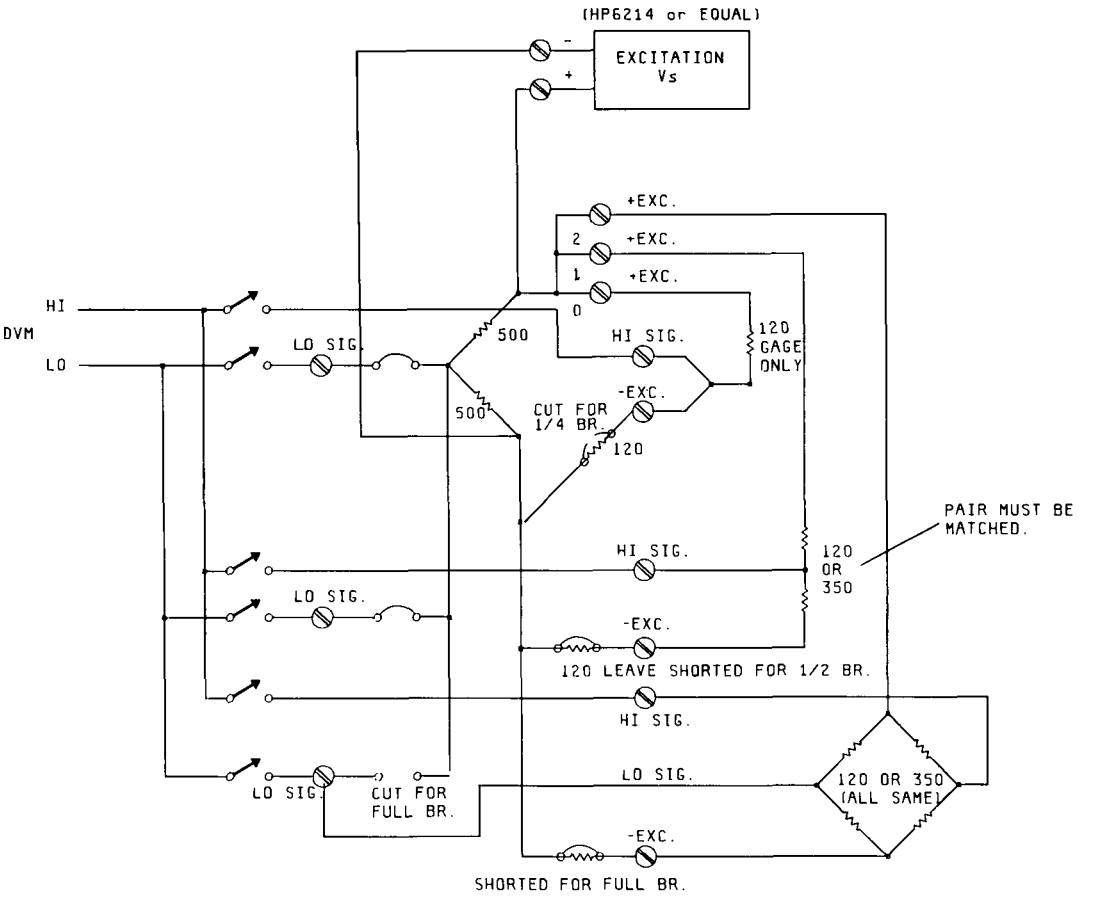


Figure 119. Options 070/071 - Combined Bridge Configurations

Strain Gauge Equations

Recall that we developed an equation for strain in terms of the input and output voltages of a ¼ bridge circuit. The assemblies can, of course, be used for ½ and full bridge measurements and a combination of bridges (10 maximum) can be input to a single assembly.

Although the assemblies are specifically designed for use with bonded resistance strain gauges, they can also be used with any resistive transducer, such as RTDs and 3-element rosettes. For these reasons, Figure 123 (at the end of this section) shows equations for determining strain for strain gauge bridges, biaxial stress state equations, rosette equations, wire resistances and selected materials properties.

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Measurement Accuracy Considerations

In our previous discussions, we assumed that no errors were introduced into the measurement by the instrumentation (i.e., no lead wire resistance, no heating or power line effects, etc.). However, for practical measurements, errors may be introduced by the measurement system. The following discussion summarizes how to minimize some of these errors. See -hp- Application Note 290-1 for details.

Self-Heating

The 44427A/B uses a shared half bridge when the terminal card is set for ¼ or ½ bridge operation. This means that half the bridge is common to all bridges on the card. Also, all gauges connected to the card remain powered by the excitation supply even though only one bridge is being measured. This setup minimizes thermal drift due to gauge self-heating and maintains constant power dissipation of the gauges.

If self-heating is a concern, use a 350 ohm gauge with the Option 071 (350 ohms) assembly. Another method is to reduce the excitation supply voltage. This, however, may increase noise level and impair accurate readings.

Power Line Noise

If power line interference may be a problem, use an integrating type DVM. The DVM error is significantly reduced if the voltmeter integrates the input for a period equal to an integer number of power line cycles (1, 10, 100, etc.). Exact amount of error reduction is determined by the DVM's Normal Mode Rejection. For example, the 3456A DVM has 60 dB rejection at one power line cycle integration and up to 80 dB at 100 power line cycles.

Voltage Offsets

When calculating strain, you can ignore voltage offsets if the offsets do not change between unstrained and strained measurements. If, however, changing offsets may be a problem (for example, thermally induced offsets), two compensation techniques may be used:

a. First, take an unstrained reading. Then disconnect the excitation supply and take a second measurement. Subtract the second (offset) reading from the unstrained reading. This calculated value can then be used as Voutu in equation (3). Similarly, take a strained measurement and an offset strained measurement. The difference can then be used as Vouts in equation (3).

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b. The second method uses a reversible excitation supply. For each unstrained and strained measurement, reverse the supply polarity and take a second measurement. Average each pair of measurements and use these values in equation (3). In this method, offsets are cancelled and there is no waiting for the gauges to cool.

Lead Wire Resistance

The equations previously used do not include compensation terms for lead wire resistance (see Figure 123 at the end of this section for bridge equations which include lead resistance). Although the bridges can be connected with two wire configurations, we highly recommend a three-wire arrangement (with shielding) to reduce the effects of lead wire resistance.

If lead wire resistance is a critical factor for your application, choose a 350 ohm gauge and use the 44427B assembly, since this gauge is less susceptible to lead wire resistance effects. If you are using ¼ bridge configuration, you can measure the lead wire resistance on channels A7, A8 and A9, as follows.

As shown in Figure 120, the lead wire resistance (R_α) can be computed from the following equation. Since R3 is specified to ± 0.12%, this is the overall accuracy of the measurement.

$$R_\alpha \quad \left[\frac{\text{(Voltage A-B)}}{\text{(Voltage B-D)}}\right] \text{(R3)} \quad [\pm .12\%] \qquad (5)$$

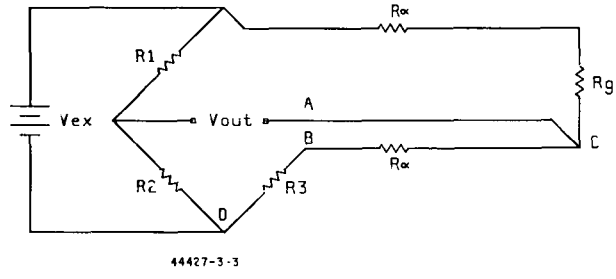


Figure 120. Options 070/071 - Lead Wire Resistance

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EXAMPLE - COMPUTE LEAD WIRE RESISTANCE

For example, to compute lead wire resistance for channel A9, use the following steps. Remember, only channel A7, A8 or A9 lead resistance can be determined.

1. Close channel A9 and record the voltage as VA9.
2. Close channel B9 and record the voltage as VB9.
3. Close channel B6 and record the voltage as VB6.
4. Compute R_{α} from:

$$R_{\alpha} = \left[\frac{VA9 - VB9}{VB6 + VB9}\right] (R3) \quad [\pm\ 0.12\%] \qquad (6)$$

½ Bridge Resistor Ratio

The ratio of the common ½ bridge resistors (R10) on the terminal card should be 1 (± 0.024%) since this ratio is used as a reference for ten bridges. If the ratio is outside this range, replace R10. To determine the ratio, first close channel B5 and record the voltage as VB5. Then close channel B6 and record the voltage as VB6. The ratio is then VB5/VB6.

A good integrating DVM (such as the -hp- 3456A) should be used for the test. The 3456A has accuracy greater than +10 ppm when set to 10 power line cycles integration.

Shunt Verification

To verify that the measured values for strain are close to the theoretical values, you can add a shunt resistor to one leg of the bridge to simulate either a tension strain or a compression strain measurement. Channel B1 is used to simulate tension strain and channel B2 is used to simulate compression strain. See Figure 121.

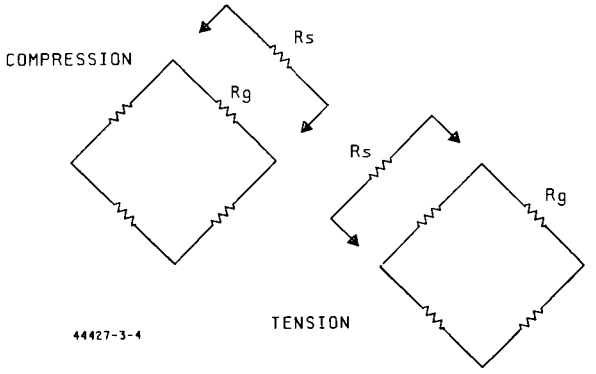


Figure 121. Options 070/071 - Shunt Verification

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For either type of simulation, the procedure is to first calculate the theoretical strain from the following equation:

$$\epsilon = [Rg-((Rg*Rs)/(Rg+Rs))]/(GF*Rg*n) \quad (7)$$

where: Rg = resistance of paralleled gauge
Rs = 79.81K (tension) or 59.41K (compression)
GF = Gauge Factor
n = 1 for ¼ bridge, 2 for ½ bridge or 4 for full bridge.

The second step is to make an unstrained measurement of the gauge under test and record this voltage as Voutu and then measure the excitation voltage and record it as Vs.

The third step is to use the AC chan#,chan# command to close channel B1 (for tension strain) or channel B2 (for compression strain) AND the channel for the gauge under test. This will simulate a strained measurement. Record the voltage as Vouts.

For example, with an assembly in slot 0 and a gauge connected to channel A3, the command for tension strain measurement is AC3,11 and the command for compression strain is AC3,12.

The final step is to compute the simulated strain using the following equations and compare it with the theoretical strain calculated with equation (7).

$$Vr = (Vouts/Vs) - (Voutu/Vs) \quad (8)$$

$$= -4Vr/[GF(1+2Vr)] \quad (9)$$

Gauge Leakage Resistance

A properly mounted gauge with fully cured adhesive usually has 1000 Megohms or more isolation resistance between the gauge and the specimen. A measured value of 500 Megohms or less usually indicates some type of surface contamination and resultant gauge leakage. At least 150 Megohms should be maintained, as gauge leakage resistance appears as a high impedance in parallel with the gauge which causes measurement errors.

To measure the gauge to specimen resistance, use a high resolution DVM. Do not use a high voltage insulation tester as damage to the gauge may result. Turn the excitation supply OFF before making the measurement. Connect the DVM OHMS terminals to the 3497A HI COM and LO COM terminals and close channel B3 to make the measurement.

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One way to reduce undesirable offsets due to gauge leakage is to use a Wagner Ground as shown in Figure 122. The Wagner Ground uses a guard shield whose voltage is approximately the same as the signal leads (excitation voltage).

The Wagner Ground is formed by dividing the excitation supply in half by using two equal value resistors. This ground is connected to the shield lead to establish a voltage reference. To check the Wagner Ground, close relay B4. The measured voltage should be within ± 4% of one-half the excitation voltage.

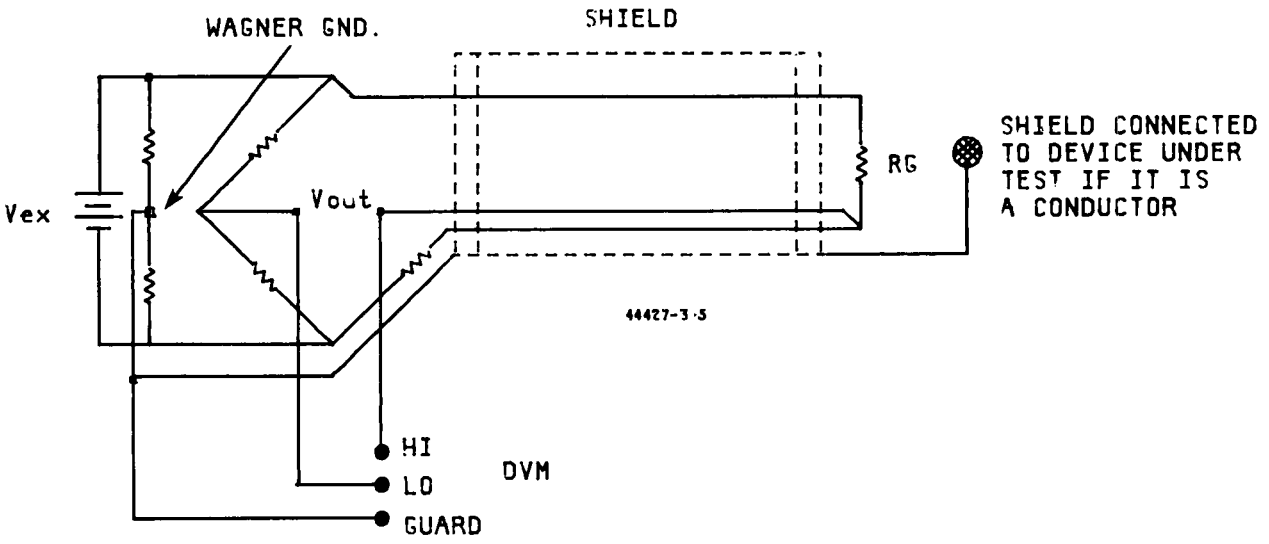


Figure 122. Options 070/071 - Wagner Ground

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MATERIAL TABLES

WIRE RESISTANCE
Solid Copper Wire

AWG	Ohms/Foot (25°C)	Diameter (in.)
18	0.0065	0.040
20	0.0104	0.032
22	0.0165	0.0253
24	0.0262	0.0201
26	0.0416	0.0159
28	0.0662	0.0126
30	0.105	0.010
32	0.167	0.008

AVERAGE PROPERTIES OF SELECTED ENGINEERING MATERIALS
Exact values may vary widely

Material	Poisson's Ratio, ν	Modulus of Elasticity, E psi x 10^6	Elastic Strength (a) Tension (psi)
ABS (unfilled)	–	0.2-0.4	4500-7500
Aluminum (2024-T4)	0.32	10.6	48000
Aluminum (7075-T6)	0.32	10.4	72000
Red Brass, soft	0.33	15	15000
Iron-Gray Cast	–	13-14	–
Polycarbonate	0.285	0.3-0.38	8000-9500
Steel-1018	0.285	30	32000
Steel-4130/4340	0.28-0.29	30	45000
Steel-304 SS	0.25	28	35000
Steel-410 SS	0.27-0.29	29	40000
Titanium alloy	0.34	14	135000

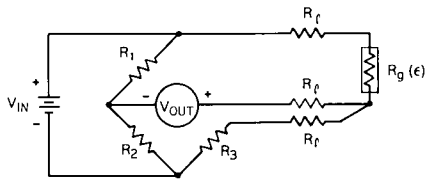
(a) Elastic strength may be represented by proportional limit, yield point, or yield strength at 0.2 percent offset.

BRIDGE CIRCUITS

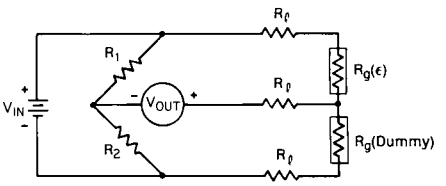
STRAIN GAGE BRIDGE CIRCUITS AND EQUATIONS

Equations compute strain from unbalanced bridge voltages:
sign is correct for V_{IN} and V_{OUT} as shown
GF = Gage Factor: ν = Poisson's ratio:
$V_r = [(V_{OUT}/V_{IN})\text{strained} - (V_{OUT}/V_{IN})\text{unstrained}]$:
ϵ = Strain; Multiply by 10^6 for micro-strain:
tensile is (+) and compressive is (−)

Quarter Bridge Configurations:

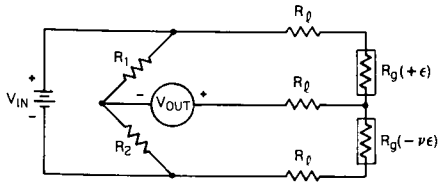


OR

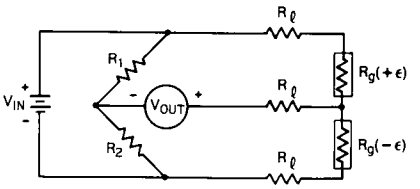


$$\epsilon = \frac{-4V_r}{GF(1+2V_r)} \cdot \left(1 + \frac{R_f}{R_g}\right)$$

Half Bridge Configurations:

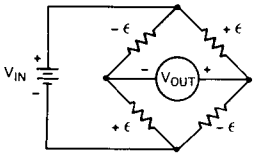


$$\epsilon = \frac{-4V_r}{GF[(1+\nu) - 2V_r(\nu-1)]} \cdot \left(1 + \frac{R_f}{R_g}\right)$$

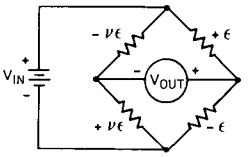


$$\epsilon = \frac{-2V_r}{GF} \cdot \left(1 + \frac{R_f}{R_g}\right)$$

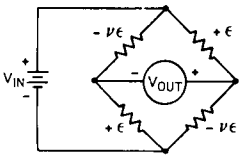
Full Bridge Configurations:



$$\epsilon = \frac{-V_r}{GF}$$



$$\epsilon = \frac{-2V_r}{GF(\nu+1)}$$



$$\epsilon = \frac{-2V_r}{GF[(\nu+1) - V_r(\nu-1)]}$$

Figure 123. Options 070/071 · Strain Gauge/Rosette Equations

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EQUATIONS

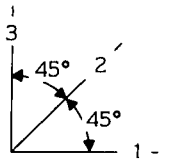
BIAXIAL STRESS STATE EQUATIONS

$$\epsilon_x = \frac{\sigma_x}{E} - \nu\frac{\sigma_y}{E} \qquad \epsilon_z = -\nu\frac{\sigma_x}{E} - \nu\frac{\sigma_y}{E} \qquad \sigma_y = \frac{E}{1-\nu^2}(\epsilon_y + \nu\,\epsilon_x)$$

$$\epsilon_y = \frac{\sigma_y}{E} - \nu\frac{\sigma_x}{E} \qquad \sigma_x = \frac{E}{1-\nu^2}(\epsilon_x + \nu\,\epsilon_y) \qquad \sigma_z = 0$$

ROSETTE EQUATIONS

Rectangular Rosette:

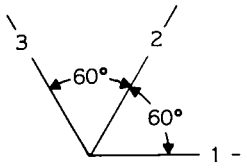


$$\epsilon_{p,q} = \left[\frac{1}{2}\ \epsilon_1 + \epsilon_3 \pm \sqrt{(\epsilon_1 - \epsilon_3)^2 + (2\epsilon_2 - \epsilon_1 - \epsilon_3)^2}\right]$$

$$\sigma_{p,q} = \left[\frac{E}{2}\ \frac{\epsilon_1 + \epsilon_3}{1-\nu} \pm \frac{1}{1+\nu}\ \sqrt{(\epsilon_1 - \epsilon_3)^2 + (2\epsilon_2 - \epsilon_1 - \epsilon_3)^2}\right]$$

$$\theta_{p,q} = \frac{1}{2}\ \text{TAN}^{-1}\frac{2\epsilon_2 - \epsilon_1 - \epsilon_3}{\epsilon_1 - \epsilon_3}$$

Delta Rosette:



$$\epsilon_{p,q} = \left[\frac{1}{3}\ \epsilon_1 + \epsilon_2 + \epsilon_3 \pm \sqrt{2[(\epsilon_1 - \epsilon_2)^2 + (\epsilon_2 - \epsilon_3)^2 + (\epsilon_3 - \epsilon_1)^2]}\right]$$

$$\sigma_{p,q} = \left[\frac{E}{3}\ \frac{\epsilon_1 + \epsilon_2 + \epsilon_3}{1-\nu} \pm \frac{1}{1+\nu}\ \sqrt{2[(\epsilon_1 - \epsilon_2)^2 + (\epsilon_2 - \epsilon_3)^2 + (\epsilon_3 - \epsilon_1)^2]}\right]$$

$$\theta_{p,q} = \frac{1}{2}\ \text{TAN}^{-1}\frac{\sqrt{3}(\epsilon_2 - \epsilon_3)}{2\epsilon_1 - \epsilon_2 - \epsilon_3}$$

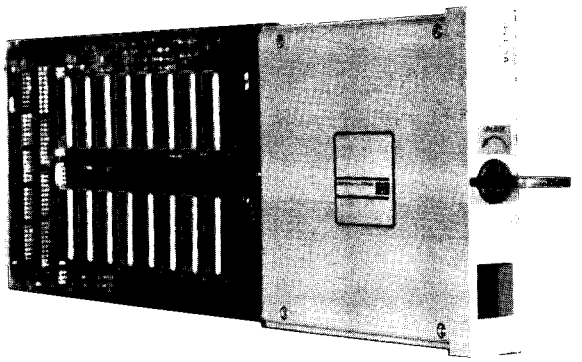
WHERE: $\epsilon_{p,q}$ = Principal strains; $\sigma_{p,q}$ = Principal stresses; and $\theta_{p,q}$ = the acute angle from the axis of gage 1 to the nearest principal axis. When positive, the direction is the same as that of the gage numbering and when negative, opposite.

NOTE: Corrections may be necessary for transverse sensitivity, refer to gage manufacturers literature.

Figure 123. Options 070/071 - Strain Gauge/Rosette Equations (Cont'd)

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OPTION 110



Actuator/Digital Output Assembly

INTRODUCTION

The Option 110 assembly consists of 16 mercury-wetted form C (single-pole double-throw) relays. The assembly has two functional modes: Actuator Mode and Digital Output Mode. In the actuator mode, each channel relay can be closed to switch power to (actuate) multiple external devices. Each relay can safely switch up to 1 amp at 100 volts (peak).

In the digital output mode, each relay can be set to the Normal Open (NO) position (logical 1) or to the Normal Closed (NC) position (logical 0) to provide an 8-bit or 16-bit wide digital output. The assembly uses "bounceless" relays, isolated Gate/Flag Handshake lines and +5V nonisolated internal excitation. The assembly has capability for up to +100V external excitation and can be configured for open collector operation.

The actuator can be configured as a 4 x 4 point matrix scanner and additional assemblies can be added to construct larger matrices. Since the actuator assembly can switch one amp at 100 volts, it can be used to switch test fixture power or to actuate alarm bells. In addition, the assembly can be used with the 16 Channel Isolated Digital Input/Interrupt Assembly (Option 050) to provide an independent digital input/output port.

Description

As shown in Figure 124, the Option 110 assembly consists of a relay card and a terminal card. The relay card consists of 16 mercury-wetted, Form C (single-pole double-throw) relays. Each relay can be individually closed (set to the Normal Open position) or opened (set to the Normal Closed position).

In addition, the relay card contains a jumper to select a positive-going (LGT) or negative-going (HGT) gate pulse, a jumper to select a positive-going (LFL) or negative-going (HFL) flag pulse, and a jumper to enable or disable the handshake function for the assembly.

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The terminal card contains input connectors for 16 channel relays (NORM OPEN, COMMON and NORM CLOSED) plus connectors for gate and flag lines and DIP connectors for pull-up resistors as required. In addition, you can use four optional jumpers on the terminal card to change gate and flag handshake lines from optically isolated (standard TTL logic) to nonoptically isolated.

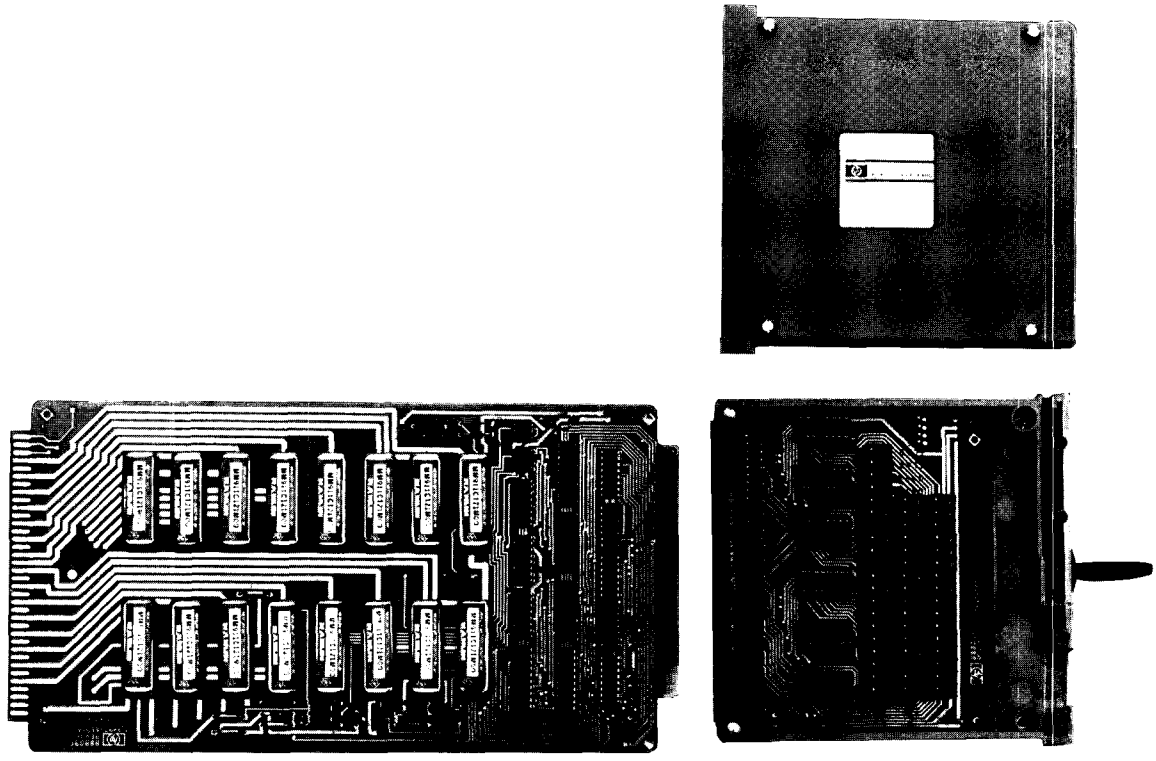


Figure 124. Option 110 - Actuator/Digital Output Assembly

Actuator (Switching) Mode

As shown in Figure 125, when the assembly is used in actuator mode, each of the 16 channel relays (K0 through K15) can be switched from the Normal Open position to the Normal Closed position and thus switch power to or from loads. When a relay is deenergized, the NORMAL CLOSED contact is connected to COMMON. When a relay is energized, the NORMAL OPEN contact is connected to COMMON.

By using DC slot#, chan#,chan#,.. and DW slot#,octal value, from one to 16 relays can be closed and each relay can be individually closed or opened. By using a DR slot# or DL slot# command, you can read the status (open or closed) of each relay. In addition, by using the SR slot#,0 command, you can verify that the assembly in the slot addressed is an Option 110 (or Option 115) assembly if 000041 OCT is returned.

In some cases (highly inductive loads, for example), contact protection may be required to prevent switch contact damage. Note that contact protection is required across BOTH the Normal Open and Normal Closed lines if loads are to be switched on each line.

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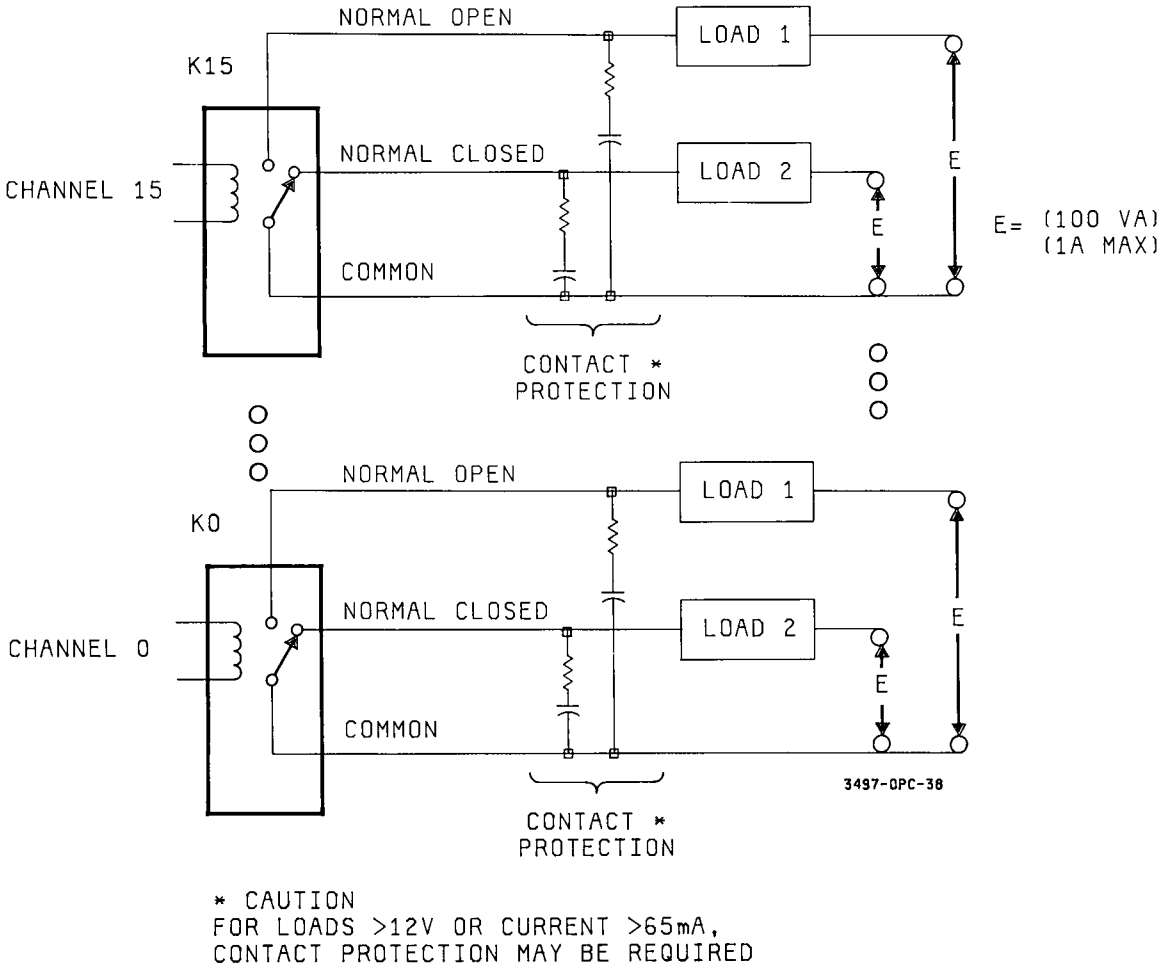


Figure 125. Option 110 - Actuator (Switching) Mode

The assembly is very versatile and can be used in many applications, as long as the load circuits are fused for 1A or less and for less than 100 VA. To indicate some of the ways that the assembly can be used in the actuator mode, Figure 126 shows examples of a relay actuated alarm circuit, voltage switching and matrix switching.

In the alarm circuit, closing the relay applies power to activate the alarm device. For example, the relay closure could be computer-controlled and generated as a result of an interrupt from the Option 050 assembly. For the voltage switching application shown, closing the relay switches +5V from load #1 to load #2.

As a specialized application of the actuator mode, the assembly can be configured as a 4 x 4 matrix switch. For example, as shown in Figure 126, signal sources S1 through S4 can be connected to measuring instruments I1 through I4 by closing relays K0 through K15 as required (i. e., to connect source S3 to instrument I2, close relay K6, etc.).

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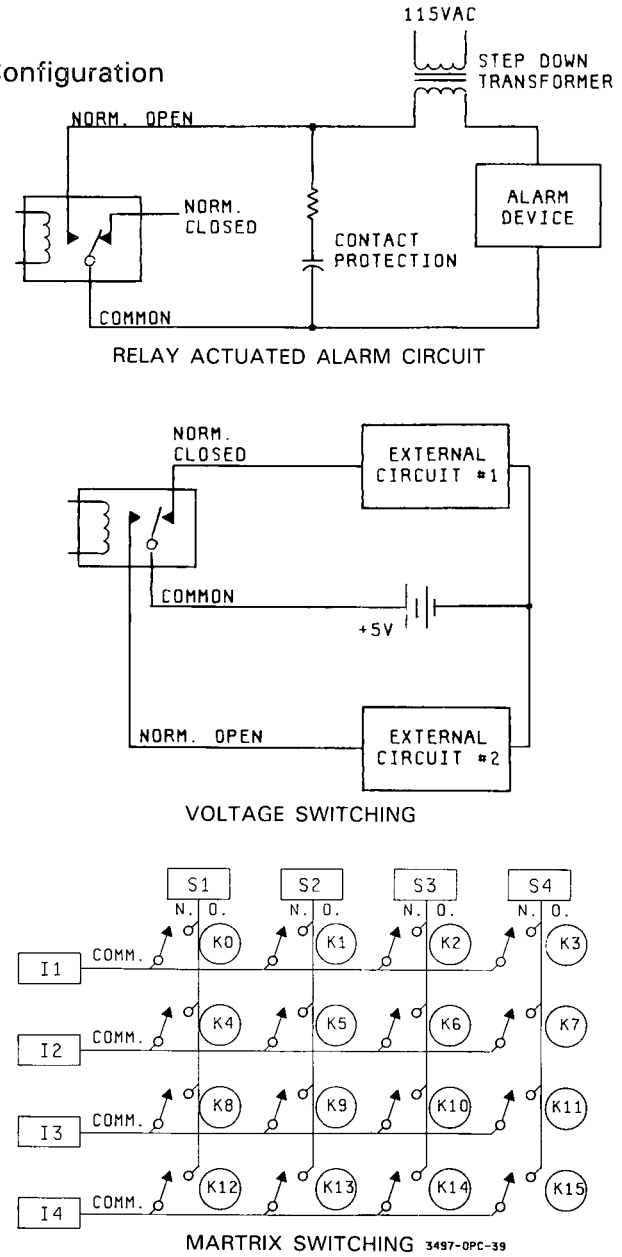


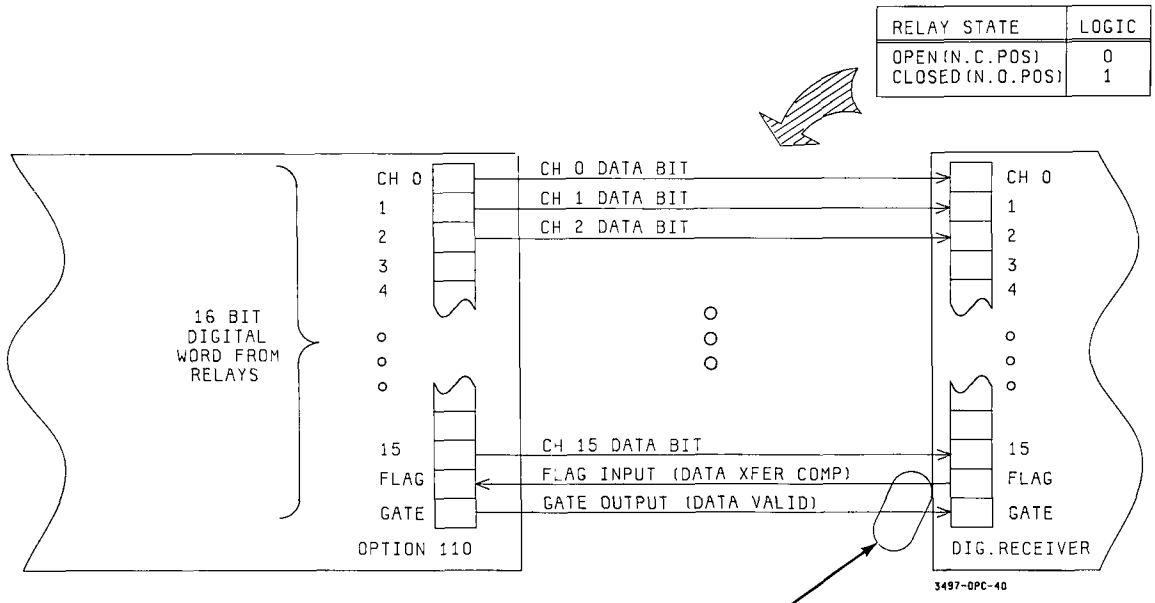
Figure 126. Option 110 - Actuator Mode Examples

Digital Output Mode

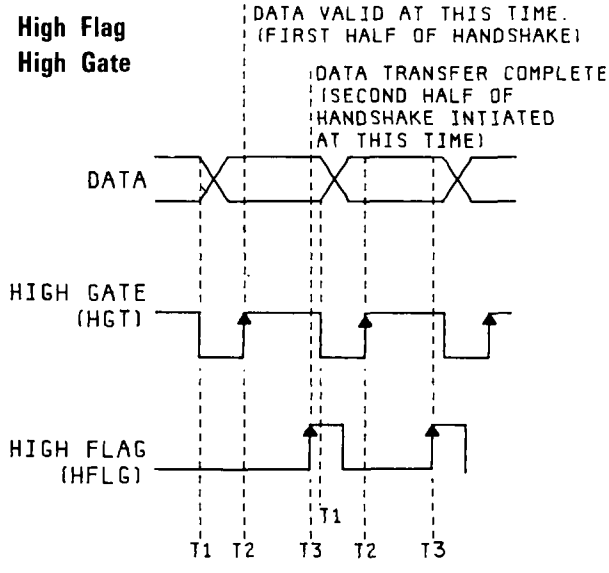
The actuator assembly can also be used in digital output mode to communicate with an 8-bit or 16-bit digital receiver at a typical maximum read rate of 400 Hz. As shown in Figure 127, a 16-bit wide digital word is input to the relays (channels 0 through 15) and the word is transferred to a digital receiver. In addition (as with the actuator mode), relay status (open or closed) can be read with a DR slot# or DL slot# command.

As factory configured, handshaking is disabled. If desired, you can set a jumper on the relay assembly to enable handshaking and (with other jumpers) can select either High Gate, High Flag or Low Gate, Low Flag handshaking. Also, as factory configured, the handshake lines are optically isolated. You can select nonisolated mode by connecting pullups across four terminal card jumpers (see CONFIGURING THE ASSEMBLY for details).

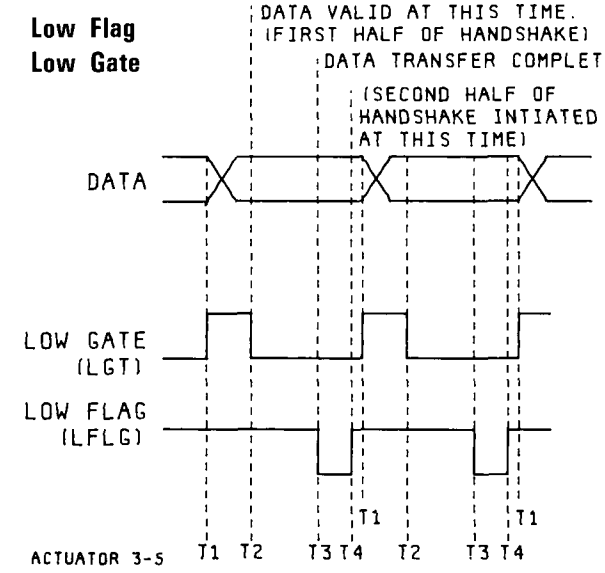
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Handshake Timing Diagrams



T1 . . . . 16 bit wide data word transferred to actuator card relays
T1-T2 . . Settling time for relays and drive circuits (≃3ms.)
T2 . . . . Data Valid, ready for transfer to external device
T2-T3 . . Data transfer executed during this time period
T3 . . . . Data transfer complete. Actuator card and 3497A wait until positive going flag pulse received



T1 . . . . 16 bit wide data word transfered to actuator card relays
T1-T2 . . Settling time for relays and drive circuits (≃3ms.)
T2 . . . . Data valid, ready for transfer to external device (first half of handshake)
T2-T3 . . Data transfer executed duing this time period
T3 . . . . Data transfer complete. External device transmits flag pulse
T4 . . . . Positive going (trailing edge) transition occurs to complete handshake

Figure 127. Option 110 - Digital Output Mode

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When handshaking is enabled, the handshake sequence for either High Gate, High Flag or Low Gate, Low Flag operation is as shown in Figure 127. When a 16-bit wide word is entered into the assembly and settling time has occured, the assembly sends a Gate output to the receiver to signal Data Valid condition. Then, after the word is transferred to the receiver, the receiver returns a Flag message to show that data transfer is complete and the receiver is ready for more data.

Specifications

Specifications for the Actuator/Digital Output assembly follow. Specifications are performance standards, or limits, against which the assembly may be tested.

OPTION 110
ACTUATOR/DIGITAL OUTPUT ASSEMBLY

Input Characteristics

Contact Ratings: Voltage: ±100 V peak
Current: 1 ampere/channel
Power: 100 volt amperes/channel

CAUTION: For use only in circuits fused at 1 ampere or less and less than 100 VA.

Thermal Offset: < 20 μV

Contact Resistance: < 400 milliohms·

Isolation: > 10^6 Ω common to open

Isolation Voltage: 170V peak any terminal to chassis

General Information

Single Channel Closure Rate: > 27/second (Using 9835A)

Switch Life: > 10^{10} with contact protection

+ 5V Supply: Source up to 50 mA per assembly

Operating Considerations: Should not be used in a position greater than 30° above horizontal

Handshake Lines: Optically isolated, TTL compatible, open collector output

AC Performance

Contact Capacitance: < 15 pF

Interchannel Capacitance: < 30 pF

Frequency Response

(10 kHz Reference)	f<100 kHz	f<1 MHz
50 Ohm Termination	±.3 dB	±.5 dB
1M Ohm Termination	±.3 dB	±.5 dB

Cross Talk

1M Ohm Termination	<30 dB	<30 dB

Manual Information

This manual contains configuration and control information for this assembly. For repair and/or service information, see 3497A Plug-In Assemblies/3498A Extender Service Manual. Assemblies manufactured after the publication date of this manual may have changes incorporated. In this case, a yellow MANUAL CHANGES sheet will accompany the manual. See Appendix B for details.

INSTALLING THE ASSEMBLY

WARNING

There is no operator installation or configuration for the Actuator/Digital Output assembly. Only qualified, service-trained personnel should install or configure the assembly.

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Initial Inspection

If you ordered the Actuator/Digital Output assembly as Option 110, the assembly is already installed in the 3497A. If you ordered the assembly as Field Installation Kit 44428A, the shipping container should contain a relay card and a terminal card (see Figure 124).

For the Field Installation Kit, if either card is missing or if there is mechanical damage or defect to the cards, contact your nearest -hp- Sales/Service office. They will arrange for replacement or repair at -hp- option.

If there is any damage to the shipping carton, keep the carton and notify the carrier as well as -hp-. If you return a relay card or terminal card to -hp-, follow the shipping guidelines in Appendix B.

CAUTION

Before installing this assembly or connecting external circuits, a qualified, service-trained person should verify the electrical performance of the assembly by using the performance checks shown in the 3497A Plug-In Assembly/3498A Extender Service Manual.

How to Install the Actuator/Digital Output Assembly

WARNING

Before touching any installed assemblies or attempting to install the Actuator/Digital Output assembly in the 3497A or 3498A, disconnect the power cords to the 3497A and 3498A and remove ALL voltage sources from these instruments. The Actuator/Digital Output assembly is not intended for outdoor use. Do not expose the assembly to rain or excessive moisture.

CAUTION

Use clean handling techniques when installing, removing or reconfiguring the relay card. Handle the card by its edges and do not subject the components to static discharges or excessive voltages.

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NOTE

Since mercury-wetted relays are used in the assembly, the arrows on the relay card must always point upward to the 12 o'clock position. Do not operate the assembly with the relays more than 30 degrees from the vertical position. After installing the assembly in the 3497A or 3498A, gently tap the assembly to settle the mercury to the bottom of the relays.

Figure 128 shows how to install the assembly in the 3497A and 3498A. After taking the steps shown in the WARNING, CAUTION and NOTE above, plug the assembly into an unused slot in the 3497A or 3498A and turn the locking key clockwise to lock the assembly in place.

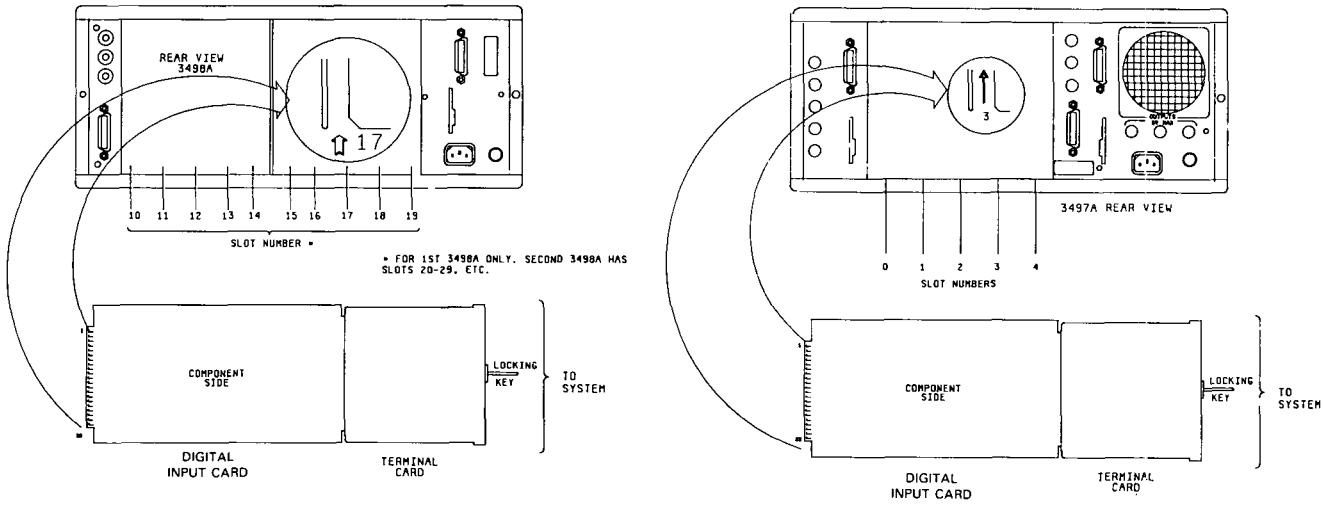


Figure 128. Option 110 - Installation in 3497A/3498A

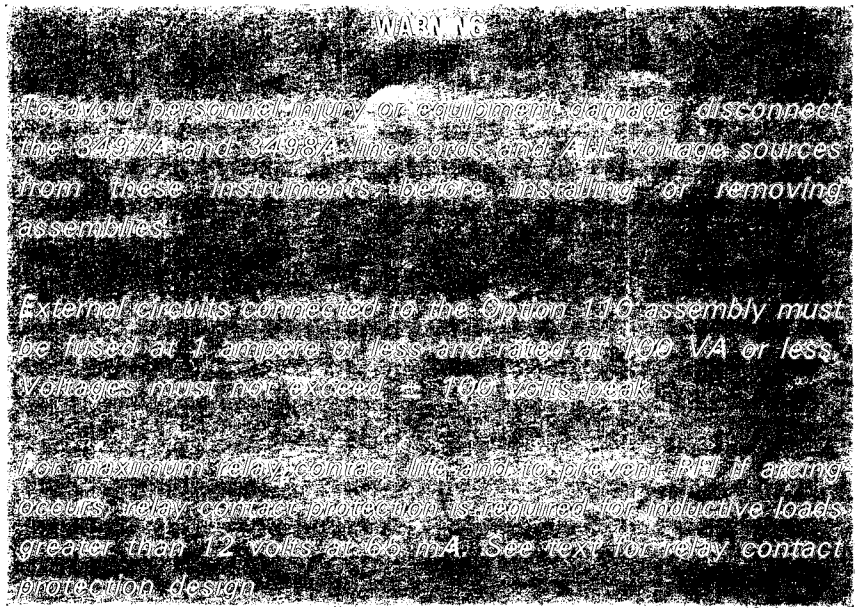
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CONFIGURING THE ASSEMBLY

As mentioned, the assembly can be configured for actuator (switching) mode or for digital output mode. The paragraphs which follow show how to configure the assembly for these two modes and provide guidelines for relay contact protection.

Actuator Mode Configuration

Previously, we showed that the assembly can be used in applications such as voltage switching, alarm circuit actuation and matrix switching. To configure the assembly for actuator mode, refer to Figure 129 which shows the jumper connections on the relay card and the terminal card.



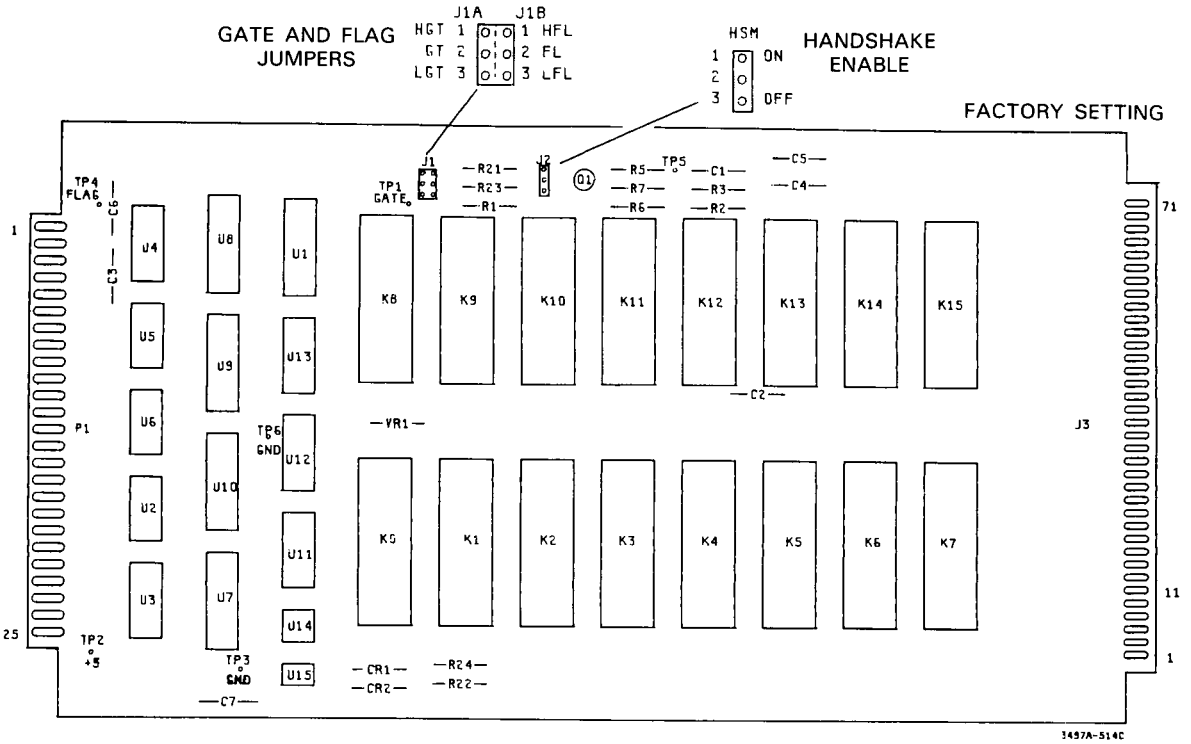
Relay Contact Protection

Loads which may cause relay contact arcing can cause contact failure unless contact protection is provided. The nomograph in Figure 130 provides guidelines for R-C network design which is suitable for most loads. For the actuator assembly, you should provide relay contact protection if the load to be switched is greater than 12 volts at 65 mA.

EXAMPLE - USING CONTACT PROTECTION NOMOGRAPH

For example, if the load to be switched is 50 volts at 300 mA, from the nomograph R = 500 ohms and C = 0.009 μF (remember that for the actuator assembly, E = 100 volts max). This R-C network should be mounted as close to the relay contacts as possible. Note from the nomograph that for $70 < E < 100$ volts, R can be $\pm$ 50% of nominal chart value.

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RELAY CARD JUMPERS

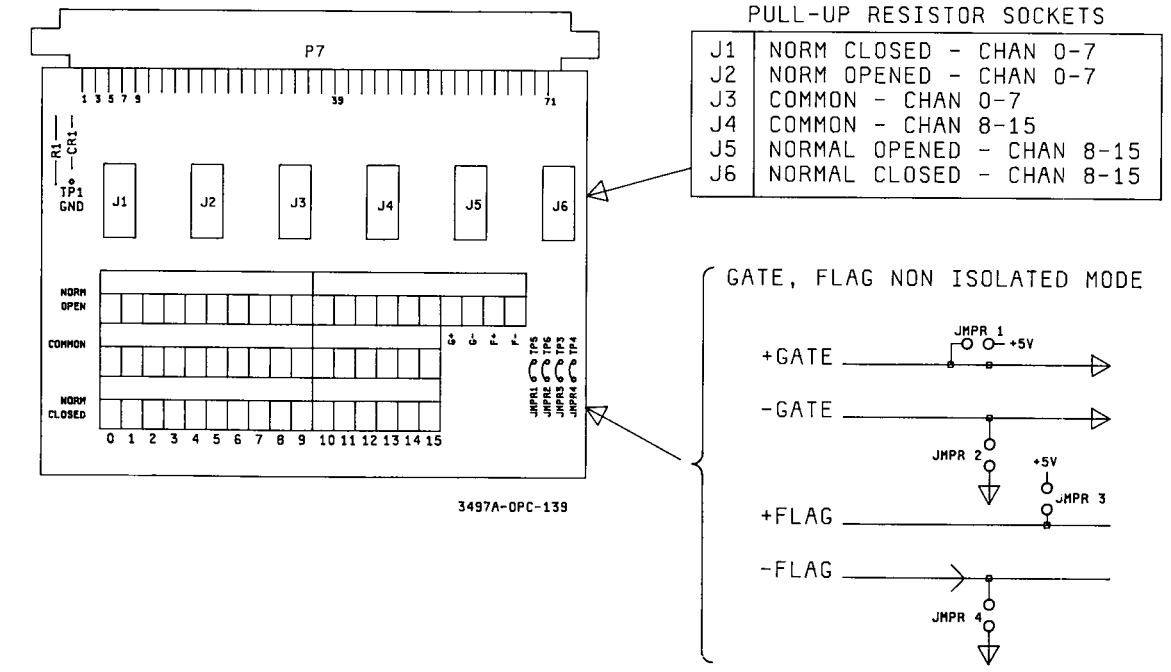


Figure 129. Option 110 - Relay and Terminal Card Jumpers

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CONTACT PROTECTION

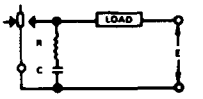
Contact loads that can cause arcing may result in contact failure unless contact protection is provided. It should be wired close to the relay terminals.

The R-C network shown is suitable for most loads. Component values may be obtained from the nomograph. Capacitance may be increased (up to 10 times) to minimize inductive load transients. Use peak values for ac circuits.

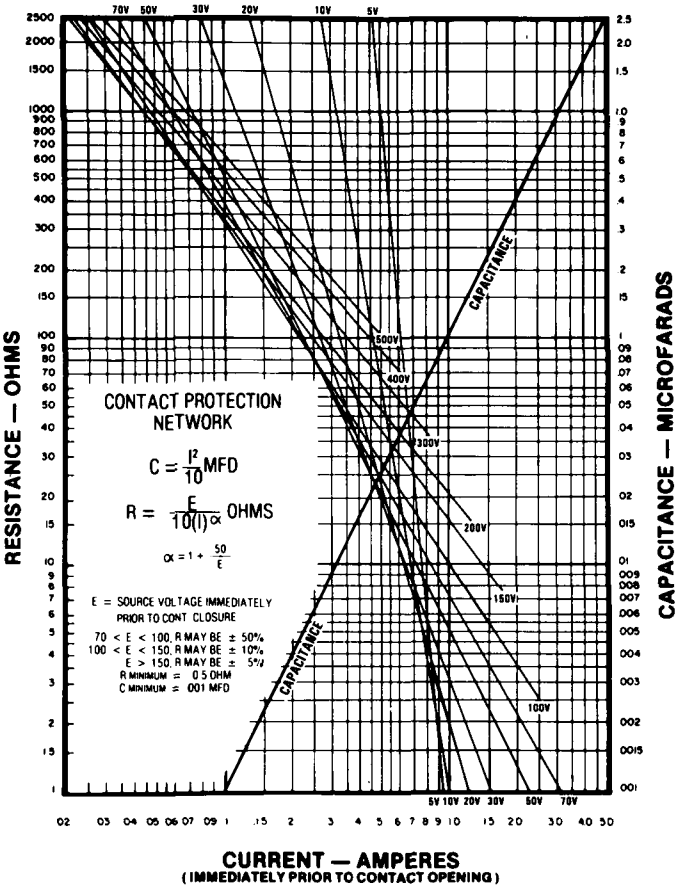
No protection is required for voltages below 12 volts or currents below 65ma.

The resistor may be eliminated for voltages below 50 volts with currents below 0.5A. The capacitor should not exceed the chart value.

Highly capacitize loads do not require protection.



CONTACT PROTECTION NOMOGRAPH



HOW TO USE THE NOMOGRAPH

To determine C, the load current value is found on the CURRENT axis. Reading directly up to the sloping capacitance line, the C value is determined from the right hand CAPACITANCE scale. To determine R, read directly up from the load current value to its intersection with the appropriate load voltage line. The value of R is then read from the left hand RESISTANCE scale. For ac loads, peak current and voltage values must be used.

Figure 130. Option 110 - Contact Protection Nomograph

After determining the values for R and C from the nomograph, place the protection networks as close to the relays as possible. Also, use R-C networks on both the NO and NC contacts are switching power levels which require protection. See Figure 131.

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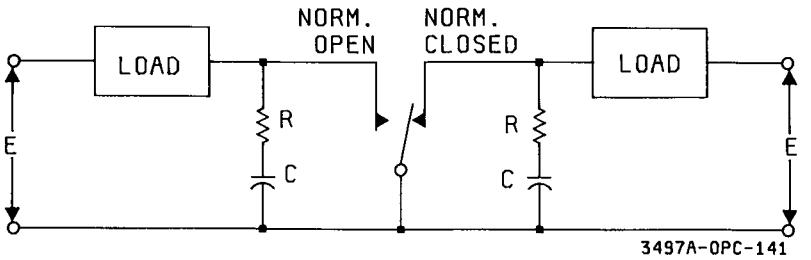


Figure 131. Option 110 - Relay Contact Protection Networks

Configuring the Assembly for Actuator Mode

To configure the assembly for actuator mode, check the relay card to ensure that the handshake enable (HSM) jumper is in the OFF position (handshake disabled). Then, to connect your inputs to the assembly, remove the cover on the terminal card and route the wires as shown in Figure 132 to the appropriate terminals - NORM OPEN, NORM CLOSED and COMMON. Replace the cover and install the assembly in a slot in the 3497A or 3498A. Then, connect relay contact protection (if required) as shown in Figure 131.

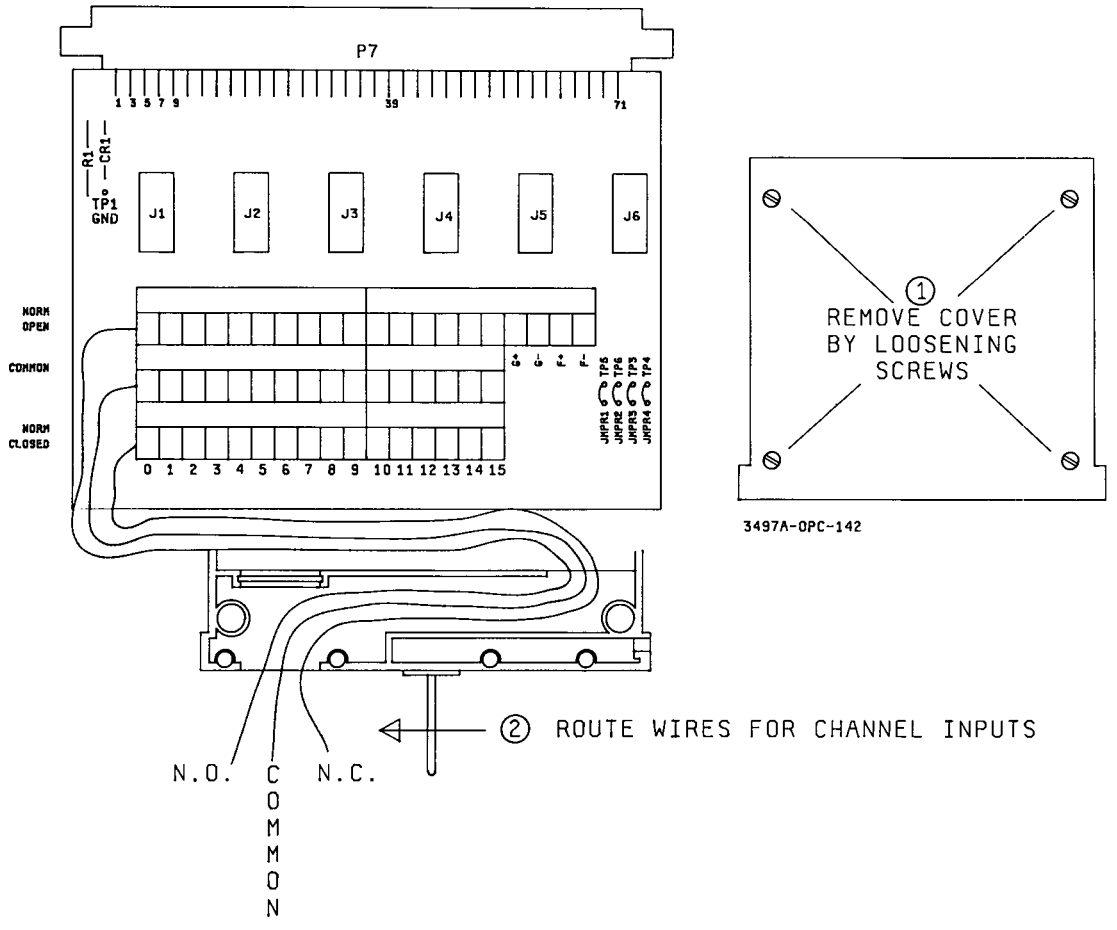


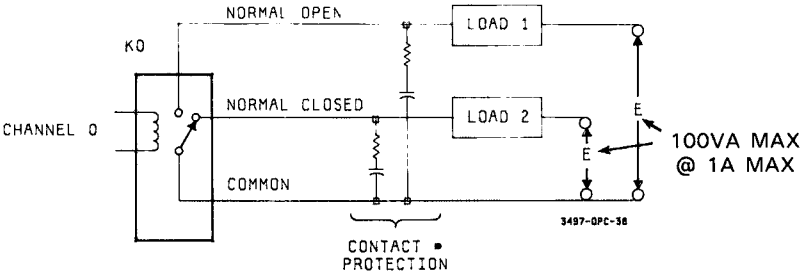
Figure 132. Option 110 - Wiring the Terminal Card

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EXAMPLE - ACTUATOR MODE VOLTAGE SWITCHING

This example shows a configuration in which load voltage E is switched from load #1 to load #2 when the relay in that channel is closed (E does not have to have the same value for both loads).

When the relay is open, the NC contact is connected to COMMON and when the relay is closed, the NO contact is connected to COMMON. If contact protection is required, it should be connected across both the NO and NC contacts, as close to the relay as possible.

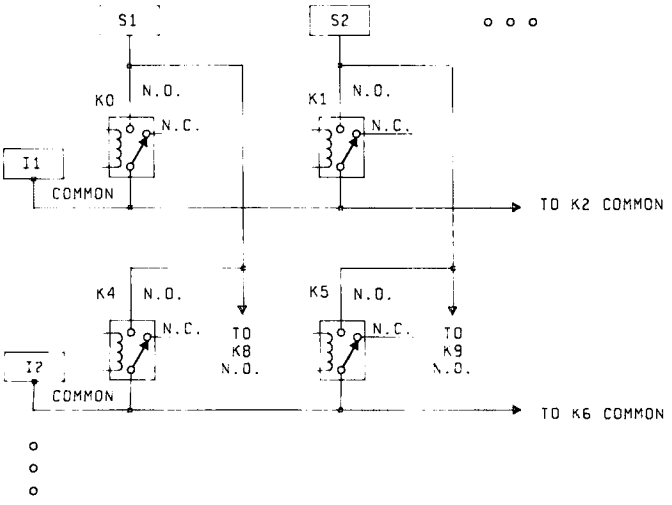


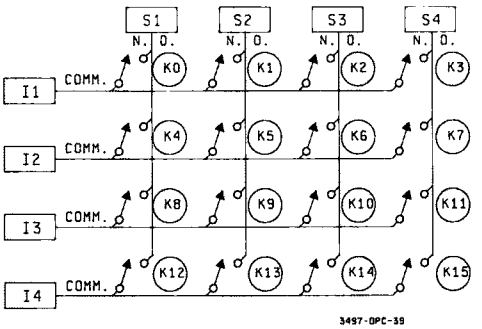
* CAUTION
FOR LOADS >12V OR CURRENT >65mA,
CONTACT PROTECTION MAY BE REQUIRED

EXAMPLE - ACTUATOR MODE MATRIX SWITCHING

Previously, we noted that the assembly could be wired as a 4 X 4 matrix switch to switch source inputs to measuring instruments. This example shows a setup in which the common terminals of relays K0-K3 are connected to I1 common, etc., and the NO contacts of relays K0, K4, K8 and K12 are connected together, etc.

To connect any source to any instrument, merely send DC slot#,chan# to close the appropriate relay. For example, to connect source S2 to instrument I3, send DC slot#,9 to close K9.





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Digital Output Mode

To configure the assembly for digital output mode, first decide whether to use the internal +5V pullup on the assembly or an external pullup. Figure 133 shows sample configurations for both internal and external pullup with 4.7K resistors used. You can select other values, but don't use less than 2K resistors.

With either internal or external pullup (assuming a +5V supply), the bit output is high (+5V) when the relay is closed (NO contact connected to COMMON) and low (0V) when the relay is opened (NC contact connected to COMMON). To connect internal pullup resistors, see Figure 129. For example, to connect +5V to channel 0 NO contact, connect a 4.7K resistor across the top contacts of J1, etc.

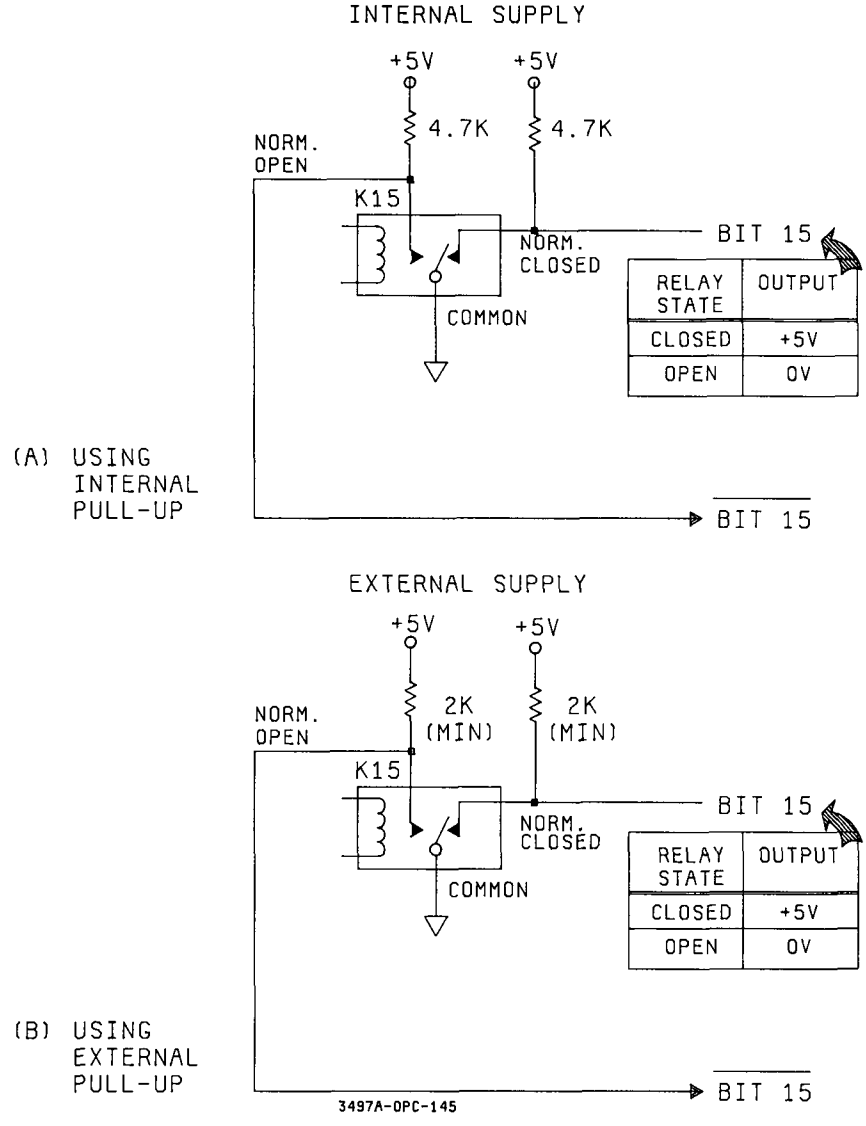


Figure 133. Option 110 - Digital Output Mode Example

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Handshake Modes

As factory configured, handshake mode is disabled for the actuator assembly. To set the handshake mode, set the handshake enable (HSM) jumper on the relay card to ON (see Figure 129). Then decide whether you want to use High Gate, High Flag or Low Gate, Low Flag operation and set the Gate and Flag jumpers as required. The jumpers are factory preset for High Gate (HGT), High Flag (HFL) operation.

A typical application may have the Gate negative (-) terminal connected to external circuit common and the Gate positive (+) terminal connected to a TTL input (via a 10K min value pullup resistor). The same application may have the Flag positive (+) line connected to external circuitry +5V supply and the Flag negative (-) line driven by a TTL device.

The Gate and Flag handshake lines operate with standard TTL logic levels and diode protection is used with both lines. When jumpers J1 through J4 on the terminal card are open, the lines are optically isolated from the relay card.

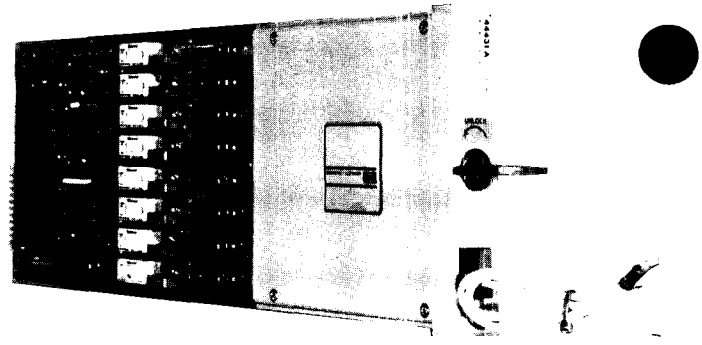
Gate, Flag Nonisolated Mode

As factory configured, the handshake lines are optically isolated. If you desire to have nonisolated operation, you can install appropriate pullups in positions J1 through J4 on the terminal card. See Figure 129 for location.

For example, connect a 10K ohm resistor across J1 and a short across J2 for nonisolated Gate line operation. Or, connect a short across J3 and a switch across J4 to activate Flag handshake when the switch is closed.

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OPTION 115



8 Channel High Voltage Actuator Assembly

INTRODUCTION

Option 115 is an 8 channel high voltage actuator which can be used to switch voltages up to 252 volts RMS and currents up to 2 amperes peak. Each channel consists of an individually fused and protected normally open dry relay. Contacts are opened only on command or on loss of power.

Each channel can be closed individually or any combination of channels can be closed simultaneously. In addition, the assembly contains a readback circuit so that the status of each channel can be determined. Because of its high voltage capability, you can use the high voltage actuator to switch power line voltages to small motors, alarm bells and lights, motor starters and solenoids.

Description

As shown in Figure 134, the high voltage actuator consists of an actuator card, a terminal card and a grounding strap for connecting the assembly to customer (earth) ground.

The actuator card consists of 8 identical channels. Each channel can be closed individually or any combination of channels on an assembly can be closed simultaneously. Each channel is individually fused (at 5 amps) and contains an RC network for relay contact protection.

At power on, all relays are open. After relays are closed, contacts are opened only on command or on loss of power. A maximum of 680 channels can be attached to actuator outputs using 3498A Extenders (five cards in the 3497A plus 10 cards in each of eight extenders).

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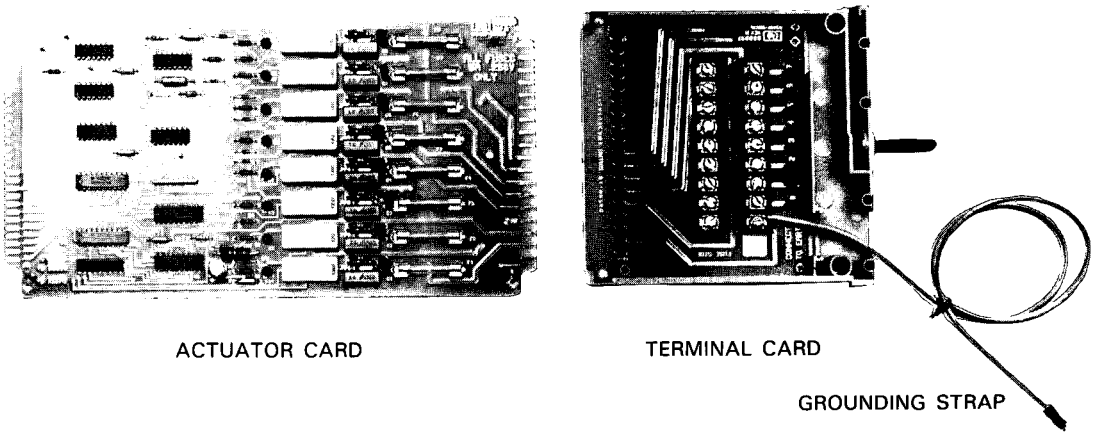


Figure 134. Option 115 - High Voltage Actuator Assembly

Simplified Operation

In typical applications (see Figure 135), actuator channels are connected to external circuits at the terminal card outputs. At power on, relays are opened which opens the load circuit. When a command is sent from the 3497A to the actuator, relays are closed for desired channels, closing the circuits for these loads.

Relay status (open or closed) is sent to the 3497A via readback circuits for front panel display and/or to the interface bus. The readback circuits are actuated in parallel with the load contacts, but are electrically separate. Thus, no load current flows through the readback contacts and they have no effect on load operation.

The actuator card has an RC relay contact protection circuit in each channel (R = 47 ohms, C = 0.047 μF). With the protection network, maximum leakage current at 250V and 60Hz is 6 mA RMS. The protection network can be removed from individual channels by removing appropriate jumpers on the actuator card. With no protection network, maximum leakage current is 1mA RMS at 250V and 60Hz. See RELAY CONTACT PROTECTION GUIDELINES for conditions under which the protection network may be removed.

Any combination of channels can be closed simultaneously. Programming and execution of a single or multiple channel closure or open requires 40 ms. Repetitive changes of the same actuator assembly require a minimum of 1.5 sec. Changes of the same assembly up to 25 per second can be jumper enabled (see CONFIGURING THE ASSEMBLY) but will result in decreased relay lifetime when switching full loads.

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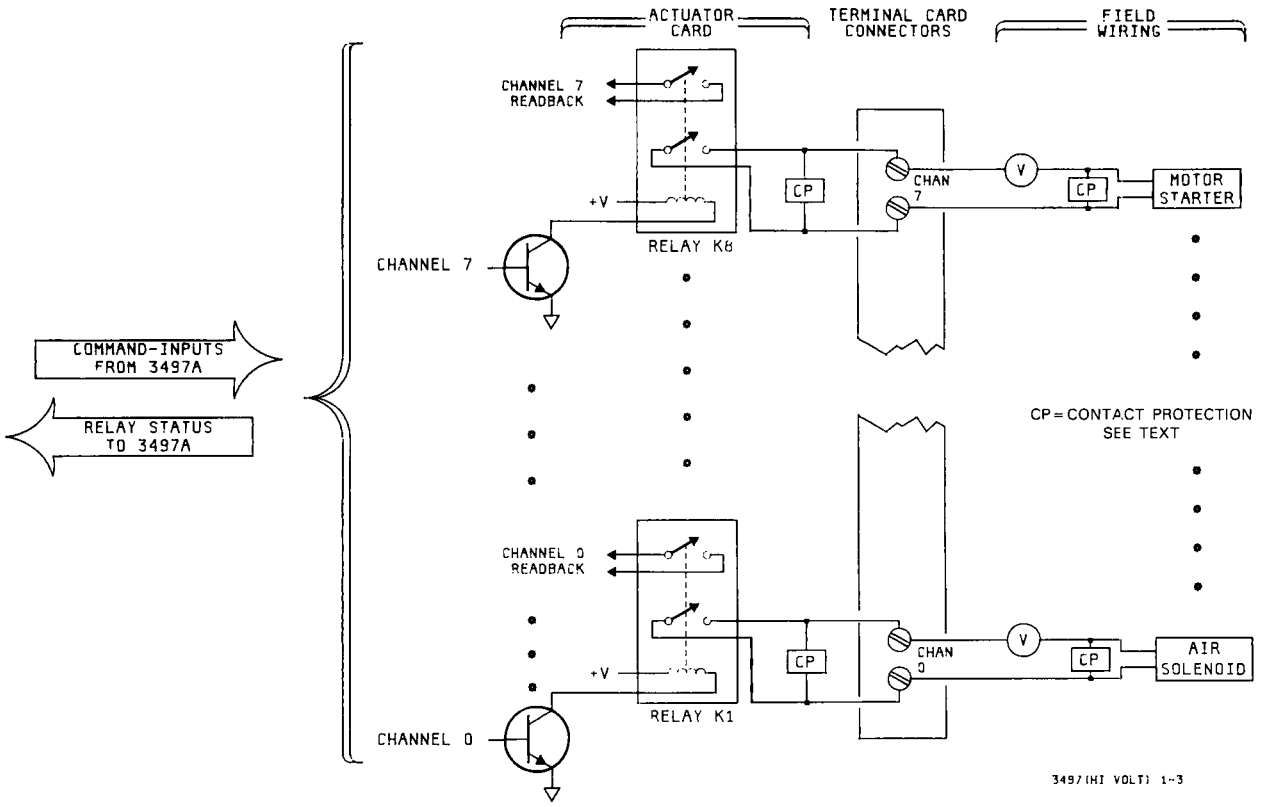


Figure 135. Option 115 - Typical Applications

Specifications

Specifications for the high voltage actuator assembly follow. Specifications are performance standards, or limits, against which the assembly may be tested.

OPTION 115
8 CHANNEL HIGH VOLTAGE ACTUATOR ASSEMBLY

Maximum Contact Ratings:

Voltage AC 252 VRMS	DC 48 VDC
Current AC 2 amps RMS	DC 2 ADC
Power AC 500 VA per chan.	DC 60 VA per chan.
Peak Surge Current: 10 Amps RMS	
Thermal Offset: $<20\mu V$	
Series Resistance: $<500\ m\Omega$	

Isolation Impedance: $>10^6$ ohms, input to output with no protection network

Isolation Voltage: >400 V peak input to output
>1500 VRMS to chassis

Minimum Input: 100 μA, 100 mV DC (for contact cleansing)

Relay Lifetime: $> 10^8$ at minimum load, $> 10^5$ at full load

Switching Speed: Any combination of channels can be closed simultaneously. Programming and execution of a single or multiple channel closure or open requires 40 ms. Repetitive changes of the same Option 115 assembly are limited to one every 1.5 seconds. Changes of the same assembly up to 25 a second can be jumper enabled but will result in decreased lifetime at full load.

Maximum Leakage Current:
(at 250 VRMS and 60 Hz)
1 mA RMS with no protection network
6 mA RMS with protection network

Protection Network: R = 47 Ohms ± 20%.
C = .047 μF ± 10%

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Manual Information

This manual contains configuration and control information for this assembly. For repair and/or service information, see 3497A Plug-In Assemblies/3498A Extender Service Manual. Assemblies manufactured after the publication date of this manual may have changes incorporated. In this case, a yellow MANUAL CHANGES sheet will accompany the manual. See Appendix B for details.

INSTALLING THE ASSEMBLY

WARNING

There is no operator installation or configuration for the high voltage actuator assembly. Only qualified, service-trained personnel should install or configure the assembly.

Initial Inspection

If you ordered the high voltage actuator assembly as Option 115, the assembly is already installed in the 3497A. If you ordered the assembly as Field Installation Kit 44431A, the shipping container should contain an actuator card, a terminal card and a grounding strap (see Figure 134).

For the Field Installation Kit, if either card is missing or if there is mechanical damage or defect to the cards, contact your nearest -hp- Sales/Service office. They will arrange for replacement or repair at -hp- option.

If there is any damage to the shipping carton, keep the carton and notify the carrier as well as -hp-. If you return a relay card or terminal card to -hp-, follow the shipping guidelines in Appendix B.

CAUTION

Before installing this assembly or connecting external circuits, a qualified, service-trained person should verify the electrical performance of the assembly by using the performance checks shown in the 3497A Plug-In Assemblies/3498A Extender Service Manual.

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How to Install the High Voltage Actuator Assembly

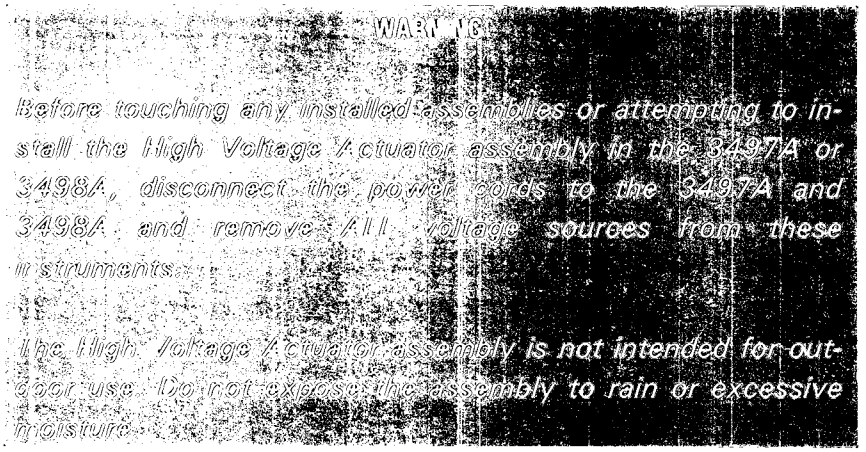


Figure 136 shows how to install the assembly in the 3497A and 3498A. After taking the steps shown in the WARNING and CAUTION notes above, plug the assembly into an unused slot in the 3497A or 3498A and turn the locking key clockwise to lock the assembly in place.

CONFIGURING THE ASSEMBLY

Before connecting loads to the actuator, you should consider three configuration requirements for the assembly: (1) Peak Voltage, Current and Volt-Amps; (2) Switching Speed and (3) Contact Protection.

Peak Voltage, Current and Volt-Amps

Do not connect loads which exceed the maximum ratings in the following table.

HIGH VOLTAGE ACTUATOR MAXIMUM RATINGS

	Voltage	Current	Volt-Amps
AC	250 VRMS	2A RMS	500 VA/Channel
DC	48V	2A	60 VA/Channel

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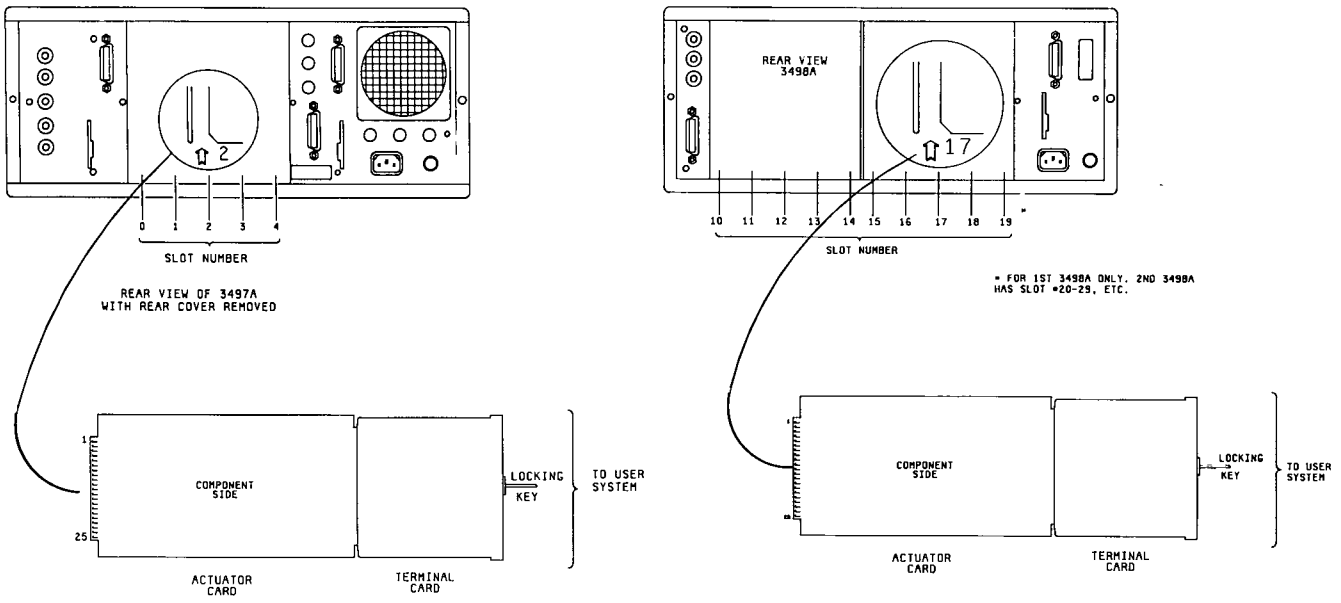


Figure 136. Option 115 - Installation in 3497A/3498A

Switching Speed

As factory configured, the actuator has a restriction on repetitive switching. Programming and execution of a single or multiple channel closure or open requires 40ms. However, repetitive changes of the same actuator assembly requires 1.5 sec between commands.

For example, if a command is sent at t=0 to an actuator in slot n (n = 0 to 7), the 3497A delays a subsequent command to this actuator for a minimum of 1.5 seconds. This restriction does not affect other assemblies and a command can be sent to an another slot immediately after the command to the slot n actuator.

If required for proper load operation, card operation can be changed to 25 operations/second (40 msec delay) by removing jumper JMP 9 on the actuator card. See Figure 137 for JMP 9 location. This change will allow high speed switching for all channels on the assembly.

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CAUTION

With JMP 9 removed, high speed switching of heavy loads may not allow relays to dissipate enough heat and may greatly reduce relay lifetime.

Relay Contact Protection

An RC relay contact protection network (R = 47 ohms, C = 0.047 μF) is installed on each channel of the actuator for two reasons. First, when an inductive load is switched, if contact protection is not used, an arc can form across the contacts. This arc ionizes some of the contact material and reduces relay lifetime. Second, the arc generates RF interference which could cause the 3497A logic to malfunction.

For these reasons, do NOT remove the internal RC contact protection network unless the load meets ALL the following requirements: (1) load is resistive (noninductive); (2) load draws less than 400mA (the minimum arcing current of the high voltage actuator relays) and (3) load uses a supply voltage less than 300 V peak (212 V RMS).

With the contact protection network installed, maximum leakage current at 250V RMS and 60 Hz is 6 mA. If this current is too high AND the load meets the criteria above, the RC network can be removed by removing jumpers (JMP1-JMP8) for the channel(s) desired. Note that jumper JMP1 is associated with channel 0, JMP 2 with channel 1, etc. See Figure 137 for JMP1-JMP8 locations.

Connecting Loads to the Actuator

WARNING

A 6mA current can exist on the actuator and terminal card channels, even when the relays are open. This is a shock hazard. Do not touch any installed assemblies in the 3497A or 3498A before disconnecting all input power sources.

CAUTION

Do not connect loads without adequate contact protection, especially highly inductive loads with supply voltages over 100VAC. See RELAY CONTACT PROTECTION GUIDELINES for contact protection network design suggestions.

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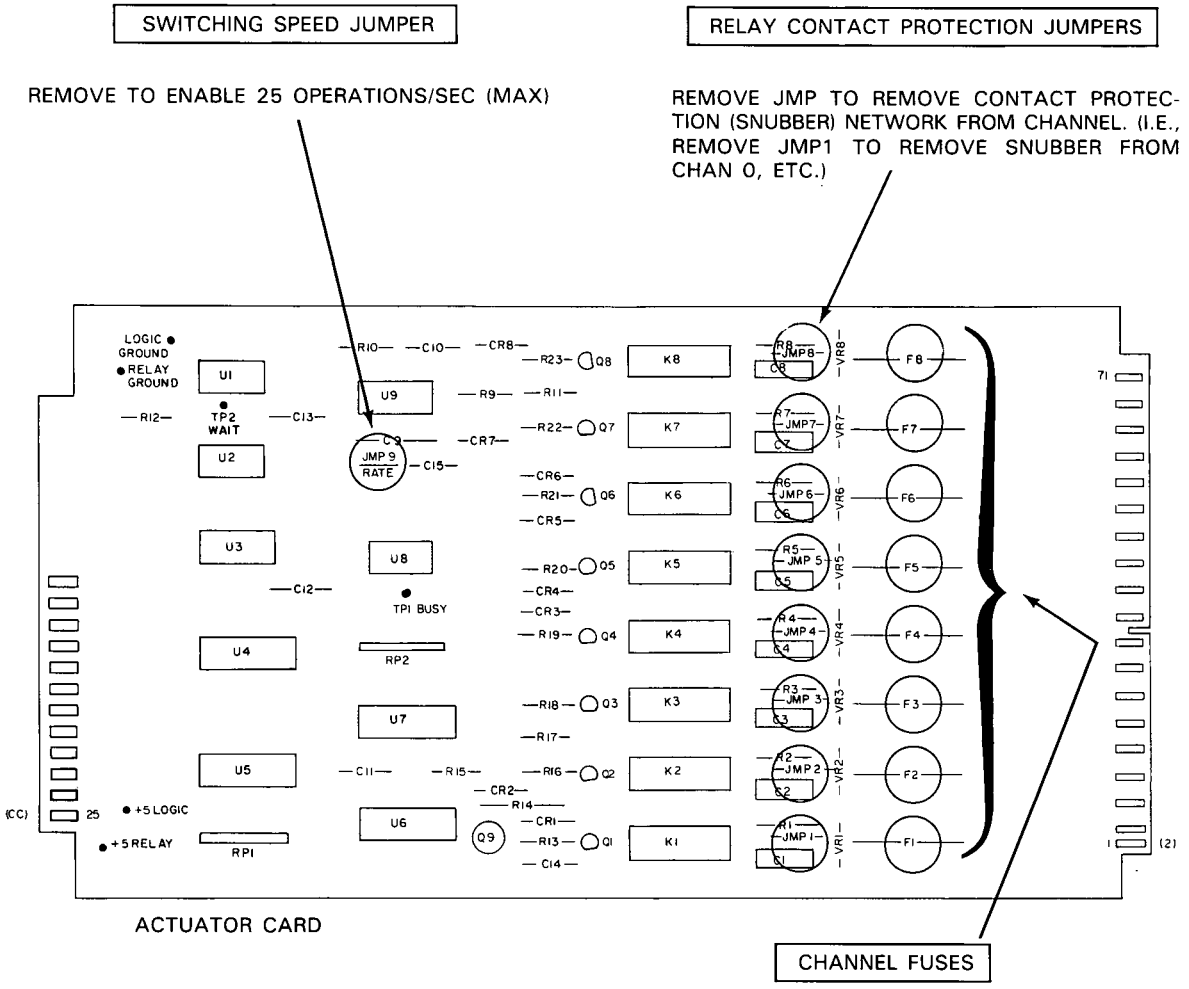


Figure 137. Option 115 - Relay Contact Protection/Speed Jumpers

After you have tested the actuator for proper operation and have established the assembly configuration for each load, connect the load lead-in wires to the terminal card connectors using the following steps. (The terminals can accommodate wire up to 12 gauge).

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CONNECTING LOADS TO TERMINAL CARD

1. Turn off power to the 3497A and 3498A. If there are other assemblies in the 3497A or 3498A, disconnect all voltage sources before touching ANY assemblies. Remove all voltage and current sources from the 3497A and 3498A input/output terminals.

2. If the actuator assembly is installed in the 3497A or 3498A, remove the protective cover from the rear panel and turn the locking key counterclockwise to unlock the actuator assembly.

3. Remove the actuator assembly from the 3497A or 3498A. Separate the actuator and terminal card and remove the terminal card cover by loosening the 4 screws at the corners of the terminal card.

4. If any load requires higher switching speeds, disconnect jumper JMP9 on the actuator card to allow higher speed switching to all channels of the actuator assembly.

5. If any load requires that the internal contact protection be removed, remove the appropriate jumper(s) for the channel(s) involved. A jumper must be removed for each channel involved. (i.e., if loads to be connected to channels 0 and 4 require that the RC network be removed, remove jumpers JMP1 and JMP5 only).

6. If loads require additional contact protection, connect the network across the load, as close to the load terminals as possible.

7. Disconnect all voltage sources from the lead-in wires. Then, connect leads to desired terminal card channels and connect the ground strap from the CONNECT TO EARTH terminal to the customer ground as shown in Figure 138.

8. Reconnect the actuator and terminal cards and reinsert the actuator assembly into the 3497A or 3498A and replace the protective cover. Then connect your user inputs to lead-in wires.

RELAY CONTACT PROTECTION GUIDELINES

As discussed, the high voltage actuator assembly has an internal RC relay contact protection network (snubber) across the relay contacts in each of the eight channels. For many loads, this snubber network provides adequate relay protection.

However, for inductive loads or loads with high inrush currents (such as lamps, motors and capacitive loads), additional protection across the load may be required. These guidelines show how to determine the type of contact protection required and some sample protection networks.

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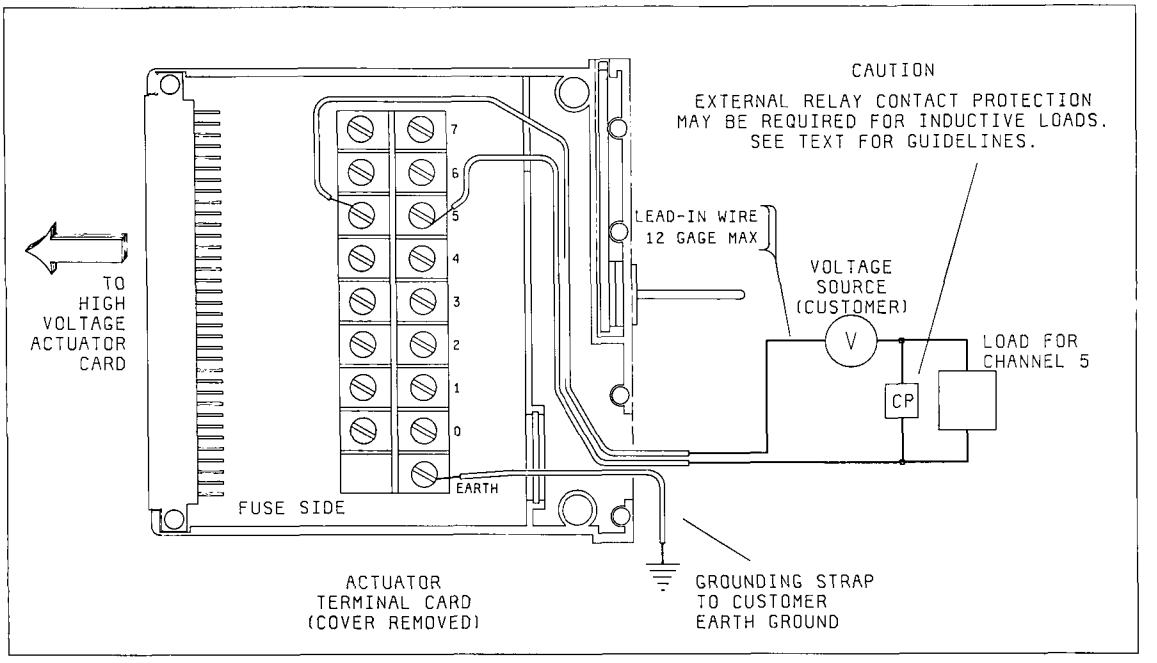


Figure 138. Option 115 - Connecting Loads to the Assembly

Contact Protection Fundamentals

Whenever relay contacts open or close, electrical breakdown can occur between the contacts which can cause high frequency radiation, voltage and current surges and physical contact damage. Two types of breakdown are important in switching contacts: glow discharge and metal-vapor or arc discharge.

Glow discharge occurs when the gas between the contacts is ionized. The voltage required to start a glow discharge between contacts depends on the gas, the gas pressure and the space between the contacts. After a glow discharge has been started, a slightly smaller voltage (about 300V in air) will keep the gas ionized. This voltage is approximately constant, regardless of the separation of the contacts.

An arc discharge starts whenever an energized contact is opened or closed. The minimum arcing voltage (Va) and arcing current (Ia) necessary to start an arc discharge depend on the type of relay contact material. Typical values range from Va = 9V, Ia = 400mA for gold alloy up to Va = 17.5V, Ia = 700 mA for platinum contacts. For the high voltage actuator, Ia = 400 mA.

After an arc discharge has been started, the arc must be broken as quickly as possible to minimize damage to the contacts. If it is not broken quickly, some material transfers from one contact to the other.

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To minimize arc and glow discharge damage, certain loads may require that external (customer-supplied) contact protection networks be added. For the high voltage actuator, two parameters are important in determining if a load requires external protection networks: contact voltage (Vc) and contact current (Io).

For the high voltage actuator, the relay manufacturer has specified that acceptable relay lifetime can be achieved by keeping the contact voltage below 353V peak (252V RMS) and limiting contact current to 4 amps. Using these parameters, relay lifetime will be shortened from 10^8 operations down to 10^5 operations when heavy loads are switched, but this is still considered acceptable lifetime for normal operation.

NOTE

Although peak contact current is specified as 4 amps, do not connect loads for which the steady-state current exceeds 2 amps RMS (2.82 amps peak)

How to Determine Contact Protection Requirements

To determine if a proposed load requires external contact protection, it is first necessary to calculate Vc and Io. Then, if Vc > 353V peak OR if Io > 4 amps, external networks will usually be required for inductive loads.

To determine Vc and Io for a proposed load, refer to the circuit in Figure 139 which shows a typical inductive load connected to a battery through a switch S. Io is the current flowing just as the switch is opened and C is the total circuit capacitance. Vc is the contact voltage which would be produced across the switch if no arc discharge or glow discharge breakdown occurs.

The total circuit capacitance C is composed of the parallel capacitances of the snubber (Cact) and the wiring (Cwiring). Because the wiring capacitance is usually difficult to accurately determine, we'll use Cwiring ~ 0.053 μF. Since the capacitance of the snubber is Cact = 0.047 μF, C = 0.1 μF is assumed for this analysis.

Since Io is the peak current flowing with the contact closed (which shunts Ract), we can compute Io from:

$Io = V/R_L$	where V	=	peak value of source voltage
	R_L	=	load resistance

Once we know Io, we can calculate the contact voltage Vc from:

$Vc = Io\sqrt{L/C}$	where L	=	load inductance
	C	=	total circuit capacitance

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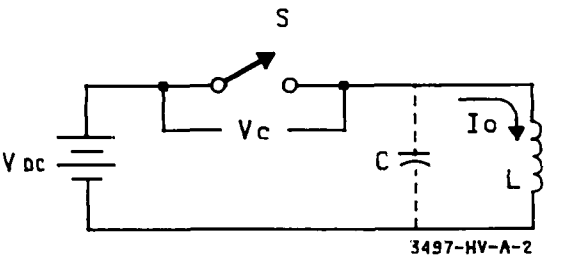


Figure 139. Option 115 - Contact Controlling Inductive Load

When Io and Vc are known, we can then determine load contact protection requirements, as summarized in the following chart where the types of loads are arbitrarily categorized as type 1, 2 or 3. Note that ONLY type 3 loads in which Vc > 353V peak OR Io > 4 amps require external contact protection (in addition to the snubber network).

If the proposed load meets type 3 requirements, see Designing External Contact Protection Networks for design samples. If the proposed load meets type 1 or 2 criteria, you don't have to add any networks and the actuator can be used as factory configured. To indicate the analysis method, some example solutions are shown for type 1, 2 and 3 loads. After you determine the type of load, refer to the appropriate section for details.

LOAD CONTACT PROTECTION CRITERIA

LOAD TYPE	PROTECTION REQUIRED	CRITERIA FOR LOAD	COMMENTS
1	NONE	Load is resistive, Vc < 353V peak AND Io < 400 mA.	Can remove the snubber network if required.
2	SNUBBER ONLY	Load is inductive, Vc < 353V peak AND Io < 4 A.	All three conditions must be met.
3	SNUBBER AND EXTERNAL NETWORK	Load is inductive, Vc > 353V peak OR Io > 4 A.	If either Vc or Io exceed limits, external network is required.

Note: Io = V(peak)/R_L and Vc = Io $\sqrt{L/C}$ where C = total circuit capacitance = 0.1 μF (assumed).

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Type 1 Load - No Contact Protection Required

No contact protection is required if the load is resistive (noninductive) and contact current Io is less than the minimum arcing current (Ia) of the relay contacts. For the high voltage actuator, since Ia = 400mA, no contact protection is required for resistive loads in which Io < 0.4A.

To compute Io, use Io = V/R_L (since L = 0 for a purely resistive circuit, Vc = 0). If Io < 400 mA, the load is type 1 and the internal snubber network can be removed if required. Note that Io is the peak current BEFORE the relay is opened, which shunts Ract so Ract is not used to calculate Io.

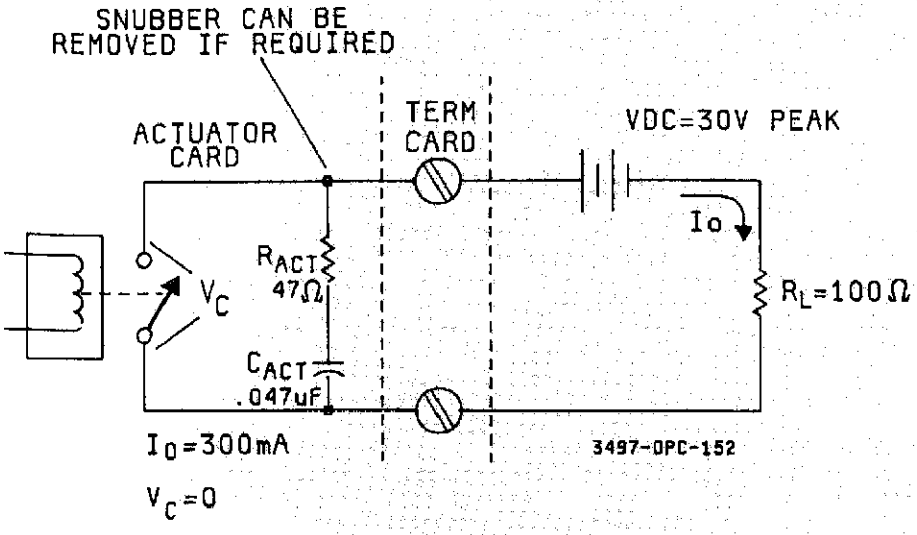
CAUTION

To protect against unwanted effects on the 3497A logic circuitry, do NOT remove the snubber network unless absolutely necessary.

EXAMPLE - TYPE 1 LOAD

This example shows a load which meets the criteria for a type 1 load. A purely resistive load of 100 ohms is connected to a channel of the actuator and a 30 volt DC power supply is used as the source voltage.

To determine that this a type 1 load, compute Io = V/R_L = 30/100 = 300 mA. For a resistive load, since L = 0, Vc = Io $\sqrt{L/C}$ = 0. Since Io = 300 mA is less than Ia = 400 mA, the load meets the criteria for type 1 and no contact protection is required. However, leave the snubber network in unless absolutely necessary to remove it.



TYPE 1 LOAD CONNECTED TO THE ACTUATOR

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Type 2 Load - Snubber Network Only Required

The majority of loads fall into type 2 where the snubber network in the actuator provides adequate contact protection. To determine if a proposed load meets the criteria for type 2, compute Io from $Io = V/R_L$. The total circuit capacitance C = Cact + Cwiring. Since we assumed Cwiring ~ 0.05 μF and since Cact = 0.047 μF, we'll use C = 0.1 μF and compute Vc from:

$$Vc = Io \sqrt{L/C} = Io \sqrt{L/0.1 \times 10^{-6}}$$

For an inductive load if Io < 4 A AND Vc < 353V peak, the snubber network provides adequate contact protection and no external network is required.

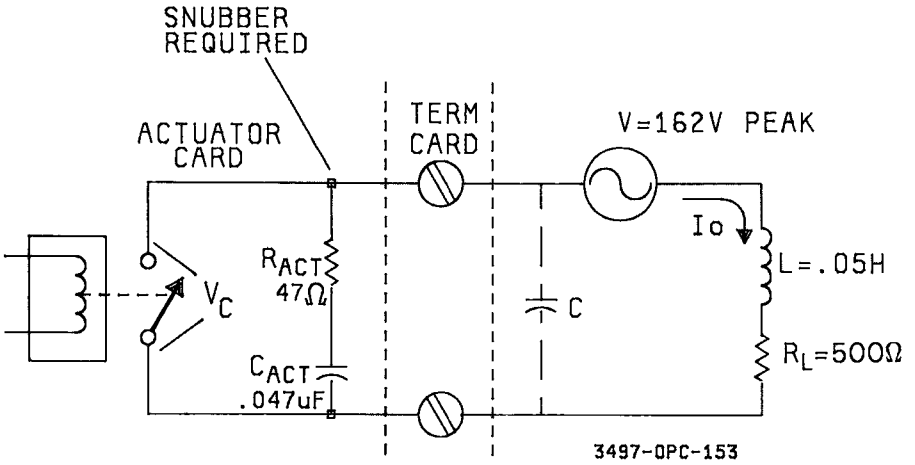
EXAMPLE - TYPE 2 LOAD

This example shows a load with R_L = 500 ohms, L = 0.05H and V = 115 volts (162 volts peak). For C = 0.1 μF,

$$Io = V/R_L = 162\ V/500\ ohms = 0.32\ A = \underline{320\ mA}$$

$$Vc = Io \sqrt{L/C} = (0.32) \sqrt{0.05/0.1 \times 10^{-6}} = \underline{226\ v}\ peak$$

Since this load meets all three criteria for type 2 loads (inductive, Io < 4 A and Vc < 353 V peak), the snubber network provides adequate protection and an external contact protection network is not needed.



I_O=320mA

V_C=226V PEAK (FOR C=.1uF)

TYPE 2 LOAD CONNECTED TO THE ACTUATOR

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Type 3 Load - External Contact Protection Required.

As mentioned, the vast majority of loads require no external contact protection network. However, for an inductive load if Io > 4 Amps OR Vc > 353V peak, contact protection across the load - in addition to the snubber network - is necessary.

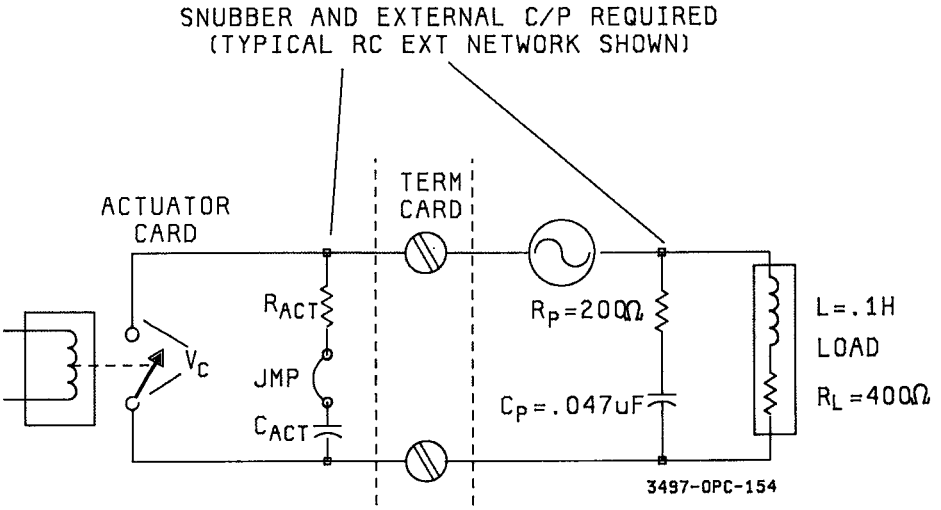
To determine if a load requires additional contact protection, first compute Io from $Io = V/R_L$ and compute $Vc = Io \sqrt{L/C}$. As with type 1 or 2 loads, we'll assume a total circuit capacitance of 0.1 μF.

EXAMPLE - TYPE 3 LOAD

This example shows a load with 0.1H inductance and 400 ohms resistance which is operated from a 120V AC line (170 volts peak). For this load, $Io = V/R_L = 170/400 = 0.425$ A. With C = 0.1 μF assumed:

$$Vc = (0.425)\sqrt{0.1/0.1 \times 10^{-6}} = 425 \text{ V peak.}$$

Since Io > 400 mA and Vc > 353 volts peak, this is a type 3 load and requires contact protection across the load contacts in addition to the snubber network. The next step is to design an appropriate contact protection network as shown in the following section.



CIRCUIT PARAMETERS IF EXTERNAL C/P NOT ADDED:
$I_O = .425A$
$V_C = 425V$ PEAK

TYPE 3 LOAD CONNECTED TO ACTUATOR

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Designing External Contact Protection Networks

After establishing that the load is type 3 and thus requires additional contact protection, the next step is to design an appropriate contact protection network. Although many types of networks can be used, guidelines for design of RC, diode and Zener diode protection networks are described.

RC Network

In designing RC networks, the protection resistor Rp is selected as a compromise between two values. The minimum value of Rp is determined by the maximum acceptable relay contact current (Io) of 4 amps. Thus, the mimimum value of Rp is V/4, where V is the peak value of the supply voltage. The maximum value is Rp is usually made equal to the load resistance, R_L. So, the limits on Rp are: $V/4 < Rp < R_L$.

To select a value for the protection network capacitor, Cp, first compute the total circuit capacitance C desired when the protection network is added. Then, Cp can be computed from C = Cact + Cwiring + Cp. For the high voltage actuator, C must be such that the peak voltage across the relay contacts does not exceed 353 V. To compute the value of C required, use:

$$C \geq (Io/353)^2 L$$

where L = load inductance, Io is the current through L just before the relay contacts open and C is the total circuit capacitance.

EXAMPLE - RC CONTACT PROTECTION NETWORK

For example, let's take another look at the type 3 load example discussed previously and see what the values of a typical RC protection network might be. The original circuit without contact protection is shown as (a). Recall that even with the snubber network the peak contact voltage Vc of 425 V exceeded 353V and thus additional contact protection was required.

To keep the maximum contact current below 4 amps, set Rp (min) = V/4 = 170/4 = 42.5 ohms. Set Rp (max) equal to the load resistance of 400 ohms. To keep the peak contact voltage below 353V peak, the total circuit capacitance C is calculated from:

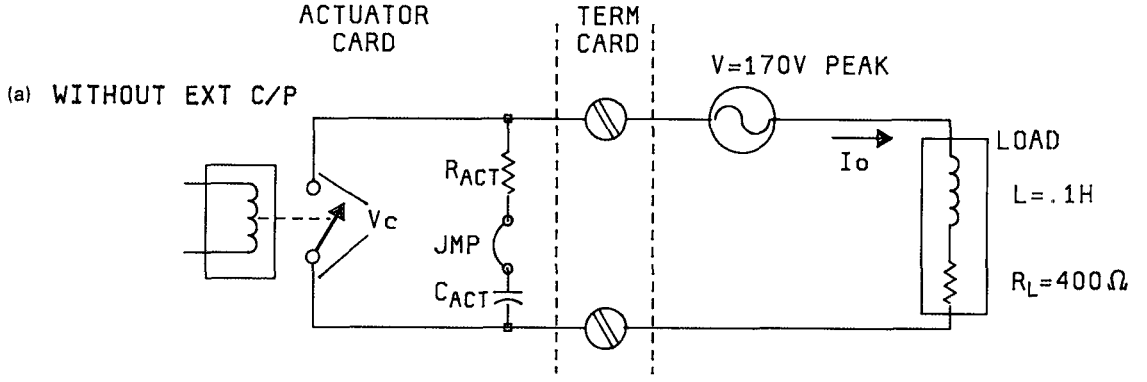
$$C \geq (Io/353)^2 (0.1) = (0.425/353)^2 (0.1) = 0.144\ \mu F$$

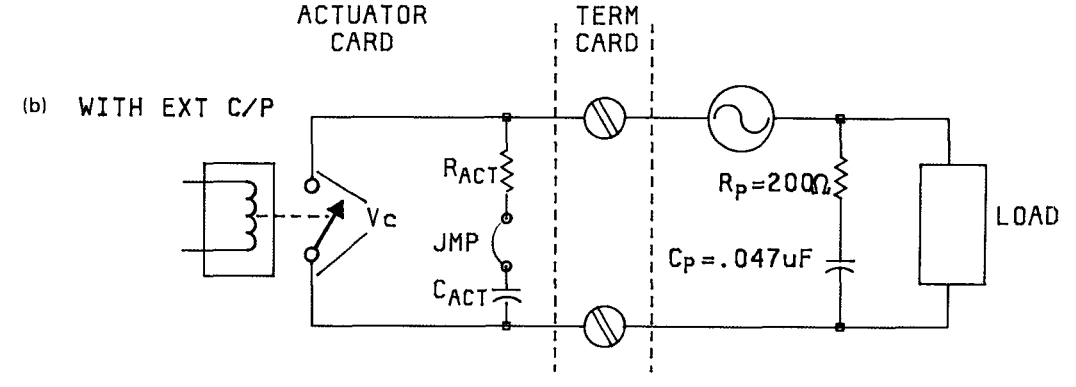
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If we assume that the wiring capacitance is about 0.05 μF, we can compute the required value of Cp from:

$$Cp = C - (Cact + Cwiring) = 0.144 - (0.047 + 0.05) = 0.047\ \mu F$$

Since Rp can vary between 42.5 ohms and 400 ohms, an appropriate network to be connected across the load is Rp = 200 ohms, Cp = 0.047μF as shown in (b). Naturally, other combinations within these ranges can be used as long as the peak current and contact voltage limits for the actuator are not exceeded.





3497-OPC-155

	I_O	V_C
WITHOUT EXT C/P	.425A	425V PEAK
WITH EXT C/P	1.3A	353V PEAK

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Diode Protection

The RC contact protection network can be used for both AC and DC sources. If a DC voltage source is used, diode protection as shown in Figure 140 can also be used. When the switch is closed, no current flows through the diode. When the contact opens, the inductor voltage polarity is opposite to the DC source polarity.

This forward biases the diode and limits the transient voltage across the inductor to a very low value (the forward voltage drop of the diode plus any IR drop in the diode). Therefore, the voltage drop across the opening contact is approximately equal to the supply voltage.

The diode circuit is very effective in suppressing transient voltages, but the time required for the inductor voltage to decay is longer than with the RC circuit, which may cause operational problems. For example, if the inductor is a relay, its release time is increased. A small resistor can be added in series with the diode which will decrease the release time but will give a higher transient voltage.

The diode used must have a voltage rating greater than the maximum supply voltage and the diode current rating must be greater than the maximum load current. If the relay contacts operate only occasionally, the peak current rating can be used. If the contacts operate several times per minute, use the continuous current rating of the diode.

Zener Diode Protection

Another protection network which can be used in the Zener Diode arrangement is also shown in Figure 140. The Zener network is useful for an AC supply or for circuits which must operate from two DC polarities, especially when the load current, Io, exceeds the minimum relay arcing current of 0.4 amps.

Each Zener must have a voltage breakdown rating greater than the peak value of the supply voltage and a current rating equal to or greater than the maximum load current. For example in the sample load described for RC contact protection networks above, if Zener Diodes were used instead of the RC network, the Zeners must have voltage ratings greater than 170 volts and current ratings greater than 0.5 amps.

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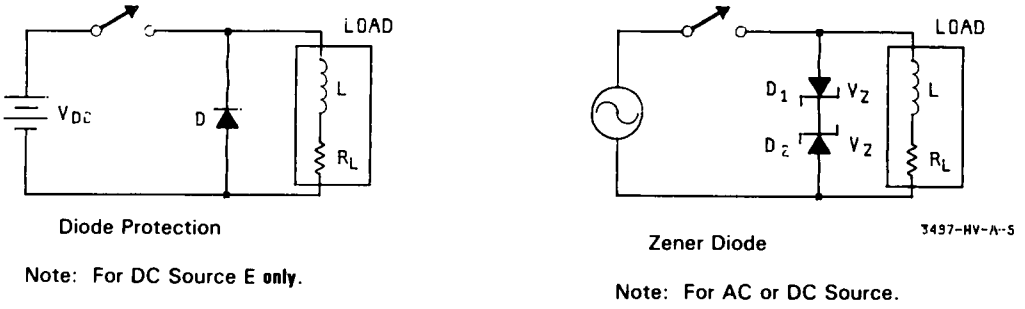
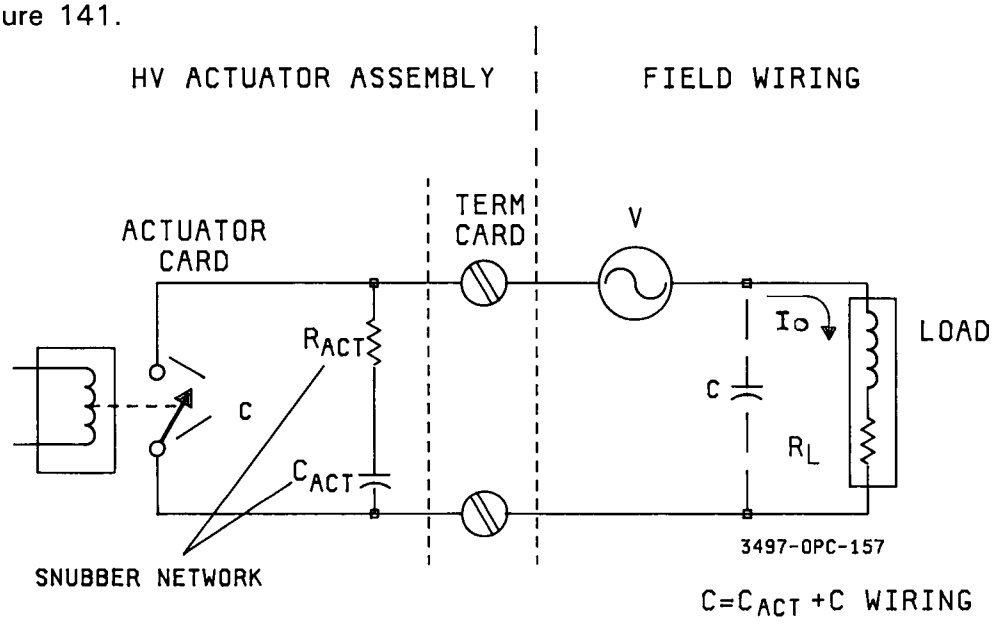


Figure 140. Option 115 - Diode/Zener Diode Protection Networks

For a summary of the three load types and definitions of circuit parameters, see Figure 141.



LOAD TYPES

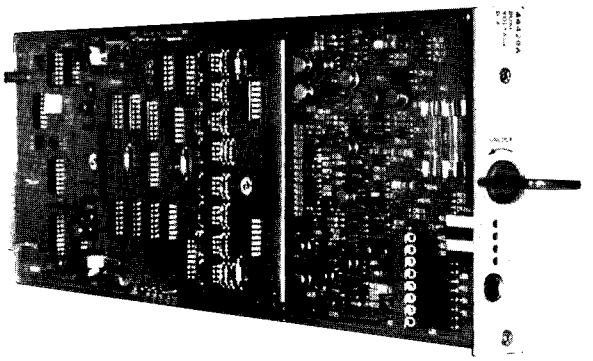
Type	Load	Circuit Parameters Io = V/R_L Vc = Io $\sqrt{L/C}$	Protection Required	Comments
1	Resistive	Io<Ia= 0.4A AND Vc<353V peak	None	All three conditions must be met for Snubber to be removed.
2	Inductive	Io<4A AND Vc<353V peak	Snubber Only	BOTH Io, Vc condition must be met for Snubber only.
3	Inductive	Io>4A OR Vc>353V peak	Snubber plus external network	If EITHER Io>4A,Vc> 353 peak, external network required.

Figure 141. Option 115 - Relay Contact Protection Summary

Reference: H. W. Ott: ''Noise Reduction Techniques in Electronic Systems'', John Wiley & Sons, Inc., New York, 1976.

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OPTION 120



Dual Output, 0 to ± 10 V Voltage D/A Converter

INTRODUCTION

The Option 120 assembly consists of two 0 to ± 10 volt programmable voltage sources (two channels). Each channel outputs a DC voltage with programmable range from -10.2375 volts to +10.2375 volts in increments of 2.5 millivolts.

Each voltage source is isolated from the other and from ground which breaks possible ground loops and permits control of devices floated up to 170 volts above ground. You can use the Option 120 assembly to provide a programmable test stimulus or to control voltage programmed devices like power supplies and VCOs.

Description

As shown in Figure 142, the Option 120 Voltage D/A Converter consists of a single board with a voltage source terminal block and a piggy-back board. The voltage source terminal block has connectors for HI, LO, +SENSE and - SENSE for each of two channels (channel 0 and channel 1).

The assembly is a programmable constant-voltage source which has an output range from -10.2375 V to +10.2375 V in 2.5 mV increments. This means that (for example), if you program the assembly to output +5.0000 V to your load, +5.0000 V will be available at the load, regardless of lead resistance or other voltage drops between the assembly and the load when the SENSE feature of the assembly is used.

Remote Sensing

The remote sensing feature of the voltage D/A converter is especially valuable when a constant, accurate voltage is required at the load. To see why this is so, consider the simplified circuit in Figure 143 (a) which does not use sense leads.

In this circuit, we've programmed the Option 120 assembly (which we'll call the VDAC from now on) to output +1.0000 V to a load resistance R_l. However, because of lead resistance R_l, the actual voltage to R_L is less than 1.0000 V because of the voltage drop across the leads.

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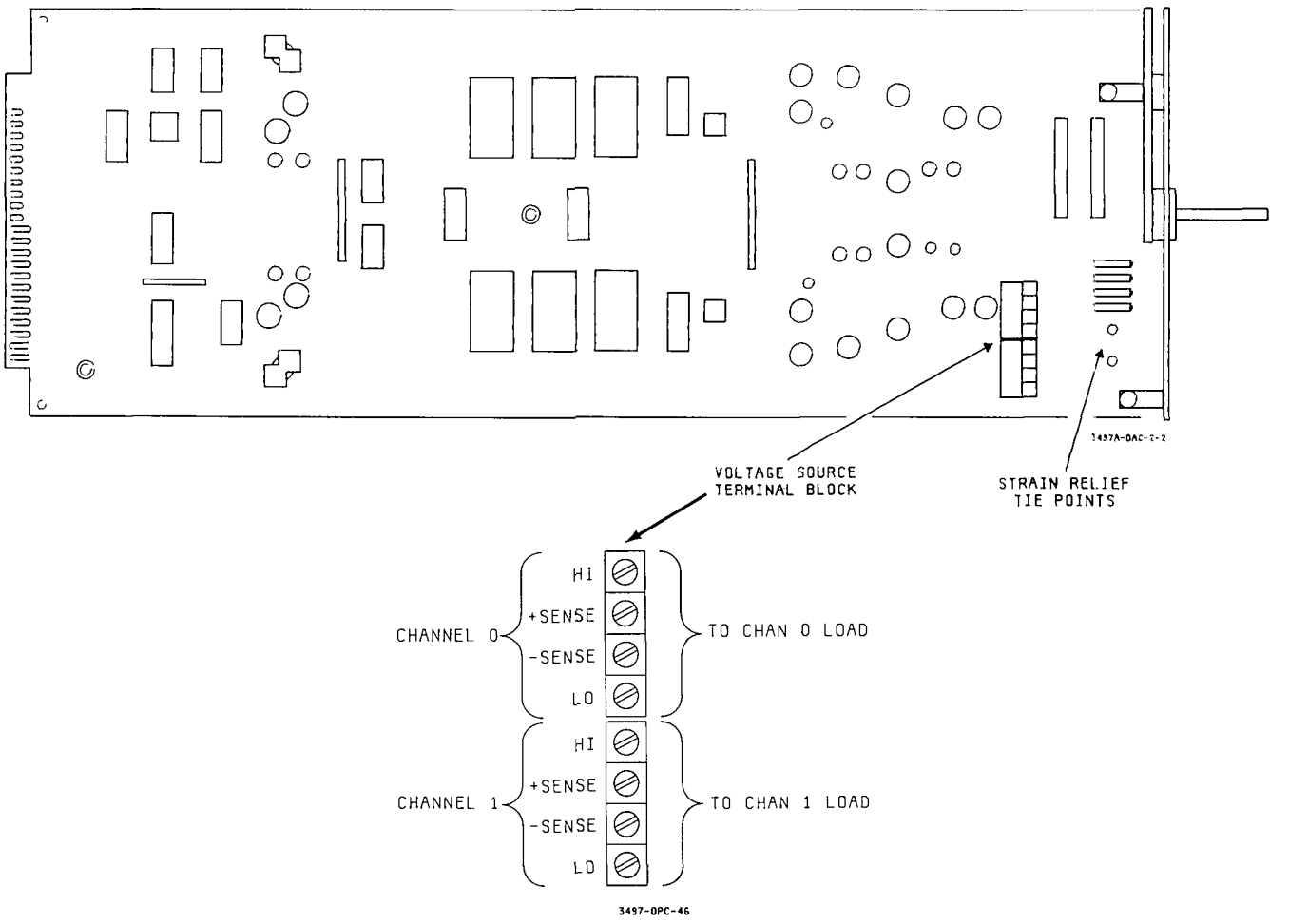


Figure 142. Option 10 - Dual Output, 0 to ± 10 V Voltage D/A Converter (VDAC)

Now, if we add remote sensing (+ SENSE and - SENSE leads) as shown in Figure 143 (b), we can measure the actual voltage across R_L. With remote sensing, the VDAC automatically adjusts the output to compensate for the IR drop in the leads. Thus, for example, if you now program the VDAC for a +1.0000V output and the IR drop in the leads is 0.1000 V, the VDAC will output +1.1000V so that the load voltage remains constant at +1.0000V.

Monotonicity

Another important feature of the VDAC is monotonicity. The VDAC has monotonicity over its operating range which guarantees that the output will never change in a direction different than that programmed. For example, if the VDAC is set for a 5 mV output and is then programmed for a 10 mV output, the actual output will not be less than 5 mV. Or, if the VDAC is set for 5 mV and is then programmed for a 2.5 mV output, the actual output will not be greater than 5 mV.

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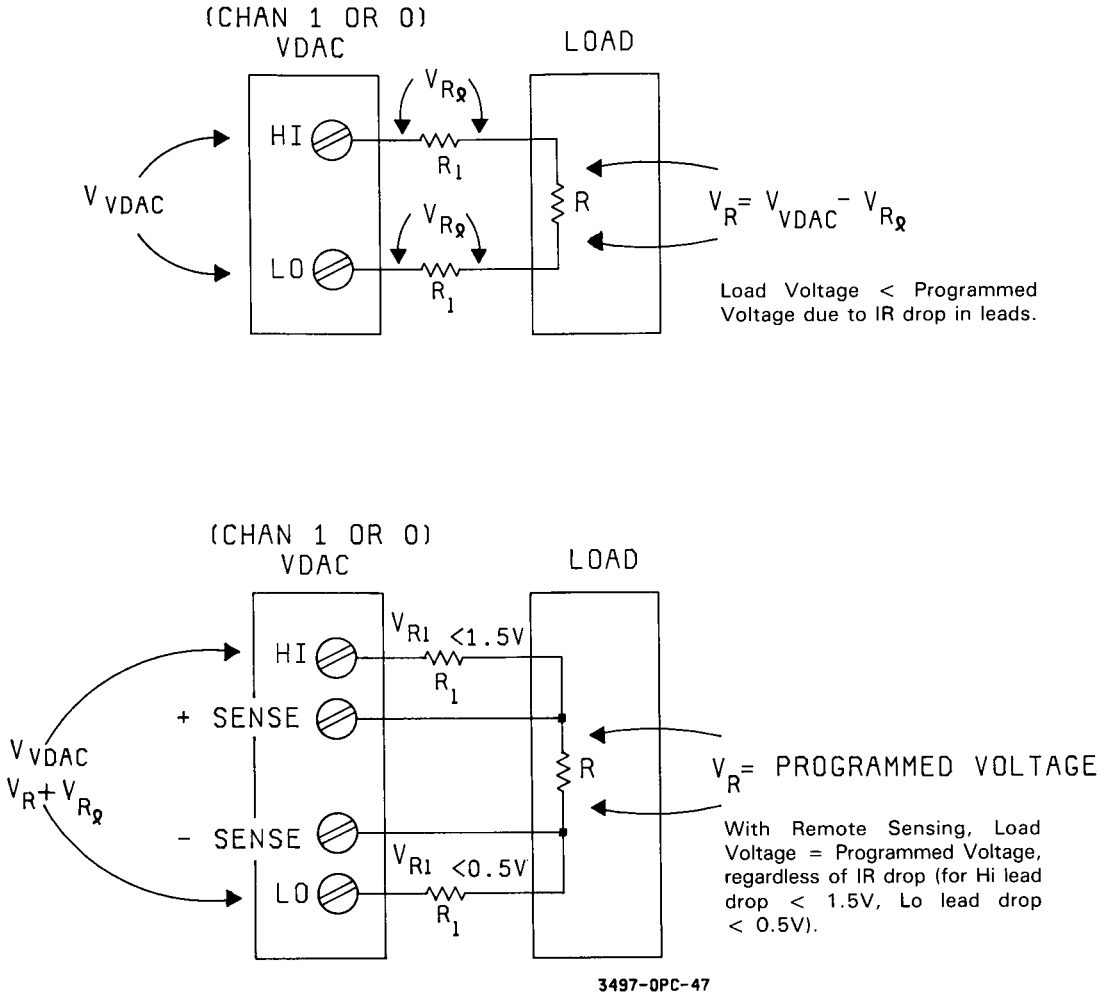


Figure 143. Option 120 · VDAC Remote Sensing

Simplified Operation

To operate the VDAC, only one command AO slot#,chan#,value is required. In this command, slot# refers to the slot in which the assembly is located, chan# refers to the channel to be output (0 or 1) and value is a digital value which programs the VDAC for a specific output. For example, AO 3,0,160 programs a VDAC in slot 3 to output +0.160 V from channel 0.

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Specifications

Specifications for the VDAC assembly follow. Specifications are performance standards, or limits, against which the assembly may be tested.

OPTION 120
DUAL OUTPUT, 0 TO ± 10V VOLTAGE D/A CONVERTER

Output: 13 bits including polarity

Least Significant Bits: 2.5 mV

Output Range: -10.2375 V to +10.2375 V

Accuracy: (Using remote sense)
24 Hours,
23°C ± 1°C: ± .024% of programmed value ± 2.8 mV
90 Days,
23°C ± 5°C: ± .070% of programmed value ± 4.0 mV

Temperature Coefficient: (0-18°C, 28-50°C) ± .0045% of programmed value/°C ± 100 μV/°C

Ripple and Noise: 2.5 mV rms, 20 Hz to 250 kHz into 1 kΩ

Load Regulation: 600 μV(0-15 mA)

Maximum Output Current: 15 mA (output within specifications)

Short Circuit Current: (maximum) 50 mA

Maximum Voltage Drop in Source Leads Using Remote Sense:
Low Lead: .5 V
High Lead: 1.5 V

Monotonicity: Over operating range (Monotonicity guarantees that the output will never change in a direction different than that programmed)

Settling and Programming Time: (Using 9835A Computer, 3497A DVM in Trigger Hold, R(L) = 1 kΩ, C(L) = 1000 pF)
To within ± 1.0 mV of final value: 100 ms

Isolation: > 170 V peak between any terminal and chassis

Protection: Can withstand indefinite open or short circuit

Manual Information

This manual contains configuration and control information for this assembly. For repair and/or service information, see 3497A Plug-In Assemblies/3498A Extender Service Manual. Assemblies manufactured after the publication date of this manual may have changes incorporated. In this case, a yellow MANUAL CHANGES sheet will accompany this manual. See Appendix B for details.

INSTALLING THE ASSEMBLY

WARNING

There is no operator installation or configuration for the Voltage D/A Converter assembly. Only qualified, service-trained personnel should install or configure the assembly.

Initial Inspection

If you ordered the Voltage D/A Converter assembly as Option 120, the assembly is already installed in the 3497A. If you ordered the assembly as Field Installation Kit 44429A, the shipping container should contain a converter card with a piggyback card attached (see Figure 142).

For the Field Installation Kit, if either card is missing or if there is mechanical damage or defect to the cards, contact your nearest -hp- Sales/Service office. They will arrange for replacement or repair at -hp- option.

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If there is any damage to the shipping carton, keep the carton and notify the carrier as well as -hp-. If you return an assembly to -hp-, follow the shipping guidelines in Appendix B.

CAUTION

Before installing this assembly or connecting external circuits, a qualified, service-trained person should verify the electrical performance of the assembly by using the performance checks shown in the 3497A Plug-In Assemblies/3498A Extender Service Manual.

How to Install the Voltage D/A Converter Assembly

WARNING

Before touching any installed assemblies or attempting to install the Voltage D/A Converter assembly in the 3497A or 3498A, disconnect the power cords to the 3497A and 3498A and remove ALL voltage sources from these instruments.

The Voltage D/A Converter assembly is not intended for outdoor use. Do not expose the assembly to rain or excessive moisture.

CAUTION

Use clean handling techniques when installing, removing or reconfiguring the assembly. Handle the voltage card by its edges and do not subject the components to static discharges or excessive voltages.

Figure 144 shows how to install the assembly in the 3497A and 3498A. After taking the steps shown in the WARNING and CAUTION notes above, plug the assembly into an unused slot in the 3497A or 3498A and turn the locking key clockwise to lock the assembly in place.

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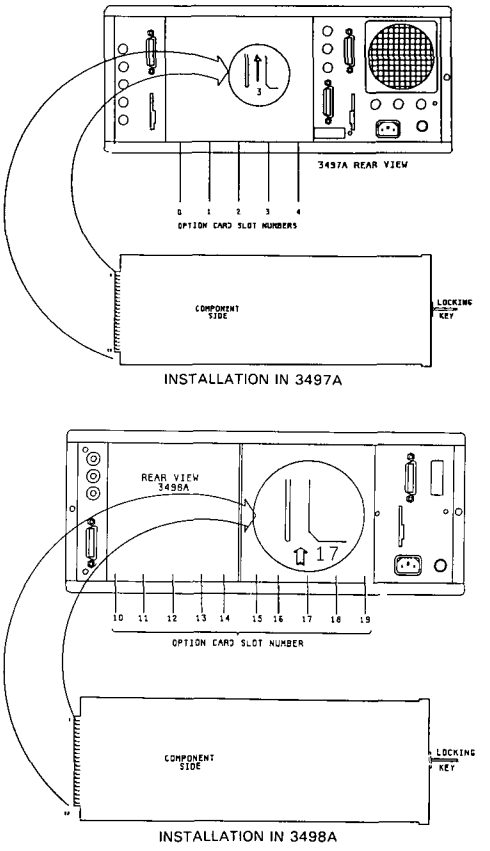


Figure 144. Option 120 - Installation in 3497A/3498A

CONFIGURING THE ASSEMBLY

To configure the assembly for operation, simply connect the HI and LO load connectors and the +SENSE and - SENSE connectors (if desired) on the assembly to your load. The VDAC has connectors for two optically isolated channels, so you can provide inputs to two separate loads simultaneously.

This section shows how to connect the assembly to a typical resistive load. Since the channels are optically isolated, you can control devices which are floated up to 170 volts above ground. To begin, we'll list some connection considerations.

Connection Considerations

WARNING

To avoid personnel injury or equipment damage, disconnect the 3497A and 3498A line cords and ALL voltage sources from these instruments before installing or removing assemblies. External circuits connected to the Option 120 assembly must not be floated more than 170 volts above ground.

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Before connecting loads to the assembly, it is important to select proper wire type, size and length for your application and to properly connect the SENSE lines for accurate load voltages. Even the shortest leads can degrade the VDAC performance because of the IR drop in the leads.

For example, approximately 15 feet of 22 AWG wire has a resistance of 0.242 ohms. At the full (15 mA) output of the VDAC, this results in a 3.63 mV voltage drop which is more than 1 LSB. If this drop is not compensated, it results in an error in the load voltage.

For this reason, it is important to connect the SENSE leads to the load so that the VDAC output can be automatically adjusted to compensate for errors due to lead resistance. Some considerations for connecting the SENSE leads and a wire chart are shown in Figure 145.

The SENSE leads (+SENSE and - SENSE) should be applied as close as possible to the point where the voltage is to be measured. Also, the voltage drop in the HI source line should not exceed 1.5V and the voltage drop in the LO source line should not exceed 0.5V. To achieve specified voltage regulation, the HI lead resistance should not exceed 100 ohms and the LO lead resistance should not exceed 50 ohms.

Although the load leads are shown as straight lines (for clarity), some immunity from stray magnetic field pickup can be achieved by twisting each pair of HI (+) and LO (-) leads.

NOTE

If sensing is not used, +SENSE should be connected to HI and -SENSE should be connected to LO at the terminal block. If this is not done, voltage output errors may occur.

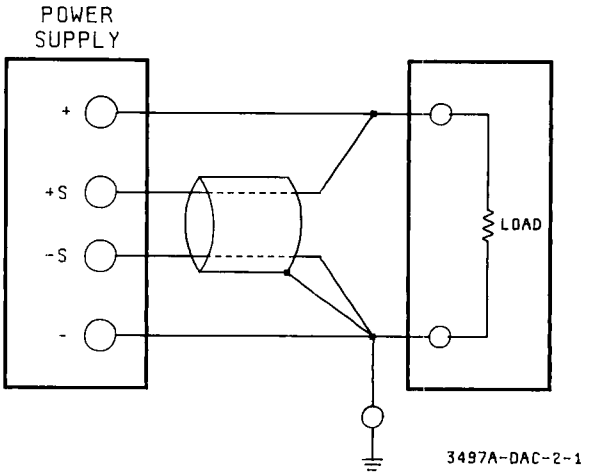
If a shield is used for the SENSE lines, do not use the shield as one of the sensing conductors. Also, one end of the shield should be tied to the low side of the load and the other end left unconnected. In general, it is desirable to connect the shield as close as posssible to the low side of the load, as shown in Figure 145.

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AWG (B&S) Wire Size	Annealed Copper Resistance at 20°C milliohms/ft.	Nominal Current Rating (amps)*
22	16.1	5
20	10.2	7
18	6.39	10
16	4.02	13
14	2.53	20
12	1.59	25
10	0.999	40
8	0.626	55
6	0.395	80
4	0.249	105
2	0.156	140
0	0.0993	195
00	0.0779	260

* Single Conductor in Free Air at 30°C with rubber or thermoplastic insulation.

WIRE CHART



Remote Sensing Connnections.

One end of the shield should be connected to a ground reference and the other end should be left unconnected. In nearly all cases this method of connecting the sensing shield will minimize ripple at the load terminals. However, in rare cases a different ground return point of this shield is preferable - it is important in such cases to experimentally verify that this relative advantage applies under all possible combinations of load and line.

Figure 145. Option 120 - Connection Considerations

Connecting Loads to the VDAC

After deciding on the wire size, type and length, to connect loads to the VDAC, route the wires as shown in Figure 146 which shows connections for both channel 0 and channel 1. Then, install the assembly in a desired slot in the 3497A or 3498A. If strain relief for lead wires is needed, use a tie wrap to secure the wires to the board at the strain relief points (see Figure 146).

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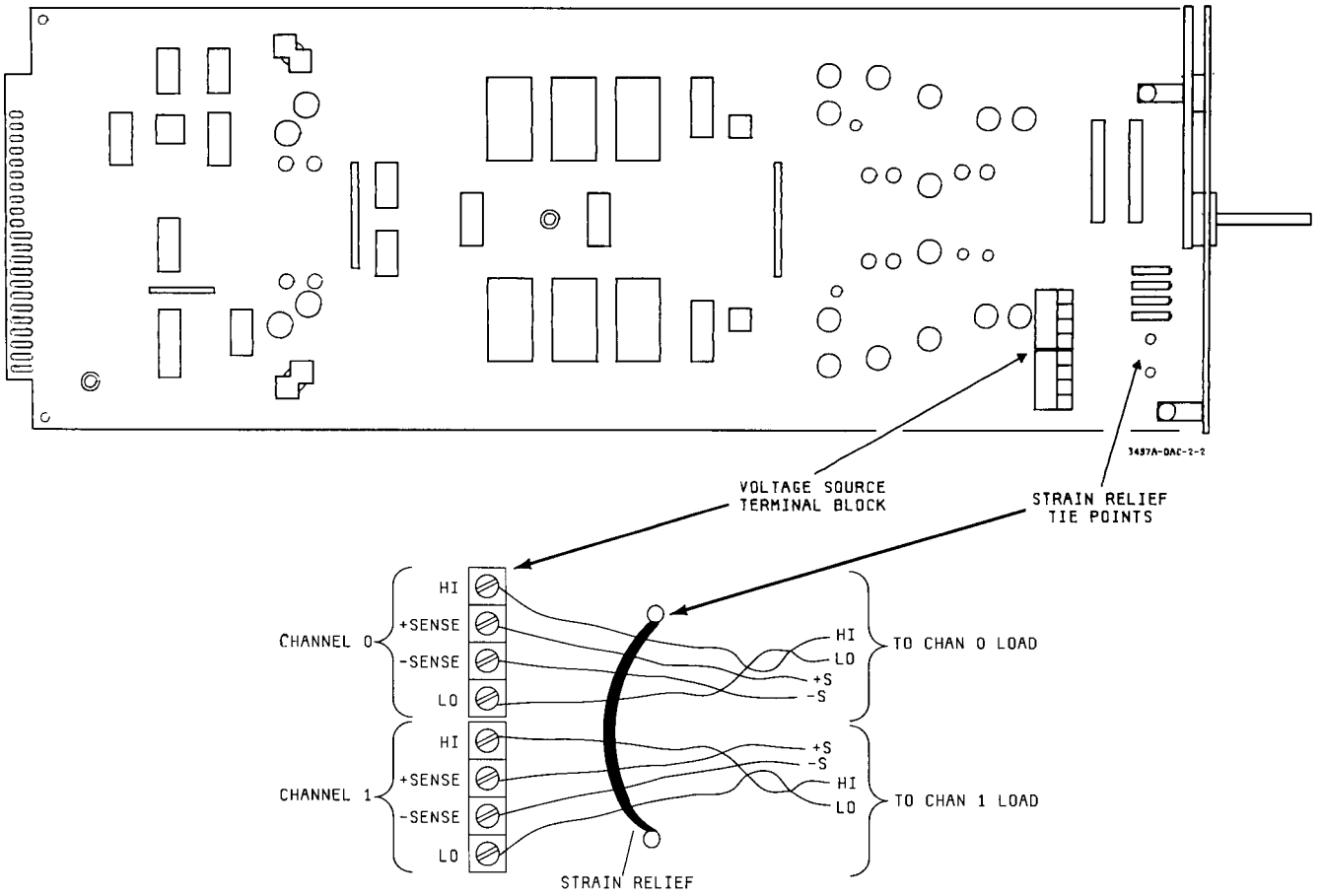
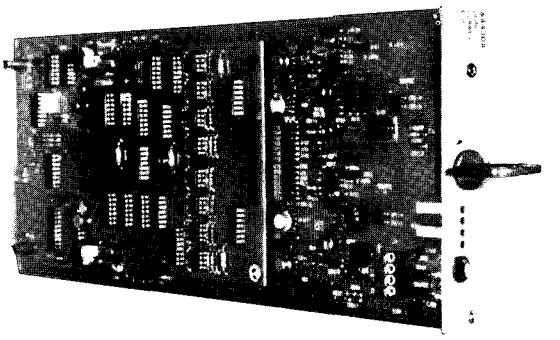


Figure 146. Option 120 - Connecting Loads to the VDAC

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OPTION 130



Dual Output, 0-20 mA/ 4-20 mA Current D/A Converter

INTRODUCTION

The Option 130 assembly provides two 0 - 20 mA or 4 - 20 mA programmable current sources. Each channel outputs a DC current with programmable range from 0 to 20.475 mA in 5 μA increments (for the 0-20 mA range) or from 4 to 20.380 mA in 4 μA increments (for the 4-20 mA range).

Each current source is isolated from the other and from ground which breaks possible ground loops and permits control of devices floated up to 170 volts above ground. Each source can be configured to operate in the 0-20 mA or 4-20 mA range.

Option 130 assemblies, especially when the 4 - 20 mA range is used, can be used as transmitters in an industrial current loops. Each output will drive an industrial current loop with up to 600 ohms of total loop resistance.

Description

As shown in Figure 147, the Option 130 Current D/A Converter consists of a single board with a current source terminal block and a piggy-back board. The current source terminal block has connectors for a current source (SOURCE) and current sink (SINK) for each of two channels (channel 0 and channel 1).

The assembly is a programmable constant current source which has an output range from 0 to 20.475 mA (in the 0-20 mA range) or from 4 to 20.380 mA (for the 4-20 mA range). For example, if you program the assembly to output 10.000 mA to the load, 10.000 mA will be available at the load (regardless of load voltage drop) as long as the assembly compliance voltage of 12V is not exceeded.

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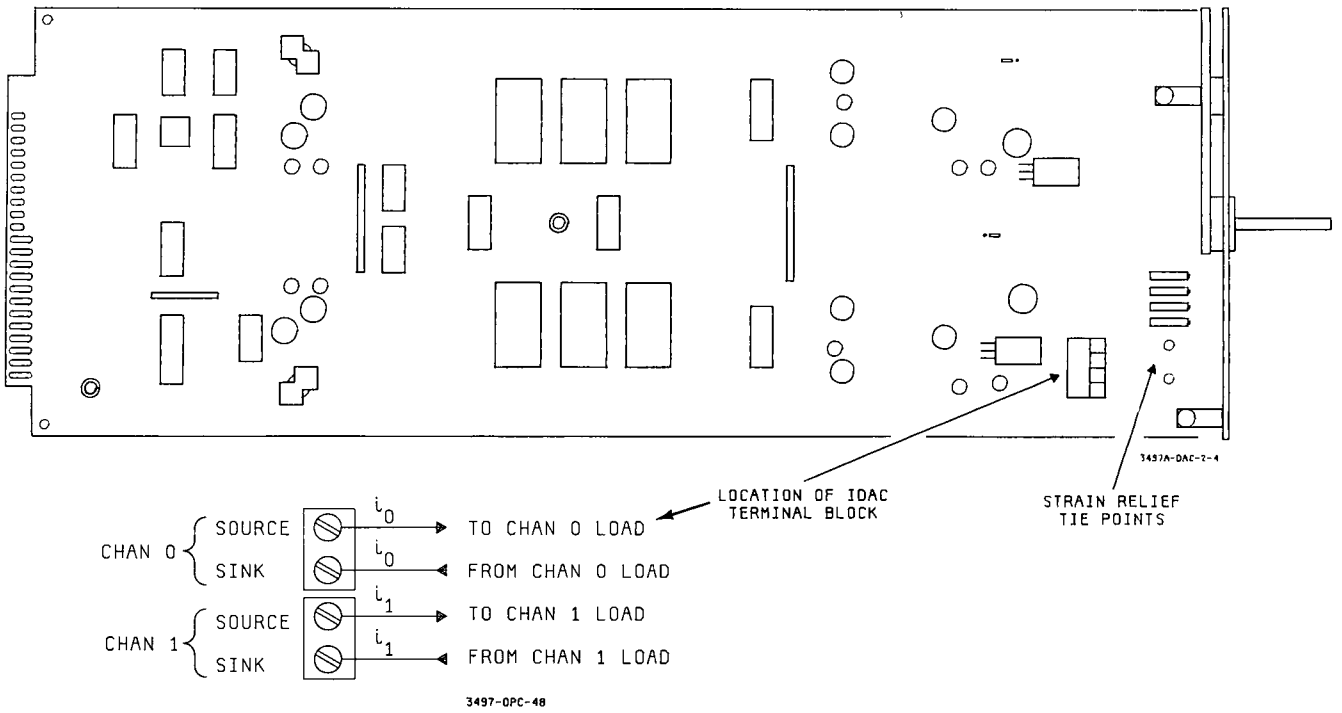


Figure 147. Option 130 - Current D/A Converter (IDAC)

Compliance Voltage

The Option 130 assembly (which we'll call the IDAC from now on) is a constant current source for 0-20 mA range, as long as the compliance voltage of 12 volts is not exceeded. As shown in Figure 148, this means that the total voltage between the SOURCE and SINK terminals must not exceed 12 volts for the IDAC to supply constant current in the 0 - 20 mA range.

Since the compliance voltage equals the total circuit resistance times the output current, for a 20 mA output the maximum load resistance for the IDAC is 600 ohms and may be less if lead resistance is relatively high.

For example, in Figure 148 if R_l = lead resistance = 0.5 ohms in each lead and load resistance R_L = 600 ohms, the total circuit resistance = 601 ohms. Thus, compliance voltage for 20 mA is 12.2V which exceeds the IDAC limit.

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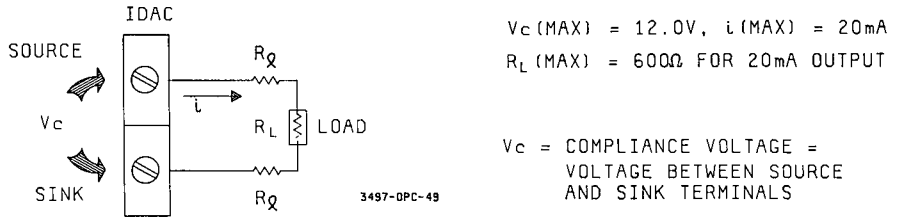


Figure 148. Option 130 - IDAC Compliance Voltage

Monotonicity

Another important feature of the IDAC is monotonicity. The IDAC has monotonicity over its operating range which guarantees that the output will never change in a direction different than that programmed. For example, if the IDAC is set for a 5 mA output and is then programmed for a 10 mA output, the actual output will not be less than 5 mA. Or, if the IDAC is set for 5 mA and is then programmed for a 2 mA output, the actual output will not be greater than 5 mA.

Simplified Operation

To operate the IDAC, only one command [AO slot#,chan#,value] is required. In this command, slot# refers to the slot in which the assembly is located, chan# refers to the channel to be output (0 or 1) and value is a digital value which programs the IDAC for a specific output, depending on the range (0-20 mA or 4 - 20 mA) selected.

For example, AO slot#,chan#,160 sets the IDAC for a constant current output of 4.256 mA for the 4-20 mA range, but sets the IDAC for an output of 0.160 mA in the 0-20 mA range. The IDAC is factory-set for the 0-20 mA range but can be jumper-enabled for 4-20 mA range on either or both channel 0 or 1.

Specifications

Specifications for the IDAC assembly follow. Specifications are performance standards, or limits, against which the assembly may be tested.

OPTION 130
DUAL OUTPUT, 0-10 mA/4-20 mA CURRENT D/A CONVERTER

Analog Output: 12 bits

Least Significant Bit: 5 μA (0-20 mA range)
4 μA (4-20 mA range)

Output Current Range: 0 to 20.475 mA or 4 to 20.380 mA (each source jumper selectable)

Accuracy:
24 Hours,
23°C ± 1°C: ± .03% of programmed value ± 6.5 μA
90 Days,
23°C ± 5°C: ± 0.07% of programmed value ± 10.0 μA

Temperature Coefficient (0-18°C, 28-50°C):
± .0075%/°C of programmed value ± 650 nA/°C

Ripple and Noise: 5 μA rms, 20 Hz to 250 kHz into 100 ohms

Compliance Voltage: 12.0 volts

Load Regulation: ± 2.0 μA (2.0 V to 12.0 V)

Monotonicity: Over operating range (Monotonicity guarantees that the output will never change in a direction different than that programmed)

Settling and Programming Time: (Using 9835A Computer, 3497A DVM in Trigger Hold, R(L) = 100 Ω)
To within ± 3.0 μA of final vlaue: 100 ms

Isolation Voltage: > 170 V peak between any terminal and chassis

Protection: Can withstand indefinite open or short circuit

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Manual Information

This manual contains configuration and control information for this assembly. For repair and/or service information, see 3497A Plug-In Assemblies/3498A Extender Service Manual. Assemblies manufactured after the publication date of this manual may have changes incorporated. In this case, a yellow MANUAL CHANGES sheet will accompany this manual. See Appendix B for details.

INSTALLING THE ASSEMBLY

WARNING

There is no operator installation or configuration for the Current D/A Converter assembly. Only qualified, service-trained personnel should install or configure the assembly.

Initial Inspection

If you ordered the Current D/A Converter assembly as Option 130, the assembly is already installed in the 3497A. If you ordered the assembly as Field Installation Kit 44430A, the shipping container should contain a converter card with a piggy-back card attached (see Figure 147).

For the Field Installation Kit, if either card is missing or if there is mechanical damage or defect to the cards, contact your nearest -hp- Sales/Service office. They will arrange for replacement or repair at -hp- option.

If there is any damage to the shipping carton, keep the carton and notify the carrier as well as -hp-. If you return an assembly to -hp-, follow the shipping guidelines in Appendix B.

CAUTION

Before installing this assembly or connecting external circuits, a qualified, service-trained person should verify the electrical performance of the assembly by using the performance tests shown in the 3497A Plug-In Assemblies/3498A Extender Service Manual.

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How to Install the Current D/A Converter Assembly

WARNING

Before touching any installed assemblies or attempting to install the Current D/A Converter assembly in the 3497A or 3498A, disconnect the power cords to the 3497A and 3498A and remove ALL voltage sources from these instruments.

The Current D/A Converter assembly is not intended for outdoor use. Do not expose the assembly to rain or excessive moisture.

CAUTION

Use clean handling techniques when installing, removing or reconfiguring the assembly. Handle the cards by the edges and do not subject the components to static discharges or excessive voltages.

Figure 149 shows how to install the assembly in the 3497A and 3498A. After taking the steps shown in the WARNING and CAUTION notes above, plug the assembly into an unused slot in the 3497A or 3498A and turn the locking key clockwise to lock the assembly in place.

CONFIGURING THE ASSEMBLY

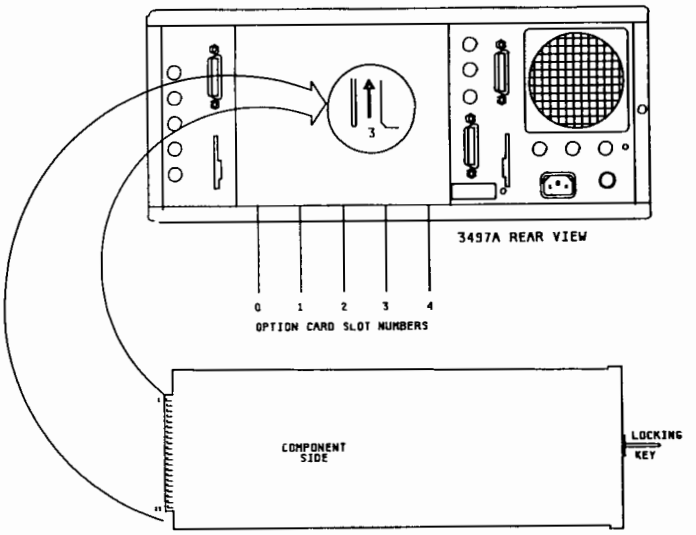
To configure the IDAC for operation, simply connect the SOURCE and SINK connectors on the assembly to your load. The IDAC has connectors for two optically isolated channels, so you can provide inputs to two separate loads simultaneously.

This section shows how to connect the assembly to a typical resistive load. Since the channels are optically isolated, you can control devices which are floated up to 170 volts above ground. To begin, let's discuss some load considerations.

WARNING

To avoid personnel injury or equipment damage, disconnect the 3497A and 3498A line cords and ALL voltage sources from these instruments before installing or removing assemblies. External circuits connected to the IDAC must not be floated more than 170 volts above ground.

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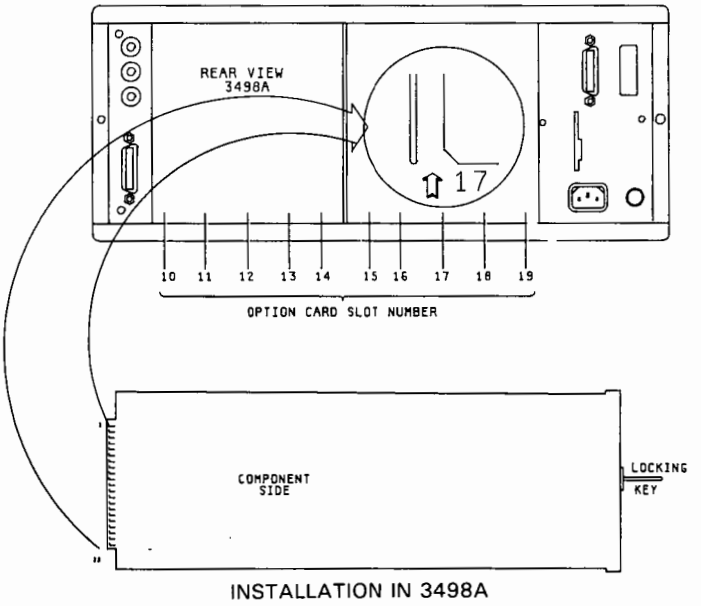


Figure 149. Option 130 - Installation in 3497A/3498A

LOAD CONSIDERATIONS

Before connecting loads to the IDAC, it is important to select proper wire type, size and length for your application. Even the shortest leads can degrade the IDAC performance because of the IR drop in the leads.

For example, approximately 15 feet of 22 AWG wire has a resistance of 0.242 ohms. At the full (20 mA) output of the IDAC, this results in a 4.84 mV voltage drop. If the load resistance is at or very close to 600 ohms, this added resistance could cause the compliance voltage in the IDAC to exceed 12 volts. Figure 150 is a wire chart showing nominal current ratings and resistances of various sizes of Annealed Copper wire.

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AWG (B&S) Wire Size	Annealed Copper Resistance at 20°C milliohms/ft.	Nominal Current Rating (amps)*
22	16.1	5
20	10.2	7
18	6.39	10
16	4.02	13
14	2.53	20
12	1.59	25
10	0.999	40
8	0.626	55
6	0.395	80
4	0.249	105
2	0.156	140
0	0.0993	195
00	0.0779	260

* Single Conductor in Free Air at 30°C with rubber or thermoplastic insulation.

Figure 150. Option 130 - Wire Chart

Also, some immunity from stray magnetic field pickup can be achieved by twisting each pair of SOURCE and SINK leads together before connecting to the load.

After deciding on the wire size, type and length, to connect loads to the assembly route the wires as shown in Figure 151, which shows connections for channel 0 and channel 1. Then install the assembly in a desired slot in the 3497A or 3498A.

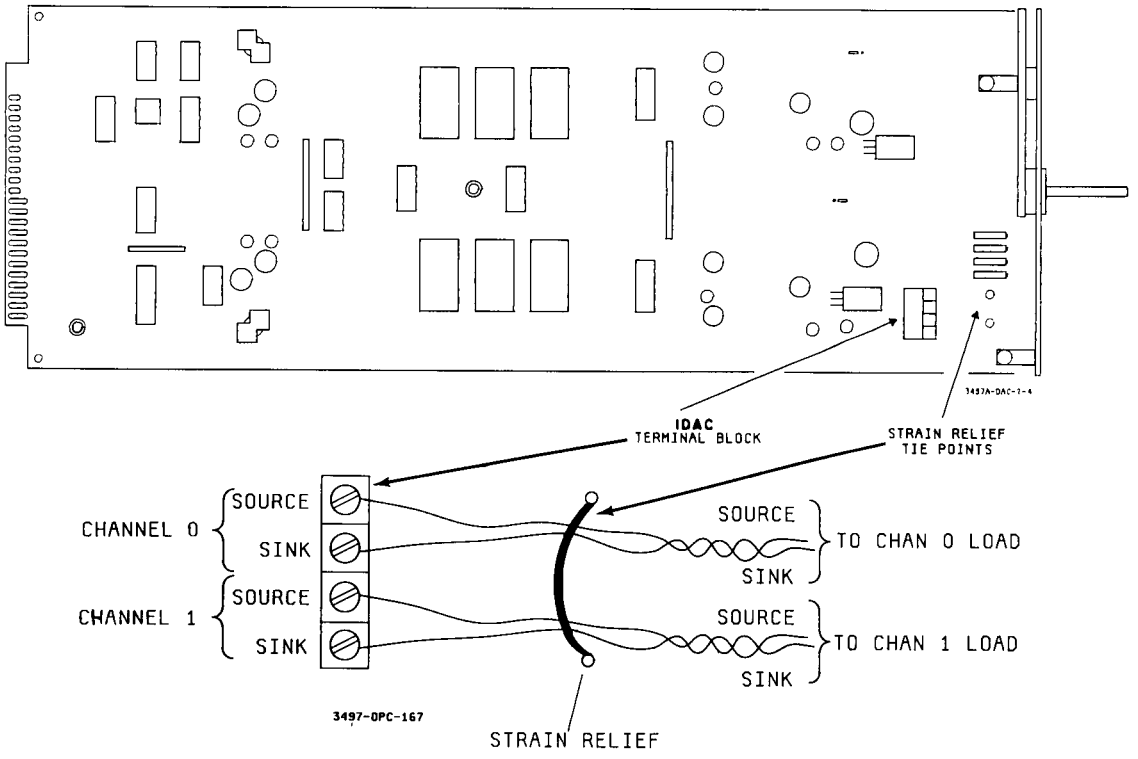


Figure 151. Option 130 - Connecting Loads to the IDAC

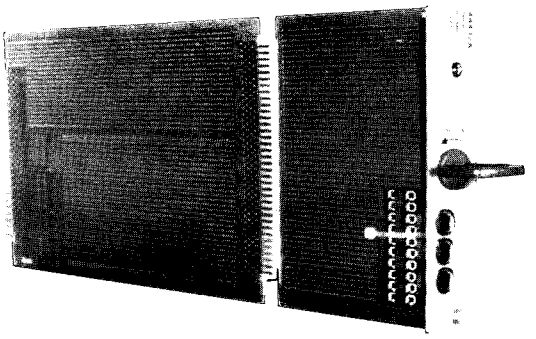
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Reconfiguring the IDAC for 4-20 mA Output

The IDAC is factory set for the 0 - 20 mA output range. You can reconfigure channel 0 or channel 1 or both for 4-20 mA output by jumper selection. However, when the IDAC is reconfigured for 4-20 mA output, the IDAC requires recalibration for output accuracy. A qualified, service-trained technician should perform this recalibration using the procedures outlined in the 3497A Plug-In Assemblies/3498A Extender Service Manual.

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OPTION 140



Breadboard Card Assembly

INTRODUCTION

In contrast to the other plug-in assemblies, Option 140 provides a ''breadboard'' for the design engineer or technician to custom design circuits for use with the 3497A or 3498A.

You can use Option 140 when you have a specialized measurement or control application which can't be satisfied by using the other option card assemblies. Possible applications include matrix and RF switches; multichannel totalizers and stepper motor controllers.

Instructions can be sent to the Breadboard Card assembly and data read from the assembly at a rate of 20 individual operations per second using the -hp- 85 and 90 operations per second using the -hp- 9826 computer.

Description

The breadboard card assembly is shown in Figure 152. The board has three grid networks to mount components (ICs, resistors, capacitors, etc.). Two of the grids are labeled ANALOG SECTION and DIGITAL SECTION. Either grid, however, can be used for either type of circuit depending on requirements. The third grid can be used as an extension of the Analog and/or Digital grids, or (if a terminal card is used) can be cut off and removed.

Interconnected holes across both the top and bottom of each grid form buses for power supply and ground connections. The analog grid has two power supply and two ground buses which can be used to connect two power supplies. Or, by using two jumpers, a single power supply bus can be configured.

Analog Section

The analog section of the assembly pertains to 3497A backplane signals which are controlled by the ANALOG command group (e.g., AC chan#,chan#,..). The control signals themselves are digital in nature. The result of executing an analog command, however, may return an analog result, such as a voltmeter reading using the HI COM, LO COM and GUARD COM lines. The analog section also contains two different power supply references.

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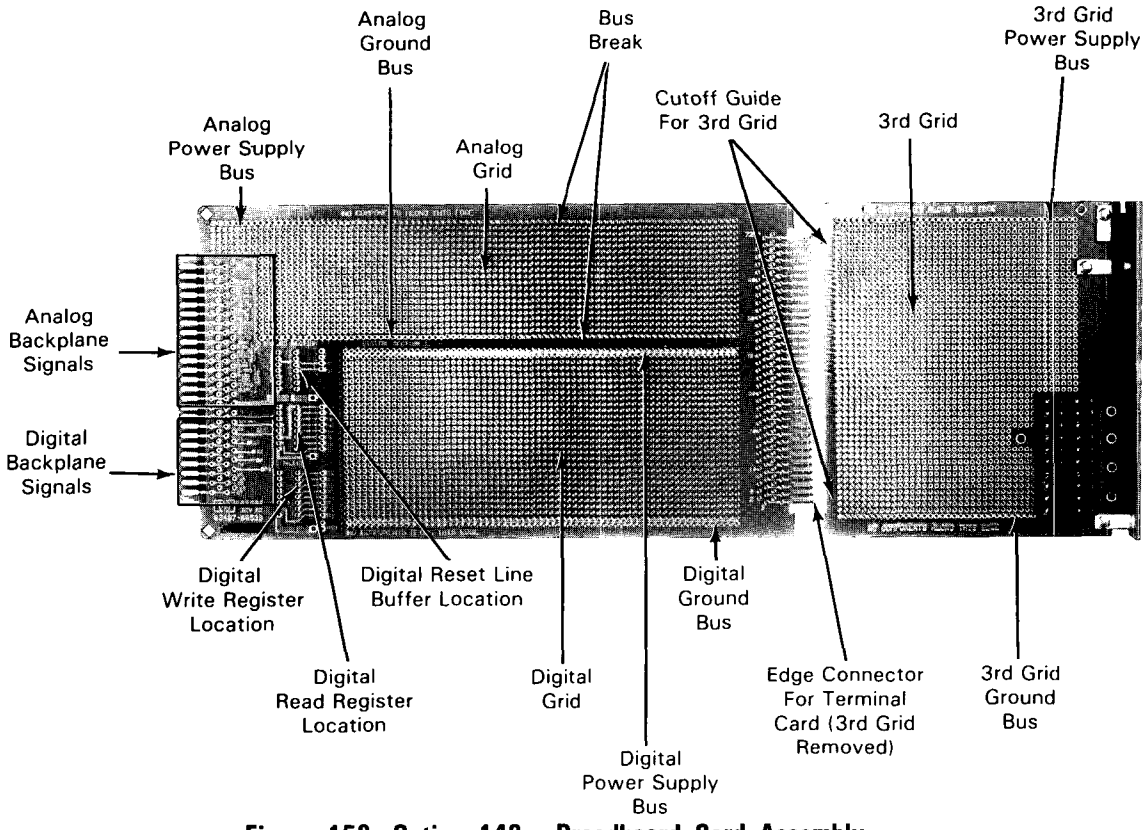


Figure 152. Option 140 - Breadboard Card Assembly

Digital Section

The digital section of the breadboard card assembly pertains to 3497A backplane signals which are controlled by one of three SYSTEM commands: SI; SR slot#,register or SW slot#,register#,octal value. DIGITAL commands or other SYSTEM commands will not be recognized by the digital section because, except for the three SYSTEMS commands mentioned, the 3497A software requires an identifying response from a digital assembly when a DIGITAL or SYSTEM command is executed.

Specifications

Specifications are performance standards, or limits, against which the assembly may be tested. Figure 153 shows the overall dimensions of the card and component height/protrusion restrictions. The component height/protrusion restrictions assume that other assemblies will be installed in slots on either side of the assembly or that the assembly will occupy the far left or far right slot.

OPTION 140
BREADBOARD CARD

Component Area: (consisting of plated thru .1168 cm. (.046") inside diameter holes spaced .254 cm. (.100") apart

368 cm.^{2} 57.13 in.^{2}

Maximum Component Height: 1.4 cm. (.55 in.)

Maximum Component Lead Length: .51 cm. (.2 in.)

Maximum Power Dissipation: (total per assembly from all supplies): 2 watts

Power Supply Rating: S: (supplied by the 3497A, maximum per card, up to 5 cards per 3497A cardcage)

Digital Supplies (Nonisolated): + 5 V @ 400 mA max.

Analog Supplies (Isolated):

		Maximum Current
Low Related Supplies	+ 5 V	50 mA
	+ 15 V	2 mA
	− 8 V	100 μA
Guard Related Supplies	+ 19 V	20 mA
	− 19 V	20 mA

To avoid design difficulty and possible damage to the 3497A, analog (isolated) and digital (nonisolated) supplies should not be interconnected.

General Communication Rate: Instructions can be sent to the 3497A breadboard card and data read from the 3497A breadboard card at a rate of 20 individual operations per second using the HP 85, and 90 operations per second using the HP 9826 computer.

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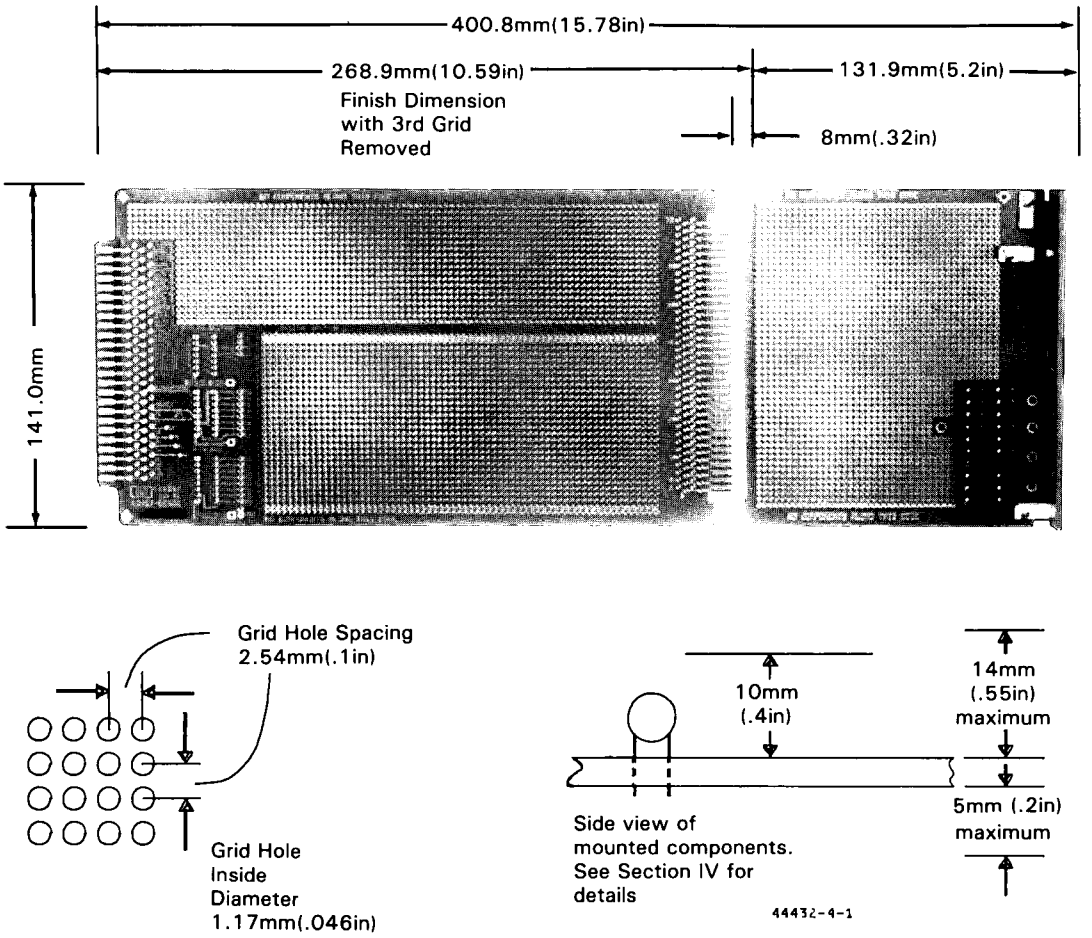


Figure 153. Option 140 - Dimensions and Component Height/Protrusion Restrictions

Manual Information

This manual contains configuration and control information for this assembly. Assemblies manufactured after the publication date of this manual may have changes incorporated. In this case, a yellow MANUAL CHANGES sheet will accompany this manual. See Appendix B for details.

Warranty

The Breadboard Card assembly warranty (shown in Appendix B) is different than the standard -hp- warranty for the 3497A and associated assemblies. While -hp- is responsible for defects in materials and workmanship of the blank board and supplied hardware, -hp- is not responsible for the performance of the customer's circuit.

In addition, -hp- is not responsible for damage or improper operation of the 3497A, 3498A or plug-in assemblies when the Breadboard Card assembly is installed in either the 3497A or the 3498A. See Appendix B for a complete warranty statement for the breadboard card assembly.

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INSTALLING THE ASSEMBLY

WARNING

There is no operator installation or configuration for the Breadboard Card assembly. Only qualified, service-trained personnel should install or configure the assembly.

Initial Inspection

If you ordered the breadboard card assembly as Option 140, the assembly is already installed in the 3497A. If you ordered the assembly as Field Installation Kit 44432A, the shipping container should contain a breadboard card assembly. Figure 154 shows the replaceable parts on the assembly.

For the Field Installation Kit, if the card is missing or if there is mechanical damage or defect to the card, contact your nearest -hp- Sales/Service office. They will arrange for replacement or repair at -hp- option.

If there is any damage to the shipping carton, keep the carton and notify the carrier as well as -hp-. If you return a breadboard card assembly to -hp-, follow the shipping guidelines in Appendix B.

How to Install the Breadboard Card Assembly

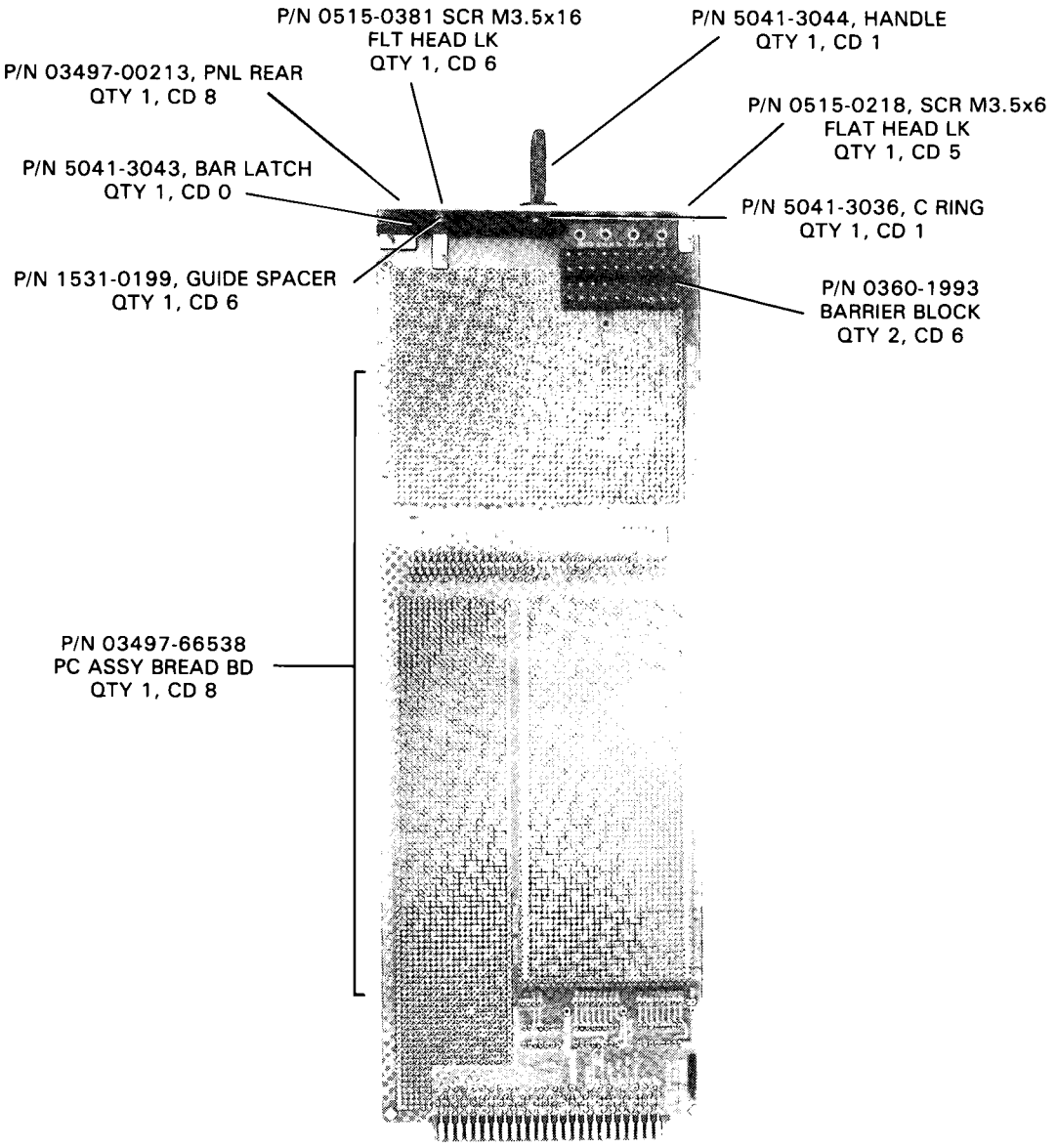
WARNING

Before touching any installed assemblies or attempting to install the Breadboard Card assembly in the 3497A or 3498A, disconnect the power cords to the 3497A and 3498A and remove ALL voltage sources from these instruments.

The Breadboard Card assembly is not intended for outdoor use. Do not expose the assembly to rain or excessive moisture.

Figure 155 shows how to install the assembly in the 3497A and 3498A. After taking the steps shown in the WARNING above, plug the assembly into an unused slot in the 3497A or 3498A and turn the locking key clockwise to lock the assembly in place.

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Suggested Parts For Custom Circuit Design

Description	Mfg P/N	-hp- P/N
3-to-8 Line Decoders/Multiplexers	SN74LS138	1820-1216
HEX Schmitt-Trigger	SN74LS14	1820-1416
Octal Buffers	SN74LS240 SN74LS241 SN74LS244 DM81LS97	1820-1917 1820-1918 1820-2024 1820-1759
Octal Latch	SN74LS273	1820-1720
Barrier Block (Terminal Strip), 10 Connections	—	0360-1993
Optoisolator	—	1990-0577

Figure 154. Option 140 - Replaceable Parts

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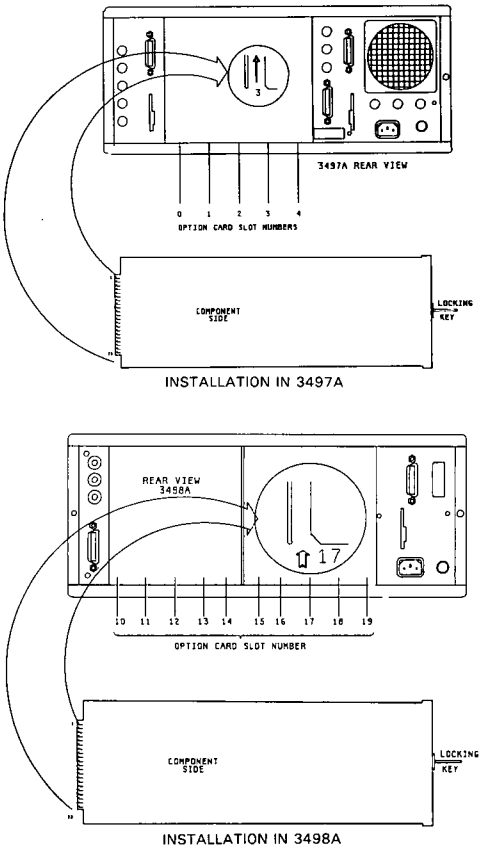


Figure 155. Option 140 - Installation in 3497A/3498A

CONFIGURING THE ASSEMBLY

Since the breadboard card assembly consists of an analog and a digital section, we'll divide assembly configuration into digital command signals and divide assembly configuration into digital command signals and analog command signals. For each section, some suggestions and examples are provided to aid you in designing your circuits. Also, some precautions to avoid damage to the 3497A or your system are listed.

Before designing or mounting any circuit, familiarize yourself with the 3497A analog and digital backplane signals available from the 3497A. Some precautions and helpful hints are:

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DESIGN PRECAUTIONS

- Observe all WARNING and CAUTION notes in the manual.
- Do NOT interconnect the analog and digital sections.
- Observe all power supply limitations.

- Observe component height/protrusion restrictions.
- Don't mount components along the top or bottom edges of the board.

- Remember that other assemblies installed in the 3497A or 3498A will share the same analog or digital lines as your custom circuit.

3497A Digital Command Signals

The 3497A backplane signals are divided into analog and digital signals. For the breadboard card assembly, the digital signals which are available from the 3497A backplane and a description of the signals are shown in Figure 156. Remember, however, that the breadboard card digital section is controlled ONLY by the SI, SR or SW commands.

The 3497A backplane connector which supplies analog and digital signals to the assembly is also shown in Figure 156. The digital signals appear on pins 16 through 25 and T through CC (pins 15 and S are not used). Analog signals appear on the remaining pins and are discussed in the 3497A Analog Command Signals section.

CAUTION

The digital and analog sections contain separate power supplies which are referenced to different potentials. Analog power supplies are referenced to GUARD potential (up to 170 volts above ground). For these reasons, NEVER interconnect the digital and analog sections. If these sections are interconnected, 3497A performance will be affected and equipment may be damaged.

CAUTION

All 3497A backplane signals are brought to the breadboard card and all are susceptible to damage from static discharge. To prevent damage to the 3497A, use anti-static techniques on all lines used for your custom circuit (i.e., buffering, voltage transient suppression, novistors, etc.).

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HCOM	1	A	LCOM
HCOM BOOT	2	B	LCOM BOOT
GUARD GND	3	C	GUARD GND
T.C. GND	4	D	UN3
-8V T.C.	5	E	UN2
+15V L	6	F	DECA1
(L) LATCH	7	H	DECB1
BREAK	8	J	UN1
MAKE	9	K	UN0
+5V LOGIC	10	L	+5V RELAY
LOGIC GND	11	M	RELAY GND
GUARD GND	12	N	GUARD GND
-19V G	13	P	+19V G
GUARD GND	14	R	GUARD GND
	15	S	
O.C. GND	16	T	O.C. GND
DIG. INTERRUPT	17	U	DIG. RESET
BD0	18	V	SLOT ENABLE
BD1	19	W	DIG. READ
BD2	20	X	DIG. WRITE
BD3	21	Y	BA2
BD4	22	Z	BA1
BD5	23	AA	BA0
BD6	24	BB	+5V O.C.
BD7	25	CC	-5V O.C.

Component Side Circuit Side

3497A DIGITAL SECTION BACKPLANE SIGNALS

DIGITAL LINE DESCRIPTION

Signal Name	Pin No	Description and/or Use
GND	T, 16	Ground for +5V digital supply. Referenced to Outguard (earth) GND.
+5V	BB, CC	+5V Digital Power Supply. Referenced to Outguard (earth) GND. Tolerance ±5% (4.75V to 5.25V). Filter and bypass capacitors recommended.
BA0, BA1, BA2	AA, Z, Y	Register Address Select Lines. BA2 Example: to select register 6, these lines would have the following logic states: BA2 BA1 BA0 1 1 0
DIG READ	W	Digital Read. A 500 nS low signal activated by executing the "SR" command.
DIG WRITE	X	Digital Write. A 500 nS low signal activated by executing the "SW" command.
DIG RESET	U	Digital Reset. A 500 nS low signal activated by executing the "SI" command or when the 3497A is reset.
DIG INTERRUPT	17	Interrupt line to 3497A μP. This line is not to be used by the breadboard card. This line is reserved for use by digital input and counter cards to interrupt the 3497A μP.
BD0 - BD7	18 - 25	Bi-directional Data Bus Lines. Transfers data between 3497A and option cards.
SLOT ENABLE	V	Slot Enable. A 750 nS low signal that is activated when a "SR" or "SW" command is being executed. This line is used to enable the slot that is being addressed by the "SR" or "SW" commands.

Figure 156. Option 140 - 3497A Digital Backplane Signals

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Design Suggestions for the Digital Section

The following paragraphs provide some suggestions and precautions for designing custom circuits using the digital section. See Chapter 6 for commands to control the digital section.

+5V Digital Power Supply

There is only one +5V (±.25V) power supply provided for the digital section. It is referenced to the outguard section of the 3497A mainframe and appears on the backplane edge connector as follows: +5V at pins BB and CC and GND at pins 16 and T.

Maximum power dissipation allowed by a card is 2 watts, including when both analog and digital section power supplies are used. Circuit traces bring the +5V and GND close to their respective buses so that only short jumpers are needed to the buses. Take care not to mount a component on a bus. IC power supply connections should be as shown in Figure 157.

It is recommended that bypass and filter capacitors always be used between +5V and ground. A good rule to follow is to use one 1μF tantalum filter capacitor and two .01 μF ceramic bypass capacitors for every eight (or less) ICs.

Buffering the Digital Reset Line

A location is provided on the breadboard card to mount a SN74LS14 IC to buffer the Digital Reset Line (pin U on the backplane connector). This IC provides a high true and low true version of the Digital Reset Line, as shown in Figure 158.

Buffering the Data Bus

The data bus drive capability is limited and may require buffering depending on your application. If the data direction is always from the 3497A to the breadboard card (write only), data latches can be placed directly on the data bus as shown in Figure 159 (a).

Whenever the data direction is from the breadboard card to the 3497A (read), the data bus must be buffered with a tri-state device(s). The buffering device must be able to drive 20 LS loads (20 Low Power Schottky inputs) such as the SN74LS24X SERIES or 81LS97. A typical data bus configuration for read operation is shown in Figure 159 (b).

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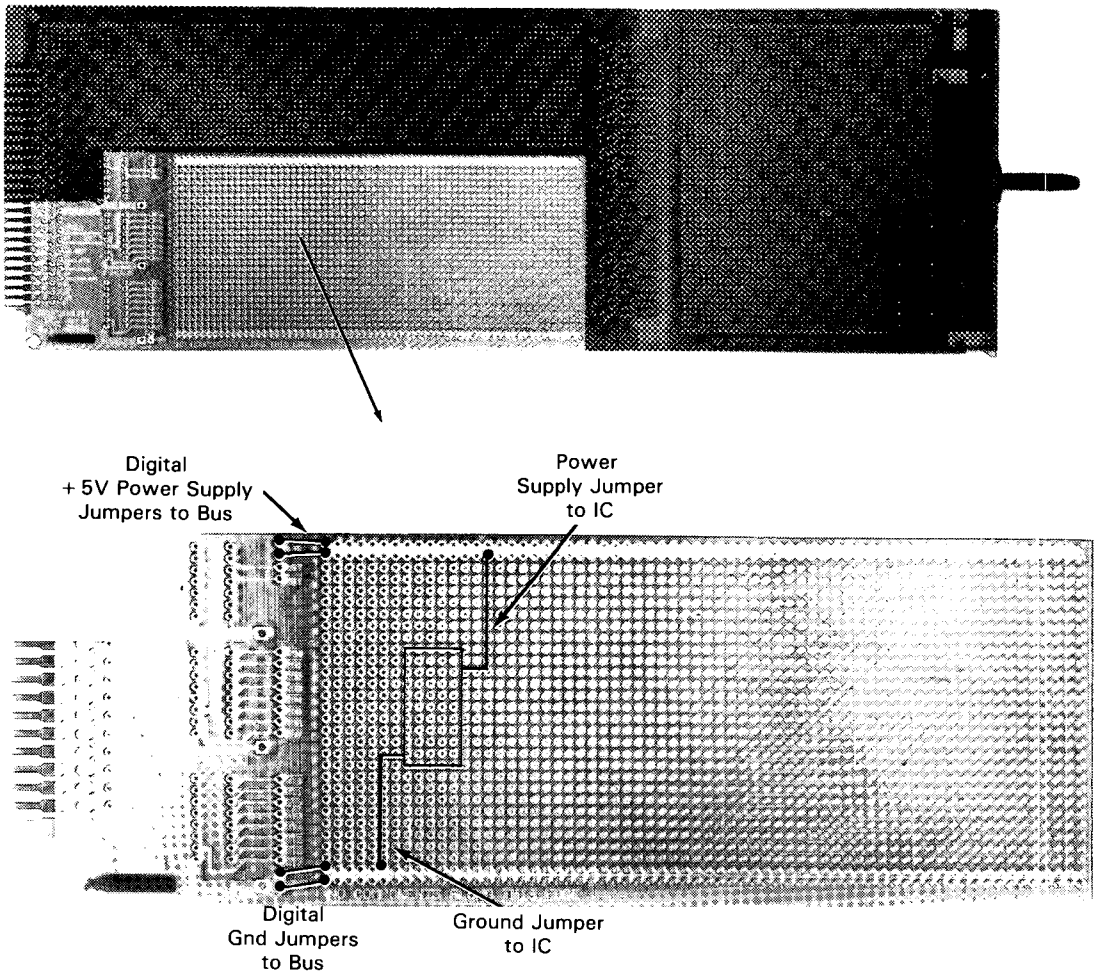


Figure 157. Option 140 - Digital Power Supply Connections

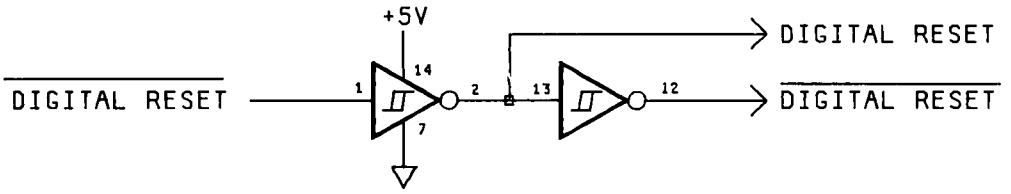
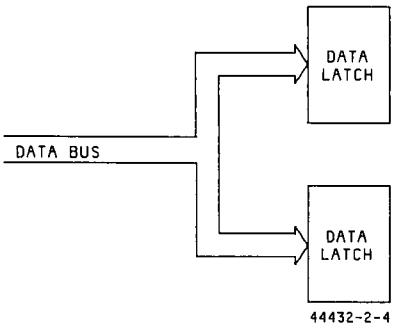


Figure 158. Option 140 - Buffering the Digital Reset Line

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(a) WRITE ONLY DATA BUS CONNECTIONS



(b) DATA BUS CONFIGURATION FOR READ OPERATION

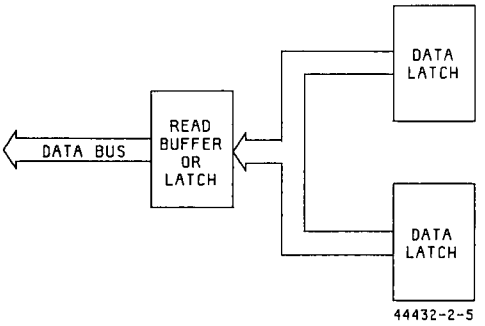


Figure 159. Option 140 - Rear and Write Data Bus Connections

Controlling Noise on the Signal Lines

Because of the distributed nature of the 3497A backplane signals, noise may be present on the control and data bus lines. The noise can be controlled somewhat by filtering. The preferred method is to buffer the lines with Schmitt Triggers, using ICs such as an SN74LS14.

Regardless of the method used to control noise, it will introduce some signal delay. Be sure to account for these delays so that timing requirements are not violated.

Typically, an oscilloscope is used to check signal lines for proper levels, noise, etc. When doing these measurements, make the measurement at the signal source and keep the ground lead of the scope as short as possible. An effective way to minimize ground lead length is to use a probe tip ground spring.

Power Switching

Two terminal blocks are provided on the board which permit up to 20 external connections. These terminal blocks are rated at 100 VA or 170V peak betwen any two terminals or any input to chassis and must be fused accordingly.

Inductive loads may require contact protection (arc suppression). If your application requires switching inductive loads, see the discussion on contact protection in the Option 115 (High Voltage Actuator) part of this chapter.

To minimize interference caused by high voltage switching, maintain maximum isolation between the switched voltages and the 3497A logic circuitry and choose relays which have a low contact-to-coil capacitance.

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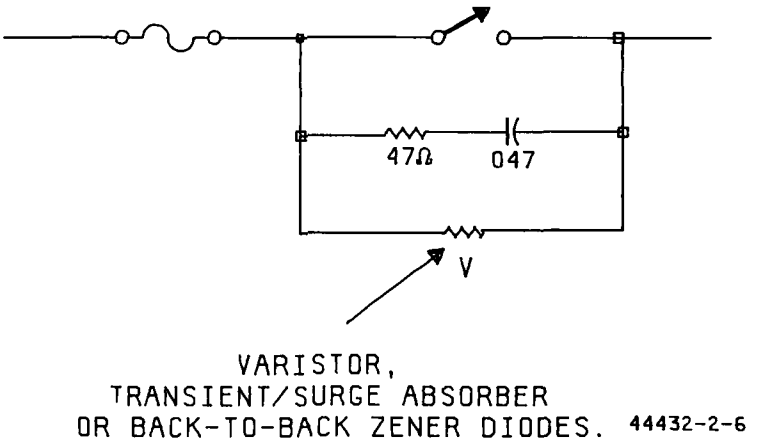


Figure 160. Option 140 - Transient Protection Circuit

To ensure compliance with applicable standards for Electromagnetic Interference, circuits should be constructed using good RF practice, such as ensuring that all interconnections are enclosed by shields connected to local earth grounds via low impedance paths.

When your application involves bringing the power line onto the board, the power line may require a transient suppression circuit to minimize interference with 3497A operation. A typical transient protection circuit is shown in Figure 160.

Read and Write Registers

Locations are provided on the card for two SN74LS138 ICs which can be used to implement a read and write register circuit. Figure 161 shows how these ICs are used in the circuit. In this circuit only three read and three write registers are shown. You can, however, have as many as eight read and eight write registers.

Direct Digital Backplane Interfacing

Direct interface to the digital backplane signals can be made without using Read and Write Registers. This type of configuration, as shown in Figure 162, can be used for counting, interval timing, interfacing UARTs, programmable peripheral interface, etc.

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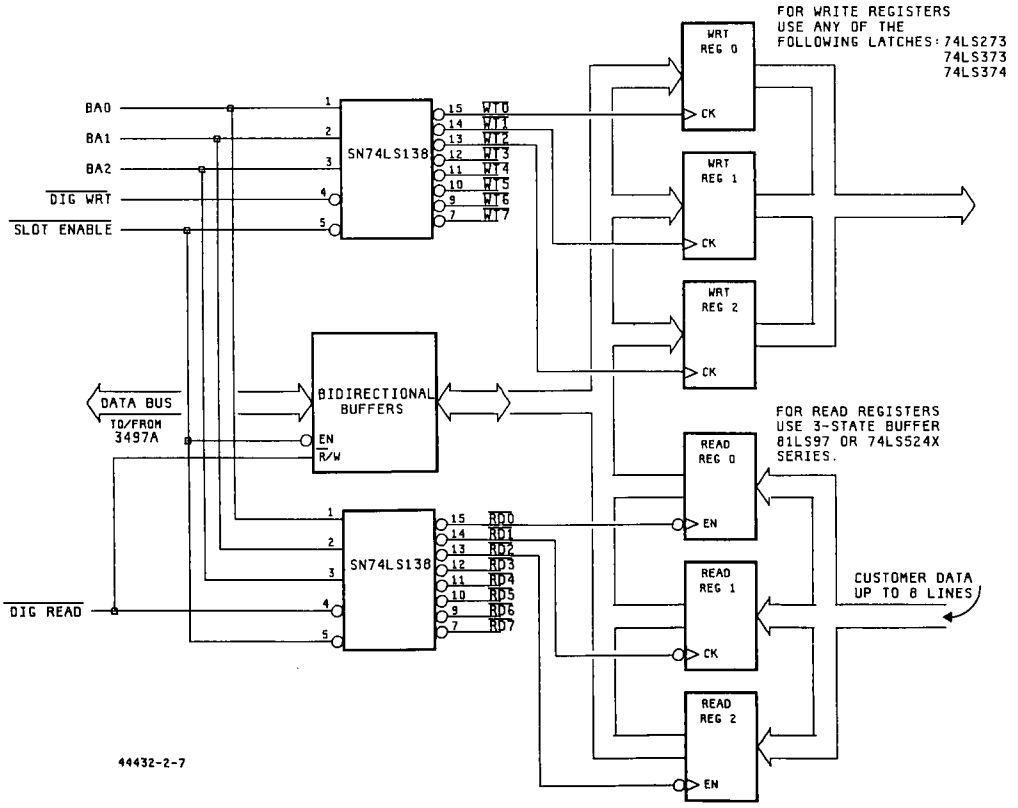


Figure 161. Option 140 - Typical Read and Write Register Circuit

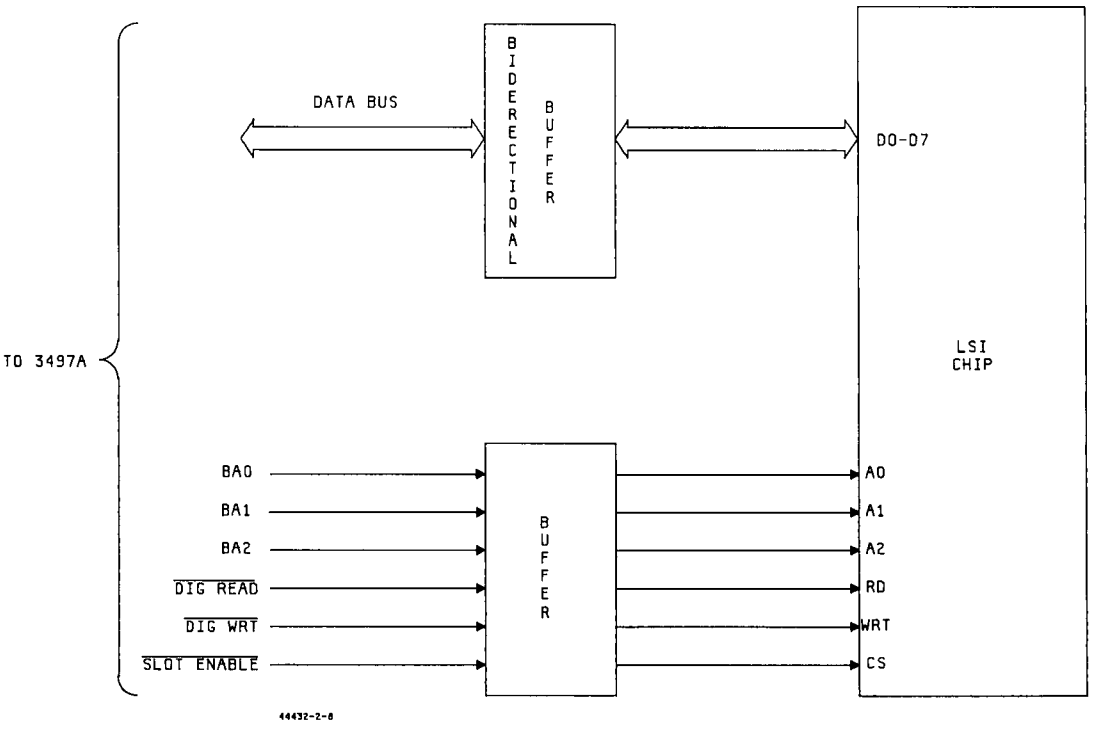


Figure 162. Option 140 - Direct Digital Backplane Interfacing

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3497A Analog Command Signals

As noted, 3497A backplane signals are divided into analog and digital signals. For the breadboard card assembly, the analog signals which are available from the 3497A backplane and a description of the signals are shown in Figure 163. See Chapter 6 for a description of the ANALOG commands used with the breadboard card assembly.

The 3497A backplane connector which supplies analog and digital signals to the assembly is also shown in Figure 163. The analog signals appear on pins 1 through 14 and A through R (pins 15 and S are not used). Digital signals appear on the remaining pins and are discussed in the 3497A Digital Command Signals section.

ANALOG LINE DESCRIPTION

Component Side		Circuit Side	
HCOM	1	A	LCOM
HCOM BOOT	2	B	LCOM BOOT
GUARD GND	3	C	GUARD GND
T.C. GND	4	D	UN3
-8V T.C.	5	E	UN2
+15V L	6	F	DECA1
(L) LATCH	7	H	DECB1
BREAK	8	J	UN1
MAKE	9	K	UN0
+5V LOGIC	10	L	+5V RELAY
LOGIC GND	11	M	RELAY GND
GUARD GND	12	N	GUARD GND
-19V G	13	P	+19V G
GUARD GND	14	R	GUARD GND
	15	S	
O.C. GND	16	T	O.C. GND
DIG. INTERRUPT	17	U	DIG. RESET
BD0	18	V	SLOT ENABLE
BD1	19	W	DIG. READ
BD2	20	X	DIG. WRITE
BD3	21	Y	BA2
BD4	22	Z	BA1
BD5	23	AA	BA0
BD6	24	BB	+5V O.C.
BD7	25	CC	-5V O.C.

3497A ANALOG SECTION BACKPLANE SIGNALS

IMPORTANT

Signals UN0-UN3, DECA1, DECB1, MAKE, BREAK, and LATCH are generated by CMOS devices and should only be used to drive CMOS inputs.

Signal Name	Pin No	Description and /or Use
UN0	K	Address Line, LSB. UN0 through UN3 indicates which channel is to be closed.
UN1	J	Address Line. See UN0 description.
UN2	E	Address Line. See UN0 description.
UN3	D	Address Line, MSB. See UN0 description.
DECA1	F	Decade A Select. Low true signal that allows a channel to be selected in decade A.
DECB1	H	Decade B Select. Low true signal that allows a channel to be selected in decade B.
MAKE	9	Make Strobe. An open collector line, used for break-before-make synchronization. This line is normally high via a 300 Ω mainframe pull-up resistor to the +5V Inguard Power Supply. A card pulls this line low when closing a channel. This informs the 3497A mainframe and other cards that a channel closure is about to take place so they will not attempt another channel closure until the channel has been opened. The MAKE line goes to every slot in the mainframe and the 3498A Extenders. This means that up to 50 cards can share this line. The voltage requirements of this line are as follows: VOL <.5V VOH >3.5V
BREAK	8	Break Strobe. An open collector line used for break-before-make synchronization. This line is normally high via a 300 Ω mainframe pull-up resistor to the +5V Inguard Power Supply. This line is the counterpart of the MAKE strobe. A card pulls this line low for the period required to open a closed channel. This line must be high for any scanning to take place. Like the MAKE strobe, this line can also be shared by up to 50 cards. The voltage requirements are the same as MAKE strobe.
LATCH	7	Latch Mode. An open collector line that is normally high via a 3 kΩ mainframe pull-up resistor to the +5V Inguard Power Supply. This line is driven low by the 3497A mainframe to permit multiple simultaneous channel closures (up to 4), with the restriction that each closed channel is in a different decade. For example, execution of "AC2,12,22,32" is valid, and will cause the LATCH line to go low.
HCOM	1	High Common. Connects to high lead of voltmeter.
LCOM	A	Low Common. Connects to low lead of voltmeter.
+19V G -19V G	P 13	+19V Guard Referenced Supply. -19V Guard Referenced Supply.
GUARD	3,12, 14, C, N, R	Guard Common or GCOM. Connects to Guard terminal of voltmeter.
+5V LOGIC	10	+5V Logic Low Reference Supply.
LOGIC GND	11	+5V Logic Supply Return Path.
+5V RELAY	L	+5V Relay Low Reference Supply.
RELAY GND	M	+5V Relay Supply Return Path.
+15V L	6	+15V Thermocouple Supply.
-8V TC	5	-8V Thermocouple Supply.
TC GND	4	Reference For +15V L and -8V TC Supplies.
BBM SYNC	Rear Panel BNC	Break-before-make synchronization pulse. This signal appears on the rear panel of the 3497A and is TTL compatible. BBM SYNC is similar to the MAKE strobe in that channel closures are not permitted when it is low (except in "AE2" mode where this signal is ignored).

Figure 163. Option 140 - 3497A Analog Backplane Signals

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CAUTION

The digital and analog sections contain separate power supplies which are referenced to different potentials. Analog power supplies are referenced to GUARD potential (up to 170 volts above ground). For these reasons, NEVER interconnect the digital and analog sections. If these sections are interconnected, 3497A performance will be affected and equipment may be damaged.

CAUTION

All 3497A backplane signals are brought to the breadboard card and all are susceptible to damage from static discharge. To prevent damage to the 3497A, use anti-static techniques on all lines used for your custom circuit (i.e., buffering, voltage transient suppression, novistors, etc.).

Design Suggestions for the Analog Section

The following paragraphs provide some suggestions and precautions for designing custom circuits using the analog section. See Chapter 6 for commands to control the analog section.

Inguard Low Referenced Power Supplies

There are two power supply references associated with the analog section (the reference is that point from which the power supply voltage(s) is measured). One reference is Inguard "LOW" and the other is "GUARD". There are four power supplies which are referenced to Inguard LOW: +5V Relay, +5V Logic, +15V L and -8V TC. Total circuit dissipation allowed is 2 watts per assembly even if both the analog and digital sections are used.

The +5V Relay, +5V Logic and +15V and -8V TC supplies are referenced to Inguard LOW. The +5V Relay and +5V Logic supplies have the same origin, but the ground returns keep any noise generated by switching relays from entering the logic circuitry.

Maximum total current which can be drawn from these supplies is 50 mA. The range of both supplies is 4.85V to 5.25V and will typically be about 5.1V. The supplies appear on the backplane connector as follows: +5V Relay at pin L; Relay Gnd at pin M; +5V Logic at pin 10 and Logic Gnd at pin 11.

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The +15V L and -8V TC supplies are used by the Option 020 thermocouple compensated terminal cards to generate hardware compensation voltages for several types of thermocouples.

Drawing excessive current from either supply could cause large compensation errors on Option 020 assemblies. Maximum current allowed from these supplies is: +15V L = 2 mA; -8V TC = 100 μA. The +15V and -8V TC supplies appear on the backplane connector as follows: +15V L at pin 6; -8V TC at pin 5 and +15V L and -8V TC GND at pin 4.

Guard Referenced Power Supplies

WARNING

The GUARD COMMON lines in the 3497A are determined by the voltage of the external circuit which is connected to the instrument. Thus, GUARD could be as much as 170 V peak above ground potential. Do not use the +19V and -19V supplies before reading Guarded Measurements following.

There are two power supplies, the +19V and -19V supplies, which are referenced to GUARD. These supplies have a tolerance of 5% (+18V to +20V and -18V to -20V). Maximum current which can be drawn per assembly from each supply is 20 mA. The +19V and -19V supplies appear on the backplane connector as follows: +19V G at pin P; -19V G at pin 13 and Guard at pins 3, 12, 14, C, N and R.

Guarded Measurements

By using the HCOM (High Common), LCOM (Low Common) and GCOM (Guard) connectors, you can make guarded voltage measurements. A brief discussion of guarded measurements follows. See -hp- Application Note 123, ''Floating Measurements and Guarding'' (-hp- part number 5952-2153) for a full explanation.

Figure 164 shows typical connections for guarded measurements from two input channels. When a channel relay is closed, the voltage appears on the HCOM, LCOM and GCOM lines and is simultaneously passed to the internal DVM, to the HI COM, LO COM and GUARD COM terminals on the rear panel of the 3497A and to other slots.

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WARNING

The potentials of HCOM, LCOM and GCOM are determined by the external circuit to which they are connected. Also, GCOM potential appears on the DVM external panel, on the sheet metal inside the 3497A front panel and on the sheet metal around the 3497A card cage.

For this reason, when making voltage measurements, NEVER input voltage simultaneously into the rear panel terminals and the backplane connectors. This can happen since the 3497A will support multiple channel closures in the Latch Mode.

GCOM is the reference for the +19V and -19V Analog Power Supplies. It can also serve as a common mode current if it is properly connected. Common mode voltages are those signals which appear on both the HIGH and LOW voltmeter terminals simultaneously and can cause reading errors if not properly handled. These voltages are shown as Vcm in Figure 164.

GUARDED MEASUREMENTS GUIDELINES

- Always know the potential of GCOM with respect to Earth ground.
- Always connect GCOM so that no common mode current flows through any resistance which determines the input voltage (i.e., the HIGH and LOW DVM input leads).
- Never exceed 170 V peak input between any two input terminals.

Interconnecting Circuitry Using Both Supply References

If your application requires that you use one or more of the Inguard Referenced Power Supplies (+5V Relay, +5V Logic, +15V L or -8V TC) with either of the Guard Referenced Power Supplies (+19V or -19V), the two references must be isolated from each other. The degree of isolation is 170 V minimum. A good way to do this is to use optoisolators as shown in Figure 165. The inputs to the optoisolators should be referenced to the Inguard section and the outputs referenced to GUARD COMMON.

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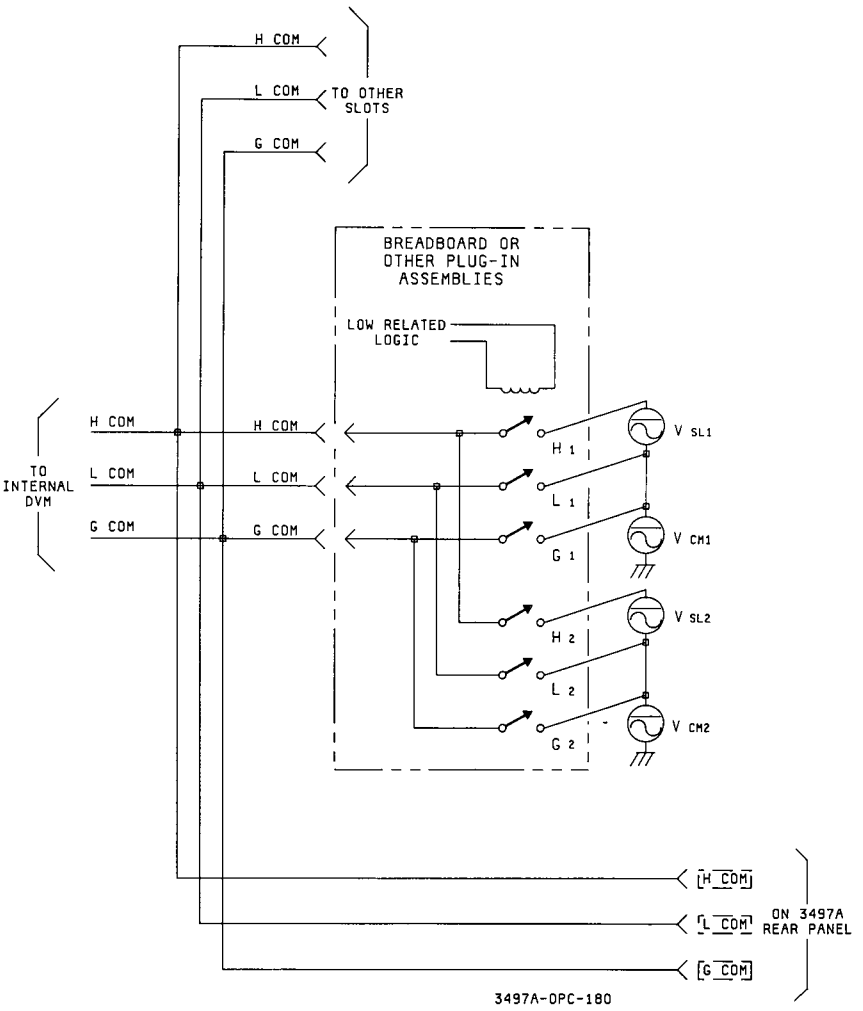


Figure 164. Option 140 - Guarded Measurements

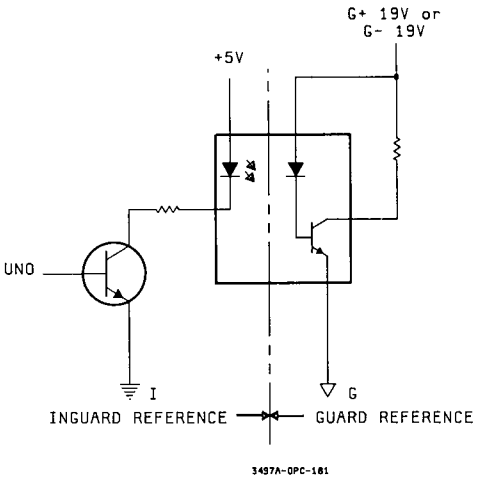


Figure 165. Option 140 - Analog Section Power Supply Isolation

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Mounting Components on the Breadboard Card

So that the breadboard card assembly will fit into the 3497A when components are loaded onto the board, the maximum component height/protrusion requirements shown in Figure 166 must be observed. The restrictions shown in Figure 166 assume that the breadboard will be used in a slot with other plug-in assemblies on either side or that the breadboard will be placed in slot 0 or 4 of a 3497A.

Absolute maximum component height allowed is 14 mm (.55 inches). However, if the height of any component exceeds 10 mm (.4 inches), the conductive surface of the component must be insulated. On the circuit side of the breadboard, the lead lengths are limited to 5 mm (.2 inches) or 4 mm (.16 inches) from the adjacent conductive surface. If the card is not adjacent to a conductive surface (i.e., no assemblies in adjacent slots or card is not in either of the end slots), these limitations can be exceeded.

Most wire wrapped components, such as IC sockets, will protrude through the breadboard further than the restrictions allow. When using such components, and the circuit side of the breadboard is adjacent to another card or in the far right slot, make sure to cut the lead lengths to meet the restrictions shown in Figure 166.

Never mount components where they will occupy space along the extreme top and bottom edges of the breadboard. This space is needed to slide the breadboard into the grooves of the slot and is labeled "NO COMPONENTS ALONG THIS EDGE". When soldering components on the breadboard, use a soldering iron with a 25 watt (or less) rating and rosin core solder.

Be careful to mount components so they are not across the power supply or ground buses. Also, remember that the analog section has two power supply and two ground buses to accommodate both analog power supply references. The recommended way to connect power supply and ground for a 14-pin IC, where the supply connection is pin 14 and ground is pin 7 is shown in Figure 157. Although Figure 157 shows connections on the digital section, it is applicable for the analog section and/or the third grid as well.

NOTE

If component height is greater than 10mm (.4in.) the conductive surface of components must be insulated. Lead length protrusion is limited to 5mm (.2 in.), or 4mm (.16 in.) from the adjacent conductive surface.

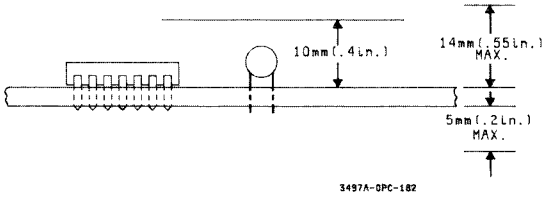


Figure 166. Option 140 · Component Height/Protrusion Requirements

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Using Terminal Strips/Cards

The breadboard assembly also contains a third section (grid) which has a terminal strip to allow up to 20 inputs (see Figure 152). If your application requires more than 20 inputs, you can remove the third grid and replace it with one of four manufactured terminal cards:

- 20 Channel Uncompensated Terminal Card (used with Option 010).
- 16 Channel Digital Input Terminal Card (used with Option 050).
- 16 Channel Digital Output Terminal Card (used with Option 110).
- 8 Channel High Voltage Terminal Card (used with Option 115).

The third grid can be removed by one of several methods. A saw, PC board cutter or a paper cutter can be used. If you use a paper cutter, be aware that some paper cutters are not strong enough to cut PC boards. The notches on the board provide a guide to cut off the third grid. When the grid has been removed, approximately 0.64 mm (.025 inches) should remain between the end of the edge connector and the edge connector fingers (see Figure 152).

After the grid has been cut off, remove all rough edges with a file or the edges may not make contact with the terminal card. File the edge connector to look like the edge connector which plugs into the mainframe.

Terminal Card Descriptions

As mentioned, four manufactured terminal cards can be used with the breadboard card assembly when the third grid is removed. The following chart briefly describes these terminal cards. For more information, refer to the appropriate option discussion in this chapter.

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TERMINAL CARDS USED WITH THE BREADBOARD CARD

20 CHANNEL UNCOMPENSATED TERMINAL CARD

Used with the 20 Channel Relay Multiplexer (Option 010). Provides straight through connections from the input terminals on the terminal card to the edge connector you have prepared on the breadboard card. Capability to add series/shunt components is provided. -hp- part number is 03497-69542. See Figure 167 for schematic.

16 CHANNEL DIGITAL INPUT TERMINAL CARD

Used with the Digital Input/Interrupt Assembly (Option 050). Provides two-wire connections for each of 16 input channels plus FLAG, GATE and GND. The logic levels are determined by placing jumpers in designated positions to allow portions of resistive networks to attenuate the signal. -hp- part number is 03497-69543. See Figure 168 for schematic.

16 CHANNEL DIGITAL OUTPUT TERMINAL CARD

Used with the Digital Output Assembly (Option 110). Each output channel has three terminals labeled NO (normally open), NC (normally closed) and C (common). Terminals are also provided for GATE+, GATE-, FLAG+ and FLAG-. 16-pin DIP IC sockets (J1,J3,J4 and J6) provide a means of limiting current to the NO,NC contacts to +5V. DIP sockets J2 and J5 can be used to jumper relay common terminal to GND. -hp- part number is 03497-69544. See Figure 169 for schematic.

8 CHANNEL HIGH VOLTAGE TERMINAL CARD

Used with the High Voltage Actuator Assembly (Option 115). This card has provisions for 8 high voltage channels. The terminal strip connections are rated at 252V RMS (AC) at 2 amps or 48V DC at 2 amps. A terminal is provided to ground the terminal card to the 3497A chassis. -hp- part number is 03497-64111. See Figure 170 for schematic.

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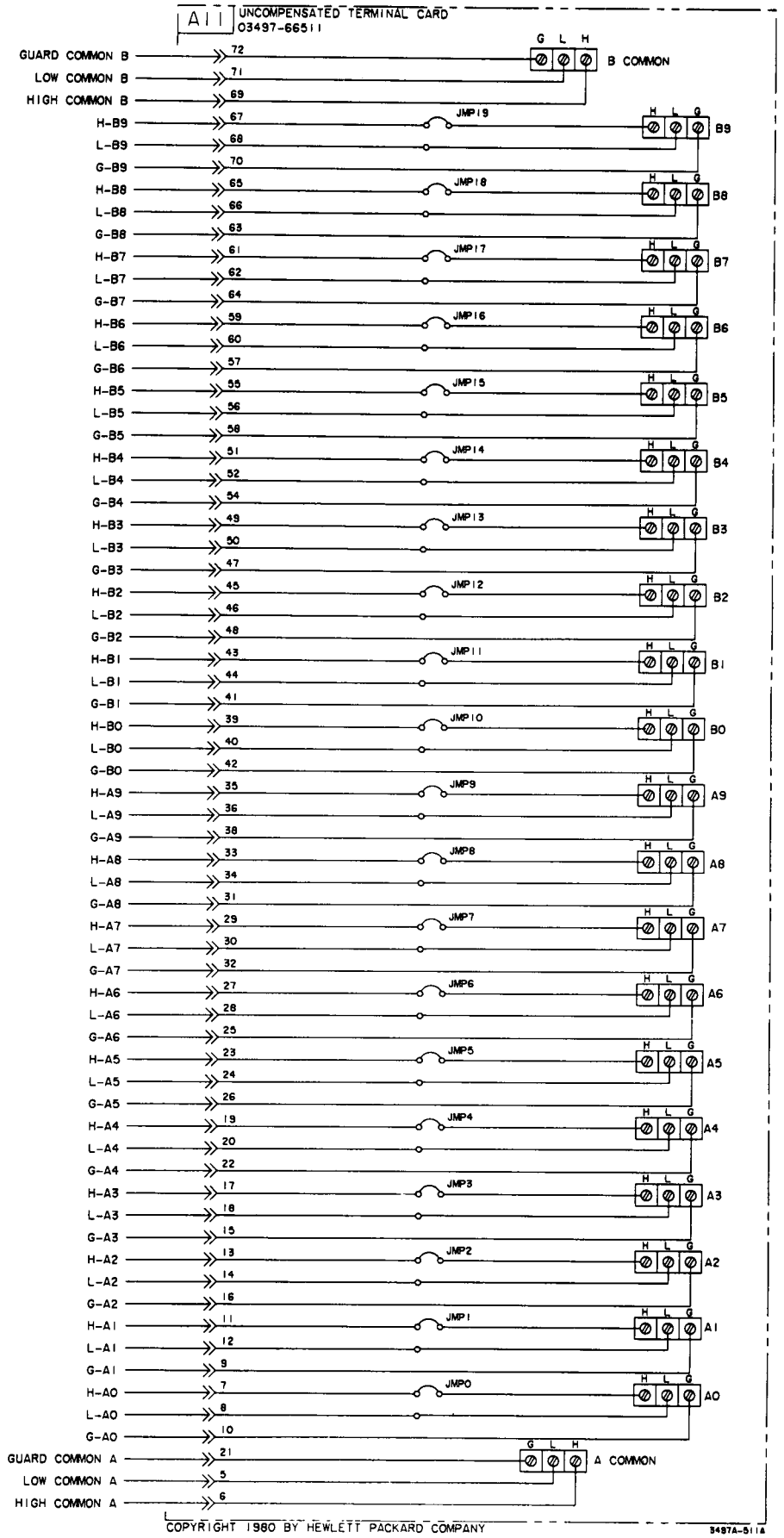
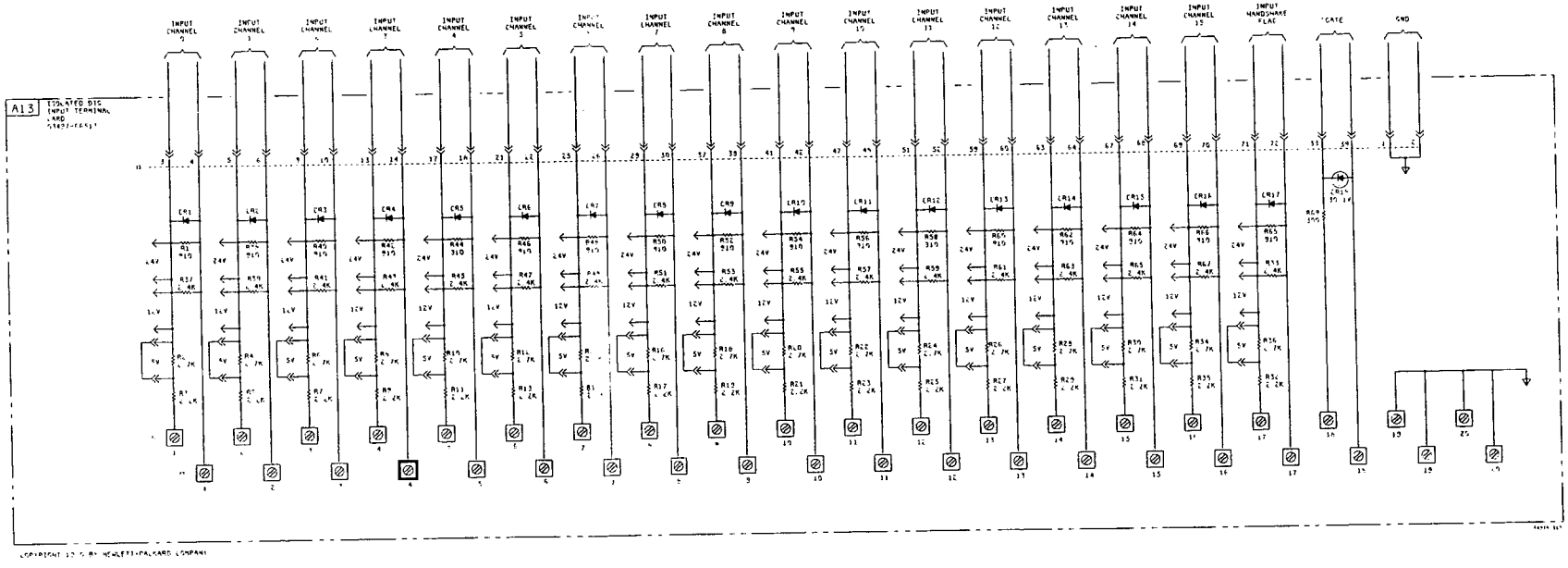


Figure 167. Option 140 - Uncomp Terminal Card (Option 010)

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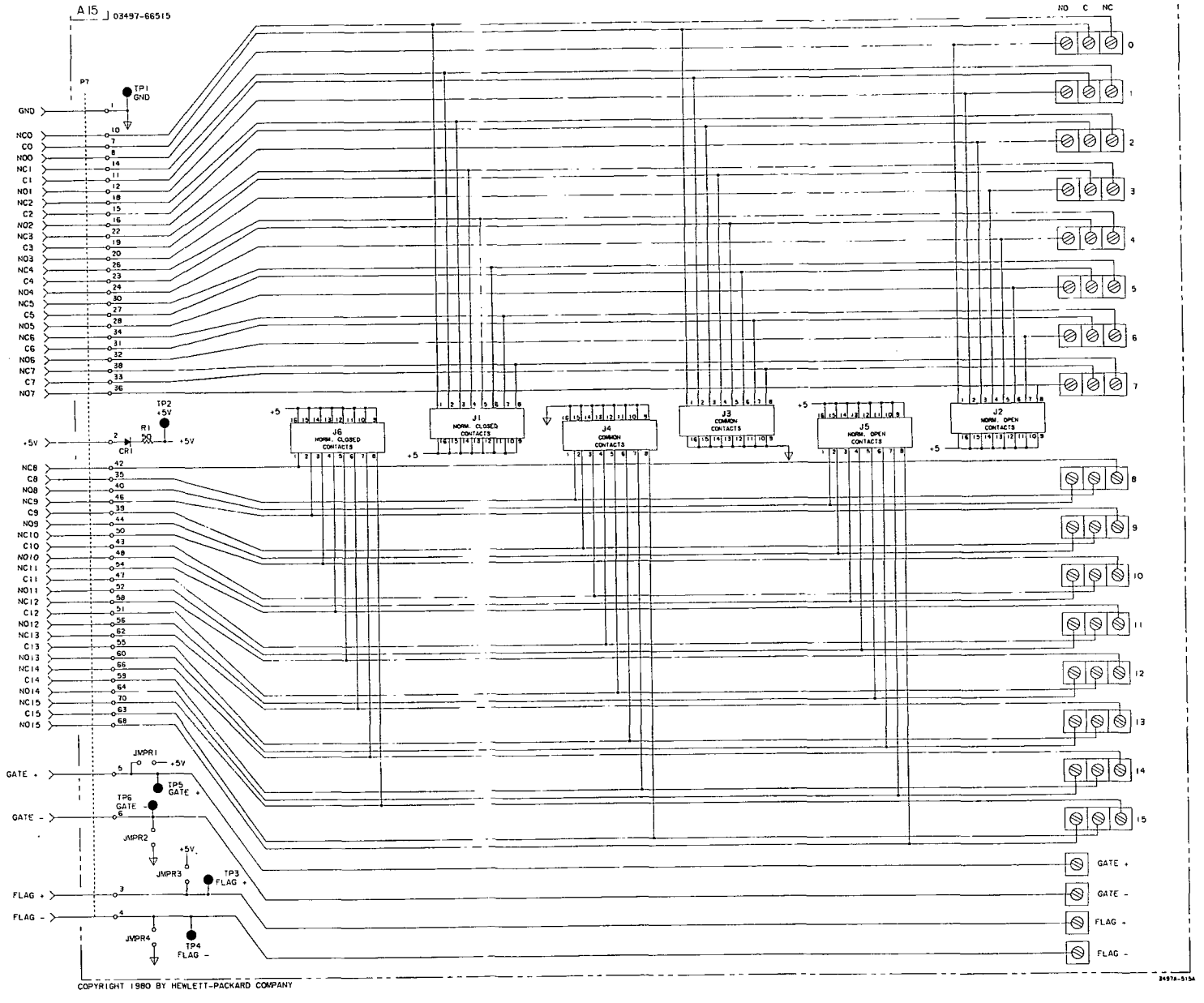


Figure 169. Option 140 · Dig Output Terminal Card (Option 110)

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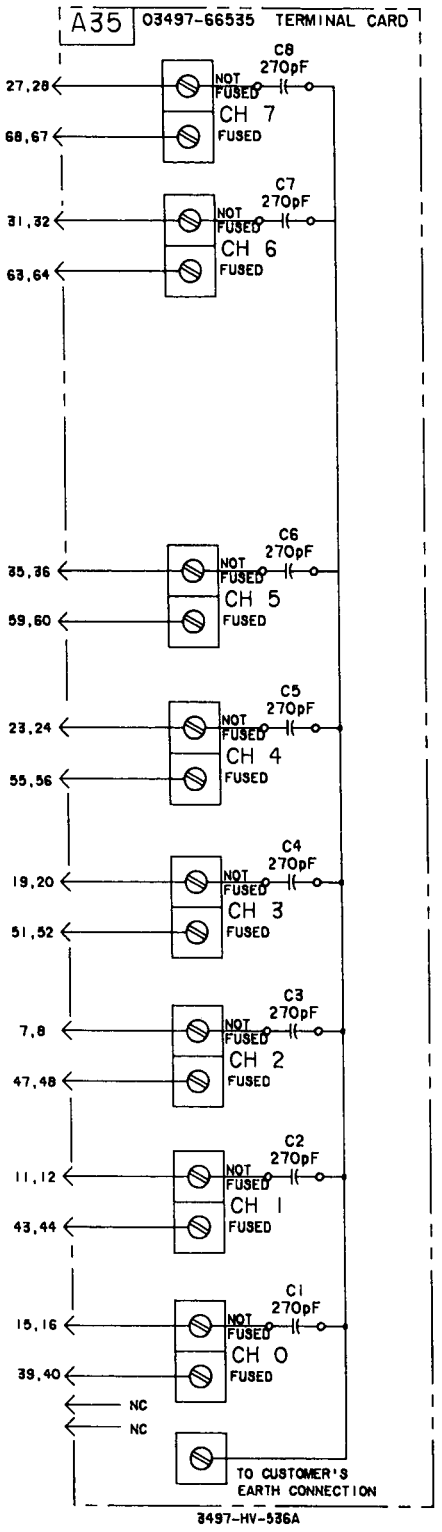
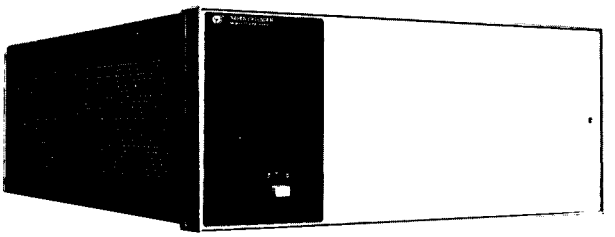


Figure 170. Option 140 - HV Actuator Terminal Card (Option 115)

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OPTION 298



3498A Extender

INTRODUCTION

The Model 3498A Extender allows you to add additional plug-in assemblies for expansion of system capability. Each 3498A can hold up to 10 plug-in assemblies. You can add a maximum of thirteen 3498As to each 3497A for a total capability of 135 assemblies (5 in the 3497A and 10 in each 3498A).

The maximum number of analog assemblies (Options 010, 020, 070 and 071) which can be added is 45. The maximum number of digital assemblies (Options 050, 060, 110, 115, 120 or 130) which can be added is 85. Thus, maximum capability is 1000 analog channels or 1360 digital channels. Use of one or more 3498As requires a 3497A for control.

Description

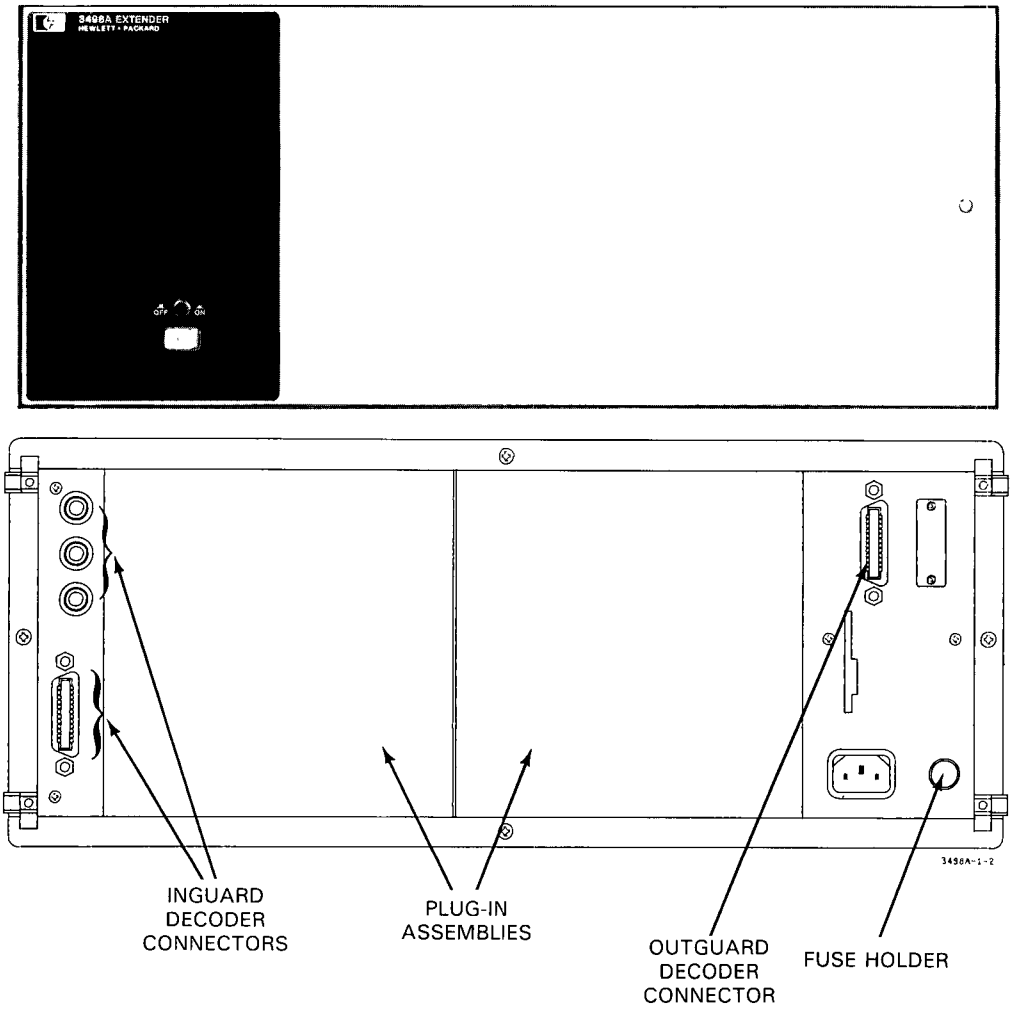
As shown in Figure 171, the 3498A Extender has a blank front panel with only a LINE switch and an indicator light for power-on conditions. The rear view shows that the extender has space for up to 10 plug-in assemblies and interconnections for analog and digital interface cables. The 3498A also includes decoding circuitry to allow the unit to operate with control signals from the 3497A and it contains power supplies for instrument devices using system ground or floating voltages.

Since the 3498A provides only POWER ON SRQ, Option 050 or Option 060 assemblies do not cause interrupt when placed in the 3498A although this capability is available when these assemblies are placed in the 3497A. Also, the DVM (Option 001) cannot be used in the 3498A.

Manual Information

This manual contains configuration and control information for the 3498A. For repair and/or service information, see 3497A Plug-In Assemblies/3498A Extender Service Manual. Instruments manufactured after the publication date of this manual may have changes incorporated. In this case, a yellow MANUAL CHANGES sheet will accompany the manual. See Appendix B for details.

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REAR VIEW SHOWN WITH SAFETY COVER REMOVED

Figure 171. Option 298 - Model 3498A Extender

Specifications

Specifications for the Model 3498A Extender follow. Specifications are performance standards or limits against which the instrument may be tested.

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OPTION 298
ADD 3498 EXTENDER

Number of Slots per 3498A: 10

Maximum Number of Added Analog Multiplexer Channels (Options 010, 020): 900 channels (45 assemblies)

Maximum Number of Added Non-analog Acquisition Assemblies (Options 050, 060, 110, 115, 120, 140): 85 assemblies

Maximum Separation From the 3497A:
3498A with analog cards (Options 010, 020, 070, 071): 100 meters
3498A with digital assemblies (all other options): 25 meters
(2 meter cables are supplied standard)

Maximum Number of 3498A's per 3497A: 13

Isolation:

	25°C, >85% R.H. 40°C, >60% R.H.	40°C, >95% R.H.
Hi to Lo	$>10^{10}$ Ohms	$>10^{9}$ Ohms
Lo to Guard	$>10^{8}$ Ohms	$>10^{7}$ Ohms
Guard to Chassis	$>10^{8}$ Ohms	$>10^{7}$ Ohms

Operating Considerations

Digital Interrupt is not passed between the 3498A and the parent 3497A. Digital Interrupt is found on the Option 050 Digital Input/Interrupt Assembly and on the Option 060 Counter Assembly.
The DVM assembly cannot be used in the 3498A.
Power and Environmental Information: see 3497A data.

INSTALLING THE 3498A

WARNING

There is no operator installation or configuration for the Model 3498A Extender. Only qualified, service-trained personnel should install or configure the instrument.

Initial Inspection

Whether you ordered the 3498A Extender as Option 298 to the 3497A or as a separate item, the shipping container should contain the items shown in Figure 172. If any item is missing or if there is mechanical damage or defect to the instrument, contact your nearest -hp- Sales/Service office. They will arrange for replacement or repair at -hp- option.

If there is any damage to the shipping carton, keep the carton and notify the carrier as well as -hp-. If you return a 3498A or accessory to -hp-, follow the shipping guidelines in Appendix B.

Line Voltage and Fuse Selection

The 3498A can be operated from any power source which supplies 100V, 120V, 220V or 240VAC (-10% to + 5%), 48-66 Hz, single phase. Power consumption is 150VA. The 3498A requires a 1 hour warm-up time. When you receive the 3498A, check to see that the Line Voltage Selector Switches and fuse size are proper for the power option you specified by doing the following:

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CHECKING FUSE AND LINE VOLTAGE SWITCHES

1. Loosen the screw on the right side of the front panel and swing the panel open.

2. Compare the line voltage selector switch positions with those shown in Figure 173. If not correct, set the switches to proper setting.

3. Check the fuse for proper type (1.25A for 100V or 120V operation; 2.5A for 220V or 240V operation). The fuse is located in the fuseholder on the right rear panel of the instrument as shown in Figure 172.

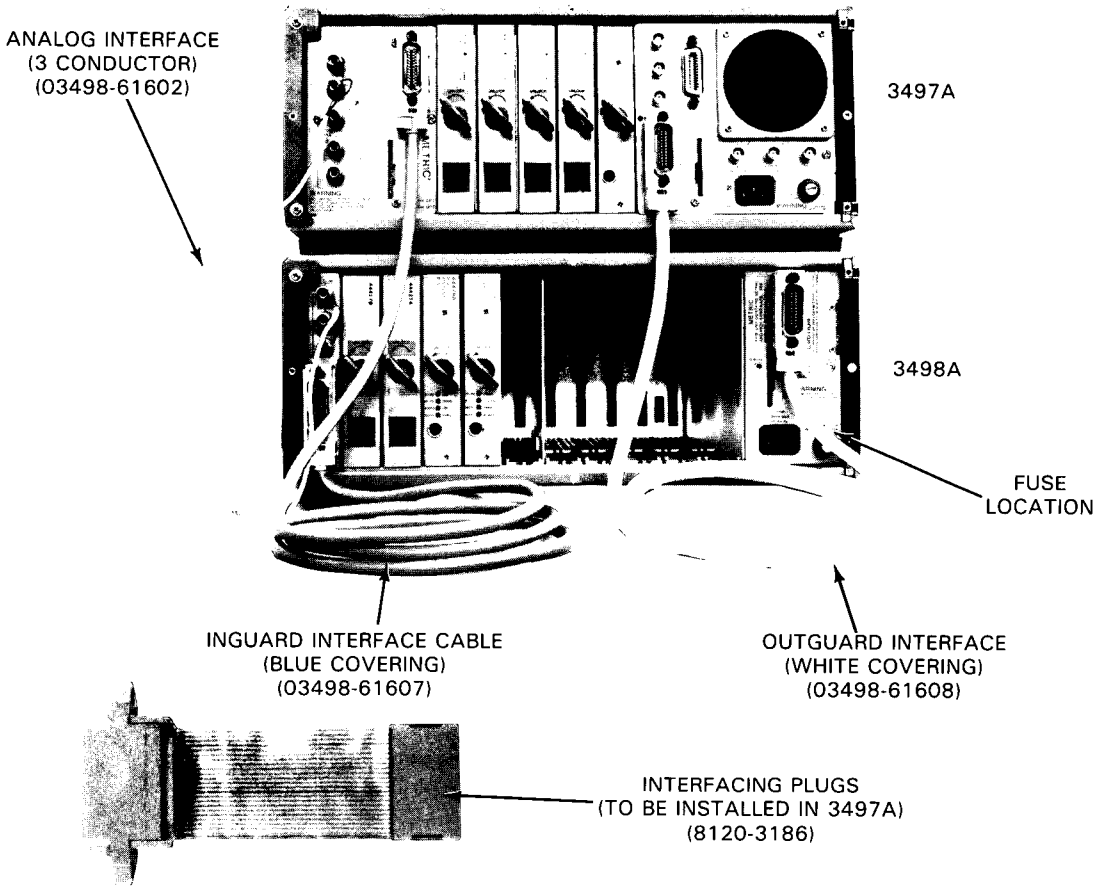


Figure 172. Option 298 - 3498A Extender and Accessories Supplied

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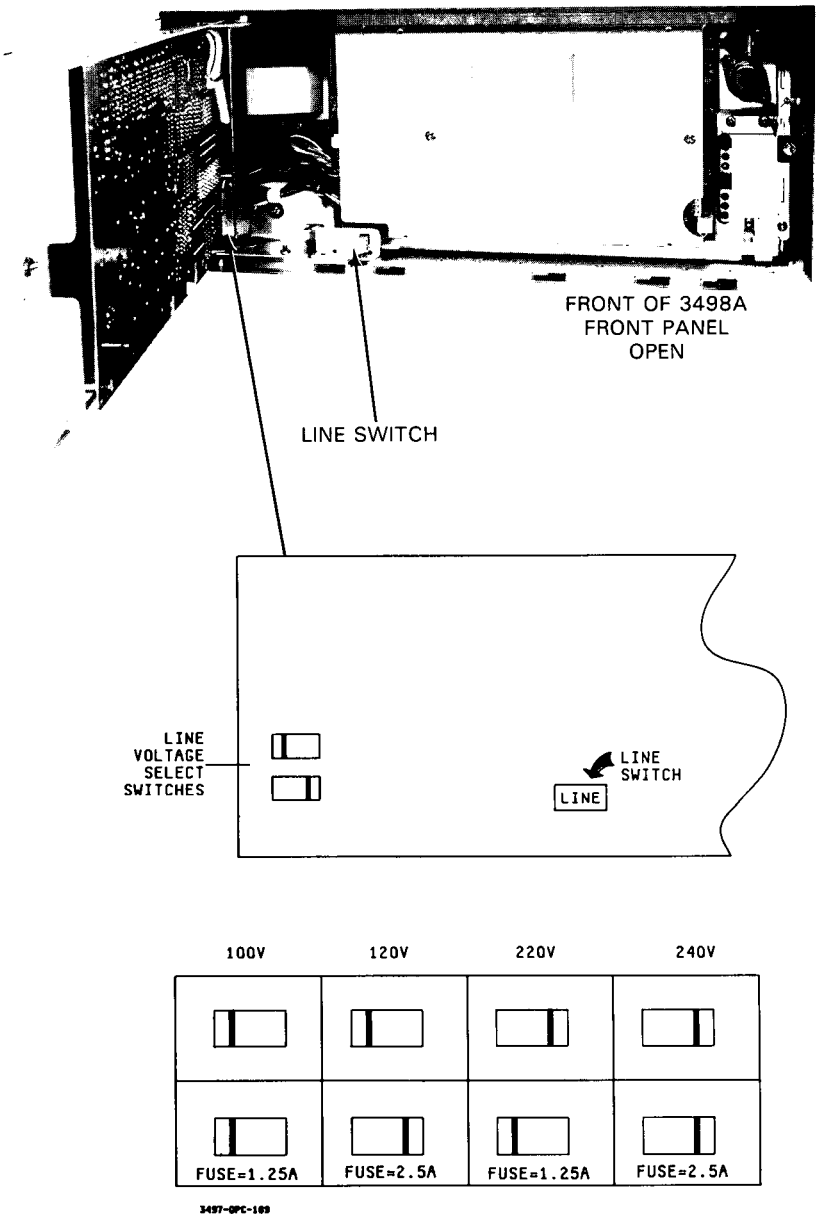


Figure 173. Option 298 - Line Voltage Switch and Fuse Locations

Power Cable and Grounding Requirements

The 3498A is equipped with a three-conductor power cord which, when plugged into an appropriate receptacle, grounds the instrument. The type of power cord shipped with the 3498A depends on the country of destination. See Figure 174 which shows the power cables available to ensure that you have the proper cord for your line voltage.

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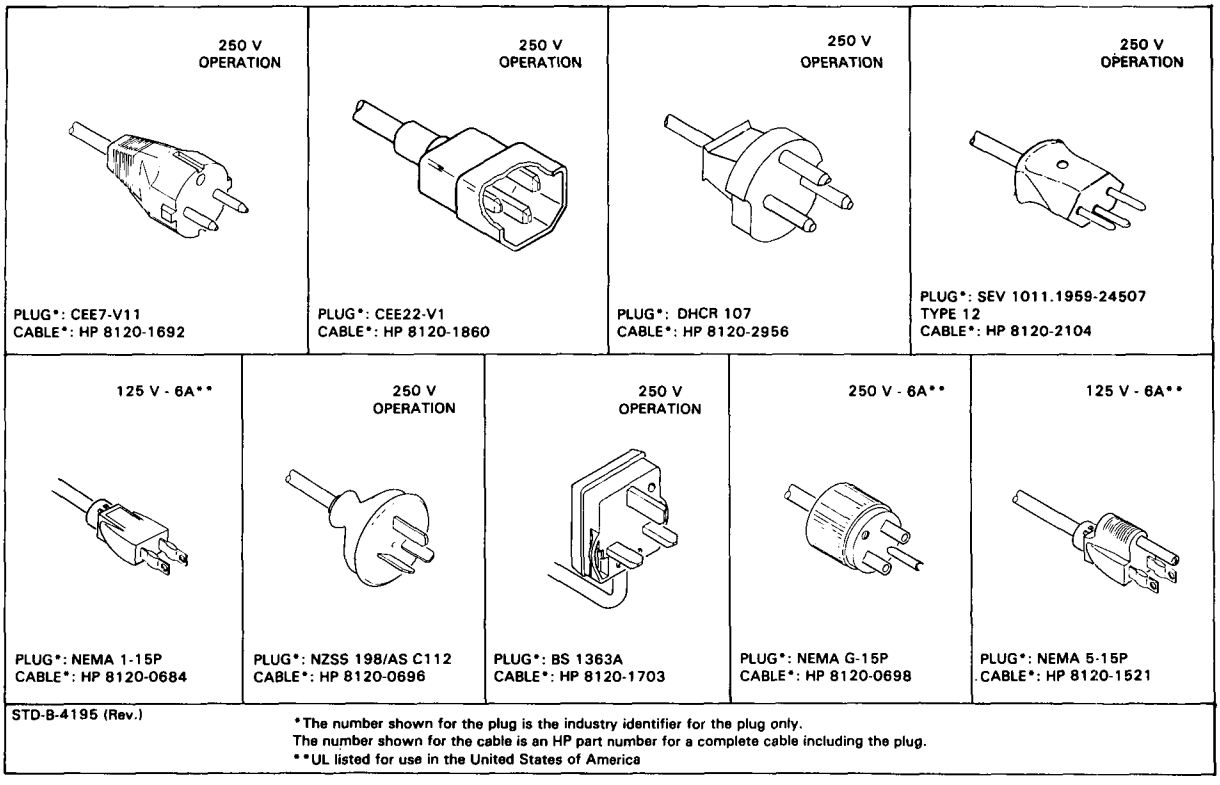


Figure 174. Option 298 - Power Cables for the 3498A

Environmental Considerations

The 3498A can be used either as a bench instrument or can be mounted in a standard 19'' rack. When the 3498A is used as a bench instrument, the plastic feet under the instrument are shaped so that the 3498A may be mounted on top of other -hp- equipment.

To meet its specifications, the 3498A should be operated within ± 5 °C (± 9 °F) of the calibration (or reference) temperature. The 3498A should be operated within an ambient temperature range of 23 °C ± 5 °C (73 °F ± 9 °F). The instrument may also be operated within an ambient temperature range of 0 °C to 55 °C (+32 °F to 131 °F), but with reduced efficiency.

WARNING

To prevent potential electrical or fire hazard, do not expose the 3498A to rain or moisture.

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3498A ENVIRONMENTAL REQUIREMENTS

Warm Up Time	1 Hour
Operating Temperature	0 °C to 55 °C
Non-Operating Temperature	-40 °C to 75 °C
Humidity	To 95% except as noted in Specifications.
Shock	30 G, 11 msec, sine wave on each of six sides.
Vibration	10 Hz to 55 Hz at .010 inch peak to peak excursion.
Operating Power	Switch selection of 110 volts, 120 volts, 220 volts, 240 volts (- 10% to +5%); 48-66 Hz, 150 VA (3497A), 150 VA (3498A).

Bench Installation

When the 3498A is used as a bench instrument, choose a location which provides at least 3 inches (8 cm) of clearance at the rear of the instrument and at least 1 inch (3 cm) on each side. If adequate clearance is not provided, excessive temperatures may be generated inside the 3498A and reduce instrument reliability. Clearances provided by the plastic feet in bench stacking allow adequate air passage across the top and bottom cabinet surfaces.

Rack Mount Installation

Options 907, 908 and 909 (Rack Mounting Kits) enable the 3498A to be mounted in a standard EIA (19'' wide) rack. Installation instructions are included with the Rack Mount Kit ordered. For further information on -hp- rack mounting kits, see -hp- SYSTEM II Rack Mounting Kits & Accessories Manual (-hp- Part Number 5952-0095) which may be ordered from your nearest -hp- Sales and Service Office.

Installing Plug-In Assemblies

To install plug-in assemblies (Options 010 through 140) in the 3498A, select the slot desired for the assembly and insert the assembly as shown in Figure 175, which shows a sample installation for the Relay Multiplexer assembly (Option 010).

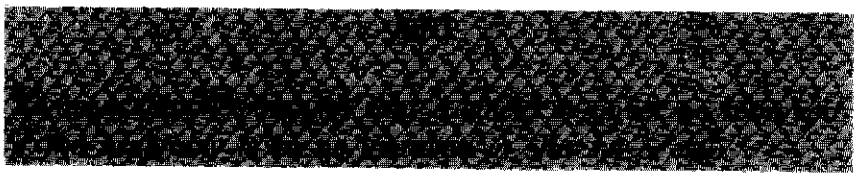
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WARNING

Do not install or remove plug-in assemblies until you remove the AC power cords from the 3497A/3498A and remove ALL external voltage sources from these instruments.

CAUTION

Most assemblies require clean handling techniques to avoid degraded performance.



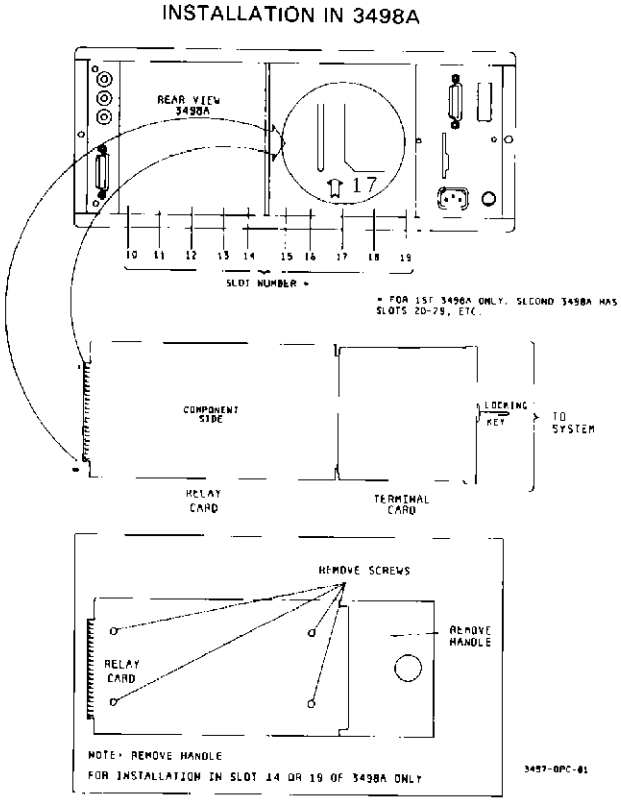


Figure 175. Option 298 - Installing Plug-In Assemblies

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Interfacing the 3498A with the 3497A

As noted, you can use up to 13 3498As per 3497A. If you ordered the 3498A as Option 298, you can directly connect the three cables supplied with the 3498A (see Figure 172) to interface the 3498A with the 3497A, as shown in Figure 176.

WARNING

Do not connect two extender cables together as a means of increasing the distance between a 3497A and a 3498A or between 3498As. The exposed metal connector plug housings are at GUARD potential (up to 170V) and thus present a lethal shock hazard.

NOTE

To avoid interference effects between 3497A systems and their installation environment, due regard should be paid to considerations of Electromagnetic Compatibility. Wiring should follow good RF practice, such as ensuring that all interconnections are enclosed by shields connected or bypassed to local earth grounds via low impedance paths.

The 3497A and 3498A outer frames should be interconnected either via heavy metallic braid or by installation in the same rack. Between the 3497A and 3498A(s), the (small white) High-Low-Guard signal cable should be arranged adjacent to the blue extender cable.

If You Ordered 3498A(s) Separately

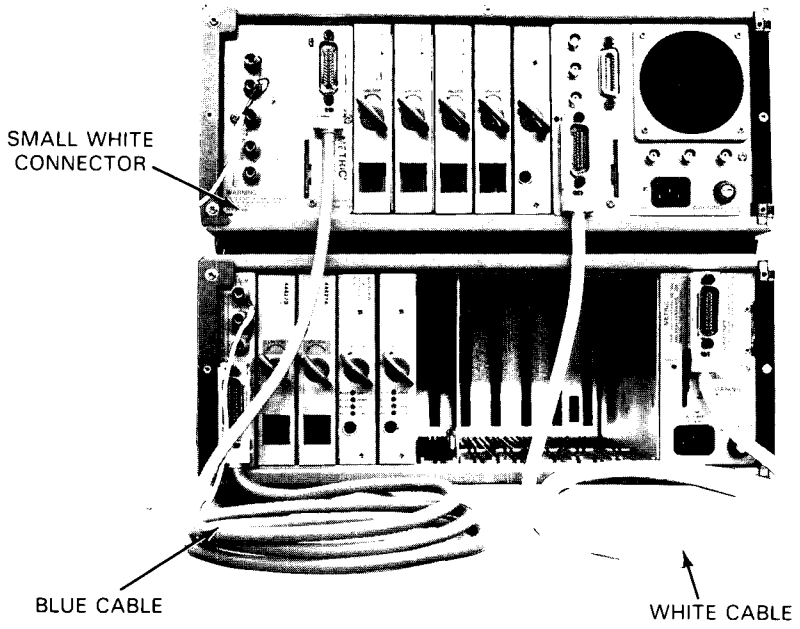
If you ordered the 3498A as a separate instrument AND did not order the 3497A with Option 298, you will need to install the two interfacing plugs shipped with the 3498A (see Figure 172) into the 3497A before you can follow the interconnection sequence shown previously.

Figure 177 (a) shows how to install an interface plug on the outguard controller of the 3497A (right side of the 3497A as viewed from the rear of the instrument) and Figure 177 (b) shows how to install the other interface plug on the inguard controller (left side of the instrument).

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WARNING

Shown with safety covers removed. Safety covers must be installed on rear of 3497A and 3498A before power is applied.



NOTE

1. *For rack connection, install 3497A and 3498As in same rack.*
2. *Arrange small white connector next to blue cable.*
3. *Interconnect 3497A and 3498A outer frames via heavy metallic braided connector.*

Figure 176. Option 298 - Interconnecting 3498A and 3497A

To install the interface plugs, first verify that all power is removed from the 3497A. Then remove the protective cover, loosen the retaining screw on the outguard controller board and remove the board using the plastic pull ring.

Remove the filler plate from the rear panel of the board and install the connector plug of one of the interface plugs in its place. Then insert the pigtail DIP plug into socket J2 on the outguard controller board. Reinstall the board in the 3497A and replace the protective cover.

To install the other interface plug on the inguard controller, follow the instructions for the outguard controller, except insert the pigtail DIP plug into J7 on the inguard controller.

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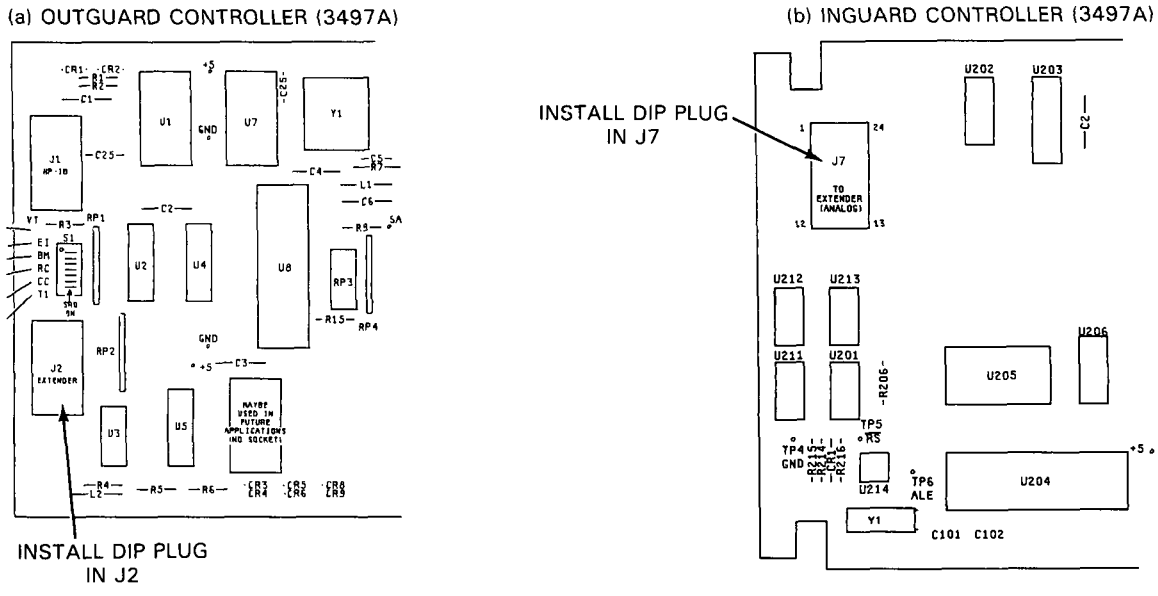


Figure 177. Option 298 - Installing Interface Connector Plugs

Installing Several 3498As

To install more than one 3498A, connections must be made from each successive extender to a previously connected extender, as shown in Figure 178. Note that the 3497A must have only one 3498A connected to it. A 3498A may have either a 3497A or two 3498As connected to it. This is necessary so that the required safety covers can be placed over the rear panels.

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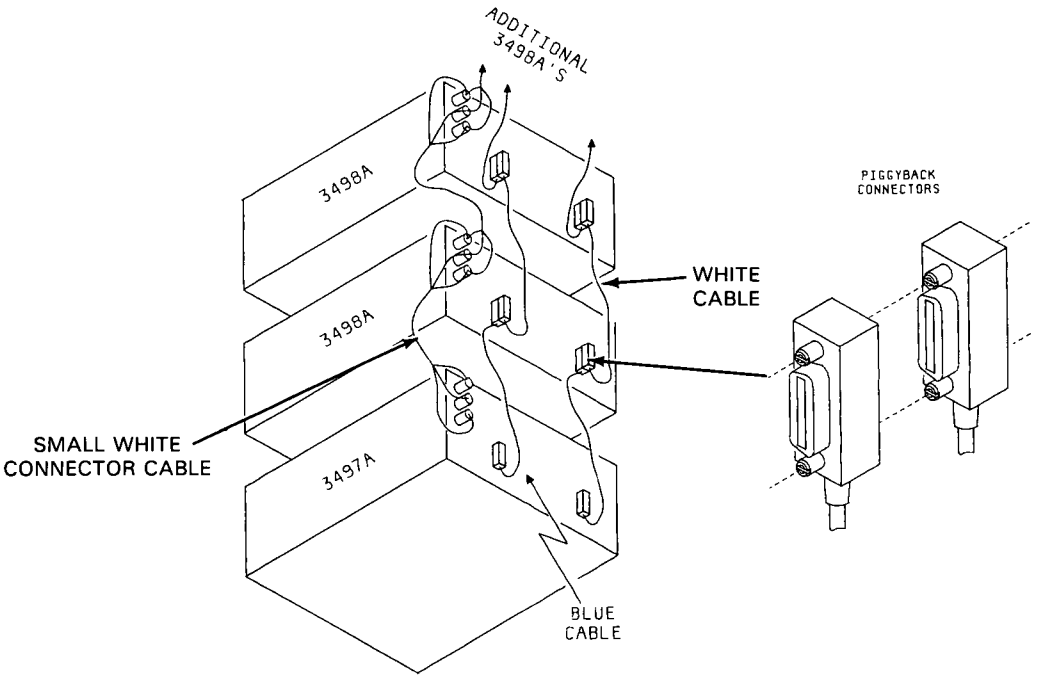


Figure 178. Option 298 - Multiple 3498A Interconnections

CONFIGURING THE ASSEMBLY

In general, it is not necessary to make configuration changes to the 3498A. However, if you use more than one 3498A with your 3497A, you will have to modify the factory set analog addresses and slot numbers. As factory preset, each 3498A is configured for analog addresses 100 through 199 and slot numbers 10 through 19.

A suggested slot and channel number addressing scheme follows. Naturally, you can configure the slot numbers and channel addresses as required for your application. For example, each decade can have any decade address from 0 to 999. Therefore, it is possible for all 20 decades (10 slots) in a 3498A to have the same 10 channel addresses.

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SUGGESTED SLOT # AND CHANNEL ADDRESSES

3498A NUMBER	SLOT NUMBER [1]	DECADE A ADDRESSES [2]	DECADE B ADDRESSES [2]
1	10	100-109	110-119
	11	120-129	130-139
	12	140-149	150-159
	13	160-169	170-179
	14	180-189	190-199
	15	200-209	210-219
	16	220-229	230-239
	17	240-249	250-259
	18	260-269	270-279
	19	280-289	290-299
2	20-29	300-399	400-499
3	30-39	500-599	600-699
4	40-49	700-799	800-899
5	50-59	900-999	----
6	60-69	----	----
7	70-79	----	----
8	80-89	----	----

[1] The maximum number of slots which can be addressed is 89 (i.e., slots 0-4 in a 3497A plus slots 10-89 in 8 added 3498As). Note that slots 5 through 9 do not exist for digital assemblies.

[2] The maximum number of analog channels is 1000 (0-999). Thus, the maximum number of analog assemblies (Options 010,020,070, 071) which can be used is 50 (i.e., 5 slots in the 3497A and 45 slots in five 3498As added).

Channel and Slot Capacity

With this suggested addressing scheme, you can input 20 analog channels (0-19) or 16 digital channels (0-15) into each slot. With a 3497A alone, total system capacity is 100 analog channels or 80 digital channels. By using 3498A Extenders, you can expand total system capacity to 1000 analog channels and 1360 digital channels, as shown.

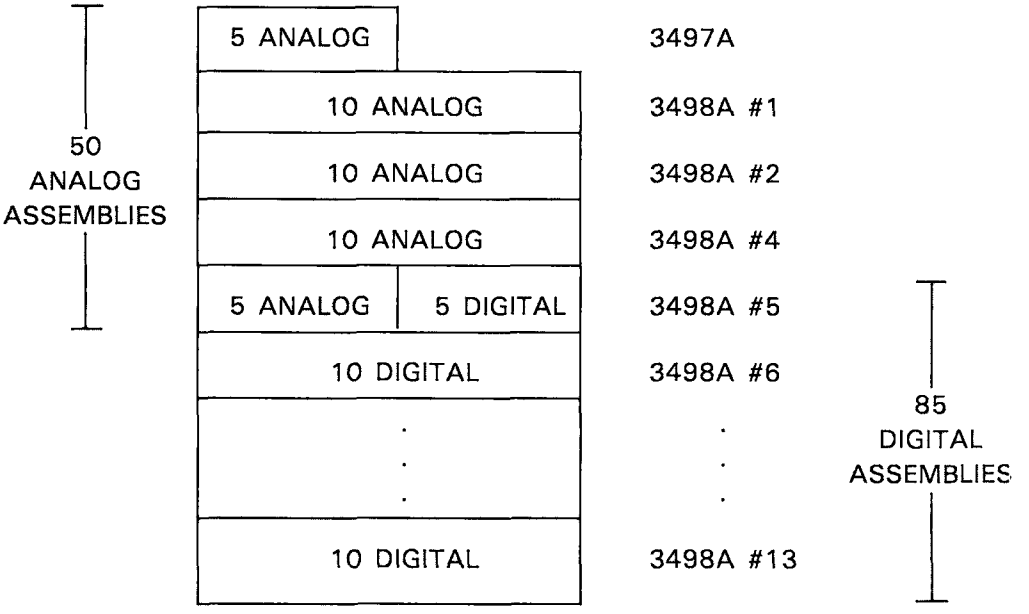
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3497A/3498A CHANNEL CAPACITY

ASSEMBLY	3497A ONLY		3497A + 3498As		
	# SLOTS	#CHANNELS	MAX # 3498As	#SLOTS	#CHANNELS
ANALOG	5	100	5	50	1000
DIGITAL	5	80	8	85	1360

EXAMPLE - MAXIMUM SLOT/CHANNEL CAPACITY

For example,to achieve maximum channel capacity, you could configure your system as shown, with analog assemblies in the 3497A and in the first 45 slots of 3498As and digital assemblies in the remaining 85 slots.



Changing Analog Addresses

If you need to change the analog addresses in a 3498A, use the procedures which follow and see Figure 179. Jumpers to modify the analog addresses are located on the Power Supply-Inguard Decoder board which is located behind the front panel of the 3498A.

To gain access to this board, first verify that all power sources are removed from the 3497A/3498A. Then loosen the fastener on the front panel and swing the panel out. Remove the two screws holding the shield over the board and remove the shield. Then locate the CENTURY and DECADE ADDRESS jumpers as shown in Figure 179.

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WARNING

The shield covering the Power Supply-Inguard Decoder board is at GUARD potential (up to 170 V) when external voltage sources are applied. Be sure that all power sources are removed from the 3497A/3498A before touching the shield.

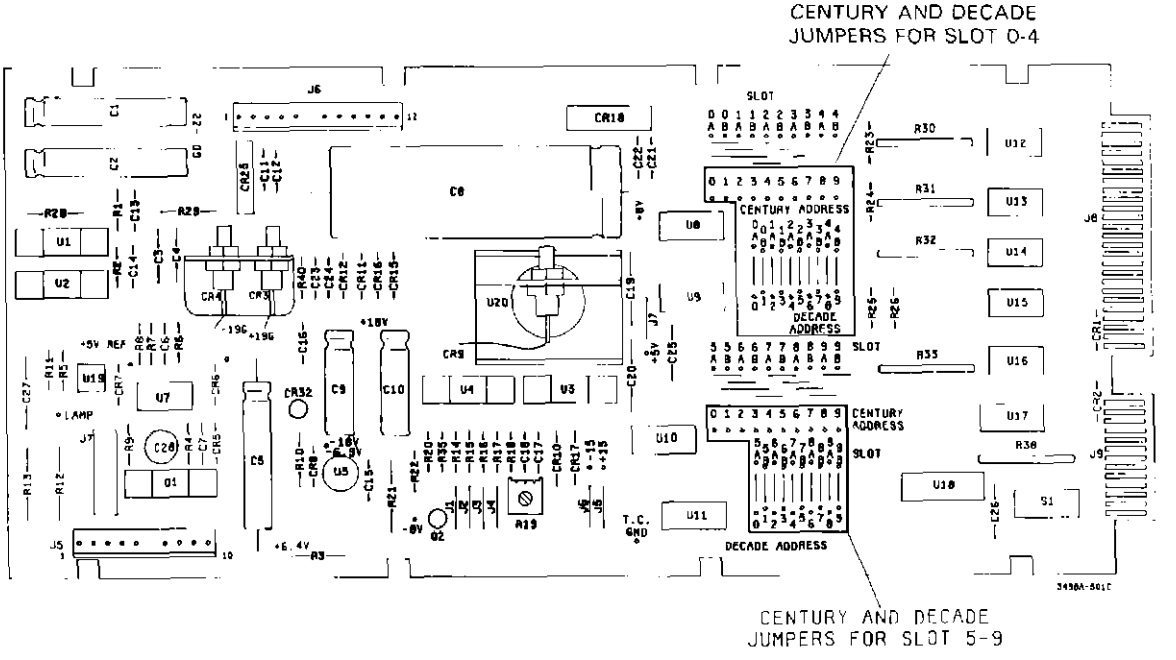


Figure 179. Option 298 - Analog Address Century/Decade Jumpers

As shown in Figure 179, each slot (shown as 0 - 9 in the figure) has CENTURY ADDRESS jumpers and DECADE ADDRESS jumpers. As factory preset, the jumpers are connected so that analog addresses are 100-199 and slot numbers are 10-19. For clarity we'll assume that the slot numbers remain 10-19 and show how to change the analog addresses. See Changing Slot Numbers for procedures to change slot numbers.

To change the analog addresses, you may need to cut and/or solder jumpers. Some examples follow to illustrate the method. When you have finished modifying the board, replace the shield and secure the front panel.

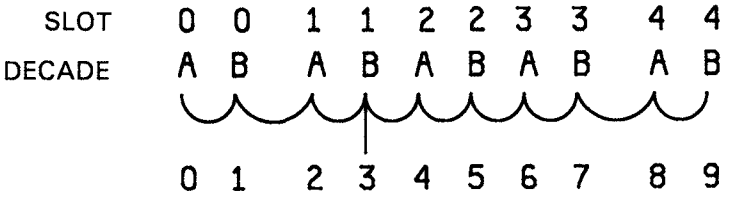
CAUTION

Use clean handling techniques when reconfiguring the board and do not subject the board to electrostatic discharge. After soldering, verify that the circuit board is properly cleaned (i.e., excess solder and flux removed).

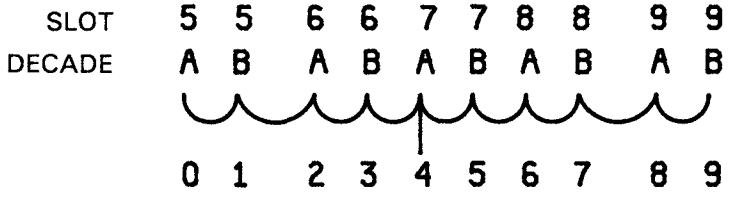
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EXAMPLE - SET 3498A TO ADDRESSES 300-499

For this example, we'll change only the CENTURY jumpers, as shown below. Since the DECADE address jumpers are not changed, with CENTURY address jumpers for slots 0-4 tied to pin 3, these slots have addresses 300-399 and with CENTURY address jumpers for slots 5-9 tied to pin 4, these slots have addresses 400-499. Since the DECADE address jumpers are not modified, they are not shown.



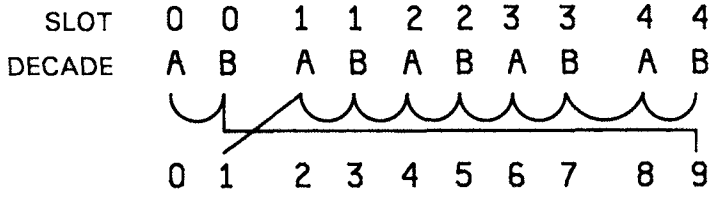
CENTURY ADDRESS



CENTURY ADDRESS

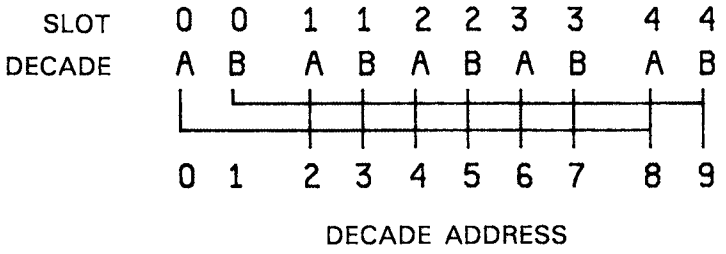
EXAMPLE - SET SLOT 0 TO ADDRESSES 980-999

In this example, we'll set the address of slot 0 (decades A and B) to 980-999 (as factory preset, slot 0 has addresses of 100-119). This will require that the CENTURY jumpers be set for "9" and that the DECADE jumpers be set for "8" for the A decade and or "9" for the B decade, as shown. Since the settings for slots 5 through 9 do not change, they are not shown.



CENTURY ADDRESS

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Changing Slot Numbers

As factory configured, each 3498A has slot numbers 10-19. To change the slot numbers for a 3498A, it is necessary to remove the Outguard Decoder circuit board located on the right rear panel of the 3498A (as seen from the rear). To remove this board, first verify that all power has been removed from the 3498A. Then remove the safety cover, loosen the retaining fastener and remove the Outguard Decoder (see Figure 180).

Next, locate the box address selector jumper block (see Figure 180 for location). To change a slot address, simply cut the appropriate jumper(s) according to the following equation, where a jumper in place = a "1" in the equation (only the first digit can be modified).

BEGINNING SLOT NUMBER = 10[8 - (A + 2B + 4C)]

For example, to change the beginning address of the slots to 20 (i. e., slots 20-29 are available for this 3498A), cut jumper A. Then, BEGINNING SLOT NUMBER = 10 [8 - (0 + 2 + 4)] = 20.

NOTE

Slot numbers for each 3498A MUST be unique to avoid spurious data which may occur if two 3498As have the same slot numbers.

When the modifications have been made, replace the Outguard Decoder and replace the protective safety cover.

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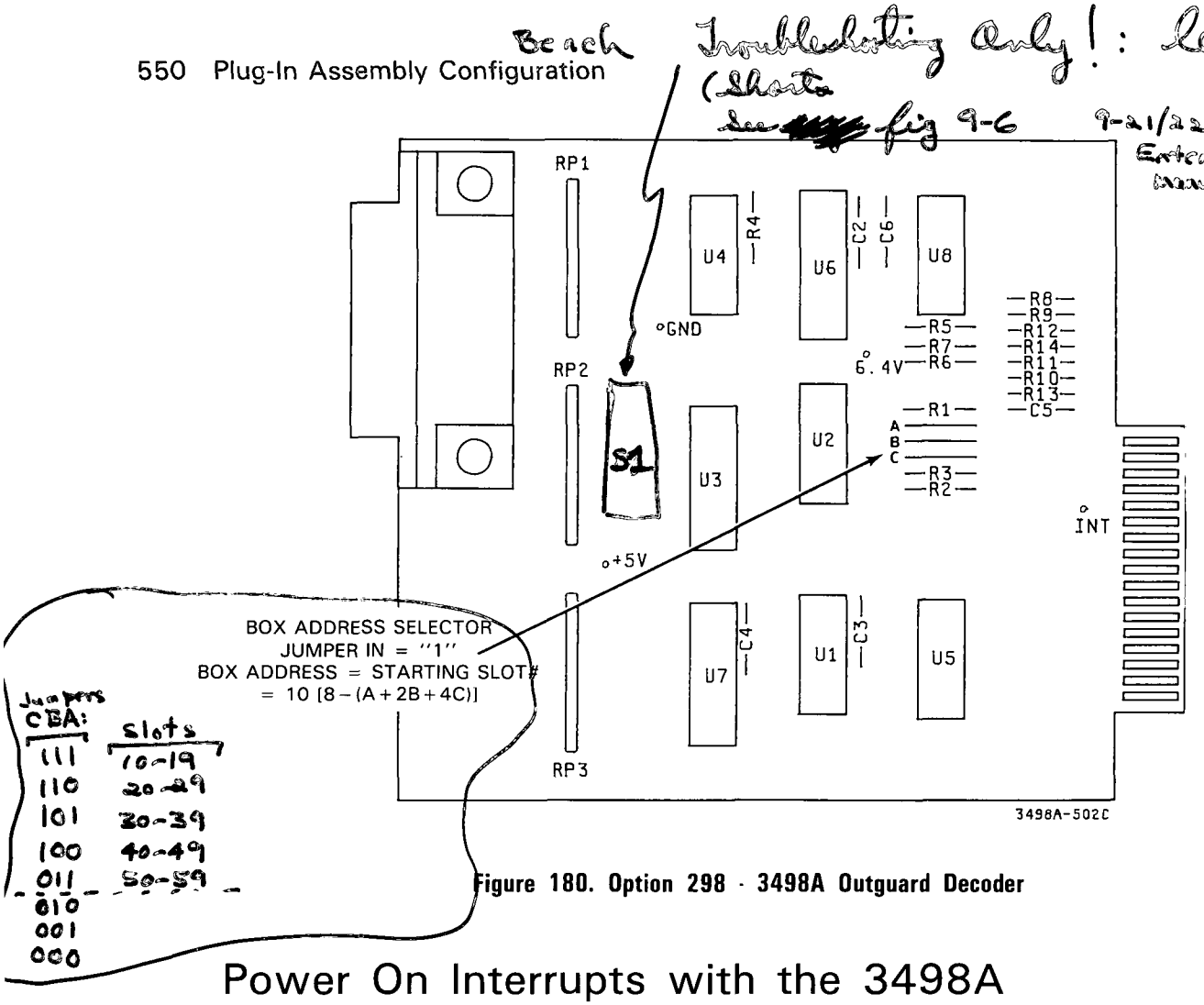


Figure 180. Option 298 - 3498A Outguard Decoder

Power On Interrupts with the 3498A

NOTE

The following discussion applies only to 3497As with HP-IB capability. For a 3497A with Serial Data (Option 232), POWER ON SRQ is automatically set.

Although both the digital input/interrupt assembly (Option 050) and the 100 kHz counter (Option 060) can cause a digital interrupt when they are placed in a 3497A, they have no interrupt capability when placed in a 3498A. The only interrupt which can be generated by the 3498A is POWER ON SRQ.

The purpose of the POWER ON SRQ is to provide an indication (when power is returned) that power has been lost to the 3498A. When the 3498A recovers from a low power condition, it sends an interrupt to the 3497A. If the 3497A has previously been enabled for POWER ON SRQ, the 3497A will then send an interrupt to the controller.

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Once POWER ON SRQ is enabled, a low power condition in either the 3497A OR the 3498A will cause an interrupt and there is no way to tell if the interrupt resulted from power loss in the 3497A, 3498A or both. If the 3497A is not set for POWER ON SRQ, interrupt is NOT sent to the controller, even if either or both instruments experienced a power failure. Also, note that POWER ON SRQ occurs when power is regained, NOT when it is lost.

To enable the 3497A for POWER ON SRQ, it is necessary to set the POWER ON SRQ switch (position #7) on the 3497A Outguard Controller to the ''1'' position. To do this, see Figure 181 and use the following sequence.

First verify that all power is removed from the 3497A and 3498As connected. Then, remove the safety cover, loosen the retaining screws holding the outguard controller and remove the outguard controller. Locate the 7-position DIP switch and set switch position #7 to the ''1'' position (see Figure 181). Replace the outguard controller and the safety cover.

ASCII Code Character		Address Switches					5-bit Decimal Code
Listen	Talk	A5	A4	A3	A2	A1	
SP	@	0	0	0	0	0	00
!	A	0	0	0	0	1	01
"	B	0	0	0	1	0	02
#	C	0	0	0	1	1	03
$	D	0	0	1	0	0	04
%	E	0	0	1	0	1	05
&	F	0	0	1	1	0	06
'	G	0	0	1	1	1	07
(	H	0	1	0	0	0	08
)	I	0	1	0	0	1	09
*	J	0	1	0	1	0	10
+	K	0	1	0	1	1	11
,	L	0	1	1	0	0	12
-	M	0	1	1	0	1	13
.	N	0	1	1	1	0	14
/	O	0	1	1	1	1	15
0	P	1	0	0	0	0	16
1	Q	1	0	0	0	1	17
2	R	1	0	0	1	0	18
3	S	1	0	0	1	1	19
4	T	1	0	1	0	0	20
5	U	1	0	1	0	1	21
6	V	1	0	1	1	0	22
7	W	1	0	1	1	1	23
8	X	1	1	0	0	0	24
9	Y	1	1	0	0	1	25
:	Z	1	1	0	1	0	26
;	[	1	1	0	1	1	27
<	\	1	1	1	0	0	28
=	]	1	1	1	0	1	29
>	~	1	1	1	1	0	30

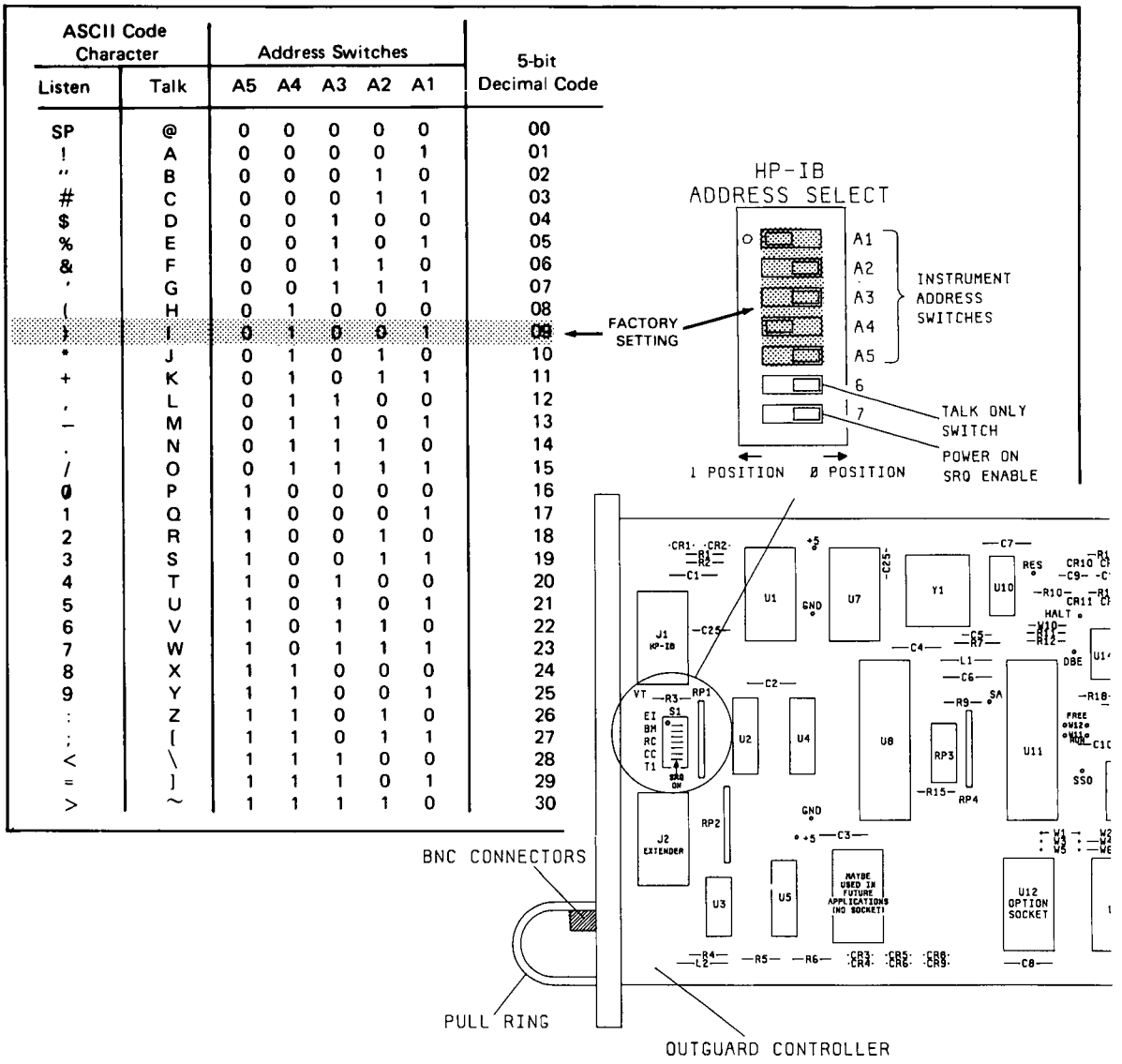


Figure 181. Option 298 - Setting 3497A Power On SRQ

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Chapter 9
EXAMPLE 3497A CONFIGURATIONS

INTRODUCTION

As shown in Chapter 1, when the 3497A is used in a Data Acquisition/Control System, the instrument can be used to perform two primary functions: data acquisition measurements and control applications. In this chapter, we'll show some typical ways that the 3497A can be used for data acquisition measurements and control applications.

Chapter 9 consists of 17 example applications divided into eight functional categories: voltage, resistance, thermocouple, frequency and pressure measurements and interrupts, switching and control sources. No attempt is made to define a specific type of user system to be connected to the 3497A. Rather, the emphasis is on the 3497A response to typical user input signals and how to configure and program the 3497A for these signals.

The examples shown apply specifically to the 3497A. If you ordered the 3497A as part of the 3054A/C or 3054DL system, consult the appropriate system manual for a wide variety of examples and programs which use the 3497A as part of the system.

All example configurations have the format shown. Examples are in summary form and assume that you are familiar with the operation and function of the 3497A and the plug-in assemblies used. The sample programs use extended BASIC language and may require conversion if you use a controller which is not compatible with this language.

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EXAMPLE CONFIGURATIONS - FORMAT

EXAMPLE TITLE

DESCRIPTION

Describes the purpose and typical applications for the example.

PROCEDURE

Shows a block diagram operation and/or shows specific settings and slot/channel numbers used.

CONFIGURATION

Shows how to connect inputs to the assemblies and/or the 3497A and how to reconfigure the 3497A and assemblies as required.

SAMPLE PROGRAM

A sample program in Extended BASIC for the example.

TYPICAL PRINTOUT

A printout (on the -hp- 85A printer) of typical values (when applicable).

COMMENTS

Precautions and/or conditions for the example.

The following table summarizes the example configurations in this chapter and is divided into the eight categories previously identified. Since the examples are grouped into functional categories, if you want to make voltage measurements, see voltage measurements. If you want to totalize events, see frequency measurements, etc.

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VOLTAGE MEASUREMENTS

EXAMPLE NUMBER	TITLE	DESCRIPTION	PAGE
①	GUARDED VOLTAGE MEASUREMENTS	Shows how to use the Option 010 assembly to make sequential DC voltage measurements from 10 electro-mechanical transducers which produce voltages in the millivolt range.	558
②	SINGLE ENDED VOLTAGE MEASUREMENT	Shows how to use the Option 010 assembly to make sequential DC voltage measurements for up to 277 single-ended inputs. This application is useful when you don't require the accuracy of three-wire techniques.	561
③	DATA LOGGING	Shows how to use the time of day function of the 3497A and the Option 010 assembly for data logging of sequentially measured DC voltages.	568
④	FAST SCAN VOLTAGE MEASUREMENT	Shows how to use the internal storage capability of the 3497A and the Option 010 assembly to make up to 60 sequential channel voltage measurements at scan rates up to 125 channels/second.	571

RESISTANCE MEASUREMENTS

⑤	2-WIRE RESISTANCE MEASUREMENTS	Shows how to use the Option 010 assembly and DVM current source for 2-wire ohms measurements.	576
⑥	4-WIRE RESISTANCE MEASUREMENTS	Shows how to use the Option 010 assembly and DVM current source for 4-wire ohms measurements. This technique is useful when highly accurate (milliohm range) measurements are required.	579

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THERMOCOUPLE MEASUREMENTS

7	HARDWARE COMP T-COUPLE MEASUREMENTS	Shows how to use the Option 020 assembly with hardware compensation to determine the temperature of a J-type thermocouple.	582
8	SOFTWARE COMP T-COUPLE MEASUREMENTS	Shows how to use the Option 020 assembly with software compensation to determine the temperatures of a mixture of J, K, T and S type thermocouples on the same assembly.	586

FREQUENCY MEASUREMENTS

9	COUNT UP/ DOWN MEASUREMENTS	Shows how to use the Option 060 assembly to count up (totalize) from a programmable start point and how to count down to zero from a programmable start point.	592
10	PERIOD MEASUREMENTS	Shows how to use the Option 060 assembly to measure the period of an input frequency.	595

PRESSURE MEASUREMENTS

11	STRAIN GAUGE MEASUREMENTS	Shows how to use the Option 070 assembly with ¼ bridge configuration to determine the strain of 120 ohm strain gauges.	598

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CONTROL APPLICATIONS - INTERRUPTS

(12)	COUNTER INTERRUPTS	Shows how to use the Option 060 assembly to generate an interrupt signal to the controller on counter overflow and/or measurement complete conditions.	602
(13)	EVENT SENSING	Shows how to use the Option 050 assembly to interrupt the controller when an external event, such as closing water valves or the end of motion by a mechanical arm, is sensed by the assembly.	608
(14)	USING THE COUNTER IN THE 3498A	Shows how to use the Option 060 and Option 050 assemblies to detect interrupts measurement complete or overflow when the Option 060 assembly is in the 3498A Extender.	611

CONTROL APPLICATIONS - SWITCHING

(15)	VOLTAGE SWITCHING/ ALARM ACTUATION	Shows how to use the Option 110 assembly to switch power from one user device to another and how to close relays to actuate an alarm.	614
(16)	HIGH VOLTAGE SWITCHING	Shows how to use the Option 115 assembly to sequentially switch power to activate motor starters.	616

CONTROL APPLICATIONS - CONTROL SOURCES

(17)	VOLTAGE AND CURRENT SOURCES	Shows how to use the Option 120 and 130 assemblies to provide a programmable voltage source and a programmable current source for control applications.	620

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EXAMPLE 1
GUARDED VOLTAGE MEASUREMENTS

DESCRIPTION

One of the primary functions of the 3497A is to make DC voltage measurements. Usually DC voltage measurements are made using the 20 Channel Relay Multiplexer assembly (Option 010). DC voltage measurements can also be made using the Relay Multiplexer assembly with Thermocouple Compensation (Option 020). This example shows how to make guarded DC voltage measurements from electromechanical transducers which produce positive millivolt level outputs.

PROCEDURE

Figure 182 shows a simplified block diagram configuration and connection diagram using the Option 010 assembly to measure the voltages from sources V1 through V10. For this example, we'll place the assembly in slot 2 and connect the sources (transducers) to the 10 relay inputs in the A Decade. Thus, the channel numbers for the transducers are 40-49.

CONFIGURATION

To configure the Option 010 assembly, see Figure 182. Connect V1 high to A0 HIGH and connect V1 low to A0 LOW on the terminal card connectors. Since we are making guarded (3-wire) measurements, connect one end of the guard lead to the A0 GUARD connector and tie the other end to V1 low, as close to the V1 source as possible. Then repeat the procedure to connect V2 to A1, etc.

When the terminal card is connected, check to see that the T/C jumper on the relay card is set to the NO T/C COMP position. After verifying that all power sources are removed from the 3497A, when the assembly is configured, insert it into slot 2 of the 3497A. Then press the LINE switch on and enter the program shown to measure the channel voltages.

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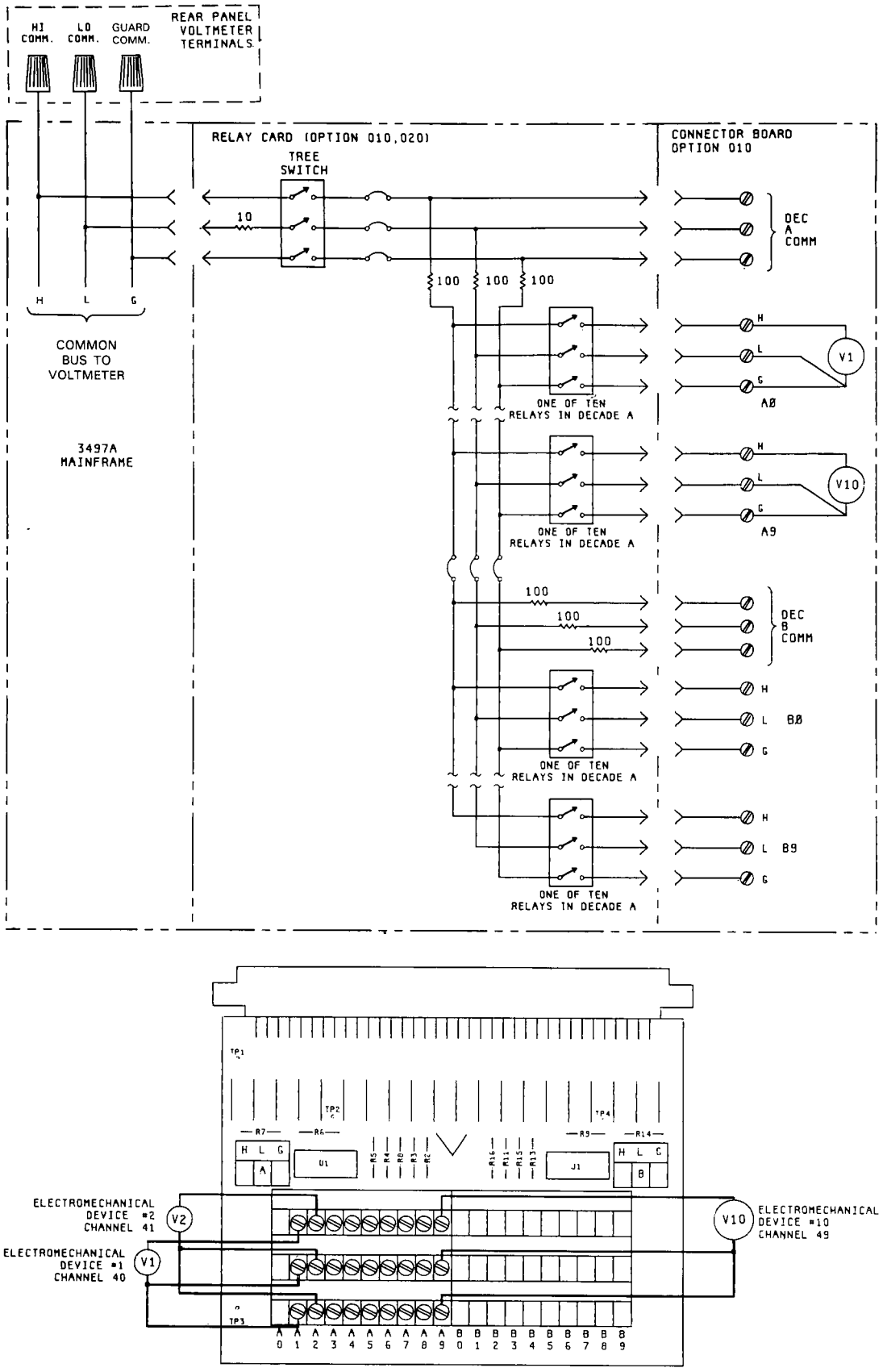


Figure 182. Example 1 - DC Voltage Measurements

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SAMPLE PROGRAM

A sample program is shown to sequentially scan channels 40 through 49, by using the AC chan# command, to measure the voltage of sources V1 through V10 and print the results (in millivolts) on an -hp-85 printer. If you want to place the assembly in a slot other than slot 2, modify lines 60 and 90 for the appropriate addresses.

```
SET INITIAL CONDITIONS

 10 PRINT ''DC VOLTAGE MEASUREMENTS''
 20 PRINT
 30 PRINT ''SOURCE'';TAB(13);''MILLIVOLTS''
 40 PRINT
 50 CLEAR 709

MEASURE VOLTAGES ON CHANNELS 40-49

 60 FOR I = 40 TO 49
 70 OUTPUT 709;''AC'',I
 80 ENTER 709;A
 90 PRINT TAB (3);I-39;TAB(15);A*1000
100 NEXT I
110 END
```

TYPICAL PRINTOUT

```
DC VOLTAGE MEASUREMENTS

  SOURCE    MILLIVOLTS

     1         398.6
     2         235.54
     .            .
     .            .
    10         612.75
```

COMMENTS

For a detailed explanation of guarded voltage measurements, see -hp- Application Note 123 ''Floating Measurements and Guarding'' (-hp- part number 5952-2153).

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EXAMPLE 2
SINGLE-ENDED MEASUREMENTS

DESCRIPTION

As factory configured, the 3497A is set to measure input voltages using 3-wire (guarded) measurement techniques. If your application doesn't require the accuracy of 3-wire measurements and if the LOW sides of all your voltage sources can be tied together, you can use 20 channnel relay multiplexer assemblies (Option 010) in the 5 slots of a 3497A to measure the inputs of up to 277 single-ended voltage inputs.

One way to do this is to use channels B0, B1 and B2 on a relay multiplexer in slot 4 to form a second level of multiplexing and then use the AC chan#,chan# command to simultaneously close a channel in slot 0, 1, 2 or 3 and the B0, B1 or B2 channel in slot 4 to measure the voltage from a specified input.

PROCEDURE

Figures 183 and 184 show the setup for single-ended measurements used in this example. Figure 183 shows the setup for an assembly in slot 0 and Figure 184 shows the configuration for an assembly in slot 4. Configurations for assemblies in slots 1 through 3 are identical to that in slot 0.

As shown in Figure 183, voltages V1 through V60 are input to relays A0 through B9. The HIGH outputs of each relay are connected to relay B0 of the assembly in slot 4 (channel 90), the LOW outputs to relay B1 (channel 91) and the GUARD outputs to relay B2 (channel 92). Similarly, V61 - V90 are input to slot 1, V91 - V120 are input to slot 2, etc.

As shown in Figure 184, for the assembly in slot 4 ONLY, channels B0, B1 and B2 (channels 90, 91 and 92) are reserved for secondary multiplexing, so only 37 voltages can be input to the slot 4 card. Total channel capacity is thus 60 x 4 = 240 + 37 = 277 single-ended inputs.

To measure a voltage, use the AC chan#,chan# command to simultaneously close the relay connected to the desired input AND relay B0, B1 or B2 of the assembly in slot 4. For example, in Figure 183, V1, V2 and V3 are connected to relay A0 (channel 0). Thus, to measure V1, use AC0,90 to simultaneously close relay A0 in slot 0 and relay B0 in slot 4. To measure V2, use AC0,91 and to measure V3, use AC0,92.

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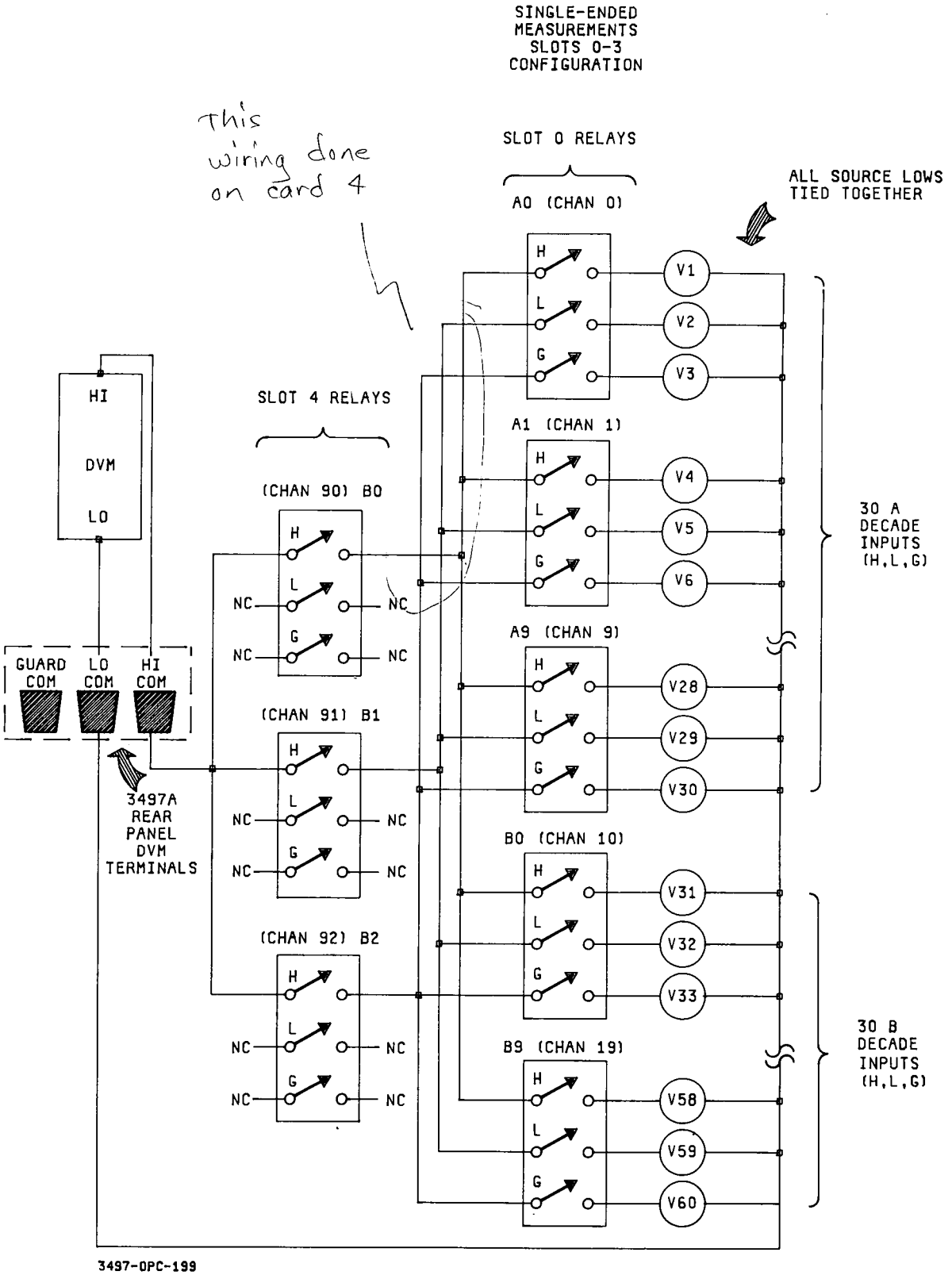


Figure 183. Example 2 - Single-Ended Measurements (Slots 0-3)

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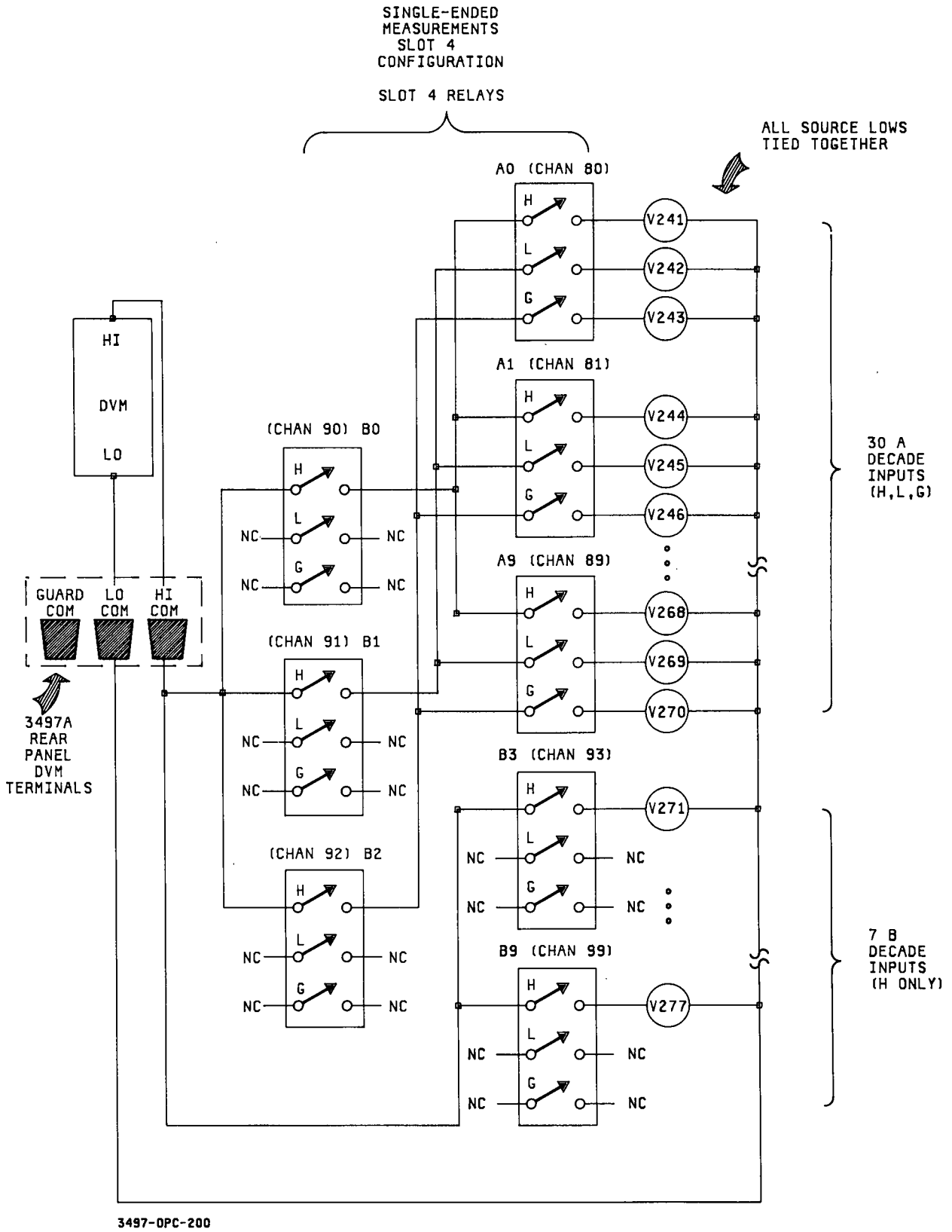


Figure 184. Example 2 - Single-Ended Measurements (Slot 4)

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CONFIGURATION

To set up the 3497A for single ended measurements, it is necessary to reconfigure both the 3497A inguard controller and the Option 010 assembly which is to be installed in slot 4 ONLY. It is not necessary to modify the other 4 assemblies.

To configure the 3497A, see Figure 185. Ensure that all voltage sources are removed from the 3497A then remove the protective cover and the inguard controller. Open jumpers JMP1 and JMP2 on the inguard controller board and replace the inguard controller and protective cover.

To configure the Option 010 assembly to be placed in slot 4, see Figure 186. For this assembly ONLY, the seven B Decade inputs (V271 - V277) are connected to the HIGH connectors for relays B3 through B9 respectively, and B0, B1 and B2 are used for secondary multiplexing.

To configure the other four Option 010 assemblies, follow the connection diagram shown for the A Decade in Figure 186 for both the A Decade and B decade inputs.

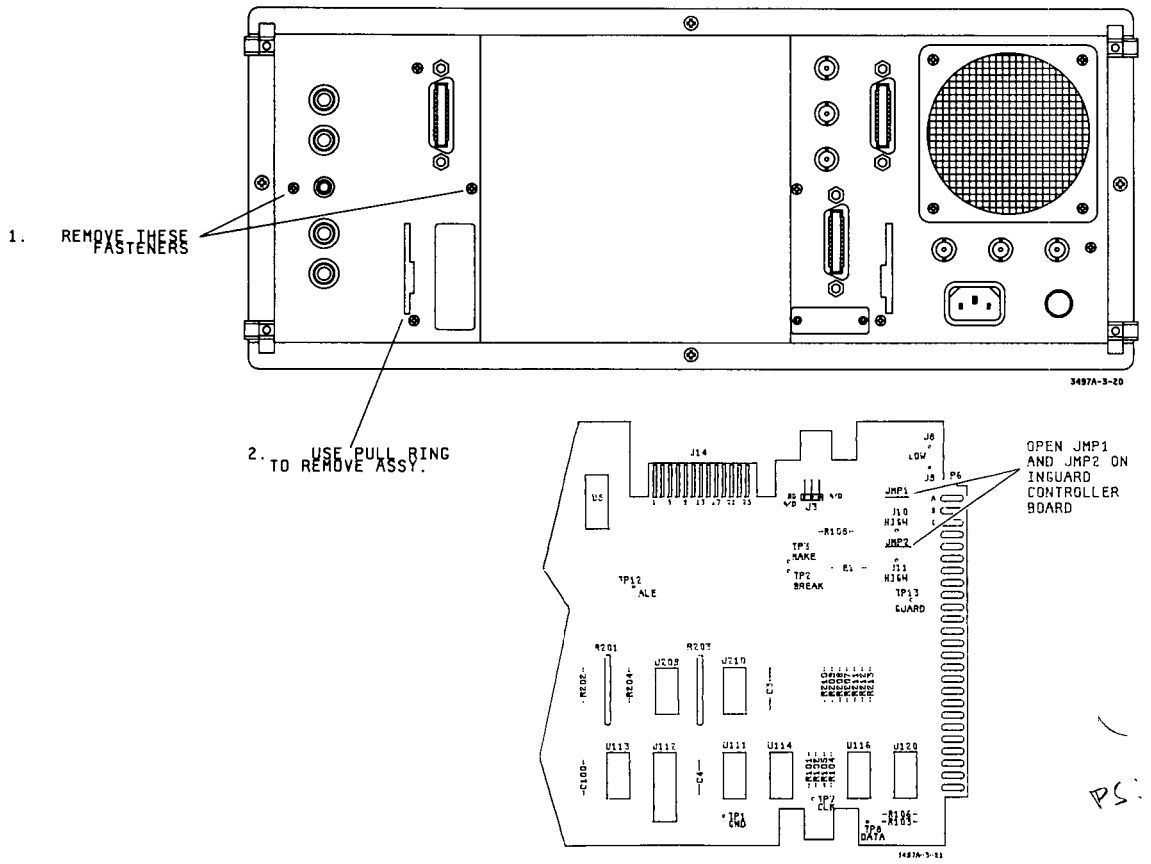


Figure 185. Example 2 - Configuring 3497A for Single-Ended Measurements

See Pg 8-E-15 of Inst. Service Manual.

PS: Don't need to remove these if wire card 4 directly to an external DVM.

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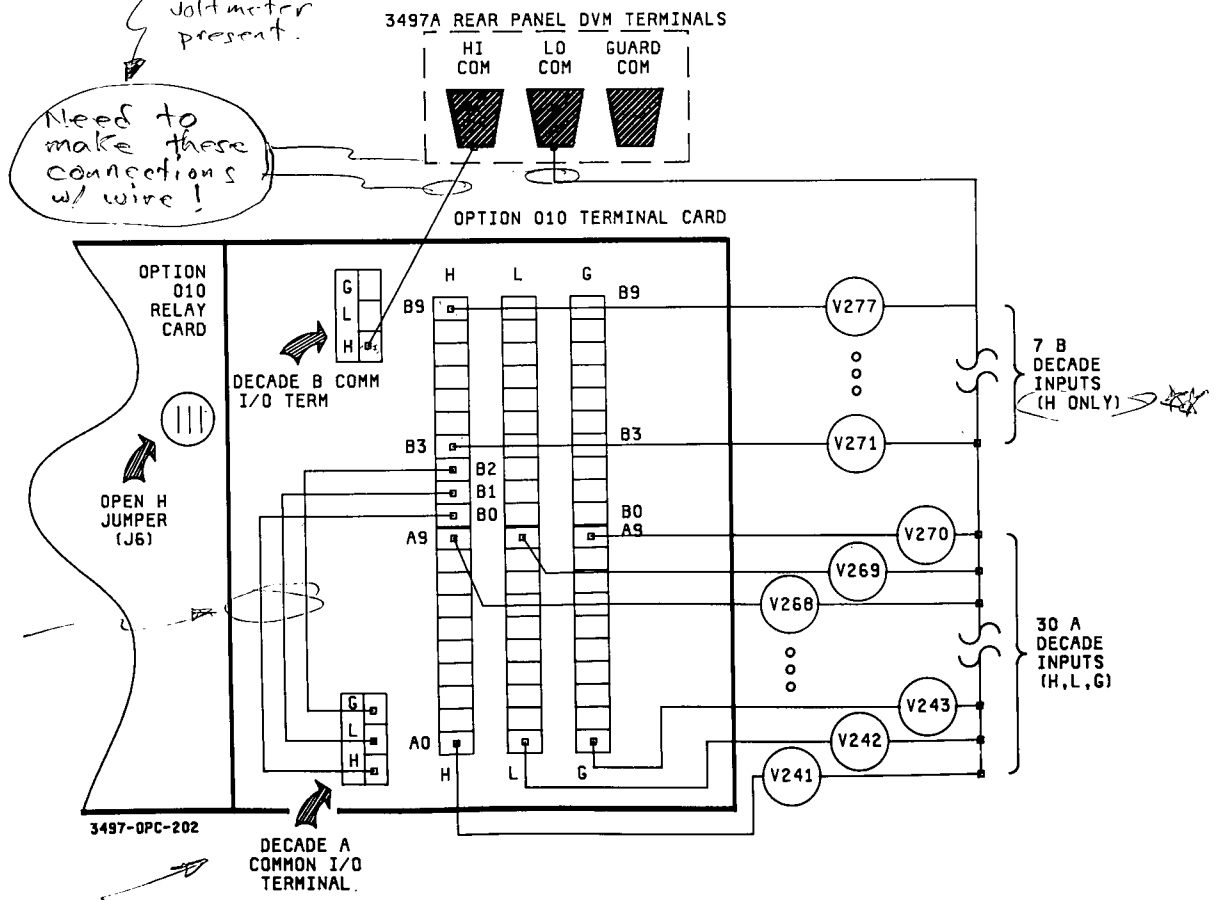


Figure 186. Example 2 - Configuring Option 010 Assembly (Slot 4)

SAMPLE PROGRAM

An example program is shown which sequentially measures the input voltages from 277 sources, assuming that the assembly with secondary multiplexing is in slot 4 and thus the B0 relay has address 90, the B1 relay has address 91 and the B2 relay has address 92.

Although the voltage source designations are arbitrary, for this program V1 is connected to relay A0 HIGH, V2 to relay A0 LOW and V3 to relay A0 GUARD, etc. The assembly with V1 through V60 connected is in slot 0, etc., as shown.

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SLOT	DECADE	CHANNELS	SOURCE (V)
0	A B	0-9 10-19	1 - 30 31 - 60
1	A B	20-29 30-39	61 - 90 91 - 120
2	A B	40-49 50-59	121 - 150 151 - 180
3	A B	60-69 70-79	181 - 210 211 - 240
4	A B	80-89 93-99*	241 - 270 271 - 277**

* Channels 90-92 reserved for secondary multiplexing.

** Can only input 7 voltage sources on B decade in slot 4.

The program sequences through V1 through V270 by using an AC chan#,90; AC chan#,91 or AC chan#,92 command. Since secondary multiplexing is not used for inputs V271 through V277, the program sequences through these inputs with an AC chan# (chan# = 93-99) command.

```
SET INITIAL CONDITIONS

10 J=1
20 DIM A(90,3)
30 PRINT ''SINGLE ENDED MEASUREMENTS''
40 PRINT
50 PRINT ''SOURCE'';TAB(17);''VOLTS''
60 PRINT
70 CLEAR 709

MEASURE VOLTAGES V1 THROUGH V270

80 FOR I = 0 TO 89
90 FOR N = 90 TO 92
100 OUTPUT 709; ''AC'',I;'','';N
110 ENTER 709; A(I,N-89)
120 PRINT J;TAB(15);A(I,N-89)
130 J=J+1
140 NEXT N
150 NEXT I

MEASURE VOLTAGES V271 THROUGH V277
```

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```
160 FOR K = 93 TO 99
170 OUTPUT 709; ''AC'',K
180 ENTER 709; B
190 PRINT K+178; TAB (15); B
200 NEXT K
210 END
```

TYPICAL PRINTOUT

SINGLE ENDED MEASUREMENTS

SOURCE	VOLTS
1	1.67853
2	2.89763
3	5.99987
.	
.	
277	0.87654

COMMENTS

For the program to work properly, you must have 20 channel relay multiplexer assemblies in slots 0 through 4 and the assembly which is modified for secondary multiplexing (on relays B0, B1 and B2) must be in slot 4. If a voltage source (V1 through V277) is not connected, the number printed out will be of random background voltage.

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EXAMPLE 3
DATA LOGGING

DESCRIPTION

In the GUARDED VOLTAGE MEASUREMENTS example (EXAMPLE 1), we showed how to make guarded DC voltage measurements from electro-mechanical transducers which produce positive millivolt output levels. In this example, we'll add the time of day to the printout so that the 3497A can act as a Data Logger for DC voltage measurements.

PROCEDURE

Figure 187 shows a simplified block diagram configuration and connection diagram using the Option 010 assembly to measure the voltages from sources V1 through V10. For this example, we'll place the assembly in slot 2 and connect the sources (transducers) to the 10 relay inputs in the A Decade. Thus, the channel numbers for the transducers are 40-49.

CONFIGURATION

To configure the Option 010 assembly, see Figure 187. Connect V1 high to A0 HIGH and connect V1 low to A0 LOW on the terminal card connectors. Since we are making guarded (3-wire) measurements, connect one end of the guard lead to the A0 GUARD connector and tie the other end to V1 low, as close to the V1 source as possible. Then repeat the procedure to connect V2 to A1, etc.

When the terminal card is connected, check to see that the T/C jumper on the relay card is set to the NO T/C COMP position. When the assembly is configured, after verifying that all power sources are removed from the 3497A, insert the assembly into slot 2 of the 3497A. Then press the LINE key ON and enter the program shown to measure the channel voltages.

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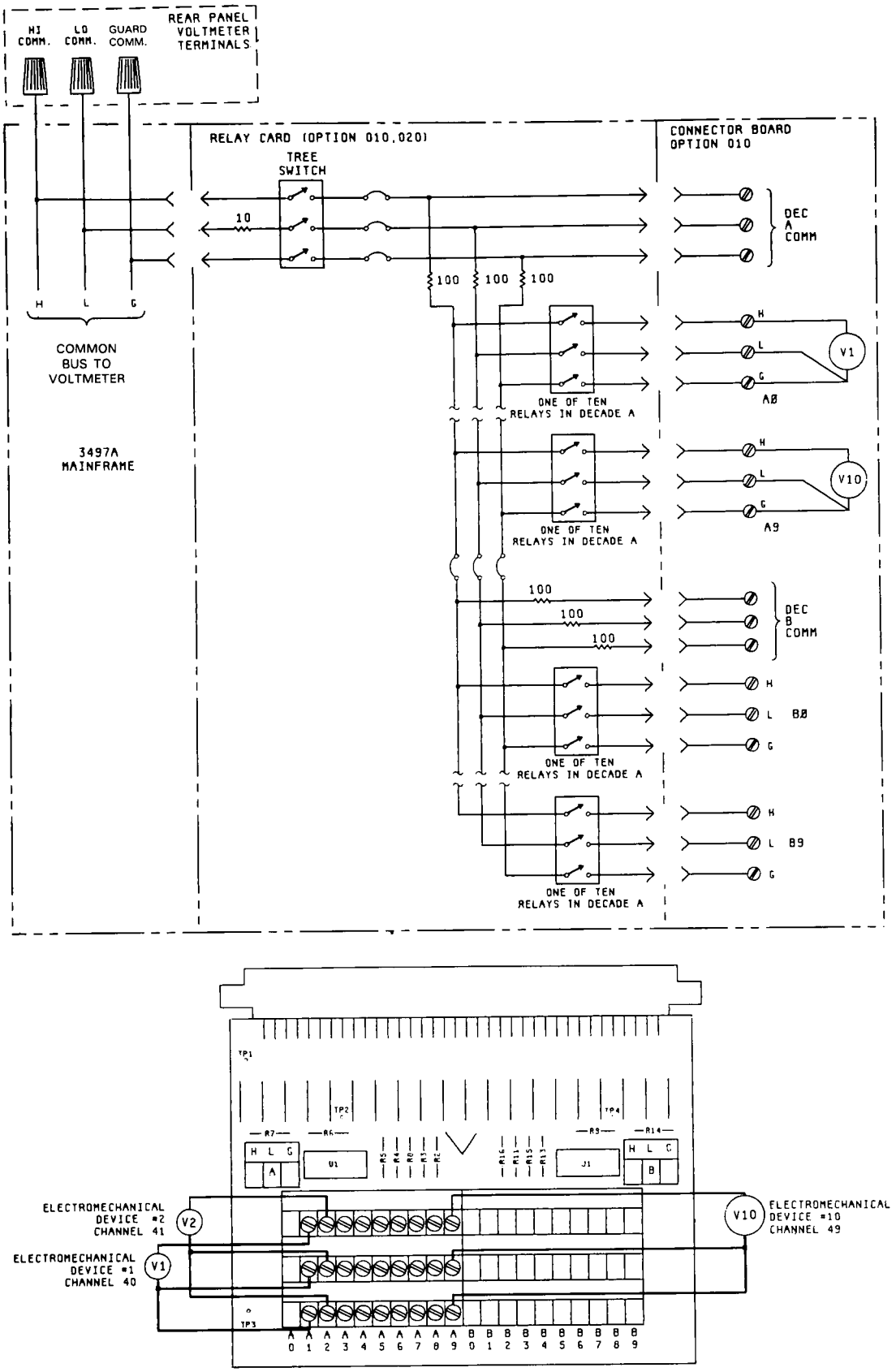


Figure 187. Example 3 - Data Logging - DC Voltages

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SAMPLE PROGRAM

A sample program is shown to sequentially scan channels 40 through 49 (by using the AC chan# command), to measure the voltage of sources V1 through V10 and print the time of day and source voltage (in millivolts) for each channel.

If you want to place the Option 010 assembly in a slot other than slot 2, modify line 80 for the appropriate addresses. Also, for this program, the time of day is set for 1:00:00 PM (13:00:00 on the 24-hour clock). For real-time data logging, set line 70 for the appropriate time of day.

```
SET INITIAL CONDITIONS

10 PRINT ''DATA LOGGING - DC VOLTS''
20 PRINT
30 PRINT ''CHAN'';TAB(10);''TIME'';TAB(23);''MILLIVOLTS''
40 PRINT
50 DIM A$[16]
60 CLEAR 709
70 OUTPUT 709; ''VT4VF3TD0715130000''

MEASURE VOLTAGES ON CHANNELS 40-49 AND INPUT TIME

80 FOR I = 40 TO 49
90 OUTPUT 709;''AC'',I
100 ENTER 709;A$,B
110 PRINT I;TAB(7);A$;TAB(23);B*1000
120 NEXT I
130 END
```

TYPICAL PRINTOUT

```
DATA LOGGING - DC VOLTAGE MEASUREMENTS

CHAN        TIME          MILLIVOLTS

 40     07:15:13:00:00      15.438
 41     07:15:13:00:01      14.999
  .           .                .
  .           .                .
 49     07:15:13:00:08      16.317
```

COMMENTS

For a detailed explanation of guarded voltage measurements, see -hp- Application Note 123 ''Floating Measurements and Guarding'' (-hp- part number 5952-2153). If desired, a wait statement (i. e., 115 WAIT 1000 for a 1 second delay) can be added between 110 and 120.

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EXAMPLE 4
FAST SCAN VOLTAGE MEASUREMENTS

DESCRIPTION

A useful application for the 3497A is high-speed voltage measurements on sequential channels. In this example, we'll show how to use the 3497A to scan 60 channels at an approximate 125 channel/second rate and store the measured DC voltages in the -hp- 85 for future printout. With this method, you can take nearly simultaneous measurements of up to 60 channel inputs.

PROCEDURE

For this example, we'll assume that a DC voltage source is connected to each of channels 0-59 (Option 010 assemblies in slots 0, 1 and 2) and that it is required to sequentially scan all 60 channel inputs after the occurrence of a specified system event, such as a switch closure.

To initiate the 60 readings, connect an external input capable of generating a high-to-low TTL pulse to the EXT TRIG port. When the specified event (switch closure) occurs, the TTL pulse to the EXT TRIG port causes the DVM to take and store a reading from each of the 60 channels. After all 60 readings are stored in the 3497A, they are transferred to the controller for printout.

To indicate speed of measurement for different 3497A resolutions, the chart shows the approximate time required to make a measurement with 3½, 4½ and 5½ digit resolution. The times shown are times to make the measurements and do not include transfer time to the controller.

Thus, for example, with 3½ digit resolution about 8 ms is required to measure each channel (a 125 channel/second measurement rate) so less than a half second is required to scan 60 channels (the maximum number of ASCII readings which can be stored).

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APPROXIMATE SCAN RATES AND MEASUREMENT TIMES - FAST SCAN

NUMBER DIGITS	TIME TO MEASURE ONE CHANNEL (MS)	SCAN RATE (CHAN/SEC)
3½	8	125
4½	9	111
5½	25	40

CONFIGURATION

Figure 188 shows a simplified block diagram configuration and connection diagram using the Option 010 assembly to measure the voltages from sources V1 through V60. For this example, we'll place the assemblies in slots 0,1 and 2 so the channel numbers are 0-59.

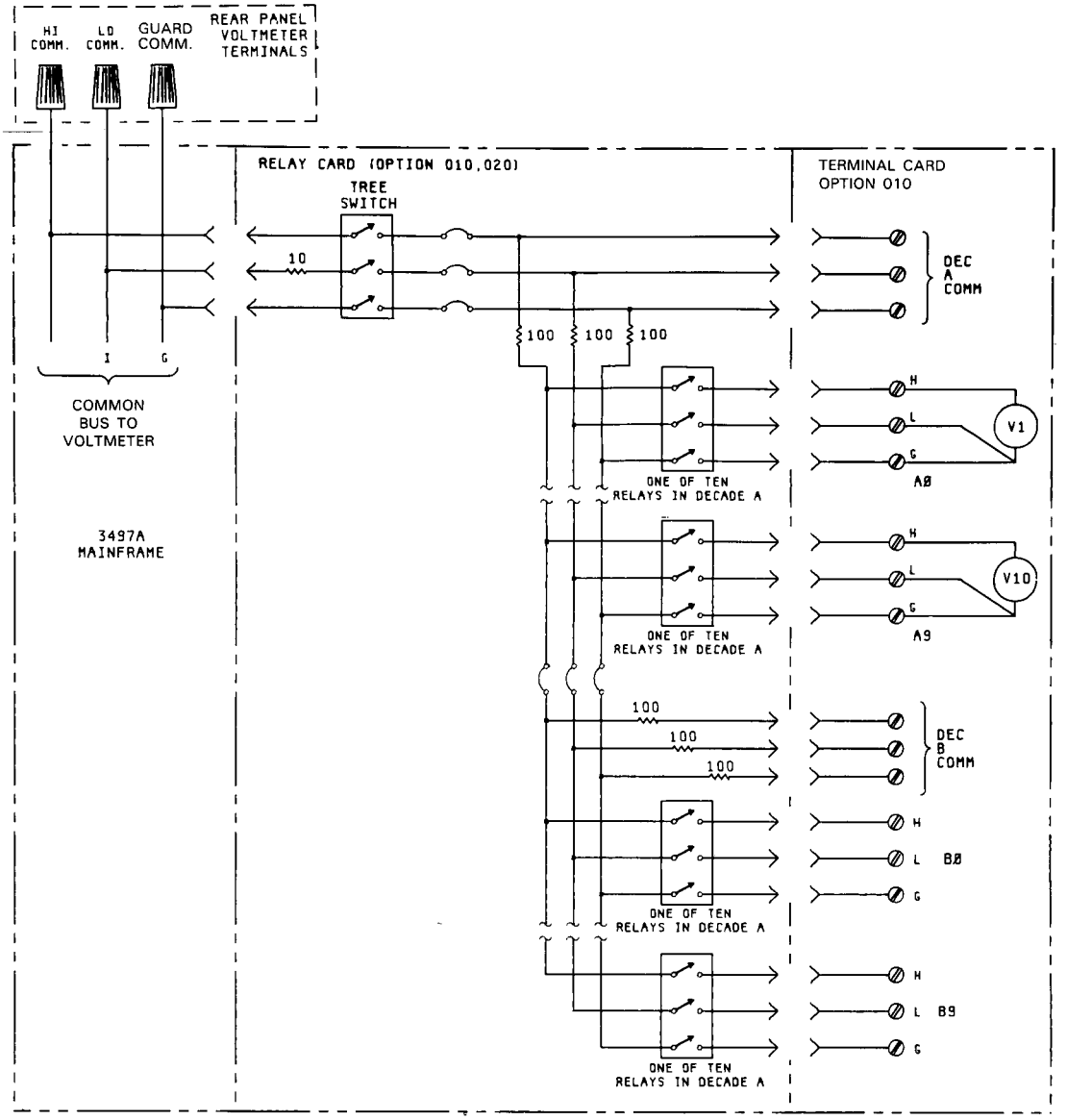
For fast scan, it is necessary to enable the EXT INCR port on the rear panel of the 3497A (by using an AE1 command) and to connect a BNC cable between the VM COMPLETE port and the EXT INCR port (see Figure 189). Then, when the DVM finishes taking a reading, the pulse out of the VM COMPLETE port causes the 3497A to increment to the next channel.

To configure the Option 010 assembly, see Figure 188. Connect V1 high to A0 HIGH and connect V1 low to A0 LOW on the terminal card connectors. Since we are making guarded (3-wire) measurements, connect one end of the guard lead to the A0 GUARD connector and tie the other end to V1 low, as close to the V1 source as possible. Then repeat the procedure to connect V2 to A1, etc.

When the terminal card is connected, check to see that the T/C jumper on the relay card is set to the NO T/C COMP position. When the assembly is configured, after verifying that all power sources are removed from the 3497A, insert the assembly into slot 0 of the 3497A. Repeat the procedure for the next two assemblies and insert them in slots 1 and 2, respectively.

The next step is to connect a BNC connector from the VM COMPLETE port to the EXT INCR port and connect an external trigger source to the EXT TRIG port with a BNC cable as shown in Figure 189. Then, press the LINE switch on and enter the program shown into the -hp- 85.

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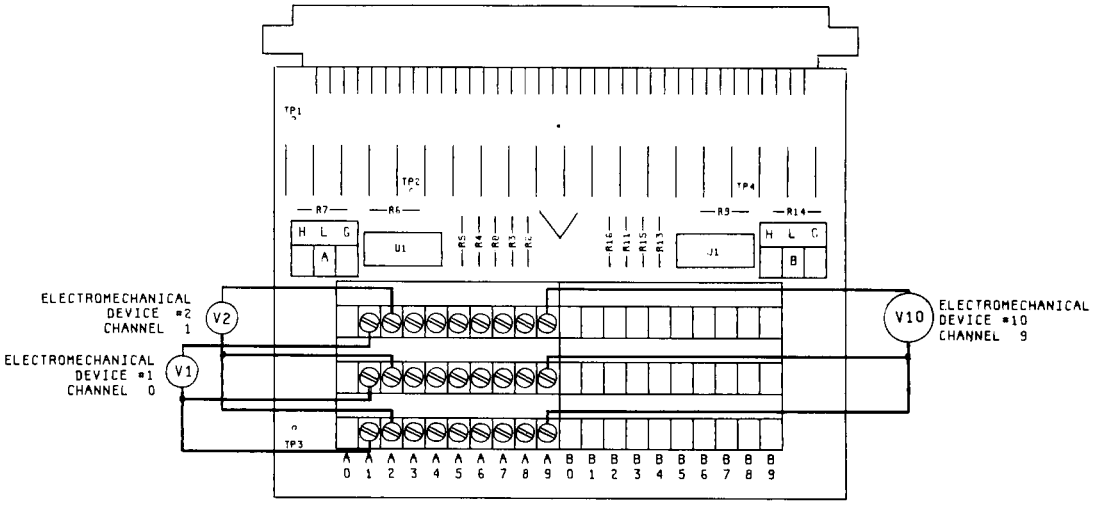


Figure 188. Example 4 - Fast Scan - Option 010 Connections

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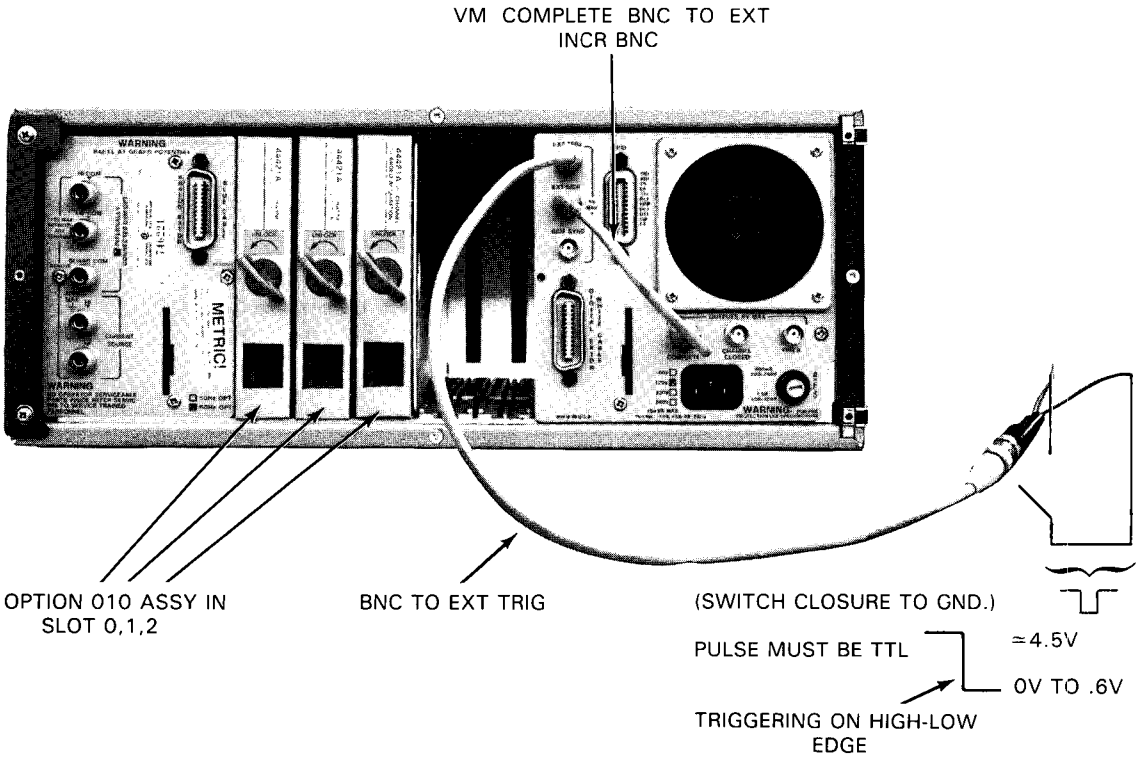


Figure 189. Example 4 - Fast Scan - Rear Panel Connections

SAMPLE PROGRAM

A sample program is shown which sequentially scans channels 0 through 59 to measure the voltage of sources V1 through V60 and print the voltage measured for each channel. If you place the Option 010 assemblies in slots other than 0, 1 and 2, modify line 70 for the appropriate addresses.

The main program is executed until an external trigger is input to the EXT TRIG port at which time the program jumps to line 1000 and the 60 readings stored in the 3497A are transferred to the controller and printed out. Line 90 sets the initial conditions for the 3497A, to await the specified event occurrence (trigger input). The conditions are:

VT4	=	DVM Trigger Hold
VD3	=	3½ Digit Resolution
VA0	=	Voltmeter Autozero OFF
SE1	=	Set 3497A for DATA READY SRQ
AF0	=	First Channel is 0
AF59	=	Last Channel is 59
VN60	=	DVM to take 60 readings/trigger input
VT2	=	DVM to External Trigger
VS1	=	Internal DVM storage (in ASCII format)
AC0	=	Close channel 0
AE1	=	Enable EXT INCR port

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```
SET INITIAL CONDITIONS

 10 PRINT ''FAST SCAN MEASUREMENTS''
 20 PRINT
 30 PRINT ''CHANNEL'';TAB(12);''VOLTS''
 40 PRINT
 50 DIM A(60)
 60 CLEAR 709
 70 ON INTR 7 GOSUB 1000
 80 ENABLE INTR 7;8
 90 OUTPUT 709; ''VT4VD3VA0SE1AF0AL59VN60VT2VS1AC0AE1''
100 !Main Program
110 GOTO 110
120 END

INTERRUPT SUBROUTINE

1000 P = SPOLL (709)
1010 IF P <>65 THEN RETURN
1020 OUTPUT 709; ''VT4AE0VS''
1030 FOR I = 1 TO 60
1040 ENTER 709 USING ''#,K'';A(I)
1050 PRINT TAB (3);I-1;TAB(10);A(I)
1060 NEXT I
1070 STATUS 7,1;A
1080 RETURN
```

TYPICAL PRINTOUT (3½ DIGIT RESOLUTION)

```
FAST SCAN MEASUREMENTS

  CHANNEL     VOLTS

     0          3.98
     1          2.35
     .            .
     .            .
    59          2.21
```

COMMENTS

1. The program shown is for 3½ digit resolution which provides the highest reading speed. For 4½ digit or 5½ digit resolution with lower reading speed, change ''VD3'' in line 90 to ''VD4'' or ''VD5'' as required.

2. For a detailed explanation of guarded voltage measurements, see -hp- Application Note 123 ''Floating Measurements and Guarding'' (-hp- part number 5952-2153).

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EXAMPLE 5
2-WIRE RESISTANCE MEASUREMENTS

DESCRIPTION

In the VOLTAGE MEASUREMENTS examples, we showed some ways that the 20 Channel Relay Multiplexer assembly (Option 010) can be used to measure voltages input to the 3497A. The Option 010 assembly can also be combined with the current source in the 3497A internal DVM (Option 001) to make resistance measurements. In this example, we'll show a way to make 2-wire ohms measurements. If your application requires highly accurate measurements, see the 4-WIRE RESISTANCE MEASUREMENTS example (EXAMPLE 6).

PROCEDURE

Figure 190 illustrates the procedure for making 2-wire resistance measurements and shows the connection diagram for the Option 010 assembly. The current source output from the 3497A is connected to the Decade B COMMON connector. Note that measurement errors will occur if the current source is placed on the Decade A COMMON connector because of the 100 ohm series resistors in the voltage sense path.

When the current source is set for a specified output (10 μA, 100 μA or 1 mA) and a channel relay is closed, the voltage drop across the channel resistance can be measured and, since I is known, the resistance computed from R = E/I.

CONFIGURATION

You can measure the resistance of up to 20 resistors with a single Option 010 assembly or up to 100 resistances per 3497A. See Figure 190 which shows connections for resistors tied to channels A0 and A9.

Note that the current source from the 3497A rear panel CURRENT SOURCE terminals is connected to the B COM connector on the Option 010 terminal card by a shielded twisted pair (for better measurement accuracy).

When the terminal card is configured, check the relay card to insure that the T/C jumper is in the NO T/C COMP position before installing the assembly in the 3497A. To use the program shown, install the assembly in slot 3.

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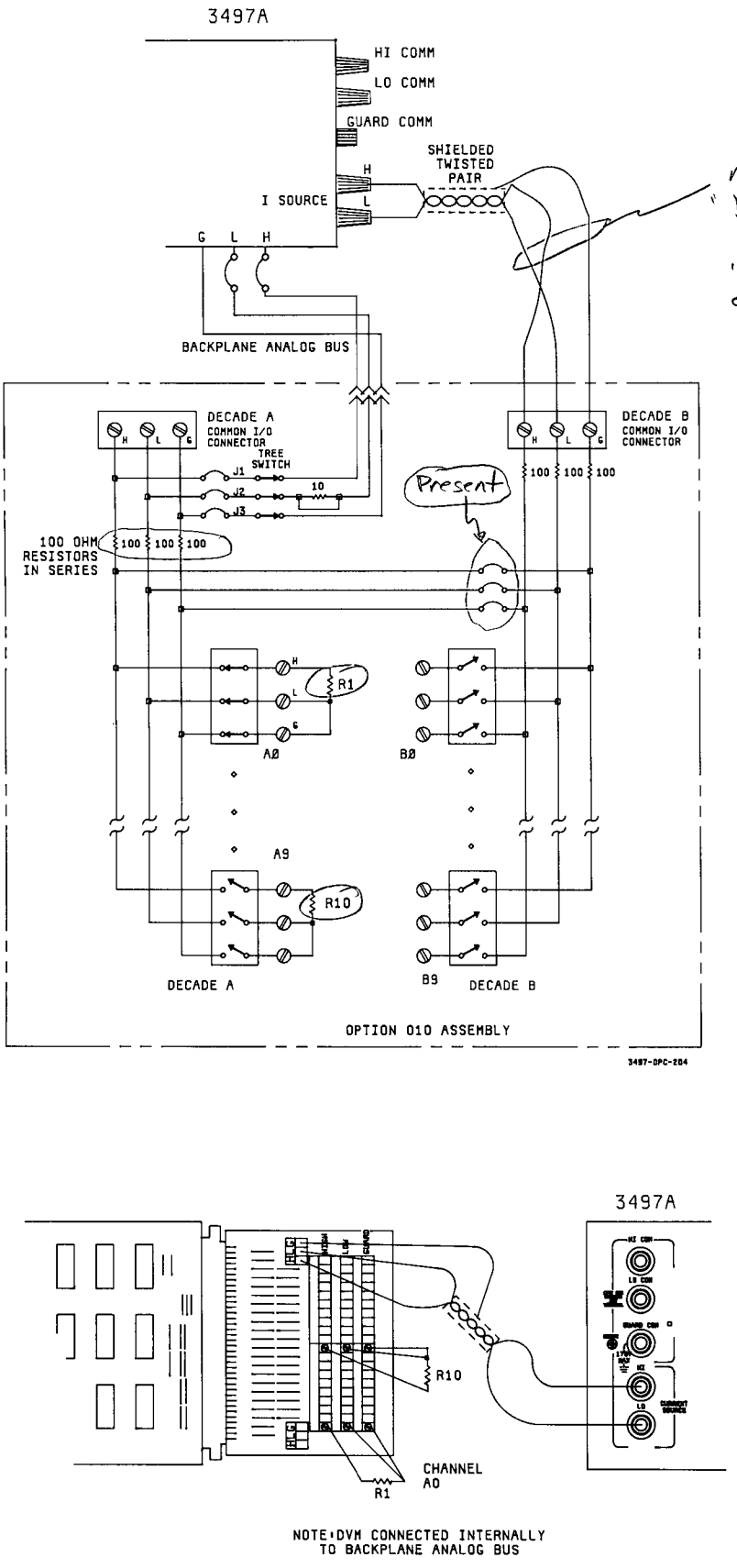


Figure 190. Example 5 - 2-Wire Resistance Measurements

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SAMPLE PROGRAM

A sample program is shown to measure the resistances of 10 resistors with R1 connected to channel A0, R2 to channel A1, etc. Since the Option 010 assembly is in slot 3, channel addresses are 60-69. The program sets a 1 mA output from the current source with the VC3 command. Thus, resistances R1 - R10 can be computed from Rx = Vx * 1000, where Vx is the channel voltage measured.

```
SET INITIAL CONDITIONS

10 PRINT ''2-WIRE RESISTANCE MEASUREMENTS''
20 PRINT
30 PRINT ''RESISTOR'';TAB(20);''OHMS''
40 PRINT
50 CLEAR 709
60 OUTPUT 709;''VC3''

MEASURE VOLTAGES ON CHANNELS 60-69 AND COMPUTE RESISTANCE

70 FOR I = 60 TO 69
80 OUTPUT 709; ''AC'',I
90 ENTER 709;A
100 PRINT TAB(2);I-59;TAB(18);A*1000
110 NEXT I
120 END
```

1ma current source range

eg AC,60

R = V/I
= V/.001
= V*1000

TYPICAL PRINTOUT

```
2-WIRE RESISTANCE MEASUREMENTS

RESISTOR      OHMS

   1          463.54
   2          110.78
   .            .
   .            .
  10          100.56
```

COMMENTS

If your application requires using the A Decade COMMON terminal to input current for A Decade (or B Decade) 2-wire resistance measurements, you can short out the 100 ohm series resistors for more accuracy. However, see Chapter 8, Option 010 description before doing this procedure.

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EXAMPLE 6
4-WIRE RESISTANCE MEASUREMENTS

DESCRIPTION

The VOLTAGE MEASUREMENTS examples showed some ways that the 20 Channel Relay Multiplexer assembly (Option 010) can be used to measure voltages input to the 3497A. The Option 010 assembly can also be combined with the current source in the 3497A internal DVM (Option 001) to make resistance measurements. In this example, we'll show a way to make 4-wire ohms measurements. If your application does not require highly accurate measurements, see the 2-WIRE RESISTANCE MEASUREMENTS example (EXAMPLE 5).

PROCEDURE

Figure 191 illustrates the procedure for making 4-wire resistance measurements and shows a connection diagram for the Option 010 assembly. The current source output from the 3497A is connected to the Decade B COMMON connector. Jumpers J4, J5 and J6 must be opened since it is necessary to close two channels simultaneously (by using the AC chan#,chan# command).

When the current source is set for a specified output (10 μA, 100 μA or 1 mA) and a channel relay is closed, the voltage drop across the channel resistance can be measured and, since the current I is known, the resistance computed from R = E/I.

CONFIGURATION

With 4-wire ohms techniques, you can measure the resistance of up to 10 resistors with a single Option 010 assembly or up to 50 resistances per 3497A. See Figure 191 which shows connections for a resistor tied to channels A0 and B0.

Note that the current source from the 3497A rear panel CURRENT SOURCE terminals is connected to the B COM connector on the Option 010 terminal card by a shielded twisted pair (for better measurement accuracy).

When the terminal card is configured, check the relay card to ensure that the T/C jumper is in the NO T/C COMP position before installing the assembly in the 3497A. To use the program shown, install the assembly in slot 3.

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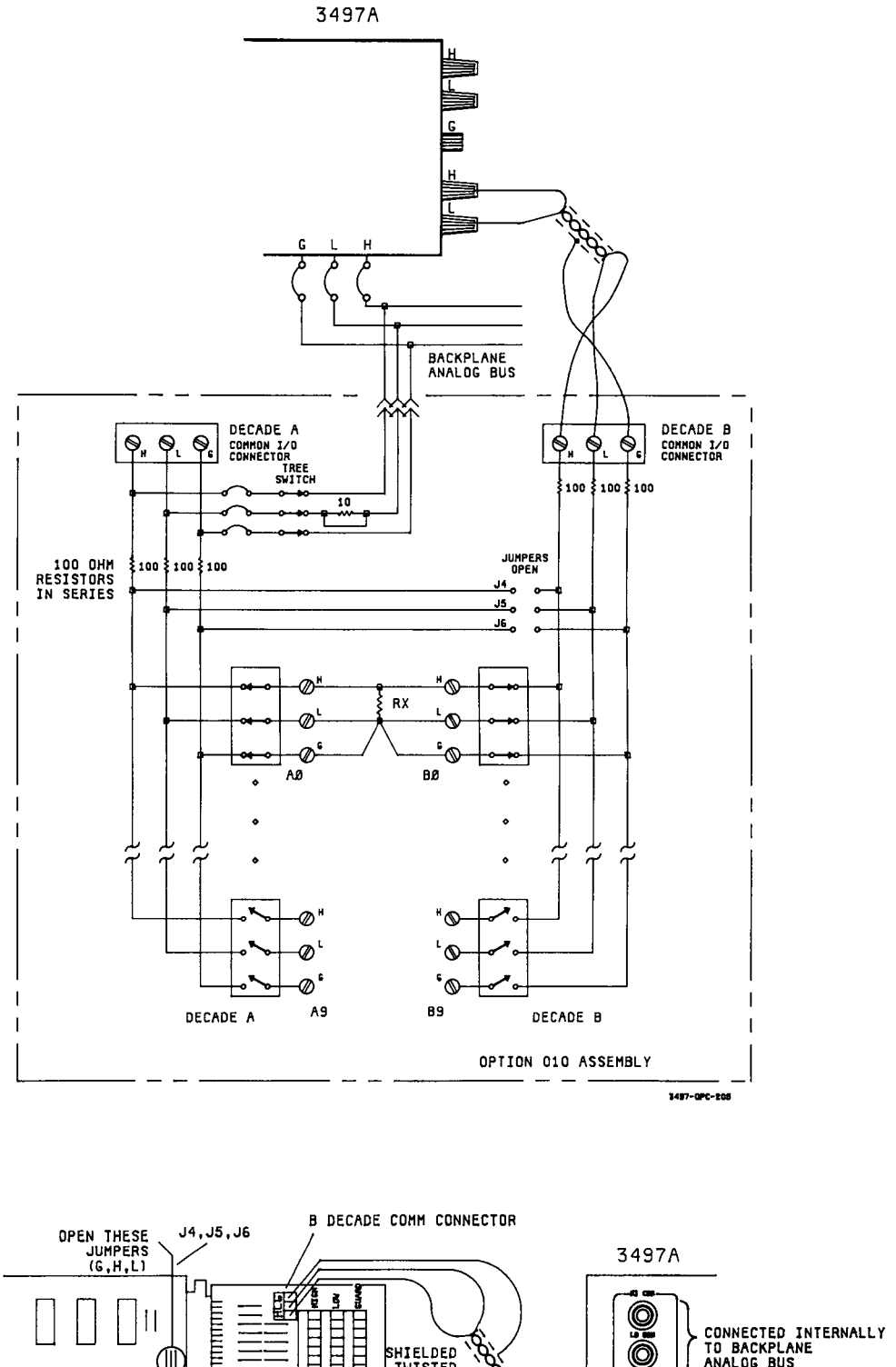


Figure 191. Example 6 - 4-Wire Resistance Measurements

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SAMPLE PROGRAM

A sample program is shown to measure the resistances of 10 resistors with R1 connected to channel A0, R2 to channel A1, etc. Since the Option 010 assembly is in slot 3, channel addresses are 60-69. The program sets a 1 mA output from the current source with the VC3 command. Thus, the resistances R1 - R10 can be computed from Rx = Vx * 1000, where Vx is the channel voltage measured.

```
SET INITIAL CONDITIONS

10 PRINT ''4-WIRE RESISTANCE MEASUREMENTS''
20 PRINT
30 PRINT ''RESISTOR'';TAB(20);''OHMS''
40 PRINT
50 CLEAR 709
60 OUTPUT 709;''VC3''

MEASURE VOLTAGES ON CHANNELS 60-69 AND COMPUTE RESISTANCE

70 FOR I = 60 TO 69
80 OUTPUT 709; ''AC'',I;'','';I+10
90 ENTER 709;A
100 PRINT TAB(2);I-59;TAB(18);A*1000
110 NEXT I
120 END
```

TYPICAL PRINTOUT

```
4-WIRE RESISTANCE MEASUREMENTS

RESISTOR      OHMS

   1          463.54
   2          110.78
   .            .
   .            .
  10          100.56
```

COMMENTS

If your application does not require highly accurate results and you want a lower cost/measurement, you may want to use the 2-wire ohms measurement technique shown in the 2-WIRE RESISTANCE MEASUREMENTS example (EXAMPLE 5).

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EXAMPLE 7
HARDWARE COMPENSATED THERMOCOUPLE MEASUREMENTS

DESCRIPTION

The 20-Channel Relay Multiplexer with Thermocouple Compensation assembly (Option 020) can be used to determine the temperature of B,E,J,K,R,S and T type thermocouples. The assembly can be configured for hardware compensation or software compensation. This example shows how the temperatures of up to 20 J-type thermocouples can be determined by using the Option 020 assembly and standard look-up (N.B.S.) voltage-to-temperature tables.

PROCEDURE

Figure 192 shows a simplified block diagram and connection diagram to measure the voltage outputs from up to 20 thermocouples connected to an Option 020 assembly in slot 0. Since hardware compensation is to be used, only ONE type of thermocouple can be used per assembly (i. e., you can't mix J and K types on an assembly, etc.).

For this example, we'll scan the 20 channels and measure the voltage on each channel. Since the assembly is in slot 0, channel numbers are 0 to 19. Then, we can use a standard lookup table to convert the measured voltages to equivalent temperatures in degrees F.

CONFIGURATION

Figure 193 shows how to configure the Option 020 terminal card for hardware compensation of J-type thermocouples. Since the Option 020 assembly is factory configured for software compensation, the jumper shown in Figure 193 must be removed when R120 and R100 are installed.

After configuring the terminal card, check to make sure that the T/C COMP jumper on the relay card is in the T/C COMP position. Then, connect thermocouples as shown in Figure 193. Note the various ways to connect thermocouples, depending on the type.

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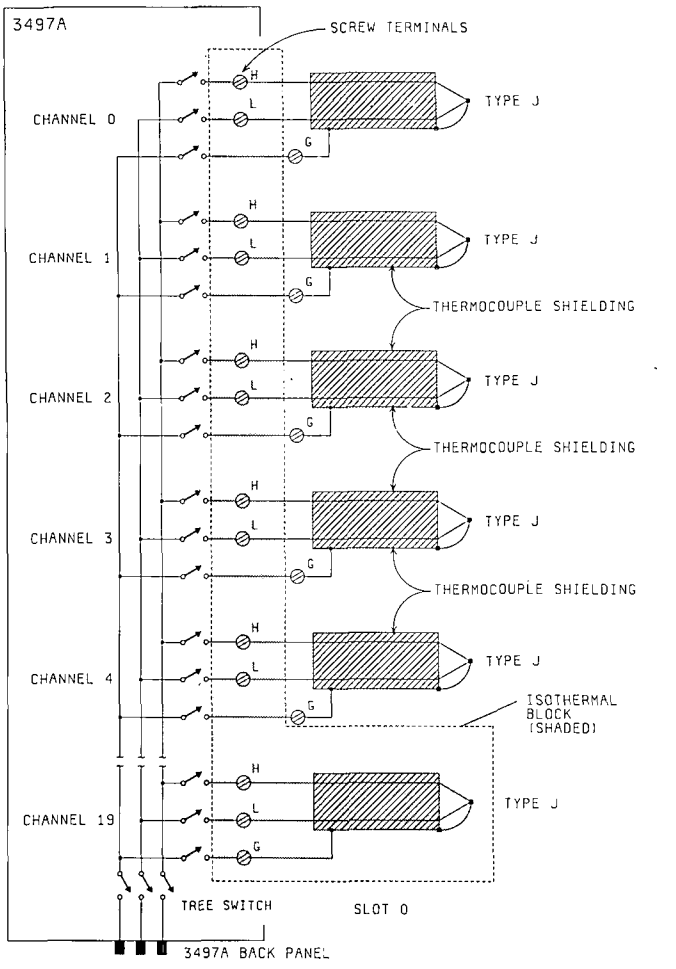


Figure 192. Example 7 - Hardware Compensation J-Type Thermocouples

SAMPLE PROGRAM

The sample program shown measures the voltage from thermocouples T1 - T20, where T1 is connected to A0 (channel 0), T2 to A1 (channel 1), etc. and prints the voltage measureed in absolute millivolts. Note that the values received are valid ONLY for J-type thermocouples.

Since the voltages printed out are already referenced to ice-point, you can directly use them to find the equivalent temperature in a standard lookup table without any need for further conversion. The program does not, however, convert voltage to temperature. See SOFTWARE COMPENSATED TEMPERATURE MEASUREMENTS (EXAMPLE 8) for a way to do this.

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```
SET INITIAL CONDITIONS

 10 PRINT ''J-TYPE THERMOCOUPLE MEASUREMENTS''
 20 PRINT
 30 PRINT ''T-COUPLE'';TAB(12);''ABS MV''
 40 PRINT
 50 CLEAR 709

MEASURE 20 THERMOCOUPLE VOLTAGES

 60 FOR I = 0 TO 19
 70 OUTPUT 709; ''AC'',I
 80 ENTER 709; A
 90 PRINT I+1;TAB(10);A*1000
100 NEXT I
110 END
```

TYPICAL PRINTOUT

```
J-TYPE THERMOCOUPLE MEASUREMENTS

T-COUPLE     ABS MV

   1          2.146
   2          4.635
   .            .
  20          0.734
```

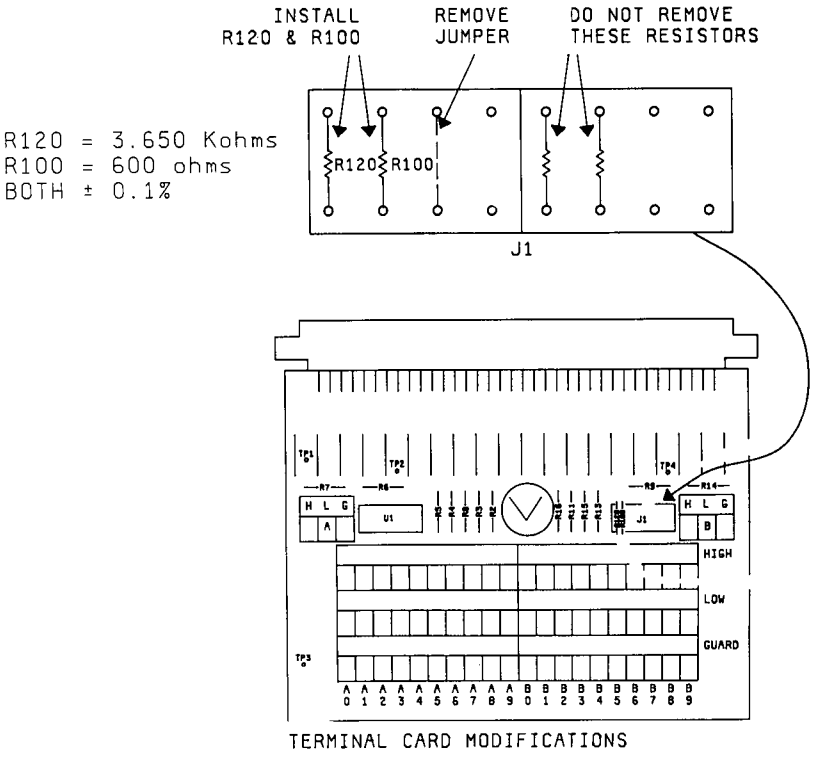
Note: Temperature associated with each ABS MV reading can be directly derived from standard (N.B.S.) conversion tables.

COMMENTS

As noted, the Option 020 assembly can be configured for software compensation of thermocouple measurements so that the manual conversion method shown in this example is not required. See SOFTWARE COMPENSATED THERMOCOUPLE MEASUREMENTS (EXAMPLE 8).

You can also use the Option 020 assembly for thermistor or RTD measurements. For a full discussion of temperature measurements, see -hp- Application Note 290, ''Practical Temperature Measurements'' (-hp- Part Number 5952-8801).

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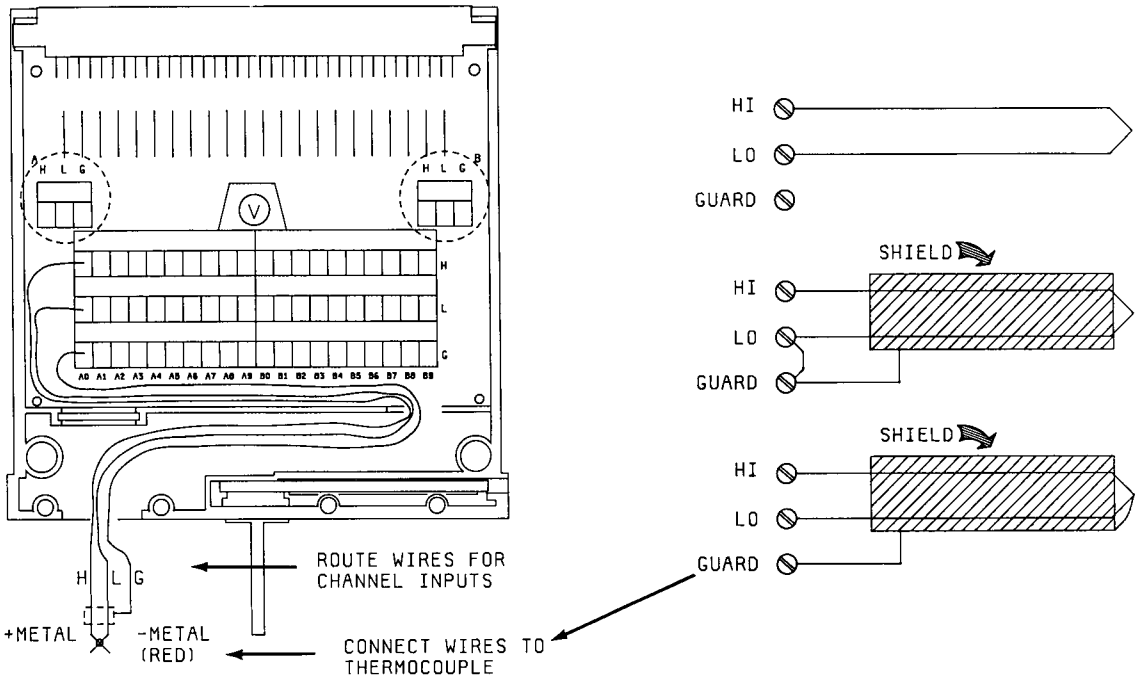


Figure 193. Example 7 - Option 020 Hardware Compensation

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EXAMPLE 8
SOFTWARE COMPENSATED THERMOCOUPLE MEASUREMENTS

DESCRIPTION

The 20 Channel Relay Multiplexer assembly with Thermocouple Compensation (Option 020) can be used to determine the temperature of B,E,J,K,R,S and T type thermocouples. The assembly can be configured for hardware compensation or software compensation. This example shows how the temperatures of up to 19 J, K, E, R and/or S-type thermocouples can be directly measured by using the Option 020 assembly.

PROCEDURE

Figure 194 shows a simplified block diagram and connection diagram to measure the voltage outputs from up to 19 thermocouples connected to an Option 020 assembly in slot 0. Since software compensation is to be used, any mixture of thermocouples can be used per assembly (i. e., you can mix J and K types on an assembly, etc.).

For this example, we'll scan the 19 channels and measure the voltage on each channel. Since the assembly is in slot 0, channel numbers are 0 to 19. Between each channel measurement, we'll measure the reference voltage on channel 19 (B9). The procedure is as follows:

1. Measure the temperature transducer voltage from channel 19 (channel B9) and compute the terminal junction's temperature in deg C (2.5V at 25 deg C with 100 mV/deg C.).

2. Convert the terminal junction's temperature to a thermocouple voltage. The converted temperature is dependent on the type of thermocouple being measured.

3. Measure the voltage produced on a channel by the thermocouple.

4. Add the reference voltage of step 2 to the voltage in step 3 for an icepoint reference voltage and then convert this to degrees C and degrees F.

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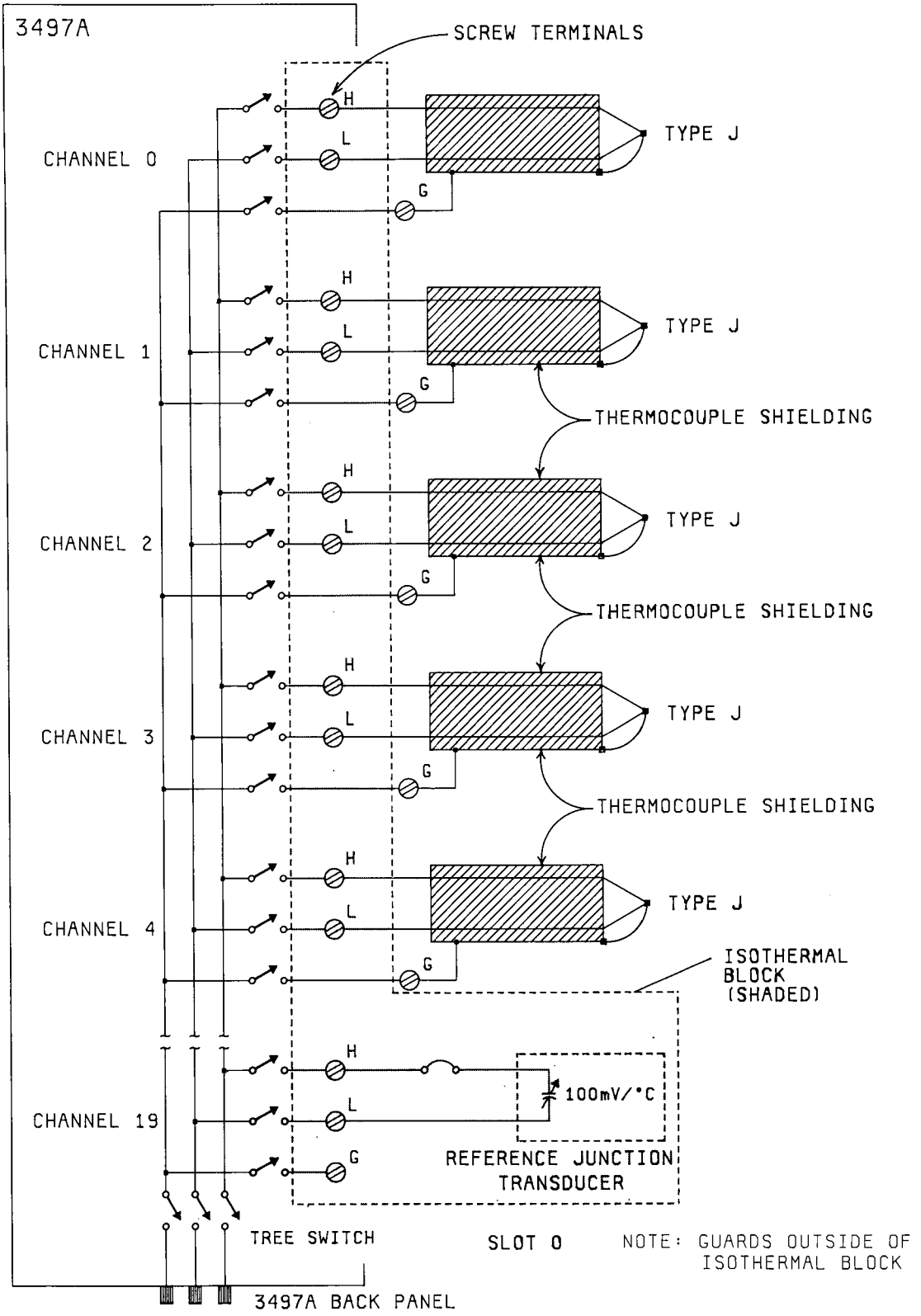
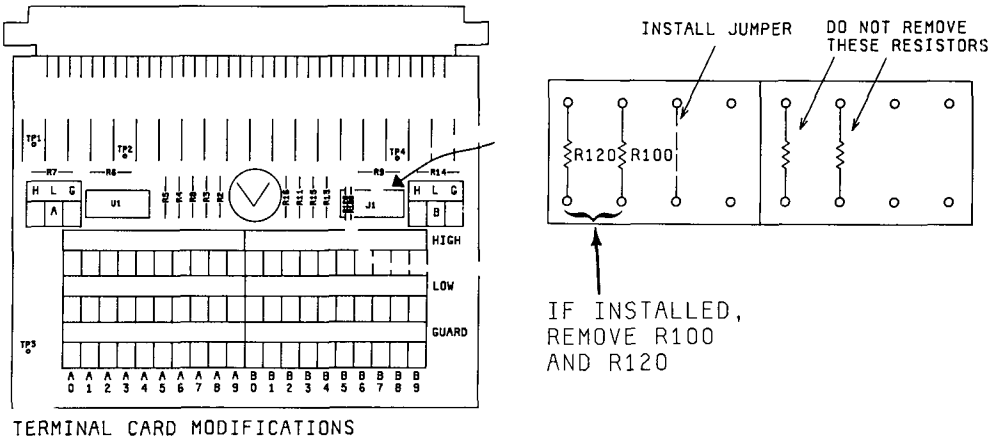


Figure 194. Example 8 - Software Compensation - J-Type Thermocouples

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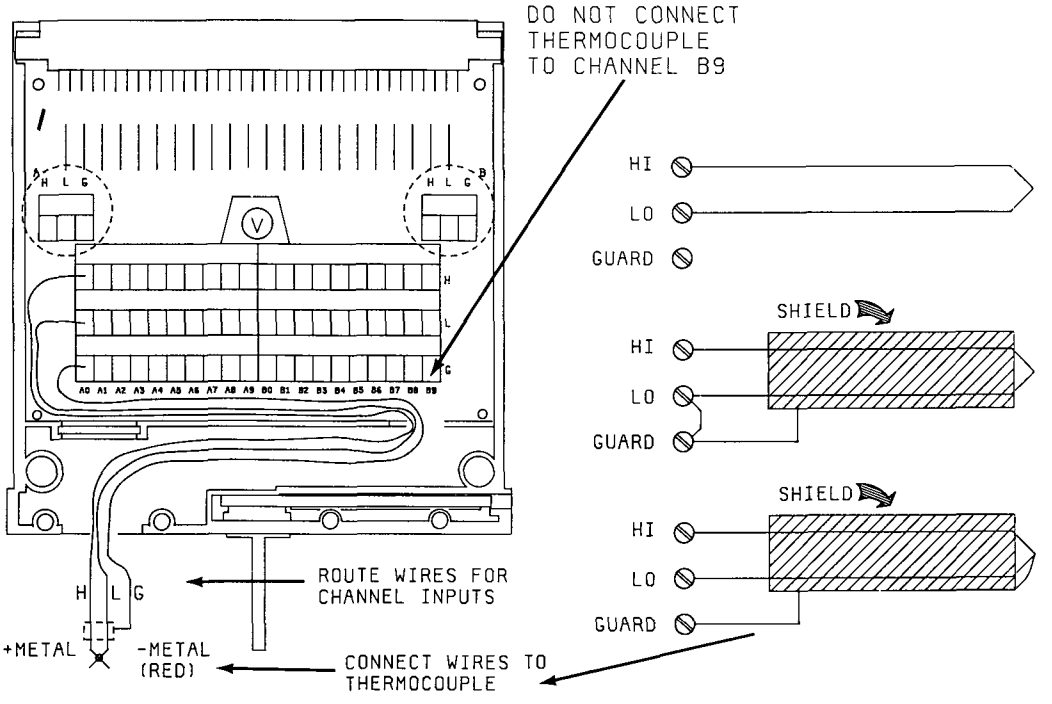


Figure 195. Example 8 - Option 020 Software Compensation

CONFIGURATION

Figure 195 shows how to configure the Option 020 terminal card for software thermocouple compensation. Since the Option 020 assembly is factory-configured for software compensation, the jumper shown must be installed and (if they are installed) R120 and R100 must be removed.

After configuring the terminal card, check to make sure that the T/C COMP jumper on the relay card is in the T/C COMP position. Then, connect thermocouples as shown in Figure 195. Note the various ways to connect thermocouples, depending on the type.

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TABLE - POLYNOMIAL CONVERSION AND REFERENCE COEFFICIENTS

	THERMOCOUPLE TYPE			
	E	R	K	S
RO	1.23773 E-7	−2.11284 E-7	−8.16774 E-7	−2.01920 E-7
R1	5.866 E-5	5.334 E-6	3.964 E-5	5.442 E-6
R2	4.5 E-8	1.2 E-8	1.6 E-8	1.1 E-8
PO	2.1 E-1	−1.5 E0	−5.1 E-2	−1.4 E0
P1	1.61299 E4	1.72645 E5	2.48503 E4	1.73545 E5
P2	−2.05411 E5	−3.27669 E7	−3.82662 E5	−3.26257 E7
P3	3.049432 E7	7.787787 E9	9.9661057 E7	8.477335 E9
P4	−2.9690242 E9	−1.18982593 E12	−1.0820624 E10	−1.327040 E12
P5	1.4284958 E11	1.01396299 E14	6.0392855 E11	1.2361123 E14
P6	−3.7221944 E12	−5.4842602 E15	−1.9109000 E13	−6.7926749 E15
P7	5.3981272 E13	1.7414495 E17	3.4782347 E14	2.0689294 E17
P8	−4.1055295 E14	−2.9235505 E18	−3.3991028 E15	−2.8874849 E18
P9	1.2777466 E15	1.9280744 E19	1.3828514 E16	8.2663728 E18

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EXAMPLE 9
COUNT UP/DOWN MEASUREMENTS

DESCRIPTION

The 100 kHz Reciprocal Counter assembly (Option 060) can be used for two primary functions: counting operations (count up/down) and period/pulse width measurements of input signals. In this example, we'll show how to use the counter assembly to count down a number of input pulses of an oscillator and how to count up (totalize) input pulses from a measurement system.

PROCEDURE

To illustrate the count up procedure, we'll totalize the number of input signals from the circuit in Figure 196 (a) for 5 seconds and print the results. In this circuit, a pulse is input whenever the conveyer belt interrupts the light source. By totalizing the number of counts in 5 seconds, we can (for example) determine if the conveyer belt speed is correct.

To illustrate count down, we'll preset the counter to 5000 counts, input a 1 kHz signal from an oscillator as shown in Figure 196 (b) and, after a 2 second wait, print the counts remaining. Since the period of a 1kHz signal is 1 msec, after 2 seconds 2000 pulses should have been input to the counter and 3000 counts should be remaining. We can then use the remaining counts to determine actual oscillator frequency.

CONFIGURATION

Figure 196 shows how to configure the Option 060 assembly using Isolated Input mode so that an external pullup is not required.

SAMPLE PROGRAMS

A sample COUNT UP program for an assembly in slot 4 is shown which starts counting up at t=0. After a 5 second delay to allow about 5000 counts to accumulate in the counter, data is transferred to the controller by the CR4,1 command and the actual number of counts printed out.

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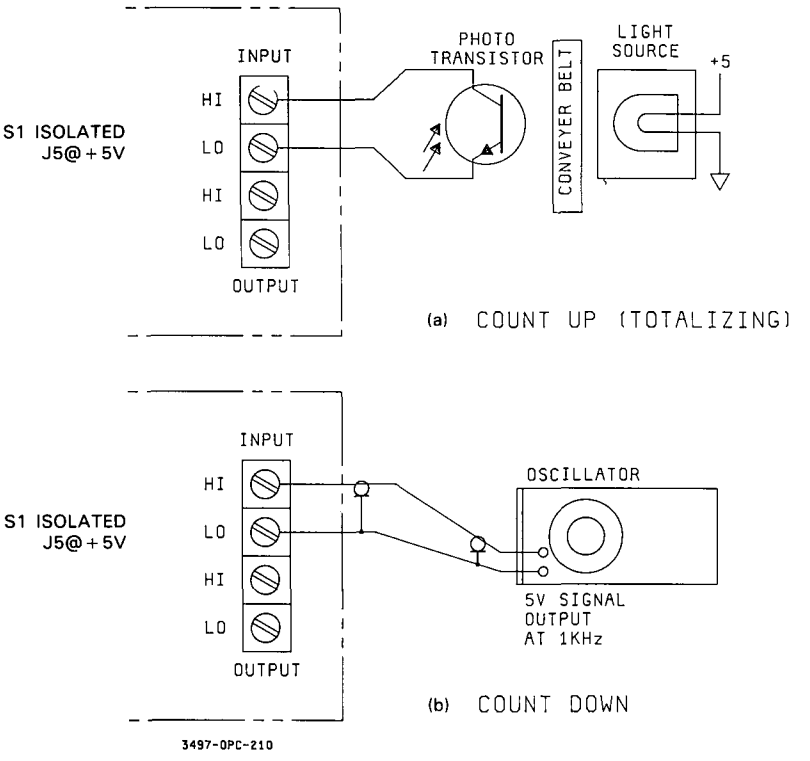


Figure 196. Example 9 - Count Up/Down with Option 060 Assembly

If, for example, we assume that the input pulses from the conveyer belt have a 1 kHz frequency, after 5 seconds 5000 counts should have accumulated in the counter. The printout shows the actual number, so the actual input pulse frequency can be determined.

COUNT UP FROM ZERO

```
10 CLEAR 709
20 OUTPUT 709;''CF4,1''
30 WAIT 5000
40 OUTPUT 709;''CR4,1''
50 ENTER 709;A
60 PRINT ''NUMBER OF COUNTS = '';A
70 END
```

The sample COUNT DOWN program shown presets a counter in slot 3 to 5000 counts and then starts the countdown process. After a 2 second delay to allow 2000 counts to be counted down (for a 1kHz input from the oscillator), the counts remaining is printed out and can be used to determine the actual oscillator input frequency. For example, if counts remaining = 3002, actual oscillator frequency = (5000-3002) = 1998 counts/2 sec = 999 Hz.

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COUNT DOWN FROM 5000 COUNTS

```
10 CLEAR 709
20 OUTPUT 709;''CS3,5000CF3,2''
30 WAIT 2000
40 OUTPUT 709;''CR3,1''
50 ENTER 709;A
60 PRINT ''COUNTS REMAINING = '';A
70 END
```

TYPICAL PRINTOUTS

```
NUMBER OF COUNTS = 5007      (Totalize Mode)
COUNTS REMAINING = 3002      (Count Down Mode)
```

COMMENTS

The Option 060 assembly can also be used to measure input periods and/or pulse widths of inputs with frequencies from 0.0001 Hz to 100 kHz. See PERIOD MEASUREMENTS (EXAMPLE 10).

The Option 060 can also be used to interrupt the 3497A and a user external circuit when measurement complete and/or counter overflow conditions occur. See COUNTER INTERRUPTS (EXAMPLE 12).

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EXAMPLE 10
PERIOD MEASUREMENTS

DESCRIPTION

The 100 kHz Reciprocal Counter assembly (Option 060) can be used for two primary functions: counting operations (count up/down) and period/pulse width measurements of input signals. In this example, we'll show how to use the counter assembly to measure the period of a 100 Hz square wave input using a read without wait technique.

PROCEDURE

To illustrate period measurements with the Option 060 assembly, we'll input a 100 Hz square wave signal and use an open collector input as shown in Figure 197. We'll average 1000 periods of the input (for greater accuracy) and then show how partial results can be displayed by using the read without wait command.

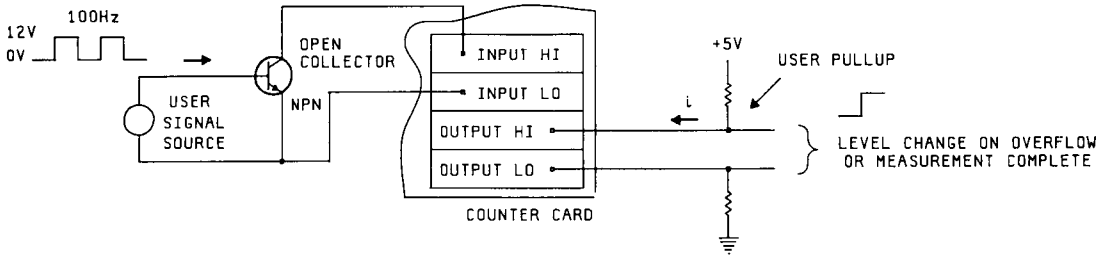
CONFIGURATION

Figure 197 shows how to configure the Option 060 assembly using an open collector input and a user-supplied pullup on the output. Note that a level change (programmable from high to low or low to high) is always available at the OUTPUT HI terminal of the assembly whenever measurement complete occurs.

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PERIOD MODE

CONNECTION DIAGRAM



Circuit	To Select	Set	
Input	Non Isolated Mode Internal Pullup +12V Logic Level	S1 to J3 to J5 to	NON ISOLATED ON 12V
Output	Interrupt Mode Isolated Pullup Positive True Logic	J7 to J1,J2 to J8 to	INTR ISOLATED POS TRUE

Figure 197. Example 10 - Option 060 Connection Diagram (Period Mode)

SAMPLE PROGRAM

When the read without wait (CR slot#,1) command is used, the counter can be read without disturbing data flow into the counter and thus interim answers can be displayed. This is useful when you are making a long measurement and want to know how far the measurement has progressed.

A sample program is shown to average 1000 periods of a 100 Hz input to a counter in slot 4 and read the results without wait. Since the counter requires over 10 seconds to average 1000 periods of the input, the program prints out the current data after 5 seconds to show interim results. In the printout, the minus (-) sign in front of the PARTIAL MEASUREMENT result indicates an incomplete measurement.

```
 10 CLEAR 709
 20 OUTPUT 709;''CF4,3''
 30 WAIT 5000
 40 OUTPUT 709;''CR4,1''
 50 ENTER 709;A
 60 PRINT ''PARTIAL MEASUREMENT''
 70 PRINT ''PERIOD = '';A;''SEC''
 80 WAIT 6000
 90 OUTPUT 709;''CR4,1''
100 ENTER 709;A
110 PRINT
120 PRINT ''COMPLETED MEASUREMENT''
130 PRINT ''PERIOD = '';A;''SEC''
140 END
```

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TYPICAL PRINTOUT

```
PARTIAL MEASUREMENT
PERIOD = -.00488705 SEC

COMPLETED MEASUREMENT
PERIOD = .01006823 SEC
```

COMMENTS

In contrast to the read without wait command, the read with wait command (CR slot#,2) will return results ONLY after the measurement is complete. For count up/down applications, the measurement is always ''complete'', so the CR slot#,1 and CR slot#,2 commands produce the same results.

However, for period (and pulse width) measurements, sending the read with wait command causes the 3497A to wait until all data is accumulated and (if required) averaged and the measurement is complete. Thus, for period measurements, the interim results available with the CR slot#,1 command are not available with CR slot#,2.

The Option 060 assembly can also be used to count up to 999999 counts or count down to zero from a programmable start point). See COUNT UP/DOWN MEASUREMENTS (EXAMPLE 9).

The Option 060 assembly can also be used for interrupts to the 3497A and to a user external circuit when measurement complete and/or counter overflow conditions occur. See COUNTER INTERRUPTS (EXAMPLE 12).

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EXAMPLE 11
STRAIN GAUGE MEASUREMENTS

DESCRIPTION

The 120/350 Ohm Strain Gauge/Bridge Completion assemblies (Options 070/071) can be used to measure the strain from 120 ohm or 350 ohms strain gauges. This example shows how to measure the strain from up to ten 120 ohm strain gauges by using an Option 070 assembly configured for ¼ bridge completion on each of the 10 channels.

PROCEDURE

To make strain gauge measurements using the Option 070 (or 071), a four-step procedure is used:

1. Measure the excitation voltage, Vs.

2. Measure bridge output voltage (Voutu) with gauge unstrained.

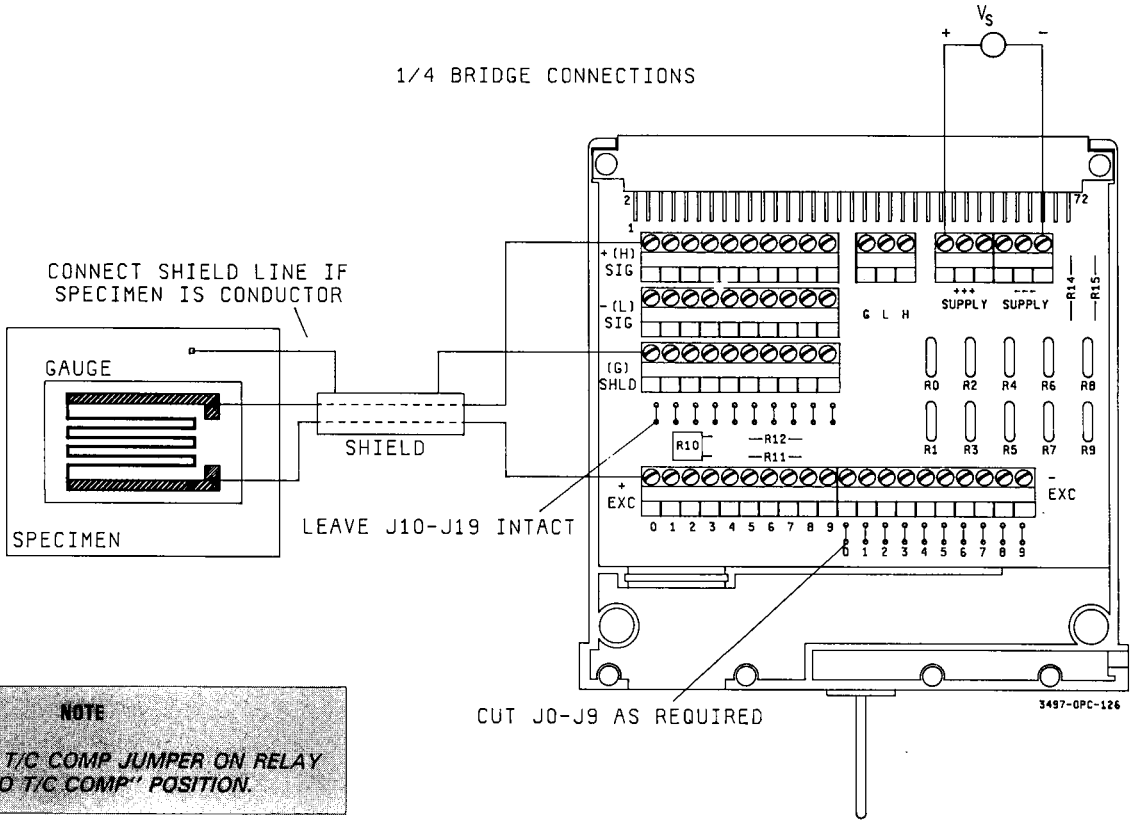
3. Measure bridge output voltage (Vouts) with gauge strained.

4. Compute strain from ϵ = -4Vr/GF(1 + 2Vr) where GF = Gauge Factor of the strain gauge and Vr = [(Vout/Vs)strained - (Vout/Vs)unstrained].

CONFIGURATION

Figure 198 shows a connection diagram and equivalent circuit for ¼ bridge configuration of a strain gauge connected to channel A0 of a terminal card. To connect up to 10 strain gauges, connect a gauge to A1, A2, .. A9 and cut jumpers J0-J9 for channels used. Note that only one excitation voltage supply (Vs) is required, whether 1, 2, ..., or 10 gauges are connected to the assembly.

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NOTE

ENSURE THAT T/C COMP JUMPER ON RELAY CARD IS IN "NO T/C COMP" POSITION.

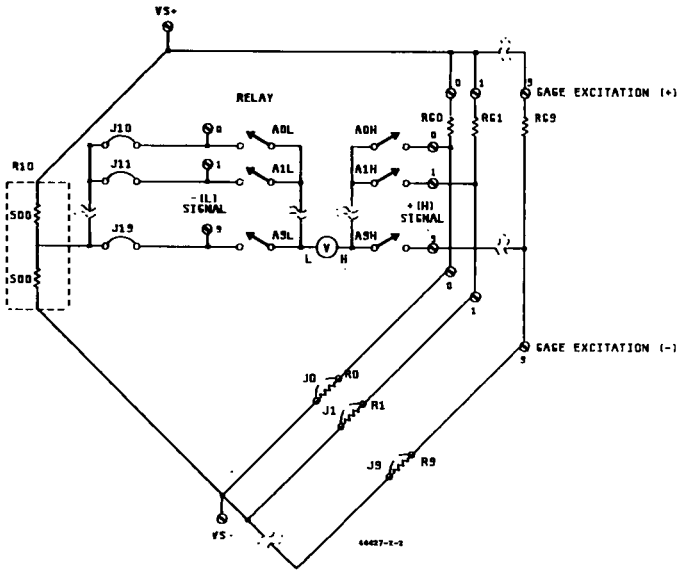


Figure 198. Example 11 - ¼ Bridge Strain Gauge Measurements

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SAMPLE PROGRAM

The sample program shown computes the strain for each of 10 gauges connected to an Option 070 assembly in slot 0 (channels 0 through 9), with GF = 2 assumed. The printout shown is in units of microstrain.

Program		Description
10 CLEAR 709	10-50	Sets first channel to 0, last channel to 9 and measures excitation voltage (Vs) on channel 10 (channel B0)
20 PRINT ''STRAIN GAUGE MEASUREMENTS''		
30 PRINT		
40 OUTPUT 709; ''AF0AL9AC10''		
50 ENTER 709; V		
60 FOR I = 0 TO 9	60-100	Measures unstrained voltage on channels 0 through 9 and computes Vout/Vin unstrained.
70 OUTPUT 709;''AS''		
80 ENTER 709; A(I)		
90 U(I) = A(I)/V		
100 NEXT I		
110 DISP ''ADD STRAIN TO GAUGES. THEN,''	110-140	Program halts to allow strain to be applied to gauges.
120 DISP ''WHEN READY PRESS CONT KEY''		
130 DISP ''TO RESUME PROGRAM''		
140 PAUSE		
150 PRINT ''GAUGE'';TAB(15); ''MICROSTRAIN''	150-200	Measures strained voltages on chans 0 through 9 and computes Vout/Vin when gauges are strained.
160 PRINT		
170 FOR I = 0 TO 9		
180 OUTPUT 709;''AS''		
190 ENTER 709; B(I)		
200 T(I) = B(I)/V		
210 X(I) = T(I) - U(I)	210-230	Computes strain and prints results in microstrain.
220 S(I) = -(4*X(I)/(2*(1+2*X(I)))		
230 PRINT I+1; TAB(15);S(I)*10**6		
240 NEXT I		
250 END		

TYPICAL PRINTOUT

STRAIN GAUGE MEASUREMENTS

GAUGE	MICROSTRAIN
1	10.75
2	−134.3
.	.
.	.
10	170.03

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COMMENTS

Use the Option 070 assembly for 120 ohm strain gauges and the Option 071 assembly for 350 ohm strain gauges. You can also use these assemblies in ½ bridge or full-bridge configuration or with mixed bridge configuration for an assembly.

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EXAMPLE 12
COUNTER INTERRUPTS

DESCRIPTION

There are two plug-in assemblies which can be used to generate interrupts to the 3497A when specified system conditions occur: the Digital Input/Interrupt assembly (Option 050) and the 100 kHz Reciprocal Counter assembly (Option 060). In this example, we'll show how the counter assembly can be used to generate an interrupt to the 3497A and, in turn, to the controller for measurement complete and/or counter overflow conditions.

PROCEDURE

The counter can generate an interrupt signal to the 3497A on measurement complete or overflow ONLY if the counter has previously been enabled for interrupts. The 3497A, in turn, can send an interrupt (SRQ or BREAK message) to the controller ONLY if the 3497A has previously been enabled for interrupt.

To enable the 3497A for interrupts from the counter, send ''SE2'' (''SE102'' for Serial Data). To enable the counter to send an interrupt to the 3497A, send ''CE slot#,1'' to enable measurement complete interrupts or send ''CE slot#,2'' to enable overflow interrupts.

After the counter assembly and the 3497A have been enabled for interrupts, you can determine the reason for the interrupt by sending a DI slot# command. The return to the controller following a DI command is either a 1 or a 3, but has four different interpretations, depending on the mode of operation of the counter, since the terms ''Measurement Complete'' and ''Overflow'' have different meanings for different operational modes. See the following chart.

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COUNTER ASSEMBLY INTERRUPT CONDITIONS

MEASUREMENT COMPLETE (CE slot#,1 set)	
Return after a DI slot# command = 1	
Count Down (CF slot#,2)	Zero Counts Reached.
Period/Pulse Width (CF slot#,3 thru 6)	Completed Measurement Available.

OVERFLOW (CE slot#,2 set)	
Return after a DI slot# command = 3	
Count Up (CF slot#,1)	>999999 Counts in Counter.
Period/Pulse Width (CF slot#,3 thru 6)	Input period exceeds maximum measurement time for range used.

Also, for each mode of operation, a level change output is available at the OUTPUT HI terminal of the counter assembly for Measurement Complete or Overflow, whether or not the counter is enabled for interrupts to the 3497A.

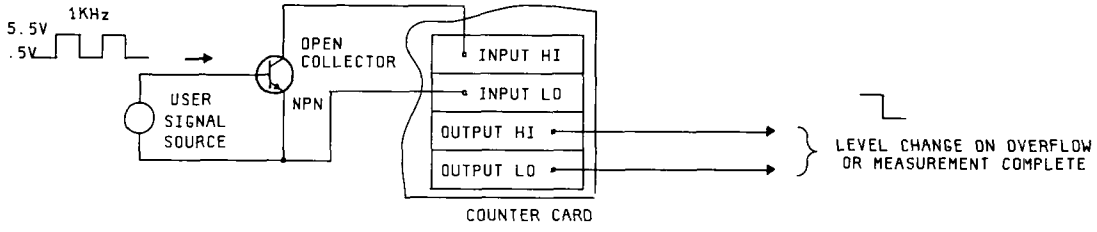
CONFIGURATION

To illustrate interrupt examples, the counter is configured as shown in Figure 199 with an open collector input. Note that the level change output shown is available whenever Measurement Complete or Overflow conditions occur.

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INTERRUPT MODE

CONNECTION DIAGRAM



Circuit	To Select	Set
Input	Non Isolated Mode No Internal Pullup +5V Logic Level	S1 to NON ISOLATED J3 to OFF J5 to 5V
Output	Interrupt Mode Non Isolated Pullup Negative True Logic	J7 to INTR J1,J2 to NON ISOLATED J8 to NEG TRUE

Figure 199. Example 12 - Counter Configuration

SAMPLE PROGRAMS

Four sample programs are shown to illustrate interrupts with the counter assembly:

(a) Interrupt on Measurement Complete - Count Down
(b) Interrupt on Measurement Complete - Period/Pulse Width
(c) Interrupt on Overflow - Count Up
(d) Interrupt on Overflow - Period/Pulse Width

For each program, the procedure is the same, so we'll describe the program for the first example, Interrupt on Measurement Complete - Count Down. The counter is assumed to be in slot 4 for all examples.

In this program, line 20 tells the controller to go to an interrupt subroutine (starting at line 1000) ONLY when an interrupt occurs on the remote interface (HP-IB). Line 30 enables the interface for interrupts. Note that the main program continues until an interrupt occurs (in this case, when zero counts are reached in the counter).

In line 40, SE2 enables the 3497A for digital interrupts, CE4,1 enables the counter to interrupt the 3497A when Measurement Complete occurs and CF4,2 sets the counter to the Count Down mode. For this set of conditions, when zero counts are reached, the counter sends an interrupt to the 3497A and the 3497A, in turn, sends an interrupt to the controller.

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When the controller receives the interrupt, it goes to line 1000 and does an SPOLL to determine the cause of the interrupt. If digital 66 is returned, interrupt is due to a Digital Interrupt and "DI4" is sent to slot 4 to determine whether the counter interrupted due to Measurement Complete or Overflow.

For this example, since the counter was enabled only for Measurement Complete (with the CE4,1 command), the return after a DI4 command is A = 1 (see the chart above) and the program prints SLOT 4 - ZERO COUNTS REACHED.

If the controller does not receive an interrupt, the sample program loops continuously from line 50 to line 980 and back if no Main Program statements are entered. If Main Program statements are entered, the computer can continue with Main Program execution and be interrupted only when zero counts are reached.

The other programs shown are identical to the Count Down Interrupts program except for lines 40 and 1040. Typical printouts for all programs follow the program listings.

(a) INTERRUPT ON MEASUREMENT COMPLETE - COUNT DOWN MODE

```
  10 CLEAR 709
  20 ON INTR 7 GOSUB 1000
  30 ENABLE INTR 7;8
  40 OUTPUT 709; "SE2CE4,1CF4,2"
  50 !Main Program
   .
   .
 980 GOTO 50
 990 END
1000 P = SPOLL (709)
1010 IF P <>66 RETURN
1020 OUTPUT 709;"DI4"
1030 ENTER 709;A
1040 IF A = 1 PRINT "SLOT 4 - ZERO COUNT REACHED"
1050 STATUS 7,1;A
1060 RETURN
```

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(b) INTERRUPT ON MEASUREMENT COMPLETE - PERIOD/PULSE WIDTH MODE

```
  10 CLEAR 709
  20 ON INTR 7 GOSUB 1000
  30 ENABLE INTR 7;8
  40 OUTPUT 709; ''SE2CE4,1CF4,3''
  50 !Main Program
       .    .
       .    .
 980 GOTO 50
 990 END
1000 P = SPOLL (709)
1010 IF P <>66 RETURN
1020 OUTPUT 709;''DI4''
1030 ENTER 709;A
1040 IF A = 1 PRINT ''SLOT 4 - MEASUREMENT COMPLETE''
1050 STATUS 7,1;A
1060 RETURN
```

(c) INTERRUPT ON OVERFLOW - COUNT UP MODE

```
  10 CLEAR 709
  20 ON INTR 7 GOSUB 1000
  30 ENABLE INTR 7;8
  40 OUTPUT 709; ''SE2CE4,2CF4,1''
  50 !Main Program
       .    .
       .    .
 980 GOTO 50
 990 END
1000 P = SPOLL (709)
1010 IF P <>66 RETURN
1020 OUTPUT 709;''DI4''
1030 ENTER 709;A
1040 IF A = 3 PRINT ''SLOT 4 - OVERFLOW - >999999 COUNTS''
1050 STATUS 7,1;A
1060 RETURN
```

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(d) INTERRUPT ON OVERFLOW - PERIOD/PULSE WIDTH MODE

```
 10 CLEAR 709
 20 ON INTR 7 GOSUB 1000
 30 ENABLE INTR 7;8
 40 OUTPUT 709; "SE2CE4,2CF4,3"
 50 !Main Program
      .   .
      .   .
980 GOTO 50
990 END
1000 P = SPOLL (709)
1010 IF P <>66 RETURN
1020 OUTPUT 709;"DI4"
1030 ENTER 709;A
1040 IF A = 3 PRINT "SLOT 4 - OVERFLOW - RANGE EXCEEDED"
1050 STATUS 7,1;A
1060 RETURN
```

TYPICAL PRINTOUTS

Program	Printout
(a)	SLOT 4 - ZERO COUNTS REACHED
(b)	SLOT 4 - MEASUREMENT COMPLETE
(c)	SLOT 4 - OVERFLOW - >999999 COUNTS
(d)	SLOT 4 - OVERFLOW - RANGE EXCEEDED

COMMENTS

Note that the return from a DI slot# command for the counter card is different from the return for an Option 050 (Digital Input/Interrupt) assembly. That is, for an Option 050 assembly, the return shows the true (high) bits in the 16 channels of the assembly, but the counter assembly returns only two values (1 or 3) when an interrupt occurs.

If you send a DI slot# command to a counter card which did not interrupt, a value of 0 is returned.

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EXAMPLE 13
EVENT SENSING

DESCRIPTION

An important application for the 3497A is to provide an interrupt to the controller when an event (valve open, mechanical movement completed, etc.) occurs. You can use the Digital Input/Interrupt assembly (Option 050) to sense specified interrupt conditions for up to eight inputs/assembly or up to 40 inputs/3497A.

You can use the first eight channels (CH0-CH7) for interrupt when the assembly is placed in a slot of the 3497A. The Option 050 does not have interrupt capability when placed in the 3498A Extender.

This example shows how to use the interrupt capability of the Option 050 assembly to sense when a mechanical system control (such as a water valve, for example) is activated.

PROCEDURE

One way to sense when a specified condition occurs is shown in Figure 200. In this figure, a relay coil is connected in parallel with a mechanical system control, such as a water valve. When the valve is open, the relay is closed and sets the channel bit high (a ''1'' condition).

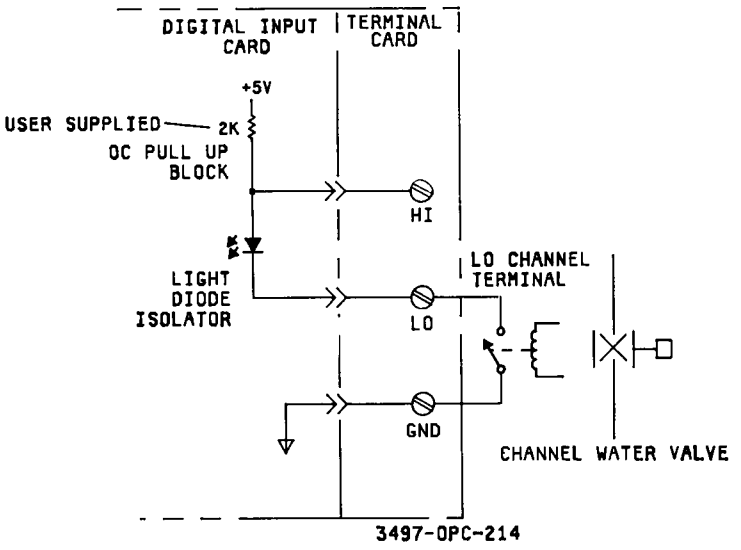
To enable an interrupt when the valve is open (relay closed), we will enable the channel to send an interrupt to the 3497A by using DE slot#,octal where the octal number represents the channel(s) to be enabled. For example, to enable channels 2 and 5 in slot 4, the command is DE4,44 since octal 44 = 00 100 100.

When interrupt channels have been enabled and an interrupt occurs on one or more of the channels, an interrupt will be sent to the 3497A. If the 3497A has previously been enabled for Digital Interrupt by sending an SE2 command (SE102 for Serial Data), the 3497A will send an interrupt to the controller for further action.

CONFIGURATION

Figure 200 shows a sample connection for relays connected to channels 2 and 5 of the terminal card of an Option 050 assembly and shows the equivalent circuit for each channel. For the contact closure to ground setup shown, note that the LO terminal is connected to one side of the relay and the GND terminal to the other side. Also note that the 2K pull-up resistor to connect the internal power supply on the assembly to the relay is user-supplied.

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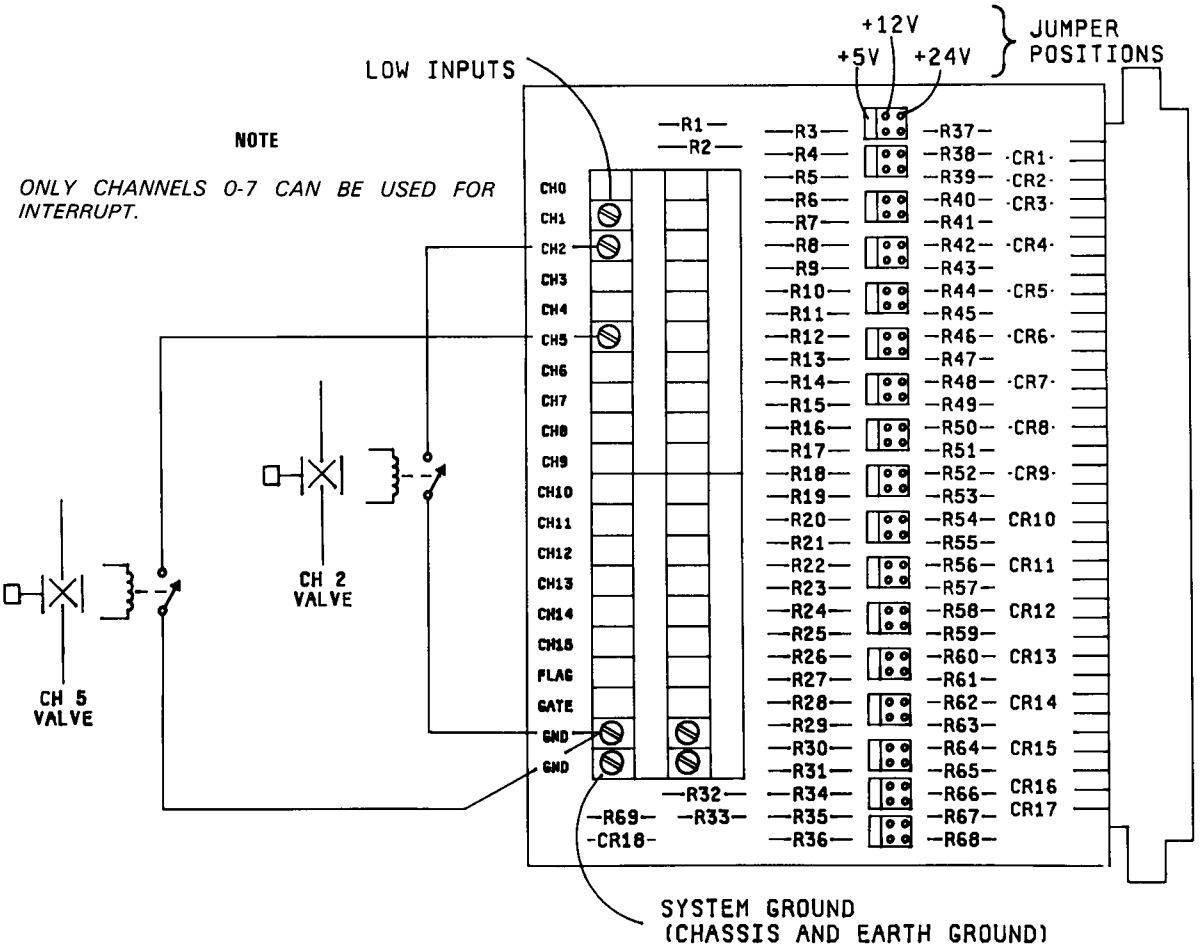


Figure 200. Example 13 - Digital Input Assembly Configuration

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SAMPLE PROGRAM

An example program is shown which enables channels 2 and 5 of an assembly in slot 3 to generate an interrupt whenever the channel relay(s) close (i.e., the water valve in that channel opens). When the interrupt occurs, the controller shifts to an interrupt subroutine (starting at line 1000) and does an SPOLL to determine the cause of the interrupt.

If the interrupt comes from the assembly, DIGITAL 66 is returned (Digital Interrupt) and the controller sends DI3 to determine which channel causes interrupt. If OCTAL 4 is returned, channel 2 caused interrupt. If OCTAL 40 is returned, channel 5 caused interrupt. If OCTAL 44 is returned, both channels interrupted simultaneously.

```
  10 CLEAR 709
  20 ON INTR 7 GOSUB 1000
  30 ENABLE INTR 7;8
  40 OUTPUT 709; ''DE3,44SE2''
  50 !Main Program
 980 GOTO 50
 990 END
1000 P = SPOLL (709)
1010 IF P <> 66 RETURN
1020 OUTPUT 709; ''DI3''
1030 ENTER 709; A
1040 IF A = 0 PRINT ''NO SLOT 3 INTERRUPT''
1050 IF A = 4 PRINT ''VALVE 2 OPEN
1060 IF A = 40 PRINT ''VALVE 5 OPEN''
1070 IF A = 44 PRINT ''VALVES 2 AND 5 OPEN''
1080 STATUS 7,1;A
1090 RETURN
```

TYPICAL PRINTOUT

Valve(s) Open	Printout
2	VALVE 2 OPEN
5	VALVE 5 OPEN
2 & 5	VALVES 2 AND 5 OPEN

COMMENTS

Only channels 0-7 can be used for interrupt and interrupt capability can't be used for an Option 050 assembly in the 3498A. Both the Option 050 assembly AND the 3497A must be enabled for specified system input to cause an interrupt.

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EXAMPLE 14
USING THE COUNTER IN THE 3498A

DESCRIPTION

The previous examples on interrupts (COUNTER INTERRUPTS and EVENT SENSING) stated that interrupt capability for the Digital Input/Interrupt assembly (Option 050) or the Counter assembly (Option 060) is not available when either assembly is placed in a slot in the 3498A.

However, you can combine the two assemblies to provide a limited interrupt capability when the counter assembly is placed in the 3498A. This example shows how to enable the counter assembly for measurement complete or overflow interrupts by placing the counter assembly in the 3498A and sending the interrupt signal to an Option 050 assembly in the 3497A.

PROCEDURE

For this example, a counter assembly is placed in slot 12 of a 3498A and a Digital Input/Interrupt assembly in slot 2 of a 3497A, as shown in Figure 201. When an interrupt condition occurs (Measurement Complete or Overflow - see the COUNTER INTERRUPTS example for definitions), the counter sends an interrupt signal to channel 1 of the Digital Input assembly.

Then, as shown in the EVENT SENSING example, if the Digital Input assembly has been enabled for channel 1 interrupts (with a DE 2,2 command) AND the 3497A has been enabled for digital interrupts (with an SE2 or SE102 command), an interrupt signal is sent to the controller for further action.

CONFIGURATION

See Figure 201 for configuration and interconnections of the two plug-in assemblies.

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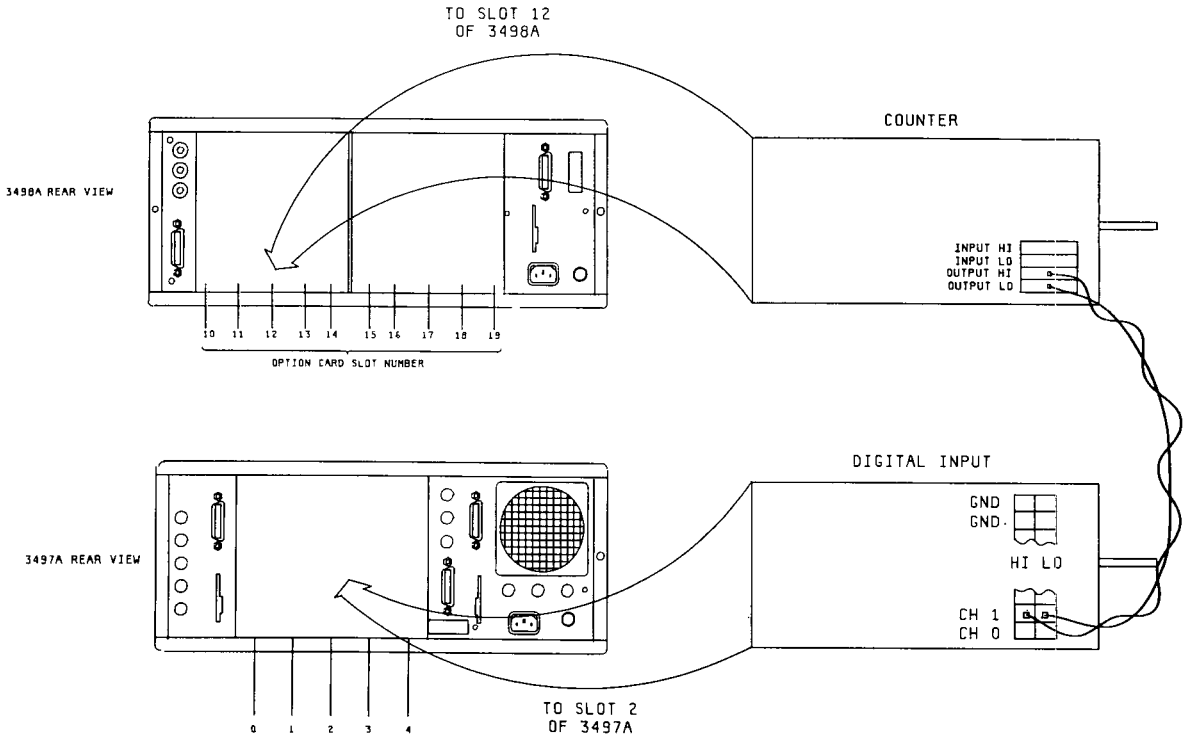


Figure 201. Example 14 - Interrupts With Counter in 3498A

SAMPLE PROGRAM

In the sample program shown, the counter is in slot 12 of a 3498A and the digital input assembly is in slot 2 of a 3497A. Whenever a Measurement Complete or Overflow condition occurs, a level change is output from the OUTPUT HI, OUTPUT LO terminals of the counter which sets channel 1 bit true in the Digital Input assembly.

Since channel 1 of the digital input assembly has been enabled for interrupt by the DE2,2 command and since the 3497A has been enabled for digital interrupt by the SE2 command, when a counter interrupt occurs, the program jumps to an interrupt subroutine (starting at line 1000) and sends a DI2 command to determine the cause of the interrupt.

If the interrupt was due to digital interrupt on channel 1, octal 1 is returned and the program prints ''INTERRUPT ON MEASUREMENT COMPLETE OR OVERFLOW''.

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```
  10 CLEAR 709
  20 ON INTR 7 GOSUB 1000
  30 ENABLE INTR 7;8
  40 OUTPUT 709; ''SE2DE2,2''
  50 !Main Program
       .    .
       .    .
 980 GOTO 50
 990 END
1000 P = SPOLL (709)
1010 IF P<>66 RETURN
1020 OUTPUT 709; ''DI2''
1030 ENTER 709; A
1040 IF A = 1 PRINT ''SLOT 12 - INTERRUPT ON MEASUREMENT
     COMPLETE OR OVERFLOW''
1050 STATUS 7,1;A
1060 RETURN
```

TYPICAL PRINTOUT

After an interrupt occurs, the printout is:

```
SLOT 12 - INTERRUPT ON MEASUREMENT COMPLETE OR OVERFLOW
```

COMMENTS

The setup shown will only provide an indication that a counter interrupt occurred, and not the specific reason (i.e., zero counts reached, measurement complete, etc.) as can be obtained when the counter is in the 3497A (see the COUNTER INTERRUPTS example). However, if you can only place your counter assemblies in a 3498A, this procedure does at least give an interrupt indication.

Note that it is not necessary to enable the counter for interrupts with a CE slot#,1 or CE slot#,2 command as the level change at the OUTPUT HI AND OUTPUT LO terminals is output whenever Measurement Complete or Overflow occurs, regardless of the CE slot#,n command setting.

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EXAMPLE 15
VOLTAGE SWITCHING AND ALARM ACTUATION

DESCRIPTION

A primary purpose of the Actuator/Digital Output assembly (Option 110) is voltage switching for applications with 100VA or less. This example shows how to use the Option 110 assembly for three voltage switching applications: alarm actuation; voltage switching and motor reversal.

PROCEDURE

Figure 202 shows a sample connection diagram with inputs connected to channels 0 through 3 of an Option 110 assembly in slot 1. The three applications are:

Alarm Actuation

When channel 0 is open, the NC contact of the relay is connected to common. To sound the alarm, send DC 1,0 which closes channel 0 and connects the NO contact of the relay to common. This completes the circuit and sounds the alarm. To turn off the alarm, send DO1,0 to open channel 0.

Voltage Switching

When channel 1 is open, the NC contact is connected to common and +5V is applied to Device B. To switch power to Device A, send DC1,1 to close channel 1 and connect the NO contact to common.

Motor Reversal

With the relays in the position shown in Figure 202 (both with NC contacts connected to common), the motor will rotate in one direction. By sending DC1,2,3, both relays are closed (NC contacts to common) and the motor will reverse direction of rotation. Note that opening or closing one relay but not the other will stop motor rotation.

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CONFIGURATION

See Figure 202 to configure the Option 110 assembly for alarm actuation, voltage switching and motor reversal.

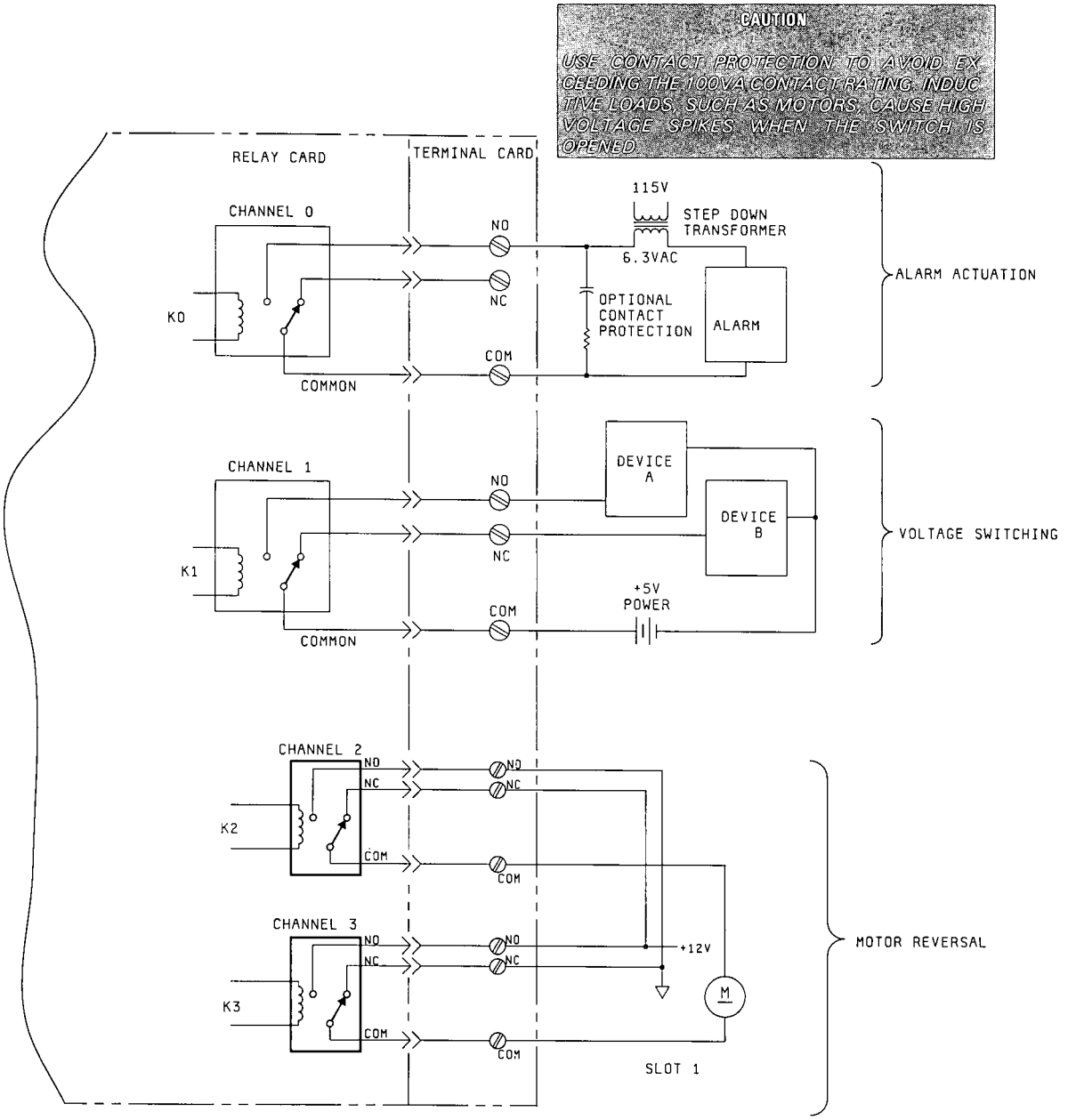


Figure 202. Example 15 - Actuator Assembly Configuration

COMMENTS

You can connect up to 16 inputs to an Option 110 assembly or up to 80 inputs/3497A. If 3498A Extenders are used, you can connect up to 1360 inputs (85 total slots x 16 channels/slot). Remember that slots 5 through 9 do not exist for digital assemblies and should NEVER be addressed in DIGITAL commands.

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EXAMPLE 16
HIGH VOLTAGE SWITCHING

DESCRIPTION

A primary application for the High Voltage Actuator assembly (Option 115) is to switch high voltage loads. Since the actuator can handle voltages up to 250V RMS at 2 amps, it is ideally suited for switching line voltages to items such as air solenoids, pilot lights and motor starters. With the Option 115 assembly, you can connect up to eight inputs per assembly or 40 inputs per 3497A. This example shows how to use the high voltage actuator to control (turn on) motor starters.

PROCEDURE

A typical application for the high voltage actuator is to control (turn on) motor starters. Although the actuator can directly switch motors up to ⅔ horsepower, the range of motors it can handle can be greatly increased by using motor starters. The actuator can be used to control the motor starter, essentially supplying the signals to turn the starter on.

For this example, an assembly process requires that three 80 horsepower motors be turned on by using motor starters, according to the following sequence. Motor A is started at time t = 0 (by motor starter A), runs for 5 minutes and is then turned off by an external circuit. At t+5 minutes, motor B is started, runs for 6 minutes and is then shut off. Then, at t+11 minutes, motor C is started, runs for 4 minutes and is stopped, completing the cycle.

MOTOR STARTER	CHANNEL NUMBER	MOTOR RUN TIME (MINUTES)	SEQUENCE NUMBER
A	0	5	1
B	1	6	2
C	2	4	3

CONFIGURATION

Figure 203 shows a simplified block diagram and typical connection diagram. For this example, motor starters are connected to channels 0, 1 and 2 of an assembly in slot 2. Although a specific contact protection network is not shown, you should consult Chapter 8, Option 115 , Contact Protection Guidelines, before running the program shown to ensure that appropriate contact protection is provided.

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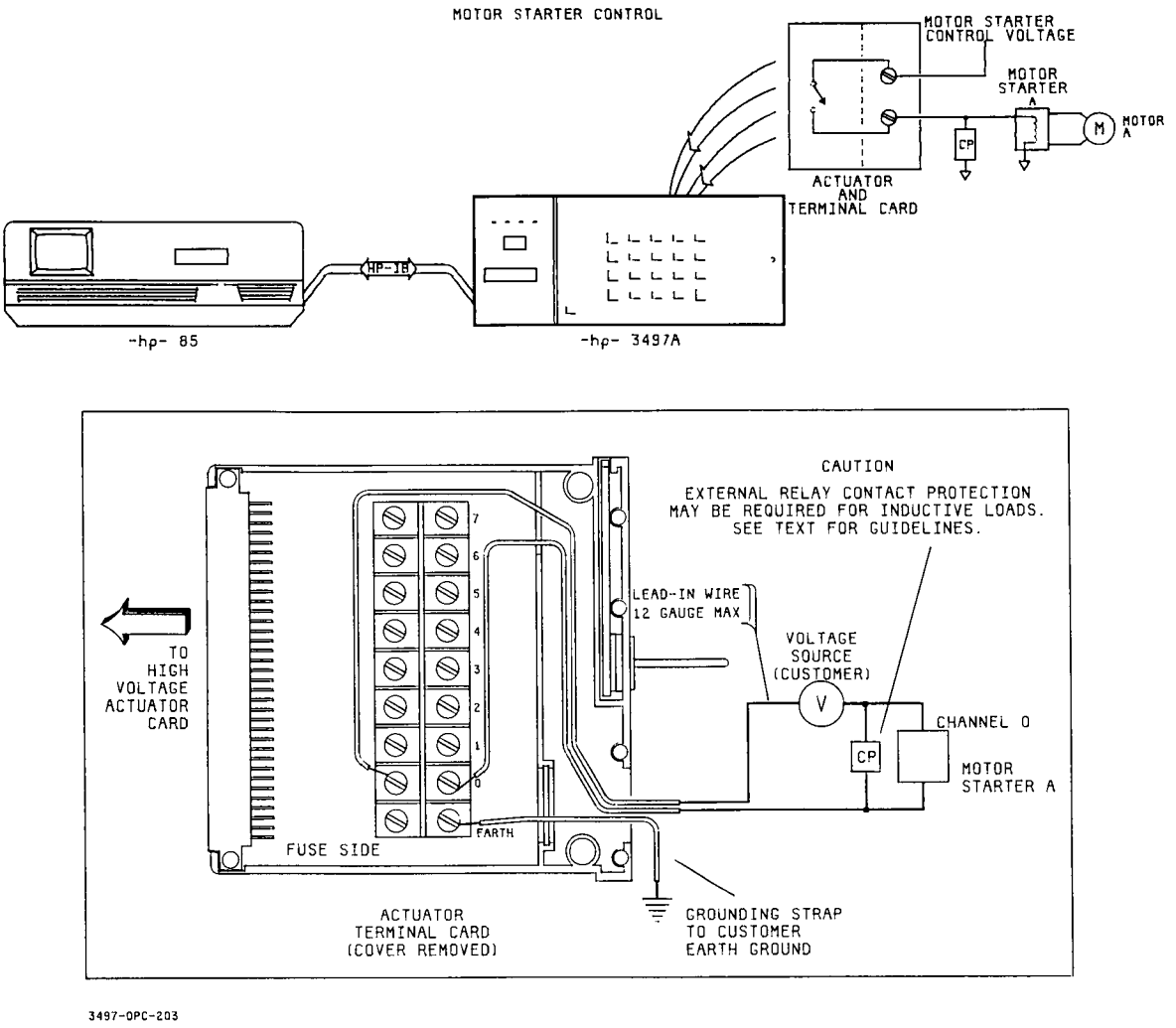


Figure 203. Example 16 - Motor Starter Configuration

SAMPLE PROGRAM

An example program for the motor starter sequence is shown. In the program, channel 0 relay is closed, supplying voltage to motor starter A which starts motor A. Three seconds later, channel 0 relay is opened to disconnect motor starter A.

After a 5 minute run time, motor A is turned off (by an external system) and channel 1 relay then closes. After a three second delay, channel 1 opens. Following a 6 minute run time for motor B, channel 2 relay is closed for 3 seconds and is then opened. After a 4 minute run time, motor C stops, completing the cycle.

If the optional DR command is used, relay status is displayed on the 3497A front panel. If the relays do not open or close as required, the program prints a ''RELAY FAILED'' message and halts the operation.

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```
 SET INITIAL CONDITIONS

 10 PRINT ''MOTOR STARTER''
 20 PRINT
 30 PRINT
 40 CLEAR 709
 50 I = 1

 CLOSE THEN OPEN CHAN 0, WAIT 5 MIN FOR MOTOR A RUN TIME

 60 OUTPUT 709; ''DC2,0DR2''
 70 ENTER 709;A
 80 IF A<>1 THEN 330
 90 WAIT 3000
100 OUTPUT 709; ''DO2,0''
110 ENTER 709;B
120 IF B<>0 THEN 340
130 I = 2
140 WAIT 300000

 CLOSE THEN OPEN CHAN 1, WAIT 6 MIN FOR MOTOR B RUN TIME

150 OUTPUT 709; ''DC2,1''
160 ENTER 709;C
170 IF C<>2 THEN 330
180 WAIT 3000
190 OUTPUT 709; ''DO2,1''
200 ENTER 709;D
210 IF D<>0 THEN 340
220 I = 3
230 WAIT 360000

 CLOSE THEN OPEN CHAN 2, WAIT 4 MIN FOR MOTOR C RUN TIME

240 OUTPUT 709; ''DC2,2''
250 ENTER 709;E
260 IF E<>4 THEN 330
270 WAIT 3000
280 OUTPUT 709; ''DO2,2''
290 ENTER 709;F
300 IF F<>0 THEN 340
310 WAIT 240000

 PRINT FAILURE NOTICE IF RELAY DOES NOT OPEN OR CLOSE

320 GOTO 350
330 PRINT ''CHANNEL'';I; ''RELAY DID NOT CLOSE''
340 PRINT ''CHANNEL'';I; ''RELAY DID NOT OPEN''
350 END
```

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TYPICAL PRINTOUT

If channel 1 relay did not open, the printout is:

CHANNEL 1 RELAY DID NOT OPEN

COMMENTS

Although motor starters do not have standard control inputs, the high voltage actuator will control common motor starters up to NEMA class 5. This starter, in turn, will handle motors up to 100 horsepower (220V) or 200 horsepower (440-550V).

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EXAMPLE 17
VOLTAGE AND CURRENT SOURCES

DESCRIPTION

The Dual Output, 0 to ± 10V Voltage D/A Converter [VDAC](Option 120) provides programmable sources for applications such as programmable test stimulus or to control voltage programmed devices such as power supplies and VCO's. The Dual Output, 0-20 mA/4-20 mA Current D/A Converter [IDAC] (Option 130) provides two 0-20 mA or 4-20 mA programmable current sources.

PROCEDURE

This example shows how to program the Option 120 and 130 assemblies to provide desired voltage and current outputs. In the example, the voltage D/A converter is in slot 2 and the current D/A converter is in slot 3. In addition, the current D/A converter is set for the 0-20 mA range.

Both assemblies are controlled by the AO slot#,chan#,value. To program a desired current or voltage output, the "value" part of the command must be specified (i.e., a value of "40" outputs 0.0400 volts from a VDAC or 0.080 mA from an IDAC set to the 0-20 mA range).

VDAC Programming

For the VDAC, the value can be programmed from 0 to ± 10238 in units of millivolts. However, the voltage output is in units of 2.5 mV. Thus, for programmed values other than integer multiples of 2.5 mV, the 3497A will round off the value to the nearest integer multiple of 2.5 mV. To program a negative voltage output, the form is AO slot#, chan#, -value (i.e., AO3,1,-40 causes the VDAC to output -0.040 volts on channel 1).

IDAC Programming

The IDAC is programmed in units of 0.01% of the "span" where the span is 20 mA for the 0-20 mA range and 16 mA for the 4-20 mA range. However, the output can change only in increments of 0.025% of span. The 3497A will round off the AO command value to the nearest integer multiple of 0.025% of span. If the 4-20 mA range is selected, the minimum output is 4.000 mA.

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For example, if the IDAC is configured for the 0 - 20 mA range, the span is 20 mA. Thus, a program value of 5000 (AO slot#,chan#,5000) is 50% of span and gives an output of 10.00 mA. If the IDAC is configured for the 4 - 20 mA range, the span is 16 mA. Thus, a program value of 5000 (AO slot#,chan#,5000) which is 50% of span gives an output of 12 mA (50% of 16 mA = 8 mA + 4 mA minimum).

CONFIGURATION

Figure 204 shows sample connection diagrams for the Option 120 and 130 assemblies, with voltage sensing connections made for the Option 120 assembly. Note that with the Option 130 assembly, conventional current flow is out the SOURCE terminal and into the SINK terminal.

SAMPLE PROGRAM

As mentioned, the voltage D/A converter is in slot 2 and the current D/A converter is in slot 3. To program a desired current or voltage output, the ''value'' part of the command must be specified. For example, a value of ''40'' outputs 0.0400 volts from a VDAC or 0.080 mA from an IDAC set to the 0-20 mA range).

An example program is shown to output 0.320 volts from channel 0 of a VDAC in slot 2 and to output 0.160 mA from channel 1 of an IDAC in slot 3 which is set for the 0-20 mA range.

```
10 CLEAR 709
20 OUTPUT 709; ''AO2,0,320''      !Sets VDAC output to 0.320 V
30 OUTPUT 709; ''AO3,1,80''       !Sets IDAC output to 0.160 mA
40 LOCAL 709                      !Returns control to front panel
50 END
```

COMMENTS

Slots 5 through 9 do not exist for the 3497A or 3498A. Do not attempt to use these slot numbers as spurious voltages may be input or output.

The IDAC is factory set to the 0 to 20 mA range. Reconfiguring the assembly to the 4-20 mA range requires recalibration for output current accuracy.

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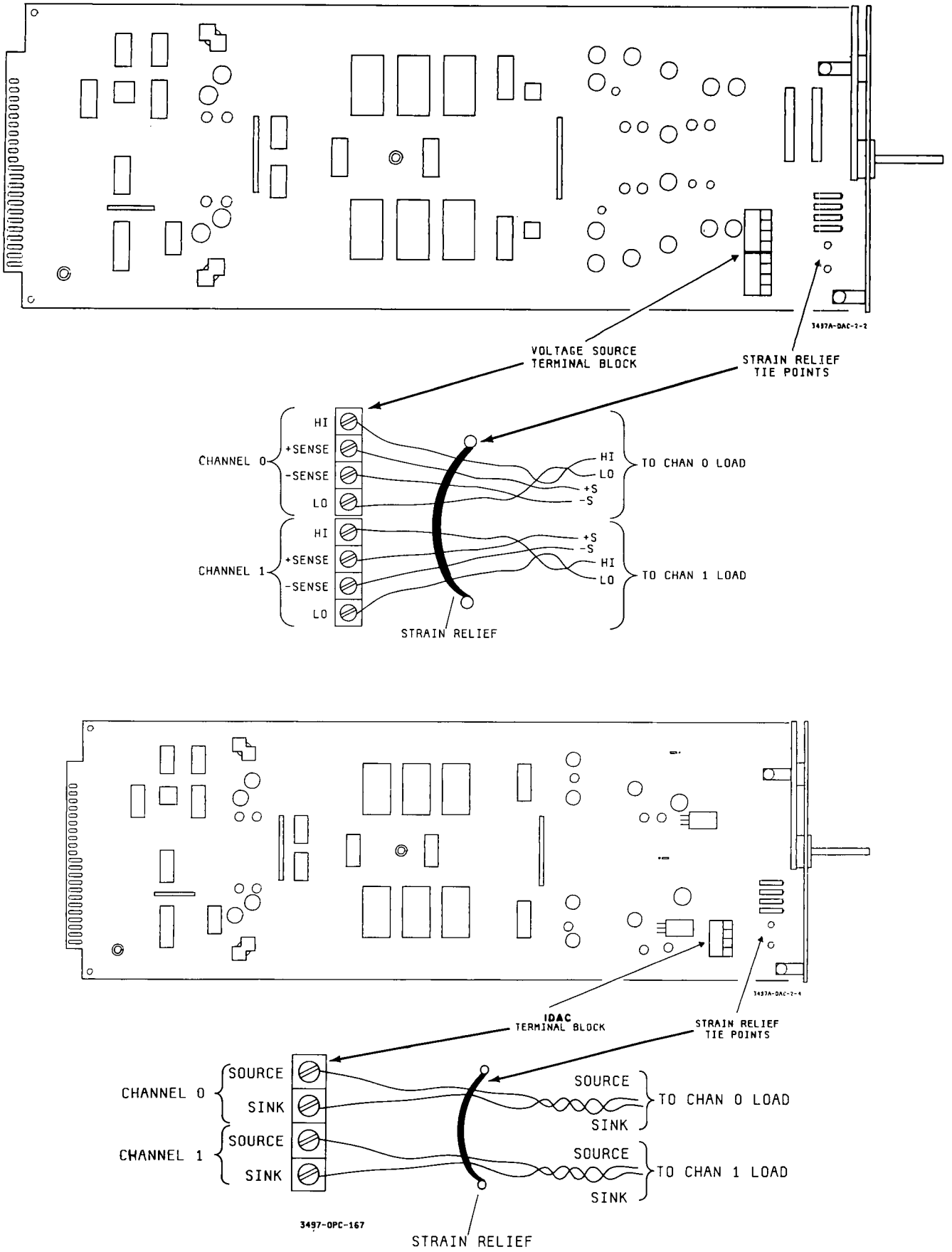


Figure 204. Example 17 - VDAC and IDAC Configurations

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Appendix A
INTERFACE CONCEPTS

This appendix introduces concepts for HP-IB and Serial Data (RS232C and RS449/423) interfaces used with the 3497A. It is divided into 3 parts: INTRODUCTION TO THE HP-IB; SERIAL I/O CONCEPTS AND THE 3497A; and INTRODUCTION TO RS232C/RS449.

INTRODUCTION TO THE HP-IB

This part of Appendix A summarizes the major functions of the HP-IB. If you need more information on HP-IB, refer to the HP-IB Abbreviated Description Manual (-hp- part number 5955-2903). A condensed description is also available in the Condensed Description of the Hewlett-Packard Interface Bus Manual (-hp- part number 59401-90030). These manuals are available through your local -hp- Sales and Service Office.

The Hewlett-Packard Interface Bus (HP-IB) is Hewlet-Packard's implementation of IEEE Standard 488-1978, ''Standard Digital Interface for Programmable Instrumentation''. HP-IB is an interface system which uses a party-line bus structure so that up to 15 devices can be placed on a single bus.

One controller can control up to 14 devices on a bus. For example, as shown in Figure A-1, an -hp- 85A Desktop Computer, acting as system controller, can control up to 14 devices over the HP-IB interface bus. Of course, more than one controller can be placed on the bus, if one of the controllers is designated as System Controller.

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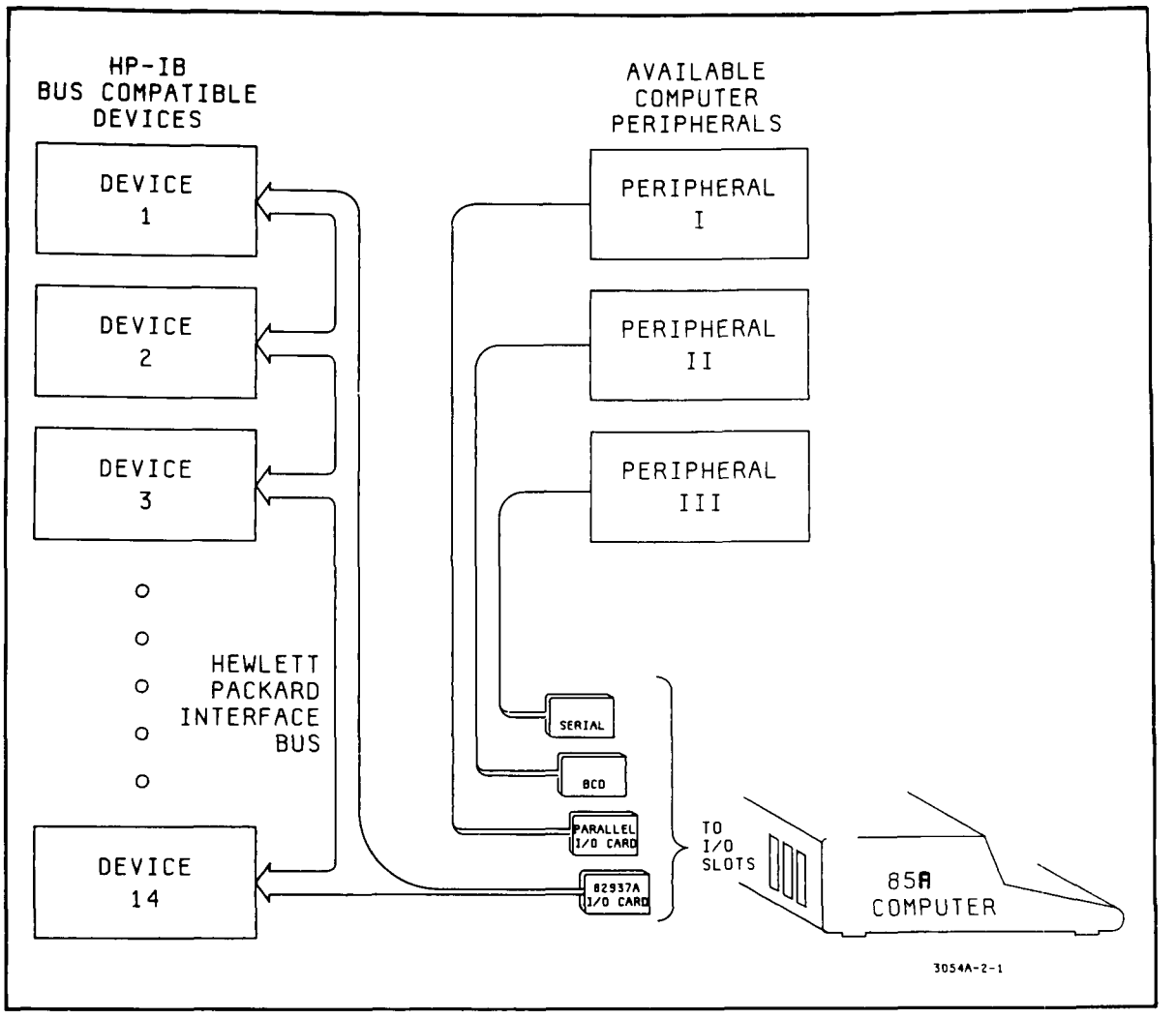


Figure A-1. Typical HP-IB System

HP-IB Bus Structure

As shown in Figure A-2, the HP-IB is a parallel bus of 16 active signal lines, grouped into 3 functional sets, to interconnect up to 15 instruments.

Eight signal lines, called the DATA lines, are used to transmit data in the form of coded messages. These messages are used to program the instrument function, transfer measurement data, coordinate instrument operation and to manage the system. Input and output of messages, in bit parallel-byte serial format, are also transferred in the DATA lines. A 7-bit ASCII code normally represents each piece of data.

The three DATA BYTE TRANSFER CONTROL lines coordinate and control transfer of data by means of an interlocking ''handshake'' technique which permits asynchronous data transfer at the rate of the slowest active device used in that transfer.

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The remaining five GENERAL INTERFACE MANAGEMENT lines are used to manage the devices on the HP-IB. This includes activating all connected devices at once, clearing the interface and others.

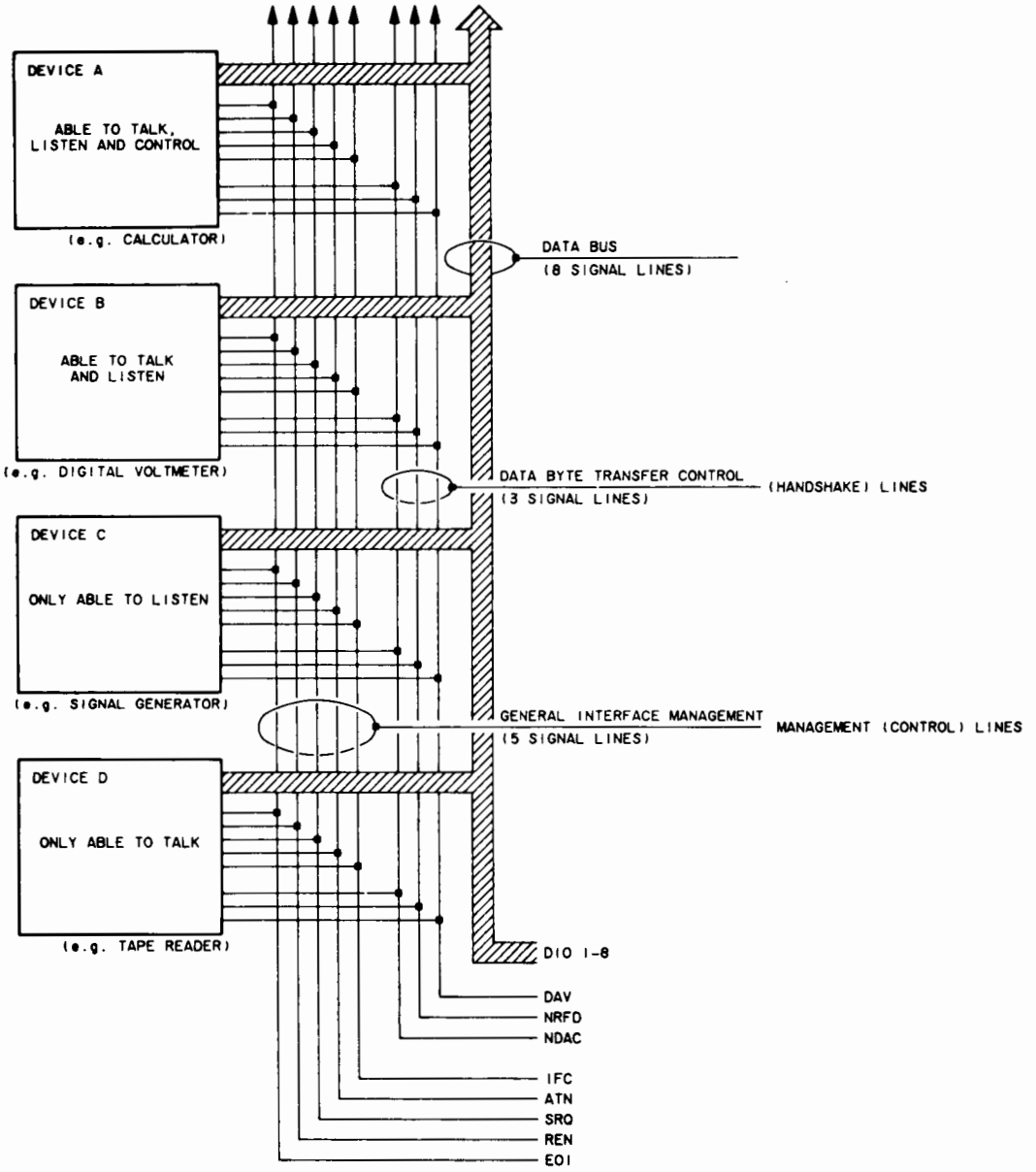


Figure A-2. Structure of the HP-IB

Device Communication Capabilities

Each device on the HP-IB is classified into one of three categories: TALKERS, LISTENERS or CONTROLLERS. The 3497A is classified as a TALKER since it can send data to the controller and a LISTENER since it can receive instructions from the controller.

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HP-IB DEVICE CAPABILITIES

LISTENER	A device which is capable of receiving data over the interface bus when addressed. A LISTENER becomes an ACTIVE LISTENER when it is addressed by the controller. There can be up to 14 active listeners simultaneously on the interface. Some examples of listeners are printers, display devices, programmable power supplies, etc.
TALKER	A device which is capable of transmitting data over the interface bus when addressed. A TALKER becomes an ACTIVE TALKER when it is addressed by the controller. There can be only one active talker on the bus at a time. Examples of talkers are tape readers, voltmeters and counters that are outputting data, etc.
CONTROLLER	A device which is capable of specifying talker and listener(s) for an information transfer. There can be two types of controllers, ACTIVE CONTROLLERS and a SYSTEM CONTROLLER. The active controller is the current controlling device. The system controller can take control of the HP-IB even if it is not the active controller. There can only be one active controller on the interface at a time. If there is more than one controller on the HP-IB, only one can be the system controller. A computer with an input/output card is an example of a controller.

HP-IB Messages

Different types of information can be passed over the HP-IB to one or more devices. One type of information is called a BUS MESSAGE. There are 12 bus messages for the HP-IB and each bus message can be divided into three parts: (1) an operation portion (2) the address specified by the controller and (3) the information in the message.

The operation mnemonic portion of a bus message tells what action to take (CLEAR, LOCAL, etc.). Each HP-IB compatible controller has an equivalent syntax (which is controller-dependent) for the operation mnemonic. The address portion of a bus message consists of an interface select code (ISC) and a device selector. The information portion consists of the commands or data.

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HP-IB BUS MESSAGES

BUS MESSAGE	DESCRIPTION
ABORT	System controller sends this message to unconditionally assume control of the HP-IB from the active controller. Message terminates all bus communication but does not implement the CLEAR message.
CLEAR	Sets all devices on the interface to pre-defined device dependent states.
DATA	Information (binary bytes) sent from a talker to a listener. The information (data) can be numeric or characters.
LOCAL	Clears the REMOTE message from listening device(s) and returns device(s) to front panel control.
LOCAL LOCKOUT	Prevents manually affecting remote program control.
CLEAR LOCKOUT AND SET LOCAL	Clears LOCAL LOCKOUT and REMOTE messages and reverts all devices to local front panel control.
PASS CONTROL	This message transfers bus management responsibility from one controller to another.
REMOTE	Causes listening device(s) to switch from local front panel control to remote program control when addressed to listen.
REQUIRE SERVICE	A device can send this message at any time to signify that the device needs some type of interaction with the controller. Message cleared by the device's STATUS BYTE message when the device no longer requires service.
STATUS BIT	A byte that represents the operational conditions of a group of devices on the HP-IB. Each device responds on a particular bit of the byte thus identifying a device dependent condition. This bit is typically sent by devices in response to a Parallel Poll operation.
STATUS BYTE	A byte that represents the current status of a single device on the HP- IB. One bit indicates whether the device sent the REQUIRE SERVICE message and the remaining seven bits indicate optional conditions defined by the device. This byte is sent from the talking device in response to a Serial Poll operation performed by the controller.
TRIGGER	Causes listening device(s) to perform a device-dependent action when addressed.

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ASCII Table

For convenient reference, an ASCII table showing ASCII character, equivalent binary, octal, hexadecimal and decimal values and (where applicable) HP-IB character follows.

ASCII TABLE

ASCII Char.	EQUIVALENT FORMS				HP-IB
	Binary	Oct	Hex	Dec	
NULL	00000000	000	00	0	
SOH	00000001	001	01	1	GTL
STX	00000010	002	02	2	
ETX	00000011	003	03	3	
EOT	00000100	004	04	4	SDC
ENQ	00000101	005	05	5	PPC
ACK	00000110	006	06	6	
BELL	00000111	007	07	7	
BS	00001000	010	08	8	GET
HT	00001001	011	09	9	TCT
LF	00001010	012	0A	10	
VT	00001011	013	0B	11	
FF	00001100	014	0C	12	
CR	00001101	015	0D	13	
SO	00001110	016	0E	14	
SI	00001111	017	0F	15	
DLE	00010000	020	10	16	
DC1	00010001	021	11	17	LLO
DC2	00010010	022	12	18	
DC3	00010011	023	13	19	
DC4	00010100	024	14	20	DCL
NAK	00010101	025	15	21	PPU
SYNC	00010110	026	16	22	
ETB	00010111	027	17	23	
CAN	00011000	030	18	24	SPE
EM	00011001	031	19	25	SPD
SUB	00011010	032	1A	26	
ESC	00011011	033	1B	27	
FS	00011100	034	1C	28	
GS	00011101	035	1D	29	
RS	00011110	036	1E	30	
US	00011111	037	1F	31	

ASCII Char.	EQUIVALENT FORMS				HP-IB
	Binary	Oct	Hex	Dec	
space	00100000	040	20	32	LA0
!	00100001	041	21	33	LA1
"	00100010	042	22	34	LA2
#	00100011	043	23	35	LA3
$	00100100	044	24	36	LA4
%	00100101	045	25	37	LA5
&	00100110	046	26	38	LA6
'	00100111	047	27	39	LA7
(	00101000	050	28	40	LA8
)	00101001	051	29	41	LA9
*	00101010	052	2A	42	LA10
+	00101011	053	2B	43	LA11
,	00101100	054	2C	44	LA12
-	00101101	055	2D	45	LA13
.	00101110	056	2E	46	LA14
/	00101111	057	2F	47	LA15
0	00110000	060	30	48	LA16
1	00110001	061	31	49	LA17
2	00110010	062	32	50	LA18
3	00110011	063	33	51	LA19
4	00110100	064	34	52	LA20
5	00110101	065	35	53	LA21
6	00110110	066	36	54	LA22
7	00110111	067	37	55	LA23
8	00111000	070	38	56	LA24
9	00111001	071	39	57	LA25
:	00111010	072	3A	58	LA26
;	00111011	073	3B	59	LA27
<	00111100	074	3C	60	LA28
=	00111101	075	3D	61	LA29
>	00111110	076	3E	62	LA30
?	00111111	077	3F	63	UNL

ASCII Char.	EQUIVALENT FORMS				HP-IB
	Binary	Oct	Hex	Dec	
@	01000000	100	40	64	TA0
A	01000001	101	41	65	TA1
B	01000010	102	42	66	TA2
C	01000011	103	43	67	TA3
D	01000100	104	44	68	TA4
E	01000101	105	45	69	TA5
F	01000110	106	46	70	TA6
G	01000111	107	47	71	TA7
H	01001000	110	48	72	TA8
I	01001001	111	49	73	TA9
J	01001010	112	4A	74	TA10
K	01001011	113	4B	75	TA11
L	01001100	114	4C	76	TA12
M	01001101	115	4D	77	TA13
N	01001110	116	4E	78	TA14
O	01001111	117	4F	79	TA15
P	01010000	120	50	80	TA16
Q	01010001	121	51	81	TA17
R	01010010	122	52	82	TA18
S	01010011	123	53	83	TA19
T	01010100	124	54	84	TA20
U	01010101	125	55	85	TA21
V	01010110	126	56	86	TA22
W	01010111	127	57	87	TA23
X	01011000	130	58	88	TA24
Y	01011001	131	59	89	TA25
Z	01011010	132	5A	90	TA26
[	01011011	133	5B	91	TA27
\	01011100	134	5C	92	TA28
]	01011101	135	5D	93	TA29
^	01011110	136	5E	94	TA30
_	01011111	137	5F	95	UNT

ASCII Char.	EQUIVALENT FORMS				HP-IB
	Binary	Oct	Hex	Dec	
`	01100000	140	60	96	SC0
a	01100001	141	61	97	SC1
b	01100010	142	62	98	SC2
c	01100011	143	63	99	SC3
d	01100100	144	64	100	SC4
e	01100101	145	65	101	SC5
f	01100110	146	66	102	SC6
g	01100111	147	67	103	SC7
h	01101000	150	68	104	SC8
i	01101001	151	69	105	SC9
j	01101010	152	6A	106	SC10
k	01101011	153	6B	107	SC11
l	01101100	154	6C	108	SC12
m	01101101	155	6D	109	SC13
n	01101110	156	6E	110	SC14
o	01101111	157	6F	111	SC15
p	01110000	160	70	112	SC16
q	01110001	161	71	113	SC17
r	01110010	162	72	114	SC18
s	01110011	163	73	115	SC19
t	01110100	164	74	116	SC20
u	01110101	165	75	117	SC21
v	01110110	166	76	118	SC22
w	01110111	167	77	119	SC23
x	01111000	170	78	120	SC24
y	01111001	171	79	121	SC25
z	01111010	172	7A	122	SC26
{	01111011	173	7B	123	SC27
|	01111100	174	7C	124	SC28
}	01111101	175	7D	125	SC29
~	01111110	176	7E	126	SC30
DEL	01111111	177	7F	127	SC31

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SERIAL I/O CONCEPTS

COMPARING SERIAL I/O TO PARALLEL I/O

What do these two terms mean? Simply stated, serial I/O is the transfer of data, one bit after another in succession, over a line. Parallel I/O, on the other hand, transfers a whole word simultaneously (usually eight or more bits) but requires a separate wire (or line) for each bit. Parallel I/O is usually faster, but not in all cases. Data transfer speeds primarily depend upon the functional capability of the devices.

Parallel I/O has dedicated lines to handshake each word transferred whereas serial I/O doesn't. In fact, serial I/O doesn't necessarily require a handshake at all. If the 3497A handshakes a transfer, it does so with either the ENQ/ACK or DC1 messages. These should not be confused with a hardware handshake. Strictly speaking, these are protocols where message bytes are sent to implement the handshake function.

Perhaps the most important distinction that can be made between serial and parallel I/O transfers, are the respective distances allowed between devices. Since parallel I/O has a separate wire for each bit, there are prohibitive cost and logistic considerations when long distances exist between devices. Serial I/O, however, permits data transfers via telephone lines when the appropriate modems are used. Even in a point to point hookup, serial I/O usually permits greater distances.

STANDARDS AND LINE PROTOCOLS

Confusion often accompanies the distinction between line protocols and standards. Line protocols are disciplines used for orderly information transfers over a communication channel. In other words, they establish the grammar by which devices communicate. Furthermore, some of the synchronous protocols are quite complex in structure.

A standard will usually define a protocol, but not always. RS-232C and RS-449/423 are examples of standards where protocols aren't defined, but they are the exception rather than the rule. A standard, however, will always define the electrical and mechanical requirements devices must adhere to for them to interoperate with other devices.

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SYNCHRONOUS VS ASYNCHRONOUS

This manual makes several references to both synchronous and asynchronous operation. Since the 3497A is asynchronous, it will be discussed thoroughly. However, to compare the two, a brief description of synchronous is given first.

Synchronous

Synchronous transmission involves a continuous bit-by-bit serial stream of characters to make up a message block, with no time interval between the characters. The transmitting and receiving station clocks must be precisely synchronized with each other so that each bit time is properly marked. Synchronous operation eliminates the need for start and stop bits to frame characters. Instead, start and stop indicators frame entire message blocks. This type of transmission requires that the transmitting station have the next character ready to transmit in the first bit time following the end of the preceding character. If it isn't ready, it must fill in with some predefined sync character to ensure that the transmitting and receiving stations do not get out of step with each other.

There are a number of synchronous line protocols in use today, such as Binary Synchronous Communications (BSC) and High Level Data Link Control (HDLC) to name only a couple. Some of the synchronous protocols are quite complex.

Asynchronous

Perhaps the first thing that should be noted about this type of operation is that you don't have to be concerned about a complex line protocol. With asynchronous, the character generation is random, thereby making the arrival of an asynchronous character unpredictable. For example, the interval between characters that are typed in from a keyboard will be determined by the operator's skill. This makes it necessary to provide built in character synchronization, which is done with start and stop bits. The asynchronous character structure is shown in Figure A-3.

Characters are transmitted using two voltage levels to represent the two possible states of a binary digit as shown in the following table.

Binary States

Voltage Level	Logic State	Line State	Level Name
+3V to +25V −3V to −25V	0 1	High Low	Space Mark

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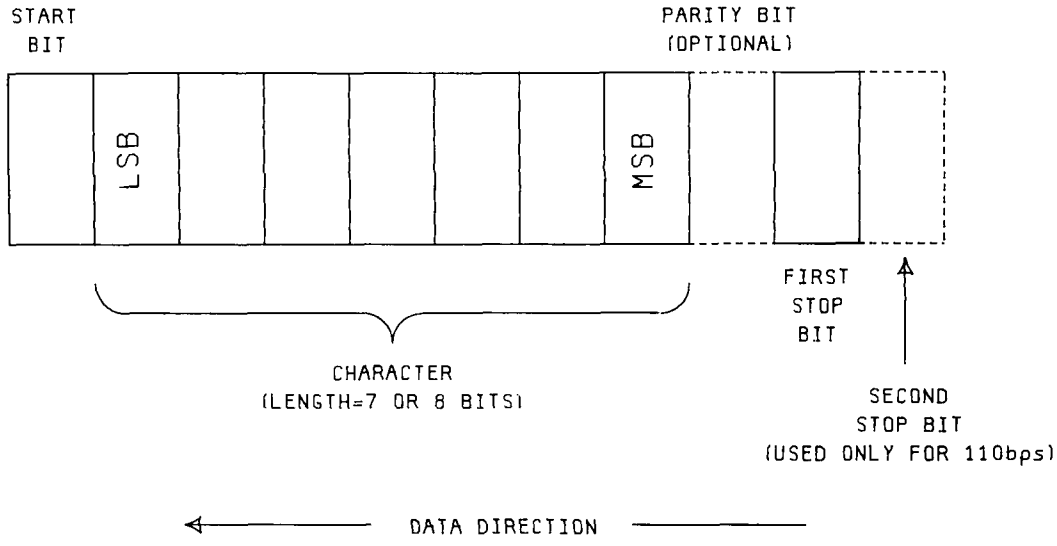


Figure A-3. Asynchronous Character Structure

When data is not being transmitted, the line is idle (low or mark). The transmitting device drives the line high (space) for one bit time when it has a character to send, hence the name start bit. The actual character is then transmitted, followed by a parity bit (optional when the 3497A is configured for 8-bit ASCII). The stop bit(s) is then sent which involves the transmitting device holding the line low (mark) for one or two bit times. The actual character transmission is shown in Figure A-4, which, in this instance, is the 7-bit ASCII representation of the letter ''E''. A more detailed explanation for each part of the character transmission follows Figure A-4.

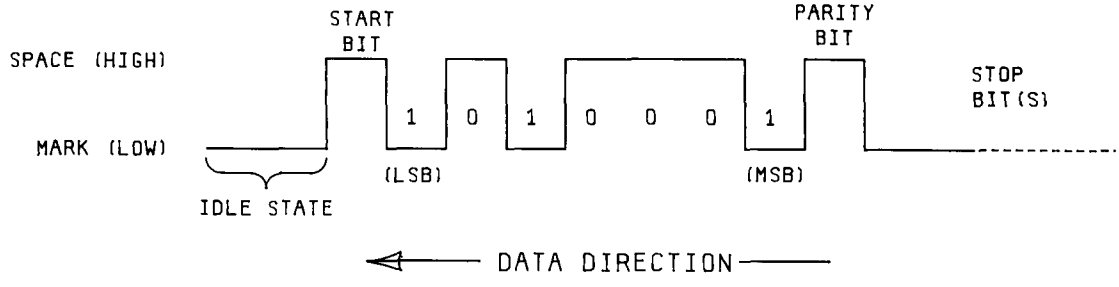


Figure A-4. Asynchronous Character Transmission

Idle State

The line is held at this low voltage level (mark) when no character is being transmitted.

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Start Bit

The start bit is inserted at the beginning of the character by the transmitting device. This is done by driving the line high (space) for one bit time. The start bit signals the receiving device that a character is starting so it can turn on its internal clock and input the character.

Character Bits

The 7-bit ASCII representation of the character "E" is 1000101. Notice that the character itself is seven bits in length without the start, stop or parity bits. These are the bits you have to consider when you are setting up a character length specification. The 3497A can be configured for 7 or 8 bit ASCII. Also, it is important that the computer has the same character length specification as the 3497A.

Parity Bit

The parity bit provides a means of checking a received character for errors. When used, it is computed and inserted after the character bits by the transmitting device. The receiving device then does a computation on the received character bits to determine what the parity bit should be and compares that with what it received.

Parity can be specified as odd or even. Odd parity simply means that the total number of 1's contained in the character bit pattern, including the parity bit, is an odd number. For even parity, there is an even number of 1's. For example, note that the 7-bit ASCII "E" has three 1's, an odd number. In this instance, if odd parity is specified, the parity bit would be a 0 making the total number of 1's an odd number. For even parity, it would be a 1 making the total number of 1's an even number. The following table shows how parity bits are determined.

Parity Specification

Parity Specified	Number of "1" Bits In Character	Parity Bit Sent
Odd	Odd	0
Odd	Even	1
Even	Odd	1
Even	Even	0
None	Odd or Even	None

The parity bit is optional when the 3497A is configured for 8-bit ASCII. If parity isn't specified, a parity bit isn't sent and no error checking is performed. Also, the length of time it takes to send an 8-bit ASCII character with a parity bit is reduced by one bit time.

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Stop Bit(s)

One stop bit is added following the parity bit for all operating speeds except 110 bps, which uses two stop bits. This involves the transmitting device allowing the line to stay idle (low) for one or two bit times. This gives the receiving device enough time to process the character before the next one is sent.

Bits and Bauds

The term "bit" is a contraction of binary digit. Bits are perhaps best represented by the square waves that were previously shown to transmit the ASCII "E". "Baud" refers to the speed of signal units and is the yardstick for measuring modems in bits per second (bps). If one bit is used as the signal unit, which is quite common, then baud speed and bps are the same. When two bits form the signal unit (double bit or dibit) then the baud rate is half the bps. When three bits form the signal unit (triple bit or tribit) then the baud rate is one third the bps. Most modems handle two state bits making baud and bps the same.

Modems (Data Sets)

The modem name is derived from the modulation and demodulation functions the device performs. Modems, also called data sets, are required when communication is performed over telephone lines. The 3497A can operate with asynchronous full duplex modems, and has been tested to operate with those models listed in Chapter 7.

Modulation is the process of converting the RS-232C or RS-449/423 level digital signals to analog waveforms for transmission over telephone lines. It follows then that demodulation is the process of reconverting the analog signals back to RS-232C or RS-449/423 digital signals. This is illustrated in Figure A-5.

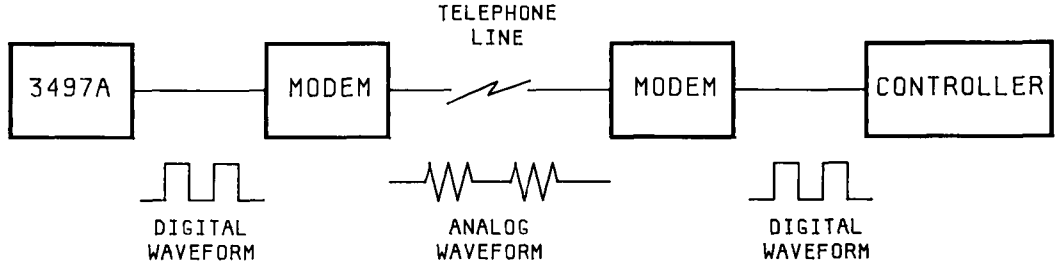


Figure A-5. Modem Functions in a System

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An asynchronous modem simply means that it operates at random speeds. That is, the character generation is random and the arrival of a character is unpredictable. This is illustrated in the Figure A-6.

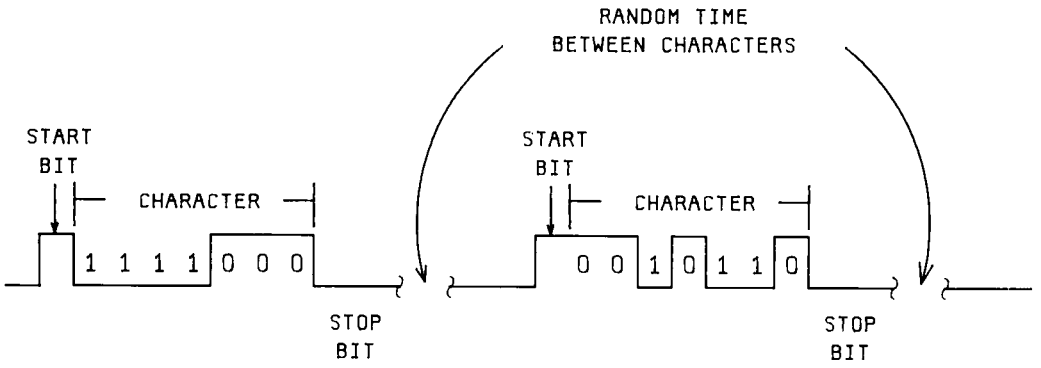


Figure A-6. Asynchronous Bit Flow

A full duplex modem is capable of transmitting and receiving data simultaneously. A half duplex modem can transmit and receive data, but it can't do both at the same time. You may wonder why full duplex operation is required in a data acquisition system since, typically, the 3497A will be instructed to perform some specified task and then transmit the results back to the computer. However, two-way simultaneous transmission is required when the 3497A sends a break. That is, when the 3497A sends a break, it may do so while the computer is still sending commands.

Echo

The 3497A does not support echo, and any computer used in the system should have this feature turned off. Where echo is supported, the receiving device transmits each character it receives back to the transmitting device. The returned character is usually then displayed on a CRT or printed on a printer, permitting a visual check to be made of the character transmission. However, characters echoed back to the 3497A will be interpreted as commands. Since they will not be understood, the 3497A will set the ''Message Not Executed'' Bit in its status register and, if enabled to do so, send a break. Another likely occurrence will be an input buffer overflow.

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INTRODUCTION TO RS232C/RS449

RS232C

In 1963 the Electronic Industry Association (EIA) established a standard for the Interface between Data Terminal Equipment (DTE) and Data Communication Equipment (DCE) that use serial binary data interchange. The latest revision of this standard, which has been in effect since 1969 is known as RS232C. This standard covers the following:

- Mechanical characteristics of the interface.
- Electrical characteristics of the interface.
- A number of interchange circuits with descriptions of their functions.
- The relationship of interchange circuits to standard interface types.

The Comite Consultatif International Telephonique et Telegraphique (CCITT) has established standard that correspond to RS232C. While these standards, CCITT V.24 and CCITT V.28, are very similar to RS232C, they are not identical.

Mechanical Characteristics of RS232C Interface

The standard gives definitions to 22 pins and designates three pins as unassigned, but does not specify a 25 pin connector. Although a particular 25 pin connector is not defined, the industry has accepted the connector shown in Figure A-7 as a de facto standard. The male connector is used with Data Terminal Equipment (e.g. desktop computer) and the female connector is used with Data Communications Equipment (the modem).

The length of the cable used by Data Terminal Equipment to connect to Data Communications Equipment should not be longer than 15.24 metres (fifty feet). This is assuming that the load capacitance at the interface point is the worst case value of 2500 picofarads. Longer cables are often used, especially in point-to-point configurations when the user knows that the total load capacitance will not exceed the 2500pF maximum.

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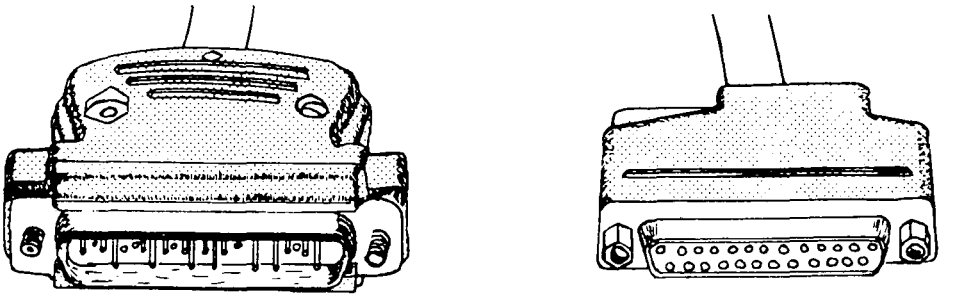


Figure A-7 25 Pin Connector

Electrical Characteristics

A number of electrical parameters and limitations are defined by RS232C for each interchange circuit. They refer to the Equivalent Interchange Circuit shown in Figure A-8.

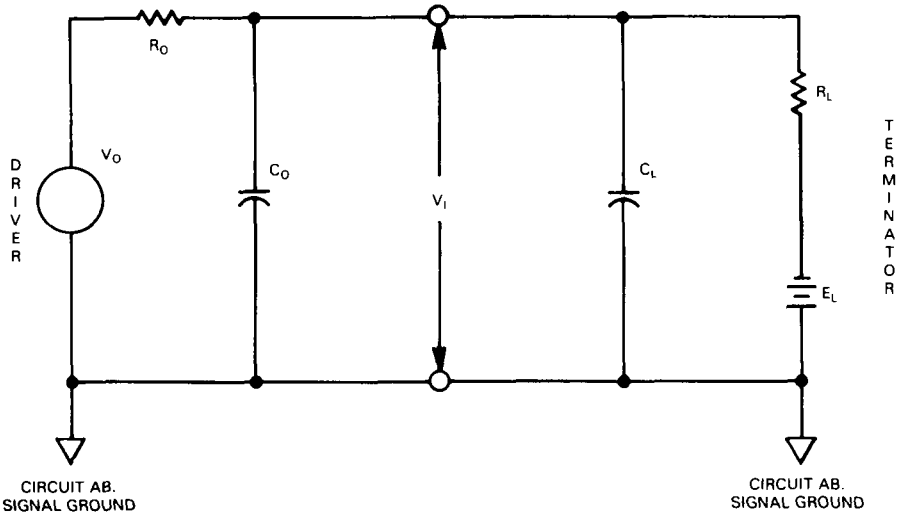


Figure A-8 Interchange Equivalent Circuit

The following electrical characteristics measurements are made at the interface point with reference to signal ground.

- Open circuit voltage from the driver shall not be greater than ±25 volts.
- The open circuit voltage of the terminator shall not exceed ±2 volts.
- The total capacitance of the terminator shall not exceed 2500 picofarads.
- The driver output voltage must be between 5 and 15 volts when the total terminator input resistance is between 3000 Ω and 7000 Ω.
- The output impedance of the driver circuit, when the driver power is off, shall not exceed 300 Ω.
- The rate of change of the driver output voltage (slew rate) shall not exceed 30 volts per microsecond.

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In addition, the following rules define the logic state indicated by the voltage levels of the circuit (see Figure A-9).

- A logical "1" (MARK) is indicated when the voltage at the interface point is more negative than −3 volts.
- A logical "0" (SPACE) is indicated when the voltage at the interface point is more positive than +3 volts.
- To indicate a "1" signal condition (MARK), the driver shall assert a voltage between −5 volts and −15 volts.
- To indicate a "0" signal condition (SPACE), the driver shall assert a voltage between +5 volts and +15 volts.

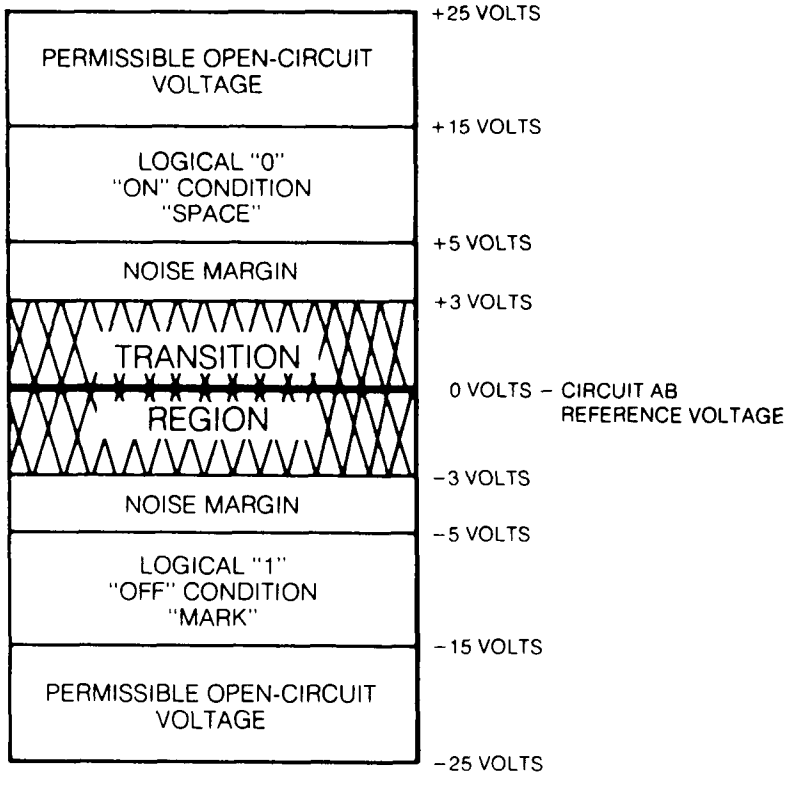


Figure A-9. Circuit Voltage Levels

Note that these standards allow for a 2 volt noise margin between the minimum driver voltage of 5 volts and the maximum undefined voltage of 3 volts. The following specifications govern the transition region.

- All interchange signals entering the transition region shall proceed to the opposite valid signal state. It shall not re-enter the transition region until the next significant change in signal state.
- While in the transition region, the direction of the voltage change must not reverse.

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- The time required for a control signal to cross the transition region shall not exceed one millisecond.
- The time required for a data or timing signal to cross the transition region shall not exceed one millisecond or four percent of the nominal signal period, whichever is the lesser.

The following table gives a description and a circuit reference for all of the assigned pins for the industry accepted connector (see Figure A-7).

RS232C Pin Identification

Pin	Circuit Reference		Description
	RS232C	CCITT	
1	AA	101	EARTH or Frame Ground
2	BA	103	Transmitted Data
3	BB	104	Received Data
4	CA	105	Request to Send
5	CB	106	Clear to Send
6	CC	107	Data Set Ready
7	AB	102	Signal Ground
8	CF	109	Received Line Signal Detector
9	+P		Positive DC Test Voltage
10	−P		Negative DC Test Voltage
11			Unassigned
12	SCF	122	Secondary Received Line Detector
13	SCB	121	Secondary Clear to Send
14	SBA	118	Secondary Transmitted Data
15	DB	114	Transmitter Clock
16	SBB	119	Secondary Received Data
17	DD	115	Received Clock
18			Unassigned
19	SCA	120	Secondary Request to Send
20	CD	108/2	Data Terminal Ready
21	CG	110	Signal Quality Detector
22	CE	125	Ring Indicator
23	CH/CI	112,111	Data Rate Selector
24	DA	113	External Transmitter Clock
25			Unassigned

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Interchange Circuit Functions

There are four categories of interchange circuits: Ground, Timing, Data, and Control. With the exception of the grounds, they can originate either in the modem (Data Communications Equipment, or DCE) or in the computer (Data Terminal Equipment, or DTE).

Ground Circuits

Circuit AA (CCITT 101)

Protective Ground: Electrically connected to the frame of the equipment and to earth ground as external regulations demand.

Circuit AB (CCITT 102)

Signal Ground: The zero-voltage reference point. Also acts as the common return for unbalanced interchange circuits.

Timing Circuits

The clock generated by the Data Terminal Equipment:

Circuit DA (CCITT 113)

Transmitter Signal Element Timing: Provides timing for the transmitted data on Circuit BA (CCITT 103). A transition from ON to OFF (positive to negative) indicates the approximate center of each signal element.

The clocks generated by Data Communications Equipment:

Circuit DB (CCITT 114)

Transmitter Signal Element Timing: Provides DTE with a timing signal to be used with the transmitted data on Circuit BA (CCITT 103). A transition from OFF to ON (negative to positive) indicates the transition between signal elements.

Circuit DD (CCITT 115)

Receiver Signal Element Timing: Provides timing for the received data on Circuit BB (CCITT 104). The transition from ON to OFF (positive to negative) indicates the approximate center of each signal element.

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Data Circuits

There are four Data Circuits, a primary circuit and a secondary circuit in each direction. Each is named in reference to the Data Terminal Equipment. For example, Received Data is driven by the DCE, and Transmitted Data is driven by the DTE.

Data circuits from the Data Terminal Equipment:

Circuit BA (CCITT 103)

Transmitted Data: The primary circuit for data originating at the DTE. Timing for data on this circuit can be provided either by circuit DA or DB.

Circuit SBA (CCITT 118)

Secondary Transmitted Data: The circuit for data originating at the DTE and transmitted via the secondary channel.

Data circuits from the Data Communications Equipment:

Circuit BB (CCITT 104)

Received Data: The circuit for data signals which have been generated by the DCE in response to signals received on the primary data channel. If necessary, timing for data on this circuit can be provided by circuit DD (CCITT 115).

Circuit SBB (CCITT 119)

Secondary Received Data: The circuit for data signals which have been generated by the DCE in response to signals received on the secondary data channel.

Control Circuits

These circuits are used to indicate to the receiving device the status or condition of the driving device.

Control circuits from the Data Terminal Equipment:

Circuit CA (CCITT 105)

Request to Send: Used to indicate to the DCE that data is ready to be sent, and also to control the direction of data transmission on a half duplex channel.

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Circuit CD (CCITT 108.2)

Data Terminal Ready: Used to control the switching of the DCE to the communication channel. This means that it allows the modem to enter the data mode in preparation for data transfer, as compared to the standby mode.

Circuit CH (CCITT 111)

Data Signal Rate Selector: Used to select between two data signalling rates when using dual rate synchronous modems. Also used to select between two ranges when using dual range asynchronous modems. Use of this circuit is not compatible with Circuit CI (CCITT 112) which performs a similar function, but is driven by the DCE.

Circuit SCA (CCITT 120)

Secondary Request to Send: Functionally similar to Circuit CA (CCITT 105) except that is requests establishment of the secondary data channel.

Control circuits from the Data Communications Equipment:

Circuit CB (CCITT 106)

Clear to Send: Indicates whether the data set is conditioned to transmit on the data channel or not.

Circuit CC (CCITT 107)

Data Set Ready: Indicates the status of the data set. It indicates only that the DCE is connected to the line, is in the data mode, and is ready to exchange further control signals with the DTE.

Circuit CE (CCITT 125)

Ring Indicator: Indicates that a calling signal is being received on the data channel.

Circuit CF (CCITT 109)

Received Line Signal Detector: Indicates that the signal received on the data channel is within specifications set by the DCE manufacturer and is therefore suitable for demodulation.

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Circuit CG (CCITT 110)

Signal Quality Detector: Indicates whether there is a probability of an error in the received data.

Circuit CI (CCITT 112)

Data Signal Rate Selector: Used to select between two data signalling rates in the DTE so that it coincides with the rate used in a dual rate synchronous DCE. Also used to select between two ranges of rates in the DTE so that it coincides with the range of rates used in a dual range asynchronous DCE.

Circuit SCB (CCITT 121)

Secondary Clear to Send: Functionally similar to Circuit CB (CCITT 106) except that it indicates the availability of the secondary channel.

Circuit SCF (CCITT 122)

Secondary Received Line Signal Detector: Functionally similar to Circuit CF (CCITT 109) except that it indicates the suitability of the signal received on the secondary data channel.

RS449

In 1977 EIA adopted the RS449 serial-interface standard. RS449 is a more capable standard than RS232C and when RS449 is implemented with an RS423 electrical subset, it is interoperable with RS232C. The European equivalency for this new standard is CCITT V.10.

RS449 provides additional interchange circuits, reduces crosstalk between interchange circuits, and allows higher signaling rates and greater distances between equipments. RS449 will gradually replace RS232C.

RS449 has a new set of mnemonics that are more descriptive and logical than those for RS232C. Like RS232C, RS449 references the digital side of the modem rather than the analog side. Three RS232C pin designations (pins 1, 9, and 10) are not included in RS449. The following 10 circuit functions were added that have no RS232C equivalent:

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LL—local loopback
RL—remote loopback
TM—test mode
SS—select standby
SB—standby indicator
IS—terminal in service
NS—new signal
SF—select frequency
SC—send common
RC—receive common

The following table lists the pin numbers and definitions for the 37-pin primary connector used with RS449. (Both primary and secondary channels are listed) and shows the relationships between RS449 and RS232C.

RS449/232C Relationships

RS449 And RS232C Equivalent Functions				EIA RS232C		
RS449		RS232C		Pin	Circuit	Description
SG	=	AB		1	AA	Protective Ground
IC	=	CE		2	BA	Transmitted Data
TR	=	CD		3	BB	Received Data
DM	=	CC		4	CA	Request to Send
SD	=	BA		5	CB	Clear to Send
RD	=	BB		6	CC	Data Set Ready
TT	=	DA		7	AB	Signal Ground
ST	=	DB		8	CF	Rec Line Sig Det
RT	=	DD		9	—	(Data Set Testing)
RS	=	CA		10	—	(Data Set Testing)
CS	=	CB		11	—	Unassigned (QM-209)
RR	=	CF		12	SCF	Sec Rec Line Sig Det
SQ	=	CG		13	SCB	Sec CTS
SR	=	CH		14	SBA	Sec Tran Data
SI	=	CI		15	DB	Trans Sig Timing (DCE)
				16	SBB	Sec Rec Data (DCT-209)
SSD	=	SBA		17	DD	Rec Sig Timing (DCE)
SRD	=	SBB	Secondary	18	—	Unassigned (DCR-209)
SRS	=	SCA	Circuits	19	SCA	Sec RTS
SCS	=	SCB		20	CD	Data Term Rdy
SRR	=	SCF		21	CG	Sig Qual Det
				22	CE	Ring Indicator
SC,RC,IS,NS,SF,LL,RL, TM,SS, and SB have no RS232C equivalents.				23	CH/CI	Data Rate Sel (DTE/DCE)
				24	DA	Trans Sig Timing (DTE)
				25	—	Unassigned (CR-202T)

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RS449 Pin Identification

Pin No.	Mnemonic	Function
1	—	Shield
2	SI	Signaling-Rate Indicator
3	—	Spare
4	SD	Send Data
5	ST	Send Timing
6	RD	Receive Data
7	RS	Request to Send
8	RT	Receive Timing
9	CS	Clear to Send
10	LL	Local Loopback
11	DM	Data Mode
12	TR	Terminal Ready
13	RR	Receiver Ready
14	RL	Remote Loopback
15	IC	Incoming Call
16	Dual-Function Pin: SF	Select Frequency
	Dual-Function Pin: SR	Signaling-Rate Selector
17	Dual-Function Pin: TT	Terminal Timing
18	TM	Test Mode
19	SG	Signal Ground
20	RC	Receive Common
21	—	Spare
22	Same as 4	Secondary
23	Same as 5	Secondary
24	Same as 6	Secondary
25	Same as 7	Secondary
26	Same as 8	Secondary
27	Same as 9	Secondary
28	IS	Terminal in Service
29	Same as 11	Secondary
30	Same as 12	Secondary
31	Same as 13	Secondary
32	SS	Select Standby
33	SQ	Signal Quality
34	NS	New Signal
35	Same as 17	Secondary
36	SB	Standby Indicated
37	SC	Send Common

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Appendix B
SPECIFICATIONS AND GENERAL INFORMATION

This appendix provides 3497A/3498A specifications and general information. SPECIFICATIONS shows overall system specifications for the 3497A and the 3498A Extender and for the 3497A options (Options 001 through 140). GENERAL INFORMATION provides warranty information, shows how to obtain repair service, gives shipping guidelines and includes manual information.

SPECIFICATIONS

Specifications for the 3497A/3498A and plug-in assemblies are performance characteristics of the instruments which are certified. These specifications are the performance standards or limits against which the instrument is tested.

Also included are some supplemental characteristics of the 3497A. These should be considered as additional and general information. Because of the many operational capabilities of the 3497A, exercise care when checking the instrument's specifications.

Any changes in specifications due to manufacturing changes, design, or traceability to the National Bureau of Standards will be covered in a MANUAL CHANGE supplement.

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SPECIFICATIONS TABLES

SYSTEM ACCURACY SPECIFICATIONS

These system specifications combine individual accuracy specifications to result in a total measurement accuracy specification. For example, the resistance specifications combine the DVM, current source and acquisition assembly error terms.

Voltage Measured Through Acquisition Assembly

3497A Configuration:
DVM: 5½ digit, auto zero on
Relays Switches: Tree Switched

Accuracy: ±(% of reading + number of counts)

90 Days 23°C ± 5°C

Voltmeter Range	Digits Displayed 5½ digits	4½ digits	3½ digits
0.1V	0.007 + 5	0.01 + 2	0.1 + 1
1.0V	0.006 + 1	0.01 + 1	0.1 + 1
10.0V	0.006 + 1	0.01 + 1	0.1 + 1
100.0V	0.006 + 1	0.01 + 1	0.1 + 1

Resistance Measured Through an Acquisition Assembly

3497A Configuration:
DVM: 5½ digit, auto zero on
Current Source: As indicated
Relay Switches: Configured for a 4-terminal resistance measurement

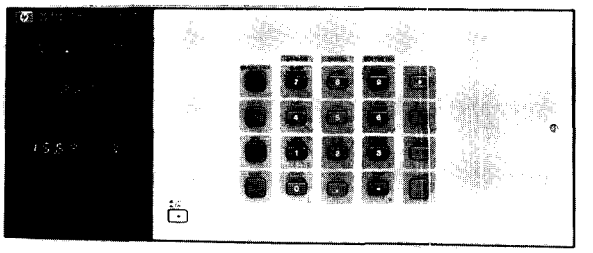
Characteristics

Effective Resistance Range	Effective Resistance Resolution	Current Source Range	Range
100 Ω	1 mΩ	1 mA	.100000
1 kΩ	10 mΩ	100 μA	1.00000
10 kΩ	100 mΩ	100 μA	10.0000
100 kΩ	1 Ω	10 μA	10.0000

Accuracy: ±(% of reading + number of counts)

90 Days 23°C ± 5°C

Range Relays (Opt. 010)	Digits Displayed 5½ digits	4½ digits	3½ digits
100 Ω	.032 + 5	.035 + 2	0.125 + 1
1 kΩ	.032 + 5	.035 + 2	0.125 + 1
10 kΩ	.032 + 5	.035 + 2	0.125 + 1
100 kΩ	.031 + 2	.035 + 2	0.125 + 1



System Noise Rejection

Normal Mode Rejection (NMR): (50 or 60 Hz + .09%)

DVM Digits Displayed	Rejection
5½	60 dB
4½	0 dB
3½	0 dB

NMR is a function of the 3497A DVM configuration only and is not affected by the number of channels in the system.

Effective Common Mode Rejection (ECMR): The ECMR of a 3497A based system is a combination of the ECMR of the 3497A DVM and the effects of adding multiplexer assemblies and 3498A extenders.

ECMR: 1(kΩ imbalance in low lead, using tree switching, ac at 50 or 60 Hz, 25°C, <85% R.H.)

Voltmeter Configuration

Number of Acquisition Channels (Options 10,20)		5½ digits	4½ digits	3½ digits
0	AC	150 dB	90 dB	90 dB
	DC	120 dB	120 dB	120 dB
<100	AC	150 dB	90 dB	90 dB
	DC	104 dB	104 dB	104 dB
<400	AC	140 dB	80 dB	80 dB
	DC	92 dB	92 dB	92 dB
<1000	AC	130 dB	70 dB	70 dB
	DC	85 dB	85 dB	85 dB

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Measurement Speeds

For the 3497A DVM and the relay multiplexer. Speeds are given for measurements on random channels (using software channel selection) and sequential channels (using external hardware increment). Speeds include I/O times to the indicated computers.

	Number of Digits Selected	85	Computer 9826*	1000L	1000E,F
Sequential Channels using external increment	5½ digits	39(33)**	39	39(25)	30(25)
	4½ digits	97(88)	103	108(79)	88(79)
	3½ digits	112(107)	123	127(99)	107(99)
Random Channels using software	5½ digits	13(15)	27	21(16)	22(16)
	4½ digits	14(21)	51	31(28)	35(30)
	3½ digits	14(23)	55	33(29)	35(32)

*9826 speeds for BASIC operating system
**50 Hz speeds in ( )

TIMER/REAL TIME CLOCK



Clock Format

Month:Day:Hours:Minutes:Seconds (Option 230)
Day:Month:Hours:Minutes:Seconds (Option 231)

	Maximum Time	Resolution	Accuracy	Output
Real Time Mode	1 year	1 second	±(.005% of time + .1s)	Display and HP-IB
Elapsed Time Mode	10^6 seconds	1 second	±(.005% of time + .1s)	Display and HP-IB
Time Alarm Mode	24 hours	1 second	±(.005% of time + .1s)	HP-IB SRQ
Time Interval Mode	24 hours	1 second	±(.005% of time + .1s)	50 μS TTL Pulse + HP-IB SRQ
Time Output Mode	1 second	100 μS	±(.02% of time)	16 μS TTL Pulse

Power Failure Protection: Battery back-up for >24 hours for time and elapsed time only

3497A MAINFRAME AUXILIARY INPUTS/OUTPUTS

Ext Trig. Input: TTL Compatible
Minimum pulse width: 50 n seconds

Ext Incr. Input: TTL Compatible
Minimum pulse width: 50 μ seconds

BBM Sync: TTL Compatible
This terminal serves as a break before make synchronizing signal to the 3497A and other equipment. The terminal is both an input and output with a low level indicating a channel is closed. The 3497A will not close any additional channels until the line is sensed high and the line will float high when all channels are open.

VM Complete Output: TTL Compatible
Pulse width = 500 n seconds

Channel Closed Output: TTL Compatible
Pulse width = 500 n seconds

Timer Interval Output: TTL Compatible
Output port for the time interval and time output functions.

Physical Parameters

Size (3497A or 3498A): 190.5 mm (7½ in.) high
428.6 mm (16 7/8 in.) wide
520.7 mm (20½ in.) deep
An additional two inches in depth should be allowed for wiring.

Net Weight:

	3497A	3498A
Maximum (with assemblies in all slots)	20.4 kg (45 lbs.)	20.4 kg (45 lbs.)

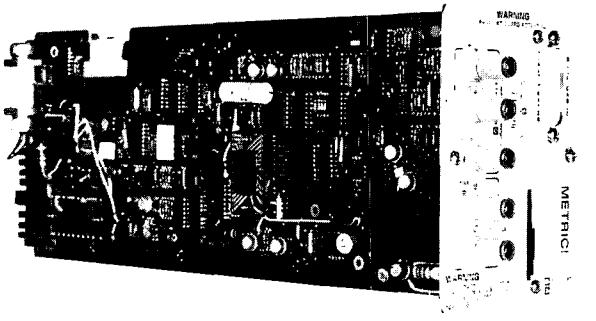
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Shipping Weight:

	3497A	3498A
Maximum (with assemblies in all slots)	26.3 kg (58 lbs.)	26.3 kg (58 lbs.)

Environmental (3497A or 3498A):
Warm Up time: 1 hour
Operating Temperature 0°C to 55°C
Non-operating Temperature: -40°C to 75°C
Humidity: to 95% at 40°C except as noted
Shock: 30 G, 11 Millisec. sine wave on each of six sides
Vibration: 10 Z to 55 Hz at .010 inch peak to peak excursion
Operating Power: switch selection of 110 volts, 120 volts, 220 volts, 240 volts, ±10%, 48-66 Hz, 150 VA 3497A, 150 VA 3498A

OPTION 001
5½ DIGIT DVM AND CURRENT SOURCE



Voltmeter Ranges/Resolution

Range	Maximum Display	5½ Digit Resolution	4½ Digit Resolution	3½ Digit Resolution	Max. Input Voltage
.10V	±.119999	1 μV	10 μV	100 μV	120V peak
1.0V	±1.19999	10 μV	100 μV	1 mV	
10.0V	±11.9999	100 μV	1 mV	10 mV	
100.0V	±119.999	1 mV	10 mV	100 mV	

Voltmeter Measurement Accuracy
± (% of reading + Number of Counts)
(Auto Zero On)

24 Hours: 23°C ± 1°C

Range	Digits Displayed 5½ Digits	4½ Digits	3½ Digits
.10V	.003 + 3	.01 + 1	.1 + 1
1.00V	.002 + 1	.01 + 1	.1 + 1
10.00V	.002 + 1	.01 + 1	.1 + 1
100.00V	.002 + 1	.01 + 1	.1 + 1

90 Days: 23°C ± 5°C

Range	Digits Displayed 5½ Digits	4½ Digits	3½ Digits
.10V	.007 + 3	.01 + 1	.1 + 1
1.00V	.006 + 1	.01 + 1	.1 + 1
10.00V	.006 + 1	.01 + 1	.1 + 1
100.00V	.006 + 1	.01 + 1	.1 + 1

1 Year: 23°C ± 5°C

Range	Digits Displayed 5½ Digits	4½ Digits	3½ Digits
.1V	0.015 + 3	0.02 + 1	0.1 + 1
1.0V	0.015 + 1	0.02 + 1	0.1 + 1
10.0V	0.015 + 1	0.02 + 1	0.1 + 1
100.0V	0.015 + 1	0.02 + 1	0.1 + 1

Auto Zero Off[1]: Additional Error if Auto Zero is turned off in a thermally stable environment (temperature deviations less than ± 1°C, up to 24 hours)

Range	Additional Error
.10V	10 counts
1.00V	1 count
10.0V	1 count
100.00V	1 count

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Temperature Coefficient[1]: ±(% Reading + Number of Counts)/°C; 0-18°C, 28-55°C

Range	
.10V	.00025 + .15
1.00V	.00020 + .02
10.00V	.00020 + .01
100.00V	.00025 + .03

[1]Valid for 5½ digit operation. Multiply counts by .1 for 4½ digit operation. Multiply counts by .01 for 3½ digit operation.

Noise Rejection

NMR = NORMAL MODE REJECTION (50 or 60 Hz. ± .09%)
ECMR = EFFECTIVE COMMON MODE REJECTION (1 kΩ unbalance, low lead)

Rejection	Digits Displayed (Integration Period in Cycles[1]) 5½ Digits (1 cycle)	4½ Digits (.1 cycle)	3½ Digits (.01 cycle)
AC NMR (dB) (50 or 60 Hz)	60	0	0
AC ECMR (dB) (50 or 60 Hz)	150	90	90
DC ECMR (dB)	120	120	120

[1]Integration Period in line cycles
1 cycle = 16.7 ms for 60 Hz operation
1 cycle = 20 ms for 50 Hz operation

Input Impedance

Hi to Low (in parallel with 120 pF at 1 MHz)	25°C, <85% R.H. 40°C, <60% R.H.	40°C, <95% R.H.
.1V to 10V Range	$>10^{10}\Omega$	$>10^{9}\Omega$
100V Range	10MΩ ± .5%	10MΩ ± .5%

Maximum Input Voltage

High to Low: 120 V peak
Low to Guard: 170 V peak
Guard to Chassis: 170 V peak

Current Source

Range	24 Hours 23°C±1°C	Accuracy 90 Days 23°C±5°C	1 Year 23°C±5°C	Temperature Coefficient (per °C; 0°C–18°C; 28°C–55°C)
10 μA	1.25 nA	2.5 nA	3.2 nA	.25 nA
100 μA	12.5 nA	25.0 nA	32.0 nA	2.5 nA
1 mA	125 nA	250 nA	320 nA	25.0 nA

Compliance: > + 15 volts
Isolation Voltage: 170 volts peak
Output Resistance: $>10^{10}\Omega$

General Information

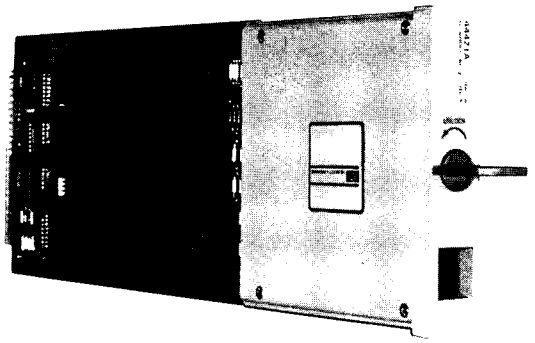
Maximum Reading Rate: (readings/second)

Auto Zero	60 Hz Operation Digits Displayed			50 Hz Operation Digits Displayed		
	5½	4½	3½	5½	4½	3½
ON	25	100	150	20	83	125
OFF	50	200	300	40	166	250

Delay: 0 to 99.9999 sec. in 100 μsec. steps
Buffer size: Packed Format: 100 Readings
ASCII Format: 60 Readings
Number of readings per Trigger: 1 to 999

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OPTION 010
20 CHANNEL RELAY MULTIPLEXER ASSEMBLY



Input Characteristics

Maximum Input Voltage: <170V peak between any two input terminals

Maximum Current: 50 mA per channel non-inductive

Maximum Power: 1 VA per channel

Thermal Offset: Direct Switched: < 1μV Differential
Tree Switched: <2 μV Differential

Closed Channel Resistasnce:
In Series: 100 Ω ± 10% in High, Lo and Guard Relays
Contacts Only: <1 Ω per contact

Open Channel Isolation:

		25°C, <85% R.H. 40°C, <60% R.H.	40°C, >95% R.H.
Hi to Lo			
Option 010		$>10^{10}\Omega$	$>10^{9}\Omega$
Option 020	Open	$<10^{10}\Omega$	$>10^{9}\Omega$
	Closed	$>10^{8}\ \Omega$	$>10^{7}\Omega$
Lo to Guard		$<10^{8}\ \Omega$	$>10^{7}\Omega$
Guard to Chassis		$>10^{10}\Omega$	$>10^{9}\Omega$

Operating Characteristics

Maximum Switch Rate: Random Channels;
Using Hardware Increments: 475/second

Rated Switch Life at 1 VA: 10^{7} operations

All Relays are Break Before Make

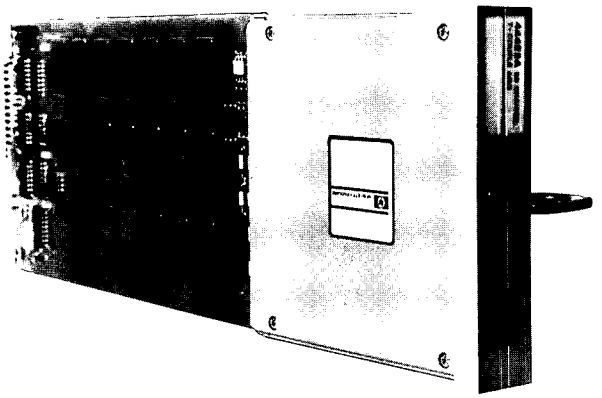
AC Performance

High to Low Capacitance: Channel Open: < 10 pF/per channel
Channel Closed: <220 pF/per channel

Interchannel Capacitance: < 10 pF

	100 kHz	1 MHz
Frequency Response (1 MΩ Termination, 10 kHz Reference)	± .3 dB	±.5 dB
Cross Talk		
Channel to Common		
50 Ohm Termination	−70 dB	−50 dB
1M Ohm Termination	−50 dB	−40 dB
Channel to Channel		
50 Ohm Termination	−60 dB	−40 dB
1M Ohm Termination	−40 dB	−30 dB

OPTION 020
RELAY MULTIPLEXER ASSEMBLY WITH THERMOCOUPLE COMPENSATION



Reference Junction Compensation Comparison

	Compensation Type Software	Hardware
Compatible Thermocouples	Any Mixture	One of the Following Types: B,E,J,K,R,S,T
Measurement Channels Available per Assembly	19	20
Reference Junction Compensation Accuracy (23°C ± 5°C)	.1°C	

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Valid for thermocouple compensation only. The total accuracy of 3497A based temperature measurement systems including compensation accuracy, 3497A scanner offsets. DVM accuracy and software accuracy is shown below.

Temperature Coefficient (0°C → 18°C, 28°C → 55°C)	.009°C/°C	
Stability	.075°C/1000 Hours	
Temperature Difference Across Isothermal Block:	< .2°C	
Software Compensation Output: (Channel B9)	100mV/0C 2.5V@25°C	
Additional In Series Resistance: (Hardware Compensation only).		10Ω

Temperature Measurement Accuracy

For a 3497A based temperature measurement system. Includes all errors introduced by the 3497A and the HP 3054A/C Data Acquisition/Control System Software.

Input Characteristics

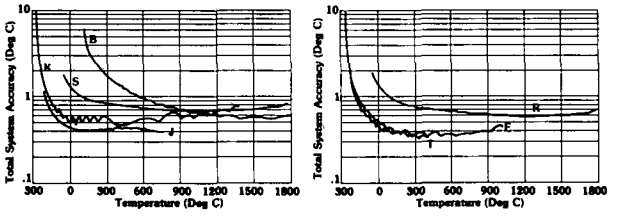
Maximum Input Voltage: < 170 V peak between any two input terminals

Maximum Current: 50 mA per channel non-inductive

Maximum Power: 1 VA per channel

Thermal Offset: Direct Switched: < 1 μV Differential
Tree Switched: < 2 μV Differential

Closed Channel Resistance:
In Series: 100 Ω ± 10% in High, Lo and Guard
Relays Contacts Only: < 1 Ω per contact



Open Channel Isolation:

		25°C, <85% R.H. 40°C, <60% R.H.	40°C, >95% R.H.
Hi to Lo			
Option 010		$>10^{10}\Omega$	$>10^{9}\Omega$
Option 020	Open	$<10^{10}\Omega$	$>10^{9}\Omega$
	Closed	$>10^{8}\ \Omega$	$>10^{7}\Omega$
Lo to Guard		$<10^{8}\ \Omega$	$>10^{7}\Omega$
Guard to Chassis		$>10^{10}\Omega$	$>10^{9}\Omega$

Operating Characteristics

Maximum Switch Rate: Random Channels;
Using Hardware Increments: 475/second

Rated Switch Life at 1 VA: 10^{7} operations

All Relays are Break Before Make

AC Performance

High to Low Capacitance: Channel Open: < 10 pF/per channel
Channel Closed: <220 pF/per channel

Interchannel Capacitance: < 10 pF

	100 kHz	1 MHz
Frequency Response (1 MΩ Termination, 10 kHz Reference)	± .3 dB	±.5 dB
Cross Talk		
Channel to Common		
50 Ohm Termination	−70 dB	−50 dB
1M Ohm Termination	−50 dB	−40 dB
Channel to Channel		
50 Ohm Termination	−60 dB	−40 dB
1M Ohm Termination	−40 dB	−30 dB

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OPTION 050
16 CHANNEL ISOLATED DIGITAL INPUT/INTERRUPT ASSEMBLY

Input Signal Characteristics

Input Level	V_{LO}(max.)	V_{HI}(min.)	Max. Input Voltage	Min. Input Current
5V	0.8V	2.4V	30V	400 μA
12V	3.0V	7.0V	42V	1 mA
24V	6.0V	13.0V	42V	2 mA

(5 volt level is standard, 12 and 24 volt levels are jumper selectable. Other voltage levels can be accepted using customer supplied resistors).

Maximum Isolation Voltage: < 170V peak between any input terminal and ground.

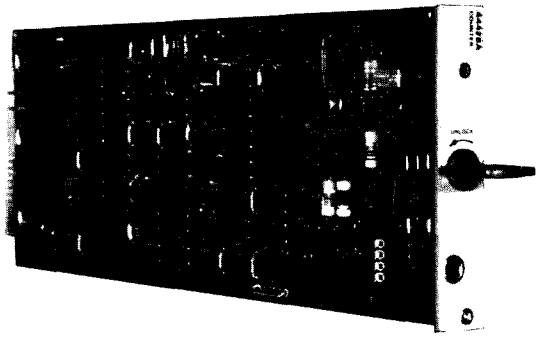
Digital Input Mode (Bits 0-15)

Logic Polarity: Positive True
(Negative True is jumper selectable)

Handshaking: Gate and Flag Lines are optically isolated. Gate output is open collector. Flag input is identical to input lines. Polarity of gate/flag is jumper selectable. The assembly may be configured to operate with no handshaking.

Interrupt Mode (Bits 0-7)

Minimum Pulse Width: 100 microseconds

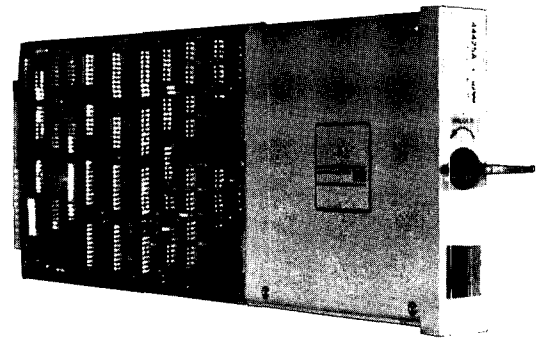


Period Mode:

Input Signal Characteristics:
Maximum Input Frequency: 100 kHz
Minimum On Time: 5 μs
Minimum Off Time: 5 μs

Range Charactristics:

Range	Least Significant Digit (LSD) HP-IB	Least Significant Digit (LSD) Display	Periods Averaged
9999.999 s	1 ms	10 ms	1
99.99999 s	10 μs	100 μs	1
0.9999999 s	100 ns	1 μs	100
.09999999 s	10 ns	1 μs	1000



Triggering: Each interrupt line is individually programmable for positive or negative edge triggering.

Masking: Each interupt line may be enabled or disabled using a programmable mask.

Multiple Interrupts: Multiple interrupts are latched and are dealt with at a computer dependent rate.

Interrupt Timing: The Option 050 assembly will respond to an interrupt within 1 millisecond of a programmed interrupt condition change.

Five Volt Supply: Source up to 20 mA per assembly.

Operating Consideration: Digital Interrupt (SRQ) is not available in the 3498A Extender.

OPTION 060
100 kHz RECIPROCAL COUNTER ASSEMBLY

Input Signal Characteristics:

Input Levels:

Input Level Range	V(Lo) (maximum) Isolated	V(Lo) (maximum) Non-iso	V(Hi) (minimum) Isolated	V(Hi) (minimum) Non-iso	Max Input Voltage
5V	1.0V	1.0V	4.2V	4.2V	±12.0V
12V	1.8V	2.7V	10.3V	8.0V	±21.0V
24V	2.6V	6.0V	18.4V	16.5V	±32.0V

Input Circuit: Switch selection of optically isolated or non-isolated input. Non-isolated input has 19.5 kΩ minimum input impedance. Non-isolated mode is standard.

Minimum Current:
Isolated: (all ranges) 8 mA
Non-isolated: 5V range: 30 μA
12V range: 250 μA
24V range: 750 μA

Input Fuse: 125 mA

Maximum Isolation Voltage: 170 V peak between any terminal and ground. Frequency ≤ 60 Hz.

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Accuracy: ±(.01% of reading + 2 LSDs + Trigger Error)

Trigger Error: Maximum Transition Time for input voltage to go from V(Lo) to V(Hi) or V(Hi) to V(Lo)

Pulse Width:

Input Signal Characteristics:
Minimum Start to Stop Time (Pulse Width): 18 μs
Minimum Stop to Start Time: 18 μs

Range Characteristics:

Range	Least Significant Digit (LSD) HP-IB	Least Significant Digit (LSD) Display	Periods Averaged
9999.999 s	1 ms	10 ms	1
99.99999 s	10 μs	100 μs	1
0.9999999 s	1 μs	1 μs	100
.099999 s	1 μs	1 μs	1000

Accuracy: ±(.01% of reading + Trigger Error + 2 LSDs or 18 μs, whichever is greater)

Trigger Error: Maximum Transition Time for input voltage to go from V(Lo) to V(Hi) + V(Hi) to V(Lo)

Totalize/Down Count Mode:

Input Signal Characteristics:
Maximum Input Frequency: 100 kHz
Minimum Pulse Width: 5 μs

OPTION 070/071
120/350 OHM, STRAIN GAUGE/BRIDGE COMPLETION ASSEMBLIES

No Manual Adjustments
The assembly is used with an external supply and either the 3497A voltmeter or an external 3456A voltmeter. The initial voltmeter readings for bridge excitation and bridge unbalance are used by the system computer to solve the bridge equation, eliminating the need for any span and offset adjustments. To compute strain, this assembly must be used in conjunction with a system computer.

Bridge Excitation
The excitation voltage V_S is always applied, never switched, so there are no errors due to the dynamic heating and cooling of the gauge. Since the excitation voltage is measured on each strain gauge/bridge card, the strain accuracy is independent of long-term supply voltage changes. An inexpensive power supply, such as the HP 6214A, is adequate to achieve the accuracy specification shown. It also has enough current capability to provide power for up to 50 channels (5 cards).

Excitation Supply Requirements:
(½ bridge configuration)
V_S max: ±5.4 volts DC
I_S: 250 mA per 10 channels (120 ohm gauges)
80 mA per 10 channels (350 ohm gauges)

General Information:

Isolation Voltage: ≥ 170 V peak between any terminal and chassis

Range: 0 to 999,999

Preset Value Range: 0 to 999,999

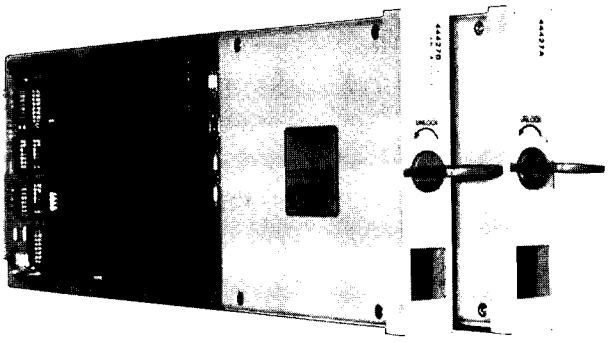
General Information

Level Change Output: Level change occurs on measurement complete, overflow and zero count (down count mode only).
Output Circuit: Open Collector
Isolated mode is standard; non-isolated is jumper selectable. Interrupt mode is standard; square wave output is jumper selectable. Negative true logic is standard; positive true is jumper selectable.
Maximum Current: 1.6 mA
Maximum Voltage: 12 volts
Maximum Low Level Voltage: .65 V at 1.6 mA

Square Wave Output Operation: The output line can be configured to act as a square wave output with a frequency equal to ½ of the counter input signal. When used in the count down function with the counter input connected to the 3497A Timer output (or other external source), the counter output line can be used to output a programmable number of square wave pulses. This feature may be useful in driving devices controlled by square wave pulse trains like stepper motor controllers.
Maximum Input Frequency: 2 kHz
Maximum Output Frequency: 1 kHz (½ of input frequency)
Output Range: 0-499,999 pulses programmable

+ 5 Volt Supply: Jumper selectable to sense contact closures and open collector outputs on the non-isolated input. May also be used to supply open collector level change output. Connected through supplied pull up resistors.

Operating consideration: Digital Interrupt (SRQ) is not available in the 3498A Extender.



Sensitivity vs. Supply Voltage

Bridge Type	V_S = 100 mV	V_S = 1 volt	V_S = 5 volts
Full	0.5 με	0.05 με	0.01 με
½	1 με	0.1 με	0.02 με
¼	2 με	0.2 με	0.04 με

(GF = 2, System Voltmeter = 3456A. For 3497A Voltmeter, multiply numbers by 10).

Accuracy
These specifications include all system-related errors: bridge resistor tolerance and drift, thermal offsets of bridge scanner and voltmeter, voltmeter accuracy, injected currents, self-heating of bridge resistors and system noise. The only exceptions are lead wire mismatch and the accuracy of the gauge itself. Specifications are valid for either the 3497A or the 3456A voltmeter with integration time set to one power line cycle.

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Accuracy at V_S = 5 volts

Bridge Type	24 Hr. ± 1°C	90 Day 23 ± 5°C	≤90 Days 23 ± 5°C	Temperature Coefficient (0-18,28-55°C)
Full	1 με	1 με	0.04 με/Mo.	0.025 με/°C
½	4 με	5 με	0.4 με/Mo.	0.3 με/°C
¼	7 με	25 με	1.8 με/Mo.	1.8 με/°C

Accuracy At V_S = 1 Volt

Full	3 με	3.5 με	0.04 με/Mo.	0.1 με/°C
½	5 με	10 με	0.9 με/Mo.	0.4 με/°C
¼	10 με	35 με	6.8 με/Mo.	1.8 με/°C

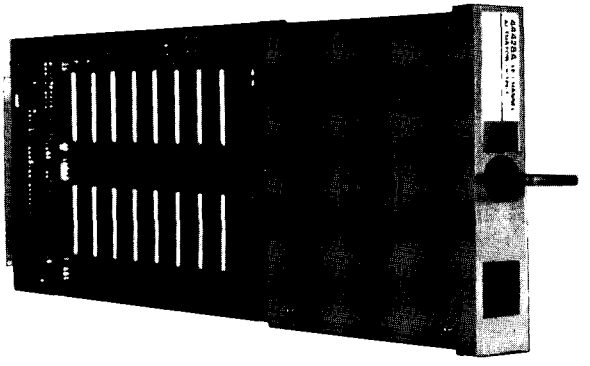
Accuracy At V_S = 100 mV

Full	20 με	35 με	0.04 με/MO.	0.8 με/°C
½	40 με	75 με	0.9 με/Mo.	1.7 με/°C
¼	80 με	150 με	6.8 με/Mo.	3.5 με/°C

All Specifications Are ±
These figures assume a gauge factor of 2.

Maximum self-heating offset due to change in the number of gauges on one assembly: 0.3 με per gauge (V_S = + 5, R_g = 120 Ω, ¼ bridge)

Maximum self-heating offset due to .1 V change in supply voltage: 0.38 με (V_S = + 5, R_g = 120 Ω, ¼ bridge).



AC Performance

Contact Capacitance: < 15 pF

Interchannel Capacitance: < 30 pF

Frequency Response

(10 kHz Reference)	f<100 kHz	f<1 MHz
50 Ohm Termination	±.3 dB	±.5 dB
1M Ohm Termination	±.3 dB	±.5 dB

Cross Talk

1M Ohm Termination	<30 dB	<30 dB

OPTION 110
ACTUATOR/DIGITAL OUTPUT ASSEMBLY

Input Characteristics

Contact Ratings: Voltage: ± 100 V peak
Current: 1 ampere/channel
Power: 100 volt amperes/channel

CAUTION: For use only in circuits fused at 1 ampere or less and less than 100 VA.

Thermal Offset: < 20 μV

Contact Resistance: < 400 milliohms

Isolation: > 10^6 Ω common to open

Isolation Voltage: 170V peak any terminal to chassis

General Information

Single Channel Closure Rate: > 27/second (Using 9835A)

Switch Life: > 10^{10} with contact protection

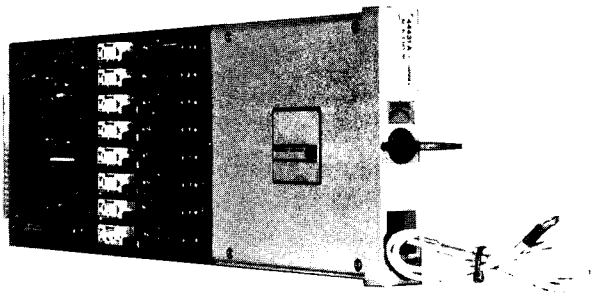
+ 5V Supply: Source up to 50 mA per assembly

Operating Considerations: Should not be used in a position greater than 30° above horizontal

Handshake Lines: Optically isolated, TTL compatible, open collector output

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OPTION 115
8 CHANNEL HIGH VOLTAGE ACTUATOR ASSEMBLY



Maximum Contact Ratings:

Voltage AC 252 VRMS	DC 48 VDC
Current AC 2 amps RMS	DC 2 ADC
Power AC 500 VA per chan.	DC 60 VA per chan.

Peak Surge Current: 10 Amps RMS
Thermal Offset: $<20\mu V$
Series Resistance: $<500\ m\Omega$

Isolation Impedance: $>10^6$ ohms, input to output with no protection network

Isolation Voltage: >400 V peak input to output
>1500 VRMS to chassis

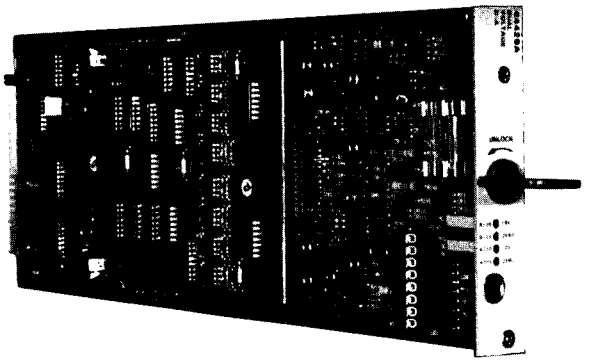
Minimum Input: 100 μA, 100 mV DC (for contact cleansing)

Relay Lifetime: $> 10^8$ at minimum load, $> 10^5$ at full load

Switching Speed: Any combination of channels can be closed simultaneously. Programming and execution of a single or multiple channel closure or open requires 40 ms. Repetitive changes of the same Option 115 assembly are limited to one every 1.5 seconds. Changes of the same assembly up to 25 a second can be jumper enabled but will result in decreased lifetime at full load.

Maximum Leakage Current:
(at 250 VRMS and 60 Hz)
1 mA RMS with no protection network
6 mA RMS with protection network

Protection Network: R = 47 Ohms ± 20%.
C = .047 μF ± 10%



Settling and Programming Time: (Using 9835A Computer, 3497A DVM in Trigger Hold, R(L) = 1 kΩ, C(L) = 1000 pF)
To within ± 1.0 mV of final value: 100 ms

Isolation: > 170 V peak between any terminal and chassis

Protection: Can withstand indefinite open or short circuit

OPTION 120
DUAL OUTPUT, 0 TO ± 10V VOLTAGE D/A CONVERTER

Output: 13 bits including polarity

Least Significant Bits: 2.5 mV

Output Range: -10.2375 V to +10.2375 V

Accuracy: (Using remote sense)
24 Hours,
23°C ± 1°C: ± .024% of programmed value ± 2.8 mV
90 Days,
23°C ± 5°C: ± .070% of programmed value ± 4.0 mV

Temperature Coefficient: (0-18°C, 28-50°C) ± .0045% of programmed value/°C ± 100 μV/°C

Ripple and Noise: 2.5 mV rms, 20 Hz to 250 kHz into 1 kΩ

Load Regulation: 600 μV(0-15 mA)

Maximum Output Current: 15 mA (output within specifications)

Short Circuit Current: (maximum) 50 mA

Maximum Voltage Drop in Source Leads Using Remote Sense:
Low Lead: .5 V
High Lead: 1.5 V

Monotonicity: Over operating range (Monotonicity guarantees that the output will never change in a direction different than that programmed)

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OPTION 130
DUAL OUTPUT, 0-10 mA/4-20 mA CURRENT D/A CONVERTER

Analog Output: 12 bits

Least Significant Bit: 5 μA (0-20 mA range)
4 μA (4-20 mA range)

Output Current Range: 0 to 20.475 mA or 4 to 20.380 mA (each source jumper selectable)

Accuracy:
24 Hours,
23°C ± 1°C: ± .03% of programmed value ± 6.5 μA
90 Days,
23°C ± 5°C: ± 0.07% of programmed value ± 10.0 μA

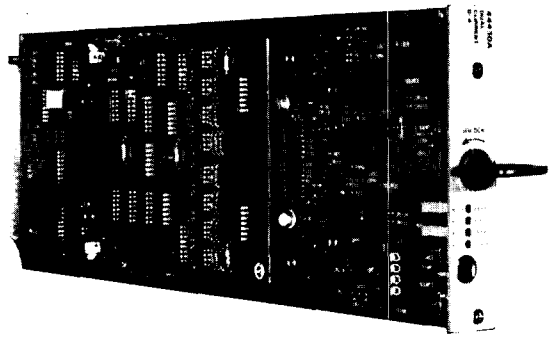
Temperature Coefficient (0-18°C, 28-50°C):
± .0075%/°C of programmed value ± 650 nA/°C

Ripple and Noise: 5 μA rms, 20 Hz to 250 kHz into 100 ohms

Compliance Voltage: 12.0 volts

Load Regulation: ± 2.0 μA (2.0 V to 12.0 V)

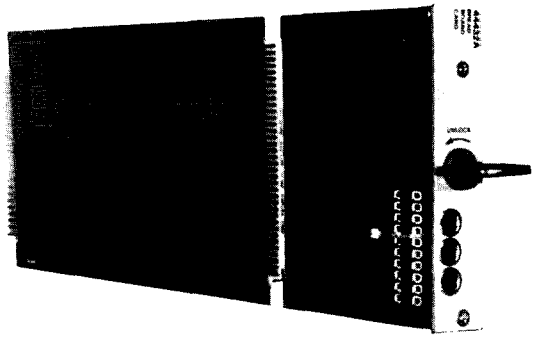
Monotonicity: Over operating range (Monotonicity guarantees that the output will never change in a direction different than that programmed)



Settling and Programming Time: (Using 9835A Computer, 3497A DVM in Trigger Hold, R(L) = 100 Ω)
To within ± 3.0 μA of final vlaue: 100 ms

Isolation Voltage: > 170 V peak between any terminal and chassis

Protection: Can withstand indefinite open or short circuit



General Communication Rate: Instructions can be sent to the 3497A breadboard card and data read from the 3497A breadboard card at a rate of 20 individual operations per second using the HP 85, and 90 operations per second using the HP 9826 computer.

OPTION 140
BREADBOARD CARD

Component Area: (consisting of plated thru .1168 cm. (.046") inside diameter holes spaced .254 cm. (.100") apart

368 cm.^{2} 57.13 in.^{2}

Maximum Component Height: 1.4 cm. (.55 in.)

Maximum Component Lead Length: .51 cm. (.2 in.)

Maximum Power Dissipation: (total per assembly from all supplies): 2 watts

Power Supply Rating: S: (supplied by the 3497A, maximum per card, up to 5 cards per 3497A cardcage)

Digital Supplies (Nonisolated): + 5 V @ 400 mA max.

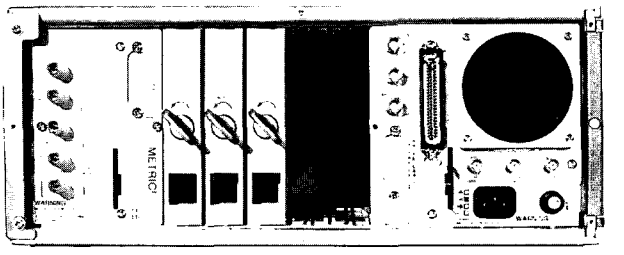
Analog Supplies (Isolated):

		Maximum Current
Low Related Supplies	+ 5 V	50 mA
	+ 15 V	2 mA
	− 8 V	100 μA
Guard Related Supplies	+ 19 V	20 mA
	− 19 V	20 mA

To avoid design difficulty and possible damage to the 3497A, analog (isolated) and digital (nonisolated) supplies should not be interconnected.

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OPTION 232
RS232/423 (CCITT V.24/V.10) INTERFACE



Specifications

These specifications are particular to the 3497A Option 232 operating at 60 Hz line frequency. For 50 Hz operation, multiply rates by 5/6.

BPS Rate Vs. Distance

RS232C (V.24) recommends a maximum cable length of 50 feet or less than 2500 pF of total load capacitance.

The distance specifications for RS423 (V.10) are:

BPS	110	300	600	1200
Distance	1200 m	1200m	1200 m	900 m
	4000 ft	4000 ft	4000 ft	3000 ft

BPS	2400	4800	9600	19200
Distance	600 m	300 m	120 m	60 m
	3000 ft	1000 ft	400 ft	200 ft

Maximum Reading Rate For 85 Readings

Packed mode, display off, reading storage on, single trigger burst, fixed channel:

#Digits	Auto Zero On	Auto Zero Off
3½	205	300
4½	125	205
5½	26	50

BPS Vs. Reading Rate

Readings transferred directly into the computer.

Packed mode, display off, internal trigger, fixed range

	BPS			
Auto Zero Off	300	1200	9600	19200
3½	10	38	190	210
4½	10	38	130	175
5½	10	30	45	45

Auto Zero On	300	1200	9600	19200
3½	10	38	140	160
4½	10	38	100	110
5½	10	20	25	25

ASCII mode, display off, internal trigger:

Auto Zero Off	300	1200	9600	19200
3½	3	10	65	100
4½	3	10	60	86
5½	3	10	30	38

Auto Zero On	300	1200	9600	19200
3½	3	10	60	90
4½	3	10	50	70
5½	3	8	20	22

Minimum analog switching time for sequential scanning:
280 channels/s (ch/s)

Minimum analog switching time for random scanning 10 channels or less:
120 channels/s (ch/s)

> 10 Channels:

BPS	300	1200	9600	19200
Switching Rate ch/s	7	26	83	95

Minimum analog switching and reading time for sequential scanning:

BPS	300	1200	9600	19200
Switching Rate ch/s	10	40	120	130

Minimum analog switching and reading time for random scanning 10 channels or less:

BPS	300	1200	9600	19200
Switching Rate ch/s	5	18	60	65

> 10 Channels:

BPS	300	1200	9600	19200
Switching Rate ch/s	7	13	25	27

Interrupt response: The length of time for BREAK to be sent to the computer after an interrupt occurs: 150 ms. Includes HP 85A response time.

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D to A output response vs. BPS: The length of time required to respond to a change in the output of the D to A card after the commands for change are received by the 3497A

BPS	300	1200	9600	19200
Switching Rate ms	500	175	100	100

Handshakes: ENQuire/ACKnowledge and DC1

Error Checking: Even, odd, or no parity. On detection of a parity error, the status register sets a bit for parity error.

Accessories Supplied: Supplied standard with Option 232 is a 13222-60001 5 meter, 50 pin connector to male RS232C connector, adapter cable.

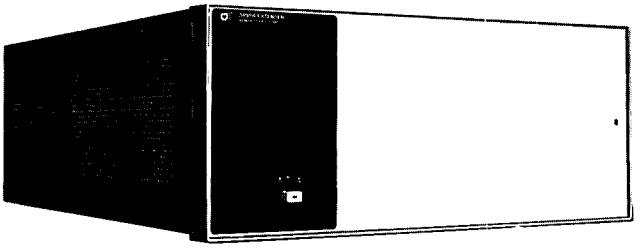
Output Data Format

The 3497 has the ability to send data in ASCII or packed BCD. The output format for ASCII is:

Measured Data	$\pm$D.DDDDDE$\pm$DC$_R$
Time of Day	DD:DD:DD:DD:DDC$_R$
Elapsed Time	DDDDDDDDDDC$_R$
	1st 4 DIGITS ARE ZEROS
Digital Read/Load	OOOOOOC$_R$ 0-177777*
Digital Interrupt	OOOOOOC$_R$ 0-377
Counter Totalize	DDDDDDC$_R$
Counter Period	D.DDDDDDE+DC$_R$ (sec)
Analog Channel	$\pm$DDDC$_R$ "-" is no channel closed
System Read	OOOOOOC$_R$ 0-377
Status Read	OOOOOOC$_R$ 0-377

*D = Decimal Digit
*O = Octal Digit

The packed BCD is used only for voltage measurements.



OPTION 298
ADD 3498 EXTENDER

Number of Slots per 3498A: 10

Maximum Number of Added Analog Multiplexer Channels (Options 010, 020): 900 channels (45 assemblies)

Maximum Number of Added Non-analog Acquisition Assemblies (Options 050, 060, 110, 115, 120, 140): 85 assemblies

Maximum Separation From the 3497A:
3498A with analog cards (Options 010, 020, 070, 071): 100 meters
3498A with digital assemblies (all other options): 25 meters (2 meter cables are supplied standard)

Maximum Number of 3498A's per 3497A: 13

Isolation:

	25°C, >85% R.H. 40°C, >60% R.H.	40°C, >95% R.H.
Hi to Lo	>10^{10} Ohms	>10^9 Ohms
Lo to Guard	>10^8 Ohms	>10^7 Ohms
Guard to Chassis	>10^8 Ohms	>10^7 Ohms

Operating Considerations

Digital Interrupt is not passed between the 3498A and the parent 3497A. Digital Interrupt is found on the Option 050 Digital Input/Interrupt Assembly and on the Option 060 Counter Assembly.
The DVM assembly cannot be used in the 3498A.
Power and Environmental Information: see 3497A data.

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WARRANTY INFORMATION

The warranty statement for the -hp- Model 3497A, -hp- Model 3498A and for all plug-in assemblies to the 3497A/3498A, EXCEPT for Option 140 (-hp- Model 44432A, Breadboard Card assembly) is in Figure B-1. The warranty statement for the Option 140 assembly ONLY is in Figure B-2.

HOW TO OBTAIN REPAIR SERVICE

You may have your 3497A repaired at your local -hp- service center at any time, whether it is under warranty or not. There is, however, a charge for repairs after the one year warranty period. Contact your local Sales and Service Office for shipping instructions prior to returning the instrument. A list of Sales and Service Offices is located in the back of this manual.

3497A SERIAL NUMBERS

Each 3497A and 3498A has a serial number printed on a plate on the rear panel. The serial number has the form XXXXAYYYYY where the XXXX is the serial prefix, A is the country of origin (A = USA) and YYYYY is the serial suffix.

We recommend that owners keep a separate record of this number. Should your instrument be lost or stolen, the complete serial number is often necessary for tracing and recovery, as well as for insurance claims.

GENERAL SHIPPING INSTRUCTIONS

If you need to ship your 3497A or a plug-in assembly back to -hp- , be sure the instrument is packaged in a protective package (use the original shipping container and cushioning material, if possible) to avoid transit damage. Such damage is not covered by the warranty.

Hewlett-Packard suggests that you always insure shipments. Attach a tag to the instrument identifying the owner and indicating the service or repair needed. Include the model number and full serial number of the instrument. In any correspondence, identify the instrument by model number and full serial number.

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WARRANTY FOR 3497A/3498A AND PLUG-IN ASSEMBLIES
(EXCEPT OPTION 140 - BREADBOARD CARD ASSEMBLY)

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Bureau of Standards, to the extent allowed by the Bureau's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

Hewlett-Packard warrants that its software and firmware designated by -hp- for use with an instrument will execute its programming instructions when properly installed on that instrument. Hewlett-Packard does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

10/1/79

Figure B-1. Warranty for 3497A/3498A

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WARRANTY FOR OPTION 140 - BREADBOARD CARD ASSEMBLY

CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory.

WARRANTY

This Hewlett-Packard product is warranted against defects in material and workmanship for a period of one year from the date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by -hp-. Buyer shall prepay shipping charges to -hp- and -hp- shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to -hp- from another country.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

The design and implementation of any circuit used on this product is solely the responsibility of the Buyer. Hewlett-Packard Company does not warrant the Buyer's circuitry or malfunctions of the 3497A, 3498A, or plug-in options that result from the Buyer's circuitry. In addition, -hp- does not warrant any damage that occurs as a result of the Buyer's circuit, including but not limited to the following:

1. Analog and digital sections are interconnected.
2. 3497A/98A power supply limitations are exceeded.
3. Component height/protrusion restrictions are violated.
4. Guard and internal 3497A DVM voltage specifications are violated.
5. Maximum input voltage on the digital lines is exceeded.
6. The trace current specifications listed in this manual are exceeded.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HEWLETT-PACKARD SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HEWLETT-PACKARD SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

Figure B-2. Warranty for Option 140

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MANUAL INFORMATION

This 3497A Operating, Programming and Configuration Manual applies to all 3497A Data Acquisition/Control Units with serial number prefixes 2222A and above and to 3498A Extenders with serial number prefixes 2223A and above.

It also applies to all plug-in assemblies (Options 010 through 140), except for -hp- Model 44426A 100 kHz Counter, Revision A. For information on Revision A Counters, see -hp- Model 44426A, 100 kHz Reciprocal Counter Assembly Operating and Service Manual (-hp- part number 44426-90000).

Instruments manufactured after the publication date of this manual may have changes incorporated. In this case, a yellow MANUAL CHANGES sheet will accompany the manual. MANUAL CHANGES may also contain information to correct manual errors.

To keep this manual as accurate as possible, we suggest that you periodically request the current MANUAL CHANGES supplement which is identified by the print date and part number on the title page of this manual. Complimentary copies are available from your nearest -hp- Sales and Service office.

One copy of this manual is supplied with each 3497A ordered. Additional copies may be ordered from your nearest -hp- Sales and Service office. The part number is listed on the title page of this manual.

You may also order 100 x 150 mm (4 x 6 inch) microfilm transparencies of this manual. The microfiche part number is listed on the manual title page below the manual part number. Each microfiche contains up to 96 photo-duplicates of the manual pages and includes the latest MANUAL CHANGES supplements.

ORDERING AND CONFIGURATION GUIDE

The 3497A has a wide variety of optional configurations. The Ordering and Configuration Guide (see Figure B-3) is provided for your convenience. If you want to order any of the configurations shown, contact your nearest -hp- Sales and Service Office for assistance.

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3497A ORDERING AND CONFIGURATION GUIDE

3497A Option Number	Description
STANDARD	Data Acquisition/Control Unit with Front Panel Keyboard and Display. Real Time clock and HP-IB Interface. Each 3497A can hold one DVM assembly (Option 001 and up to 5 plug-in assemblies. Each 3498A (Option 298) can hold 10 additional plug-ins. For plug-ins in excess of cardcage capacity, order as 444XXX field installation kits. REQUIRED ON EVERY ORDER: ● A Clock Format (Option 230 or 231) ● A Power Line Frequency and Voltage (Options 315 through 346) ● Suboptions for Option 020 (if ordered)
001	5½ Digit DVM and Current Source ● 1 μV Sensitivity ● Fully Programmable ● 300 Readings/Second in 3½ Digit Mode To field install Option 001, order 44420A kit
PLUG-IN ASSEMBLIES	
010	20 Channel Relay Multiplexer Assembly To field install Option 010, order 44421A kit
020	Relay Multiplexer Assembly with Thermocouple Compensation Must specifiy one of the following no charge sub-options for each of the assemblies ordered: A20 software compensation B20 hardware compensation for type B thermocouples E20 hardware compensation for type E thermocouples J20 hardware compensation for type J thermocouples K20 hardware compensation for type K thermocouples R20 hardware compensation for type R thermocouples S20 hardware compensation for type S thermocouples T20 hardware compensation for type T thermocouples To field install Option 020, order 44422A kit
050	16 channel Isolated Digital Input/Interrupt Assembly To field install Option 050, order 44425A kit
060	100 kHz, Reciprocal Counter Assembly To field install Option 060, order 44426A kit
070	120 Ohm Strain Gauge/Bridge Completion Assembly To field install Option 070, order 44427A kit
071	350 Ohm Strain Gauge/Bridge Completion Assembly To field install Option 071, order 44427B kit
110	16 Channel Actuator/Digital Output Assembly To field install Option 110, order 44428A kit
115	8 Channel High Voltage Actuator Assembly To field install Option 115, order 44431A kit
120	Dual Output 0 to ± 10 Volt D/A Converter Assembly To field install Option 120, order 44429A kit
130	Dual Output 0-20 mA or 4-20 mA D/A Converter Assembly To field install Option 130, order 44430A kit
140	Breadboard Card To field install Option 140, order 44432A kit

Figure B-3. 3497A Ordering and Configuration Guide

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3497A Option Number	Description
CONFIGURATION OPTIONS	
230	Clock Format (Month:Day:Hours:Min:Sec)
231	Clock Format (Day:Month:Hours:Min:Sec)
232	Delete HP-IB Interface Add RS232C (CCITT V.24)/RS423 (CCITT V.10) Interface Includes 13222-60001 Cable
260	Delete Keyboard and Display on the 3497A
298	Add 3498A Extender and Connecting Cables
POWER AND FREQUENCY OPTIONS	
315	100 Volts, 50 Hz
316	100 Volts, 60 Hz
325	120 Volts, 50 Hz
326	120 Volts, 60 Hz
335	220 Volts, 50 Hz
336	220 Volts, 60 Hz
345	240 Volts, 50 Hz
346	240 Volts, 60 Hz
RACK MOUNTING/DOCUMENTATION OPTIONS	
907	Front Handle Kit (Part Number 5061-0090)
908	Rack Flange Kit (Part Number 5061-0078)
909	Rack Flange and Front Handle Kit (Part Number 5061-0084)
910	Extra Set of 3497A/3498A Documentation

ACCESSORIES

Extender Board for Servicing:	03497-67913
Verification Connector and Software for Options 010, 020, 050, 070, 071, 110, 115	
85A Computer:	03497-67912
9825A Computer:	03497-67911
9835A Computer:	03497-67909
9845A Computer:	03497-67910
Connector Only:	03497-67908
Extra Terminal Assemblies for 20 Channel Multiplexer:	03497-69542
Relay Multiplexer with Thermocouple Compensation:	03497-69540
Digital Input/Interrupt:	03497-69543
120 Ohm Strain Gauge:	03497-64109
340 Ohm Strain Gauge:	03497-64110
16 Channel Actuator:	03497-69544
8 Channel Actuator:	03497-64111
Kit to Convert Thermocouple Compensation:	03497-69541
30 cm (12 in.) BNC to BNC Cable	11170A
60 cm (24 in.) BNC to BNC Cable	11170B
120 cm (48 in.) BNC to BNC Cable	11170C
1 meter (39.37 in.) HP-IB Cable	10631A
2 meter (78.74 in.) HP-IB Cable	10631B
4 meter (157.48 in.) HP-IB Cable	10631C

Figure B-3. 3497A Ordering and Configuration Guide (Cont'd)

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SALES & SUPPORT OFFICES

Arranged alphabetically by country

Product Line Sales/Support Key

Key	Product Line
A	Analytical
CM	Components
C	Computer Systems
CP	Computer Systems Primary Service Responsible Office (SRO)
CS	Computer Systems Secondary SRO
E	Electronic Instruments & Measurement Systems
M	Medical Products
MP	Medical Products Primary SRO
MS	Medical Products Secondary SRO
P	Personal Computing Products
*	Sales only for specific product line
**	Support only for specific product line

IMPORTANT: These symbols designate general product line capability. They do not insure sales or support availability for all products within a line, at all locations. Contact your local sales office for information regarding locations where HP support is available for specific products.

HP distributors are printed in italics.

ANGOLA

Telectra
Empresa Técnica de Equipamentos Eléctricos, S.A.R.L.
R. Barbosa Rodrigues, 41-1 DT.
Caixa Postal 6487
LUANDA
Tel: 35515,35516
A,E,M,P*

ARGENTINA

Hewlett-Packard Argentina S.A.
Avenida Santa Fe 2035
Martinez 1640 **BUENOS AIRES**
Tel: 798-5735, 792-1293
Telex: 122443 AR CIGY
Cable: HEWPACKARG
A,E,CP,P

Biotron S.A.C.I.y.M
Avenida Paseo Colon 221
9 Piso
*1399 **BUENOS AIRES***
Tel: 30-4846, 30-1851, 30-8384
Telex: (33)17595 BIONAR
Cable: BIOTRON Argentina
M

Fate S.A. Electronica
Bartolomeu Mitre 833
*1036 **BUENOS AIRES***
Tel: 74-41011, 74-49277, 74-43459
Telex: 18137, 22754
P

AUSTRALIA

Adelaide, South Australia Pty. Ltd.

Hewlett-Packard Australia Pty.Ltd.
153 Greenhill Road
PARKSIDE, S.A. 5063
Tel: 272-5911
Telex: 82536
Cable: HEWPARD Adelaide
A*,CM,CS,E,MS,P

Brisbane, Queensland Office

Hewlett-Packard Australia Pty.Ltd.
5th Floor
Teachers Union Building
495-499 Boundary Street
SPRING HILL, Queensland 4000
Tel: 229-1544
Telex: 42133
Cable: HEWPARD Brisbane
A,CM,CS,E,MS,P

Canberra, Australia Capital Office

Hewlett-Packard Australia Pty.Ltd.
121 Wollongong Street
FYSHWICK, A.C.T. 2069
Tel: 804244
Telex: 62650
Cable: HEWPARD Canberra
A*,CM,CS,E,MS,P

Melbourne, Victoria Office

Hewlett-Packard Australia Pty.Ltd.
31-41 Joseph Street
BLACKBURN, Victoria 3130
Tel: 89-6351
Telex: 31-024
Cable: HEWPARD Melbourne
A,CM,CP,E,MS,P

Perth, Western Australia Office

Hewlett-Packard Australia Pty.Ltd.
141 Stirling Highway
NEDLANDS, W.A. 6009
Tel: 386-5455
Telex: 93859
Cable: HEWPARD Perth
A,CM,CS,E,MS,P

Sydney, New South Wales Office

Hewlett-Packard Australia Pty.Ltd.
17-23 Talavera Road
NORTH RYDE, N.S.W. 2113
P.O. Box 308
Tel: 887-1611
Telex: 21561
Cable: HEWPARD Sydney
A,CM,CP,E,MS,P

AUSTRIA

Hewlett-Packard Ges.m.b.h.
Grottenhofstrasse 94
Verkaufsburo Graz
8052 **GRAZ**
Tel: 21-5-66
Telex: 32375
CM,C*,E*

Hewlett-Packard Ges.m.b.h.
Wehlistrasse 29
P.O. Box 7
A-1205 **VIENNA**
Tel: (222) 35-16-210
Telex: 135823/135066
A,CM,CP,E,MS,P

BAHRAIN

Green Salon
P.O. Box 557
BAHRAIN
Tel: 5503
Telex: 88419
P

Wael Pharmacy
P.O. Box 648
BAHRAIN
Tel: 54886, 56123
Telex: 8550 WAEL GJ
M

BELGIUM

Hewlett-Packard Belgium S.A./N.V.
Blvd de la Woluwe, 100
Woluwedal
B-1200 ***BRUSSELS***
Tel: (02) 762-32-00
Telex: 23-494 paloben bru
A,CM,CP,E,MP,P

BRAZIL

Hewlett-Packard do Brasil I.e.C. Ltda.
Alameda Rio Negro, 750
ALPHAVILLE 06400 Barueri SP
Tel: 421-1311
Telex: 011 23602 HPBR-BR
Cable: HEWPACK Sao Paulo
A,CM,CP,E,MS

Hewlett-Packard do Brasil I.e.C. Ltda.
Avenida Epitacio Pessoa, 4664
22471 **RIO DE JANEIRO**-RJ
Tel: 286-0237
Telex: 021-21905 HPBR-BR
Cable: HEWPACK Rio de Janeiro
A,CM,E,MS,P*

BURUNDI

Typomeca S.P.R.L.
B.P. 553
BUJUMBURA
Tel: 2659
P

CANADA

Alberta

Hewlett-Packard (Canada) Ltd.
210, 7220 Fisher Street S.E.
CALGARY, Alberta T2H 2H8
Tel: (403) 253-2713
Telex: 610-821-6141
A,CM,CP,E*,MS,P*

Hewlett-Packard (Canada) Ltd.
11620A-168th Street
EDMONTON, Alberta T5M 3T9
Tel: (403) 452-3670
Telex: 610-831-2431
A,CM,CP,E,MS,P*

British Columbia

Hewlett-Packard (Canada) Ltd.
10691 Shellbridge Way
RICHMOND, British Columbia
V6X 2W7
Tel: (604) 270-2277
Telex: 610-922-5059
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Manitoba

Hewlett-Packard (Canada) Ltd.
380-550 Century Street
WINNIPEG, Manitoba R3H 0Y1
Tel: (204) 786-6701
A,CM,CS,E,MS,P*

Nova Scotia

Hewlett-Packard (Canada) Ltd.
P.O. Box 931
900 Windmill Road
DARTMOUTH, Nova Scotia B2Y 3Z6
Tel: (902) 469-7820
Telex: 610-271-4482
CM,CP,E*,MS,P*

Ontario

Hewlett-Packard (Canada) Ltd.
552 Newbold Street
LONDON, Ontario N6E 2S5
Tel: (519) 686-9181
Telex: 610-352-1201
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Hewlett-Packard (Canada) Ltd.
6877 Goreway Drive
MISSISSAUGA, Ontario L4V 1M8
Tel: (416) 678-9430
Telex: 610-492-4246
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Hewlett-Packard (Canada) Ltd.
1020 Morrison Drive
OTTAWA, Ontario K2H 8K7
Tel: (613) 820-6483
Telex: 610-563-1636
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Quebec

Hewlett-Packard (Canada) Ltd.
17500 South Service Road
Trans-Canada Highway
KIRKLAND, Quebec H9J 2M5
Tel: (514) 697-4232
Telex: 610-422-3022
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CHILE

Jorge Calcagni y Cia. Ltda.
Arturo Burhle 065
Casilla 16475
SANTIAGO 9
Tel: 220222
Telex: JCALCAGNI
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Olympia (Chile) Ltd.
Rodrico de Araya 1045
Casilla 256-V
SANTIAGO 21
Tel: 25-50-44
Telex: 40-565
C,P

COLOMBIA

Instrumentación
H. A. Langebaek & Kier S.A.
Apartado Aéreo 6287
BOGOTÁ 1, D.E.
Carrera 7 No. 48-75
BOGOTA, 2 D.E.
Tel: 287-8877
Telex: 44400
Cable: AARIS Bogota
A,CM,E,M,P

COSTA RICA

Cientifica Costarricense S.A.
Avenida 2, Calle 5
San Pedro de Montes de Oca
Apartado 10159
SAN JOSÉ
Tel: 24-38-20, 24-08-19
Telex: 2367 GALGUR
Cable: GALGUR
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CYPRUS

Telerexa Ltd.
P.O. Box 4809
14C Stassinos Avenue
NICOSIA
Tel: 45628
Telex: 2894
E,M,P

CZECHOSLOVAKIA

Hewlett-Packard
Obchodni Zastupitelstvi v CSSR
Post. schranka 27
*CS-118 01 **PRAHA 011***
Tel: 66-296
Telex: 121353 IHC

DENMARK

Hewlett-Packard A/S
Datavej 52
DK-3460 **BIRKEROD**
Tel: (02) 81-66-40
Telex: 37409 hpas dk
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Hewlett-Packard A/S
Navervej 1
DK-8600 **SILKEBORG**
Tel: (06) 82-71-66
Telex: 37409 hpas dk
CM,CS,E

ECUADOR

CYEDE Cia. Ltda.
P.O. Box 6423 CCI
Avenida Eloy Alfaro 1749
QUITO
Tel: 450-975, 243-052
Telex: 2548 CYEDE ED
Cable: CYEDE-Quito
A,CM,E,P

Hospitalar S.A.
Casilla 3590
Robles 625
QUITO
Tel: 545-250, 545-122
Cable: HOSPITALAR-Quito
M

EGYPT

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Sami Amin Trading Office
18 Abdel Aziz Gawish
ABDINE-CAIRO
Tel: 24-932
P

International Engineering Associates
24 Hussein Hegazi Street
Kasr-el-Aini
CAIRO
Tel: 23-829
Telex: 93830
E,M

Informatic For Computer Systems
22 Talaat Harb Street
CAIRO
Tel: 759006
Telex: 93938 FRANK UN
C

EL SALVADOR

IPESA
Boulevard de los Heroes
Edificio Sarah 1148
SAN SALVADOR
Tel: 252787
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FINLAND

Hewlett-Packard Oy
Revontulentie 7
SF-02100 **ESPOO** 10
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Telex: 121563 hewpa sf
A,CM,CP,E,MS,P

FRANCE

Hewlett-Packard France
Le Ligoures
Bureau de Vente de
Aix-en-Provence
Place Romée de Villeneuve
F-13090 **AIX-EN-PROVENCE**
Tel: (42) 59-41-02
Telex: 410770F
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SALES & SUPPORT OFFICES

Arranged alphabetically by country

FRANCE (Cont.)

Hewlett-Packard France
Boite Postale No. 503
F-25026 **BESANCON**
28 Rue de la Republique
F-25000 **BESANCON**
Tel: (81) 83-16-22
C,M

Hewlett-Packard France
Bureau de Vente de Lyon
Chemin des Mouilles
Boite Postale No. 162
F-69130 **ECULLY** Cédex
Tel: (78) 33-81-25
Telex: 310617F
A,CM,CP,E,MP

Hewlett-Packard France
Immeuble France Evry
Tour Lorraine
Boulevard de France
F-91035 **EVRY** Cédex
Tel: (60) 77-96-60
Telex: 692315F
CM,E

Hewlett-Packard France
5th Avenue Raymond Chanas
F-38320 **EYBENS**
Tel: (76) 25-81-41
Telex: 980124 HP GRENOB EYBE
CM,CS

Hewlett-Packard France
Bâtiment Ampère
Rue de la Commune de Paris
Boite Postale 300
F-93153 **LE BLANC MESNIL**
Tel: (01) 865-44-52
Telex: 211032F
CM,CP,E,MS

Hewlett-Packard France
Le Montesquieu
Avenue du President JF Kennedy
F-33700 **MERIGNAC**
Tel: (56) 34-00-84
Telex: 550105F
CM,CP,E,MS

Hewlett-Packard France
32 Rue Lothaire
F-57000 **METZ**
Tel: (87) 65-53-50
CM,CS

Hewlett-Packard France
F-91947 Les Ulis Cédex**ORSAY**
Tel: (1) 907-78-25
Telex: 600048F
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Hewlett-Packard France
Paris Porte-Maillot 13, 15 25
Boulevard De L'Amiral Bruix
F-75782 **PARIS** Cédex 16
Tel: (01) 502-12-20
Telex: 613663F
CM,CP,MS,P

Hewlett-Packard France
2 Allee de la Bourgonette
F-35100 **RENNES**
Tel: (99) 51-42-44
Telex: 740912F
CM,CS,E,MS,P*

Hewlett-Packard France
4 Rue Thomas Mann
Boite Postale 56
F-67200 **STRASBOURG**
Tel: (88) 28-56-46
Telex: 890141F
CM,CS,E,MS,P*

Hewlett-Packard France
20 Chemin de la Cépière
F-31081 **TOULOUSE** Cédex
Tel: (61) 40-11-12
Telex: 531639F
A,CM,CS,E,P*

Hewlett-Packard France
Bureau de Vente de Lille
Immeuble Péricentre
Rue Van Gogh
F-59650 **VILLENEUVE D'ASQ**
Tel: (20) 91-41-25
Telex: 160124F
CM,CS,E,MS,P*

GERMAN FEDERAL REPUBLIC

Hewlett-Packard GmbH
Technisches Büro Berlin
Keithstrasse 2-4
D-1000 **BERLIN** 30
Tel: (030) 24-90-86
Telex: 018 3405 hpbln d
A,CM,CS,E,X,M,P

Hewlett-Packard GmbH
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Herrenberger Strasse 110
D-7030 **BÖBLINGEN**
Tel: (07031) 667-1
Telex: 07265739 bbn or 07265743
A,CM,CP,E,MP,P

Hewlett-Packard GmbH
Technisches Büro Dusseldorf
Emanuel-Leutze-Strasse 1
D-4000 **DUSSELDORF**
Tel: (0211) 5971-1
Telex: 085/86 533 hpdd d
A,CM,CP,E,MS,P

Hewlett-Packard GmbH
Vertriebszentrale Frankfurt
Berner Strasse 117
Postfach 560 140
D-6000 **FRANKFURT** 56
Tel: (0611) 50-04-1
Telex: 04 13249 hpffm d
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6. Have you used computers or programmable instruments before? ☐ Yes ☐ No

THE 3497A

7. What is your major application for the 3497A? _____

8. What computer are you using to control the 3497A?

☐ -hp- 85/87 ☐ -hp- 9825 ☐ -hp- 9826/36 ☐ -hp- 1000 ☐ DEC ☐ IBM ☐ OTHER _____

9. We want the 3497A to fulfill most of your automation needs. What additional functions or capabilities would you like to see added to the 3497A? _____

THE MANUAL

10. How would you rate:	excellent	good	average	fair	poor
depth of coverage	☐	☐	☐	☐	☐
examples	☐	☐	☐	☐	☐
graphic presentation	☐	☐	☐	☐	☐
indexing	☐	☐	☐	☐	☐
level of writing	☐	☐	☐	☐	☐
organization	☐	☐	☐	☐	☐
overall manual	☐	☐	☐	☐	☐
technical accuracy	☐	☐	☐	☐	☐

11. How would you rate the number of examples in the manual?

☐ more required ☐ current number sufficient ☐ fewer required

12. Did you have difficulty in:	none	minimal	some	considerable
understanding information in this manual?	☐	☐	☐	☐
applying that information?	☐	☐	☐	☐

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3497A SYSTEM LOG

For your convenience in logging system inputs to your 3497A/3498A, a 3497A SYSTEM LOG form is shown in Figure B-4.

3497A SYSTEM LOG

3497A S/N: _____ ASSEMBLY OPTION _____

DATE RECEIVED: _____ INSTALLED IN SLOT# _____

CHAN	CARD CHAN	TRANSDUCER CONNECTED TYPE	FUNCTION	DATE	VALUES/LIMITS MIN	TYP	MAX

Figure B-4. 3497A SYSTEM LOG Form

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