Table 9-4c HP 44719A 10 Bridge 120 ohm Strain Gage FET Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44719A	Module; 20 channel FET mux component	1	44709-66201	5	MOD-20CH FET MUX
A1	PCA; 20 channel FET mux component	1	44709-66501	8	PCA-20CH GP F/MU
A10	PCA; 10 chan 120 ohm str. gage term	1	44717-66510	9	PCA-10CH 120 OHM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44709/44710/44719/44720 mod	1	44709-84320	7	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44719A	1	44719-84325	5	LBL-ID,TERM ASSY

Completely assembled HP 44719A terminal modules can be ordered from your local HP Office by ordering Number 44719AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44709A	Module; 20 channel FET mux component		44709-69201	1	RBLT-44709-66201

Table 9-4d HP 44720A 10 Bridge 350 ohm Strain Gage FET Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44720A	Module; 20 channel FET mux component	1	44709-66201	5	MOD-20CH FET MUX
A1	PCA; 20 channel FET mux component	1	44709-66501	8	PCA-20CH GP F/MU
A10	PCA; 10 chan 120 ohm str. gage term	1	44718-66510	0	PCA-10CH 350 OHM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44709/44710/44719/44720 mod	1	44709-84320	7	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44719A	1	44720-84325	7	LBL-ID,TERM ASSY

Completely assembled HP 44720A terminal modules can be ordered from your local HP Office by ordering Number 44720AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44709A	Module; 20 channel FET mux component		44709-69201	1	RBLT-44709-66201

CHAPTER 10
HP 44711A/44712A/44713A
HIGH SPEED FET MULTIPLEXER

CHAPTER 10

HP 44711A/44712A/44713A

HIGH-SPEED FET MULTIPLEXERS

10-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, and replaceable parts lists for the HP 44711A 24 Channel High-Speed FET Multiplexer, HP 47712A 48 Channel Single Ended High-Speed FET Multiplexer, and HP 44713A 24 Channel High-Speed FET Multiplexer with Thermocouple Compensation. All three FET multiplexers use the same component module and are made unique by the addition of the terminal modules.

10-2 HP 44711A Technical Description

The HP 44711A 24 Channel High-Speed FET Multiplexer has two main assemblies: the component module and the terminal module. The component module contains the backplane interface electronics, the ribbon cable interface electronics, the switching FETs, the FET control logic, and the isolation relay control logic. The terminal module contains terminal strips for connection to external wiring and provides mounting holes for user installed parts such as one pole low pass filters or voltage dividers. The printed circuit board used in the component module is also used in the HP 44712A and HP 44713A component modules.

Figure 10-1 shows a simplified schematic of the HP 44711A. In the component module the FET switches are arranged into channel switches and tree switches. There are 48 channel switches arranged and switched in pairs. Each channel switch pair switches a high line and a low line. The channel switches are arranged into two banks, referred to as Bank A and Bank B. There are 12 channels in each bank and each bank has its own set of common terminals. Only one channel in each bank can be closed at the same time.

The tree switches allow the multiplexer channels to be connected to either the backplane analog bus or the high-speed voltmeter ribbon cable. There are eight tree switches arranged and switched in pairs. Each tree switch pair switches a high line and a low line. Two of the tree switch pairs connect to the sense bus and two connect to the source bus. The sense bus is used for measurements. The source bus provides a current source for resistance measurements. The current on the source bus is provided by either an HP 44701A through the backplane analog bus or an HP 44702A/B through either the backplane analog bus or the ribbon cable.

The tree switches are controlled independently of the channel switches in the high level commands. The tree switches are controlled by the use of channel numbers 91, 92, 93, and 94. Channel 91 controls the source bus tree switch, channel 92 controls the sense bus tree switch, channel 93 configures the HP 44711A for two-wire ohms measurements, and channel 94 configures the HP 44711A for four-wire ohms measurements.

The HP 44711A is specifically designed to connect to an HP 44702A/B High-Speed Voltmeter. The ribbon cable is provided for this purpose. The HP 44702A/B is able to control the multiplexer switches and take measurements through the ribbon cable. This control can be established independently of the HP 3852A backplane. The connection of one or more high-speed FET multiplexers with the HP 44702A/B through the ribbon cable creates a separate subsystem within the HP 3852A system.

Isolation relays are provided on the HP 44711A. These relays allow the FET multiplexer to be completely isolated from the backplane analog bus. The state of these relays are controlled by assigning them channel number 90. Once the isolation relays have been closed, they will remain closed until specifically instructed to open or a reset occurs. The isolation relays can be opened to reduce the leakage current on the backplane analog bus for critical measurements. Also, since the backplane analog sense bus can have up to 42 V peak (with an HP 44711A installed), the isolation relays provide protection for the FET switches. If, for example, an application requires that the backplane analog sense bus voltage is greater than 12 V peak, the isolation relays should be opened to prevent damage to the FET switches. In addition, the FETs are protected from voltages above 16 Vdc by the overvoltage protection circuit on the multiplexer assembly (the input impedance to the FETs, however, decreases above 12 V peak). The overvoltage protection circuit automatically opens the isolation relays, if the backplane analog bus voltage exceeds 16 Vdc.

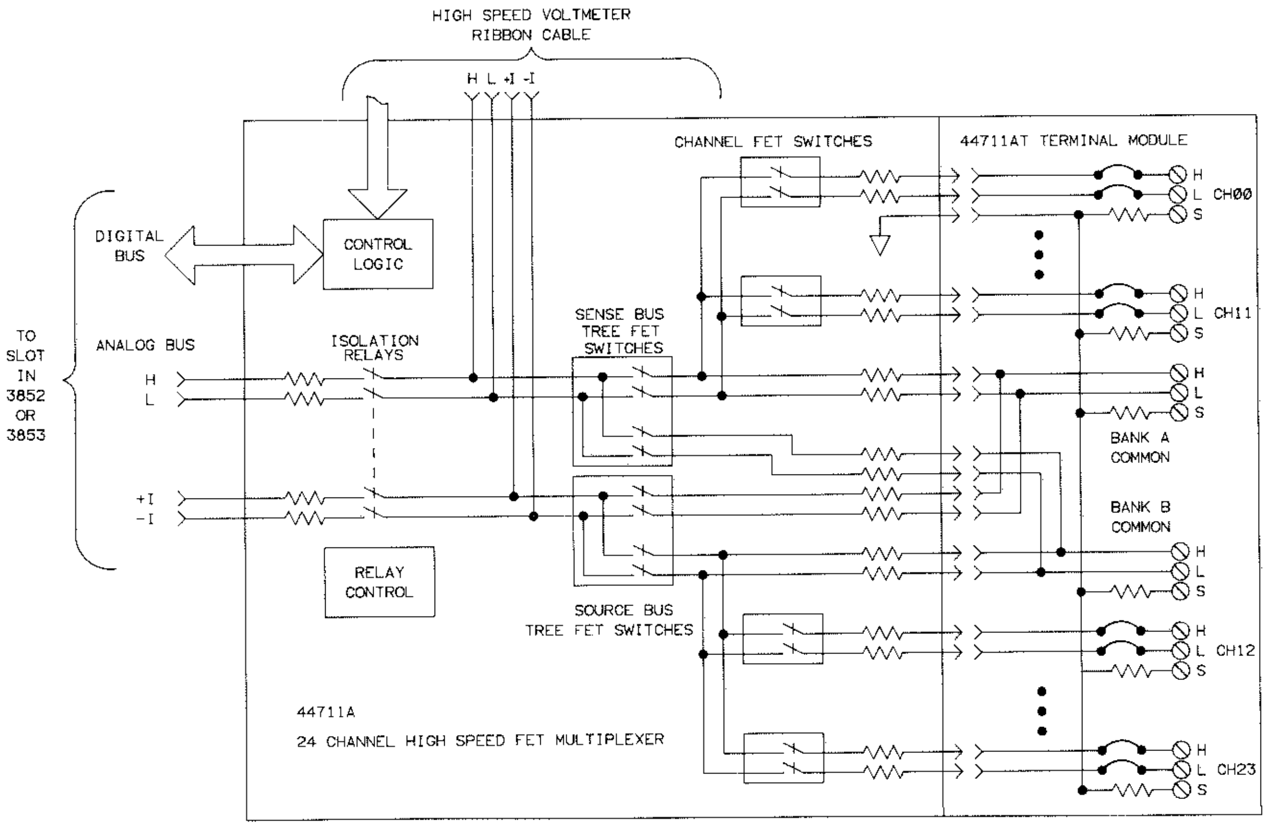


Figure 10-1 HP 44711A Simplified Schematic

10-3 HP 44712A Technical Description

The HP 44712A 48 Channel Single Ended High-Speed FET Multiplexer has two main assemblies: a component module and a terminal module. The component module contains the backplane interface electronics, the ribbon cable interface electronics, the FET control logic, and the isolation relay control logic. The terminal module contains terminal strips for connection to external wiring. The printed circuit board used in the component module is also used in the HP 44711A and HP 44713A component modules. The terminal module is unique.

Figure 10-2 shows a simplified schematic of the HP 44712A. In the component module the FET switches are arranged into channel switches and tree switches. There are 48 channel switches arranged and switched in pairs. Each channel switch pair switches two channel high lines into the tree switches. The low lines for all channels are common on the terminal module and are connected to the component module circuit ground through a 100 ohm resistor.

The tree switches connect the multiplexer channels to either the backplane analog bus or the high-speed voltmeter ribbon cable. There are eight tree switches arranged and switched in pairs. Each tree switch pair switches a channel high line and circuit ground. The tree switches allow selection of a single channel from the paired channel switches. Two of the tree switch pairs are connected to the sense bus and two are connected to the source bus. The sense bus is used for measurements. The source bus provides a current source for resistance measurements. The current on the source bus is provided by either an HP 44701A through the backplane analog bus or by an HP 44702A/B through either the backplane analog bus or the ribbon cable.

The tree switches are controlled independently of the channel switches in the high level commands. The tree switches are controlled by use of channel numbers 91, 92, and 93. Channel 91 connects the source bus, channel 92 connects the sense bus, and channel 93 configures the HP 44712A for two-wire ohms measurements.

The HP 44712A is specifically designed to connect to an HP 44702A/B High-Speed Voltmeter. The ribbon cable is provided for this purpose. The HP 44702A/B is able to control the multiplexer switches and take measurements through the ribbon cable. This control can be established independently of the HP 3852A backplane. The connection of one or more high-speed FET multiplexers with the HP 44702A/B through the ribbon cable creates a separate subsystem within the HP 3852A system.

Isolation relays are provided on the HP 44712A. These relays allow the FET multiplexer to be completely isolated from the backplane analog bus. The state of these relays are controlled by assigning them channel number 90. Once the isolation relays have been closed, they will remain closed until specifically instructed to open or a reset occurs. The isolation relays can be opened to reduce the leakage current on the backplane analog bus for critical measurements. Also, since the backplane analog sense bus can have up to 42 V peak (with an HP 44712A installed), the isolation relays provide protection for the FET switches. If, for example, an application requires that the backplane analog sense bus voltage is greater than 12 V peak, the isolation relays should be opened to prevent damage to the FET switches. In addition, the FETs are protected from voltages above 16 Vdc by the overvoltage protection circuit on the multiplexer assembly (the input impedance to the FETs, however, decreases above 12 V peak). The overvoltage protection circuit automatically opens the isolation relays, if the backplane analog bus voltage exceeds 16 Vdc.

10-4 HP 44713A Technical Description

The HP 44713A has two main assemblies: a component module and a terminal module. The component module contains the backplane interface electronics, the ribbon cable interface electronics, the FET control logic and the isolation relays control logic. The terminal module contains terminal strips for connection to external wiring, a thermistor in an isothermal block, and provides mounting holes for user installed parts such as one pole low pass filters or voltage dividers. The printed circuit board used in the component module is also used the HP 44711A and HP 44712A component modules. The terminal module is unique.

Figure 10-3 shows a simplified schematic of the HP 44713A. In the component module the FET switches are arranged into channel switches and tree switches. There are 48 channel switches arranged and switched in pairs. Each channel switch pair switches a high line and a low line. One set of multiplexer common terminals is provided on the terminal module.

The tree switches allow the multiplexer channels to be connected to either the backplane analog bus or the high-speed voltmeter ribbon cable. There are eight tree switches arranged and switched in pairs. Each tree switch pair switches a high line and a low line. Two of the tree switch pairs connect to the sense bus and two connect to the source bus. The sense bus is used for measurements. The source bus provides a current source for resistance measurements. The current on the source bus is provided by either an HP 44701A through the backplane analog bus or an HP 44702A/B through either the backplane analog bus or the ribbon cable.

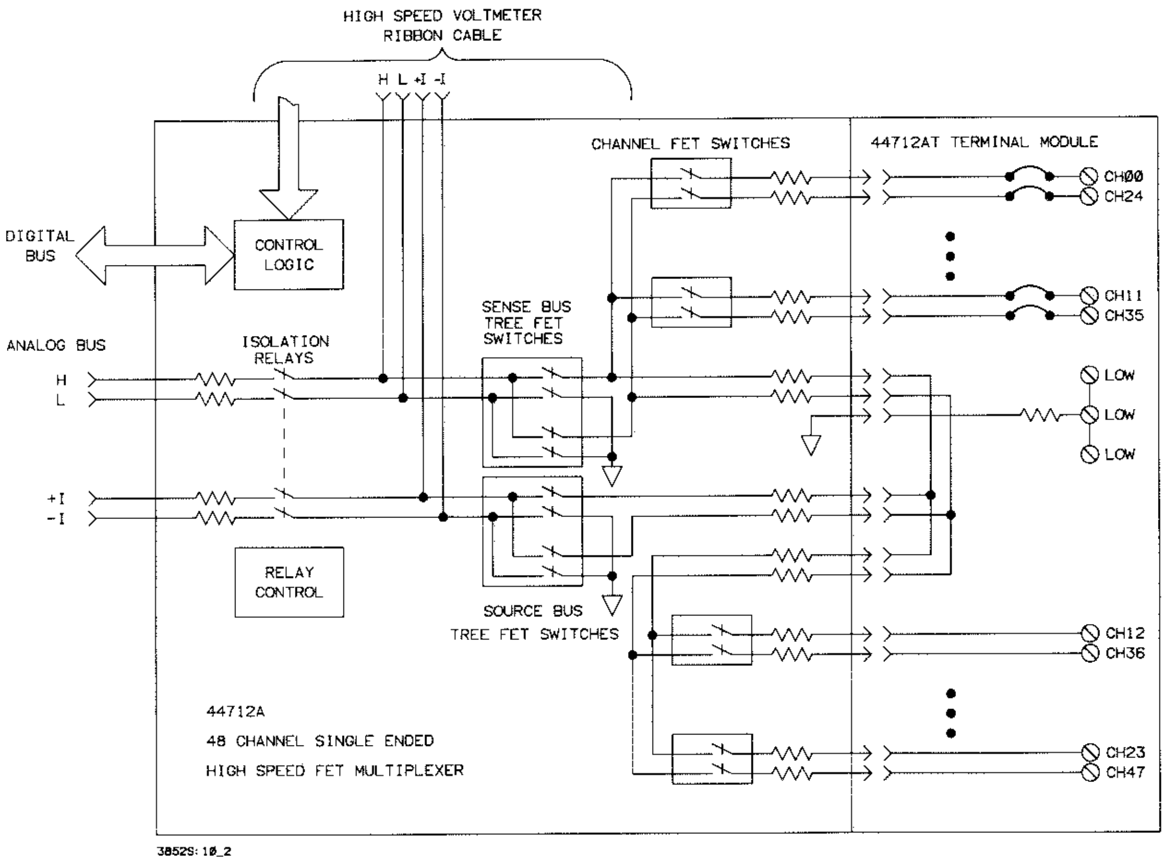


Figure 10-2 HP 44712A Simplified Schematic

The tree switches are controlled independently of the channel switches in the high level commands. The tree switches are controlled by the use of channel numbers 91, 92, 93, and 94. Channel 91 controls the source bus tree switch, channel 92 controls the sense bus tree switch, channel 93 configures the HP 44713A for two-wire ohms measurements and channel 94 configures the HP 44713A to measure the thermistor.

The HP 44713A is specifically designed to connect to an HP 44702A/B High-Speed Voltmeter. The ribbon cable is provided for this purpose. The HP 44702A/B is able to control the multiplexer switches and take measurements through the ribbon cable. This control can be established independently of the HP 3852A backplane. The connection of one or more high-speed FET multiplexers with the HP 44702A/B through the ribbon cable creates a separate subsystem within the HP 3852A system.

Isolation relays are provided on the HP 44713A. These relays allow the FET multiplexer to be completely isolated from the backplane analog bus. The state of these relays are controlled by assigning them channel number 90. Once the isolation relays have been closed, they will remain closed until specifically instructed to open or a reset occurs. The isolation relays can be opened to reduce the leakage current on the backplane analog bus for critical measurements. Also, since the backplane analog sense bus can have up to 42 V peak (with an HP 44713A installed), the isolation relays provide protection for the FET switches. If, for example, an application requires that the backplane analog sense bus voltage is greater than 12 V peak, the isolation relays should be opened to prevent damage to the FET switches. In addition, the FETs are protected from voltages above 16 Vdc by the overvoltage protection circuit on the multiplexer assembly (the input impedance to the FETs, however, decreases above 12 V peak). The overvoltage protection circuit automatically opens the isolation relays, if the backplane analog bus voltage exceeds 16 Vdc.

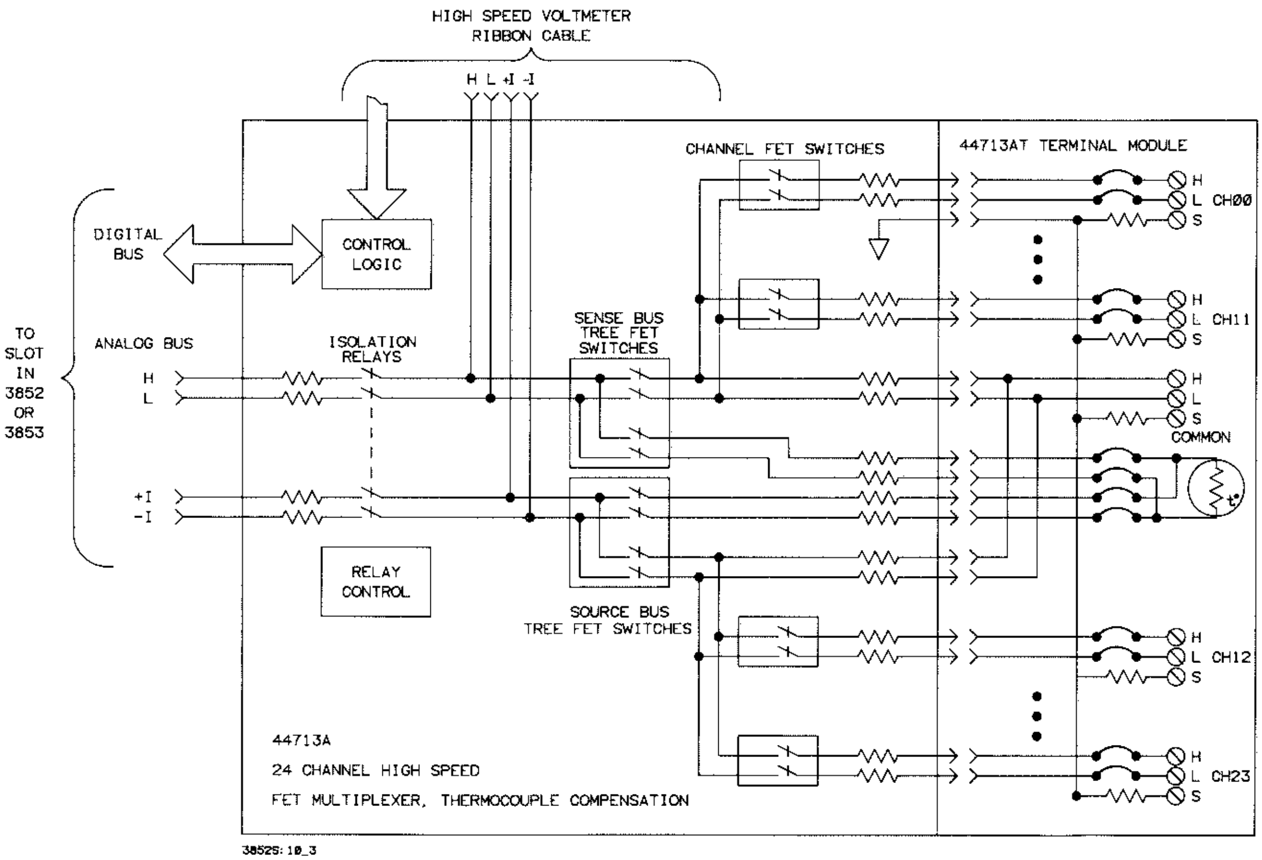


Figure 10-3 HP 44713A Simplified Schematic

10-5 Read and Write Registers

The HP 3852A communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 2 of this manual. Table 10-1 shows the registers used by the HP 44711A, HP 44712A, and HP 44713A.

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessories. It is possible to program some plug-in accessories into illegal and potentially damaging states with these commands. The commands are documented here for service purposes only.

10-6 Read Registers

NOTE

The decimal number returned after the execution of an SREAD command represents the two's compliment of the status word.

Table 10-1 High-Speed FET Multiplexer Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Reset
1	Accessory Status	Accessory Address
2	FET Switch Status	Not used
3	Not Used	FET Opening
4	Not Used	Isolation Relays Opening
5	Not Used	Isolation Relays Closing
6	Not used	FET Closing
7	Not Used	Not Used

10-7 Register 0. Read Register 0 contains the accessory identification. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data bus.

The eight bit identification is in two parts. The five most significant bits identify the component module installed. The least significant three bits identify the type of terminal module installed. If the terminal module is not present, the lower three bits are set high by the component module. If a terminal module is installed, the type of terminal module is also identified.

Table 10-2 lists the decimal equivalent codes returned in response to an SREAD of Register 0 for all combinations of the modules. Note that all three FET multiplexers use the same component module, identified as an HP 44711A in Table 10-2.

Table 10-2 HP 44711A, HP 44712A, and HP 44713A Identification Codes

Module Combinations	Codes
HP 44711A Component Module (no terminal module installed)	-137
HP 44711A Component Module, HP 44711AT Terminal Module installed	-141
HP 44711A Component Module, HP 44712AT Terminal Module installed	-139
HP 44711A Component Module, HP 44713AT Terminal Module installed	-144

10-8 Register 1. Read Register 1 is the accessory status register. This register uses backplane data bits 0 through 7 to indicate the current operating status of the accessory to the HP 3852A local controller. The following paragraphs describe the meaning of each bit in the status word.

Bit 7 indicates the status of the isolation relays. Bit 7 is set high when the isolation relays have been instructed to open and low when instructed to close. It is possible that the status bit will not correctly indicate the status of the isolation relays if the register is read too soon after the close or open command has been sent. The period of uncertainty is 1 millisecond after a close command and 0.5 millisecond after an open command.

Bit 6 is used to indicate the connection status of the ribbon cable. When the ribbon cable is connected to an HP 44702A/B bit 6 is pulled low.

Bit 5 is used to indicate the active bus for switch control. A high level indicates that the accessory control has been assigned to the HP 44702A/B High-Speed Voltmeter. A low level indicates that the accessory control is assigned to the HP 3852A backplane bus.

Bit 4 is set low when a HP 44702A/B High-Speed Voltmeter scan is in progress. The bit returns high when the scan is completed. A scan operation also sets bit 1 high so bits 4 and 1 can be used to determine if the accessory is currently scanning or is busy processing a command.

Bit 3 indicates the current status of the HP 3852A backplane OPENING line. When the OPENING pulse on the backplane is asserted, bit 3 is set high.

Bit 2 is the local opening signal. Bit 2 is set high while the multiplexer is opening a switch.

Bit 1 indicates the busy/ready status of the multiplexer. When bit 1 is set high the multiplexer is processing the last command or is involved in a scan operation. When bit 1 is high no write operations should be made to the multiplexer. Bit 1 is set low to indicate that the multiplexer is ready to accept a new command.

Bit 0 is fixed low.

10-9 Register 2. Read Register 2 is the switch status register. Figure 10-4 shows the eight bits returned from the switch status register.

7	6	5	4	3	2	1	0
0	0	0	0	C	C	C	C

Figure 10-4 Read Register 2

The most significant four bits, D4 through D7, are an operation code that provides an indication of the tree switch states and the channel bank that is currently enabled. Bits D0 through D3 provides an indication of the channel number that is being used with the operation codes. Table 10-3 gives the operation codes for the HP 44711A. Table 10-4 gives the operation codes for the HP 44712A and Table 10-5 gives the operation codes for the HP 44713A. The channel number codes for the HP 44711A and HP 44713A are given in Table 10-6. Channel codes for the HP 44712A are given in Table 10-7.

10-10 Write Registers

10-11 Register 0. Write Register 0 is the accessory reset register. Any data written to this register will open any FET switches closed, open the isolation relays, and stop opening and closing coordination on the backplane. A write to register 0 produces the same results as a system reset (backplane reset).

10-12 Register 1. Write Register 1 is the accessory address register. The address register is used to assign each FET multiplexer a unique address on the ribbon cable. The address is used when the FET Multiplexers are being controlled by the HP 44702A/B over the ribbon cable. Additionally the address register uses one bit to set the control of the FET multiplexer to either the HP 3852A backplane or the HP 44702A/B. Figure 10-5 shows the accessory address word.

Table 10-3 HP 44711A Operation Codes

Code	Tree Switches	Bank Enabled
0000	None	Bank B
0001	None	Bank B
0010	None	Bank A
0011	None	Bank A
0100	Bank A source bus	Bank B
0101	Bank B source bus	Bank B
0110	Bank A source bus	Bank A
0111	Bank B source bus	Bank A
1000	Bank A sense bus	Bank B
1001	Bank B sense bus	Bank B
1010	Bank A sense bus	Bank A
1011	Bank B sense bus	Bank A
1100	Bank A sense, Bank B source	Bank A, Bank B
1101	Bank B sense, Bank B source	Bank B
1110	Bank A sense, Bank A source	Bank A
1111	Bank B sense, Bank A source	Bank A, Bank B

Table 10-4 HP 44712A Operation Codes

Code	Tree Switches	Channels Enabled
0000	None	12-23, 36-47
0001	None	12-23, 36-47
0010	None	00-11, 24-35
0011	None	00-11, 24-35
0100	Ch 24-47 source bus	12-23, 36-47
0101	Ch 0-23 source bus	12-23, 36-47
0110	Ch 24-47 source bus	00-11, 24-35
0111	Ch 0-23 source bus	00-11, 24-35
1000	Ch 24-47 sense bus	12-23, 36-47
1001	Ch 0-23 sense bus	12-23, 36-47
1010	Ch 24-47 sense bus	00-11, 24-35
1011	Ch 0-23 sense bus	00-11, 24-35
1100	Ch 24-47 sense and source	12-23, 36-47
1101	Ch 0-23 sense and source	12-23, 36-47
1110	Ch 24-47 sense and source	00-11, 24-35
1111	Ch 0-23 sense and source	00-11, 24-35

Table 10-5 HP 44713A Operation Codes

Code	Tree Switches	Channels Enabled
0000	None	Ch 12-23
0001	None	Ch 12-23
0010	None	Ch 00-11
0011	None	Ch 00-11
0100	Source to common	Ch 12-23
0101	Source to thermistor	Ch 12-23
0110	Source to common	Ch 00-11
0111	Source to thermistor	Ch 00-11
1000	Sense to common	Ch 12-23
1001	Sense to thermistor	Ch 12-23
1010	Sense to common	Ch 00-11
1011	Sense to thermistor	Ch 00-11
1100	Sense and source to common	Ch 12-23
1101	Sense and source to thermistor	Ch 12-23
1110	Sense and source to common	Ch 00-11
1111	Sense and source to thermistor	Ch 00-11

Table 10-6 HP 44711A and HP 44713A Channel Codes

Code	Channel	Code	Channel
0000	None	1000	7 (19)
0001	None	1001	6 (18)
0010	None	1010	5 (17)
0011	None	1011	4 (16)
0100	11 (23)	1100	3 (15)
0101	10 (22)	1101	2 (14)
0110	9 (21)	1110	1 (13)
0111	8 (20)	1111	0 (12)

Table 10-7 HP 44712A Channel Codes

Code	Channel	Code	Channel
0000	None	1000	7 & 31 (19 & 43)
0001	None	1001	6 & 30 (18 & 42)
0010	None	1010	5 & 29 (17 & 41)
0011	None	1011	4 & 28 (16 & 40)
0100	11 & 35 (23 & 47)	1100	3 & 27 (15 & 39)
0101	10 & 34 (22 & 46)	1101	2 & 26 (14 & 38)
0110	9 & 33 (21 & 45)	1110	1 & 25 (13 & 37)
0111	8 & 32 (20 & 44)	1111	0 & 24 (12 & 36)

```
7 6 5 4 3 2 1 0
X X X X B A A A
```

Figure 10-5 Write Register 1 Accessory Address Word

In the accessory address word, bits 4 through 7 are not used. Bit 3 is the bus control bit. When this bit is set high, the control of the FET Multiplexer is given to the HP 44702A/B. When set low, control returns to the HP 3852A backplane. Bits 0 through 2 are the address bits. Typically, the addresses assigned correspond to the slot number where the FET Multiplexer is installed.

10-13 Register 3. Write Register 3 is the Opening register. A write to this register opens the FET switches indicated in the command word. The command word is described in Section 10-17. When the command word is sent to register 3, the backplane OPENING line is pulsed to coordinate the break-before-make feature.

10-14 Register 4. Write Register 4 opens the isolation relays. Any data sent to this register causes the isolation relays to open and pulses the HP 3852A backplane OPENING line.

10-15 Register 5. Write Register 5 closes the isolation relays. Any data written to this register initiates the closing of the isolation relays. Before the relay closes, the HP 3852A backplane OPENING line is examined. If the OPENING line is low the relays closure is delayed until the line returns high. When the isolation relays are closing the HP 3852A backplane CLOSING line is pulsed.

10-16 Register 6. Write Register 6 is the is the FET switch closing register. A write to this register will close the FET switches indicated in the command word. The command word is described in Section 10-17. When the command word is sent to this register the HP 3852A backplane CLOSING line is pulsed.

10-17 Command Word

The command word uses 15 bits. The bits are arranged into isolation relays control, tree switch operation code bits, and channel bits. The command word is shown in Figure 10-6. The command word is used for both opening and closing functions. The function is determined by the register receiving the command word.

```
Bits:  15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
Use:    C  X  X  X  X  X X X 0 0 0 0 C C C C
```

Figure 10-6 Command Word

Bit 15 controls the isolation relays. Bits 8 through 14 are not used and will be ignored. Bits 4 through 7 are the tree switch operation codes bits. The operation codes for the FET Multiplexers are shown in Tables 10-3, 10-4 and 10-5. Bits 0 through 3 are the channel control bits. The actual channels that these bits control is determined by the operation code in bits 4 through 7. The channel codes for the FET multiplexers are given in Tables 10-6 and 10-7. The decimal number sent by an SWRITE command represents the two's compliment of the command word.

10-18 SPECIFICATIONS

Specifications for the HP 44711A, HP 44712A and HP 44713A are given in Table 10-8. Specifications are the performance standards or limits against which the FET multiplexers may be tested.

CAUTION

The installation of the HP 44711A, HP 44712A, or HP 44713A reduces the maximum allowable backplane voltages to 42 V peak.

Table 10-8 HP 44711A/44712A/44713A Specifications

HP 44711A 24 Channel High Speed FET Multiplexer

Maximum Switch Rates: 5500 channels/second (from back-plane)*
100000 channels/second (from ribbon cable)

Maximum Input Voltage: Rear and back-plane inputs protected to 16 V peak (input impedance decreases above 12 V due to internal protection circuitry). With analog back-plane disconnected from multiplexer, the back-plane voltage can go up to 42 V peak.

Maximum Input Current: 1 mA non-inductive per channel

Input Impedance:

Impedance	Terminals: High to Low	Terminals: High or Low to Chassis
Power On Resistance (Ω)	$>10^8$	$>10^8$
Power Off Resistance (Ω) Vin 10 V	>1000	>1000
Power Off Resistance (Ω) Vin >10 V	>200	>200
Max. Capacitance (pf) at 1MHz	200	200

Closed Channel Path Resistance: 3.1 kΩ for either High or Low Inputs considered separately

Bandwidth: 1.0% flatness at 20 kHz, -3 dB Bandwidth at 200 kHz (50 Ω source, 1 MΩ termination)

Crosstalk: -50 dB at 10 kHz, -35 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 15 µV at 0 to 28 °C
185 µV at 28 to 55 °C
(offset voltage between High and Low)

Maximum Bias Current: ±5 nA DC at 0 to 28 °C
±15 nA DC at 28 to 55 °C
(Current sourced by High or Low to Chassis into Input Terminals or back-plane, with isolation relays closed)

±1 nA DC at 0 to 55 °C
(Current sourced by High or Low to Chassis into back-plane, with isolation relays open)

Maximum Wire Size: 16 AWG

Table 10-8 HP 44711A/44712A/44713A Specifications (Cont.)

HP 44712A 48 Channel Single Ended High Speed FET Multiplexer

Maximum Switch Rates: 5500 channels/second (from back-plane)*
100000 channels/second (from ribbon cable)

Maximum Input Voltage: Rear and back-plane inputs protected to 16 V peak (input impedance decreases above 12 V due to internal protection circuitry). With analog back-plane disconnected from multiplexer, the back-plane voltage can go up to 42 V peak.

Maximum Input Current: 1 mA non-inductive per channel

Input Impedance: High to Low, $>10^8$ Ω, <=200 pF (at 1 MHz)
Power Off Resistance, >1000 Ω (Vin <=10 V)
Power Off Resistance, >200 Ω (Vin >10 V)

Closed Channel Path Resistance: 3.1 kΩ for either High or Low Inputs considered separately

Bandwidth: 1.0% flatness at 20 kHz, -3 dB Bandwidth at 200 kHz (50 Ω source, 1 MΩ termination)

Crosstalk: -50 dB at 10 kHz, -35 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 15 µV at 0 to 28 °C
185 µV at 28 to 55 °C
(offset voltage between High and Low)

Maximum Bias Current: ±5 nA DC at 0 to 28 °C
±15 nA DC at 28 to 55 °C
(Current sourced by High or Low to Chassis into Input Terminals or back-plane, with isolation relays closed)

±1 nA DC at 0 to 55 °C
(Current sourced by High or Low to Chassis into back-plane, with isolation relays open)

Maximum Wire Size: 16 AWG

HP 44713A 24 Channel High Speed FET Mux with Thermocouple Compensation

Maximum Switch Rates: 5500 channels/second (from back-plane)*
100000 channels/second (from ribbon cable)

Table 10-8 HP 44711A/44712A/44713A Specifications (Cont.)

Maximum Input Voltage: Rear and back-plane inputs protected to 16 V peak (input impedance decreases above 12 V due to internal protection circuitry). With analog back-plane disconnected from multiplexer, the back-plane voltage can go up to 42 V peak.

Maximum Input Current: 1 mA non-inductive per channel

Input Impedance:

Impedance	Terminals: High to Low	Terminals: High or Low to Chassis
Power On Resistance (Ω)	$>10^8$	$>10^8$
Power Off Resistance (Ω) Vin 10 V	>1000	>1000
Power Off Resistance (Ω) Vin >10 V	>200	>200
Max. Capacitance (pf) at 1MHz	200	200

Closed Channel Path Resistance: 3.1 kΩ for either High or Low Inputs considered separately

Bandwidth: 1.0% flatness at 20 kHz, -3 dB Bandwidth at 200 kHz (50 Ω source, 1 MΩ termination)

Crosstalk: -50 dB at 10 kHz, -35 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 15 µV at 0 to 28 °C
185 µV at 28 to 55 °C
(offset voltage between High and Low)

Maximum Bias Current: ±5 nA DC at 0 to 28 °C
±45 nA DC at 28 to 55 °C
(Current sourced by High or Low to Chassis into Input Terminals or back-plane, with isolation relays closed)

±1 nA DC at 0 to 55 °C
(Current sourced by High or Low to Chassis into back-plane, with isolation relays open)

Maximum Wire Size: 16 AWG

Ref. Junction Compensation Accuracy: 0.1 °C (over 18 to 28 °C operating temperature)

Max Temperature Difference Across Isothermal Module: 0.2 °C

*Applies to HP 3852As with firmware revision 2.0 or above.

10-19 HP 44711A AND HP 44713A PERFORMANCE TESTS

10-20 Introduction

The following Performance Tests check the operation of the HP 44711A and HP 44713A component module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this chapter provides a high confidence level that the FET Multiplexer is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in FET Multiplexer operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 10-21.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the FET Multiplexer is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

10-21 Operational Verification

The first tests given in this section are the minimum set of tests recommended for the FET Multiplexer. These tests are designed to test the functionality and the on resistance of the FET switches. A ribbon cable test is included to verify that the HP 44711A or HP 44713A can communicate and transmit data over the ribbon cable to an HP 44702A/B. Successful completion of the Operational Verification Tests provides a 90% confidence level that the FET Multiplexer is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 10-25 - Set-Up Procedure
Section 10-26 - Channel Switches Test
Section 10-27 - Tree Switch and Isolation Relay Test
Section 10-28 - Ribbon Cable Test

10-22 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first four items in the list are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 10-23)

2. Digital Multimeter -- HP 3456A or equivalent

3. HP 44702A/B High-Speed Voltmeter (for Ribbon Cable Test only)

4. Test Leads and Jumpers

5. Service Module -- HP 44743A

6. Resistor -- 10 Mohm

7. Resistor -- 1 kohm

8. Oscilloscope -- HP 1740A or equivalent (dual trace with delayed sweep)

9. +10 V Power Supply -- HP 6234 or equivalent

10. -10 V Power Supply -- HP 6234 or equivalent

NOTE

Except for the Ribbon Cable Test (it requires the HP 44702A/B), either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for this test. This test does not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

10-23 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 10-7a. A test fixture can be manufactured using an HP 44711AT terminal module (see Figure 10-7b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44711AT terminal module, it is important that the terminal ID lines, shown in Figure 10-7a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The test fixture consists of a short circuit between all channel HIGH lines and a short circuit between all channel LOW lines. The use of the test fixture minimizes the number of test lead connections required for the tests.

10-24 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

10-25 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the FET multiplexer. Disconnect the ribbon cable if it is connected to either an HP 44702A/B or another FET multiplexer. Install the test fixture on the multiplexer. Note the slot number where the multiplexer under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

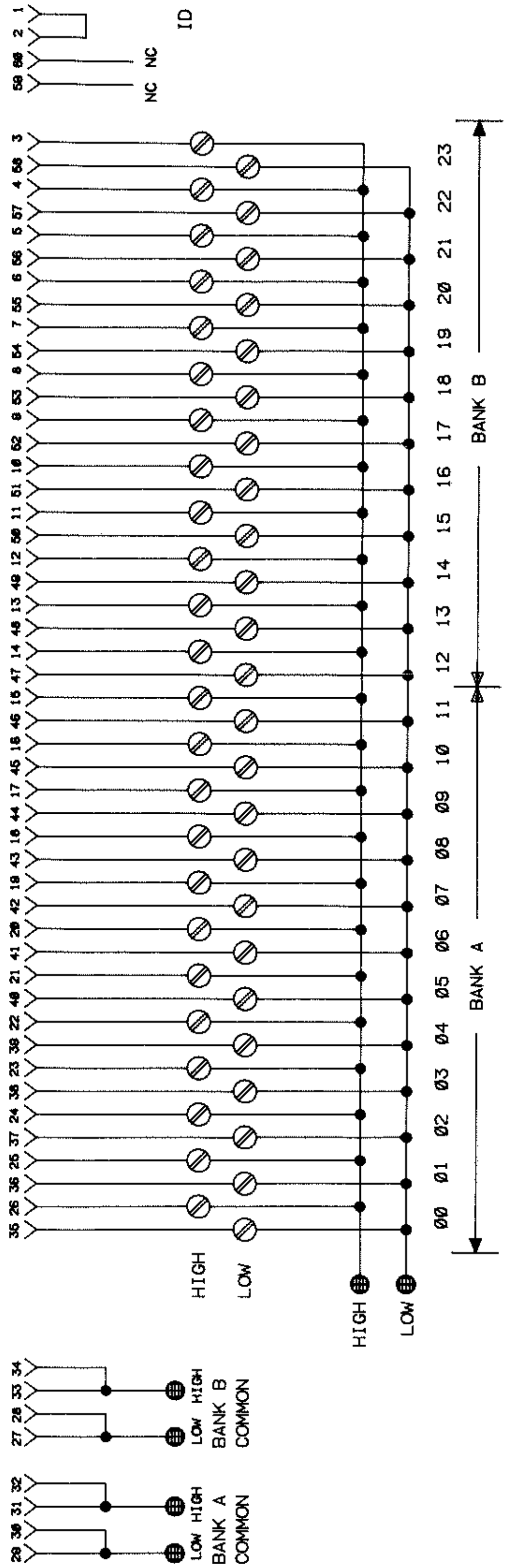


Figure 10-7a HP 44711A Test Fixture Schematic

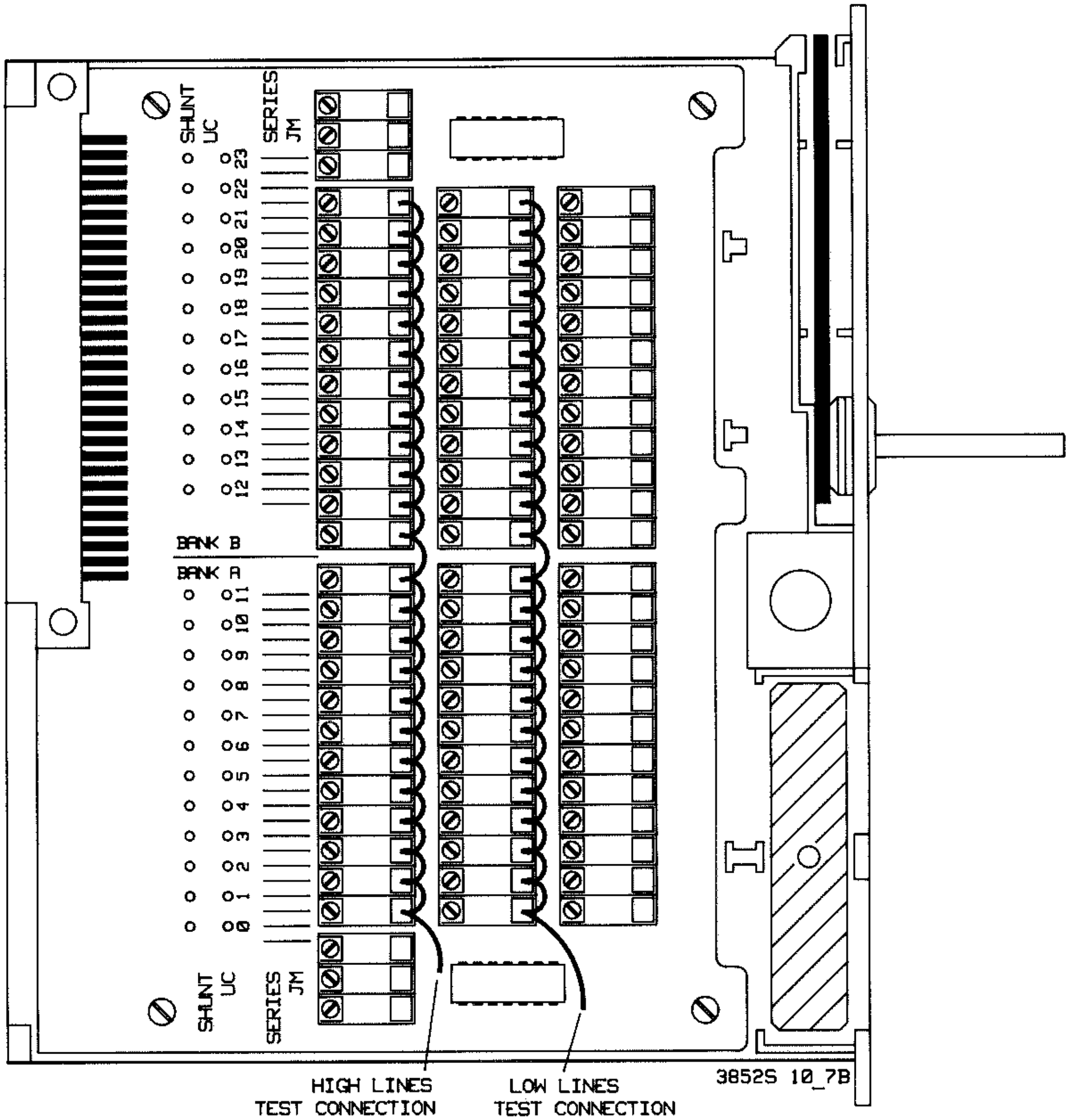


Figure 10-7b HP 44711A Test Fixure

c. Verify that the HP 3852A right display shows:

44711A

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

10-26 Channel Switches Test

This test checks the on resistance for the HIGH and LOW FET switches in both Banks A and B.

1. Set the HP 44711A to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

This opens all switches on the HP 44711A.

2. On the test fixture, connect the multimeter DCV lead to the Bank A HIGH common test point. Connect the multimeter COM lead to the shorted HIGH connections of the channels. Short the Bank A and Bank B HIGH common test points together. Set the multimeter to measure two-wire ohms. The connections are shown in Figure 10-8.

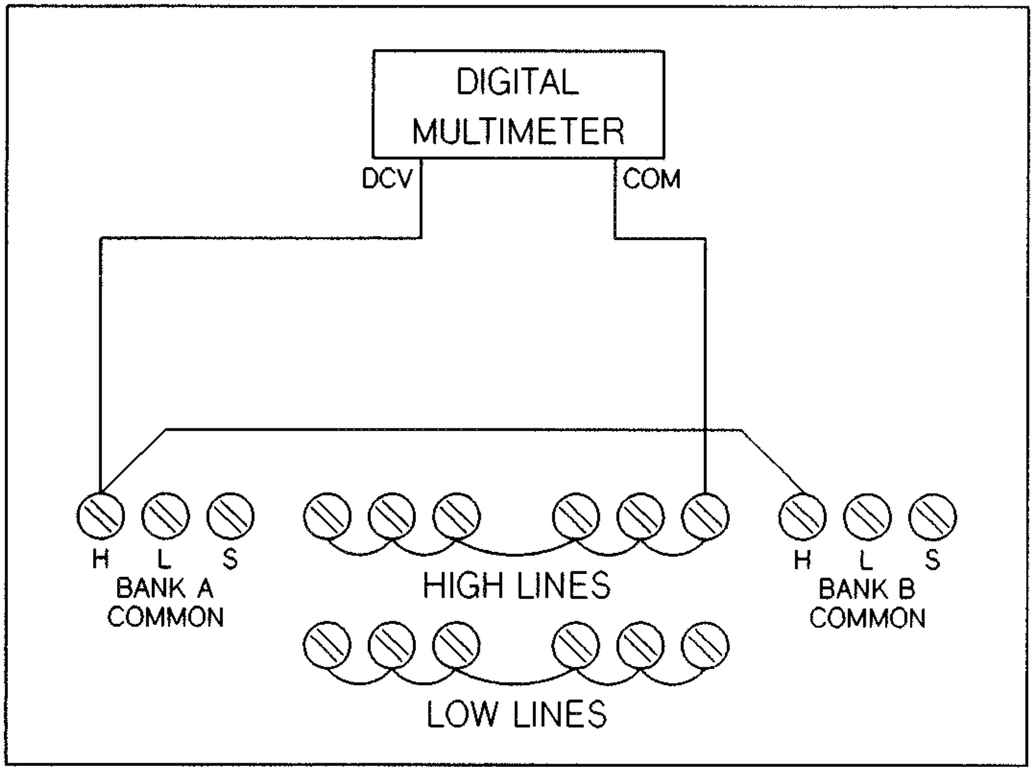


Figure 10-8 HP 44711A HIGH Channel Test Set-Up

3. Close the first channel by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

4. Observe the reading on the multimeter. The multimeter should indicate <1.6 kohms resistance. If the reading is greater than 1.6 kohms, the channel FET switch may be faulty.

5. Open the channel by executing:

   OPEN ES00 (where E = extender number, S = slot number)

6. Observe the reading on the multimeter. The multimeter should indicate a resistance greater than 100 Mohm. It is important to perform this step to ensure that none of the FET switches are stuck on or leaking.

7. Repeat steps 4, 5, 6, and 7 for channels 01 through 23. In the CLOSE and OPEN commands the last two digits indicate the channel number. For example, CLOSE ES01 closes channel 01 in extender E at slot S.

8. Connect the multimeter DCV lead to the Bank A LOW common test point on the test fixture. Connect the multimeter COM lead to the shorted LOW connections of the channels. Short the Bank A and Bank B LOW common test points together. The connections are shown in Figure 10-9.

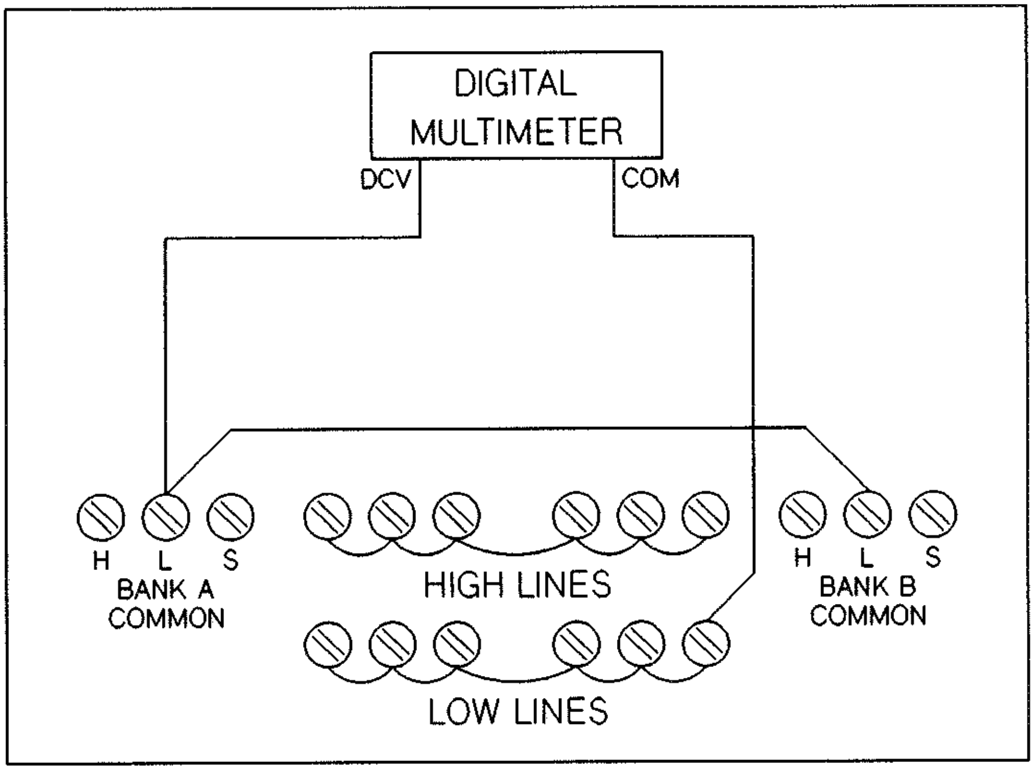


Figure 10-9 HP 44711A LOW Channel Test Set-Up

9. Repeat steps 3, 4, 5, 6, and 7. This checks the LOW path through the FET switches.

10-27 Tree Switch and Isolation Relay Test

1. SENSE BUS TREE SWITCH AND ISOLATION RELAY TEST: This test checks the measurement path from the backplane analog sense bus through the isolation relay and tree switches.

2. Connect a jumper between the Bank A common HIGH and Bank A common LOW connections on the test fixture.

3. Set the multimeter to measure two-wire ohms. Connect the multimeter test leads to the backplane analog bus sense HIGH and LOW lines.

NOTE

The backplane analog bus can be tested in one of two ways: 1) By connecting an external multimeter to the analog bus connector on the rear panel of the power supply module as shown in Figure 10-10, or 2) By connecting an external multimeter to the backplane analog bus line jumpers provided on the 44743A service module as shown in Figure 10-11.

4. Close Bank A sense tree switch and isolation relay by executing:

   SWRITE ES00,6,-32608 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The multimeter should indicate less than 3.2 kohm.

6. Open the tree switch and isolation relay by executing:

   RESET ES00 (where E= extender number, S= slot number)

7. Observe the indication on the multimeter. The multimeter should indicate greater than 100 Mohm.

8. Disconnect the jumper between the Bank A common HIGH and the Bank A common low connection on the test fixure. Connect a jumper between the Bank B common HIGH and the Bank B common LOW connections on the test fixture.

9. Close the Bank B sense tree switch and isolation relay by executing:

   SWRITE ES00,6,-32624 (where E = extender number, S = slot number)

10. Observe the indication on the multimeter. The multimeter should indicate less than 3.2 kohm.

11. Open the Bank B sense tree switch and isolation relay by executing:

    RESET ES00 (where E= extender number, S= slot number)

12. Observe the indication on the multimeter. The multimeter should indicate greater than 100 Mohm.

13. SOURCE BUS TREE SWITCH AND ISOLATION RELAY TEST: This test checks the measurement path from the backplane analog source bus through the isolation relay and tree switches.

14. Set the multimeter to measure two-wire ohms. Connect the multimeter test leads to the backplane analog source bus HIGH and LOW lines.

15. Disconnect the jumper between the Bank B common HIGH and the Bank B common low connection on the test fixure. Connect a jumper between the Bank A common HIGH and the Bank A common LOW connections on the test fixture.

16. Close Bank A source tree switch and isolation relay by executing:

    SWRITE ES00,6,-32672 (where E = extender number, S = slot number)

17. Observe the indication on the multimeter. The multimeter should indicate less than 3.2 kohm.

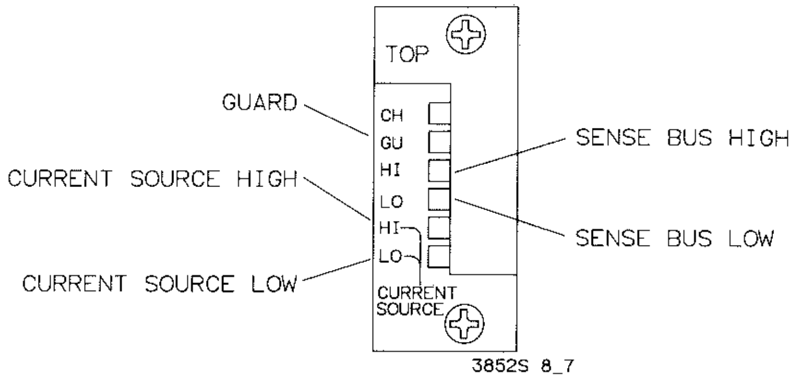


Figure 10-10 Analog Bus Connector

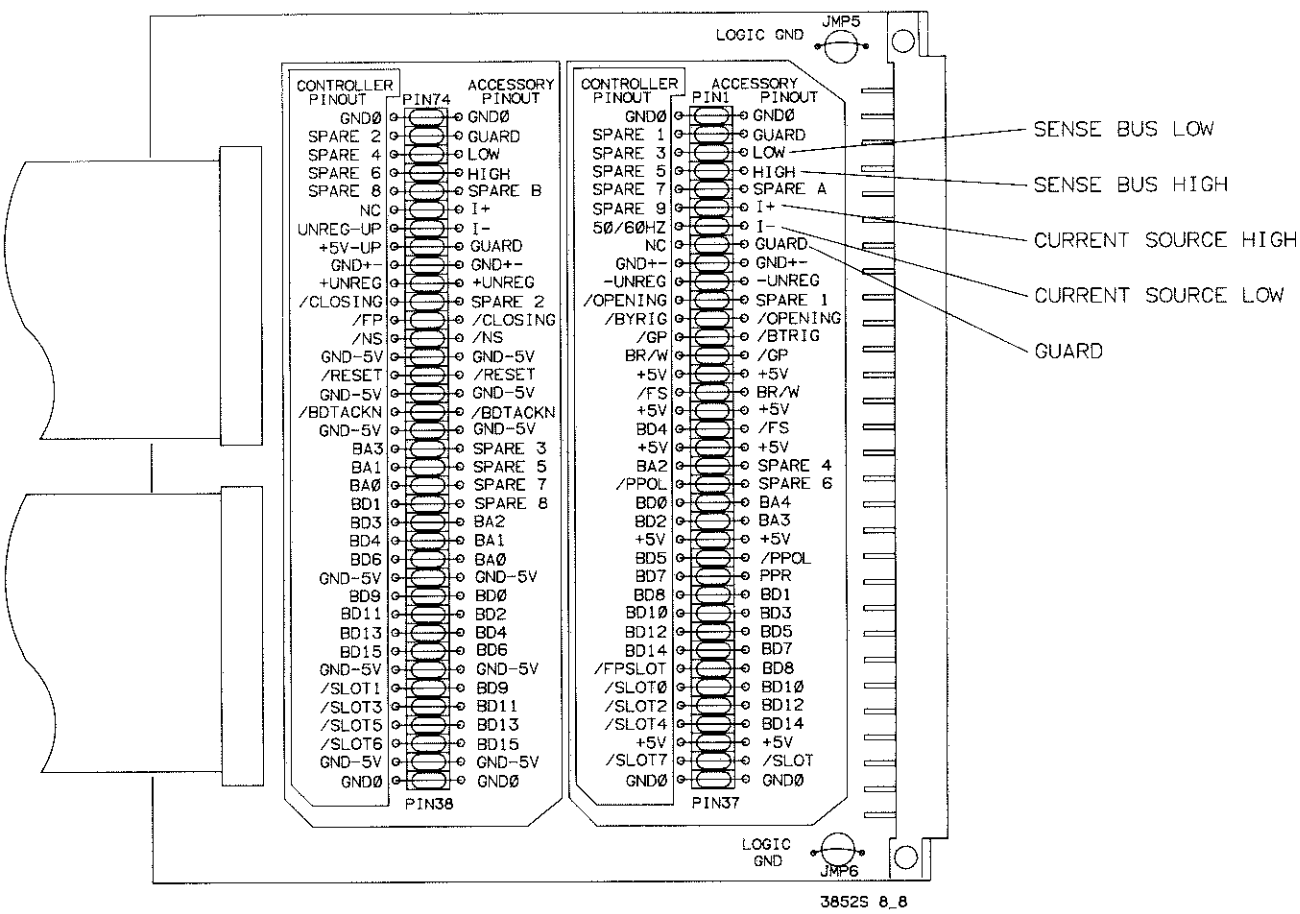


Figure 10-11 HP 44743A Service Module

18. Open the tree switch and isolation relay by executing:

RESET ES00 (where E = extender number, S = slot number)

19. Observe the indication on the multimeter. The multimeter should indicate greater than 100 Mohm.

20. Disconnect the jumper between the Bank A common HIGH and the Bank A common LOW connection on the test fixure. Connect a jumper between the Bank B common HIGH and the Bank B common LOW connections on the test fixture.

21. Close the Bank B source tree switch and isolation relay by executing:

SWRITE ES00,6,-32688 (where E = extender number, S = slot number)

22. Observe the indication on the multimeter. The multimeter should indicate less than 3.2 kohm.

23. Open the Bank B source tree switch and isolation relay by executing:

RESET ES00 (where E = extender number, S = slot number)

24. Observe the indication on the multimeter. The multimeter should indicate greater than 100 Mohm.

10-28 Ribbon Cable Test

This test verifies that the FET multiplexer can be controlled by the HP 44702A/B High-Speed Voltmeter. It also verifies that measurement results can be transferred to the voltmeter over the ribbon cable.

1. Remove power from the HP 3852A.

2. Install the HP 44711A component module in the mainframe next to an HP 44702A/B. Connect the ribbon cable between the FET multiplexer and the HP 44702A/B. Note the slot number where the FET under test is installed and the slot number where the HP 44702A/B is installed.

3. Install the test fixture on the FET multiplexer.

4. Apply power to the HP 3852A.

5. Set up the tests by executing the following commands:

USE ES00 (where E = extender number, S = slot number for High Speed Voltmeter)
FASTDISP OFF
SCANMODE ON
TERM RIBBON

6. On the test fixture, connect a jumper between the shorted HIGH lines and the shorted LOW lines.

7. Enter, but do not execute, the following command:

CONFMEAS OHM ES00-ES23 (where E = extender number, S = FET mux. slot number)

8. When the command entered in step 7 is executed, the HP 44702A/B will perform a resistance measurement on all channels on the HP 44711A. With the FASTDISP OFF, each measurement will appear in the HP 3852A right display. The HP 3852A left display will indicate each channel as it is scanned. Observe the HP 3852A displays and press execute. The resistance indicated in the right display, for all channels, should

be less than 6.2 kohms (the number in the display will be in exponential format). The resistance indicated includes the on-resistance of the channel FET switch, the on-resistance of the tree FET switch, and the resistance of the series protection resistors. The scan list can be repeated, if desired, by pressing the RECALL ENTRY key and then the ENTER key.

9. Remove the jumper from the test fixture.

10. Press the RECALL ENTRY key to retrieve the scan list command. Press the ENTER key and observe the displays. The resistance indicated in the HP 3852A right display should be infinite (the HP 44702A/B indicates an infinite resistance by the display: 1.000000E+38).

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44711A/44713A PERFORMANCE TESTS.

10-29 DC Offset Test

1. Perform the Set-Up Procedure given in Section 10-25. The DC Offset test set-up is shown in Figure 10-12.

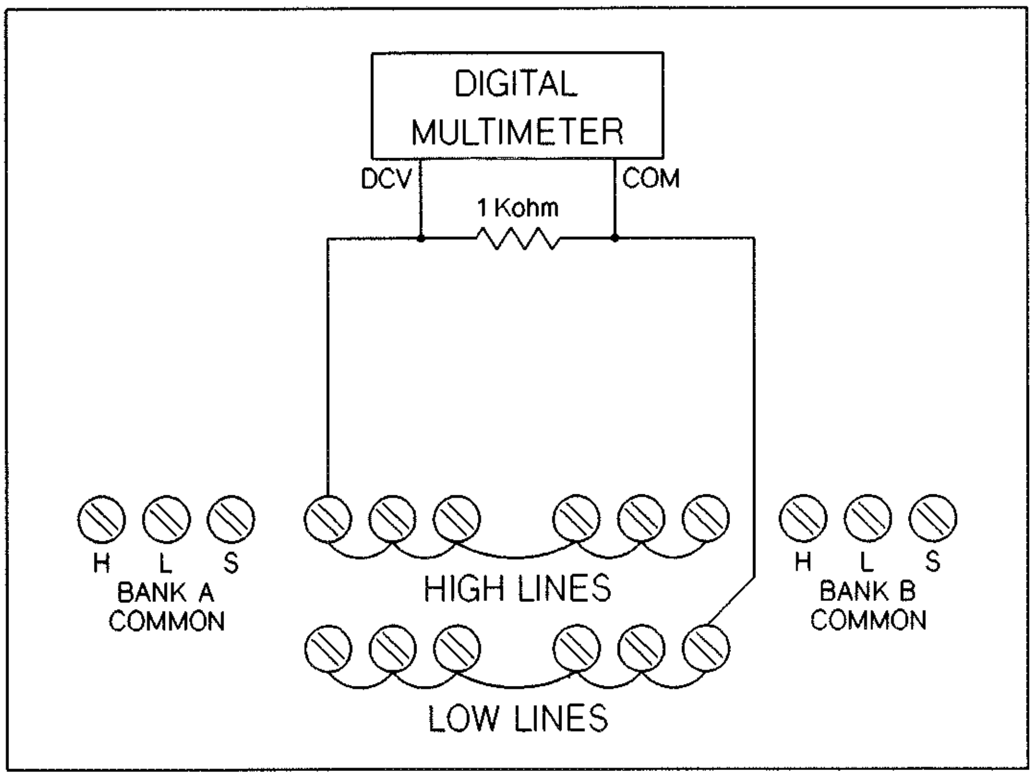


Figure 10-12 HP 44711A DC Offset Test Set-Up

2. Set the multimeter to measure DC volts, on a range with at least 10 μV resolution. Connect the multimeter DCV lead to the shorted HIGH lines of the test fixture. Connect the multimeter COM lead to the shorted LOW lines of the test fixture.

3. Connect the 1 kohm resistor across the multimeter input leads.

NOTE

The offset voltage is specified with a resistance of 1 kohm or less. A smaller value resistor may be used for this test.

4. Close the first channel in the multiplexer by executing:

   CLOSE ES00   (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The voltage indicated should be less than 15 µV (0 to 28 °C) or less than 185 µV (28 to 55 °C). A failure of the DC Offset test indicates a failing channel FET switch.

6. Repeat steps 4 and 5 for channels 01 through 23. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 would close channel 01 in extender E at slot S).

10-30 Opening and Closing Time Set-Up Procedure

The Opening and Closing Time test verifies that the channel FETs will switch on and off and that the multiplexer can scan the channels at the specified speed.

1. Remove power from the HP 3852A and unplug the multiplexer to be tested. Install the Service Module in a convenient slot in the HP 3852A. Note the slot number where the Service Module is installed. Install the multiplexer on the service module. Install the test fixture on the multiplexer. The Set-Up Procedure is depicted in Figure 10-13.

2. On an oscilloscope, connect probes to the Channel A INPUT and the Channel B INPUT. Set up the oscilloscope to the following:

   Dual Trace
   Channel A -- DC, 0.2 Volts/Div (if using 10:1 probes)
   Channel B -- DC, 0.5 Volts/Div (if using 10:1 probes)
   Trigger -- Internal, triggered on Channel B
   Vertical Display -- Alternate
   Time -- 0.5 mses/Div
   Delayed Sweep -- 0.1 µsec/Div
   Delayed Sweep Dial -- Minimum

3. Connect a jumper from the +5V test connection on the service module to the shorted HIGH connections on the test fixture.

4. Connect a jumper between the Bank A HIGH common test point and the Bank B HIGH common test point on the test fixure.

5. Connect the 1 kohm resistor between the HIGH common test points on the test fixture and the logic ground test connection on the service module.

6. Connect the Channel A oscilloscope probe to the HIGH common test points on the test fixture.

7. Connect the Channel B oscilloscope probe to the OPENING test connection on the service module.

8. Apply power to the HP 3852A. Wait for the wake-up sequence to complete.

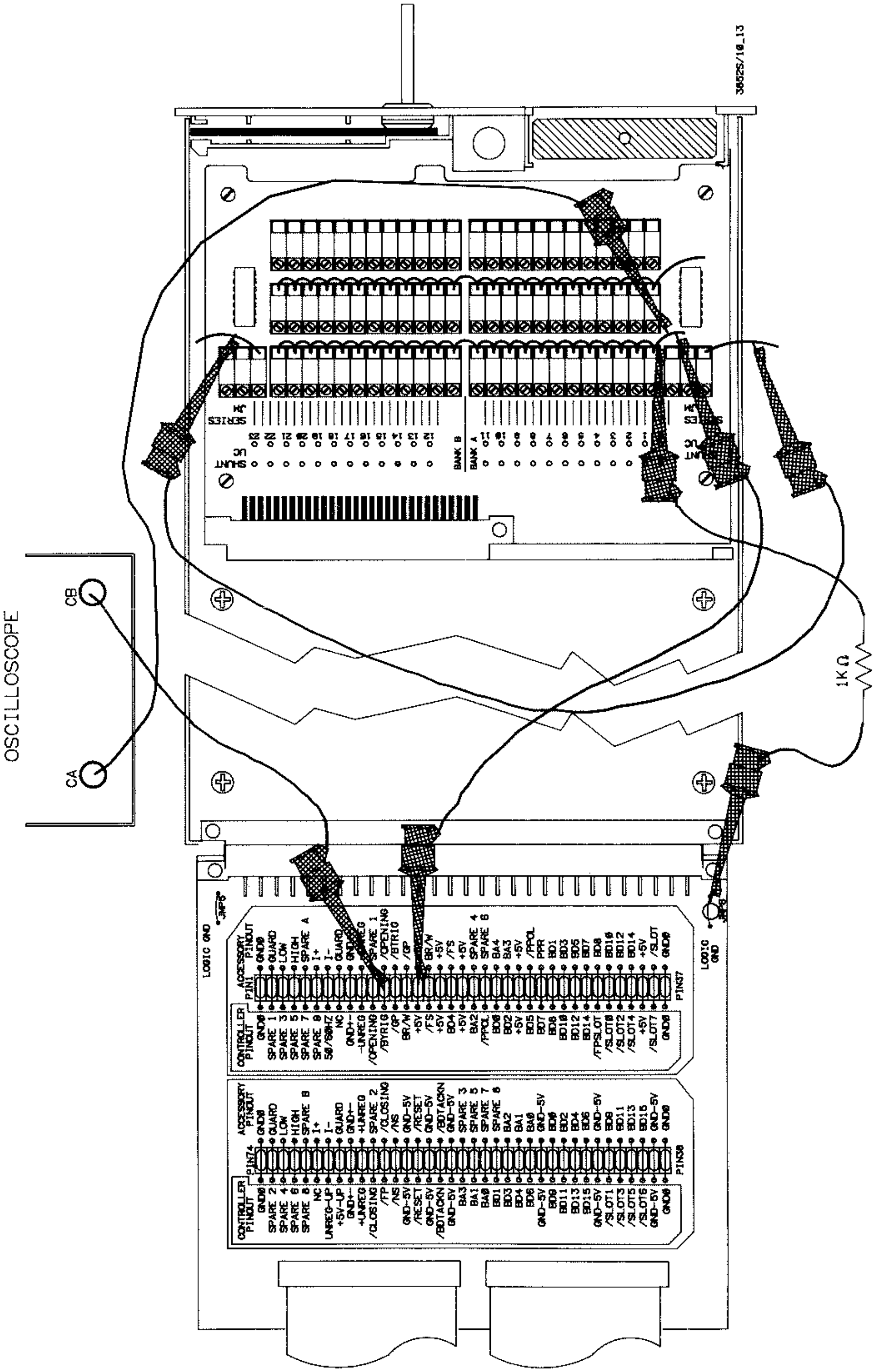


Figure 10-13 HP 44711A Opening Time Set-Up

9. Set up the following subroutine in HP 3852A memory. When the first statement is entered the SUB ENTRY annunciator should be on in the left display. This annunciator should remain on until the SUBEND statement is entered.

```
SUB A
TRG
SCAN ES00-ES23   (where E = extender number, S = slot number)
SUBEND
```

The subroutine will scan all channels on the FET multiplexer. Do not reset or cycle power to the HP 3852A or the subroutine will be erased from memory. The front panel CLEAR key may be used without disturbing the subroutine.

10-31 Opening Time Test

This test checks the time it takes for the FET to open after receiving an OPENING pulse from the FET multiplexer.

1. Repetitively call the entered subroutine 10000 times by executing:

```
CALL A,10000
```

This statement will call the subroutine 10000 times.

2. Observe the waveform displayed on the Channel B trace and make sure all 24 channels are present. It may also be necessary to adjust the TRIGGER LEVEL and TRIGGER HOLD controls, and to select the negative trigger pulse position on the scope to synchronize the signal on the scope.

3. Rotate the DELAY SWEEP dial to the minimum position. Select the DELAYED sweep mode on the scope. Slowly rotate the DELAY SWEEP dial clockwise while observing the displayed waveforms. The Channel B waveform is the OPENING pulse. The Channel A waveform is the +5V supply as switched by the relays. As the DELAY SWEEP dial is rotated, each channel switch and the associated OPENING pulse will come into view. The FET opening time is the time from the falling edge of the OPENING pulse to the falling edge of the Channel A waveform. This time must be less than 1.2 μseconds. The opening time is illustrated in Figure 10-14.

NOTE

The +5 V power supply waveform on Channel A will show an amplitude difference between the Bank A and Bank B FET switches. This is due to impedance differences in the Bank A common and Bank B common measurements paths on the multiplexer.

Continue rotating the DELAY Sweep dial until all 24 FET channels have been checked. A failing channel indicates a failing FET switch.

To stop the test at any time, press the front panel CLEAR key. The test time may be extended by increasing the number of times the subroutine is called, as specified in step 1.

The waveform will exhibit a small amount of jitter due to the overhead requirements of the HP 3852A operating system.

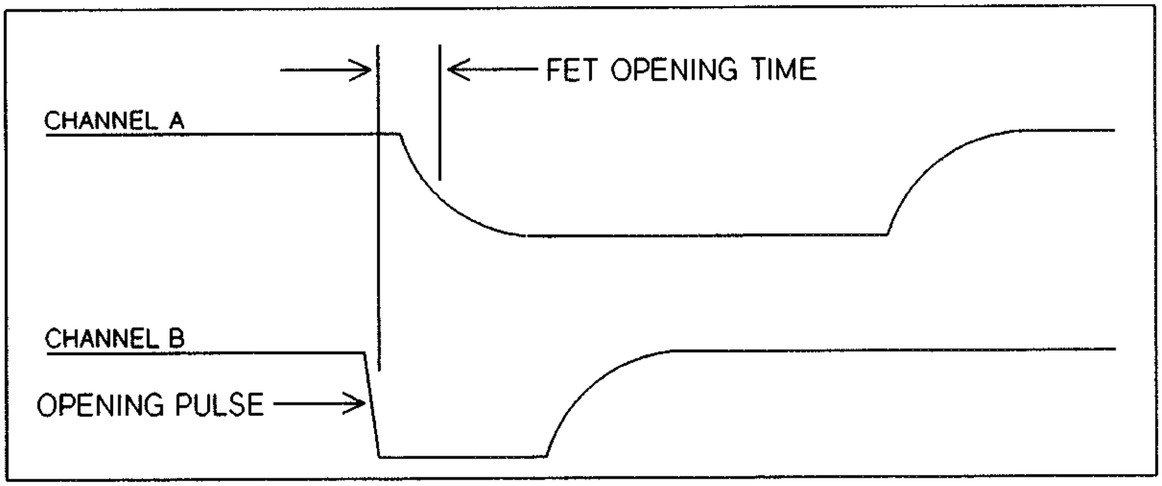


Figure 10-14 HP 44711A Opening Time

10-32 Closing Time Test

This test checks the time it takes for the FET to close after receiving a CLOSING pulse from the FET multiplexer.

1. Move the channel B oscilloscope probe to the CLOSING connection on the service module. The Closing Time test set-up is shown in Figure 10-15.

2. Repetitively call the entered subroutine by executing:

    CALL A,10000

3. Rotate the DELAY SWEEP dial on the oscilloscope to the minimum position. Slowly rotate the dial clockwise until the first closing is displayed. The Channel B trace is the closing pulse output from the multiplexer. The Channel A waveform is the +5V supply, as switched by the FET channel switches. As the DELAY SWEEP dial is rotated, each channel switch and the associated CLOSING pulse will come into view. The FET closing time is the time from the falling edge of the CLOSING pulse to the rising edge of the Channel A waveform. This time must be less than 2.25 µseconds. The closing time is illustrated in Figure 10-16.

Continue rotating the DELAY Sweep dial until all 24 FET channels have been checked. A failing channel indicates a failing FET switch.

To stop the test at any time, press the front panel CLEAR key. The test time may be extended by by increasing the number of times the subroutine is called, as specified in step 2.

The waveform will exhibit a small amount of jitter due to the overhead requirements of the HP 3852A operating system.

10-33 Leakage/Bias Current Test

The leakage current test checks the FET switches for excessive leakage/bias current. Leakage/bias current is sourced by the multiplexer from HIGH or LOW to chassis ground.

1. OPEN CHANNELS LEAKAGE/BIAS CURRENT TEST. This test checks the leakage current with all channels open. A simplified schematic of the setup is shown in Figure 10-17 and the test setup for the HIGH lines is shown in Figure 10-18.

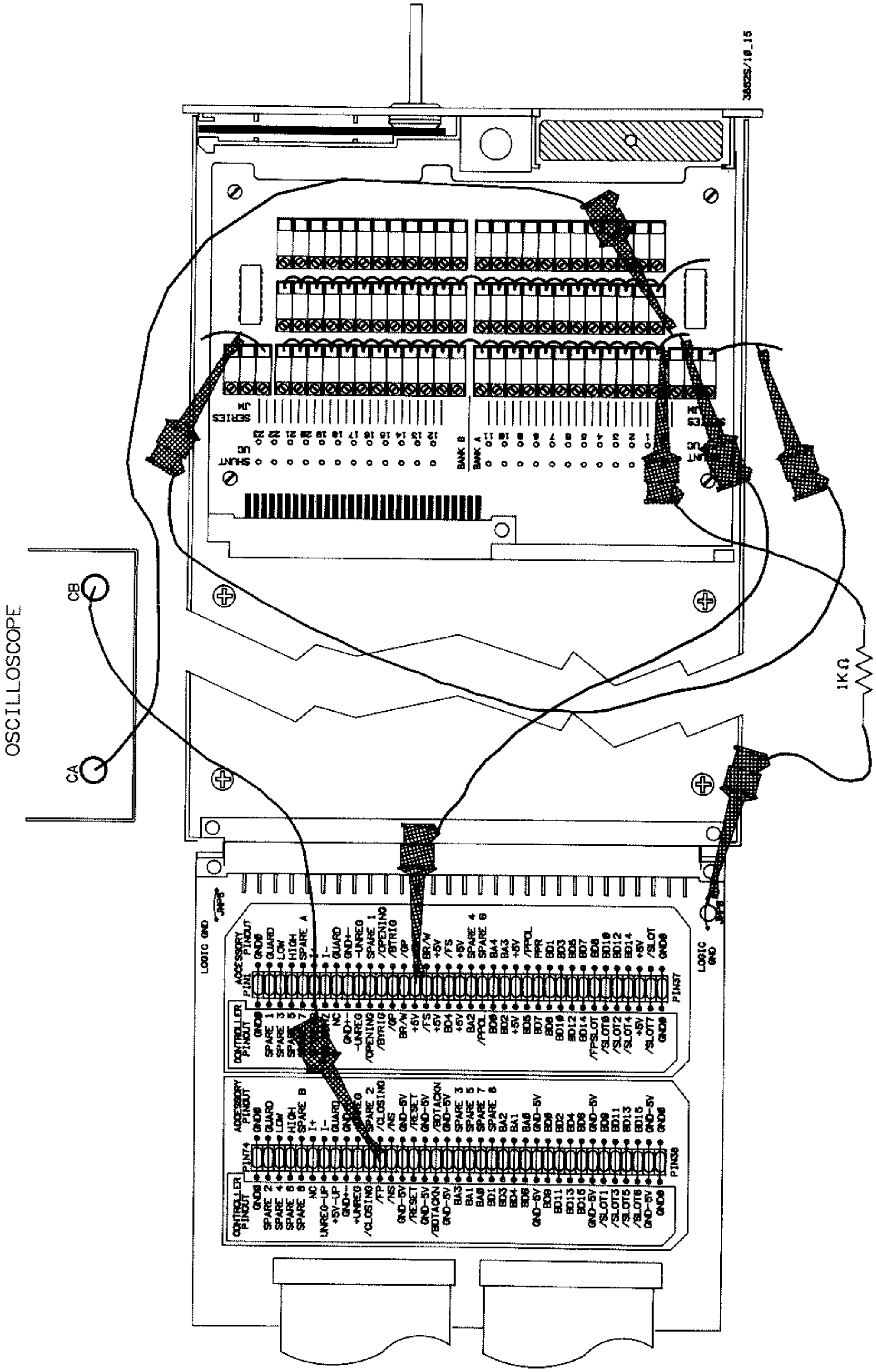


Figure 10-15 HP 44711A Closing Time Set-Up

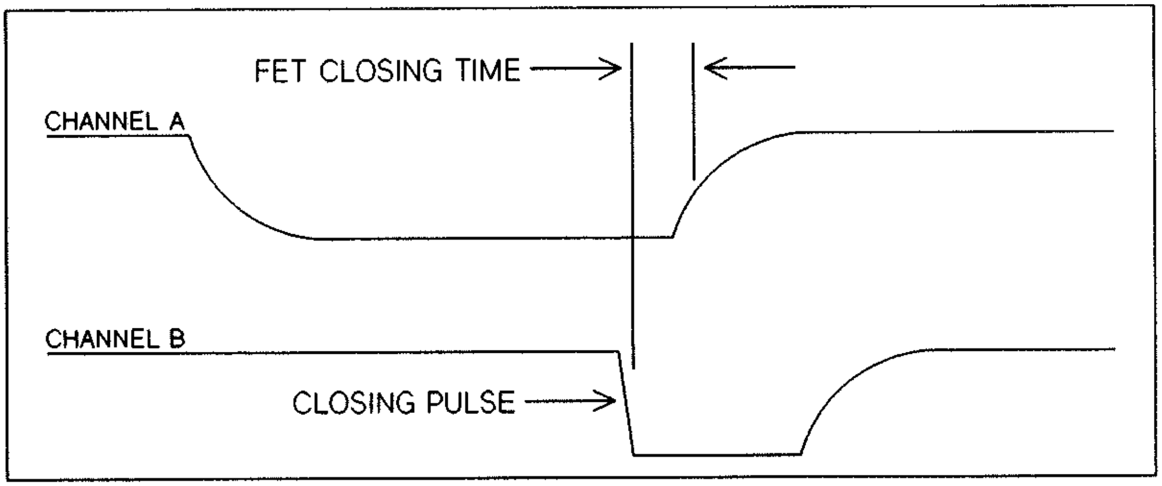


Figure 10-16 HP 44711A Closing Time

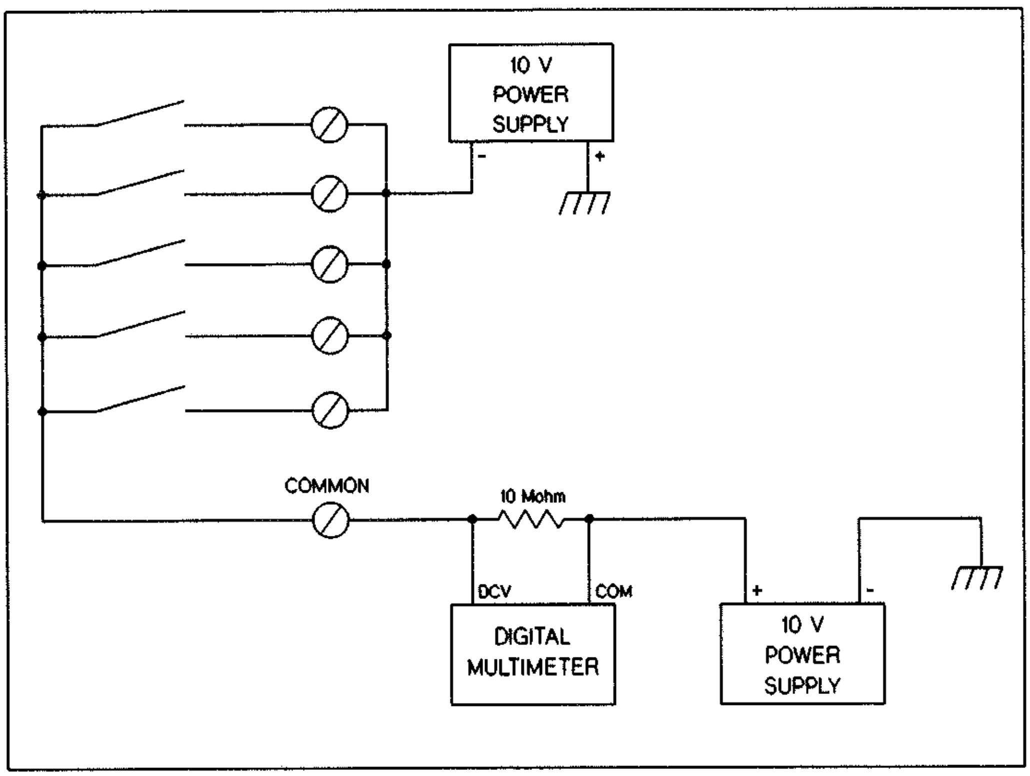


Figure 10-17 Open Channel Leakage Test

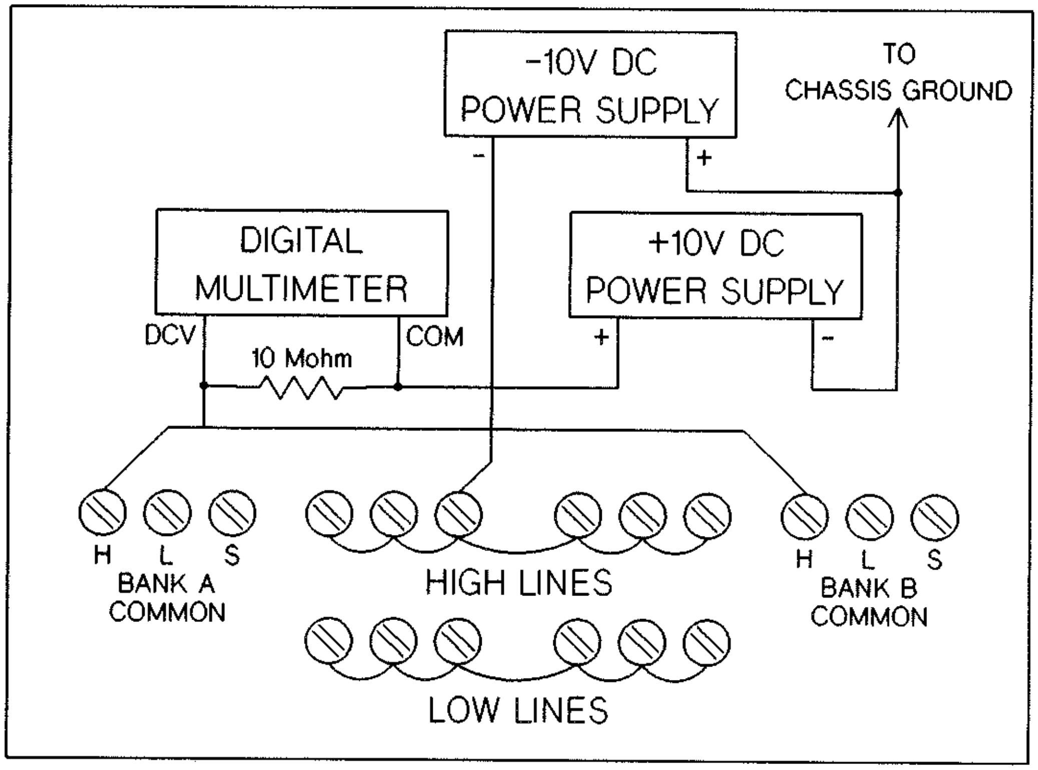


Figure 10-18 HP 44711A Open HIGH Channel Test Set-Up

2. Perform the Set-Up procedure in Section 10-23.

3. Set the negative power supply to 10 Vdc and connect the negative lead to the shorted HIGH lines on the test fixure. Connect the negative power supply common lead to the chassis.

NOTE

Connections to chassis ground can be accomplished by connecting to any sheet metal part. Chassis ground is also available at a connector on the rear panel of the HP 3852A power supply.

4. Set the positive power supply output to 10 Vdc and connect the positive lead to the multimeter common. Connect the positive power supply common to the chassis.

5. Connect the 10 Mohm resistor (**R1**) across the multimeter input terminals. Connect the multimeter DCV input terminal to the Bank A HIGH common test point. Short the Bank A and Bank B HIGH common test points together.

6. Open all switches on the multiplexer by executing:

   RESET ES00 (where E = extender number, S = slot number)

7. Close the isolation relay and a tree switch by executing:

   CLOSE ES90,ES94 (where E = extender number, S = slot number)

8. Observe the reading on the multimeter. This reading is referred to as **V1** in the following steps.

9. Calculate the leakage current (**I**) from the formula:

$$I = \frac{V1}{R1}$$

The calculated open channel leakage current for the HIGH lines should be less than 2 nA for a room temperature between 0° and 28° C (for temperatures in the range of 0° to 55° C the leakage current should be less than 11 nA).

10. Refer to Figure 10-19. Connect the negative power supply's negative lead to the shorted LOW lines on the test fixure. Connect the negative power supply common lead to the chassis.

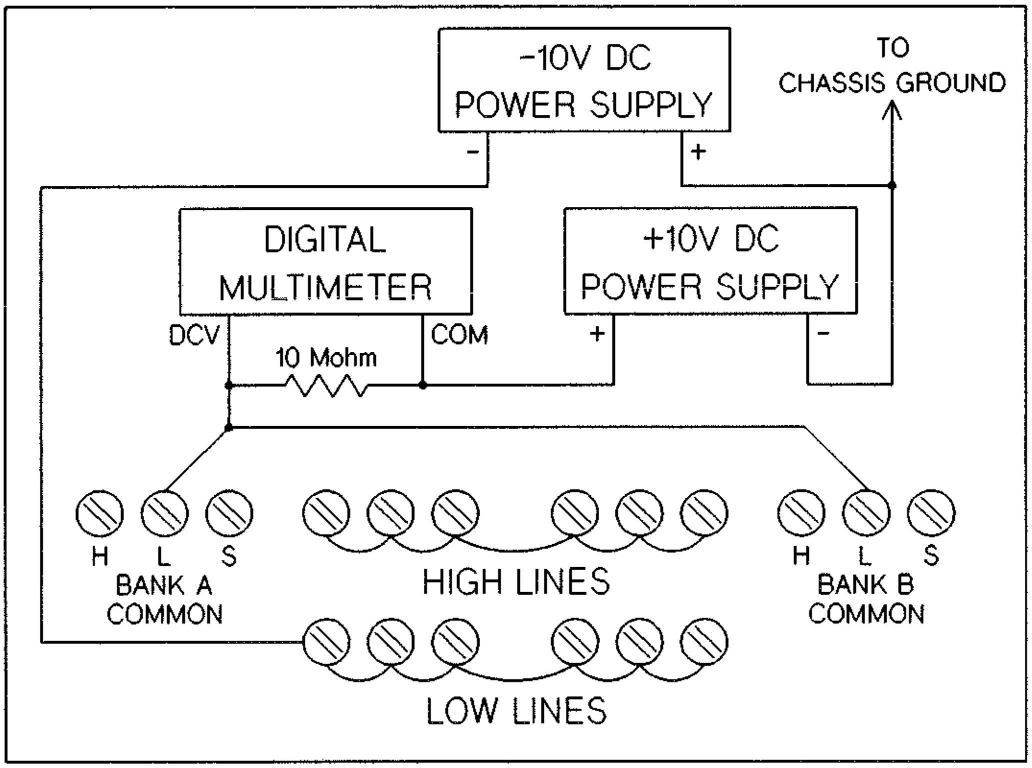


Figure 10-19 HP 44711A Open LOW Channel Test-Setup

11. Connect the multimeter DCV lead to the Bank A common LOW test point. Short the Bank A and Bank B LOW common test points together.

12. Observe the reading on the multimeter. This reading is referred to as **V1** in the following step.

13. Calculate the leakage current (**I**) from the formula:

$$I = \frac{V1}{R1}$$

The calculated open channel leakage current for the LOW lines should be less than 2 nA for a room temperature between 0° and 28° C (for temperatures in the range of 0° to 55° C the leakage current should be less than 11 nA).

14. CLOSED CHANNEL LEAKAGE/BIAS CURRENT TEST. This test checks each channel HIGH and LOW for leakage current when a channel is closed. A simplified schematic of the setup is shown in Figure 10-20 and the test setup for the HIGH lines is shown in Figure 10-21.

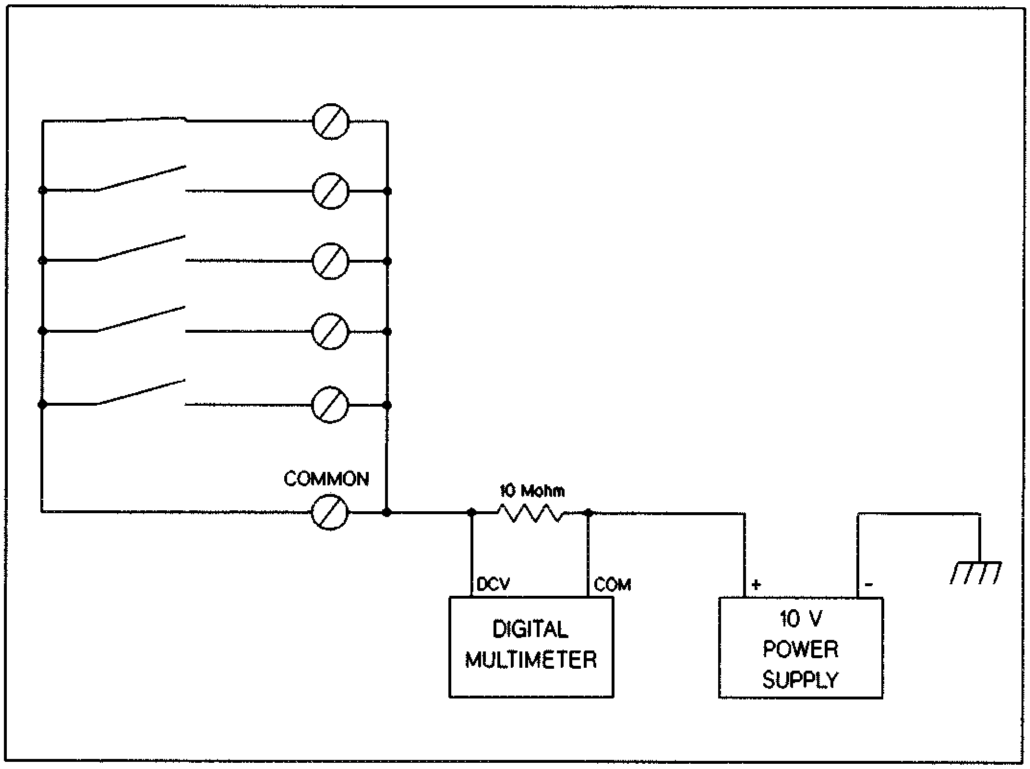


Figure 10-20 Closed Channel Leakage Test

15. Remove the negative power supply from the test fixture.

16. On the test fixture, connect the shorted HIGH lines to the Bank A HIGH common test point. Short the Bank A and Bank B common HIGH test points together.

17. Connect the +10 V power supply common to chassis ground. Connect the power supply positive lead to the common input of the multimeter.

18. Connect the 10 Mohm resistor across the multimeter input terminals. Connect the multimeter DCV input terminal to the shorted HIGH lines on the test fixture.

19. Close the isolation relay by executing:

CLOSE ES90 (where E = mainframe number, S = slot number)

20. Close the first channel in Bank A and the switch by executing:

CLOSE ES94,ES00 (where E = mainframe number, S = slot number)

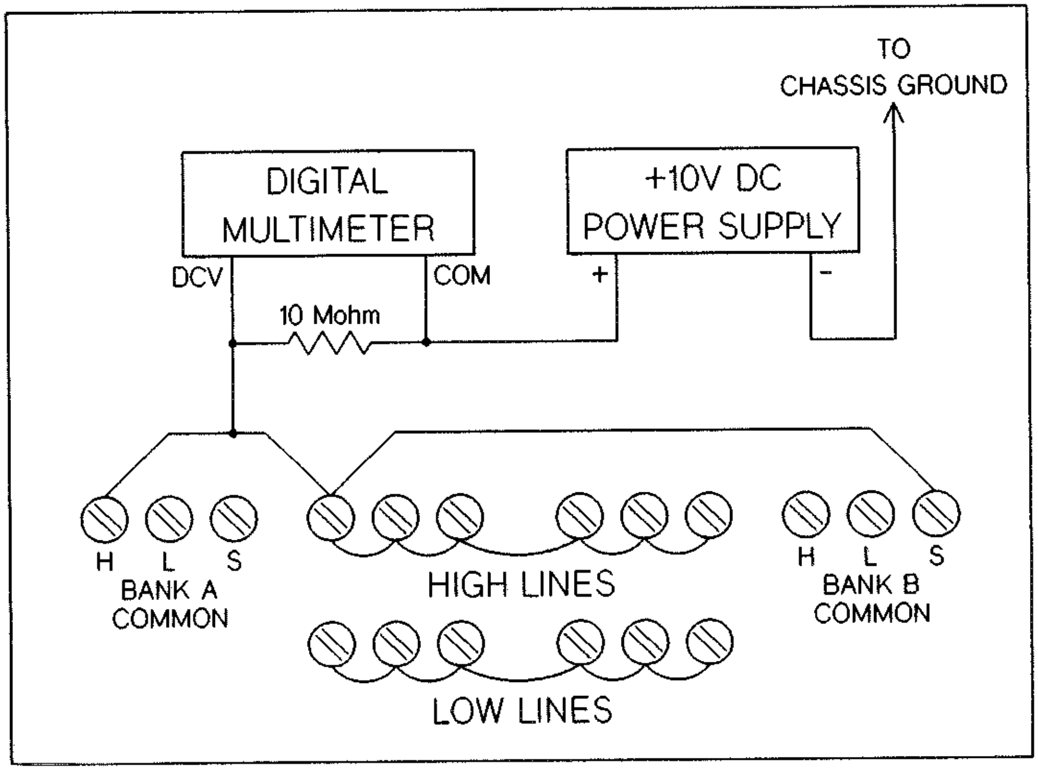


Figure 10-21 HP 44711A Closed HIGH Channel Test Set-Up

21. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

22. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

23. Repeat steps 24, 25, and 26 for channels 01 through 11. In step 21, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES94,ES01 for channel 01).

24. Close the first channel in Bank B and the tree switch by executing:

CLOSE ES94,ES12 (where E = mainframe number, S = slot number)

25. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

26. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

27. Repeat steps 24, 25, and 26 for channels 12 through 23. In step 24, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES92,ES11 for channel 11).

28. Refer to Figure 10-22. On the test fixture, connect the shorted LOW lines to the Bank A common LOW test point. Short the Bank A and Bank B LOW common test points together.

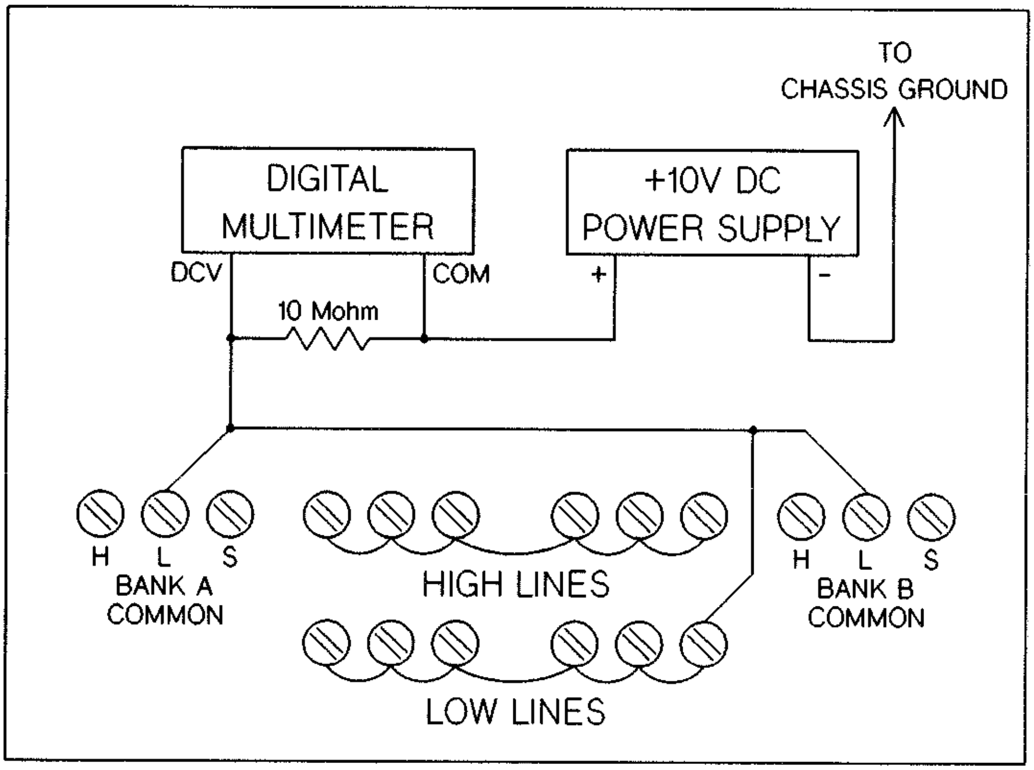


Figure 10-22 HP 44711A Closed LOW Channel Test Set-Up

29. Connect the multimeter DCV input terminal to the shorted LOW lines on the test fixture.

30. Close the first channel in Bank A and the tree switch by executing:

CLOSE ES94,ES00 (where E = mainframe number, S = slot number)

31. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

32. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

33. Repeat steps 30, 31, and 32 for channels 01 through 11. In step 30, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES94,ES01 for channel 01).

34. Close the first channel in Bank B and the associated tree switch by executing:

CLOSE ES94,ES10 (where E = mainframe number, S = slot number)

35. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

36. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

37. Repeat steps 34, 35, and 36 for channels 12 through 23. In step 34, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES94,ES12 for channel 12).

10-34 HP 44712A PERFORMANCE TESTS

10-35 Introduction

The following Performance Tests check the operation of the HP 44712A component module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this chapter provides a high confidence level that the FET Multiplexer is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in FET Multiplexer operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 10-36.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the FET Multiplexer is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

10-36 Operational Verification

The first tests given in this section are the minimum set of tests recommended for the FET Multiplexer. These tests are designed to test the functionality and the on resistance of the FET switches. A ribbon cable test is included to verify that the HP 44712A can communicate and transmit data over the ribbon cable to an HP 44702A/B. Successful completion of the Operational Verification Tests provides a 90% confidence level that the FET Multiplexer is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 10-40 - Set-Up Procedure
Section 10-40 - Channel Switches Test
Section 10-42 - Tree Switch and Isolation Relay Test
Section 10-43 - Ribbon Cable Test

10-37 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first four items in the list are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 10-38)

2. Digital Multimeter -- HP 3456A or equivalent

3. HP 44702A/B High-Speed Voltmeter (for Ribbon Cable Test only)

4. Test Leads and Jumpers

5. Service Module -- HP 44743A

6. Resistor -- 10 Mohm

7. Resistor -- 1 kohm

8. Oscilloscope -- HP 1740A or equivalent (dual trace with delayed sweep)

9. +10 V Power Supply -- HP 6234 or equivalent

10. -10 V Power Supply -- HP 6234 or equivalent

NOTE

Except for the Ribbon Cable Test (it requires the HP 44702A/B), either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for this test. This test does not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

10-38 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 10-23a. A test fixture can be manufactured using an HP 44712AT terminal module (see Figure 10-23b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44712AT terminal module, it is important that the terminal ID lines, shown in Figure 10-23a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The test fixture consists of a short circuit between all channel HIGH lines and test connections for the LOW line. The use of the test fixture minimizes the number of test lead connections required for the tests.

10-39 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

10-40 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the FET multiplexer. Disconnect the ribbon cable if it is connected to either an HP 44702A/B or another FET multiplexer. Install the test fixture on the multiplexer. Note the slot number where the multiplexer under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

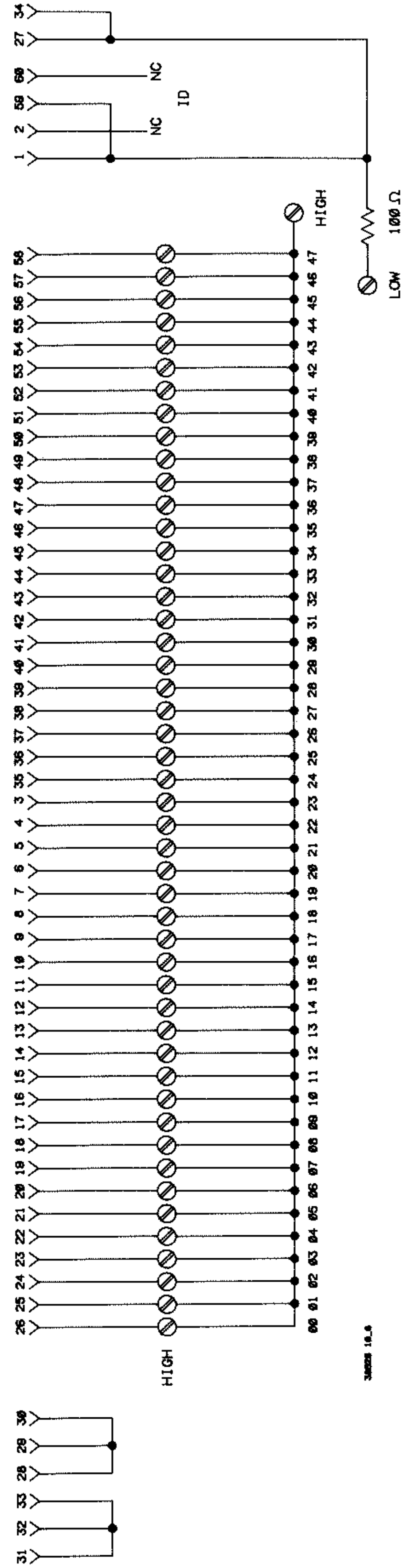


Figure 10-23a HP 44712A Test Fixure Schematic

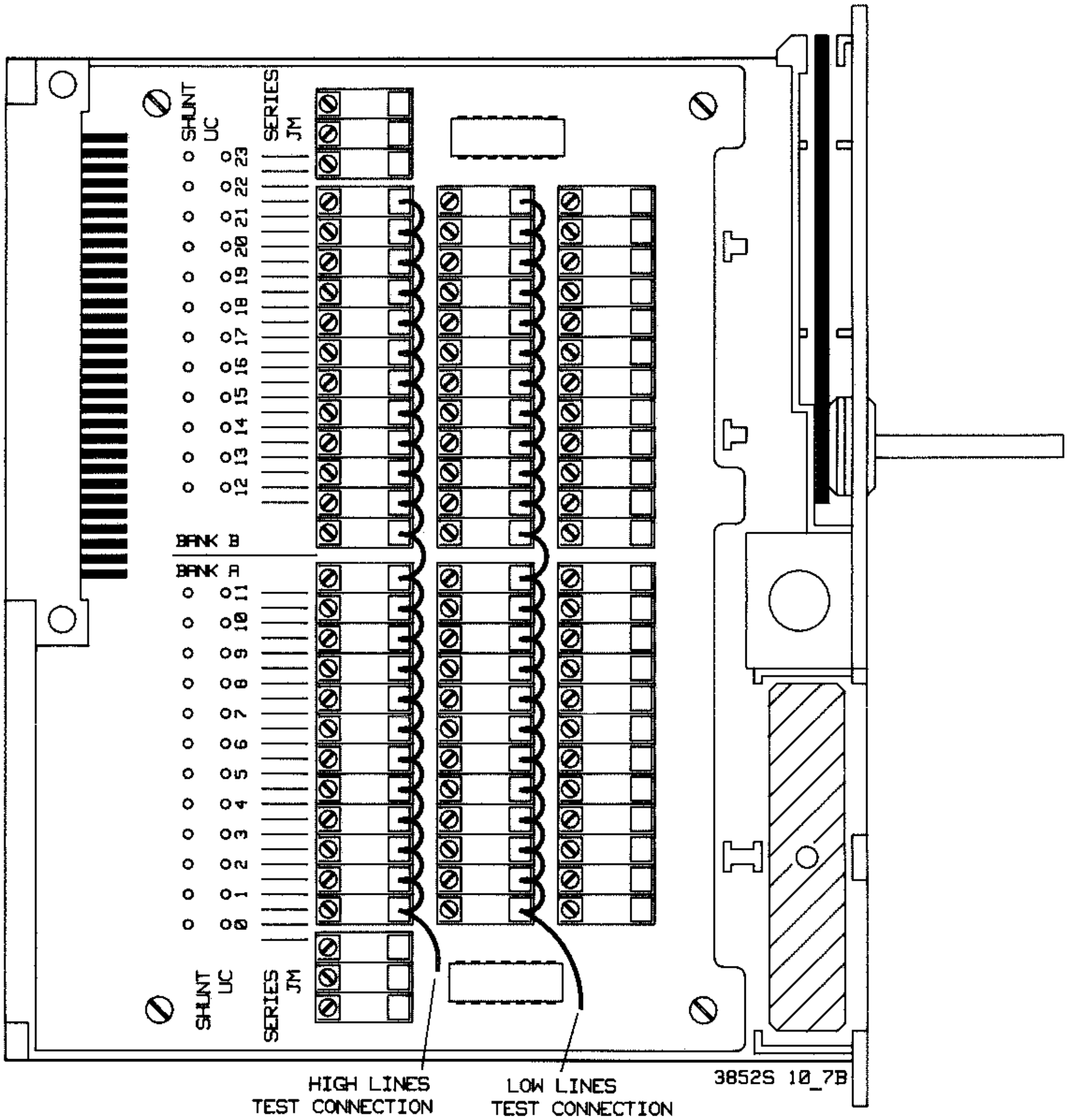


Figure 10-23b HP 44712A Test Fixure

c. Verify that the HP 3852A right display shows:

44712A

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

10-41 Channel and Sense Bus Tree Switches, and Isolation Relay Test

This test checks the measurement path from each channel input to the HP 3852A backplane analog sense bus.

1. Set the HP 44712A to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

This opens all switches on the HP 44712A.

2. Set the multimeter to measure two-wire ohms. Connect the multimeter DCV lead to the backplane analog bus sense HIGH line. Connect the multimeter COM lead to the backplane analog bus sense LOW line.

NOTE

The backplane analog bus can be tested in one of two ways: 1) By connecting an external multimeter to the analog bus connector on the rear panel of the power supply module as shown in Figure 10-24, or 2) By connecting an external multimeter to the backplane analog bus line jumpers provided on the 44743A service module as shown in Figure 10-25.

3. Connect a jumper between the shorted HIGH lines and the shorted LOW lines on the test fixure.

4. Close the first channel by executing:

CLOSE ES90,ES92,ES00 (where E = extender number, S = slot number)

5. Observe the reading on the multimeter. The multimeter should indicate <4.6 kohms resistance. If the reading is greater than 4.6 kohms, the channel FET switch or sense bus tree switch FET, or isolation relay may be faulty.

6. Open the channel by executing:

OPEN ES90,ES92,ES00 (where E = extender number, S = slot number)

7. Observe the reading on the multimeter. The multimeter should indicate greater than 100 Mohm.

8. Repeat steps 4, 5, 6, and 7 for channels 01 through 47. In the CLOSE and OPEN commands the last two digits indicate the channel number. For example, CLOSE ES01 closes channel 01 in extender E at slot S. Note that in steps 3 and 5 the isolation relays and tree FET switches are controlled by using channel numbers 90 and 92, respectively. These two channels must remain the same for all channels tested in this test.

10-42 Source Bus Tree Switches Test

This test checks the measurement path from the backplane analog source bus through the isolation relay and tree switches. Only two channels are used for the test since all channel switches should be tested by the previous test in Section 10-41.

1. Set the multimeter to measure two-wire ohms. Connect the multimeter DCV lead to the backplane analog bus source HIGH line. Connect the multimeter COM lead to the backplane analog bus source LOW line.

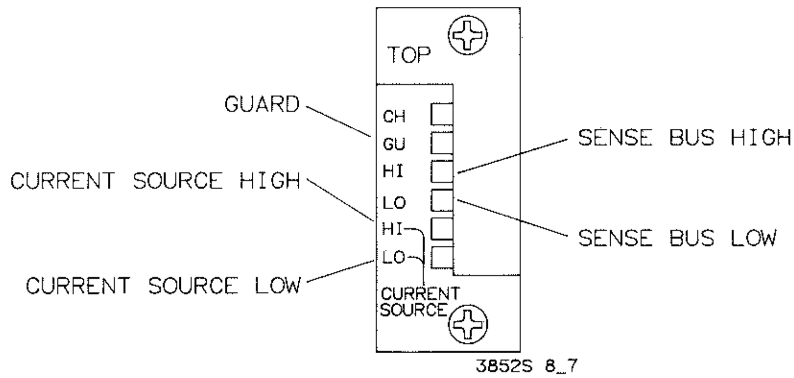


Figure 10-24 Analog Bus Connector

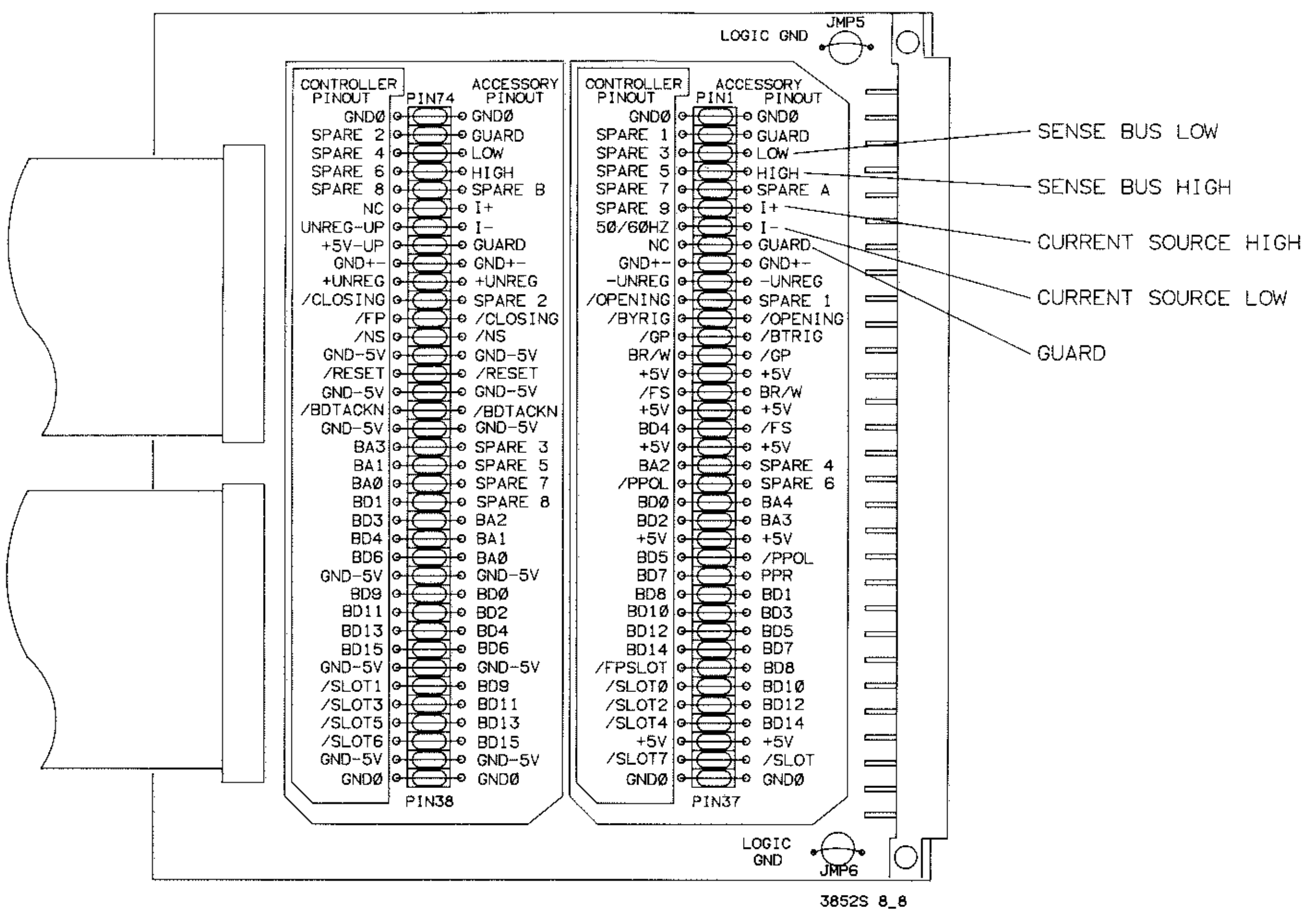


Figure 10-25 HP 44743A Service Module

2. Connect a jumper between the shorted HIGH lines and the shorted LOW lines on the test fixure.

3. Close the first channel by executing:

CLOSE ES90,ES91,ES00 (where E = extender number, S = slot number)

4. Observe the reading on the multimeter. The multimeter should indicate <4.6 kohms resistance. If the reading is greater than 4.6 kohms, the source bus tree switch FET may be faulty.

5. Open the channel by executing:

OPEN ES90,ES91,ES00 (where E = extender number, S = slot number)

6. Observe the reading on the multimeter. The multimeter should indicate greater than 100 Mohm.

7. Close channel 24 by executing:

CLOSE ES90,ES91,ES24 (where E = extender number, S = slot number)

8. Observe the reading on the multimeter. The multimeter should indicate <4.6 kohms resistance.

9. Open the channel by executing:

OPEN ES90,ES91,ES00 (where E= extender number, S= slot number)

10. Observe the reading on the multimeter. The multimeter should indicate greater than 100 Mohm.

10-43 Ribbon Cable Test

This test verifies that the FET multiplexer can be controlled by the HP 44702A/B High-Speed Voltmeter. It also verifies that measurement results can be transferred to the voltmeter over the ribbon cable.

1. Remove power from the HP 3852A.

2. Install the HP 44712A component module in the mainframe next to an HP 44702A/B. Connect the ribbon cable between the FET multiplexer and the HP 44702A/B. Note the slot number where the FET under test is installed and the slot number where the HP 44702A/B is installed.

3. Install the test fixture on the FET multiplexer.

4. Apply power to the HP 3852A.

5. Set up the tests by executing the following commands:

USE ES00 (where E = extender number, S = slot number for High Speed Voltmeter)
FASTDISP OFF
SCANMODE ON
TERM RIBBON

6. On the test fixture, connect a jumper between the shorted HIGH lines and the shorted LOW lines.

7. Enter, but do not execute, the following command:

CONFMEAS OHM ES00-ES23 (where E = extender number, S = FET mux. slot number)

8. When the command entered in step 7 is executed, the HP 44702A/B will perform a resistance measurement on all channels on the HP 44712A. With the FASTDISP OFF, each measurement will appear in the HP 3852A right display. The HP 3852A left display will indicate each channel as it is scanned. Observe the HP 3852A displays and press execute. The resistance indicated in the right display, for all channels, should be less than 4.6 kohms (the number in the display will be in exponential format). The resistance indicated includes the on-resistance of the channel FET switch, the on-resistance of the tree FET switch, and the resistance of the series protection resistor. The scan list can be repeated, if desired, by pressing the RECALL ENTRY key and then the ENTER key.

9. Remove the jumper from the test fixture.

10. Press the RECALL ENTRY key to retrieve the scan list command. Press the ENTER key and observe the displays. The resistance indicated in the HP 3852A right display should be infinite (the HP 44702A/B indicates an infinite resistance by the display: 1.000000E+38).

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44712A PERFORMANCE TESTS.

10-44 DC Offset Test

1. Perform the Set-Up Procedure given in Section 10-40. The DC Offset test set-up is shown in Figure 10-26.

2. Set the multimeter to measure DC volts, on a range with at least 10 µV resolution. Connect the multimeter DCV lead to the shorted HIGH lines of the test fixture. Connect the multimeter COM lead to the LOW lines of the test fixture.

3. Connect the 1 kohm resistor across the multimeter input leads.

NOTE

The offset voltage is specified with a resistance of 1 kohm or less. A smaller value resistor may be used for this test.

4. Close the first channel in the multiplexer by executing:

CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The voltage indicated should be less than 15 µV (0 to 28 °C) or less than 185 µV (28 to 55 °C). A failure of the DC Offset test indicates a failing channel FET switch.

6. Repeat steps 4 and 5 for channels 01 through 47. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 would close channel 01 in extender E at slot S).

10-45 Opening and Closing Time Set-Up Procedure

The Opening and Closing Time test verifies that the channel FETs will switch on and off and that the multiplexer can scan the channels at the specified speed.

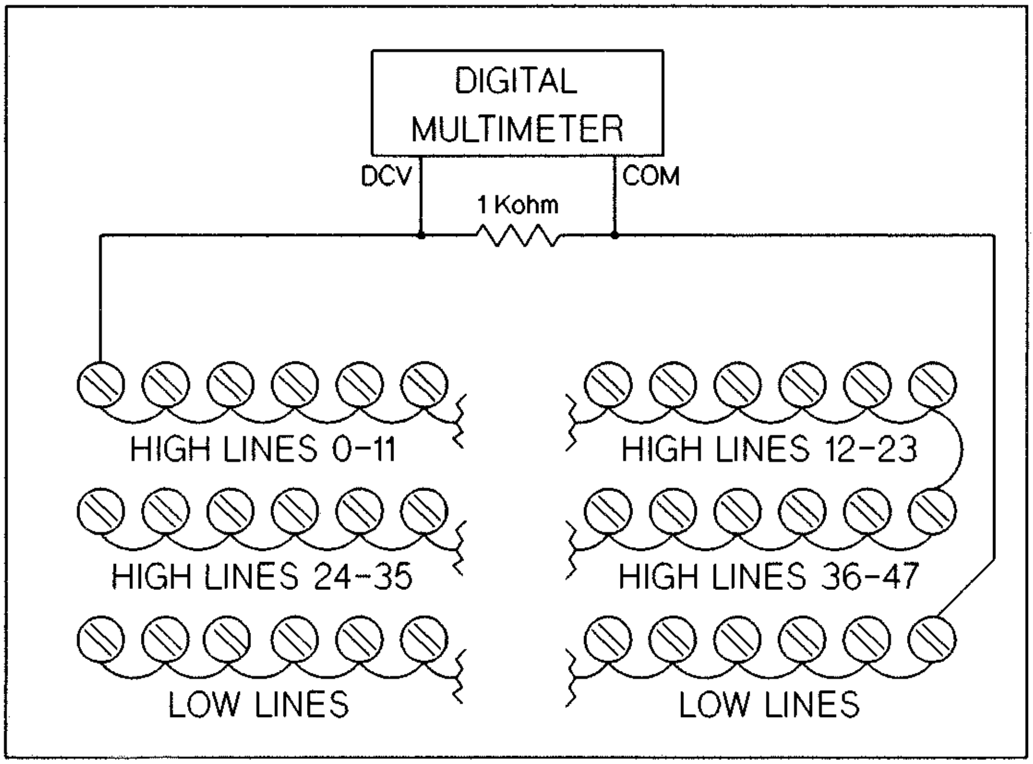


Figure 10-26 HP 44712A DC Offset Test Set-Up

1. Remove power from the HP 3852A and unplug the multiplexer to be tested. Install the Service Module in a convenient slot in the HP 3852A. Note the slot number where the Service Module is installed. Install the multiplexer on the service module. Install the test fixture on the multiplexer. The Set-Up Procedure is depicted in Figure 10-27.

2. On an oscilloscope, connect probes to the Channel A INPUT and the Channel B INPUT. Set up the oscilloscope to the following:

   Dual Trace
   Channel A -- DC, 0.2 Volts/Div (if using 10:1 probes)
   Channel B -- DC, 0.5 Volts/Div (if using 10:1 probes)
   Trigger -- Internal, triggered on Channel B
   Vertical Display -- Alternate
   Time -- 0.5 mses/Div
   Delayed Sweep -- 0.1 µsec/Div
   Delayed Sweep Dial -- Minimum

3. Connect the 1 kohm resistor between the analog bus sense HIGH connection and the +5 V connection on the service module.

4. Connect a jumper between the analog bus sense LOW connection and the logic ground test point on the service module.

5. Connect the shorted HIGH lines to the shorted LOW lines on the test fixure.

6. Connect the Channel A oscilloscope probe to the analog bus sense HIGH connection on the service module.

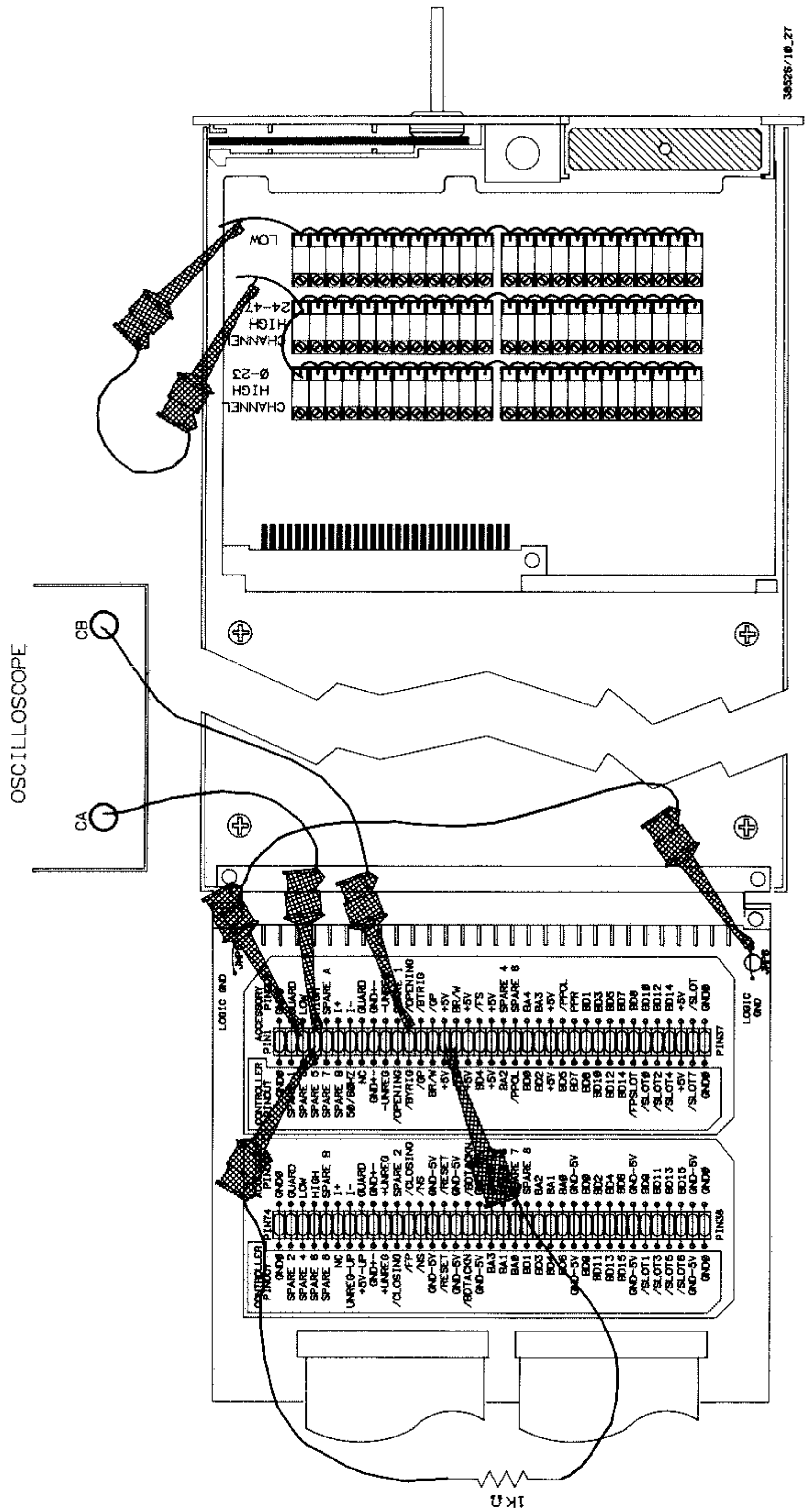


Figure 10-27 HP 44712A Opening Time Set-Up

7. Connect the Channel B oscilloscope probe to the OPENING test connection on the service module.

8. Apply power to the HP 3852A. Wait for the wake-up sequence to complete.

9. Set up the following subroutine in HP 3852A memory. When the first statement is entered the SUB ENTRY annunciator should be on in the left display. This annunciator should remain on until the SUBEND statement is entered.

```
SUB A
TRG
SCAN ES00-ES47   (where E = extender number, S = slot number)
SUBEND
```

The subroutine will scan all channels on the FET multiplexer. Do not reset or cycle power to the HP 3852A or the subroutine will be erased from memory. The front panel CLEAR key may be used without disturbing the subroutine.

10-46 Opening Time Test

This test checks the time it takes for the FET to open after receiving an OPENING pulse from the FET multiplexer.

1. Repetitively call the entered subroutine 10000 times by executing:

```
CALL A,10000
```

This statement will call the subroutine 10000 times.

2. Observe the waveform displayed on the Channel B trace and make sure all 48 channels are present. It may also be necessary to adjust the TRIGGER LEVEL and TRIGGER HOLD controls, and to select the negative trigger pulse position on the scope to synchronize the signal on the scope.

3. Rotate the DELAY SWEEP dial to the minimum position. Select the DELAYED sweep mode on the scope. Slowly rotate the DELAY SWEEP dial clockwise while observing the displayed waveforms. The Channel B waveform is the OPENING pulse. The Channel A waveform is the +5V supply as switched by the relays. As the DELAY SWEEP dial is rotated, each channel switch and the associated OPENING pulse will come into view. The FET opening time is the time from the falling edge of the OPENING pulse to the rising edge of the Channel A waveform. This time must be less than 1.2 µseconds. The opening time is illustrated in Figure 10-28.

Continue rotating the DELAY Sweep dial until all 48 FET channels have been checked. A failing channel indicates a failing FET switch.

To stop the test at any time, press the front panel CLEAR key. The test time may be extended by by increasing the number of times the subroutine is called, as specified in step 1.

The waveform will exhibit a small amount of jitter due to the overhead requirements of the HP 3852A operating system.

10-47 Closing Time Test

This test checks the time it takes for the FET to close after receiving a CLOSING pulse from the FET multiplexer.

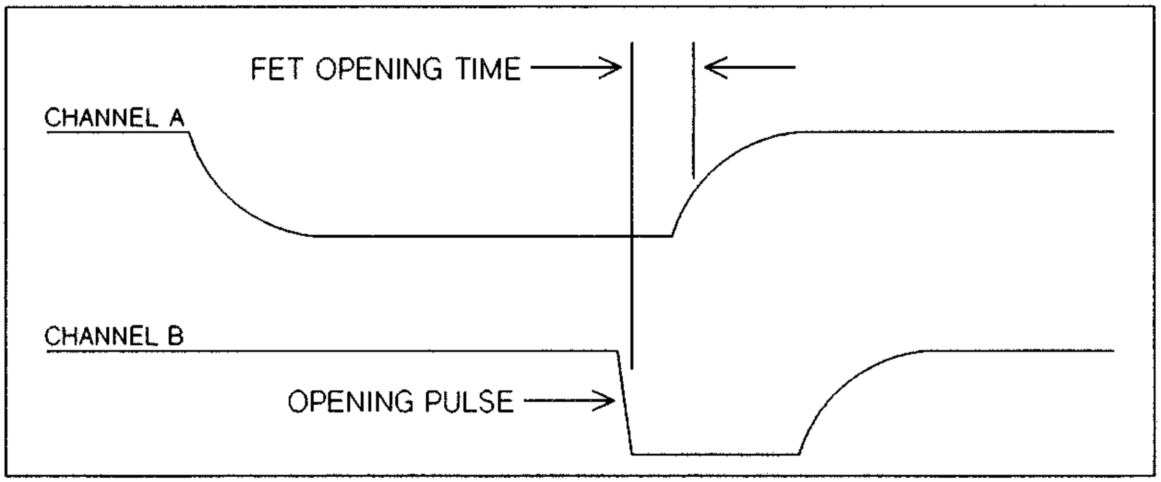


Figure 10-28 HP 44712A Opening Time

1. Move the channel B oscilloscope probe to the CLOSING connection on the service module. The Closing Time test set-up is shown in Figure 10-29.

2. Repetitively call the entered subroutine by executing:

    CALL A,10000

3. Rotate the DELAY SWEEP dial on the oscilloscope to the minimum position. Slowly rotate the dial clockwise until the first closing is displayed. The Channel B trace is the closing pulse output from the multiplexer. The Channel A waveform is the +5V supply, as switched by the FET channel switches. As the DELAY SWEEP dial is rotated, each channel switch and the associated CLOSING pulse will come into view. The FET closing time is the time from the falling edge of the CLOSING pulse to the falling edge of the Channel A waveform. This time must be less than 2.25 µseconds. The closing time is illustrated in Figure 10-30.

Continue rotating the DELAY Sweep dial until all 48 FET channels have been checked. A failing channel indicates a failing FET switch.

To stop the test at any time, press the front panel CLEAR key. The test time may be extended by by increasing the number of times the subroutine is called, as specified in step 2.

The waveform will exhibit a small amount of jitter due to the overhead requirements of the HP 3852A operating system.

10-48 Leakage/Bias Current Test

The leakage current test checks the FET switches for excessive leakage/bias current. Leakage/bias current is sourced by the multiplexer from HIGH or LOW to chassis ground.

1. OPEN CHANNELS LEAKAGE/BIAS CURRENT TEST. This test checks the leakage current with all channels open. A simplified schematic of the setup is shown in Figure 10-31 and the test setup is shown in Figure 10-32.

2. Perform the Set-Up procedure in Section 10-40.

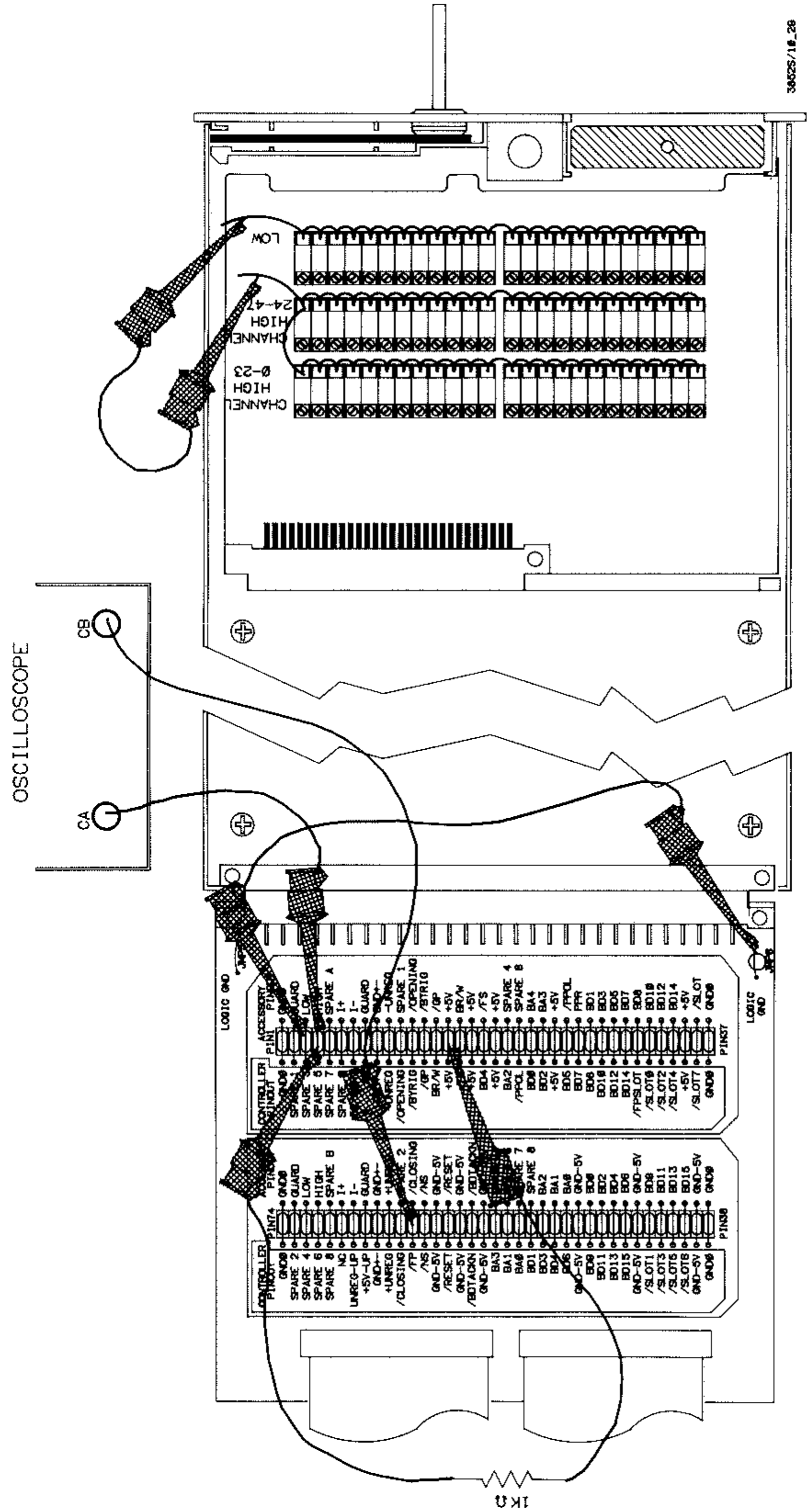


Figure 10-29 HP 44712A Closing Time Set-Up

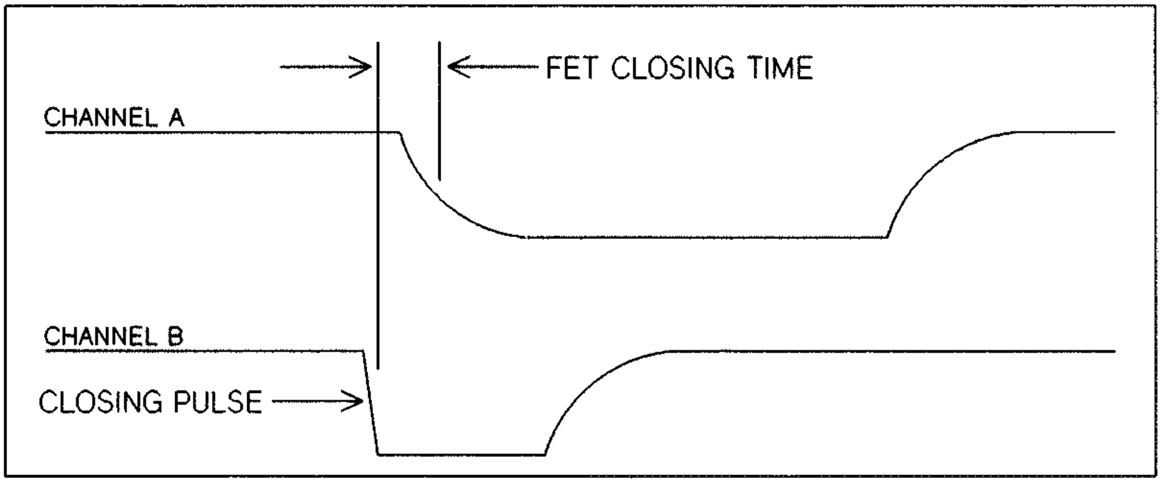


Figure 10-30 HP 44712A Closing Time

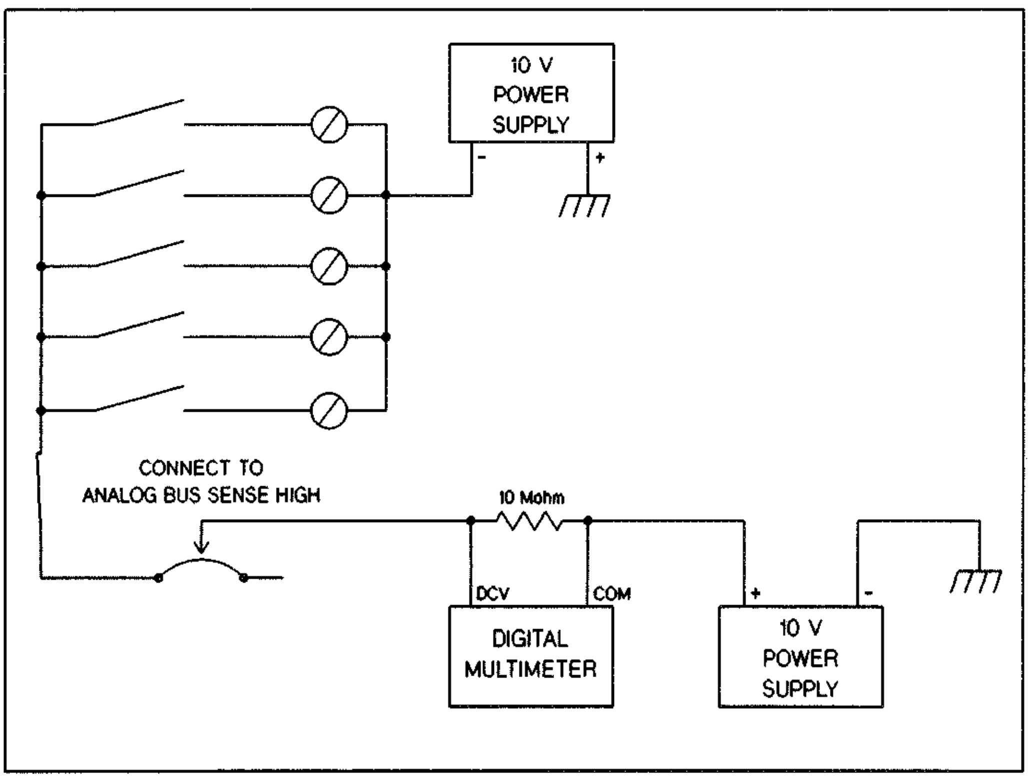


Figure 10-31 Open Channel Leakage Test

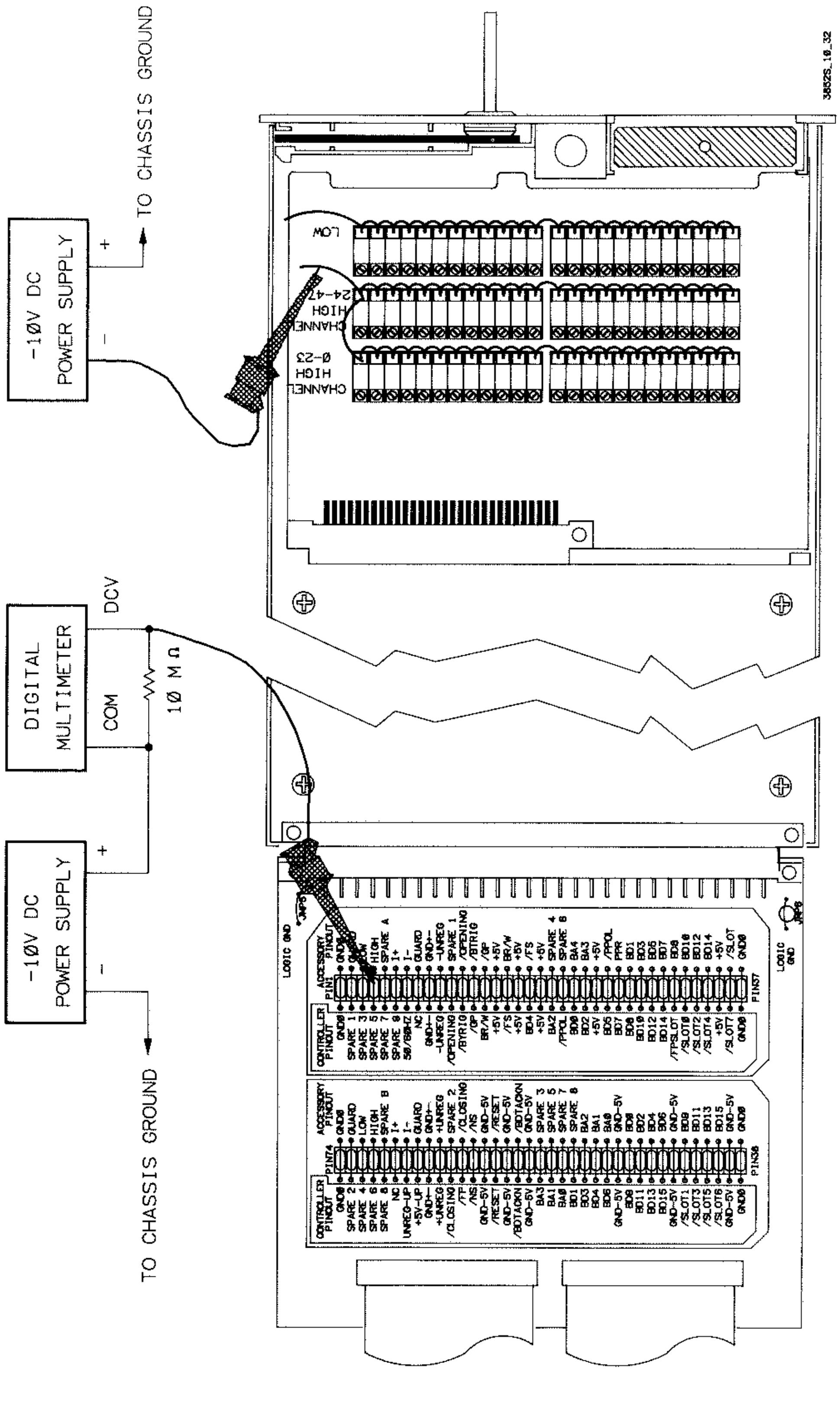


Figure 10-32 HP 44712A Open Channel Test Set-Up

3. Set the negative power supply output to 10 Vdc and connect the negative lead to the shorted HIGH lines on the test fixture. Connect the negative power supply common lead to the chassis.

NOTE

Connections to chassis ground can be accomplished by connecting to any sheet metal part. Chassis ground is also available at a connector on the rear panel of the HP 3852A power supply.

4. Set the positive power supply output to 10 Vdc and connect the positive lead to the multimeter common. Connect the positive power supply common to the chassis.

5. Connect the 10 Mohm resistor (**R1**) across the multimeter input terminals. Connect the multimeter DCV input terminal to the analog bus sense HIGH connection on the service module.

6. Open all switches on the multiplexer by executing:

RESET ES00 (where E = extender number, S = slot number)

7. Close the isolation relay and tree switches by executing:

CLOSE ES90,ES94 (where E = extender number, S = slot number)

8. Observe the reading on the multimeter. This reading is referred to as **V1** in the following steps.

9. Calculate the leakage current (**I**) from the formula:

$$I = \frac{V1}{R1}$$

The calculated open channel leakage current for the HIGH lines should be less than 2 nA for a room temperature between 0° and 28° C (for temperatures in the range of 0° to 55° C the leakage current should be less than 11 nA).

10. CLOSED CHANNEL LEAKAGE/BIAS CURRENT TEST. This test checks each channel HIGH lines for leakage current when a channel is closed. A simplified schematic of the setup is shown in Figure 10-31 and the test setup is shown in Figure 10-32.

11. Remove the negative power supply from the shorted HIGH lines on the test fixure.

12. Connect the shorted HIGH lines on the test fixure to the analog bus sense HIGH connection on the service module.

13. Connect the +10 V power supply common to chassis ground. Connect the power supply positive lead to the common lead of the multimeter.

14. Connect the 10 Mohm resistor across the multimeter input terminals. Connect the multimeter DCV input terminal to the shorted HIGH lines on the test fixture.

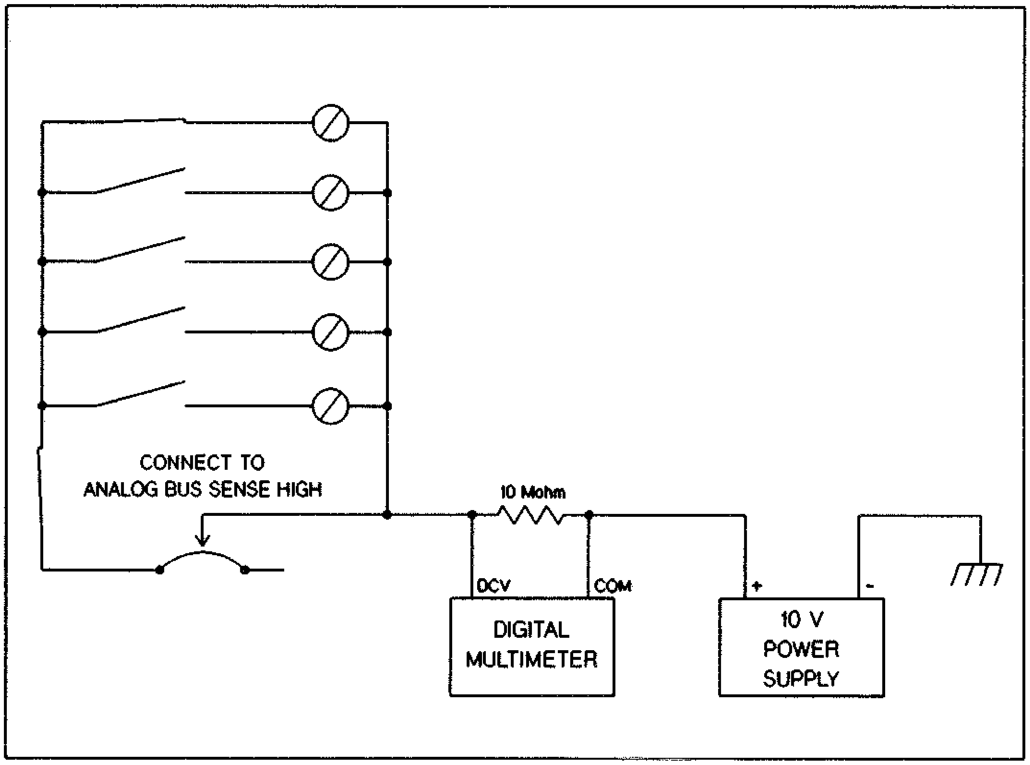


Figure 10-33 Closed Channel Leakage Test

15. Close the isolation relay by executing:

    CLOSE ES90 (where E = mainframe number, S = slot number)

16. Close the first channel in Bank A and the tree switches by executing:

    CLOSE ES94,ES00 (where E = mainframe number, S = slot number)

17. Observe the voltage reading on the multimeter. This voltage is referred to as **V1** in the following step.

18. Calculate the leakage current (I) from the formula:

$$I = \frac{V1}{R1}$$

The leakage current should be less than 5.0 nA for room temperatures in the range of 0° to 28° C (leakage current should be less than 15 nA for a temperature range of 28° to 55° C).

19. Repeat steps 16, 17, and 18 for channels 01 through 47. In step 16, the channel under test is specified in the second term of the CLOSE command (i.e., CLOSE ES94,ES01 for channel 01).

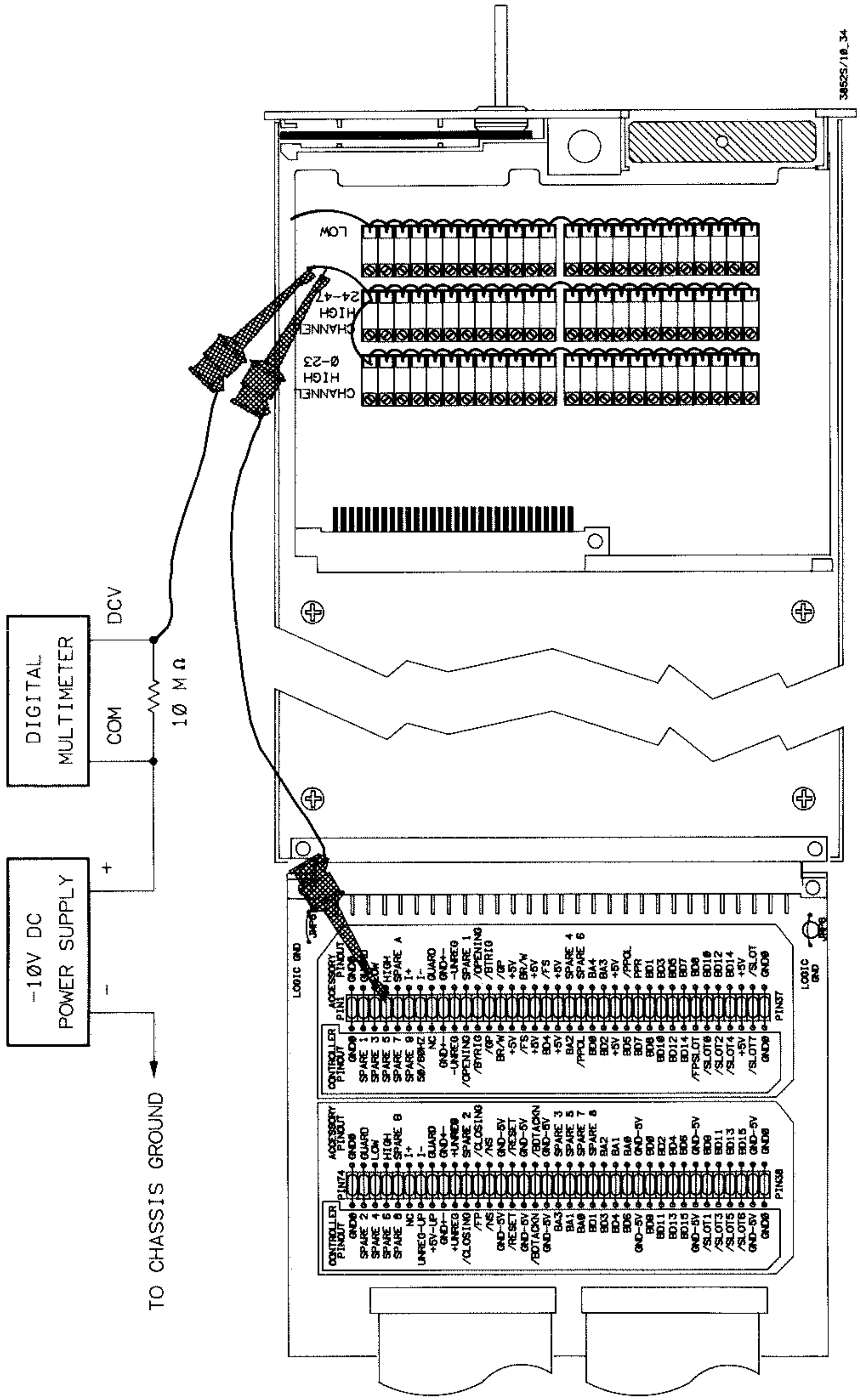


Figure 10-34 HP 44712A Closed Channel Test Set-Up

10-49 REPLACEABLE PARTS

Figure 10-35 shows the mechanical breakdown of the HP 44711A, HP 44712A and HP 44713A. The figure also provides assembly and disassembly information. The parts shown in Figure 10-35 are keyed to the parts lists in Table 10-9.

To order a part listed in Table 10-9, quote the Hewlett-Packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 10-9). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board for the FET multiplexers is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

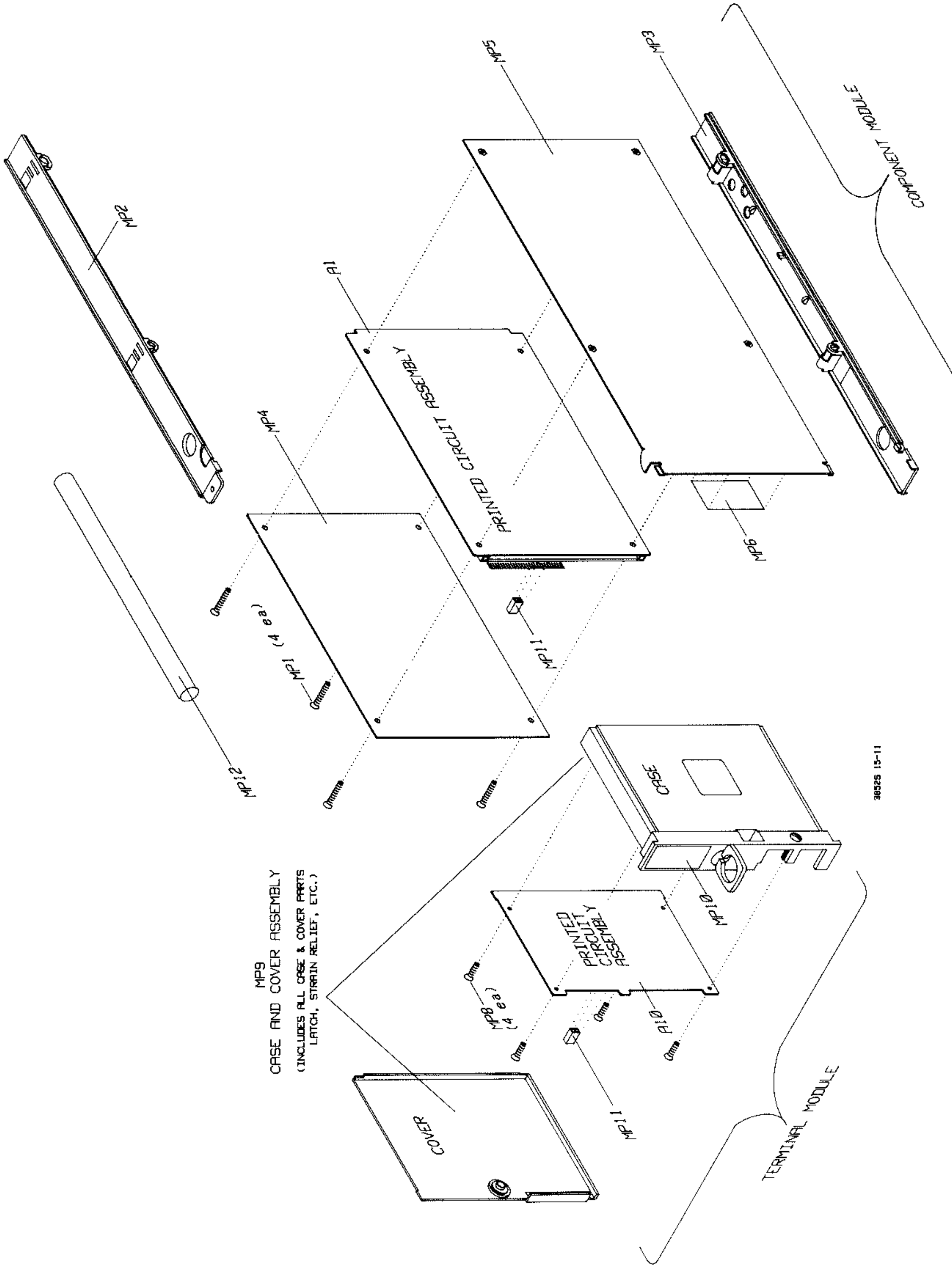


Figure 10-35 High Speed FET Multiplexer Exploded View

Table 10-9a HP 44711A 24 Channel High Speed FET Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44711A	Module; 24/48ch HS FET mux component	1	44711-66201	9	MOD-24/48CH FMUX
A1	PCA; 24/48 chan HS FET mux component	1	44711-66501	2	PCA-24/48CH FMUX
A10	PCA; 24 channel mux terminal	1	44711-66510	3	PCA-24CH GP TERM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (alum) w/ribbon-c access	1	44711-04101	8	0601 COV LEFT
MP5	Cover; right (alum) w/ribbn-c access	1	44711-04102	9	0601 COV RIGHT
MP6	Label; 44711/44712/44713 compont mod	1	44711-84320	1	LBL-I/O OPTIONS
MP7	Label; "STOP" internal cable warning	1	44711-84321	2	LBL-CAUTION-STOP
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84411	5	ASSY-TERM-SM OPN
MP10	Label; rear panel of term mod 44711A	1	44711-84325	6	LBL-ID,TERM ASSY

Completely assembled HP 44711A terminal modules can be ordered from your local HP Office by ordering Number 44711AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44711A	Module; 24/48ch HS FET mux component		44711-69201	5	RBLT-44711-66201

Table 10-9b HP 44712A 48 Channel High Speed Single Ended FET Multiplexer

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44712A	Module; 24/48ch HS FET mux component	1	44711-66201	9	MOD-24/48CH FMUX
A1	PCA; 24/48 chan HS FET mux component	1	44711-66501	2	PCA-24/48CH FMUX
A10	PCA; 48 chan single-end mux terminal	1	44712-66510	4	PCA-48CH,SE TERM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (alum) w/ribbon-c access	1	44711-04101	8	0601 COV LEFT
MP5	Cover; right (alum) w/ribbn-c access	1	44711-04102	9	0601 COV RIGHT
MP6	Label; 44711/44712/44713 compont mod	1	44711-84320	1	LBL-I/O OPTIONS
MP7	Label; "STOP" internal cable warning	1	44711-84321	2	LBL-CAUTION-STOP
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84411	5	ASSY-TERM-SM OPN
MP10	Label; rear panel of term mod 44712A	1	44712-84325	7	LBL-ID,TERM ASSY

Completely assembled HP 44712A terminal modules can be ordered from your local HP Office by ordering Number 44712AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44712A	Module; 24/48ch HS FET mux component		44711-69201	5	RBLT-44711-66201

Table 10-9c HP 44713A 24 Channel High Speed FET Mux with Thermocouple Compensation

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44713A	Module; 24/48ch HS FET mux component	1	44711-66201	9	MOD-24/48CH FMUX
A1	PCA; 24/48 chan HS FET mux component	1	44711-66501	2	PCA-24/48CH FMUX
A10	PCA; 24 chan mux term w/TC reference	1	44713-66510	5	PCA-24CH TC COMP
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (alum) w/ribbon-c access	1	44711-04101	8	0601 COV LEFT
MP5	Cover; right (alum) w/ribbn-c access	1	44711-04102	9	0601 COV RIGHT
MP6	Label; 44711/44712/44713 compont mod	1	44711-84320	1	LBL-I/O OPTIONS
MP7	Label; "STOP" internal cable warning	1	44711-84321	2	LBL-CAUTION-STOP
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84411	5	ASSY-TERM-SM OPN
MP10	Label; rear panel of term mod 44713A	1	44713-84325	8	LBL-ID,TERM ASSY

Completetely assembled HP 44713A terminal modules can be ordered from your local HP Office by ordering Number 44713AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44713A	Module; 24/48ch HS FET mux component		44711-69201	5	RBLT-44711-66201

Chapter 11
HP 44715A 5-Channel Counter

CHAPTER 11

HP 44715A 5 CHANNEL COUNTER/TOTALIZER

CHAPTER 11
HP 44715A
5 CHANNEL COUNTER/TOTALIZER

11-1 INTRODUCTION

This chapter contains a technical description, performance test procedures, and a replaceable parts list for the HP 44715A 5 Channel Counter/Totalizer.

11-2 Technical Description

The HP 44715A is a twelve function counter/totalizer which can operate at frequencies of up to 200 kHz. It has five independent input channels, each of which can be isolated or referenced to ground. The non-isolated inputs can either be TTL levels or AC signals with amplitudes as low as 25 mV RMS.

Up to five independent inputs can be measured for frequency or totalized using the HP 44715A. The other functions require two input channels per function. The reference timebase is generated internally in the counter, and is stable to 0.01% (100 ppm).

Figure 11-1 shows a simplified block diagram of the HP 44715A. Only two of the five input channels are shown on the block diagram. Each channel has two input paths that can be individually selected by the source select circuitry. The isolated input path is opto-isolated. The non-isolated path has signal conditioning which can be selected for 5, 12, or 24 volts DC inputs. AC signals can also be measured using the non-isolated inputs. Amplitudes as low as 25 mV RMS can be measured at frequencies up to 10 kHz. AC signals with amplitudes as low as 50 mV RMS can be measured at frequencies up to 200 kHz. Provisions are also made on the board for an optional low-pass filter capacitor on each channel.

Transition selection is made for each of the five input channels after the source, isolated or non-isolated, has been selected. Transition selection allows the user to select whether the counter should respond to low to high transitions, or high to low transitions. An external trigger input is also provided.

The heart of the HP 44715A is an LSI chip used in conjunction with the on card microprocessor. These two chips handle all the signal routing and count acquisition and computation. Commands to the HP 44715A come from the HP 3852A mainframe via the backplane interface. The local controller in the HP 44715A interprets these commands, executes them, and returns data to the mainframe processor via the backplane interface.

The HP 44715A is a very powerful counter with an extensive command set. To learn more about the set up and use of the HP 44715A, refer to the HP 3852A Data Acquisition and Control Unit Plug-In Accessories Configuration and Programming Manual, Chapter 12.

11-3 SPECIFICATIONS

Specifications for the HP 44715A are given in Table 11-1. Specifications are the performance standards or limits against which the counter may be tested.

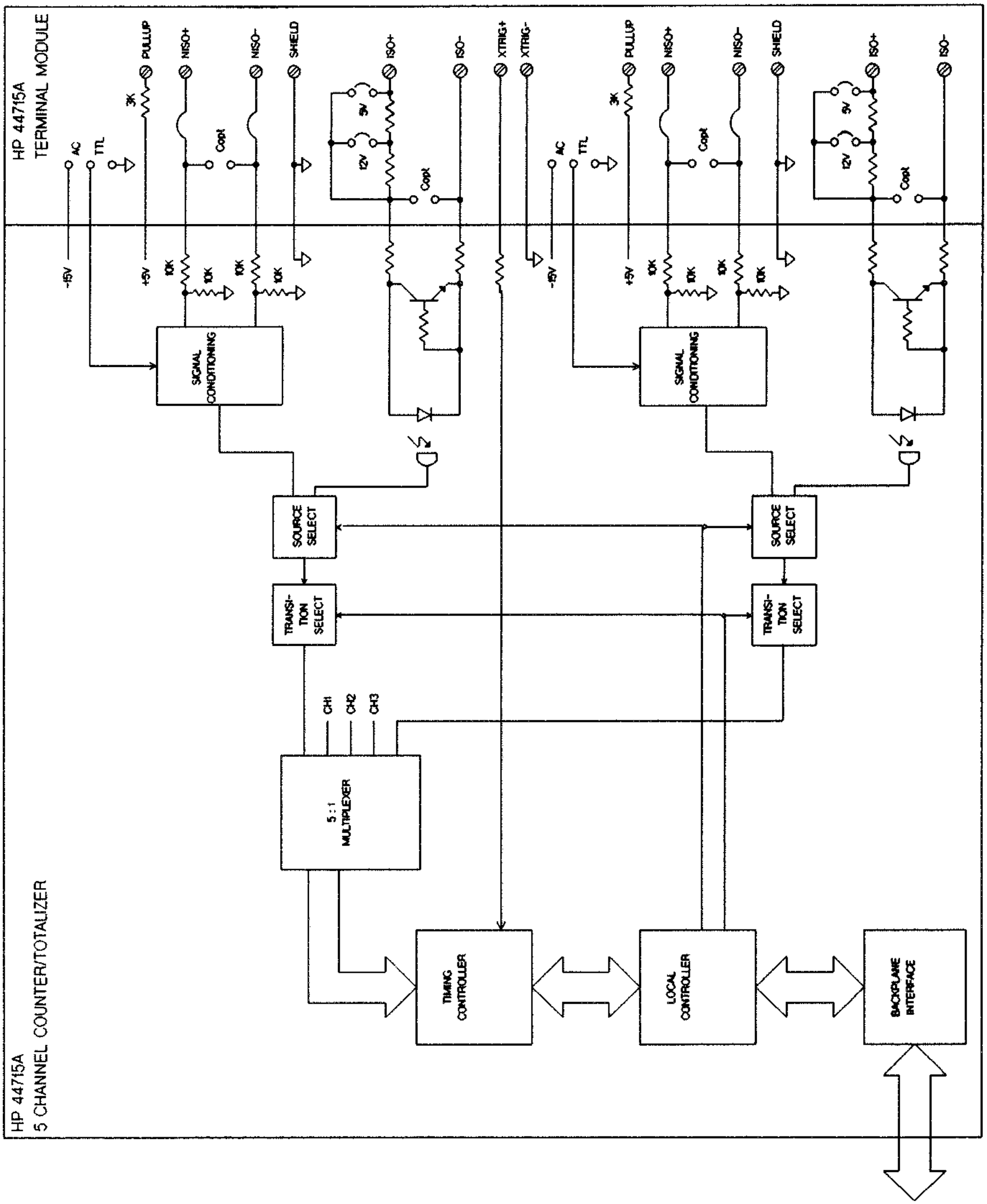


Figure 11-1 HP 44715A Simplified Block Diagram

Table 11-1 HP 44715A Specifications

Totalize and Totalize Modulo:

Counts number of transitions. Counting starts from zero to a programmable preset value (totalize only). Counting up to a programmable N limit (totalize modulo) or a count transition from -1 to 0 (totalize) can cause an interrupt if enabled. Normally one-channel functions, these functions use two channels when gating is desired.

Accuracy: ±1 count

Range: -2^{31} to $+2^{31} - 1$ (32 bits, 2's complement)

Range of Modulo N: 2 to 65,535

Up/Down (A-B) and Up/Down Count Modulo:

Counts A transitions and B transitions, starting from zero. Subtracts (A-B) when asked for reading. No interrupt is generated. Two-channel functions.

Accuracy: ±2 counts

Range: -2^{31} to $+2^{31} - 1$ (32 bits, 2's complement)

Range of Modulo N: 2 to 65,535

Count with Direction Control and Count Modulo with Direction Control:

Counter A increments or decrements according to level of B. No interrupt can overflow or underflow. B must hold its level for greater than 2 µsec before the count signal changes and greater than 1 µsec after the signal changes. Two-channel function.

Accuracy: ±1 count + # reversals/2

Range: -2^{31} to $+2^{31} - 1$ (32 bits, 2's complement)

Range of Modulo N: 2 to 65,535

Quadrature Count and Quadrature Count Modulo:

Similar to Count with Direction Control except **every** transition of A is counted according to level B as indicated above. Two-channel function.

Accuracy: ±1 count + # reversals/2

Range: -2^{31} to $+2^{31} - 1$ (32 bits, 2's complement)

Table 11-1 HP 44715A Specifications (Cont.)

Range of Modulo N: 2 to 65,535

Ratio Count (A/B):

Counts A transitions during N periods of B. The count is divided by N to get average number of A counts per B period. Two-channel function.

Accuracy: ±1/N count

Max Counts on A or B inputs: 65,535

Range of N or B Input: 1 to 65,535

Period:

Averages N periods of A. Minimum period for A is 5 µsec (maximum period is 655.35 seconds). Resolution of reading can be increased by increasing N. The timer base for each measurement is faster than the period (reciprocal counter). When selected, auto-ranging for the input period is independently determined for each input. Function requires two channel even though B is not used directly.

Accuracy:

±0.01% of reading ±1 count of resolution + trigger error, where trigger error = maximum time for input voltage to change from low to high or high to low.

Resolution:

	Time Base				
	1 µsec	10 µsec	100 µsec	1 msec	10 msec
Resolution	1/N µsec	10/N µsec	100/N µsec	1/N msec	10/N msec

Range of N: 1 to 65,535

Period After Delay:

Time for one period of A after N edges of A. Valid edges are gated by B. Measures the Nth gated period of A.

Accuracy:

±0.01% of reading ±1 count of resolution + trigger error, where trigger error = maximum time for input voltage to change from low to high or high to low.

Table 11-1 HP 44715A Specifications (Cont.)

Resolution:

	Time Base 1 µsec	10 µsec	100 µsec	1 msec	10 msec
Resolution	1/N µsec	10/N µsec	100/N µsec	1/N msec	10/N msec

Range of N: 1 to 65,535

Frequency:

Counts number of transitions over the time base. Provides average frequency. Time base adjusts from 10 msec to 1 sec. The time base (gate time) is the same for all channels, and frequency auto-ranging, when selected, is determined by the channel that has the highest frequency input. (The period function resolution is better than this function and hence more accurate for determining frequency.) One-channel function.

Accuracy:

±0.01% of reading ±1 count of resolution + trigger error, where trigger error = maximum time for input voltage to change from low to high or high to low.

Range/Resolution:

Gate Time	Range	Resolution
1 sec	1 Hz to 65,535 kHz	1 Hz
100 msec	10 Hz to 200 kHz	10 Hz
10 msec	100 Hz to 200 kHz	100 Hz

Minimum Pulse Width: 2.5 µsec

Minimum Period: **5.0** µsec

Operating Range:

Isolated:

Accessory Input		Nominal Voltage (Vdc) 5	12	24
Threshold Voltage (V):	Vlow(max)	1	1.2	1.5
	Vhigh(min)	4	10	16
Threshold Current (mA):	Ilow(max)	0.05	0.05	0.05
	Ihigh(min)	1.8	1.8	1.8

Non-Isolated:

For 5 V DC (TTL) nominal voltage,
Vlow(max) is 0.8 V
Vhigh(min) is 2.25 V

For RMS signals (zero-crossing detector is used),
25 mV RMS sensitivity (DC to 10 kHz)
50 mV RMS sensitivity (10 kHz to 200 kHz)

Maximum Input Voltage:

Isolated:

Between high and low terminals of each channel,
24 V DC (5 V, 12 V nominal voltage)
42 V DC (42 V nominal voltage)

Between any terminal and chassis (DC to 60 Hz),
170 V peak

Between channels (DC to 60 Hz),
340 V peak

Non-Isolated:

All inputs (rear and back-plane) are protected to 16 V peak. Input impedance, however, decreases above 12 V due to internal protection circuitry.

Noise Rejection:

Rejected common mode voltages are prevented from triggering false counts.

60 dB minimum effective common mode noise rejection with 1 kΩ in low lead (DC to 120 Hz).

Non-Isolated Input Resistance (balance differential input):

High to Low: 20 MΩ ±10%

High or Low to Chassis: 10 MΩ ±5%

Maximum Wire Size: 16 AWG

Pull-Up Connection:

Output Voltage: 4.7 V to 5.25 V DC

Maximum Output Current: 1.67 mA per pull-up connection

11-4 HP 44715A PERFORMANCE TESTS

11-5 Introduction

The following Performance Tests check the operation of the HP 44715A Component Module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this chapter provides a high confidence level that the Counter is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in Counter operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 11-6.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the Counter is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

11-6 Operational Verification

The first tests given in this section are the minimum set of tests recommended for the Counter. These tests are designed to test the input circuitry operation and the functionality of the counter. Successful completion of the Operational Verification Tests provides a 90% confidence level that the Counter is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 11-10 - Self-Test Procedure
Section 11-11 - Input Signal Conditioning Test

11-7 Equipment Required

The following test equipment is required to run the Performance Tests.

1. Test Fixture (as described in Section 11-8)

2. Test Leads

3. Function Generator -- HP Model 3325A

If the recommended function generator is not available, use one that is capable of meeting the following critical specifications and requirements.

a. Sinewave output with the following specifications:

   25 mV RMS (±0.2 dB) from 1 Hz to 10 kHz
   50 mV RMS (±0.6 dB) from 10 kHz to 200 kHz

b. Squarewave output with the following specification:

   0.8 V DC to 4.0 V DC (±1%) from 1 Hz to 200 kHz

c. Frequency accuracy within 0.001%

11-8 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 11-2a. A test fixture can be manufactured using an HP 44715AT terminal module (see Figure 11-2b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44715AT terminal module, it is important that the correct Card Configuration is selected, as shown in Figure 11-2a. For the Totalizer mode, connect pin 40 to pin 34 on the terminal module connector. For the Frequency mode, connect pin 40 to pin 35 on the terminal module connector.

The test fixture consists of a short circuit between all channel Isolated and Non-Isolated "+" lines and a short circuit between all channel Isolated and Non-Isolated "-" lines. The use of the test fixture minimizes the number of test lead connections required for the tests.

11-9 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

11-10 Self-Test Procedure

1. Apply power to the HP 3852A.

2. Press the RESET button on the HP 3852A front panel. Perform the HP 44715A 5 Channel Counter/Totalizer self-test by executing:

    TEST ES00 (where E = extender number, S = slot number)

3. The HP 3852A right display should show:

    SELF TEST OK

4. If the display shows a different message, or if the ERR annunciator is on, the HP 44715A may be failing its self test. Test the counter again by executing the command in step 2. If the counter still fails, repair of the unit may be necessary.

11-11 Input Signal Conditioning Tests

The following tests the Isolated Inputs and Non-Isolated Inputs of all channels, and the Trigger operation.

1. ISOLATED INPUTS. The following tests the Isolated Inputs of all channels.

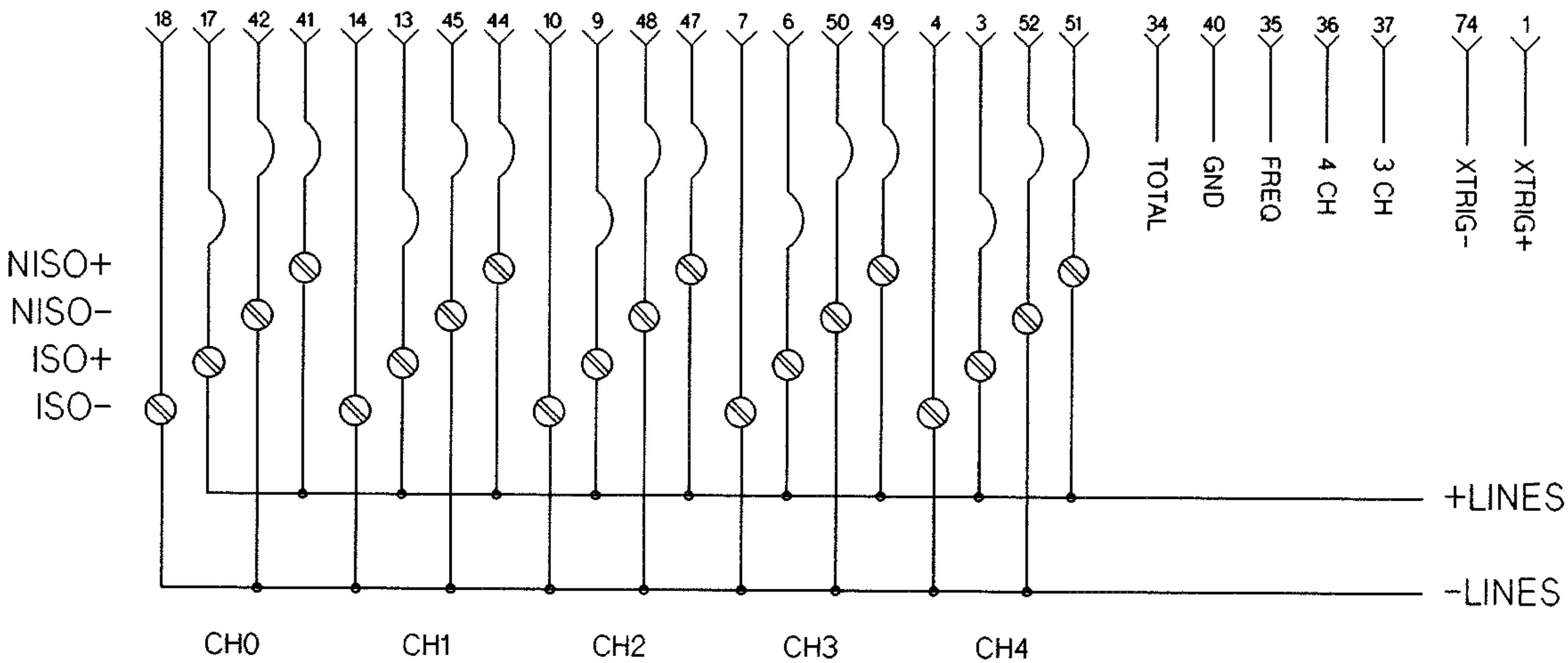


Figure 11-2a HP 44715A Test Fixure Schematic

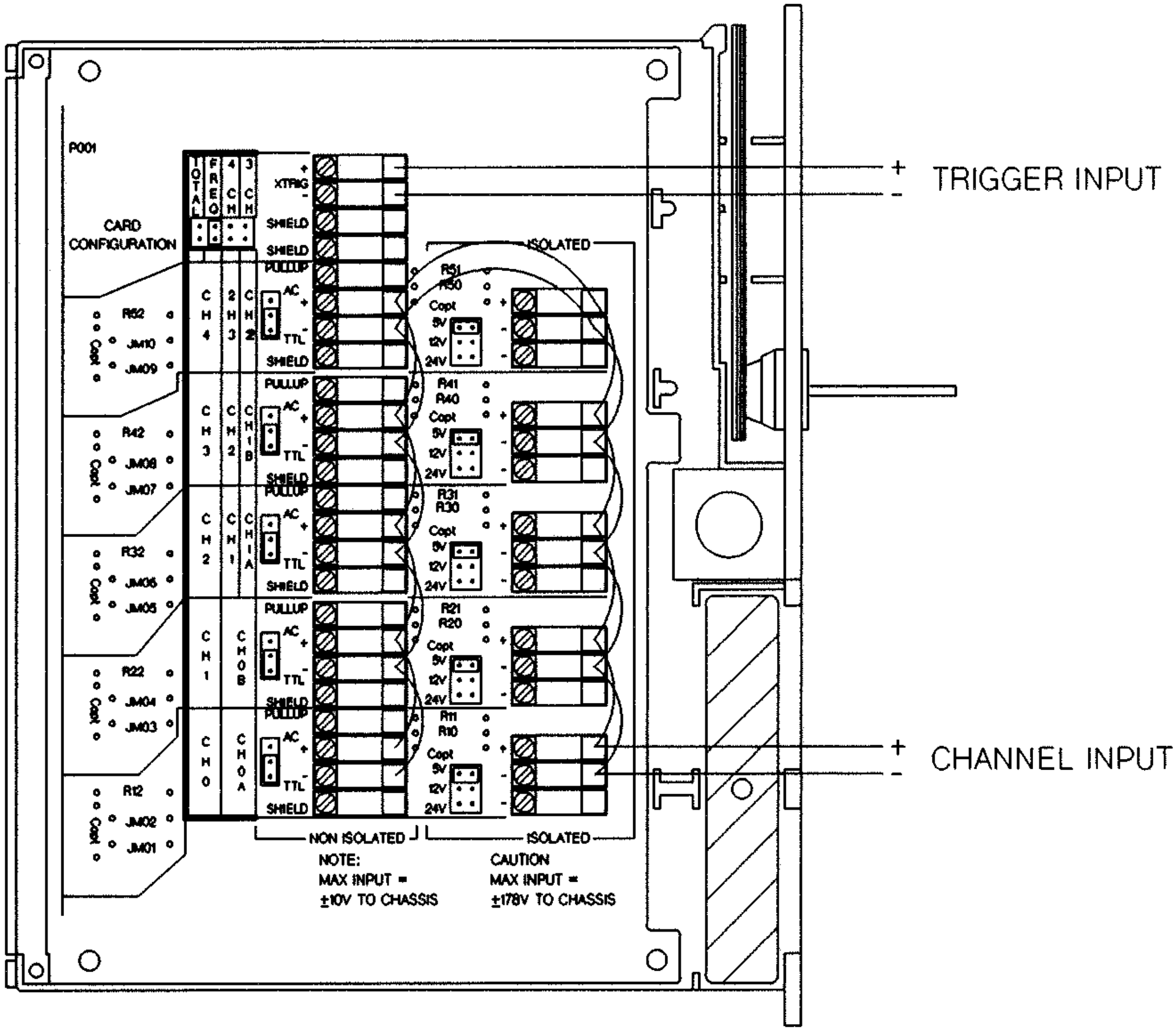


Figure 11-2b HP 44715A Test Fixure

2. Set the function generator to output a +1 V to +4 V peak-to-peak, 200 kHz square wave. The signal is represented in Figure 11-3. If using the recommended function generator, set it up as follows (a 50 Ω output impedance is assumed):

Function -- Square Wave
Frequency -- 200 kHz
Amplitude -- 3 V p-p
DC Offset -- 2.5 V

3. Connect the function generator to the shorted "+" and "-" inputs of the Isolated and Non-Isolated channels. The connections are shown in Figure 11-4.

4. Refer to Figure 11-4. Set the Isolated Input range jumpers to 5 V and set the Card Configuration jumper to FREQ.

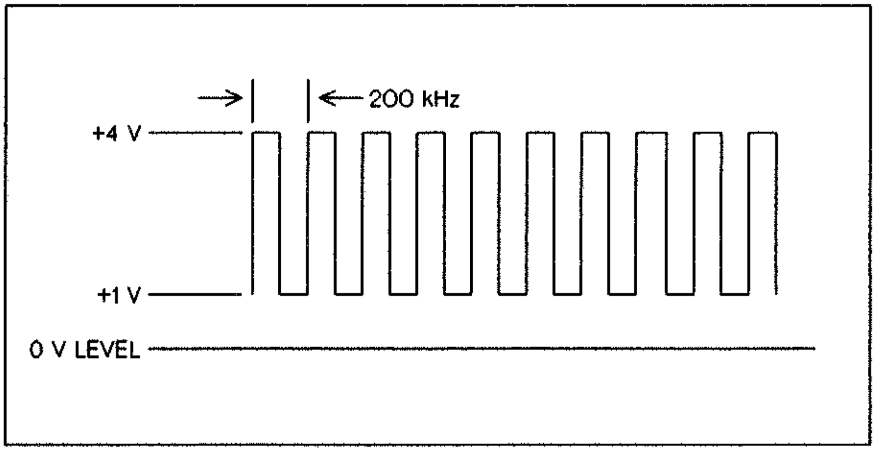


Figure 11-3 Isolated Input Test Signal

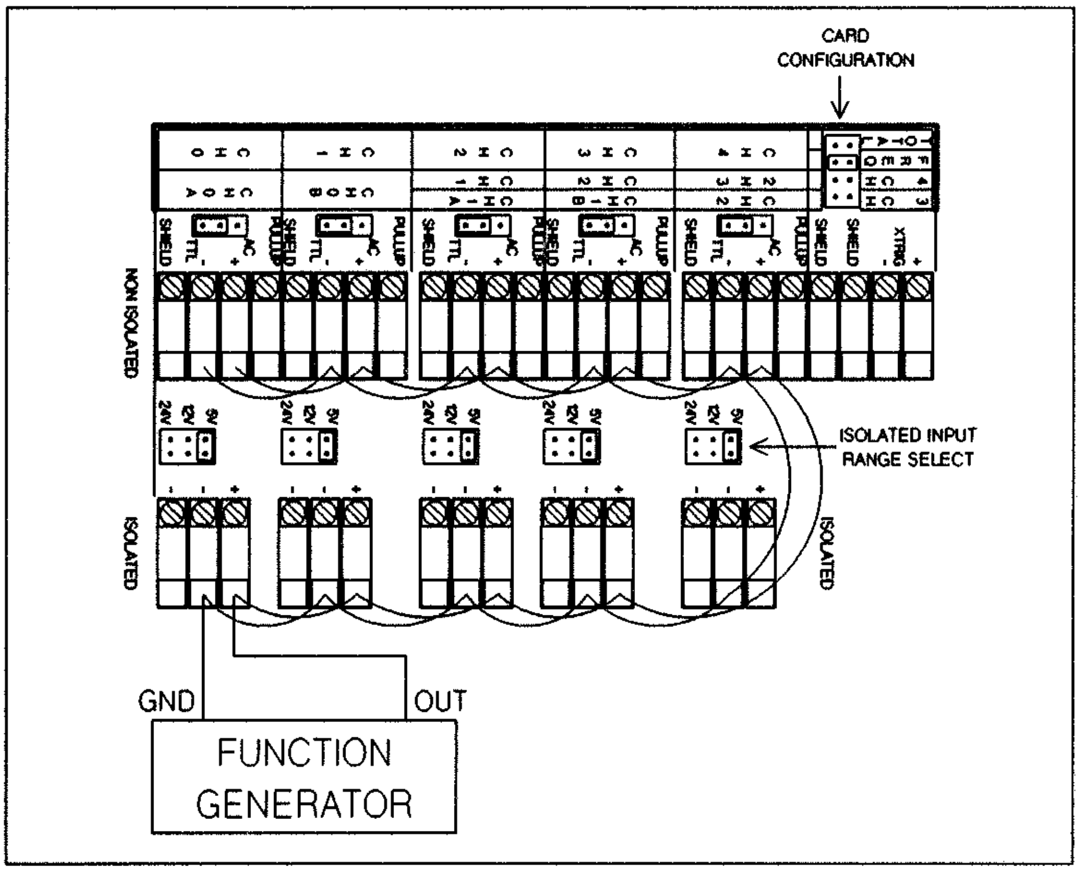


Figure 11-4 Isolated/Non-Isolated TTL Tests

5. Setup the HP 44715A by executing:

TRIG AUTO
TBASE 0.1

6. Setup channel 0 by executing:

USE ES00 (where E = extender number, S = slot number)
TERM ISO

7. Read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

8. Verify that the HP 3852A right display shows:

1.999880E+05 to 2.000120E+05

9. Repeat steps 6, 7, and 8 for channels 1, 2, 3, and 4. In the USE command in step 6 and the CHREAD command in step 7, the last two digits indicate the channel number. For example, USE ES02 and CHREAD ES02 would be for channel 2.

10. Leave the function generator connected for the next test.

11. NON-ISOLATED TTL INPUTS. The following tests the Non-Isolated Inputs of all channels in the TTL mode.

12. Set the Non-Isolated Input jumpers to TTL, as shown in Figure 11-4.

13. Set the function generator to output a +0.8 V to +2.25 V peak-to-peak, 200 kHz square wave. The signal is represented in Figure 11-5. If using the recommended function generator, set it up as follows (a 50 Ω output impedance is assumed):

Function -- Square Wave
Frequency -- 200 kHz
Amplitude -- 1.45 V p-p
DC Offset -- 1.525 V

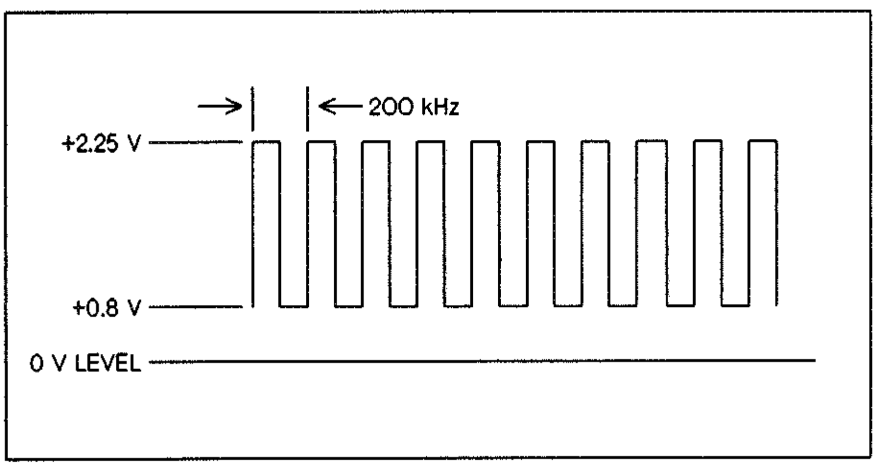


Figure 11-5 Non-Isolated TTL Input Test Signal

14. Setup channel 0 by executing:

USE ES00 (where E = extender number, S = slot number)
TERM NON

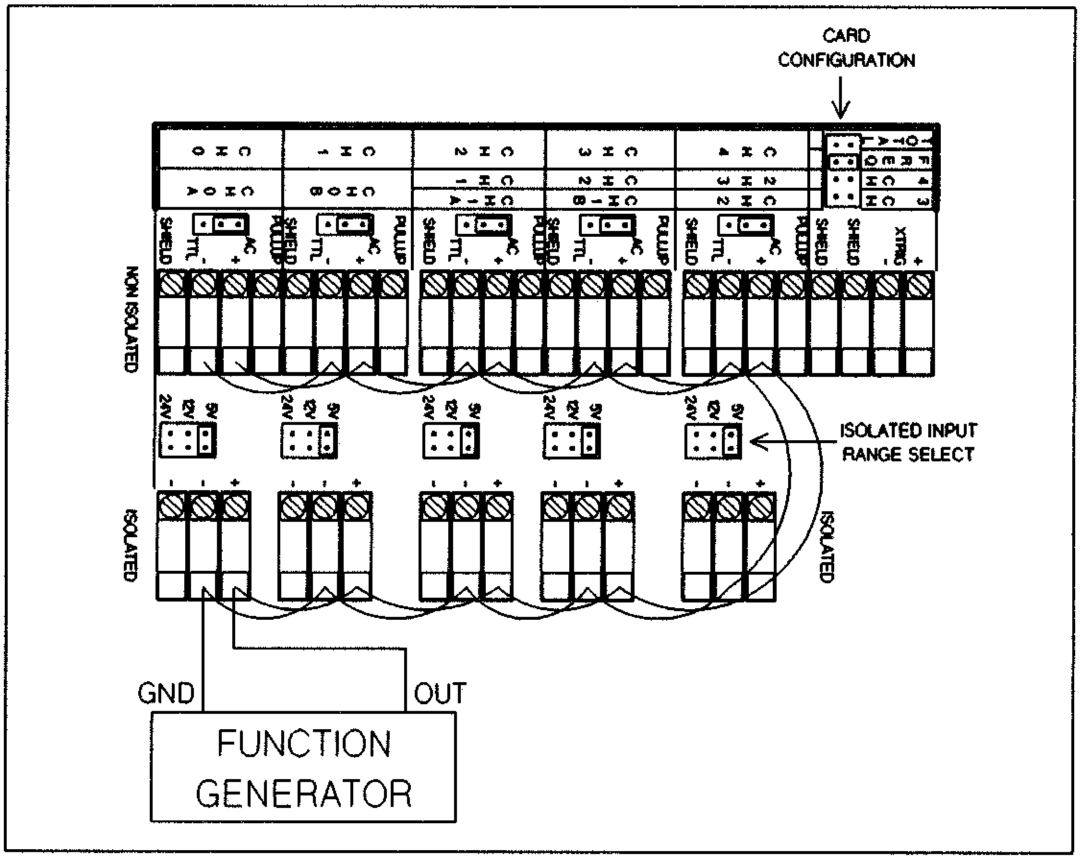


Figure 11-6 Non-Isolated AC Input Test

15. Read channel 0 by executing:

    CHREAD ES00 (where E = extender number, S = slot number)

16. Verify that the HP 3852A right display shows:

    1.999880E+05 to 2.000120E+05

17. Repeat steps 14, 15, and 16 for channels 1, 2, 3, and 4. In the USE command in step 14 and the CHREAD command in step 15, the last two digits indicate the channel number. For example, USE ES02 and CHREAD ES02 would be for channel 2.

18. Leave the function generator connected for the next test.

19. NON-ISOLATED AC INPUTS. The following tests the Non-Isolated Inputs of all channels in the AC input mode.

20. Set the Non-Isolated Input jumpers to AC, as shown in Figure 11-6.

21. Set the function generator to output a 50 mV RMS, 200 kHz sine wave (DC Offset to 0 V). If using the recommended function generator, set it up as follows (a 50Ω output impedance is assumed):

    Function -- Sine Wave
    Frequency -- 200 kHz
    Amplitude -- 50 mV RMS
    Offset -- 0 V

22. Setup the HP 44715A by executing:

TRIG AUTO
TBASE 0.1

23. Setup channel 0 by executing:

USE ES00 (where E = extender number, S = slot number)
TERM NON

24. Transfer 10000 readings from channel 0 by executing:

XRDGS ES00,10000 (where E = extender number, S = slot number)

25. Verify that the HP 3852A right display shows:

1.999880E+05 to 2.000120E+05

26. Change the function generator output to 25 mV RMS at 10 kHz.

27. Verify that the HP 3852A right display changes to:

1.001100E+04 to 9.989000E+03

28. Change the function generator output to 25 mV RMS at 100 Hz.

29. Verify that the HP 3852A right display changes to:

8.999000E+01 to 1.100100E+02

30. Press the HP 3852A front panel CLEAR key to stop transferring readings to the display.

31. Repeat steps 22 through 30 for channels 1, 2, 3, and 4. In the USE command in step 23 and the XRDGS command in step 24, the last two digits indicate the channel number. For example, USE ES02 and XRDGS ES02,10000 would be for channel 2.

32. Leave the function generator connected for the next test.

33. TRIGGER INPUT. The following tests the Trigger operation.

34. Change the function generator output to 25 mV RMS at 10 Hz.

35. Setup the HP 44715A by executing:

TRIG EXT
TBASE 1
CHREAD ES00 (where E = extender number, S = slot number)

36. Short the two wires connected to the trigger input, as shown in Figure 11-7.

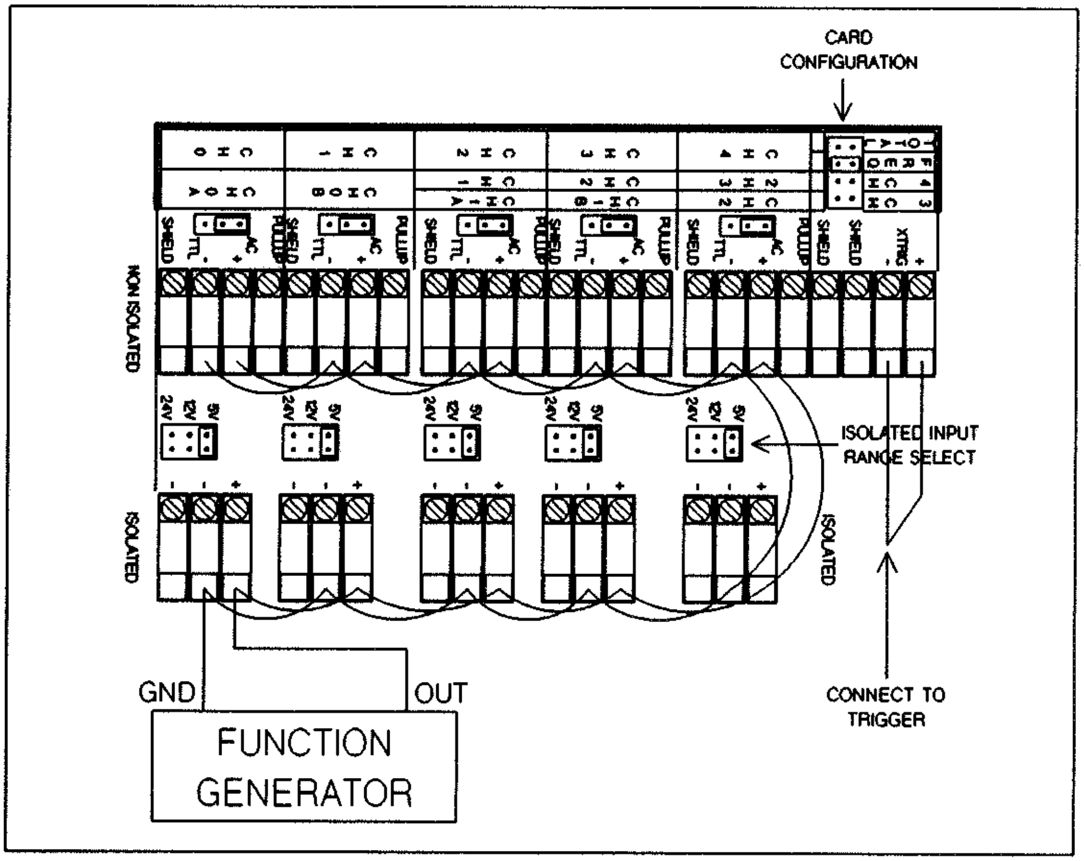


Figure 11-7 Trigger Input Test

37. After triggering the HP 44715A, the HP 3852A right display should be blank for approximately 1 second. Then the display should show:

8.999000E+00 to 1.100100E+01

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44715A PERFORMANCE TESTS.

11-12 Functional Tests

The following tests checks the Frequency, Totalize/Interrupt, Period, and Ratio functions of the Counter.

1. FREQUENCY TEST. The following tests the Frequency function.

2. Set the function generator to output a 25 mV RMS, 10 kHz sine wave. If using the recommended function generator, set it up as follows (a 50 Ω output impedance is assumed):

Function -- Sine Wave
Frequency -- 10 kHz
Amplitude -- 25 mV RMS
DC Offset -- 0 V

3. Connect the function generator to the shorted "+" and "-" inputs of the Isolated and Non-Isolated channels. The connections are shown in Figure 11-8.

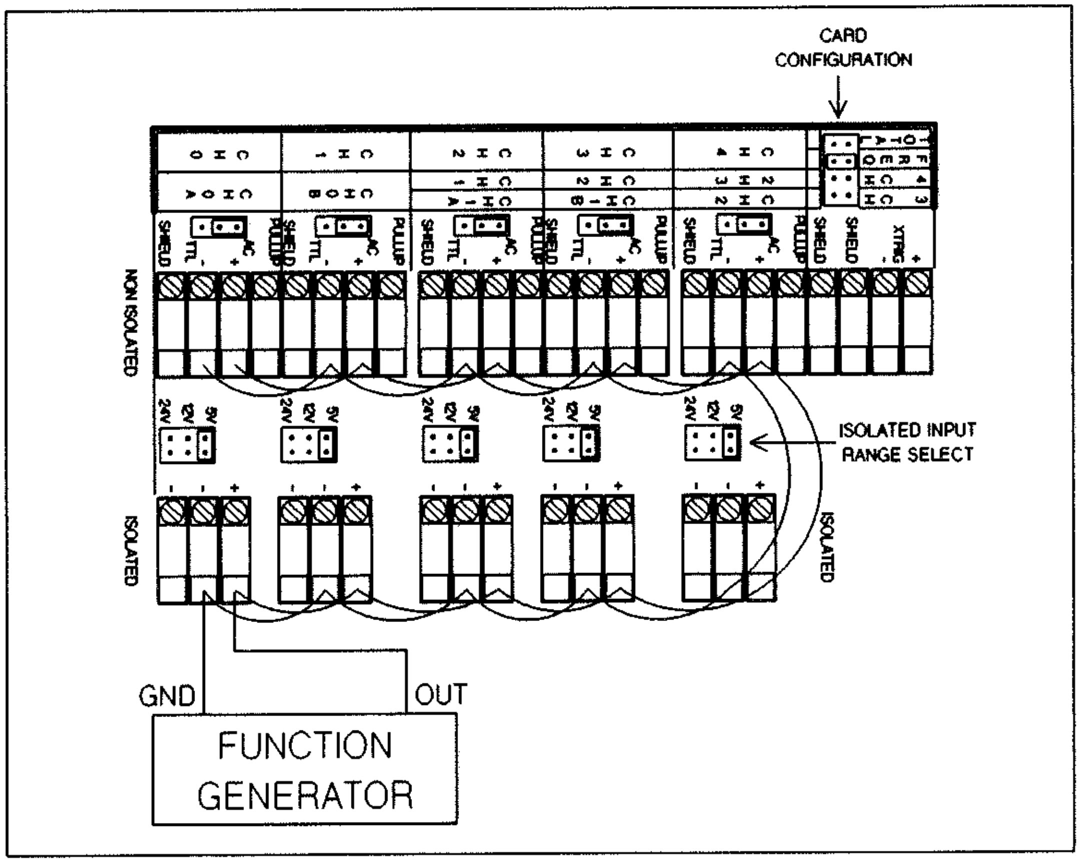


Figure 11-8 Frequency Test

4. Refer to Figure 11-8. Set the Non-Isolated Input jumpers to AC and set the Card Configuration jumper to FREQ.

5. Setup the HP 44715A by executing:

USE ES00 (where E = extender number, S = slot number)
TRIG AUTO
TERM NON

6. Set the counter time base to .01 by executing:

TBASE .01

7. Read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

8. Note the reading on the HP 3852A right display. Make sure it is within the specified limits in Table 11-2.

9. Repeat steps 6, 7, and 8 for time base 0.1 and 1.0. In the TBASE command in step 6, use TBASE 0.1 for time base 0.1, and TBASE 1 for time base 1.0.

10. Leave the function generator connected for the next test.

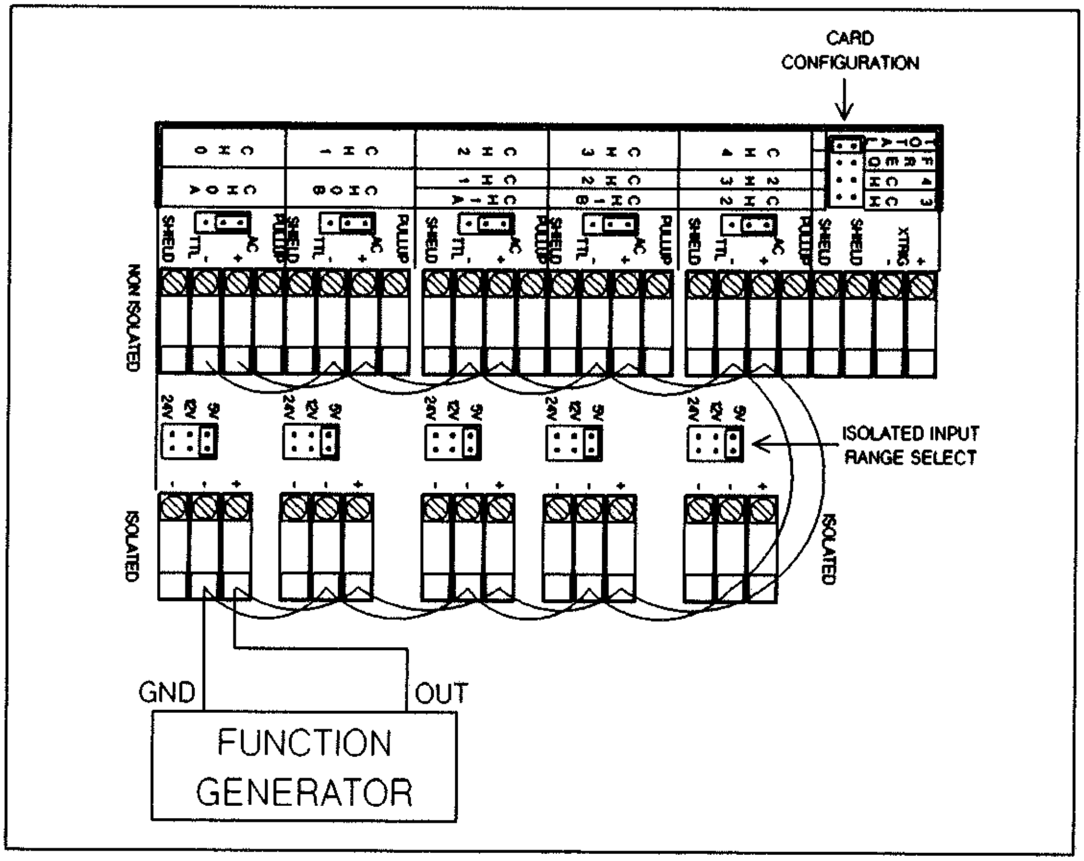


Figure 11-9 Totalize/Interrupt Tests

Table 11-2 Frequency Test limits

44715A Input	44715A Set-Up	44715A TBASE	Test Limits High	Low
10 kHz	FREQ	.01	1.010100E+04	9.899000E+03
10 kHz	FREQ	0.1	1.001100E+04	9.989000E+03
10 kHz	FREQ	1	1.000200E+04	9.998000E+03

11. TOTALIZE/INTERRUPT TEST. The following tests the Totalize/Interrupt functions.

12. Turn the function generator output off. If using other than the recommended function generator without an output switch, it may have to be disconnected from the counter accessory.

13. Set the function generator to output a 25 mV RMS, 1 Hz sine wave. If using the recommended function generator, set it up as follows (a 50 Ω output impedance is assumed):

Function -- Sine Wave
Frequency -- 1 Hz
Amplitude -- 25 mV RMS
DC Offset -- 0 V

14. Set the Card Configuration jumper to TOTAL, as shown in Figure 11-9.

15. Setup the HP 44715A by executing:

```
FUNC TOTAL
ENABLE INTR
CNTSET -10
```

16. Transfer 10000 readings from channel 0 by executing:

XRDGS ES00,10000 (where E = extender number, S = slot number)

17. Verify that the HP 3852A right display shows:

-1.000000E+01

18. Turn the function generator output on (or connect it to the counter accessory).

19. The reading in the display should increase towards zero, at a 1 Hz rate. When the reading changes from "-1.000000E+00" to "0.000000E+00", the interrupt annunciator in the HP 3852A right display should turn on.

20. Press the HP 3852A front panel CLEAR key to stop transferring readings to the display.

21. Re-configure the HP 44715A by executing:

FUNC TOTALM
NPER 8
XRDGS ES00,1000 (where E = extender number, S = slot number)

22. The reading in the display should increase from "0.000000E+00" to "7.000000E+00" at a 1 Hz rate. After the reading reaches "7.000000E+00" it should then change to "0.000000E+00".

23. Press the HP 3852A front panel CLEAR key to stop transferring readings to the display.

24. Leave the function generator connected for the next test.

25. PERIOD TEST. The following tests the Period function.

26. Set the function generator to output a 25 mV RMS, 200 Hz sine wave. If using the recommended function generator, set it up as follows (a 50 Ω output impedance is assumed):

Function -- Sine Wave
Frequency -- 200 Hz
Amplitude -- 25 mV RMS
DC Offset -- 0 V

27. Set the Card Configuration jumper to 3 CH, as shown in Figure 11-10.

28. Setup the HP 44715A by executing:

FUNC PER
TBASE .000001
NPER 1

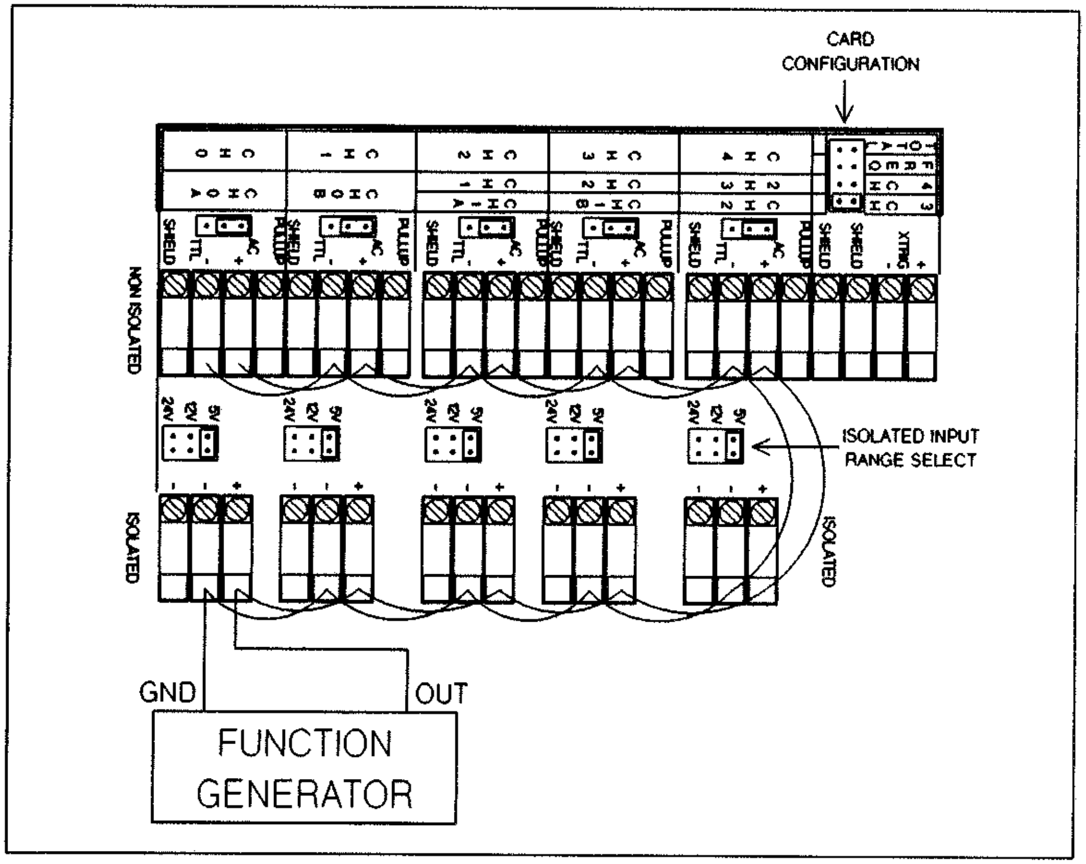


Figure 11-10 Period/Ratio Tests

29. read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

30. Note the reading on the HP 3852A right display. Make sure it is within the specified limits in Table 11-3. This reading is for a .000001 time base and 1 period counter configuration.

Table 11-3 Period Test limits

44715A Input	44715A NPER	44715A TBASE	Test Limits High	Low
200 Hz	1	.000001	5.001500E-03	4.998500E-03
200 Hz	1	.00001	5.010500E-03	4.989500E-03
200 Hz	10	.00001	5.001500E-03	4.998500E-03
200 Hz	100	.00001	5.000700E-03	4.999300E-03

31. Change the time base to .00001 by executing:

TBASE .00001

32. Read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

33. Note the reading on the HP 3852A right display. Make sure it is within the specified limits in Table 11-3. This reading is for a .00001 time base and 1 period counter configuration.

34. Change the period to 10 by executing:

NPER 10

35. read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

36. Note the reading on the HP 3852A right display. Make sure it is within the specified limits in Table 11-3. This reading is for a .00001 time base and 10 period counter configuration.

37. Change the period to 100 by executing:

NPER 100

38. read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

39. Note the reading on the HP 3852A right display. Make sure it is within the specified limits in Table 11-3. This reading is for a .00001 time base and 100 period counter configuration.

40. Leave the function generator connected for the next test.

41. RATIO TEST. The following tests the Ratio function.

42. Set the function generator to output a 50 mV RMS, 200 kHz sine wave. If using the recommended function generator, set it up as follows (a 50 Ω output impedance is assumed):

Function -- Sine Wave
Frequency -- 200 kHz
Amplitude -- 50 mV RMS
DC Offset -- 0 V

43. Setup the HP 44715A by executing:

FUNC RATIO
NPER 1000

44. read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

45. Verify that the HP 3852A right display shows:

1.000000E+00

11-13 REPLACEABLE PARTS

Figure 11-11 shows the mechanical breakdown of the HP 44715A. The figure also provides assembly and disassembly information. The parts shown in Figure 11-11 are keyed to the parts lists in Table 11-4.

To order a part listed in Table 11-4, quote the Hewlett-Packard part number, the quantity desired, the HP factory reference, and the check digit (abbreviated CD in Table 11-4). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

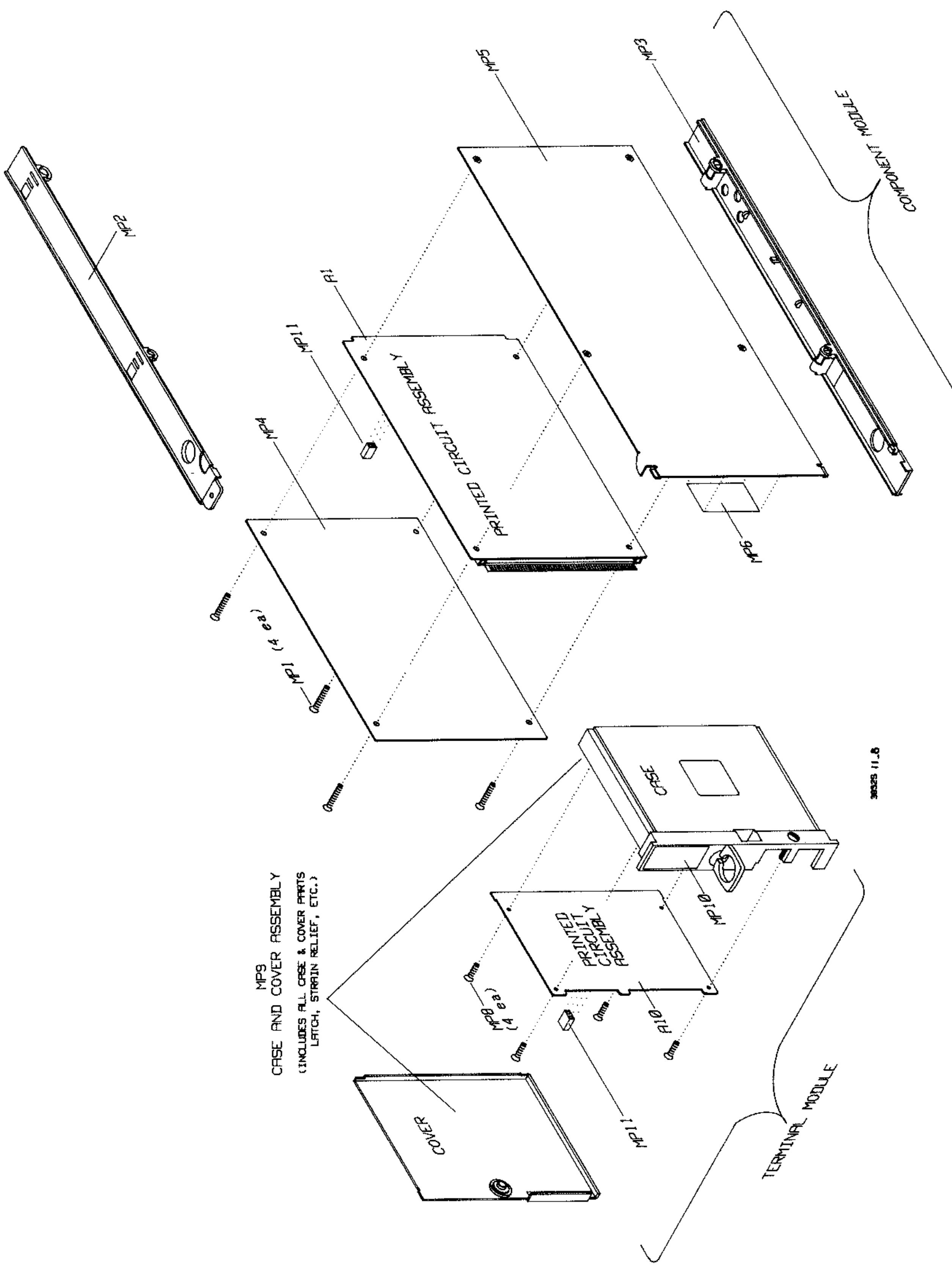


Figure 11-11 5 Channel Counter/Totalizer Exploded View

Table 11-4 HP 44715A 5 Channel Counter/Totalizer (200 kHz)

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44715A	Module; 5 ch counter/total component	1	44715-66201	3	MOD-5CH COUNTER
A1	PCA; 5 ch counter/totalizr component	1	44715-66501	6	PCA-5CH COUNTER
A10	PCA; 5 ch counter/totalizr terminal	1	44715-66510	7	PCA-TERM,5CH CNT
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44715 component module	1	44715-84320	5	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44715A	1	44715-84325	0	LBL-ID,TERM ASSY
MP11	Jumper; removable, A1/A10 PCAs	15	1258-0141	8	JMPR-REM.025P

Completely assembled HP 44715A terminal modules can be ordered from your local HP Office by ordering Number 44715AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44715A	Module; 5 ch counter/total component		44715-69201	9	RBLT-44715-66201

Chapter 12
HP 44721A/22A Digital Inputs

CHAPTER 12
HP 44721A/44722A DIGITAL INPUTS

CHAPTER 12
HP 44721A/44722A
DIGITAL INPUTS

12-1 INTRODUCTION

This chapter contains a technical description, performance tests, and replaceable parts for the HP 44721A 16 Channel Digital Input and the HP 44722A 8 Channel AC Digital Input.

12-2 HP 44721A Technical Description

The HP 44721A 16 Channel Digital Input Accessory can read the state of any or all of the 16 digital channels. Each of the channels can also be programmed as a low frequency counter.

The HP 44721A has the capability to interrupt the HP 3852A local controller. Each of the 16 channels can be programmed to generate an HP 3852A interrupt on either an event or a count. An event for a channel is a high-to-low or low-to-high transition (selected by program codes). A count interrupt can be programmed to occur on a specified count or when the counter reaches roll-over.

A simplified block diagram of the HP 44721A is given in Figure 12-1. The HP 44721A has two main assemblies: a component module and a terminal module. The component module contains the backplane interface electronics, the debounce oscillator, and the channel opto-isolators. The terminal module contains terminal blocks for connection to external wiring, the debounce oscillator capacitor (selected by a jumper) and a jumper selected input attenuator. The printed circuit board used in the component module is also used in the HP 44722A component module.

The control logic interfaces the HP 44721A with the HP 3852A backplane. The control logic contains the read and write registers used by the digital bus to communicate with the accessory. The control logic uses a microprocessor to control the registers, set-up the desired functions on each channel, monitor the conditions of each channel and generate the appropriate interrupts to the HP 3852A local controller. The counter function is also implemented in the microprocessor.

The input from each channel is optically isolated on the component module. In parallel with each opto-isolator is a reverse polarity protection diode.

After the opto-isolator, the input is sent to the digital debounce circuit. This circuit prevents erroneous readings. The digital debounce circuit is a four bit shift register, clocked by the debounce oscillator. The input to the shift register and the output from the shift register are combined in an exclusive or (EXOR) gate that controls the shift register. If the output of the EXOR gate is set true, the shift register is reset. An input signal must remain at a constant level for at least four oscillator clock cycles for the output of the digital debounce circuit to be true.

The debounce oscillator controls the digital debounce circuit for each channel by setting the rate at which the input is shifted through the four bit shift register. The debounce oscillator is designed to operate at one of three frequencies and the frequency of operation is determined by a jumper selected capacitor on the terminal module. The debounce oscillator frequency selected applies to all 16 channels. The frequency is user selected based upon the minimum pulse width required to sense and the maximum bounce time of the input signal.

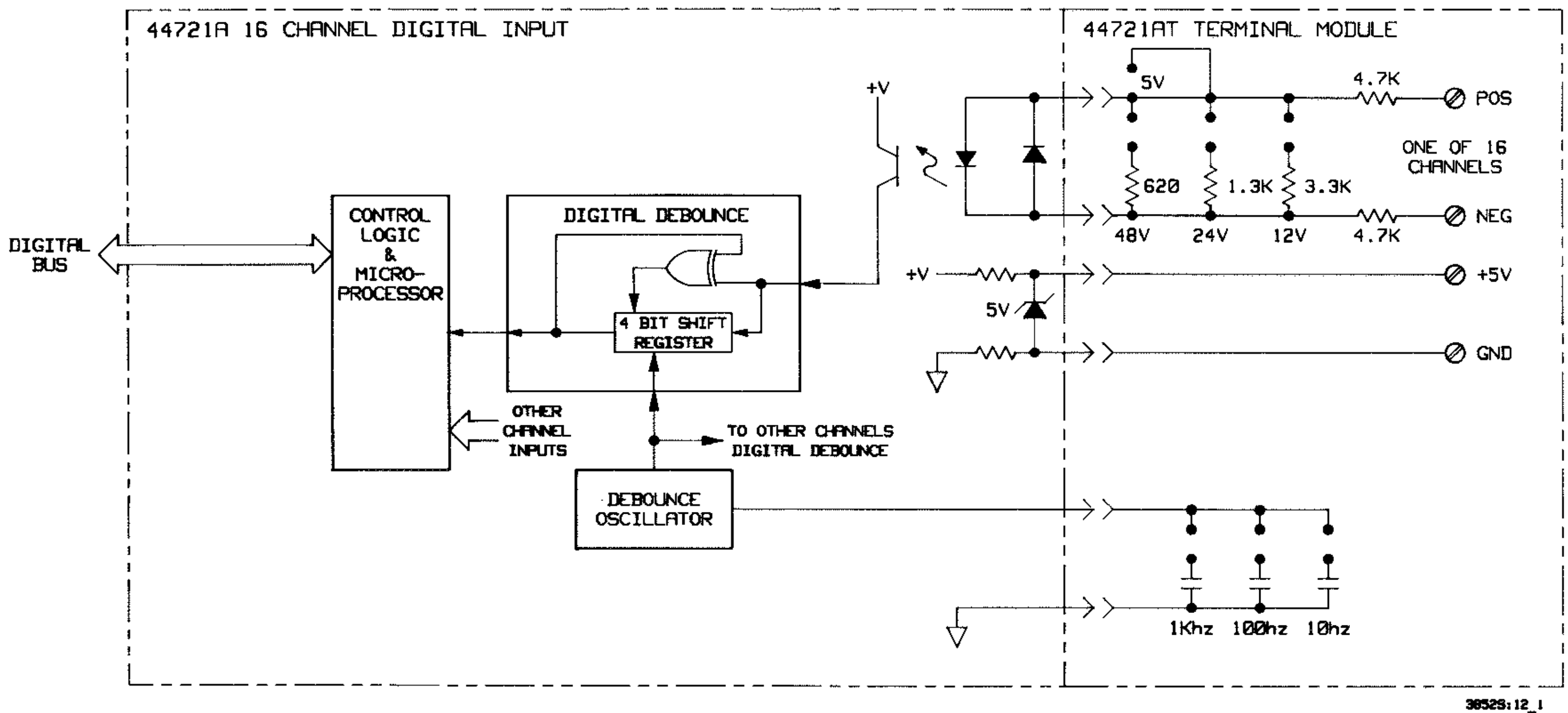


Figure 12-1 HP 44721A Simplified Block Diagram

On the terminal module, in addition to the terminal blocks for external wiring, is a jumper selected input attenuator. With no jumper installed (or with the jumper installed in a dummy position), the input is set for 5 V. Other input voltage ranges as set by the jumper are: 12 V, 24V, and 48 V.

Also provided on the terminal module are +5 VDC and ground. These terminals can be used to measure dry contact inputs. If the +5 VDC terminal is used, the channel connected is no longer isolated from the HP 3852A.

12-3 HP 44722A Technical Description

A simplified block diagram of the HP 44722A is given in Figure 12-2. The HP 44722A has two main assemblies: a component module and a terminal module. The component module is identical to the HP 44721A component module. The accessory is made unique by the addition of the terminal module. The functions and features of the HP 44722A are the same as the HP 44721A. Because of the physical size of the components and the higher rated input voltages for the HP 44722A, only every other input channel is used on the component module.

The debounce oscillator is fixed at a frequency that will allow the accessory to read 47 Hz to 470 Hz AC line voltage interrupted at a 10 Hz rate. The 44722AT terminal module also allows higher input voltages than the HP 44721AT. The jumper selected input voltage ranges are: 24 V, 120 V, and 240 V. The accessory can accept either AC or DC voltage inputs.

12-4 Read and Write Registers

The HP 3852A local controller communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 2 of this manual. Table 12-1 shows the registers used by the HP 44721A/ and HP 44722A accessories.

Table 12-1 Digital Input Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Control
1	Status	Processor Command
2	Not Used	Not Used
3	Processor Data	Processor Data
4	Not Used	Not Used
5	Input Data	Not Used

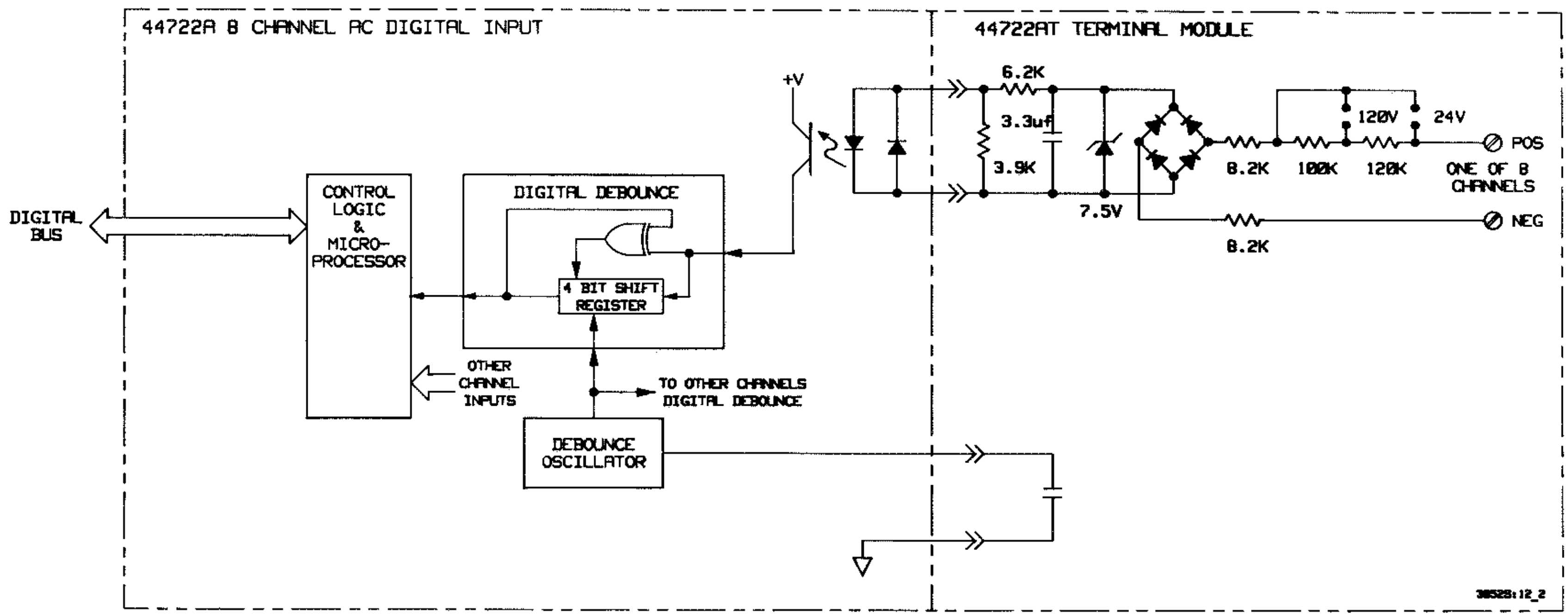


Figure 12-2 HP 44722A Simplified Block Diagram

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessories. It is possible to program some plug-in accessories into illegal and potentially damaging states with these commands. The commands are documented here for service purposes only.

12-5 Read Registers

12-6 Register 0. Read Register 0 contains the accessory identification. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data lines.

The eight bit identification is in two parts. The five most significant bits identify the component module and the three least significant bits identify the type of terminal module installed. If a terminal module is not present, the lower three bits are set high by the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed.

Table 12-2 lists the decimal equivalent codes returned in response to an SREAD of Register 0 for all combinations of the accessory.

Table 12-2 HP 44721A and HP 44722A Identification Codes

Module Combinations	Codes
HP 44721A Component Module (no terminal module installed)	-241
HP 44721A Component Module, HP 44721AT Terminal Module installed	-248
HP 44721A Component Module, HP 44722AT Terminal Module installed	-240

12-7 Register 1. Read Register 1 is the status register. The register shows the present status of the accessory. The definitions of the bits are in Table 12-3.

Table 12-3 Read Status Register

Bit #	Definitions
0	Data Ready (Output Buffer Full)
1	Busy (Input Buffer Full)
2	Not Used
3	Not Used
4	Done (Ready for Next Command)

12-8 Register 3. Read Registers 3 reads the data register of the microprocessor on the component module. This data serves no useful purpose for troubleshooting.

12-9 Register 5. Read Registers 5 reads the input data to the component module. This data serves no useful purpose for troubleshooting.

12-10 Write Registers

12-11 Register 0. Write Registers 0 is the accessory control register. The purpose of the register is to enable interrupt and enable interrupt acknowledge and clear the interrupt of the accessory. The register can also reset the accessory. The definitions of the bits are in Table 12-4.

Table 12-4 Write Control Register

Bit #	Definitions
0	Interrupt Enable
1	Reset Accessory
2	Interrupt Acknowledge/Clear

12-12 Register 1. Write Register 1 is the microprocessor command register. This register serves no useful purpose for troubleshooting.

12-13 Register 2. Write Register 2 is the microprocessor data register. This register serves no useful purpose for troubleshooting.

12-14 SPECIFICATIONS

Specifications for the HP 44721A and HP 44722A are given in Table 12-5. Specifications are the performance standards or limits against which the Digital Input Accessories may be tested.

Table 12-5 HP 44721A/44722A Specifications

HP 44721A

Operating Range:

Accessory Input	Nominal Voltage (Vdc) 5	12	24	48
Threshold Voltage (V): Vlow (max)	1	2.5	7	14
Vhigh (min)	4	9.5	17	31
Input Current (ma) at Nominal Voltage	0.5	1.3	2.8	5.8

Maximum Input Voltage: 80 V peak (between High and Low Terminal of each Channel)
354 V peak or 250 V DC (between channels or between any Terminal and Chassis)

Totalize and Totalize Modulo:

Accuracy: ±1 count

Range: -2^{31} to $+2^{31} - 1$ (32 bits, 2's complement)

Range of Modulo N: 2 to 65,535

Maximum On/Off Frequency: 500 cycles per second

5 Volt Power Supply: 4.5 V to 5.5 V DC
8 mA maximum output current

Maximum Wire Size: 16 AWG

Table 12-5 HP 44721A/44722A Specifications (Cont.)

HP 44722A

Operating Range: For sine wave frequencies between 47 to 470 Hz

Accessory Input	Nominal Voltage (Vdc) 24	120	240
Threshold Voltage (V): Vlow (max)	5.5	30	65
Vhigh (min)	16.5	90	185
Input Current (ma) at Nominal Voltage	1.7	1.1	1.1

Maximum Input Voltage: 354 V peak or 250 V DC between High and Low Terminal of Each Channel)
354 V peak or 250 V dc (between channels or between any Terminal and Chassis)

Totalize and Totalize Modulo:

Accuracy: ±1 count

Range: -2^{31} to $+2^{31} - 1$ (32 bits, 2's complement)

Range of Modulo N: 2 to 65,535

Maximum On/Off Frequency: 10 cycles per second

Maximum Wire Size: 14 AWG

12-15 PERFORMANCE TESTS

12-16 Introduction

The following Performance Tests check the operation of the HP 44721A and HP 44722A component module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this chapter provides a high confidence level that the Digital Input Accessory is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in the Digital Input Accessory operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 12-17.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the Digital Input Accessory is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

12-17 Operational Verification

The first tests given in this section are the minimum set of tests recommended for the Digital Input Accessory. These tests are designed to test the functionality of the accessory. Successful completion of the Operational Verification Tests provides a 90% confidence level that the Digital Input Accessory is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 12-21 - Set-Up Procedure
Section 12-22 - +5 V Supply Test
Section 12-23 - Pattern Test
Section 12-24 - Counter Test
Section 12-25 - Interrupt Test

12-18 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first three items in the list are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 12-19)

2. Test Leads and Jumpers

3. Voltmeter -- Any DC Voltmeter able to read +5 V at ±10%

4. Function Generator -- HP 8116A or equivalent

NOTE

Either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for the +5 V Supply Test. This test does not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

12-19 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 12-3a. A test fixture can be manufactured using an HP 44721AT terminal module, (see Figure 12-3b). Make sure only the HP 44721AT module is used; an HP 44722AT module cannot be used. Because wiring the fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44721AT terminal module, it is important that the terminal ID lines, shown in Figure 12-3a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The test fixture consists of the following:

1. A short circuit between all odd numbered channels POS (positive) connections.

2. A short circuit between all even numbered channels POS connections.

3. A short circuit between all channels NEG (negative) and GND (ground) connections.

4. A connection to the +5 V supply.

On the test fixure, set the input attenuator jumpers of all channels to the 5 V position.

12-20 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

12-21 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the Digital Input Accessory component module and install the test fixture. Note the slot number where the Digital Input Accessory under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows:

      44721A

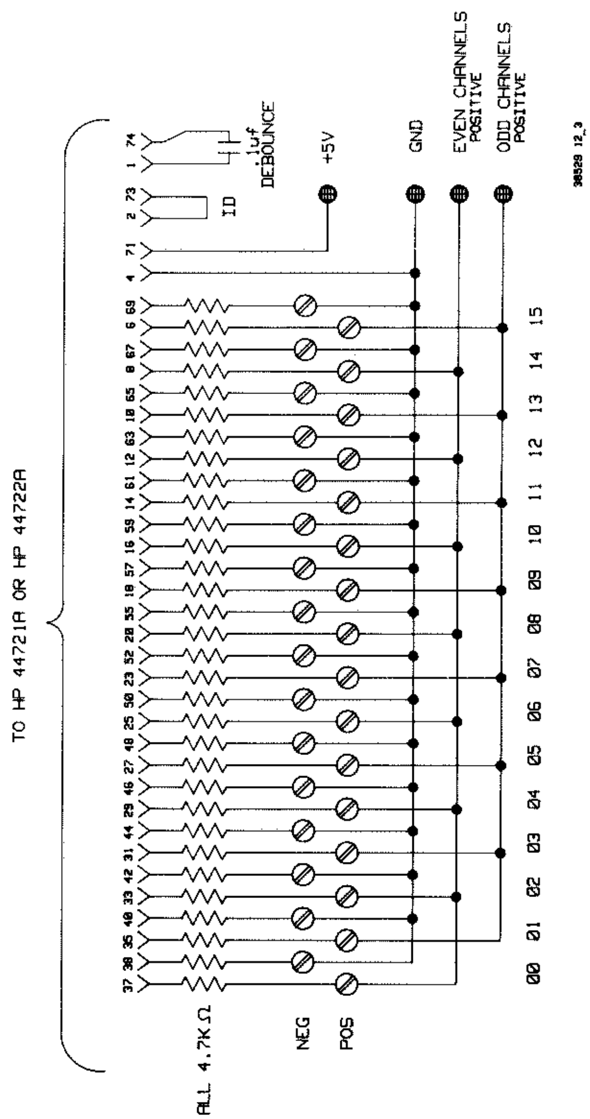


Figure 12-3a HP 44721A Test Fixture Schematic

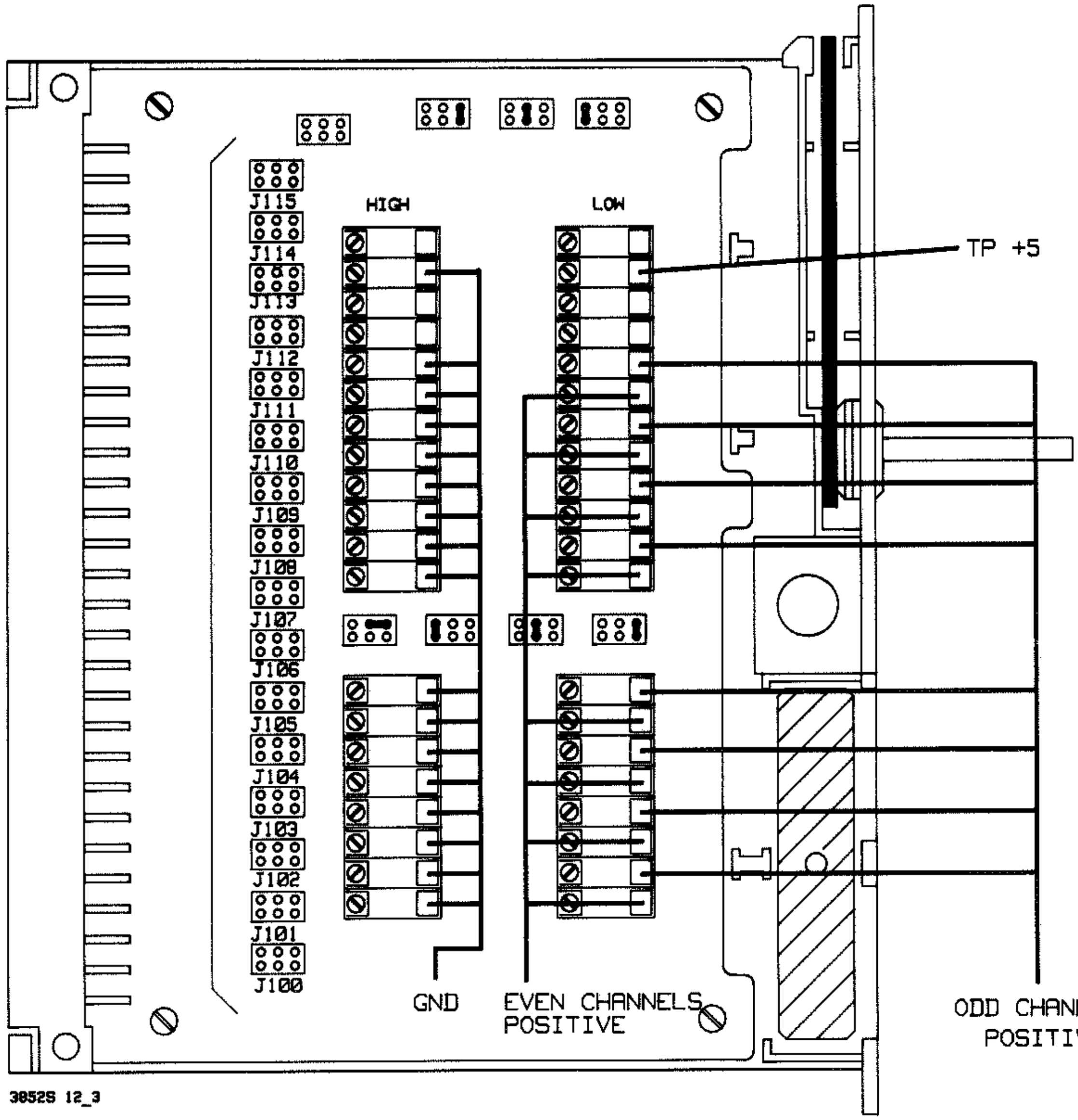


Figure 12-3b HP 44721A Test Fixture

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

12-22 +5 V Supply Test

This test checks the component module's +5 V Supply.

1. Set the voltmeter to measure 5 Vdc. Connect the voltmeter to the +5 supply and ground connections on the test fixure. The connections are shown in Figure 12-4.

2. Observe the indication on the voltmeter. The voltmeter should indicate +5 V ±0.5 V.

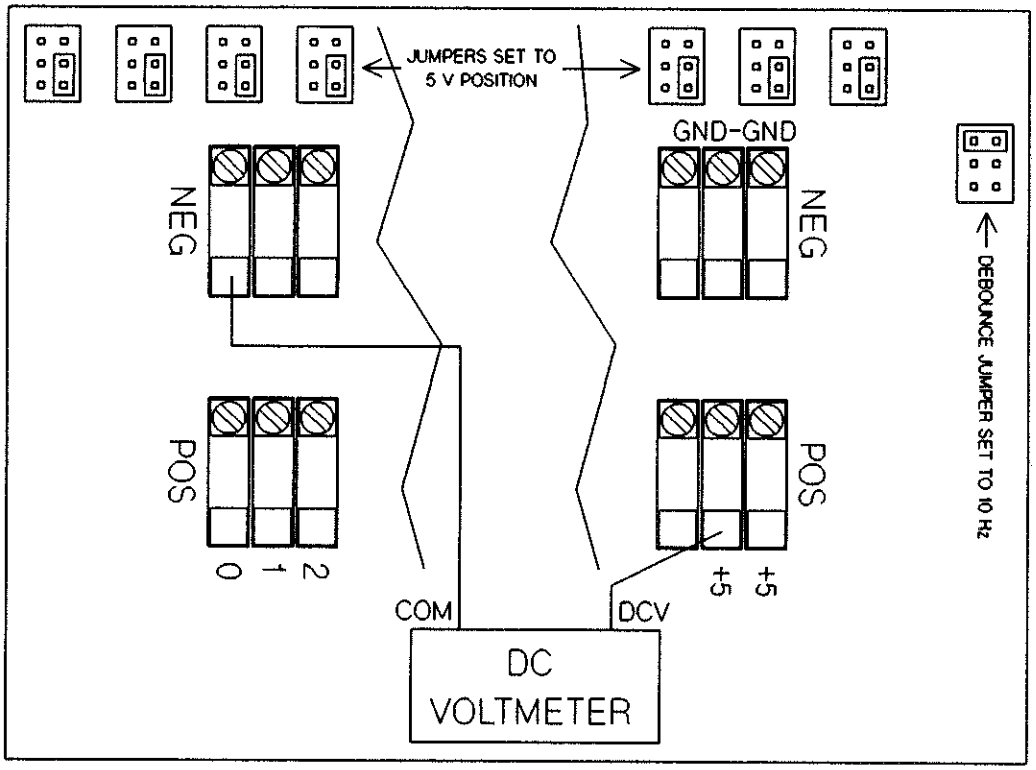


Figure 12-4 +5 V Supply Test

12-23 Pattern Test

1. EVEN NUMBERED CHANNELS PATTERN TEST. This test verifies the accessory can detect and correctly report a pattern of inputs on even numbered channels.

2. Set all HP 44721A channels to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

3. Set all even numbered channel inputs high by installing a jumper between the shorted even channel POS (positive) connections and the +5 V connection. The connections are shown in Figure 12-5.

4. Read the channels by executing:

READ ES00 (where E = extender number, S = slot number)

5. Verify that the HP 3852A right display shows:

21845

The number in the display is a decimal equivalent of a two's compliment binary representation of the 16 channel inputs. A number other than "21845" shows a failing channel. The displayed number can be decoded as a binary number to determine a failing channel(s).

6. Set all channels low by removing the jumper from the POS and +5 V connections.

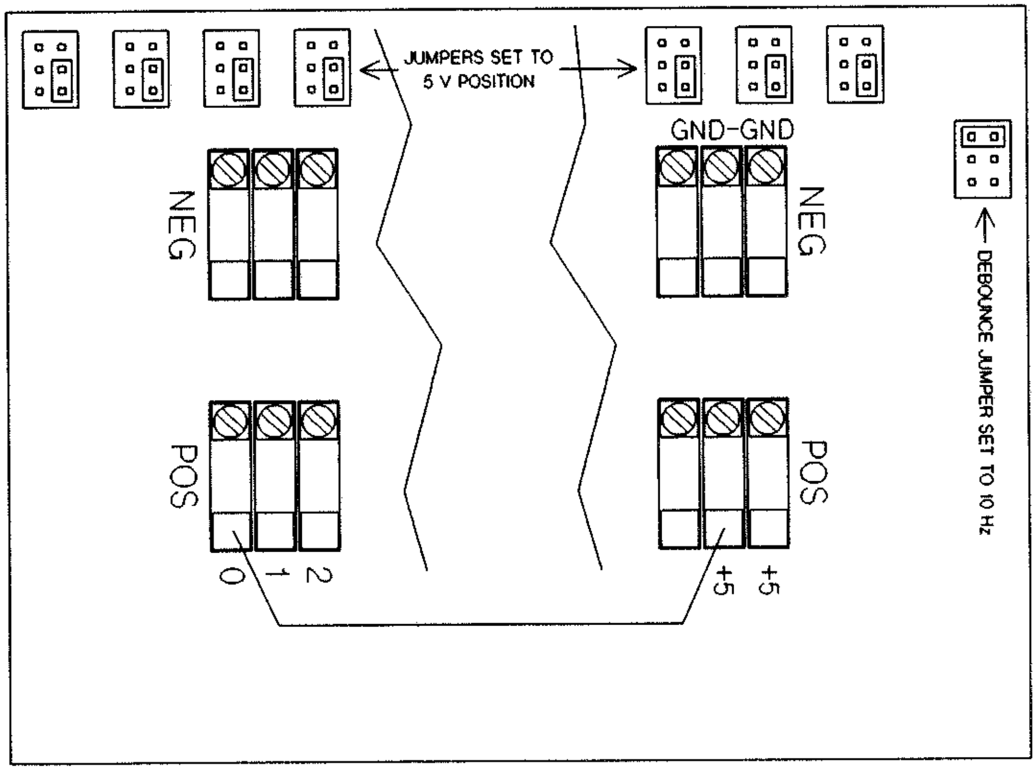


Figure 12-5 Even Channel Pattern Test

7. Read the channels by executing:

   READ ES00 (where E = extender number, S = <slot number)

8. Verify that the HP 3852A right display shows:

   0

9. ODD NUMBERED CHANNELS PATTERN TEST. This test verifies the the accessory can detect and correctly report a pattern of inputs on odd numbered channels.

10. Set all odd numbered channel inputs high by installing a jumper between the shorted odd channel POS (positive) connections and the +5 V connection. The connections are in Figure 12-6.

11. Read the channels by executing:

    READ ES00 (where E = extender number, S = slot number)

12. Verify that the HP 3852A right display shows:

    -21846

The number in the display is a decimal equivalent of a two's compliment binary representation of the 16 channel inputs. A number other than "-21846" shows a failing channel. The displayed number can be decoded as a binary number to determine a failing channel(s).

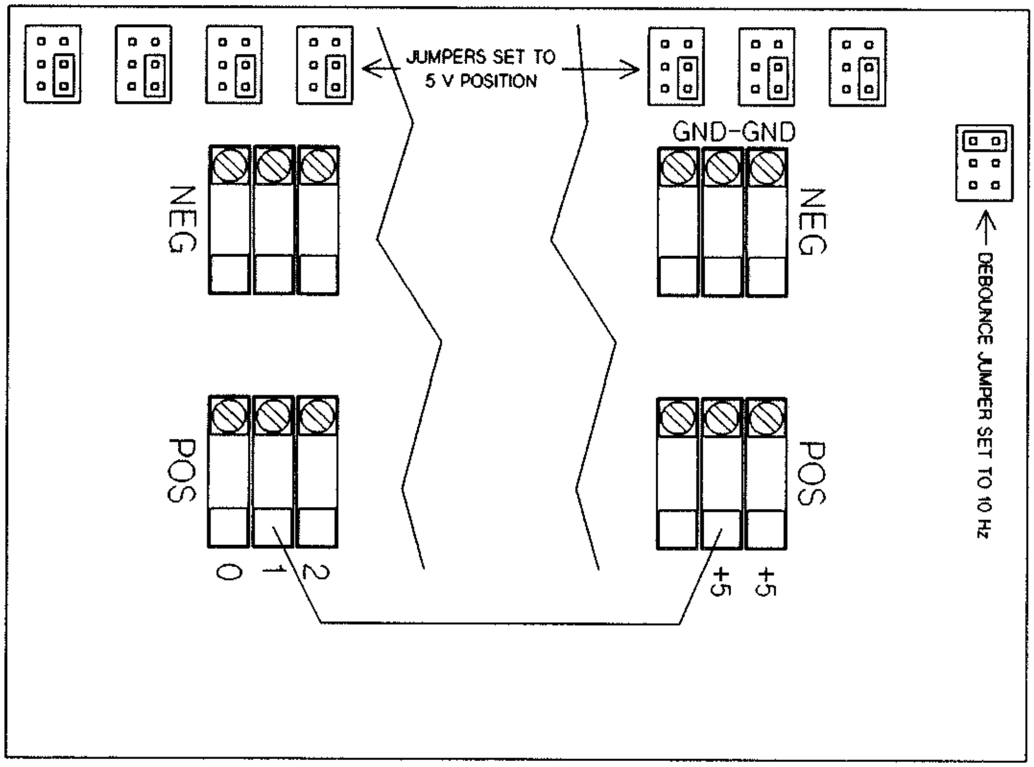


Figure 12-6 Odd Channel Pattern Test

13. ALL CHANNELS HIGH TEST. This test verifies that the accessory can detect and correctly report the results of all channels set to a high input.

14. Set all channel inputs high by installing a jumper between the shorted even channel POS (positive) connections and the +5 V connection, and installing a jumper between the shorted odd channel POS (positive) connections and the +5 V connection. The connections are shown in Figure 12-7.

15. Read the channels by executing:

READ ES00 (where E = extender number, S = slot number)

16. Verify that the HP 3852A right display shows:

-1

17. Return the HP 44721A to a known state by removing all jumpers and executing:

RESET ES00 (where E = extender number, S = slot number)

12-24 Counter Test

1. EVEN NUMBERED CHANNELS COUNTER TEST. This test verifies that even numbered channels can count transitions on the channel inputs and correctly report the number of counts.

2. Refer to Figure 12-8. On the test fixture, set the debounce jumper to the 10 Hz position.

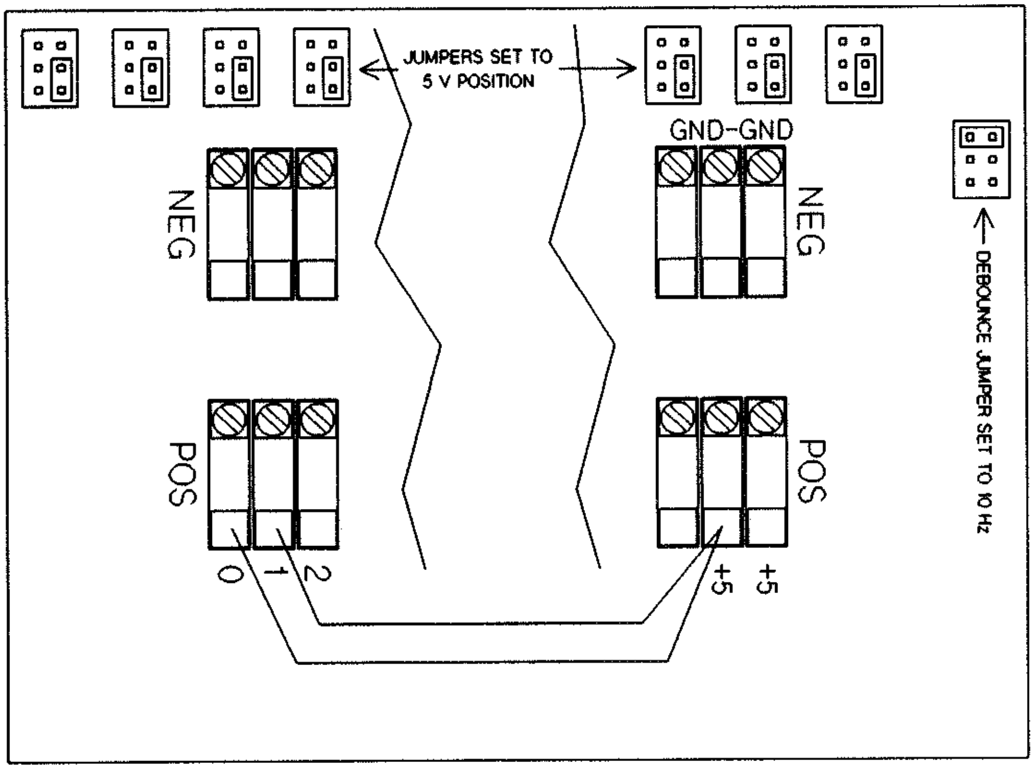


Figure 12-7 All Channel Pattern Test

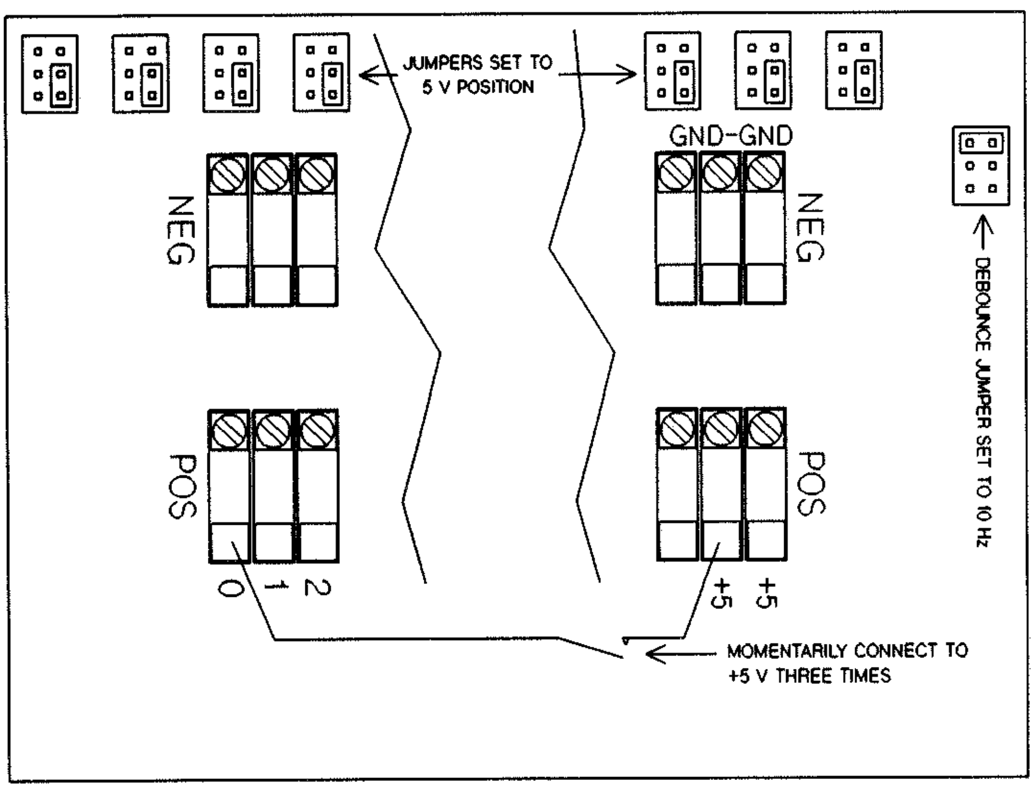


Figure 12-8 Even Channel Counter Test

3. Setup counter measurement by executing:

EDGE LH,USE ES00 (where E = extender number, S = slot number)

4. Refer to Figure 12-8. With a jumper, momentarily connect the shorted even numbered channel POS (positive) connections to the +5 V connection three times.

5. Read the counter input of the even numbered channels by executing:

CHREAD ES00 (where E = extender number, S = slot number)

6. Verify that the counter counted the transitions on the even numbered channels. The HP 3852A right display should show:

3.000000E+00

7. Read the counter input of the odd numbered channels by executing:

CHREAD ES01 (where E = extender number, S = slot number)

8. Verify that the counter counted no transitions on the odd numbered channels. The HP 3852A right display should show:

0.000000E+00

9. ODD NUMBERED CHANNELS COUNTER TEST. This test verifies that odd numbered channels can count transitions on the channel inputs and correctly report the number of counts.

10. Setup counter measurement by executing:

EDGE LH,USE ES01 (where E = extender number, S = slot number)

11. Refer to Figure 12-9. With a jumper, momentarily connect the shorted odd numbered channel POS (positive) connections to the +5 V connection three times.

12. Read the counter input of the odd numbered channels by executing:

CHREAD ES01 (where E = extender number, S = slot number)

13. Verify that the counter counted the transitions on the odd numbered channels. The HP 3852A right display should show:

3.000000E+00

14. Read the counter input of the even numbered channels by executing:

CHREAD ES00 (where E = extender number, S = slot number)

15. Verify that the counter counted no transitions on the even numbered channels. Since in step 4 the counter incremented three times, the HP 3852A right display should show:

3.000000E+00

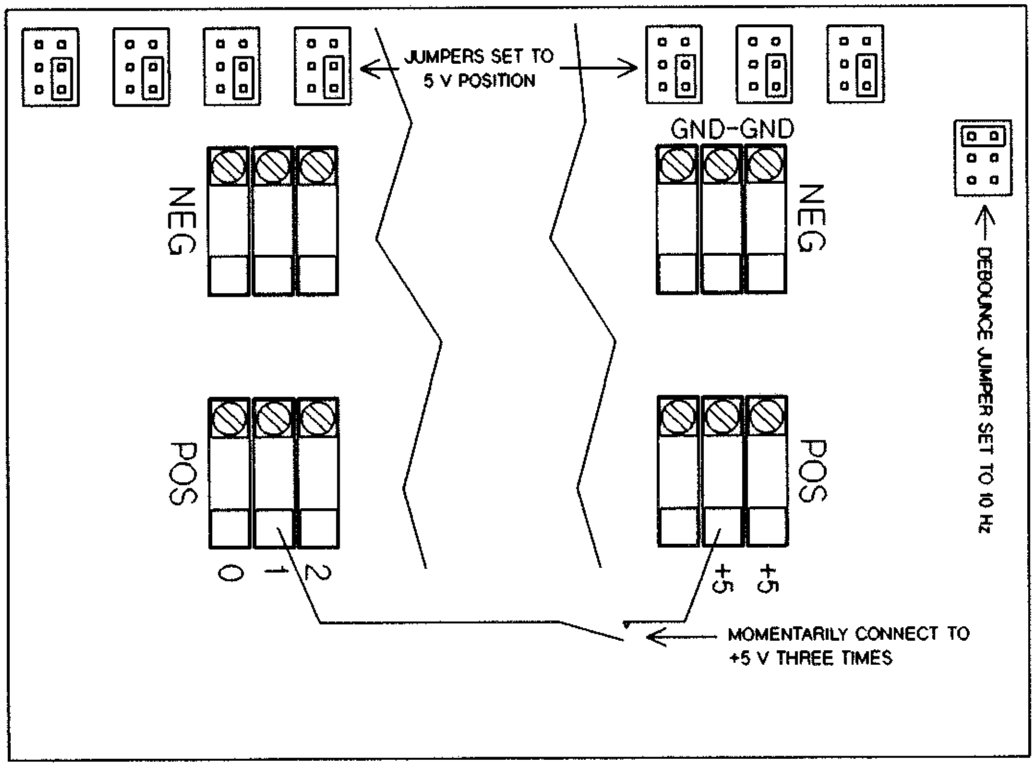


Figure 12-9 Odd Channel Counter Test

12-25 Interrupt Test

This test verifies that the accessory can detect and report an interrupt.

1. Setup the interrupt by executing:

   USE ES16 (where E = extender number, S = slot number)

2. Setup the counter by executing:

   EDGE LH

3. Enable the interrupt by executing:

   ENABLE INTR

4. Refer to Figure 12-10. With a jumper, momentarily connect the shorted even numbered channels POS (positive) connections to the +5 V connection.

5. Verify that the INTR annunciator (second annunciator from right) below the HP 3852A left display is on.

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44721A/44722A PERFORMANCE TESTS.

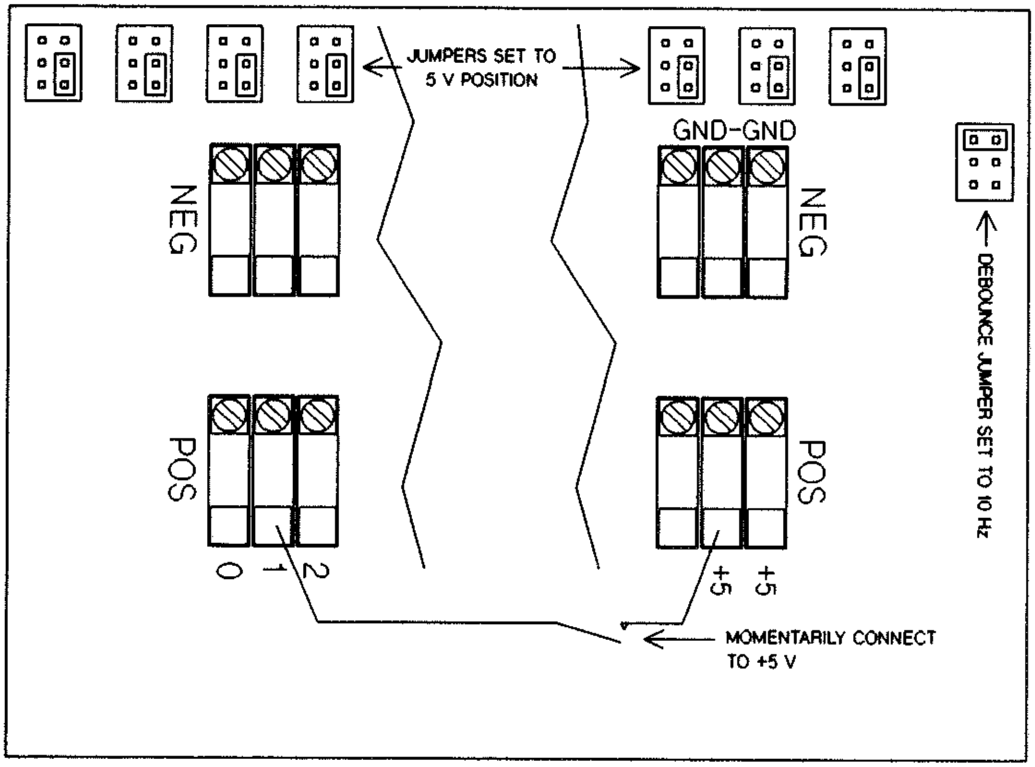


Figure 12-10 Interrupt Test

12-26 Input, Totalize, and Debounce Tests

This test verifies that the accessory detects inputs within the specified threshold voltage limits. The test also tests the counter's totalizing operation and the debounce operation.

In the following tests, a function generator outputs a burst of ten +1 V to +4 V peak-to-peak 500 Hz square waves, after being triggered (see Figure 12-11). The Digital Input Accessory then counts those ten cycles. A +1 V to +4 V square wave is used to check the upper and lower limits of the accessory's threshold voltage. A frequency of 500 Hz is used since that is the maximum frequency the accessory is able to count transitions accurately.

1. EVEN CHANNEL INPUT/TOTALIZING TEST. This test verifies the operation of all even channels.

2. Set all HP 44721A channels to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

3. Set the function generator to output a ten cycle burst of +1 V to +4 V peak-to-peak 500 Hz square waves. The square waves are represented in Figure 12-11. If using the recommended function generator, set it up as follows:

   Mode -- External Burst (E.BURST)
   Function -- Square Wave
   Frequency (FRQ) -- 500 Hz
   Amplitude (AMP) -- 1.5 V RMS
   Offset (OFS) -- +1.25 V
   Duty Cycle (DTY) -- 50%
   Burst Cycles (BUR) -- 10

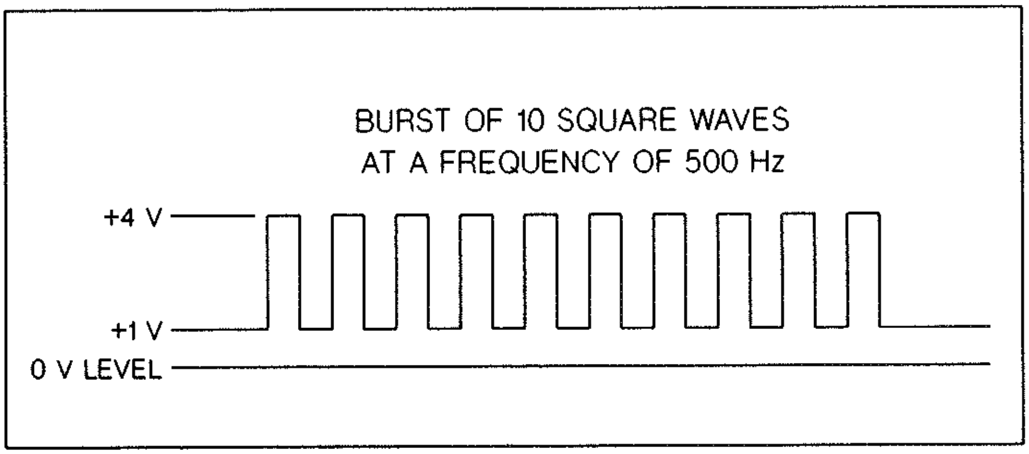


Figure 12-11 Input/Totalize Test Signal

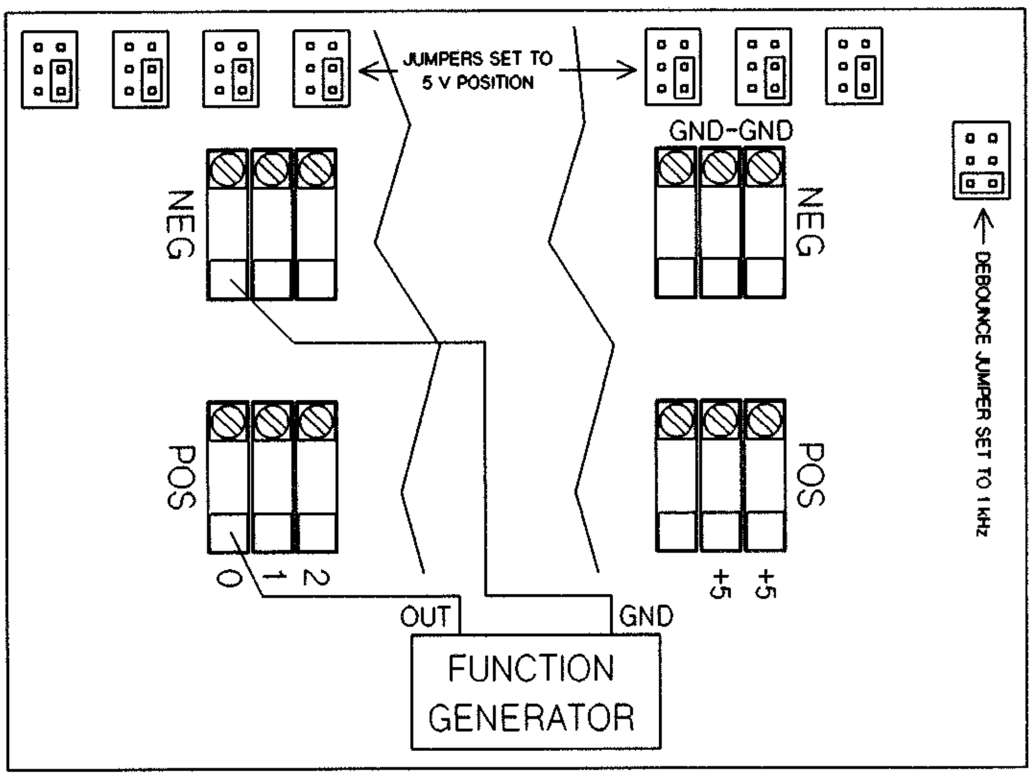


Figure 12-12 Even Channel Input/Totalize Test

4. Connect the function generator to the shorted even channel POS (positive) connections and the GND (ground) connections. The connections are shown in Figure 12-12.

5. On the test fixure, set the debounce jumper to the 1 kHz position, as shown in Figure 12-12.

6. Set the Digital Input Accessory to count positive transitions on Channel 0 by executing:

EDGE LH,USE ES00 (where E = extender number, S = slot number)

7. Trigger the function generator to output the ten cycle burst. If using the recommended function generator, press the MAN button.

8. After the accessory has read all ten cycles, read channel 0 by executing:

CHREAD ES00 (E = extender number, S = slot number)

9. Verify that the HP 3852A right display shows:

1.000000E+01 ±1 count (i.e., 9.000000E+00 to 1.100000E+01)

Note this reading for the negative transition test in the next step.

10. Set the Digital Input Accessory to count negative transitions on Channel 0 by executing:

EDGE HL,USE ES00 (where E = extender number, S = slot number)

11. Trigger the function generator to output the ten cycle burst.

12. After the accessory has read all ten cycles, read channel 0 by executing:

CHREAD ES00 (where E = extender number, S = slot number)

13. Add the reading on the the HP 3852A right display to the reading in step 9. If the reading in step 9 was 1.000000E+01, the reading in the display should be as follows:

2.000000E+01 ±1 count (i.e., 1.900000E+1 to 2.100000E+1)

14. Repeat steps 6 through 13 for channels 2, 4, 6, 8, 10, 12, and 14. In the USE and CHREAD commands, the last two digits indicate the channel number. For example, CHREAD ES02 would read channel 2.

15. ODD CHANNEL INPUT/TOTALIZE TEST. This test verifies the operation of all odd channels.

16. Connect the function generator to the shorted odd channel POS (positive) connections and the GND (ground) connections. The connections are shown in Figure 12-13.

17. Set the Digital Input Accessory to count positive transitions on Channel 1 by executing:

EDGE LH,USE ES01 (where E = extender number, S = slot number)

18. Trigger the function generator to output the ten cycle burst.

19. After the accessory has read all ten cycles, read channel 1 by executing:

CHREAD ES01 (where E = extender number, S = slot number)

20. Verify that the HP 3852A right display shows:

1.000000E+01 ±1 count (i.e., 9.000000E+00 to 1.100000E+01)

Note this reading for the negative transition test in the next step.

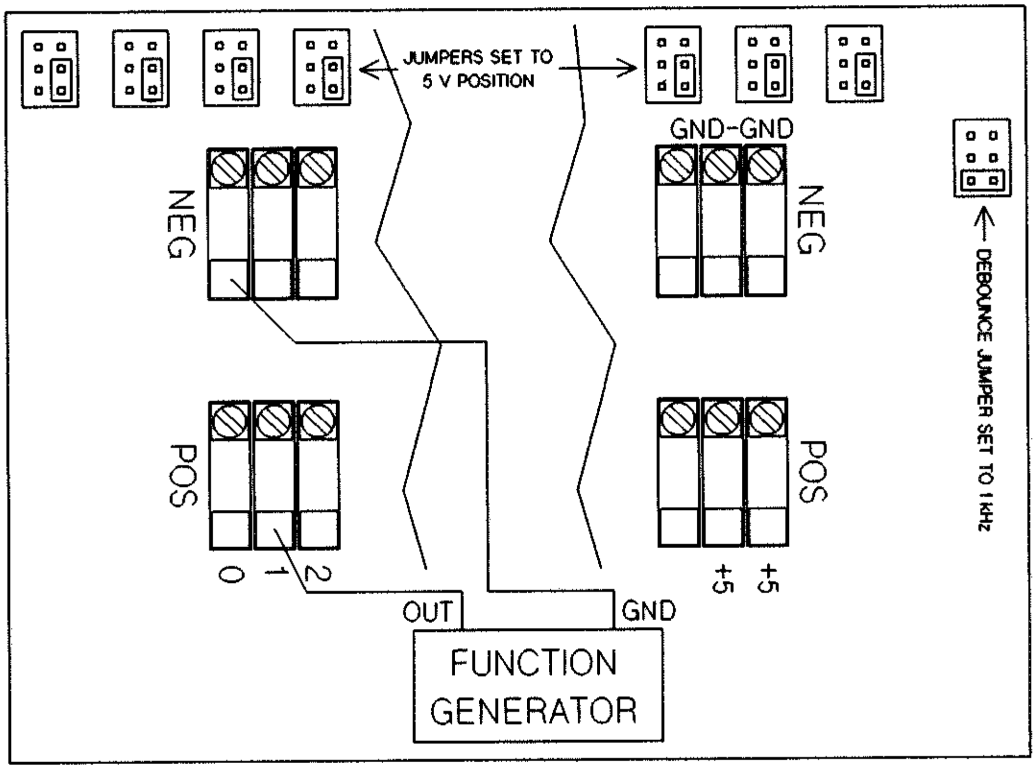


Figure 12-13 Odd Channel Input/Totalize Test

21. Set the Digital Input Accessory to count negative transitions on Channel 1 by executing:

    EDGE HL,USE ES01 (where E = extender number, S = slot number)

22. Trigger the function generator to output the ten cycle burst.

23. After the accessory has read all ten cycles, read channel 1 by executing:

    CHREAD ES01 (where E = extender number, S = slot number)

24. Add the reading on the the HP 3852A right display to the reading in step 9. If the reading in step 20 was 1.000000E+01, the reading in the display should be as follows:

    2.000000E+01 ±1 count (i.e., 1.900000E+01 to 2.100000E+01)

25. Repeat steps 17 through 24 for channels 3, 5, 7, 9, 11, 13, and 15. In the USE and CHREAD commands, the last two digits indicate the channel number. For example, CHREAD ES03 would read channel 3.

26. Leave the function generator connected to the test fixure for the next test.

27. DEBOUNCE TEST. This checks the operation of the debounce circuitry.

28. On the test fixure, set the debounce jumper to the 10 Hz position.

29. Read channel 1 by executing:

    CHREAD ES01 (where E = extender number, S = slot number)

30. Note and record the reading on the HP 3852A right display.

32. Set the Digital Input Accessory to count positive transitions on Channel 1 by executing:

    EDGE LH,USE ES01 (where E = extender number, S = slot number)

31. Trigger the function generator to output the ten cycle burst.

32. Read channel 1 by executing:

    CHREAD ES01 (where E = extender number, S = slot number)

33. Verify that the HP 3852A right display shows the same as in step 30.

12-27 REPLACEABLE PARTS

Figure 12-14 shows the mechanical breakdown of the HP 44721A and HP 44722A. The figure also provides assembly and disassembly information. The parts shown in Figure 12-14 are keyed to the parts lists in Table 12-6.

To order a part listed in Table 12-6, quote the Hewlett-Packard part number, the quantity desired, the HP factory reference, and the check digit (abbreviated CD in Table 12-6). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board for the digital input accessory is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

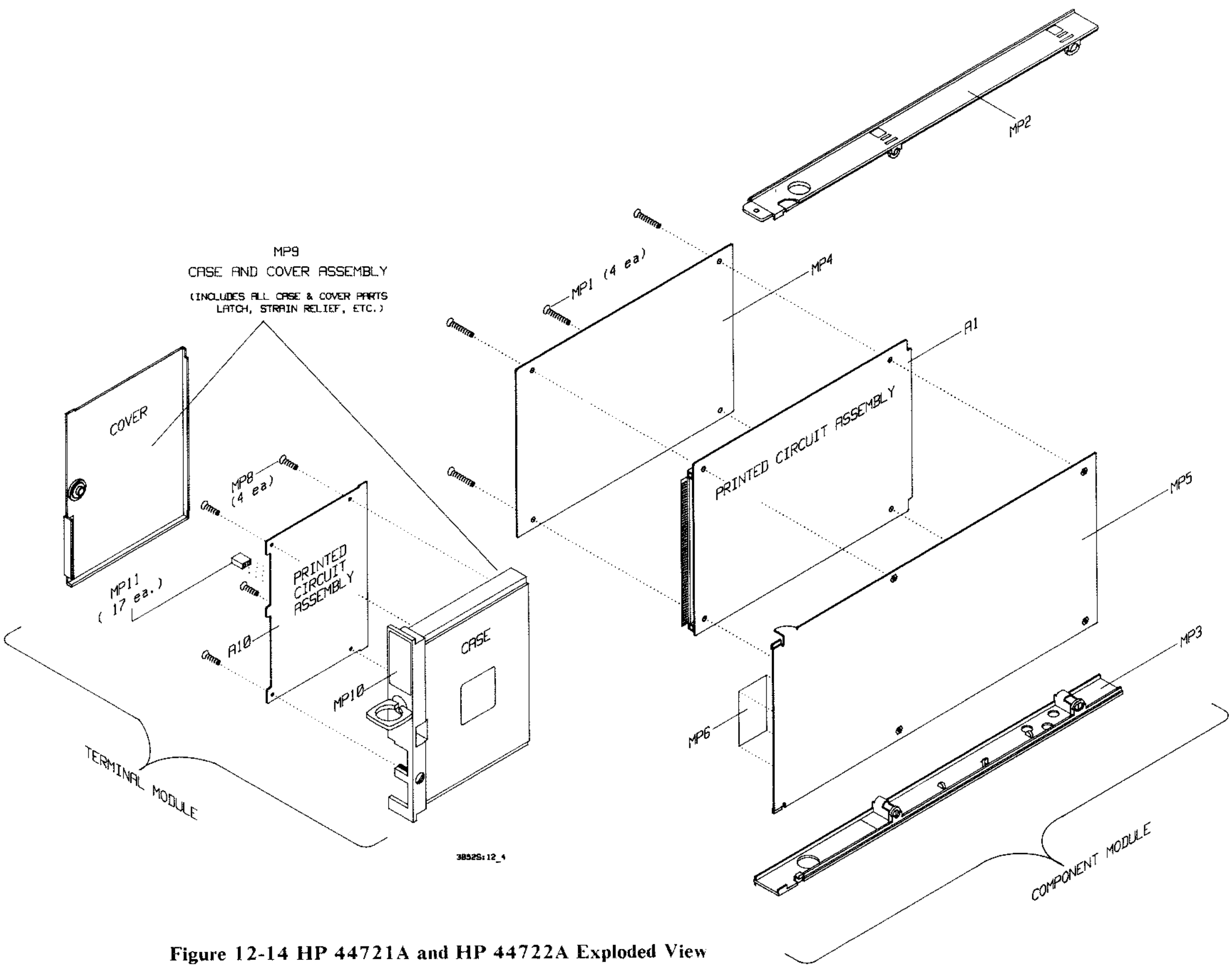


Figure 12-14 HP 44721A and HP 44722A Exploded View

Table 12-6a HP 44721A 16 Channel Digital Input with Totalize and Interrupt

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44721A	Module; 16ch DC/8ch AC dig-in compon	1	44721-66201	1	MOD-DC/AC DIG IN
A1	PCA; 16ch DC/8ch AC dig-in component	1	44721-66501	4	PCA-DC/AC DIG IN
A10	PCA; 16 ch DC digital input terminal	1	44721-66510	5	PCA-DC D-IN TERM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44721/44722A component module	1	44721-84320	3	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44721A	1	44721-84325	8	LBL-ID,TERM ASSY
MP11	Jumper; removable, A10 PCA	17	1258-0141	8	JMPR-REM.025P

Completely assembled HP 44721A terminal modules can be ordered from your local HP Office by ordering Number 44721AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44721A	Module; 16ch DC/8ch AC dig-in compon		44721-69201	7	RBLT-44721-66201

Table 12-6b HP 44722A 8 Channel AC Digital Input with Totalize and Interrupt

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44722A	Module; 16ch DC/8ch AC dig-in compon	1	44721-66201	1	MOD-DC/AC DIG IN
A1	PCA; 16ch DC/8ch AC dig-in component	1	44721-66501	4	PCA-DC/AC DIG IN
A10	PCA; 8 ch AC digital input terminal	1	44722-66510	6	PCA-AC D-IN TERM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44721/44722A component module	1	44721-84320	3	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44722A	1	44722-84325	9	LBL-ID,TERM ASSY
MP11	Jumper; removable, A10 PCA	8	1258-0141	8	JMPR-REM.025P

Completely assembled HP 44722A terminal modules can be ordered from your local HP Office by ordering Number 44722AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44722A	Module; 16ch DC/8ch AC dig-in compon		44721-69201	7	RBLT-44721-66201

Chapter 13
HP 44724A Digital Output

CHAPTER 13
HP 44724A DIGITAL OUTPUT

CHAPTER 13
HP 44724A
16 CHANNEL DIGITAL OUTPUT

13-1 INTRODUCTION

This chapter provides a technical description, operational verification procedures, and replaceable parts lists for the HP 44724A 16 Channel Digital Output accessory.

13-2 Technical Description

The HP 44724A can be used to control low level DC devices or to drive logic levels. In either case, an external power supply and pull-up resistors are needed. When a channel is turned on, a low impedance path is created between the HIGH and LOW inputs of the terminal module.

The HP 44724A has two main assemblies: a component module and a terminal module. The component module contains the backplane interface electronics, the channel driver control logic, the channel drivers, and the channel output MOSFET switches. The terminal module contains terminal blocks for connection to external wiring and fuses for the protection of the component module.

A simplified block diagram of the HP 44724A is shown in Figure 13-1. The control logic interfaces the HP 44724A with the HP 3852A or HP 3853A backplane. The control logic accepts commands from the HP 3852A and controls the desired channel driver. The channel drivers turn the output MOSFET on or off as indicated in the command received.

There are two protection diodes on the output of each MOSFET. One diode, external to the MOSFET, provides overvoltage protection. The other diode is an integral part of the MOSFET. This diode provides reverse polarity protection. If a reverse polarity voltage is applied to the HIGH and LOW terminals on the terminal module, this diode is forward biased. Any channel wired with reverse polarity will always appear to be on.

On the terminal module each channel HIGH line is fused to provide further protection for the output MOSFET. The fuses are rated at 1 Amp.

13-3 Read and Write Registers

The HP 3852A local controller communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 2 of this manual. Table 13-1 shows the registers used by the HP 44724A.

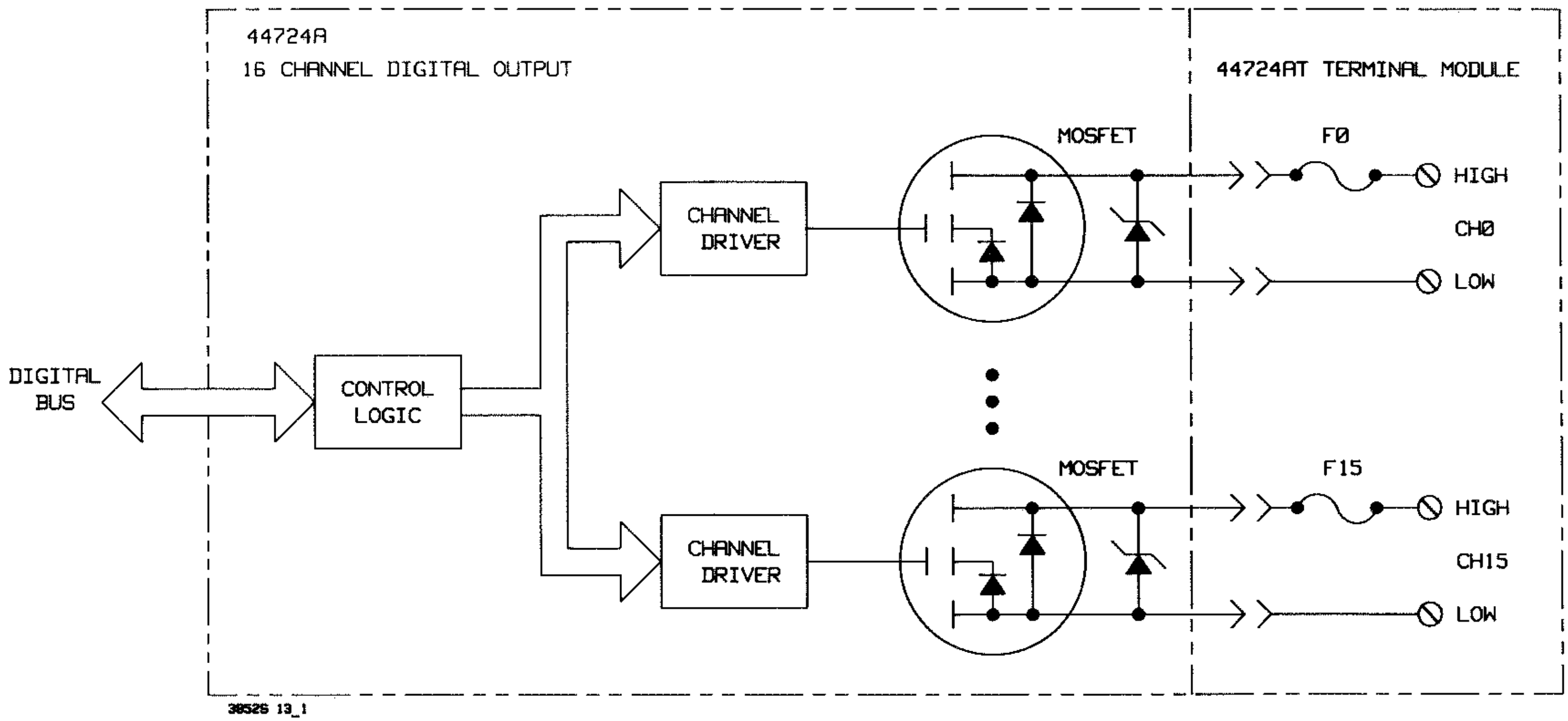


Figure 13-1 HP 44724A Simplified Block Diagram

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessories. It is possible to program some plug-in accessories into illegal and potentially damaging states with these commands. The commands are documented here for service purposes only.

Table 13-1 Digital Output Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Control
1	Always -240	Not Used
2	Channels 8 through 15	Channels 8 through 15
3	Channels 0 through 7	Channels 0 through 7

13-4 Read Registers

13-5 Register 0. Read Register 0 contains the accessory identification. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data lines.

The eight bit identification is in two parts. The five most significant bits identify the component module and the three least significant bits identify the type of terminal module installed. If a terminal module is not present, the lower three bits are set high by the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed.

Table 13-2 lists the decimal equivalent codes returned in response to an SREAD of Register 0 for all combinations of the accessory.

Table 13-2 HP 44724A Identification Codes

Module Combinations	Codes
HP 44724A Component Module (no terminal module installed)	-89
HP 44724A Component Module, HP 44724AT Terminal Module installed	-95

13-6 Register 1. Read Register 1 is a hardwired register and will always return a decimal value of -240 in response to an SREAD.

13-7 Register 2. Read Register 2 is the upper channel condition register. The eight bit register contains a binary representation of the last state programmed for channels 8 through 15. Note that the register latches the last state programmed, not the actual state of the MOSFET switches. Figure 13-2 is an example of the word in the register. In the figure, it is presumed that channel 7 was programmed to be closed.

13-8 Register 3. Read Register 3 is the lower channel condition register. The eight bit register contains a binary representation of the last state programmed for channels 0 through 7. Note that the register latches the last state programmed, not the actual state of the MOSFET switches. Figure 13-2 is an example of the word in the register. In the figure, it is presumed that channel 15 was programmed to be closed.

```
Bits:       7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0
```

Figure 13-2 Read Registers 2 and 3

NOTE

The decimal number returned after the execution of an SREAD command represents the two's compliment of the status word.

13-9 Write Registers

13-10 Register 0. Write Register 0 is the accessory reset register. Any data written to this register will cause a reset of the accessory and force all the channel switches open. A write to Register 0 has the same effect as a backplane reset.

13-11 Register 2. Write Register 2 is a control register for channels 8 through 15. An eight bit word is used to control the status of the channels. The bits in the command word corresponds one-to-one to the channel numbers (i.e., setting bit 9 closes channel 9). Figure 13-3 is an example of the command word. In the figure, it is presumed that channel 9 is to be closed.

13-12 Register 3. Write Register 3 is a control register for channels 0 through 7. An eight bit word is used to control the status of the channels. The bits in the command word corresponds one-to-one to the channel numbers (i.e., setting bit 7 closes channel 15). Figure 13-3 is an example of the command word. In the figure, it is presumed that channel 15 is to be closed.

```
Bits:       7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0
```

Figure 13-3 Command Word

13-13 SPECIFICATIONS

Specifications for the HP 44724A are given in Table 13-3. Specifications are the performance standards or limits against which the accessory may be tested tested.

Table 13-3 HP 44724A Specifications

Maximum Input Voltage:	55 V DC Between High and Low Terminal (of each channel) 350 V peak or 250 V DC (between channels or between any Terminal and Chassis)
Maximum Sink Current:	500 mA DC per channel (1 A fuse protected)
Maximum Reverse Polarity Current:	500 mA DC per channel
TTL Compatibility:	200 mA per channel with Vout =<0.4 volts
Closed Channel Path Resistance:	1.5 Ω
Maximum Off Leakage:	0.25 mA per channel at 55 V DC
Maximum Wire Size:	16 AWG

13-14 PERFORMANCE TESTS

13-15 Introduction

The following Performance Tests check the operation of the HP 44724A component module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this chapter provides a high confidence level that the Digital Output Accessory is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in the Digital Output Accessory operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 13-16.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the Digital Output Accessory is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

13-16 Operational Verification

The first tests given in this section are the minimum set of tests recommended for the Digital Output Accessory. These tests are designed to test the functionality of the accessory. Successful completion of the Operational Verification Tests provides a 90% confidence level that the Digital Output Accessory is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 13-20 - Set-Up Procedure
Section 13-21 - Channels On-Resistance Test

13-17 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first three items in the list are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 13-18)
2. Test Leads and Jumpers
3. Digital Multimeter -- HP 3456A or equivalent
4. +5 V Power Supply -- HP 6214 or equivalent
5. Resistor -- 10 ohms (5 W, 10% or better)

NOTE

Either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for the +5 V Supply Test. This test does not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

13-18 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 13-4a. A test fixture can be manufactured using an HP 44724AT terminal module (see Figure 13-4b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44724AT terminal module, it is important that the terminal ID lines, shown in Figure 13-4a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The test fixture consists of a short circuit between the odd numbered channels HIGH connections, a short circuit between all even numbered HIGH connections, and a short circuit between all channels LOW connections.

13-19 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

13-20 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the Digital Output Accessory component module and install the test fixture. Note the slot number where the Digital Output Accessory under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows:

      44724A

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

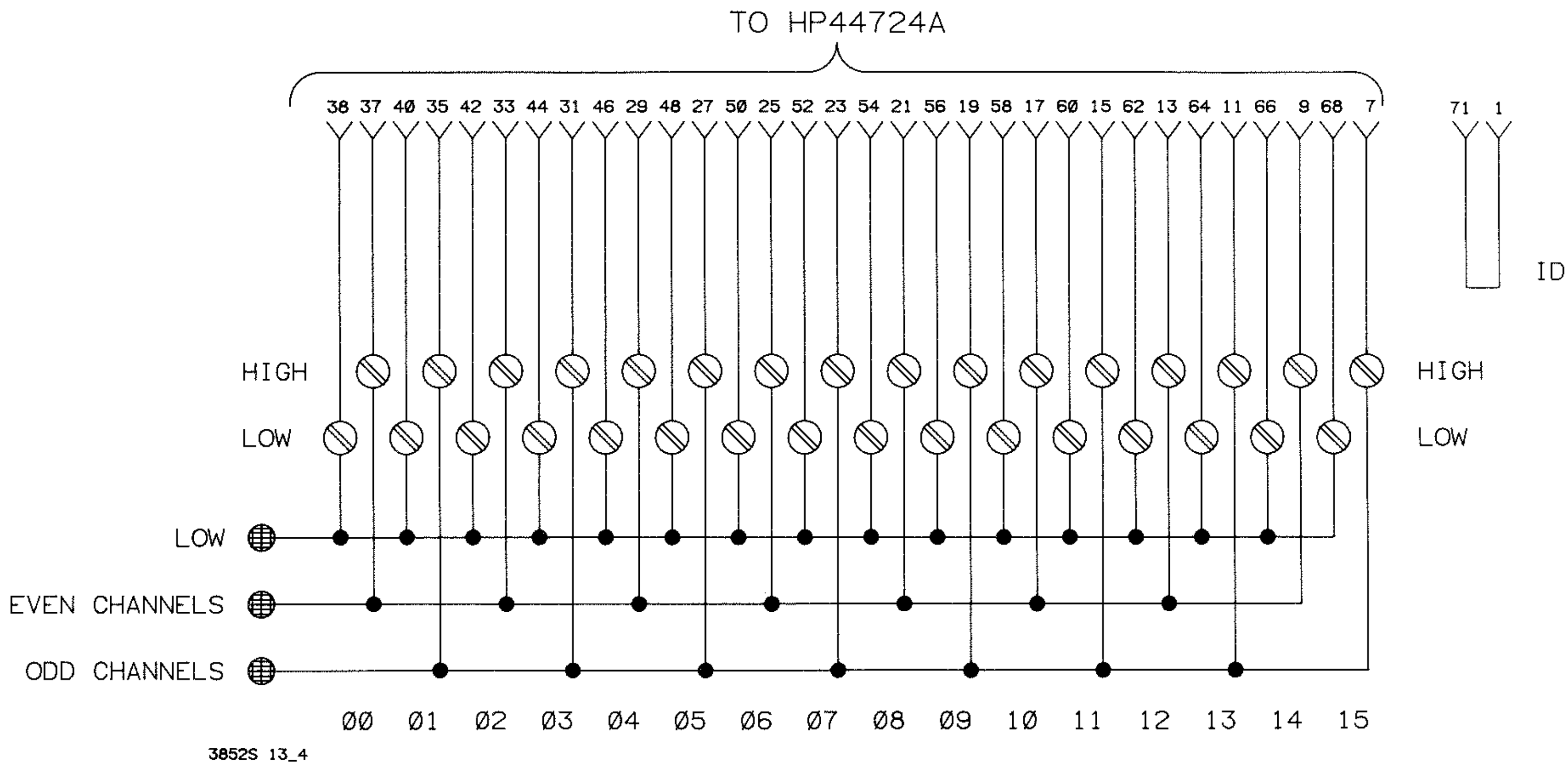


Figure 13-4a HP 44724A Test Fixure Schematic

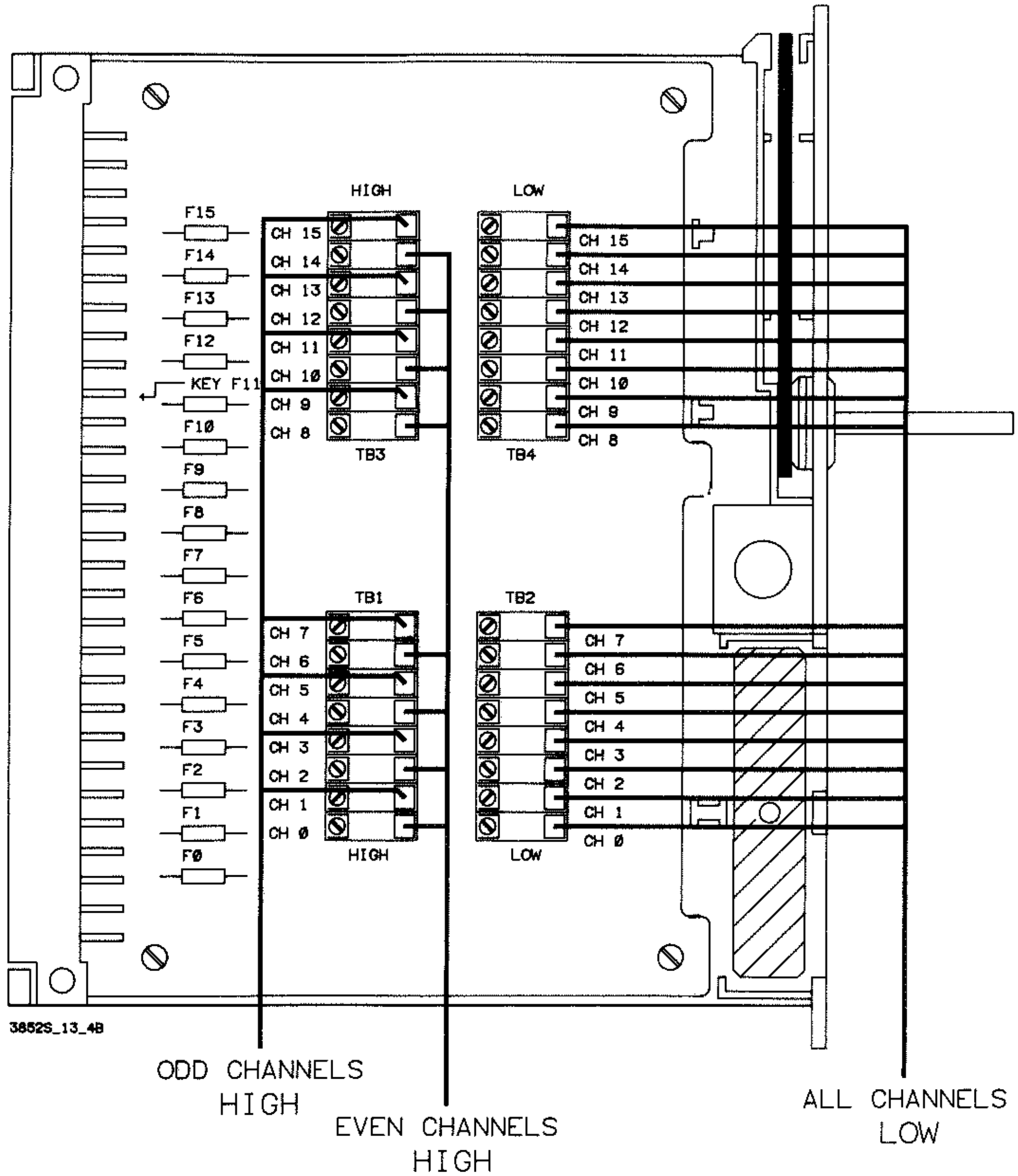


Figure 13-4b HP 44724A Test Fixture

13-21 Channels On-Resistance Test

The following tests check the on-resistance of the channel switches for the both the even and odd numbered channels.

1. EVEN CHANNEL ON-RESISTANCE TEST: This test checks the on-resistance of the channel switches for the even numbered channels.

2. Set all HP 44724A channel relays to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

3. Set the multimeter to measure two-wire ohms. If using the recommended multimeter (i.e., HP 3456A), connect the DCV (HI) input of the multimeter to the shorted LOW connections on the test fixure. Connect the multimeter COM (LO) input to the even channels HIGH connections on the test fixure. The connections are shown in Figure 13-5.

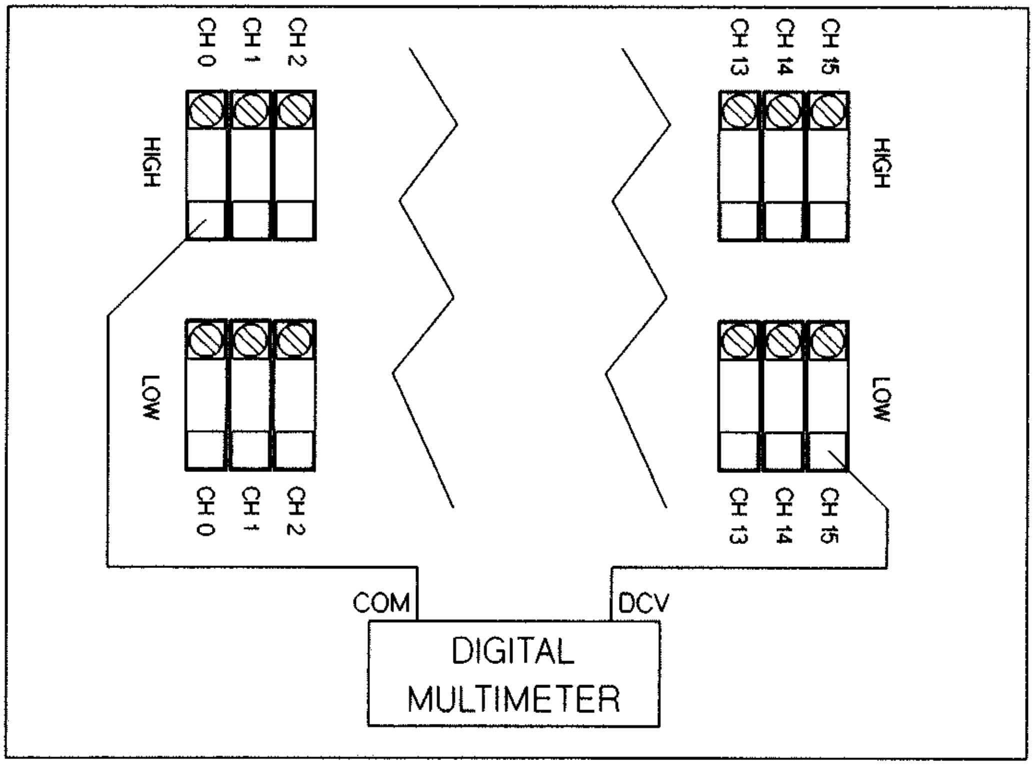


Figure 13-5 Even Channels Tests

If using a different multimeter/voltmeter than the recommended model, the multimeter/voltmeter current source polarity must be determined. For negative polarity current sources, like the recommended multimeter, make the connections as stated above and as shown in Figure 13-5. For positive polarity current sources, like the HP 44701A plug-in voltmeter, connect the multimeter/voltmeter High lead to the HIGH connections on the test fixure and the Low lead to the LOW connections on the test fixure. Incorrect connections may cause the reverse bias protection diode of the output MOSFET to be forward biased by the current source. This can result in incorrect readings.

4. Close channel 0 by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The multimeter should indicate a resistance less than 1.5 ohms.

6. Open channel 0 by executing:

   OPEN ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. The multimeter should indicate greater than 10 Mohms.

8. Repeat Steps 3, 4, 5, and 6 for channels 2, 4, 6, 8, 10, 12, and 14. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES02 for channel 2).

9. ODD CHANNEL ON-RESISTANCE TEST: This test checks the on-resistance of the odd numbered channels.

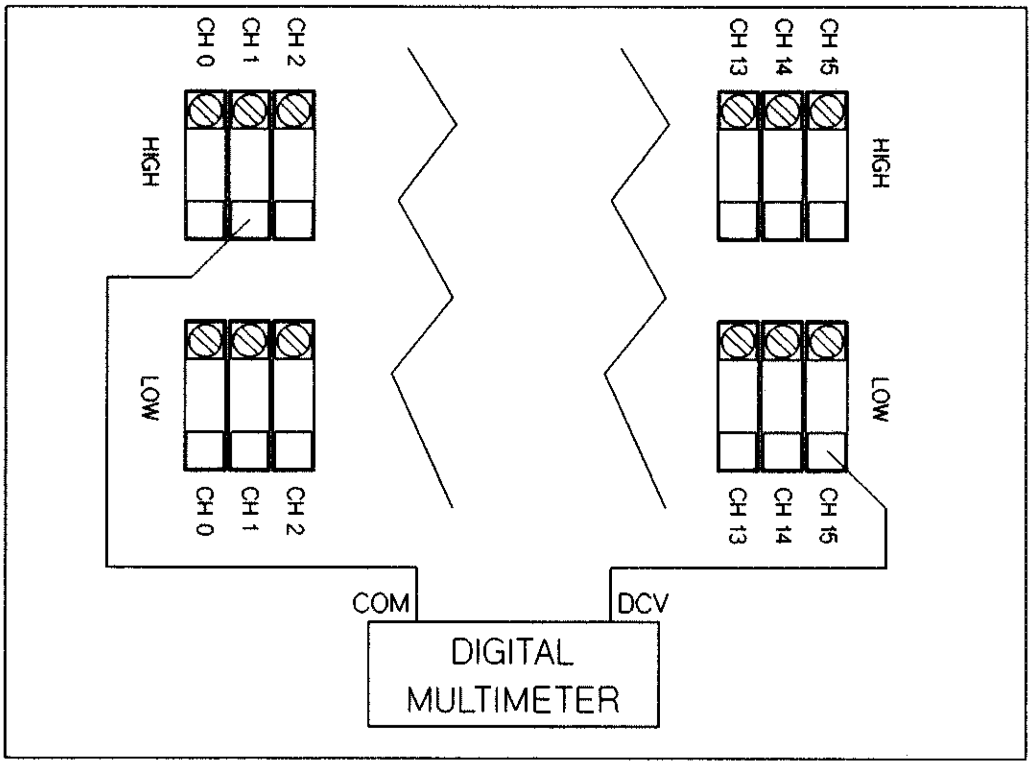


Figure 13-6 Odd Channels Tests

10. If using the recommended multimeter (i.e., HP 3456A), connect the DCV (HI) input of the multimeter to the shorted LOW connections on the test fixure. Connect the multimeter COM (LO) input to the odd channels HIGH connections on the test fixure. The connections are shown in Figure 13-6. See step 3 above if using other than the recommended multimeter.

11. Close channel 1 by executing:

CLOSE ES01 (where E = extender number, S = slot number)

12. Observe the indication on the multimeter. The multimeter should indicate a resistance less than 1.5 ohms.

13. Open channel 1 by executing:

OPEN ES01 (where E = extender number, S = slot number)

14. Observe the indication on the multimeter. The multimeter should indicate greater than 10 Mohms.

15. Repeat Steps 11, 12, 13, and 14 for channels 3, 5, 7, 9, 11, 13 and 15. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES03 for channel 3).

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44724A PERFORMANCE TESTS.

13-22 Adjacent Channels Test

This test checks the isolation between adjacent channels.

1. Set the multimeter to measure two-wire ohms. If using the recommended multimeter (i.e., HP 3456A), connect the DCV (HI) input of the multimeter to the shorted LOW connections on the test fixure. Connect the multimeter COM (LO) input to the odd channels HIGH connections on the test fixure. The connections are shown in Figure 13-6. See paragraph 13-19 step 3 if using other than the recommended multimeter.

2. Close all the odd channels by executing:

WRITE ES00,43690 (where E = extender number, S = slot number)

3. Verify that the channels have closed by observing the indication on the multimeter. The resistance reading indicated should be less than 1.5 ohms.

4. Connect the COM (LO) input of the multimeter to the even channels shorted HIGH connections. Leave the DCV (HI) input connected to the shorted LOW connections. The connections are shown in Figure 13-5.

5. Observe the indication on the multimeter. The multimeter should indicate greater than 10 Mohms, verifying that all even numbered channels are open. If the multimeter indicates that a channel is closed, two adjacent channels are closing at the same time.

6. Open the odd numbered channels by executing:

WRITE ES00,0 (where E = extender number, S = slot number)

7. Close the even numbered channels by executing:

WRITE ES00,21845 (where E = extender number, S = slot number)

8. Verify that the channels have closed by observing the indication on the multimeter. The resistance reading indicated should be less than 1.5 ohms.

9. Connect the COM (LO) input of the multimeter to the odd channels shorted HIGH connections. Leave the DCV (HI) input connected to the shorted LOW connections (see Figure 13-6).

10. Observe the indication on the multimeter. The multimeter should indicate greater than 10 Mohms, verifying that all odd numbered channels are open. If the multimeter indicates that a channel is closed, two adjacent channels are closing at the same time.

11. Open the even numbered channels by executing:

WRITE ES00,0 (where E = extender number, S = slot number)

13-23 Maximum Sink Current Test

The maximum sink current test ensures that each channel output MOSFET is able to sink 500 mA of current. The test also checks the MOSFET's on-resistance at the specified maximum sink current. The test uses a 10 ohm resistor and a dc power supply to develop the 500 mA of sink current.

1. SET-UP PROCEDURE. Using the multimeter, measure the exact resistance of the 10 ohm resistor. This resistance is referred to as **R** in the following step.

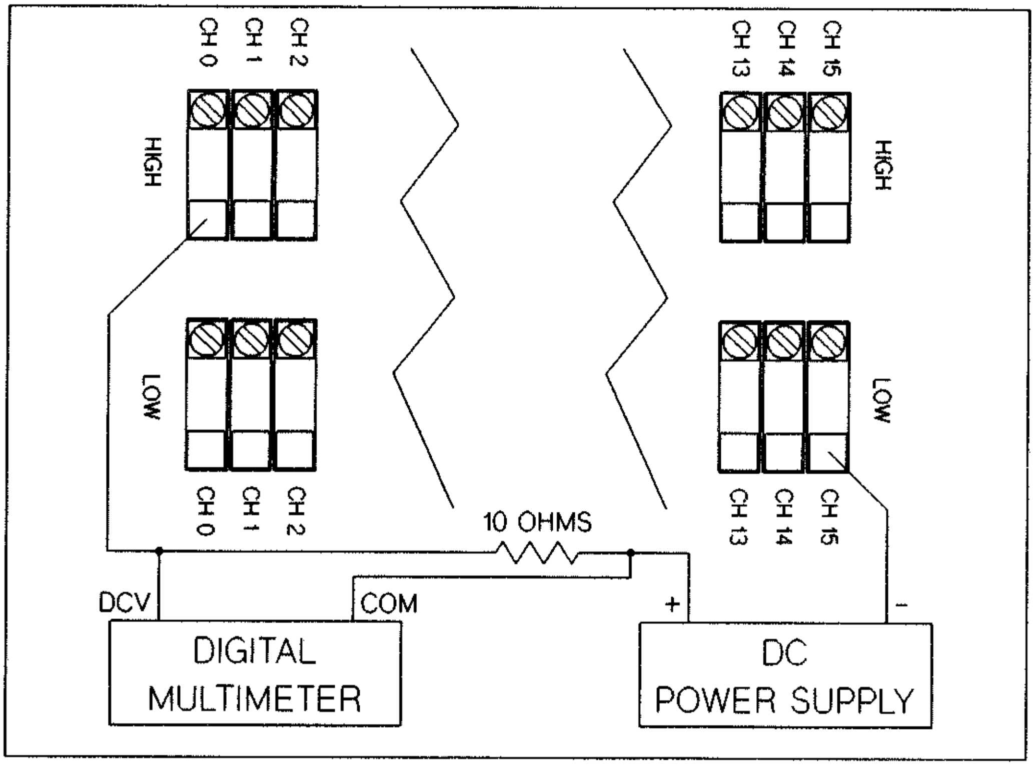


Figure 13-7 Even Channel Sink Current Test Set-Up

2. Calculate the voltage necessary to develop 500 mA of current by the formula:

   V = 0.5 • R

3. EVEN CHANNEL SINK CURRENT TEST. The following test checks the sink current capability of even channel output MOSFETs.

4. Set the power supply to output approximately +5 V dc. Connect the 10 ohm resistor (**R**) between the power supply + output and the even channel HIGH connections on the test fixure. Connect the power supply's - output to the shorted LOW connections on the test fixure. The connections are shown in Figure 13-7.

5. Set the multimeter to measure dc volts. Connect the DCV (HI) input of the multimeter to the shorted even channel HIGH connections on the test fixure. Connect the multimeter COM (LO) input to the + output on the power supply. The connections are shown in Figure 13-7.

6. Close channel 0 by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

7. Adjust the power supply until the voltage reading on the multimeter is at the same value as voltage **V** noted in step 2 (approximately -4.5 V). This should develop a sink current of 500 mA.

8. Connect the COM (LO) input of the multimeter to the shorted LOW connections on the test fixure. the connections are shown in Figure 13-8.

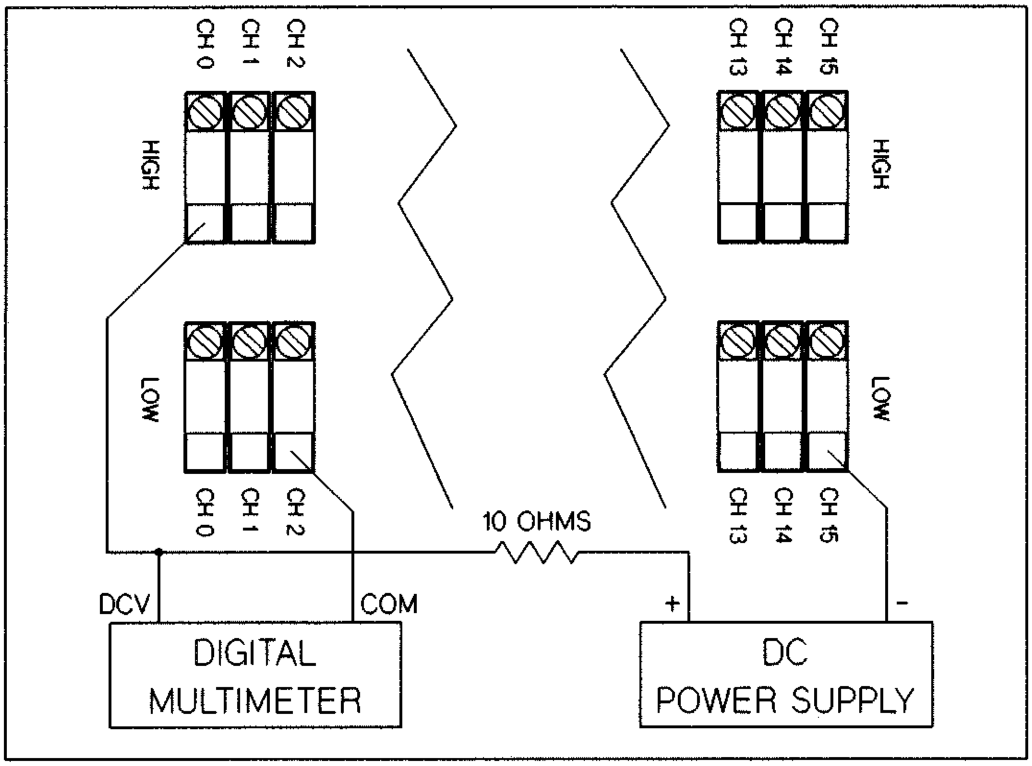


Figure 13-8 Even Channel Sink Current Test

9. Verify that the reading on the multimeter is 0.75 volts or less. This indicates an on-resistance of 1.5 ohms or less at a sink current of 500 mA.

10. Open channel 0 by executing:

OPEN ES00 (where E = extender number, S = slot number)

11. Repeat steps 5, 6, 7, 8, 9, and 10 for channels 2, 4, 6, 8, 10, 12, and 14. In the CLOSE and OPEN commands, the last two digits are the channel numbers (i.e., CLOSE ES02 for channel 2).

12. ODD CHANNEL SINK CURRENT TEST. The following test checks the sink current capability of odd channel output MOSFETs.

13. Connect the 10 ohm resistor (**R**) between the power supply + output and the odd channel HIGH connections on the test fixure. Connect the DCV (HI) input of the multimeter to the shorted odd channel HIGH connections on the test fixure. Connect the multimeter COM (LO) input to the + output on the power supply. The connections are shown in Figure 13-9.

14. Close channel 1 by executing:

CLOSE ES01 (where E = extender number, S = slot number)

15. Adjust the power supply until the voltage reading on the multimeter is the same as voltage **V** noted in step 2 (ignore polarity). This should develop a sink current of 500 mA.

16. Connect the COM (LO) input of the multimeter to the shorted LOW connections on the test fixure. the connections are shown in Figure 13-10.

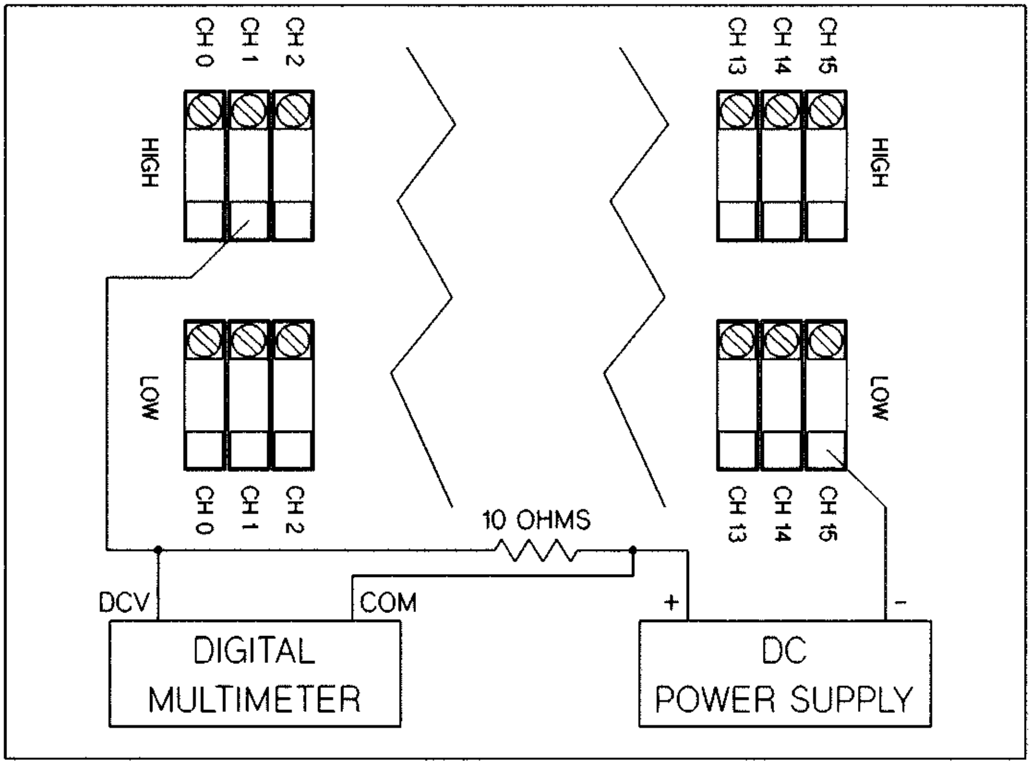


Figure 13-9 Odd Channel Sink Current Test Set-Up

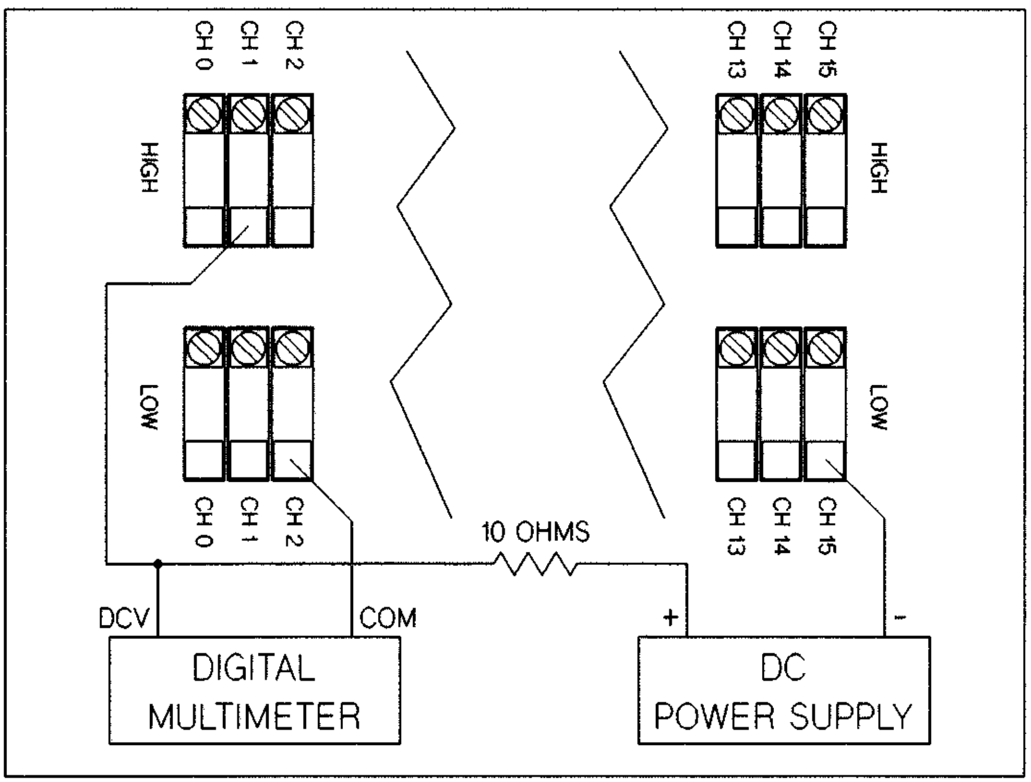


Figure 13-10 Odd Channel Sink Current Test

17. Verify that the reading on the multimeter is 0.75 volts or less. This indicates an on-resistance of 1.5 ohms or less at a sink current of 500 mA.

18. Open channel 1 by executing:

OPEN ES01 (where E = extender number, S = slot number)

19. Repeat steps 13, 14, 15, 16, 17, and 18 for channels 3, 5, 7, 9, 11, 13, and 15. In the CLOSE and OPEN commands, the last two digits are the channel numbers (i.e., CLOSE ES03 for channel 3).

13-24 REPLACEABLE PARTS

Figure 13-11 shows the mechanical breakdown of the HP 44724A. The figure also provides assembly and disassembly information. The parts shown in Figure 13-11 are keyed to the parts lists in Table 13-4.

To order a part listed in Table 13-4, quote the Hewlett-Packard part number, the quantity desired, the HP factory reference, and the check digit (abbreviated CD in Table 13-4). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

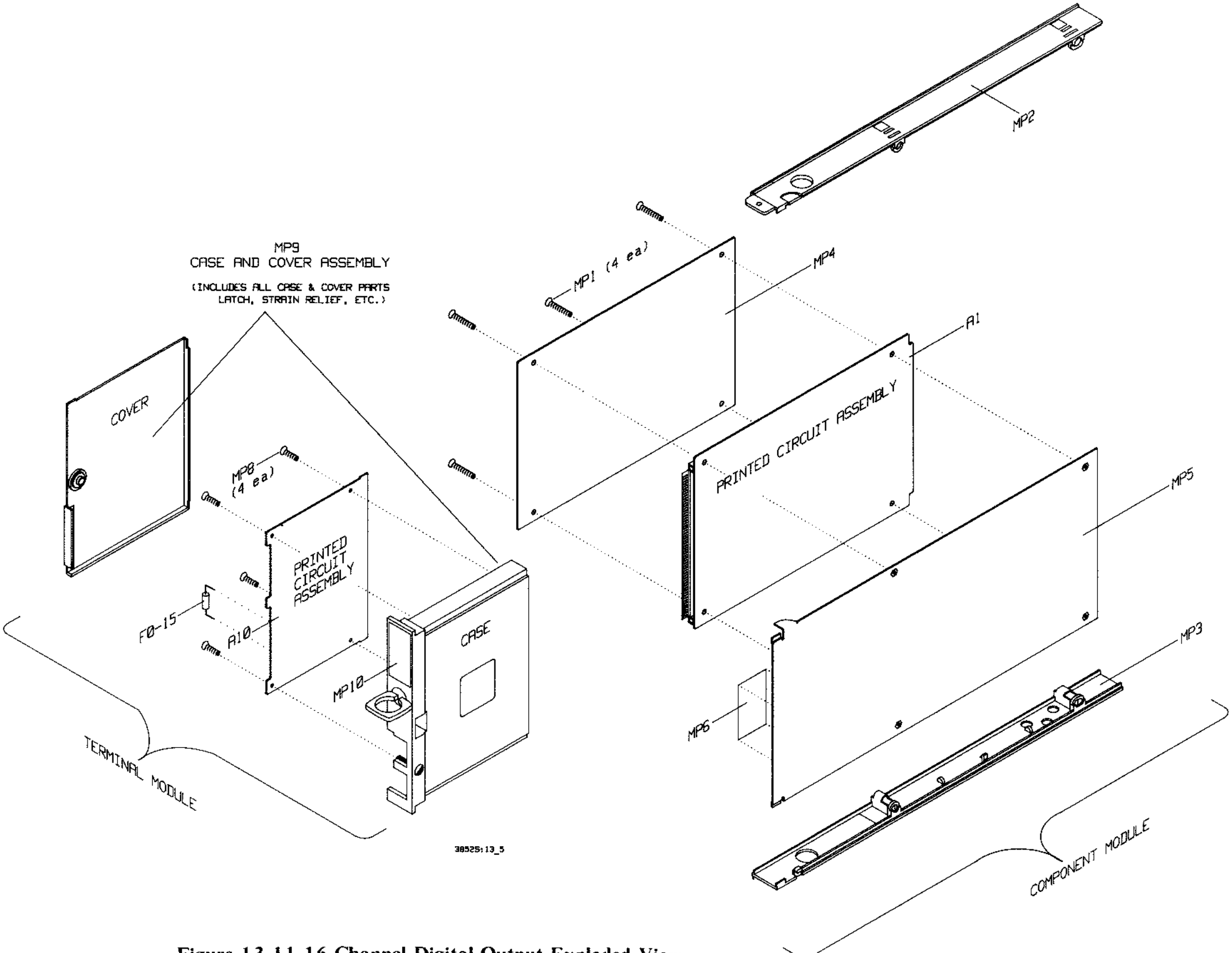


Figure 13-11 16 Channel Digital Output Exploded View

Table 13-4 HP 44724A 16 Channel Digital Output

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44724A	Module; 16 ch digtl output component	1	44724-66201	4	MOD-16CH DIG OUT
A1	PCA; 16 ch digital output component	1	44724-66501	7	PCA-DGTL OUT,DC
A10	PCA; 16 chan digital output terminal	1	44724-66510	8	PCA-DIG OUT TERM
F0-15	Fuse; subminiature 1A 125V, A10 PCA	16	2110-0099	4	FUSE-1A 125V
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44724A component module	1	44724-84320	6	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44724A	1	44724-84325	1	LBL-ID,TERM ASSY

Completely assembled HP 44724A terminal modules can be ordered from your local HP Office by ordering Number 44724AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44724A	Module; 16 ch digtl output component		44724-69201	0	RBLT-44724-66201

Chapter 14
HP 4725A General Purpose Switch

CHAPTER 14
HP 44725A 16 CHANNEL GENERAL PURPOSE SWITCH

CHAPTER 14
HP 44725A
16 CHANNEL
GENERAL PURPOSE SWITCH

14-1 INTRODUCTION

This chapter contains a technical description, performance test procedures, relay troubleshooting procedures, and replaceable parts for the HP 44725A 16 Channel General Purpose Switch.

14-2 Technical Description

The HP 44725A 16 Channel General Purpose Switch is designed to switch low and moderate levels of voltage and current. The switches are low noise, break-before-make single pole, double throw (SPDT) form C relays with normally open and normally closed contacts. The relays are not latching relays and return to the normally closed position after a reset, if power is removed, or following an OPEN command.

A block diagram of the HP 44725A is shown in Figure 14-1. On the schematic only two of the 16 channels are shown. The HP 44725A is made up of two main assemblies: a component module and a terminal module. The component module contains the backplane interface electronics, the relay drive control logic, the relay drivers and the channel relays. The component module contains terminal blocks for connection to external wiring.

14-3 Read and Write Registers

The HP 3852A communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 2 of this manual. Table 14-1 shows the registers used by the HP 44725A accessory.

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessory. It is possible to program some plug-in accessories into illegal ant potentially damaging states with these commands. The commands are documented here for service purposes only.

14-4 Read Registers

14-5 Register 0. Read Register 0 contains the accessory identification. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data bus.

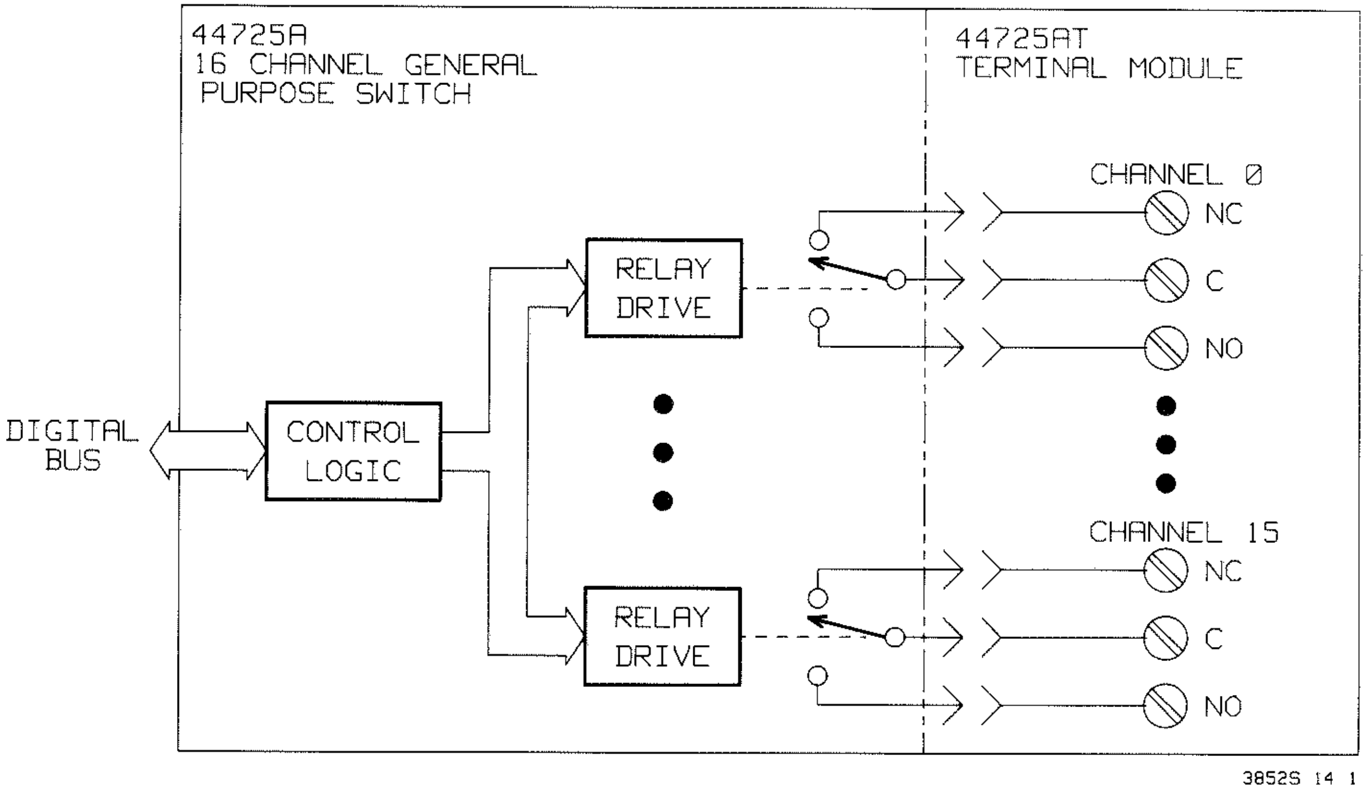


Figure 14-1 HP 44725A Block Diagram

Table 14-1 General Purpose Switch Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Reset
1	Always -239	Not Used
2	Not Used	Not used
3	Channels 0 through 15	Channels 0 through 15

The eight bit identification is in two parts. The five most significant bits identify the component module and the three least significant bits identify the type of terminal module installed. If a terminal module is not present, the lower three bits are set high by the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed.

Table 14-2 lists the decimal equivalent codes returned in response to an SREAD of Register 0.

14-6 Register 1. Read Register 1 is a hardwired register and will always return a decimal value of -239 in response to an SREAD.

Table 14-2 HP 44725A Identification Codes

Module Combinations	Codes
HP 44725A Component Module (no terminal module installed)	-217
HP 44725A Component Module, HP 44725AT Terminal Module installed	-222

14-7 Register 3. Read Register 3 is the status register. The register contains a sixteen bit status word, representing the last programmed state of the channel switches. The bits in the status word correspond one-to-one with the channel numbers (i.e., bit 15 represents channel 15). Figure 14-2 is an example of the status word. In the figure, it is presumed that channel 15 is closed.

```
Bits:       15 14 13 12 11 10 9  8  7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

Figure 14-2 Read Register 3

NOTE

The decimal number returned after the execution of an SREAD command represents the two's compliment of the status word.

14-8 Write Registers

14-9 Register 0. Write Register 0 is the accessory reset register. Any data written to this register will cause a reset of the accessory and force all the channel switches open. A write to Register 0 has the same effect as a backplane accessory reset.

14-10 Register 3. Register 3 is the control register. A sixteen bit word is used to control the status of the channel switches. The bits in the command word correspond one-to-one to the channel number (i.e., setting bit 15 closes channel 15). Figure 14-3 is an example of the command word. In the figure, it is presumed that channel 15 to be closed.

```
Bits:       15 14 13 12 11 10 9  8  7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0  0  0  0  0  0  0  0  0
```

Figure 14-3 Command Word

NOTE

The decimal number sent by an SWRITE command represents the two's compliment of the command word in the write register.

14-11 SPECIFICATIONS

Specifications for the HP 44725A are given in Table 14-3. Specifications are the performance standards or limits against which the General Purpose Switch may be tested.

Table 14-3 HP 44725A Specifications

Maximum Input Voltage (Vmax) per channel: 30 V DC or RMS
42 V peak

Maximum Input Current: 1.5 A DC, 1.5 A RMS per channel

Maximum Sum of the Squared RMS Currents in Each Channel (per module; for any type load): 24 A^2

Closed Channel Path Resistance: 175 mΩ

Switch Life: At Full Load, 10^5 (<=2 switches per second)
At Minimum Load, 10^8 (<=2 switches per second)

Input Impedance:

Impedance	Terminals		
	Open Contacts	Channel to Channel	Channel to Earth
Resistance (Ω)	$>10^9$	$>10^9$	$>10^9$
Max. Capacitance (pf) at 1MHz	10	5	30

Crosstalk: -73 dB at 100 kHz (channel-to-channel, 50 Ω source, 1 MΩ termination)

Maximum Offset Voltage: 5 µV

Maximum Bias Current: ±5 nA DC

Minimum Load: 100 mV minimum DC voltage and 100 µA minimum DC current is needed to avoid excessive buildup of contact resistance

Maximum Wire Size: 16 AWG

14-12 PERFORMANCE TESTS

14-13 Introduction

The following Performance Tests check the operation of the HP 44725A component module. Performance Tests are not given for the terminal modules. Successful completion of all tests in this chapter provides a high confidence level that the General Purpose Switch is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in the General Purpose Switch operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 14-14.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence that the General Purpose Switch is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

14-14 Operational Verification

The first tests given in this section are the minimum set of tests recommended for the General Purpose Switch. These tests are designed to test the functionality and the contact resistance of the relays. Successful completion of the Operational Verification Tests provides a 90% confidence level that the General Purpose Switch is operating normally and is within specification.

The Operational Verification Tests consist of the following:

Section 14-15 - Set-Up Procedure
Section 14-19 - Contact Resistance Test

14-15 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first three items in the list are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 14-16)

2. Digital Multimeter -- HP 3456A or equivalent

3. Test Leads and Jumpers

4. Service Module -- HP 44743A

5. Resistor -- 10 Mohm

6. +20 V Power Supply -- HP 6212 or equivalent

NOTE

Either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for this test. This test does not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

14-16 Test Fixture

A test fixture is required to run the Performance Tests. A schematic of the required test fixture is shown in Figure 14-4a. A test fixture can be manufactured using an HP 44725AT terminal module (see Figure 14-4b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44725AT terminal module, it is important that the terminal ID lines, shown in Figure 14-4a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The test fixture consists of: a short circuit between all channel NC (Normally Closed) lines, a short circuit between all channel NO (Normally Open) lines, and a short circuit between all channel C (Common) lines. The use of the test fixture minimizes the number of test lead connections required for the tests.

14-17 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

14-18 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the General Purpose Switch component module and install the test fixture. Note the slot number where the General Purpose Switch under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows:

      44725

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

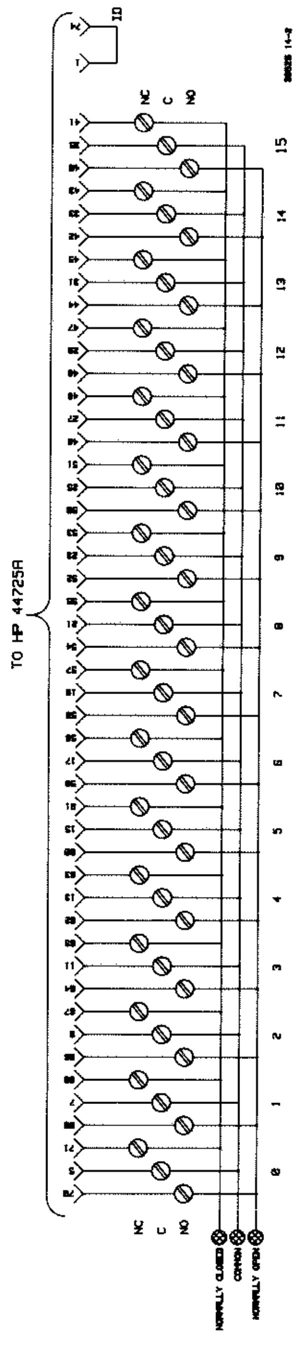


Figure 14-4a HP 44725A Test Fixure Schematic

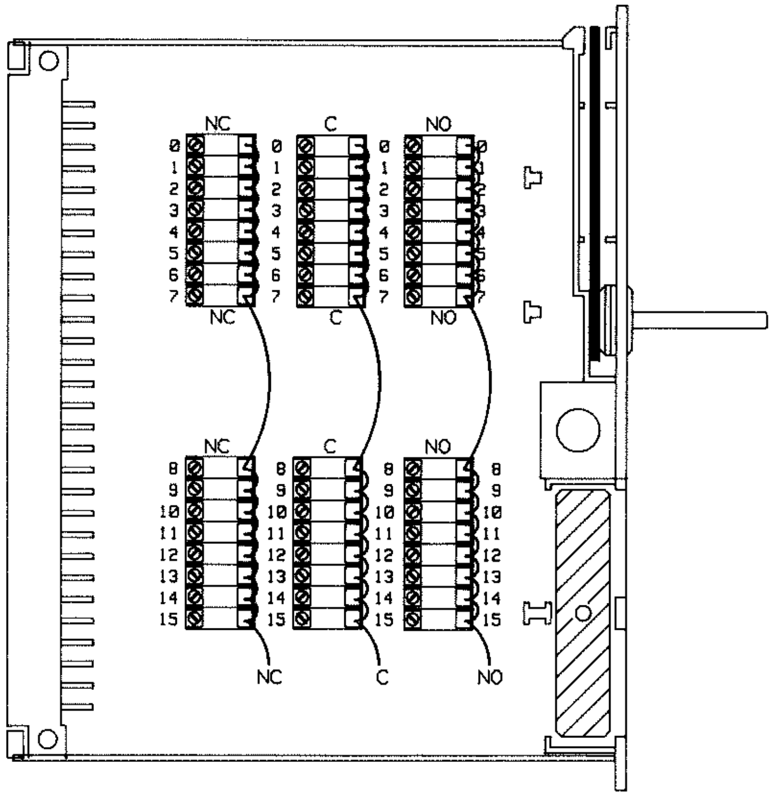


Figure 14-4b HP 44725A Test Fixure

14-19 Contact Resistance Test

1. NORMALLY OPEN CONTACT RESISTANCE TEST: This test checks the contact resistance of the normally open relay contacts. Since these contacts are normally open, a CLOSE command closes the contacts and an OPEN command opens the contacts.

2. Set all HP 44725A channel relays to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

3. Set the multimeter to measure four-wire ohms. Connect the multimeter DCV input and high SENSE leads to the NO (Normally Open) connection on the test fixture. Connect the multimeter COM input and COM SENSE leads to the C (Common) connection on the test fixture. The connections are shown in Figure 14-5.

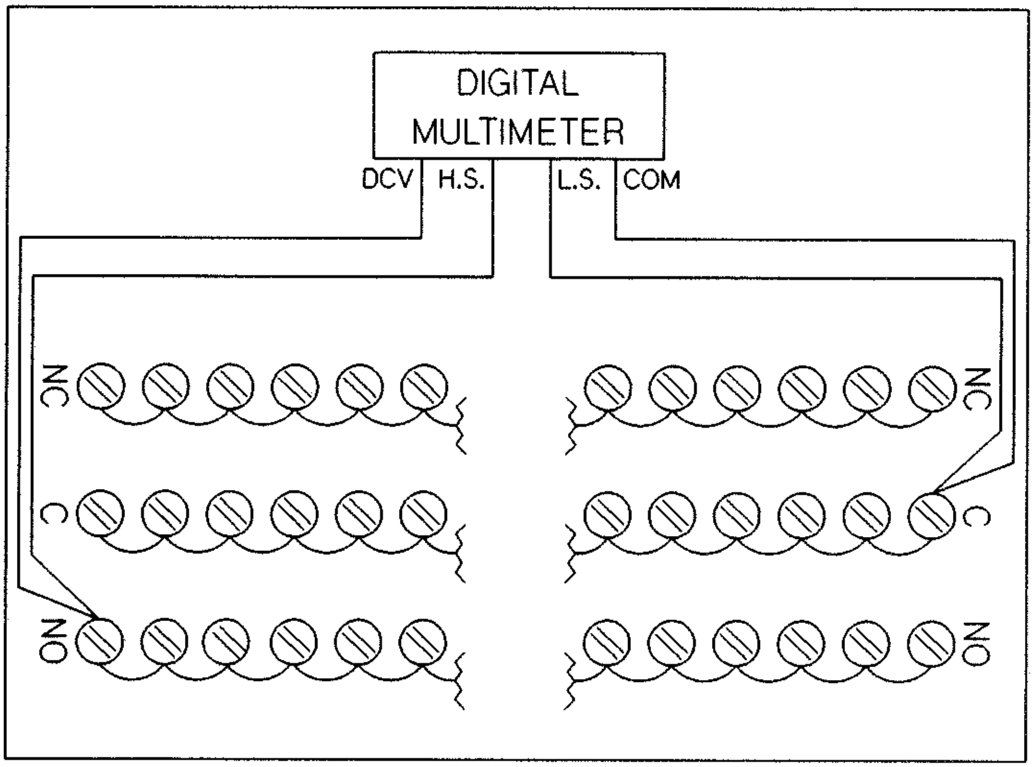


Figure 14-5 HP 44725A NO Channels Contact Resistance Test

4. Close channel 00 by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The multimeter should indicate a resistance less than 0.175 ohms.

6. Open channel 00 by executing:

   OPEN ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. The multimeter should indicate an open circuit ($>=10^9$ ohm). It is important to perform this step to ensure that none of the relays are stuck closed. If the multimeter does not indicate an open, troubleshooting will be necessary to locate the stuck relay. Section 14-23 describes locating a stuck relay.

8. Repeat steps 4, 5, 6, and 7 for channels 01 through 15. In the CLOSE and OPEN command the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

9. NORMALLY CLOSED CONTACT RESISTANCE TEST: This test checks the contact resistance of the normally closed relay contacts. Since these contacts are normally closed, a CLOSE command opens the contacts and an OPEN command closes the contacts.

10. Connect the multimeter DCV input and high SENSE leads to the NC (Normally Closed) connection on the test fixture. Connect the multimeter COM input and low SENSE leads to the C (Common) connection on the test fixture. The connections are shown in Figure 14-6.

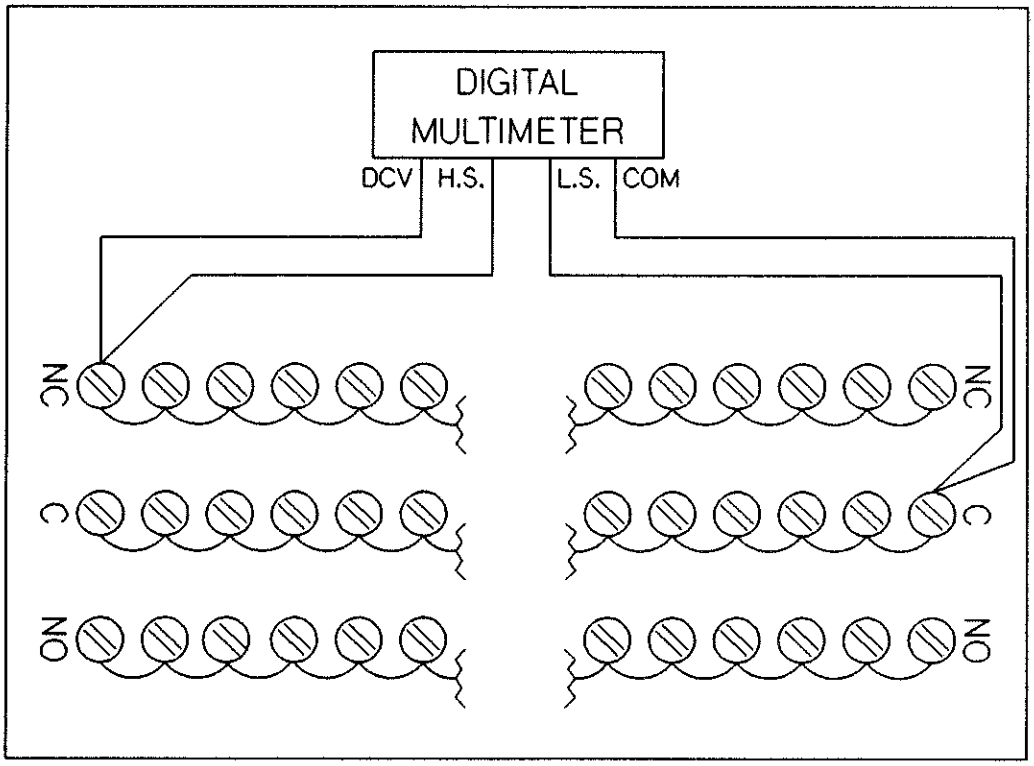


Figure 14-6 HP 44725A NC Channels Contact Resistance Test

11. Open all channels by executing:

CLOSE ES00-ES15 (where E = extender number, S = slot number)

The multimeter should indicate an open circuit.

12. Close channel 00 by executing:

OPEN ES00 (where E = extender number, S = slot number)

13. Observe the indication on the multimeter. The multimeter should indicate a resistance of less than 0.175 ohms.

14. Open channel 00 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

15. Observe the indication on the multimeter. The multimeter should indicate an open circuit (>=10^9 ohm) It is important to perform this step to ensure that none of the relays are stuck closed. If the multimeter does not indicate an open, troubleshooting will be necessary to locate the stuck relay. Section 14-23 describes locating a stuck relay.

16. Repeat steps 12, 13, 14, and 15 for channels 01 through 15. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44725A PERFORMANCE TESTS.

14-20 Thermal Offset Test

1. NORMALLY OPEN THERMAL OFFSET TEST: This test checks the thermal offset of the normally open relay contacts. Since these relays are normally open, a CLOSE command closes the relays.

2. Set all HP 44725A channel relays to a known state by executing:

   RESET ES00 (where E= extender number, S= slot number)

3. Perform the Set-Up Procedure given in Section 14-18. The NO Thermal Offset test set-up is shown in Figure 14-7.

4. Set the multimeter to measure DC volts, on a range with at least 1 µV resolution. Connect the multimeter DCV lead to the shorted NO (Normally Open) lines of the test fixture. Connect the multimeter COM lead to the shorted C (Common) lines of the test fixture.

5. Close channel 00 by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

6. Observe the indication on the multimeter. The voltage indicated should be less than 5 µV.

7. Repeat steps 5 and 6 for channels 01 through 15. In the CLOSE command the last two digits are the channel number (i.e., CLOSE ES01 would close channel 01 in extender E at slot S).

8. NORMALLY CLOSED THERMAL OFFSET TEST: This test checks the thermal offset of the normally closed relay contacts. Since these relays are normally closed, a CLOSE command opens the relays and an OPEN command closes the relays.

9. Refer to Figure 14-8 for the test set-up. Connect the multimeter DCV lead to the shorted NC (Normally Closed) lines of the test fixture. Connect the multimeter COM lead to the shorted C (Common) lines of the test fixture.

10. Open all channels by executing the following:

    CLOSE ES00-ES15 (where E = extender number, S = slot number)

11. Close channel 00 by executing:

    OPEN ES00 (where E = extender number, S = slot number)

12. Observe the indication on the multimeter. The voltage indicated should be less than 5 µV.

13. Repeat steps 11 and 12 for channels 01 through 15. In the OPEN and CLOSE commands, the last two digits are the channel number (i.e., OPEN ES01 would close channel 01 in extender E at slot S).

14-21 DC Isolation Tests

The DC Isolation tests use a power supply, a resistor and the voltmeter to form a voltage divider. The channel being tested is then connected in parallel with this divider and the isolation resistance computed from the measured voltage across the divider. The best test results will be obtained when the resistor value used is the same value as the internal resistance of the voltmeter. The recommended 10 Mohm resistor was selected to match the input impedance of an HP 3456A multimeter set to the 100 Vdc range.

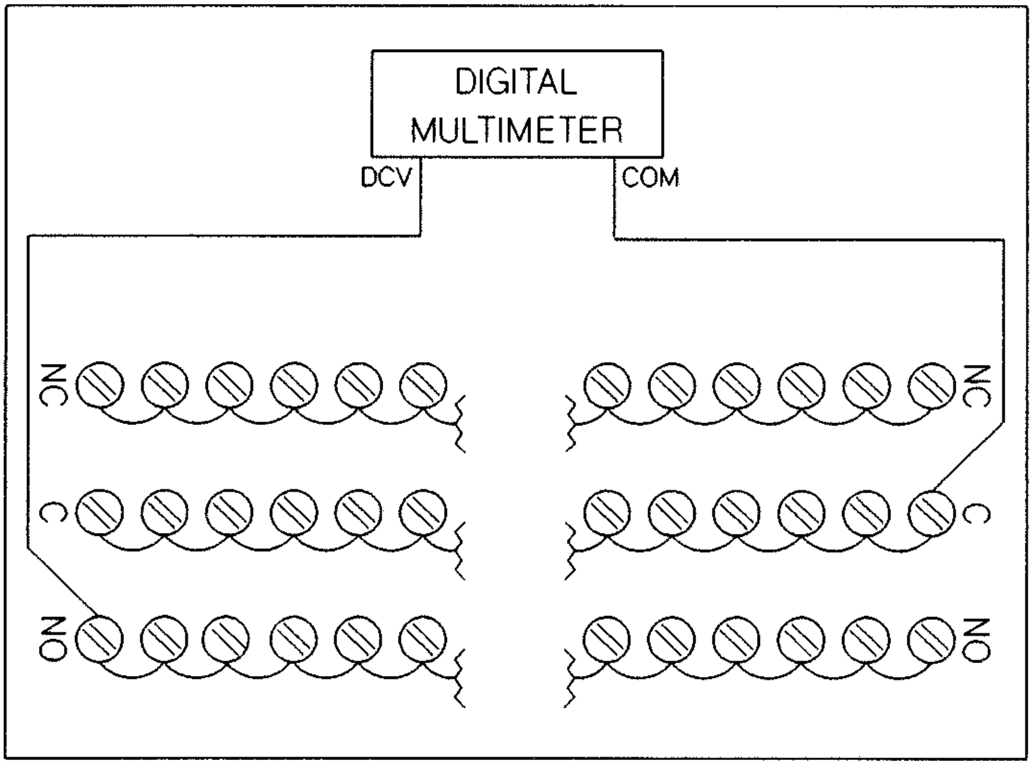


Figure 14-7 HP 44725A NO Channels Thermal Offset Test Set-Up

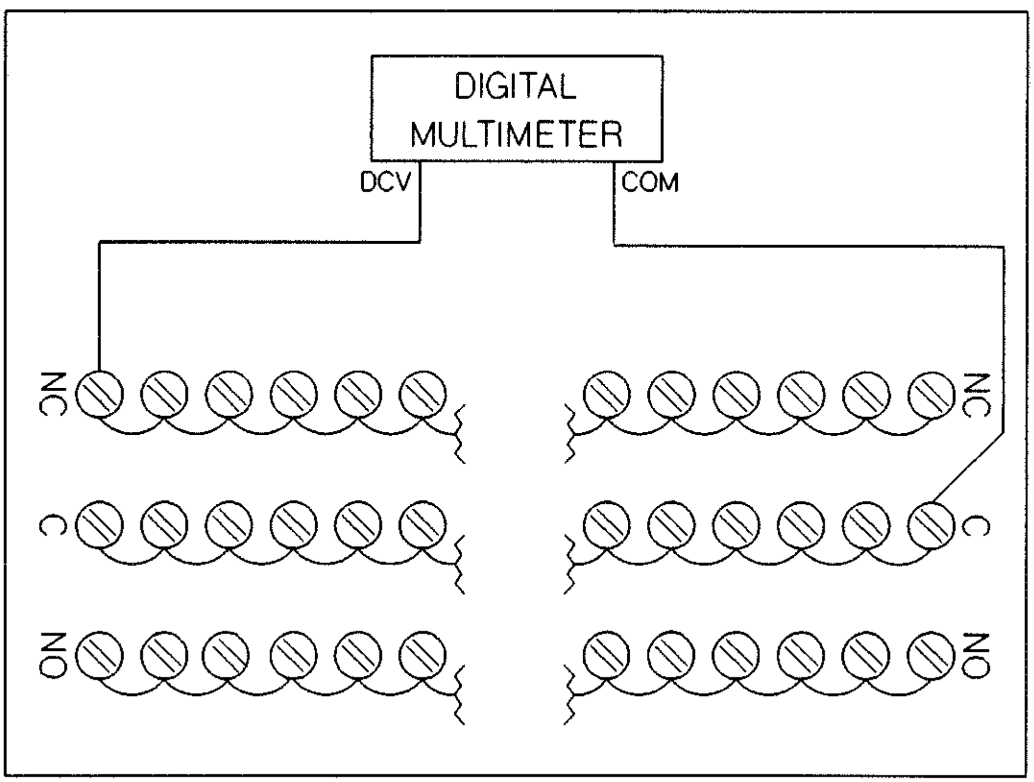


Figure 14-8 HP 44725A NC Channels Thermal Offset Test Set-Up

1. SET-UP PROCEDURE. Using the multimeter, measure the exact resistance of the 10 Mohm resistor. This resistance will be referred to as **R1** in the following steps.

2. Set the multimeter to measure DC volts and connect the multimeter to the DC power supply. Adjust the DC power supply output to +20 Vdc ±0.01 Vdc. This voltage will be referred to as **V1** in the following steps.

3. Connect the resistor, power supply and multimeter as shown in Figure 14-9.

4. Set the multimeter to the 100 Vdc range. Measure the exact voltage displayed on the multimeter. This voltage will be referred to as **V2** in the following steps.

5. Calculate the internal resistance of the multimeter (**Rm**) using the following equation:

$$Rm = R1 \bullet V2/(V1-V2)$$

NOTE

In most cases, the internal resistance of the multimeter is dependent upon the range selected. For this reason, do not change the multimeter range setting in the following procedure.

6. NORMALLY OPEN CHANNELS TO COMMON ISOLATION TEST. This test checks the open channel DC isolation across the NO (Normally Open) relay contacts.

7. Set the General Purpose Switch to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

8. Refer to Figure 14-10. Connect test lead A of the test circuit to the shorted NO lines on the test fixure. Connect test lead B of the test circuit to the shorted C (Common) lines on the test fixture.

9. Record the multimeter voltage measurement. This reading will be referred to as **V3**.

10. Calculate the DC isolation (**Rc**) using the following equation:

$$Rc = \frac{V3 \bullet R1 \bullet Rm}{Rm \bullet (V1 - V3) - (R1 \bullet V3)}$$

The open channel DC isolation should be greater than 65 Mohms. If the isolation is less than 65 Mohms, one or more of the Normally Open channel relays may be defective.

11. NORMALLY CLOSED CHANNELS TO COMMON ISOLATION TEST. This test checks the open channel DC isolation across the NC (Normally Closed) relay contacts.

12. Open the NC channels by executing:

CLOSE ES00-ES15 (where E = extender number, S = slot number)

13. Refer to Figure 14-11. Connect test lead A of the test circuit to the shorted NC lines on the test fixure. Connect test lead B of the test circuit to the shorted C (Common) lines on the test fixture.

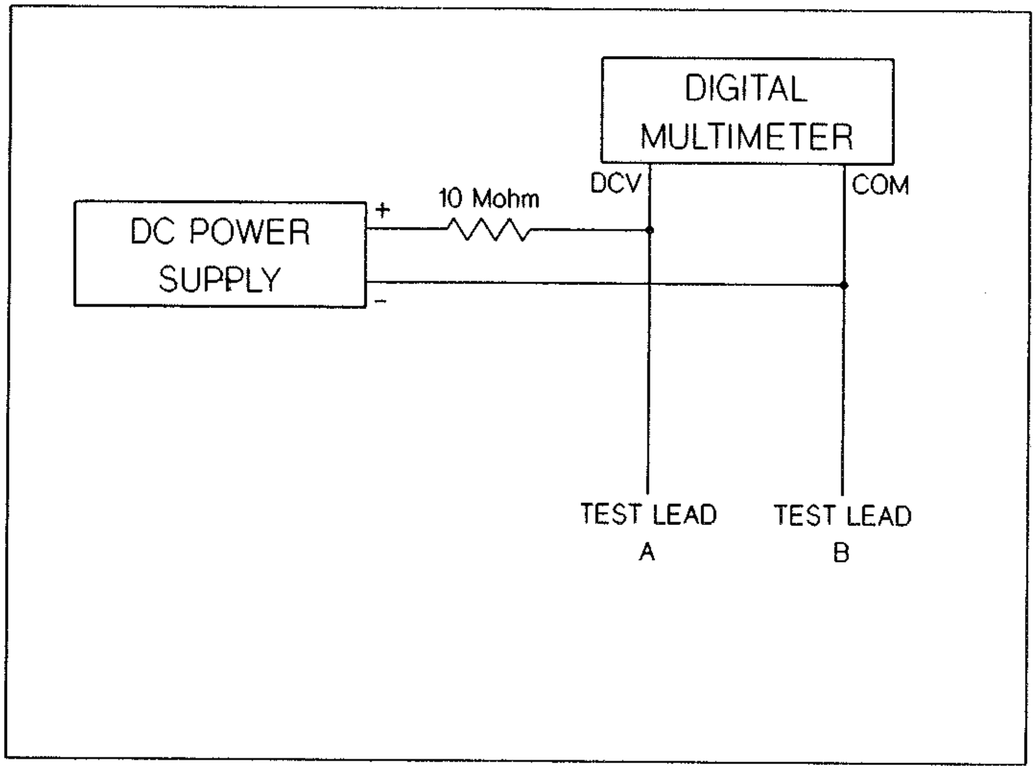


Figure 14-9 HP 44725A DC Isolation Test Set-Up

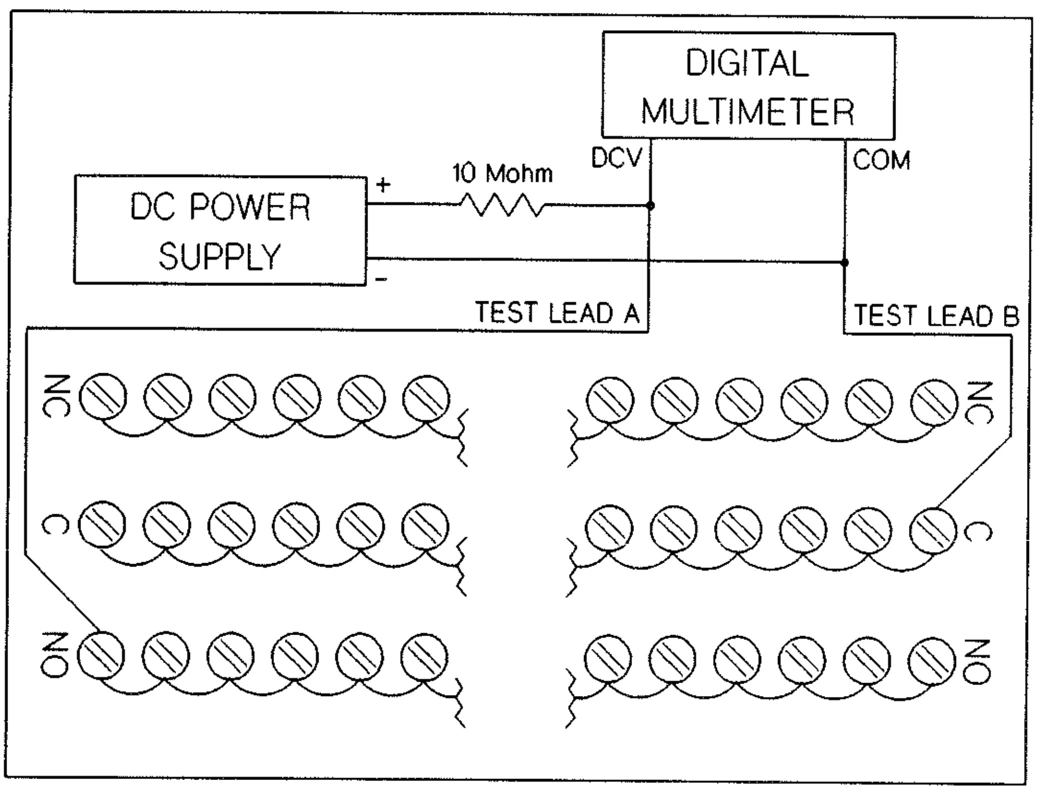


Figure 14-10 HP 44725A NO Channels to Common DC Isolation Test

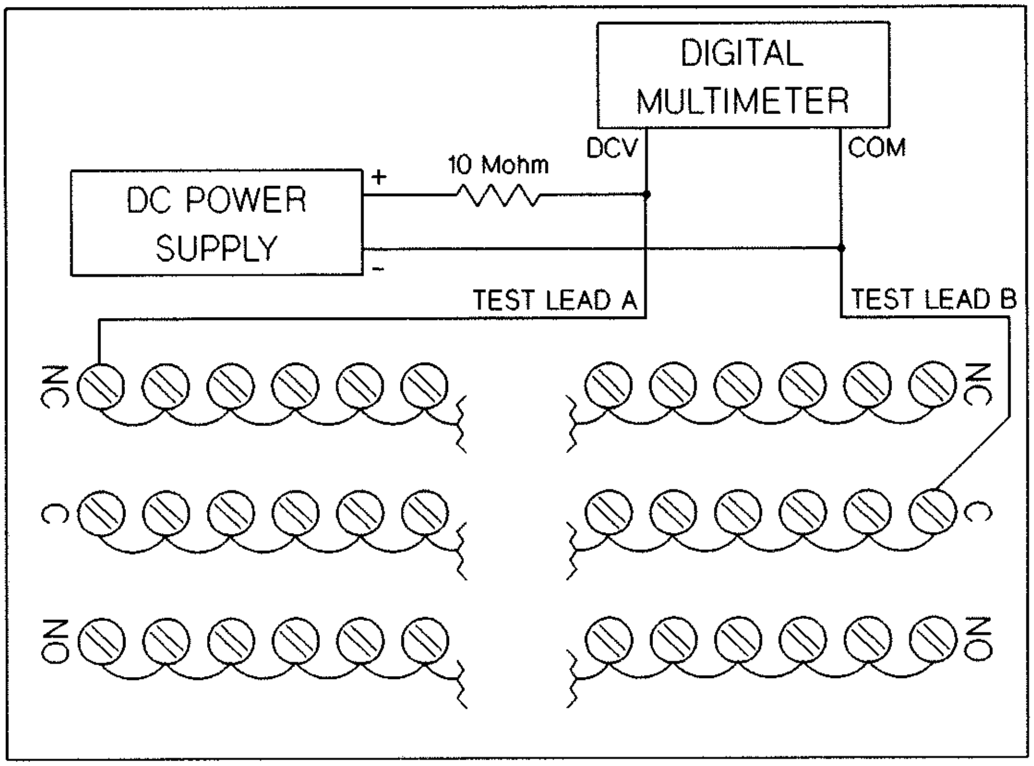


Figure 14-11 HP 44725A NC Channels to Common DC Isolation Test

14. Record the multimeter voltage measurement. This reading will be referred to as **V4**.

15. Calculate the DC isolation (**Rc**) using the following equation:

$$\mathbf{Rc} = \frac{\mathbf{V4 \bullet R1 \bullet Rm}}{\mathbf{Rm \bullet (V1 - V4) - (R1 \bullet V4)}}$$

The open channel DC isolation should be greater than 65 Mohms. If the isolation is less than 65 Mohms, one or more of the Normally Closed channel relays may be defective.

16. NORMALLY OPEN CHANNELS TO EARTH GROUND ISOLATION TEST. This test checks the NO (Normally Open) channels to earth ground DC isolation.

17. Close the NO channels by executing:

CLOSE ES00-ES15 (where E = extender number, S = slot number)

18. Refer to Figure 14-12. Connect test lead A of the test circuit to the shorted C (Common) lines on the test fixture. Connect test lead B of the test circuit to the chassis.

NOTE

Connections to chassis ground can be accomplished by connecting to any sheet metal part. Chassis ground is also available at a connector on the rear panel of the HP 3852A power supply.

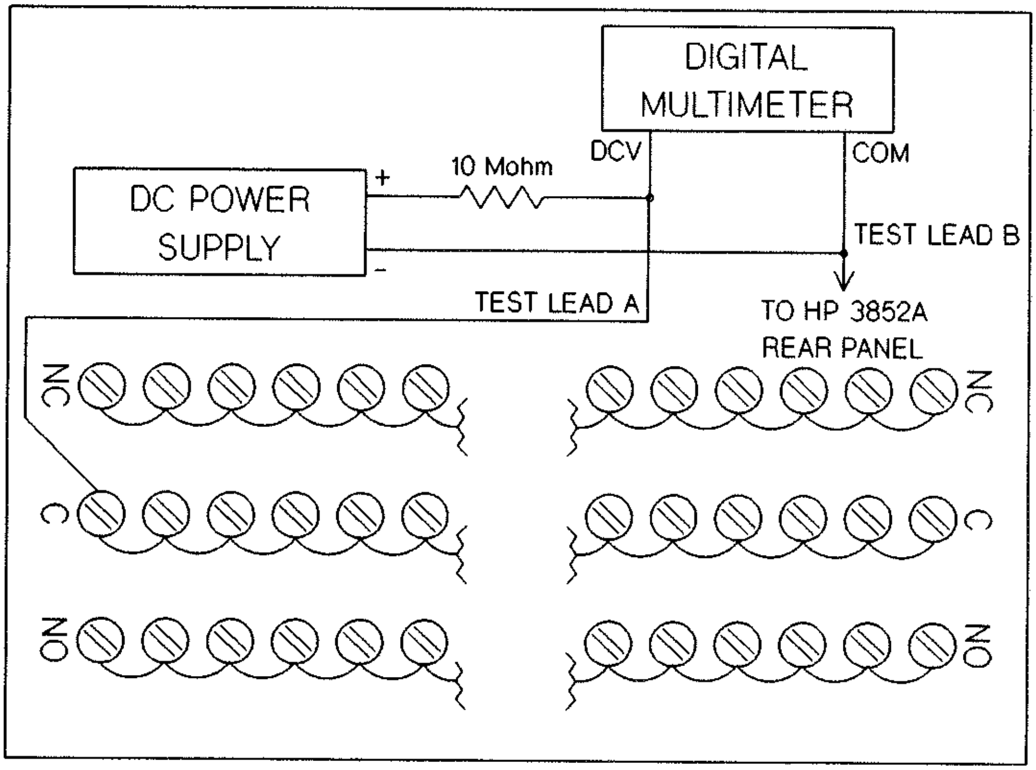


Figure 14-12 HP 44725A Channels to Earth Ground DC Isolation Test

19. Record the multimeter voltage measurement. This reading will be referred to as **V5**.

20. Calculate the DC isolation (**Rc**) using the following equation:

$$\mathbf{Rc} = \frac{\mathbf{V5 \bullet R1 \bullet Rm}}{\mathbf{Rm \bullet (V1 - V5) - (R1 \bullet V5)}}$$

The NO channels to earth ground DC isolation should be greater than 10^9 ohms.

21. NORMALLY CLOSED CHANNELS TO EARTH GROUND ISOLATION TEST. This test checks the NC (Normally Closed) channels to earth ground DC isolation.

22. Close the NC channels by executing:

OPEN ES00-ES15 (where E = extender number, S = slot number)

23. Refer to Figure 14-12. Connect test lead A of the test circuit to the shorted C (Common) lines on the test fixture. Connect test lead B of the test circuit to the chassis.

24. Record the multimeter voltage measurement. This reading will be referred to as **V6**.

25. Calculate the DC isolation (**Rc**) using the following equation:

$$\mathbf{Rc} = \frac{\mathbf{V6 \bullet R1 \bullet Rm}}{\mathbf{Rm \bullet (V1 - V6) - (R1 \bullet V6)}}$$

The NC channels to earth ground DC isolation should be greater than 10^9 ohms.

14-22 Injected Current Test

This test measures the amount of current injected into the NO (Normally Open) and NC (Normally Closed) contacts of each channel relay. The amount of injected current is deduced by measuring the voltage drop across a known value resistor. A 10 Mohm resistor is recommended.

1. NO LINES INJECTED CURRENT TEST. Set the multimeter to the DC volts function on a range with at least 10 µV of resolution. Install the 10 Mohm resistor across the input terminals of the multimeter. This resistance will be referred to as **R1** in the following steps.

2. Refer to Figure 14-13. Connect the multimeter DCV lead to the shorted NO lines of the test fixture. Connect the multimeter COM lead to the shorted C (Common) lines of the test fixure.

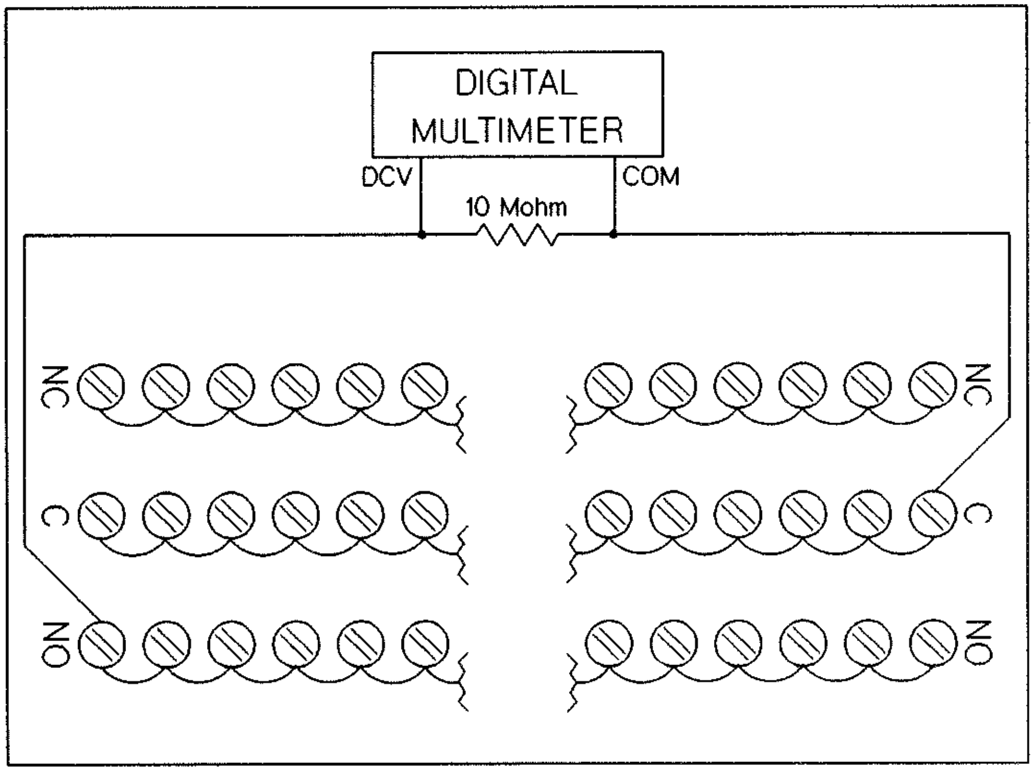


Figure 14-13 HP 44725A NO Channels Injected Current Test

3. Set the General Purpose Switch to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

4. Close the first NO channel in the General Purpose Switch by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

5. Record the voltage indicated on the multimeter. This voltage will be referred to as **V1**.

6. Calculate the injected current (I) from the formula:

$$I = \frac{V1}{R1}$$

The injected current must be less than 5 nA.

Once the value of the resistor used is known, the specification can be checked by simply measuring the voltage. For example, using the recommended 10 Mohm resistor, the voltage indicated on the multimeter must be less than 0.05 VDC.

7. Open the first NO channel by executing:

OPEN ES00 (where E = extender number, S = slot number)

8. Repeat steps 4, 5, 6, and 7 for channels 01 through 15. In the CLOSE and OPEN commands, the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

9. NC LINES INJECTED CURRENT TEST. Set the multimeter to the DC volts function on a range with at least 10 µV of resolution. Install the 10 Mohm resistor across the input terminals of the multimeter. This resistance will be referred to as **R1** in the following steps.

10. Refer to Figure 14-14. Connect the multimeter DCV lead to the shorted NC lines of the test fixture. Connect the multimeter COM lead to the shorted C (Common) lines of the test fixure.

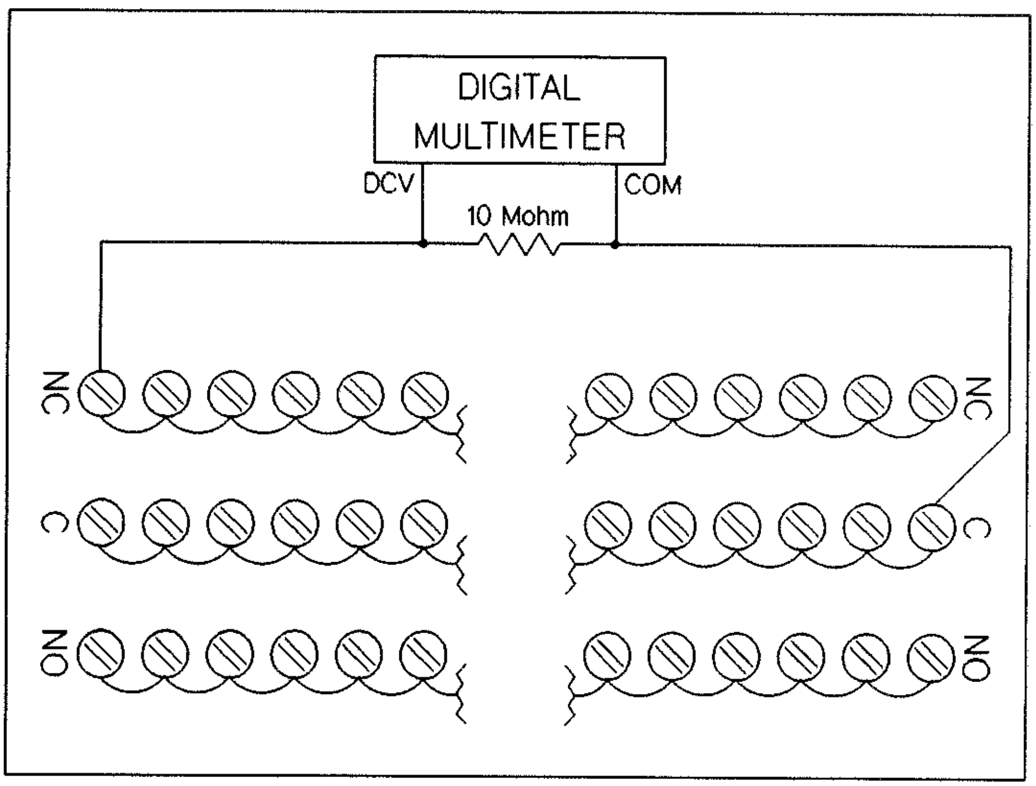


Figure 14-14 HP 44725A NC Channels Injected Current Test

11. Open all NC channel by executing:

CLOSE ES00-ES15 (where E = extender number, S = slot number)

12. Close the first NC channel in the General Purpose Switch by executing:

    OPEN ES00 (where E = extender number, S = slot number)

13. Record the voltage indicated on the multimeter. This voltage will be referred to as **V1**.

14. Calculate the injected current (I) from the formula:

$$I = \frac{V1}{R1}$$

The injected current must be less than 5 nA.

15. Open the first NC channel by executing:

    CLOSE ES00 (where E = extender number, S = slot number)

16. Repeat steps 12, 13, 14, and 15 for channels 01 through 15. In the OPEN and CLOSE commands, the last two digits are the channel number (i.e., OPEN ES01 for channel 01).

14-23 RELAY TROUBLESHOOTING

This section describes relay troubleshooting. The troubleshooting procedures first determine if the problem is located in the relays, or in the control logic. If the problem is determined to be in the control logic, complete replacement of the printed circuit board is required. Individual relays may be replaced.

The Operational Verification tests provide a starting point for problem isolation. Operational Verification tests are described in Section 14-14.

A single failing channel indicates a failing channel relay. Table 14-4 is the relay cross reference table showing the relationship between channel numbers, relay numbers, and relay drivers and their corresponding input/output pin numbers. The table also shows the NC, NO, and C pin numbers on the component module connector.

Figure 14-15 shows the location of the relays on the component module board. Figure 14-16 shows a simplified schematic of one relay and associated circuitry. Since all the relay circuitry is the same, only one relay circuit is shown in the figure. Also shown in Figure 14-16 is a package outline and pinout diagram of the type of relay used. Use both Figures 14-13 and 14-14, and Table 14-4 for the following troubleshooting procedures.

CAUTION

To prevent equipment circuit damage always set the line power switch to off before removing or replacing any assembly. To prevent static zap of ICs always observe anti-static handling techniques when assemblies are handled or stored.

Table 14-4 HP 44725A Relay Cross Reference Table

Channel Number	Relay Number	Relay Driver Input/Output		Component Module Connector Pins		
		Input	Output	NC	NO	C
0	K1	U13 pin 1	U13 pin 18	71	70	5
1	K2	U13 pin 2	U13 pin 17	69	68	7
2	K3	U13 pin 3	U13 pin 16	67	66	9
3	K4	U13 pin 4	U13 pin 15	65	64	11
4	K5	U13 pin 5	U13 pin 14	63	62	13
5	K6	U13 pin 6	U13 pin 13	61	60	15
6	K7	U13 pin 7	U13 pin 12	59	58	17
7	K8	U13 pin 8	U13 pin 11	57	56	19
8	K9	U14 pin 1	U14 pin 18	55	54	21
9	K10	U14 pin 2	U14 pin 17	53	52	23
10	K11	U14 pin 3	U14 pin 16	51	50	25
11	K12	U14 pin 4	U14 pin 15	49	48	27
12	K13	U14 pin 5	U14 pin 14	47	46	29
13	K14	U14 pin 6	U14 pin 13	45	44	31
14	K15	U14 pin 7	U14 pin 12	43	42	33
15	K16	U14 pin 8	U14 pin 11	41	40	35

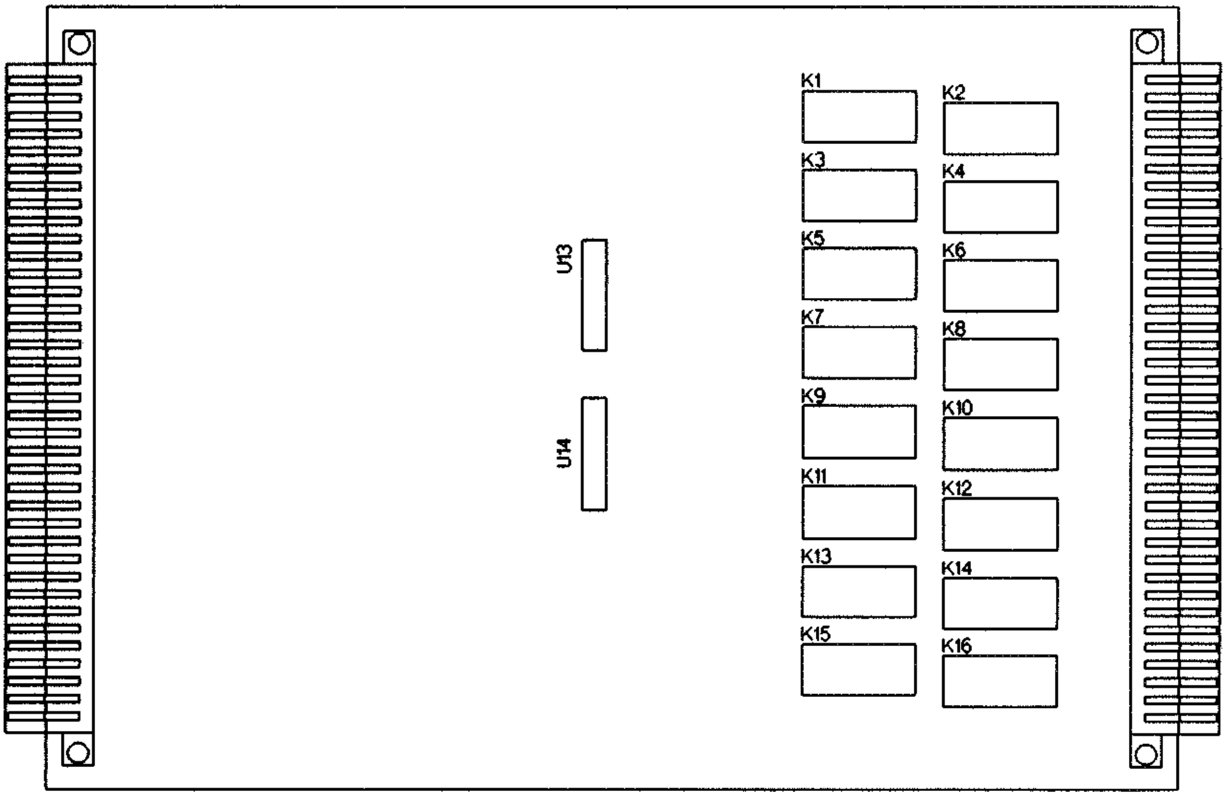


Figure 14-15 Relay Component Locator

14-24 Control Logic Problem Isolation

The following control logic test writes relay closing patterns to the General Purpose Switch and then checks for an indication of the relay state in the status register (Read Register 3). Electrically, this test checks that the correct relay drive lines were enabled. It does not actually check the drive lines. The test does provide an indication that the control logic is performing as required and can communicate with the HP 3852A local controller.

NOTE

If using an HP 9000 Series 300 or Series 300 computer to perform this test, it may be necessary to program a delay between the SWRITE and SREAD commands (steps 2, 4, and 5) to allow time for the relay states to be latched into the status register.

1. Reset the HP 44725A General Purpose Switch by executing:

   RESET ES00 (where E = extender number, S = slot number)

2. Read the status register by executing:

   SREAD ES00 (where E = extender number, S = slot number)

3. Verify that the right display shows:

   0

If the display shows 0 (all channels open), the HP 44725A has been reset. Proceed to Step 4. If a number other than 0 is displayed, cycle power on the HP 3852A and perform steps 2 and 3 again. If the number is still incorrect, a failure exists with the HP 44725A control logic or with the HP 3852A. If the HP 3852A seems to operate normally (see Chapter 5 for HP 3852A problem isolation), the fault most likely exists in the HP 44725A switch control logic.

4. Close all relays by executing:

   SWRITE ES00,3,-1 (where E = extender number, S = slot number)

5. Read the status register by executing:

   SREAD ES00,3 (where E = extender number, S = slot number)

6. Verify that the right display shows:

   -1

7. Reset the HP 44725A General Purpose Switch by executing:

   RESET ES00 (where E = extender number, S = slot number)

CAUTION

This procedure sets illegal and potentially damaging states on the HP 44725A General Purpose Switch. Be sure to execute the RESET command in Step 7 to clear these states.

If the control logic test passed and a relay is not closing or opening, relay replacement is indicated. Since the control logic test is unable to check the actual relay drive lines, an additional test can be performed. With a digital multimeter, check the voltage across the faulty relay coil. The multimeter should indicate a steady state voltage of approximately 4.0 Vdc when the relay is open. The multimeter should indicate less than 0.2 Vdc when the relay is closed. The resistance across the relay coil should be approximately 130 Ω.

14-25 Stuck Relay Troubleshooting

When a relay contact is stuck in the closed position it cannot be isolated with the test fixture installed. The test fixture parallels all the relays together. However, the test fixture, or a terminal module, must be installed to allow the HP 3852A to normally communicate with the component module.

There are two ways to isolate the stuck relay. The first, and easiest means is to install a regular terminal module on the failing component module. Each channel of the multiplexer can then be checked with an ohmmeter. Measure between the faulty NO or NC terminal (depending on which contact is stuck) and the corresponding C terminal on the terminal module. Once the stuck channel is isolated, Table 14-4 identifies the stuck relay.

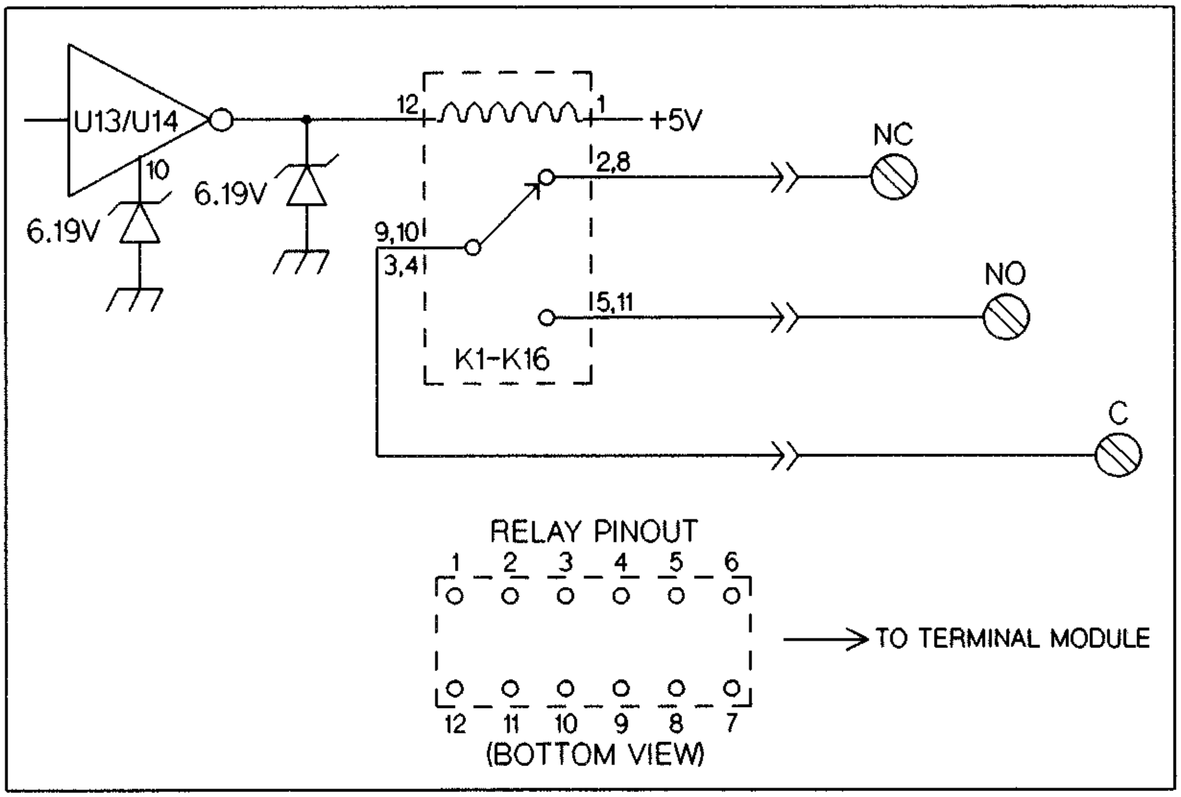


Figure 14-16 Relay Simplified Schematic

The second means to isolate a stuck relay involves checking for the stuck contacts on the component module connector. This method is not recommended for general use. To use this method, the test fixture or a terminal module must be installed and the HP 3852A power applied. When the wake-up sequence has completed, the test fixture or terminal module is removed. Removing the module after the wake-up sequence will allow commands to be processed since the local controller only queries the slots for accessory identification after power-on or reset.

It is recommended that the entire component module be replaced if the relays are at or near the relay maximum specified life cycle (shown in Table 14-3) and the relays are sticking or the contact resistance is out of specification.

14-26 REPLACEABLE PARTS

Figure 14-17 shows the mechanical breakdown of the HP 44725A. This figure also provides assembly and disassembly information. The parts shown in Figure 14-17 are keyed to the parts list in Table 14-5.

To order a part listed in Table 14-5, quote the Hewlett-Packard part number, the check digit (abbreviated CD in Table 14-4), and the quantity desired. Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

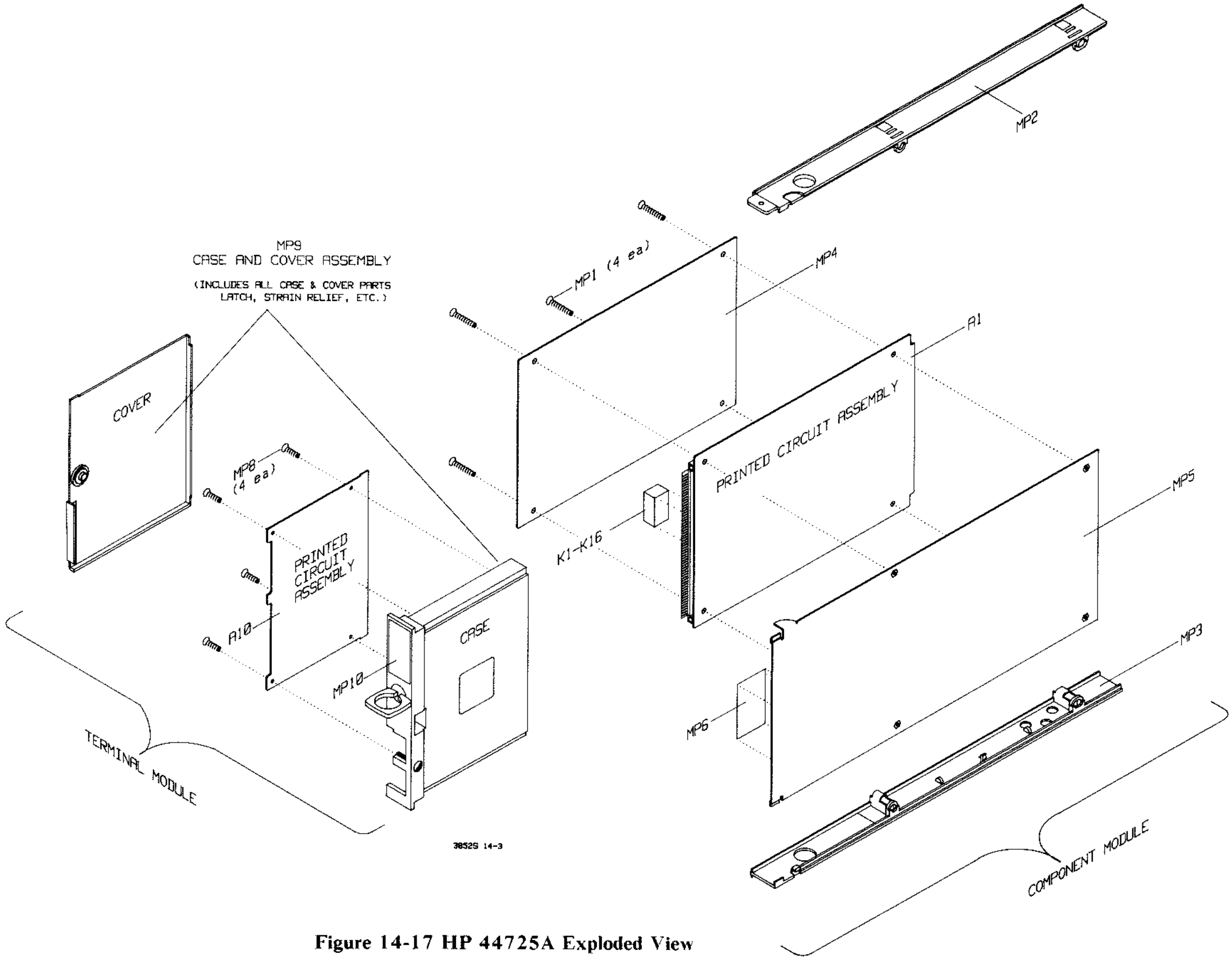


Figure 14-17 HP 44725A Exploded View

Table 14-5 HP 44725A 16 Channel General Purpose Switch

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44725A	Module; 16 chan GP switch component	1	44725-66201	5	MOD-16CH GP SWCH
A1	PCA; 16 channel GP switch component	1	44725-66501	8	PCA-16CH GP SWCH
A10	PCA; 16 channel GP switch terminal	1	44725-66510	9	PCA-GP SWCH TERM
K1-16	Relay; A1 PCA	16	0490-1512	0	RLY-S2EB-5V
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44725A component module	1	44725-84320	7	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44725A	1	44725-84325	2	LBL-ID,TERM ASSY

Completely assembled HP 44725A terminal modules can be ordered from your local HP Office by ordering Number 44725AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Chapter 18
HP 44727A/B/C 4-Channel DACs

CHAPTER 15

HP 44727A/B/C 4 CHANNEL VOLTAGE/CURRENT DACs

CHAPTER 15
HP 44727A/B/C
4 CHANNEL VOLTAGE/CURRENT DACs

15-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, calibration procedures, and replaceable parts lists for the HP 44727A/B/C 4 Channel Voltage/Current DAC.

15-2 Technical Description

The HP 44727A/B/C 4 Channel Voltage/Current DACs are designed to output analog voltages or currents that can be used to test and control devices. The HP 44727A/B/C are identical products, but configured for different applications. The HP 44727A has all 4 channels configured for voltage outputs. The HP 44727B has all 4 channels configured for current outputs. The HP 44727C has two channels configured for voltage and two channels configured for current. Each channel can be configured for one of four modes by movable jumpers and switch settings. The modes are 0 to +10.235 volts, -10.235 to +10.235 volts, 0 to +20.16 mA, and +4 mA to +20.16 mA. Each channel of the HP 44727A/B/C has remote sense capability for accurate outputs at the test point. The channels can float up to 170 volts peak above ground.

A simplified block diagram of HP 44727A/B/C is shown in Figure 15-1. The accessory is made up of two main assemblies: a component module and a terminal module. The component module contains both analog and digital sections. The digital section consists of a local controller to interface with the backplane and channel drivers. The analog section is identical for each channel and consists of error amplifiers, sense amplifiers, output buffers, and potentiometers for calibration. The terminal module contains jumpers to configure and calibrate the output channels. The module also contains terminal strips for user connections and calibration resistors for current.

NOTE

Since the HP 44727A/B/C accessories consume a relatively large amount of power, only a limited number of accessories can be installed in the HP 3852A and HP 3853A. Consult the HP 44727A/B/C and HP 3852A Operating and Programming Manual for more information.

15-3 Read and Write Registers

The HP 3852A local controller communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 2 of this manual. Table 15-1 shows the registers used by the HP 44727/B/C.

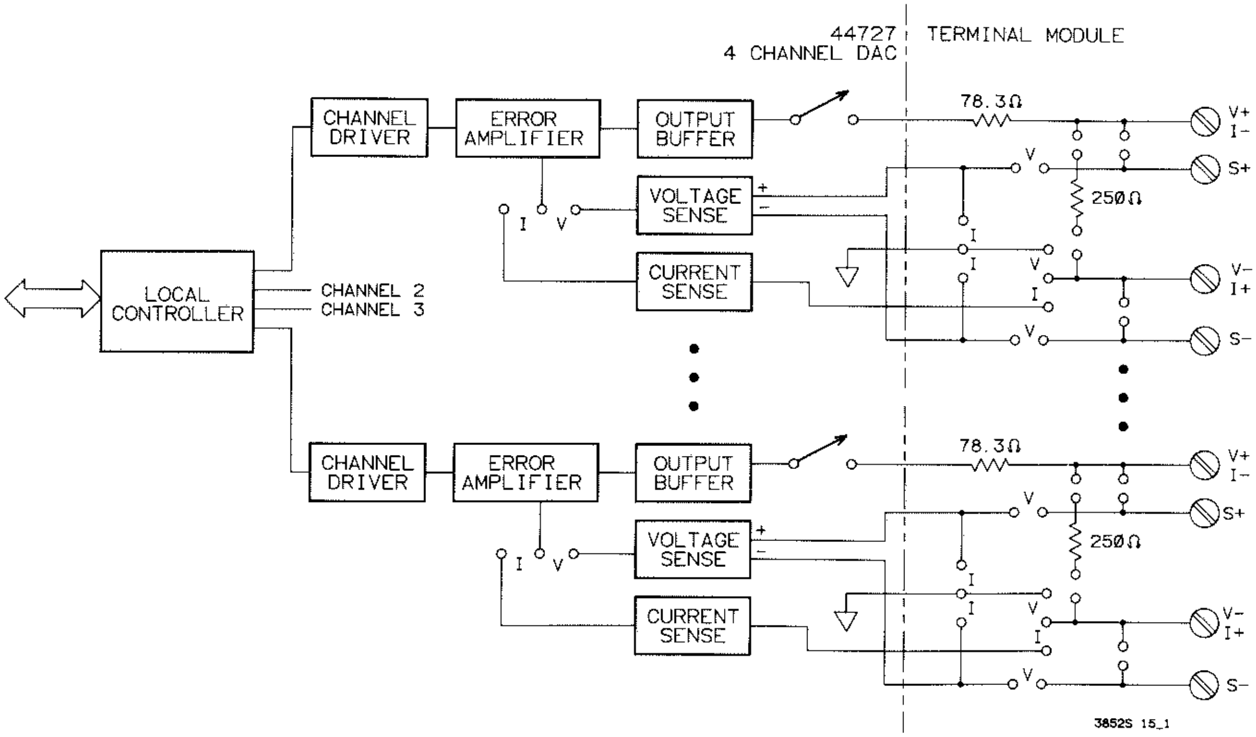


Figure 15-1 HP 44727A/B/C Simplified Block Diagram

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessories. It is possible to program some plug-in accessories into illegal and potentially damaging states with these commands. The commands are documented here for service purposes only.

15-4 Read Registers

15-5 Registers 0 and 4. Read Registers 0 and 4 contain the accessory identification. The registers are identical. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data lines.

The eight bit identification is in two parts. The five most significant bits identify the component module and the three least significant bits identify the type of terminal module installed. If a terminal module is not present, the lower three bits are set high by the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed.

Table 15-2 lists the decimal equivalent codes returned in response to an SREAD of Registers 0 and 4 for all combinations of the accessory.

Table 15-1 DAC Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Reset
1	Status	Not Used
2	Read Control	Write Control
3	External Identification	Output Enable
4	Accessory Identification	Accessory Reset
5	Status	Not Used
6	Read Data	Write Data
7	External Identification	Output Enable

Table 15-2 HP 44727A/B/C Identification Codes

Module Combinations	Codes
HP 44727A/B/C Component Module (no terminal module installed)	-226
HP 44729A/B/C Component Module, HP 44727AT Terminal Module installed	-225

15-6 Registers 1 and 5. Read Registers 1 and 5 are status registers. The registers are identical. Eight bits are used to determine if the HP 44727A/B/C needs initialization or if it has been done. A decimal value of -248 shows that initialization is needed and a decimal value of -240 shows that it has been done. Initialization is needed after a power-up or reset is performed. However, initialization is normally done when the HP 44727A/B/C is setup to output voltage/current using higher level commands (i.e., the APPLY command).

15-7 Register 2. Read Register 2 is the read control register. It determines the last control data sent to various circuitry on the component module, after the Write Control command was sent.

15-8 Registers 3 and 7. Read Registers 3 and 7 are the external identification registers. The registers are identical. They contain an eight bit word, representing the output modes of the four channels on the HP 44727A/B/C. Figure 15-2 is an example of the word and Table 15-3 lists the different output modes of the HP 44727A/B/C. You can use Registers 3 and 7, and Table 15-3 to determine the output configuration of the channels. It is presumed in Figure 15-2 that the channels are configured as follows:

Channel 0: 0 to +10.235 V
Channel 1: -10.235 V to +10.235 V
Channel 2: 0 to +20.16 mA
Channel 3: +4 mA to +20.16 mA

Table 15-3 Channel Output Modes

Mode	M1	M2
0 to +10.235 V	0	0
-10.235 V to +10.235 V	0	1
0 to +20.16 mA	1	0
+4 mA to +20.16 mA	1	1

Bits:	7	6	5	4	3	2	1	0
Channels:	CH0	CH0	CH1	CH1	CH2	CH2	CH3	CH3
Output Mode:	M2	M1	M2	M1	M2	M1	M2	M1
Bit Value:	0	0	1	0	0	1	1	1

Figure 15-2 Read Registers 3 and 7

15-9 Register 6. Read Registers 6 is the read data register. It determines the last configuration data sent to various circuitry on the component module, after the Write Data command was sent.

NOTE

The decimal number returned after the execution of an SREAD command represents the two's compliment of the status word.

15-10 Write Registers

15-11 Registers 0 and 4. Write Registers 0 and 4 are the accessory reset registers. The registers are identical. Any data written to these registers will cause a reset of the accessory and forces the accessory's output relays to open. A write to Register 0 or 4 has the same effect as a backplane reset.

15-12 Register 2. Write Register 2 is the write control register. It is used to send control data to various circuitry on the component module.

15-13 Registers 3 and 7. Write Registers 3 and 7 are the output enable registers. The registers are identical. Any data written to these registers will cause the accessory's output relays to close.

15-14 Register 6. Write Register 6 is the write data register. It is used to send configuration data to various circuitry on the component module.

15-15 SPECIFICATIONS

Specifications for the HP 44727A/B/C are given in Table 15-4. Specifications are the performance standards or limits against which the accessory may be tested tested.

Table 15-4 HP 44727A/B/C Specifications

DC Voltage

Ranges: 0 to +10.235 V or -10.325 to +10.325 V

Resolution: 2.5 mV (12 bits plus a sign bit for bipolar range)

Protection: 170 V peak or 120 V DC channel to channel or channel to chassis

DC Accuracy: Specified over load and operating temperature for 90 days since last calibration. Rload is load used for calibration (open circuit at the factory). Using remote sense where resistance of each SENSE lead is less than 2.5 Ω, and max IR drop in SOURCE leads is 1.5 V.

Rload, 18 to 28°C: ±(0.05% of programmed output + 2.5 mV)

Load Regulation: If actual load used is different than Rload, the maximum additional error for loads as small as 500 Ω is 0.6 mV.

Temperature Coefficient: Adds as an additional accuracy error using ±(% of programmed output + volts) per °C change outside 18 to 28°C, as long as the operating temperature is maintained between 0 to 18 or 28 to 55°C. 0.002% + 0.035 mV.

Maximum Output Current: 20 mA

Ripple and Noise: 2.5 mV RMS (20 Hz to 250 kHz)

Maximum Wire Size: 16 AWG

Table 15-4 HP 44727A/B/C Specifications (Cont.)

DC Current
Ranges: 0 to +20.16 mA or +4 to +20.16 mA
Resolution: 2.5 µA (13 bits)
Protection: 170 V peak or 120 V DC channel to channel or channel to chassis
DC Accuracy: Specified over load and operating temperature for 90 days since last calibration. Rload is load used for calibration (250 Ω circuit at the factory).
Rload, 18 to 28°C: ±(0.05% of programmed output + 5 µA)
Load Regulation: If actual load used is different than Rload, the maximum additional error for loads as large as 600 Ω is 2 µA.
Temperature Coefficient: Adds as an additional accuracy error using ±(% of programmed output + volts) per °C change outside 18 to 28°C, as long as the operating temperature is maintained between 0 to 18 or 28 to 55°C. 0.003% + 0.3 µA.
Compliance: 12 V
Ripple and Noise: 7.5 µA RMS (20 Hz to 250 kHz)
Maximum Wire Size: 16 AWG

15-16 PERFORMANCE TESTS

15-17 Introduction

The following Performance Tests checks the operation of the HP 44727A/B/C component module. Performance Tests are not given for the terminal modules. Successful completion of the tests in this chapter provides a high confidence level that the HP 44727A/B/C is meeting its listed specifications.

The Performance Tests should be performed in the order they are presented. The completion of each test increases the confidence level in the HP 44727A/B/C operation. A minimum set of tests is given as Operational Verification Tests. These tests are described in Section 15-18.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence level that the HP 44727A/B/C is operating normally, it is not recommended that the Performance Tests be performed unless one of the tested specifications is in question.

15-18 Operational Verification Test

The first tests given in this section are the minimum set of tests recommended for the HP 44727A/B/C. These tests are designed to test the functionality of the DACs. Successful completion of the Operational Verification Tests provides a 90% confidence level that the DACs are operating normally and are within specifications.

The Operational Verification Tests consist of the following:

Section 15-22 - Set-Up Procedure
Section 15-23 - Voltage Channel Output Test
Section 15-24 - Current Channel Output Test

15-19 Equipment Required

The following test equipment is required to run the Performance Test. Only the first two items in the list are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 15-20)

2. Digital Multimeter -- HP 3456A or equivalent

3. Service Module -- HP 44743A

4. Resistor -- 500 ohms (.25 W, 5% or better)

5. Resistor -- 600 to 630 ohms (.5 W, 5% or better, low TC)

6. Resistor -- 125 ohms (5 W, 5% or better, low TC)

NOTE

The integrating plug-in voltmeter (HP 44701A) may be used for this test. This test does not describe the specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

15-20 Test Fixture

A test fixure is required to run the Performance Test. The fixure is shown in Figure 15-3. This test fixture is made from an HP 44727AT terminal module. To prevent any disconnections from your terminal module, it may be to your advantage to order an additional terminal module for service purposes.

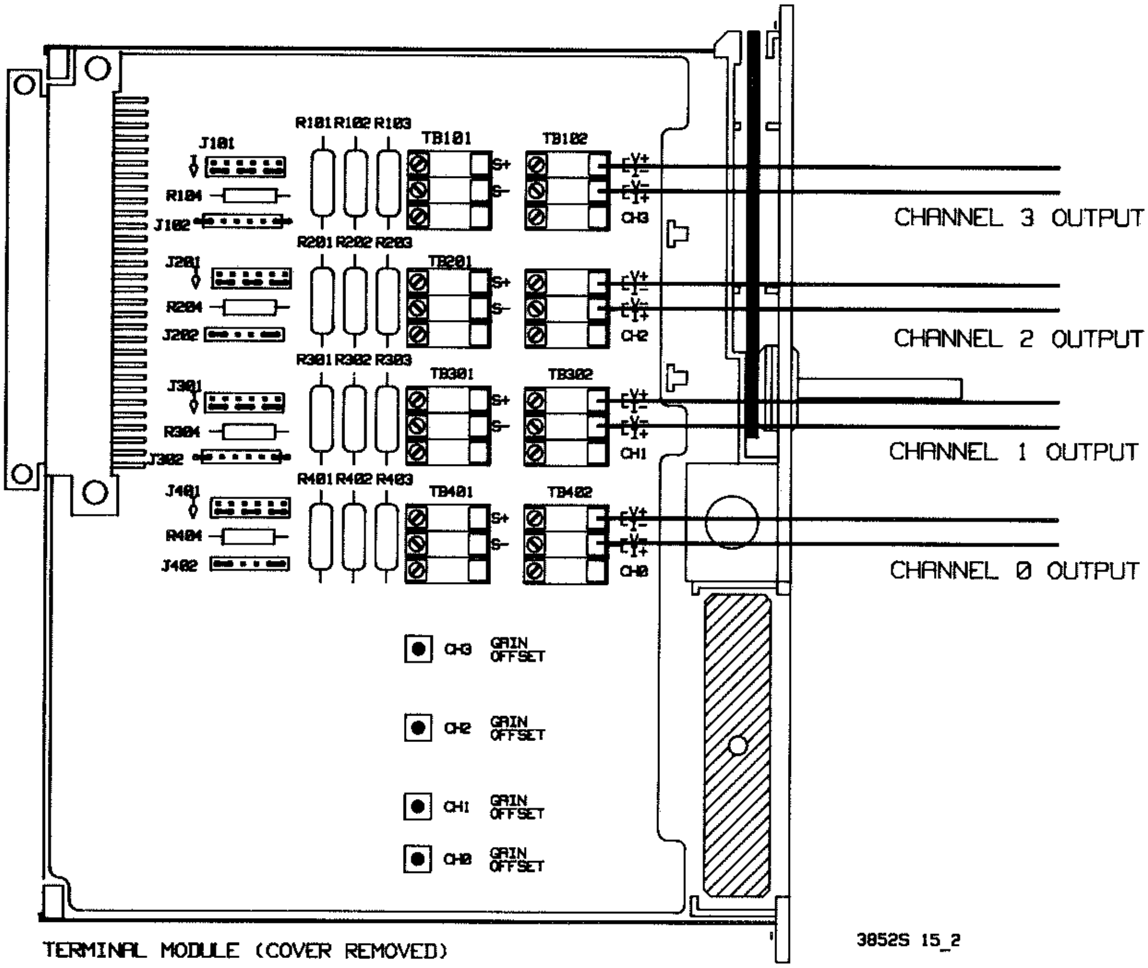


Figure 15-3 HP 44727A/B/C Test Fixure

15-21 Test Procedure

The following procedures test both the voltage and current channels of the HP 44727A/B/C. For voltage channels perform only the voltage test procedures. Likewise, for current channels perform only the current test procedures. The procedures test both the 0 to +10.235 V or -10.235 V to +10.235 V voltage output modes, and both the 0 to +20.16 mA or +4 mA to +20.16 mA current output modes.

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

15-22 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the HP 44727A/B/C component module.

3. Configure the test fixure for the correct voltage and/or current channels. Use the terminal module removed in step 2 to determine the correct channel configuration. Configure the test fixure as follows:

   a. Remove the window from the test fixure.

   b. Refer to Figure 15-4 and locate the Voltage/Current configuration jumpers and the Sense Jumpers on the test fixure.

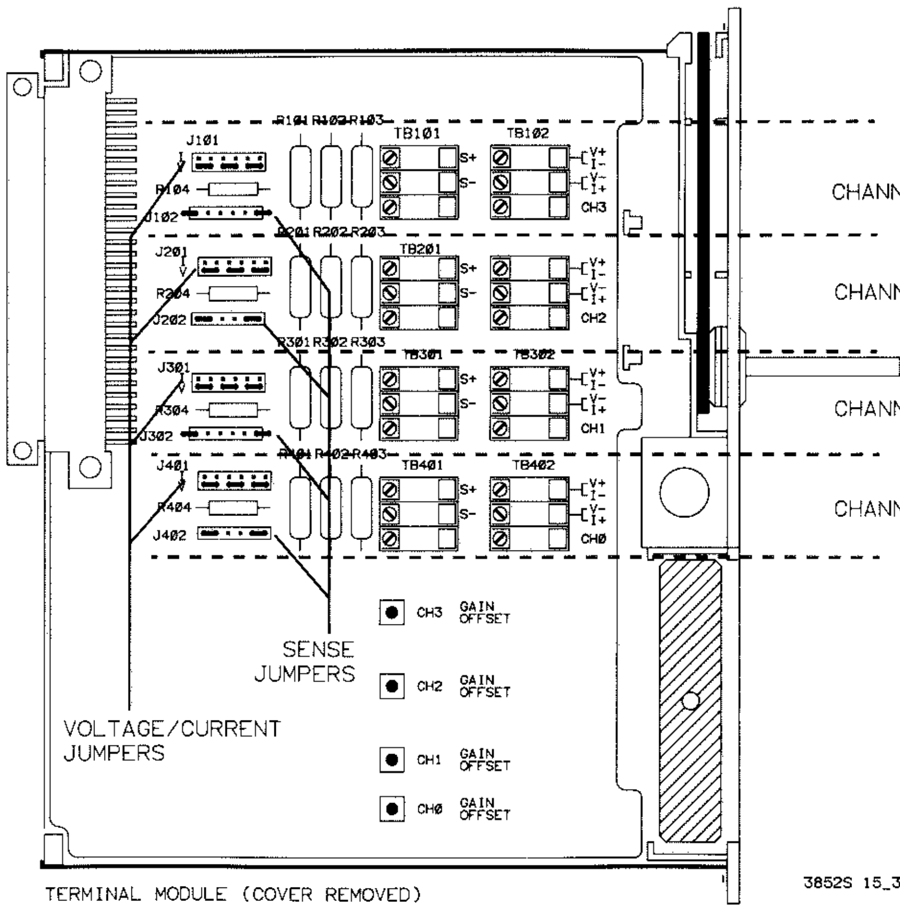


Figure 15-4 Terminal Module Jumpers

   b. Configure the test fixture for each voltage channel by moving the configuration jumpers on the test fixture to the positions shown in Figure 15-5. Make sure the Sense jumpers are in the LOCAL position (and not the CAL position) as shown in the figure.

   c. Configure the test fixture for each current channel by moving the configuration jumpers on the test fixture to the positions shown in Figure 15-6. Make sure the Sense jumpers are in the CAL position (and not the LOCAL position) as shown in the figure.

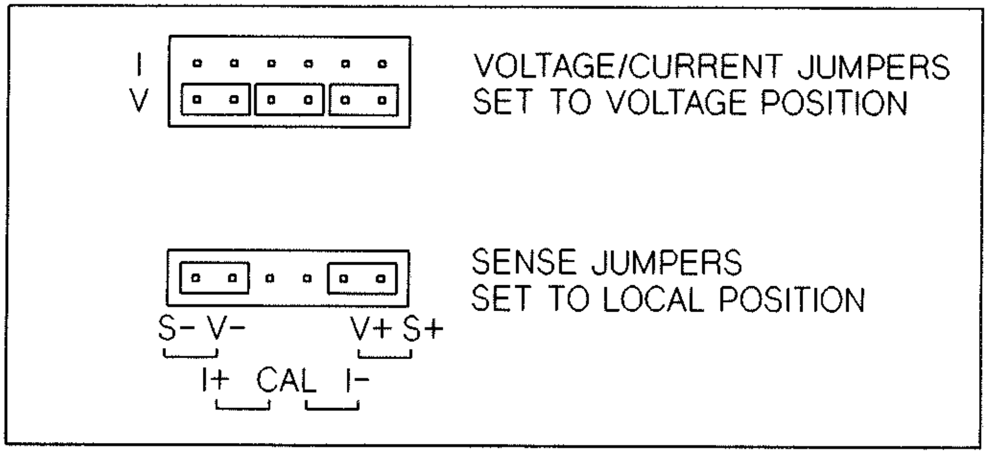


Figure 15-5 Configuration Jumpers set to Voltage/Local Positions

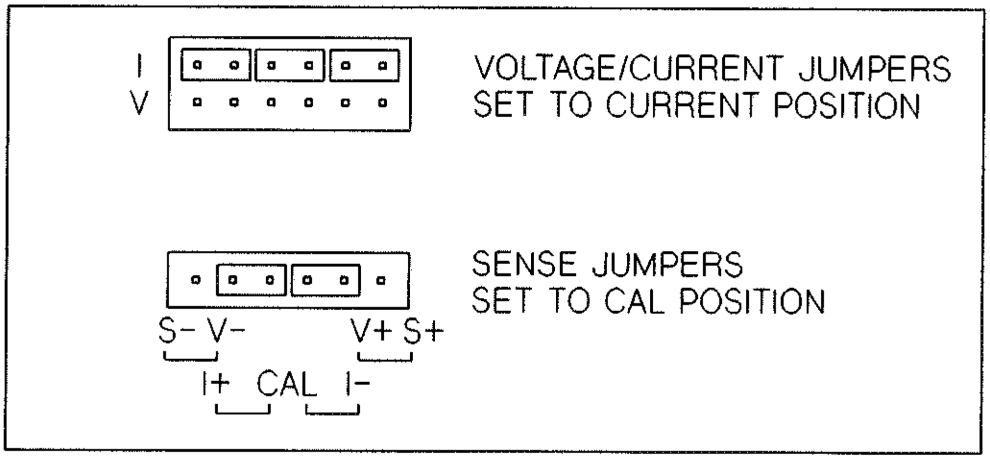


Figure 15-6 Configuration Jumpers set to Current/Cal Positions

d. Reinstall the window on the test fixture.

4. Install the test fixture on the component module. Note the slot number where the HP 44727A/B/C under test is installed.

5. Verify the slot number:

a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

b. Execute:

ID? ES00 (where E = extender number, S = slot number)

c. Verify that the HP 3852A right display shows:

44727X

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

15-23 Voltage Channel Output Test

Steps 1 through 9 in this test check both the 0 to +10.235 V and -10.235 V to +10.235 V output modes. Steps 10 through 13 includes an additional test that checks the -10.235 V to +10.235 V output mode only. Perform the following procedure only for channels configured for voltage.

NOTE

If attempting to perform voltage channel tests on channels configured for current, the HP 3852A will display an "Invalid Command for Accessory" error.

1. 0 TO +10.235 V AND -10.235 V TO +10.235 V TEST. This test checks both the 0 to +10.235 V and -10.235 V to +10.235 V output modes.

2. Set the HP 44727A/B/C channels to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

3. Set the multimeter to measure dc volts. On the test fixure, connect the multimeter DCV input to the V+ connection and connect the COM input to the V- connection of the channel to be tested. The connections are shown in Figure 15-7.

4. On the test fixure, make sure the Sense jumpers are set to the LOCAL position as shown in Figure 15-5 or 15-7.

5. Output 0 V by executing:

   APPLY DCV ESXX,0 (where E = extender number, S = slot number, XX = channel)

6. Observe the indication on the multimeter. The multimeter should indicate 0.00000 ±.0025 volts.

7. Output +10 V by executing:

   APPLY DCV ESXX,10 (where E = extender number, S = slot number, XX = channel)

8. Observe the indication on the multimeter. The multimeter should indicate +10.00000 ±.0075 volts.

9. Repeat steps 5, 6, 7, and 8 for other channels configured for voltage. If any reading in steps 6 and 8 are out of tolerance, calibration of the channel may be necessary. The calibration procedures are in Section 15-32.

10. -10.235 V TO +10.235 V TEST. Steps 9 through 12 is for the -10.235 V to +10.235 V output mode only.

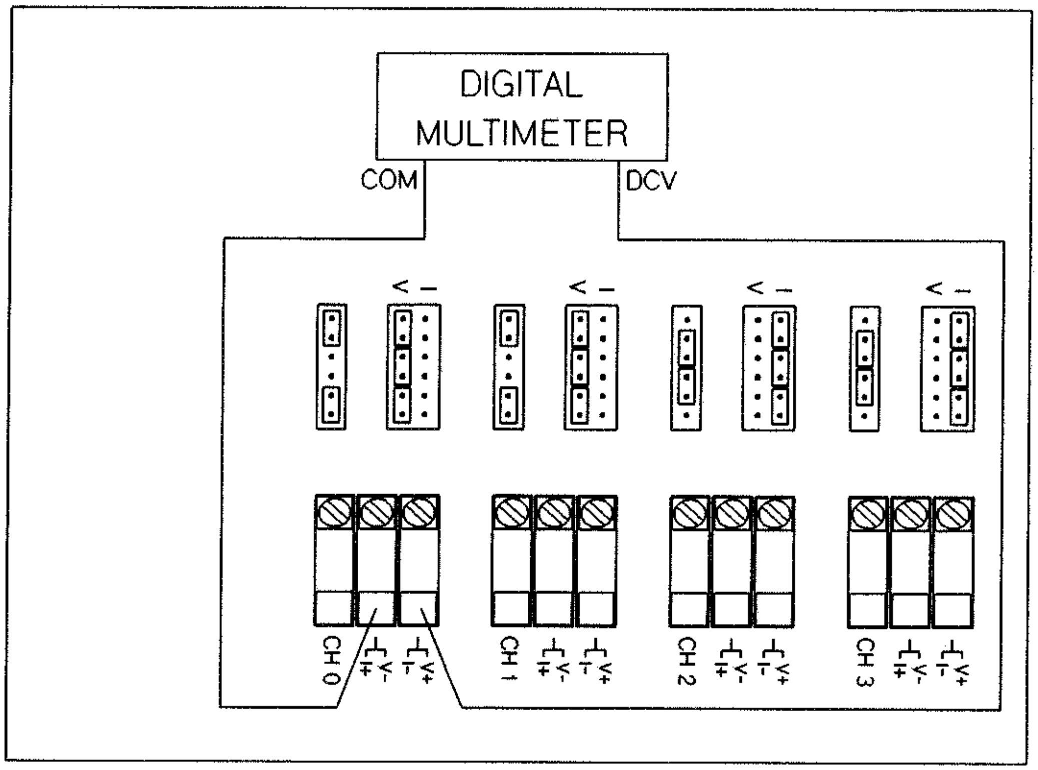


Figure 15-7 HP 44727A/B/C Voltage Channel Test

11. Output -10 V by executing:

    APPLY DCV ESXX,-10 (where E = extender number, S = slot number, XX = channel)

12. Observe the indication on the multimeter. The multimeter should indicate -10.00000 ±.0075 volts.

13. Repeat steps 11 and 12 for other channels configured for voltage. If any reading in step 12 is out of tolerance, calibration of the channel may be necessary. The calibration procedures are in Section 15-32.

15-24 Current Channel Output Test

This test checks both the 0 to +20.16 mA and +4 mA to +20.16 mA output modes. Perform the following procedure only for channels configured for current.

NOTE

If attempting to perform current channel tests on channels configured for voltage, the HP 3852A will display an "Invalid Command for Accessory" error.

1. Set the HP 44727A/B/C channels to a known state by executing:

    RESET ES00 (where E = extender number, S = slot number)

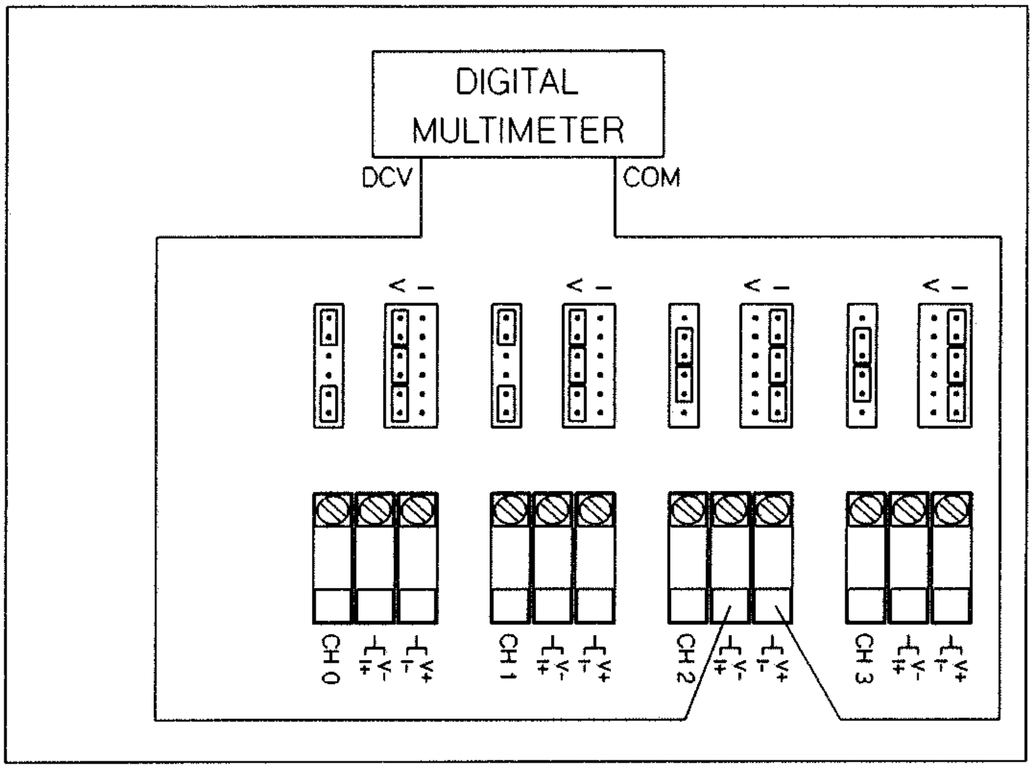


Figure 15-8 HP 44727A/B/C Current Channel Test

2. Set the multimeter to measure dc volts. On the test fixure, connect the multimeter DCV input to the I+ connection and connect the COM input to the I- connection of the channel to be tested. The connections are shown in Figure 15-8.

3. On the test fixure, make sure the Sense jumpers are set to the CAL position as shown in Figure 15-6 or 15-8.

4. Output 4 mA by executing:

APPLY DCI ESXX,.004 (where E = extender number, S = slot number, XX = channel)

5. Observe the indication on the multimeter. The multimeter is reading the voltage across the 250 ohm calibration resistor. It should be +1.00000 ±.002 volts.

6. Output +20 mA by executing:

APPLY DCI ESXX,.02 (where E = extender number, S = slot number, XX = channel)

7. Observe the indication on the multimeter. The multimeter should indicate +5.00000 ±.004 volts.

8. Repeat steps 4, 5, 6, and 7 for other channels configured for current. If any reading in steps 5 and 7 are out of tolerance, calibration of the channel may be necessary. The calibration procedures are in Section 15-32.

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44727A/B/C PERFORMANCE TESTS.

15-25 Voltage Channel Tests

Perform the following test procedures only for channels configured for voltage.

NOTE

If attempting to perform voltage channel tests on channels configured for current, the HP 3852A will display an "Invalid Command for Accessory" error.

15-26 Maximum Current and Full Load Test. This test checks the maximum output current and full load capabilities of channels configured for voltage.

1. Perform the setup procedure in Section 15-22.

2. Set the multimeter to measure dc volts. On the test fixure, connect the multimeter DCV input to the V+ connection and connect the COM input to the V- connection of the channel to be tested. Connect a 500 ohm resistor across the channel's V+ and V- connections. The connections are shown in Figure 15-9.

3. Output +10 V by executing:

   APPLY DCV ESXX,10 (where E = extender number, S = slot number, XX = channel)

4. Observe the indication on the multimeter. The reading should be +10.00000 ±.0081 volts. Note the reading on the multimeter.

5. Remove the 500 ohm resistor from the test fixure.

6. Observe the indication on the multimeter. The reading should not change more than±.0006 volts from the reading noted in step 4.

7. Repeat steps 1 through 6 for other channels configured for voltage.

8. Remove the resistor and multimeter from the test fixure.

15-27 RMS Noise Test. This test checks the output noise for channels configured for voltage.

1. Set the multimeter to measure ac volts. On the test fixure, connect the multimeter ACV input to the V+ connection and connect the COM input to the V- connection of the channel to be tested. The connections are shown in Figure 15-10.

2. Output +10 V by executing:

   APPLY DCV ESXX,10 (where E = extender number, S = slot number, XX = channel)

3. Observe the indication on the multimeter. It should be less than .0025 volts ac.

4. Repeat steps 1 through 3 for other channels configured for voltage.

5. Remove the multimeter from the test fixure.

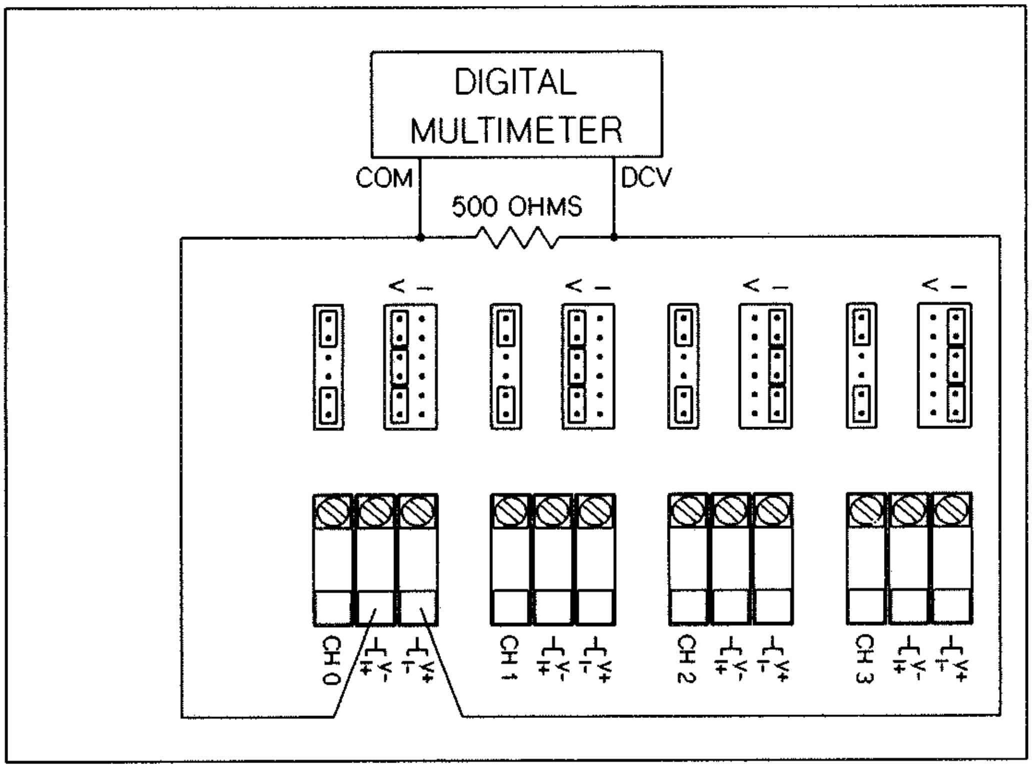


Figure 15-9 HP 44727A/B/C Maximum Current/Load Tests

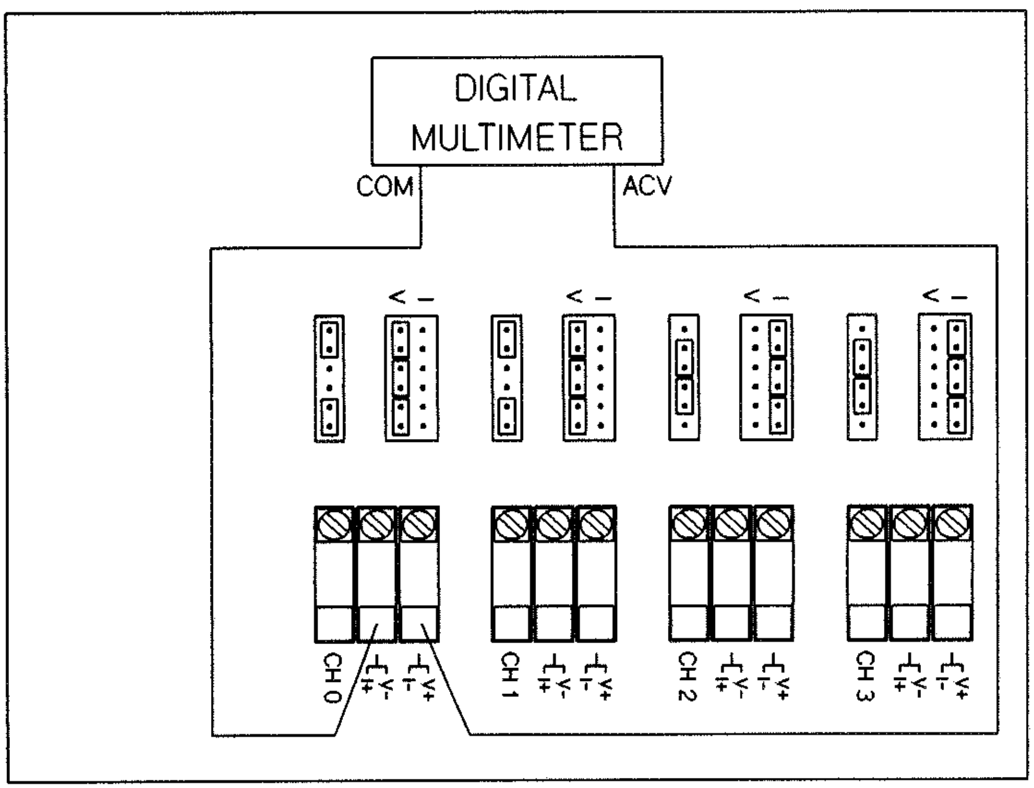


Figure 15-10 HP 44727A/B/C Voltage Noise Test

15-28 Current Channel Tests

Perform the following test procedures only for channels configured for current.

NOTE

If attempting to perform current channel tests on channels configured for voltage, the HP 3852A will display an "Invalid Command for Accessory" error.

15-29 Compliance Test. This test checks the compliance of channels configured for current.

1. Perform the setup procedure in Section 15-22, except place the Sense jumpers in the LOCAL position (and not the CAL position) as shown in Figure 15-11.

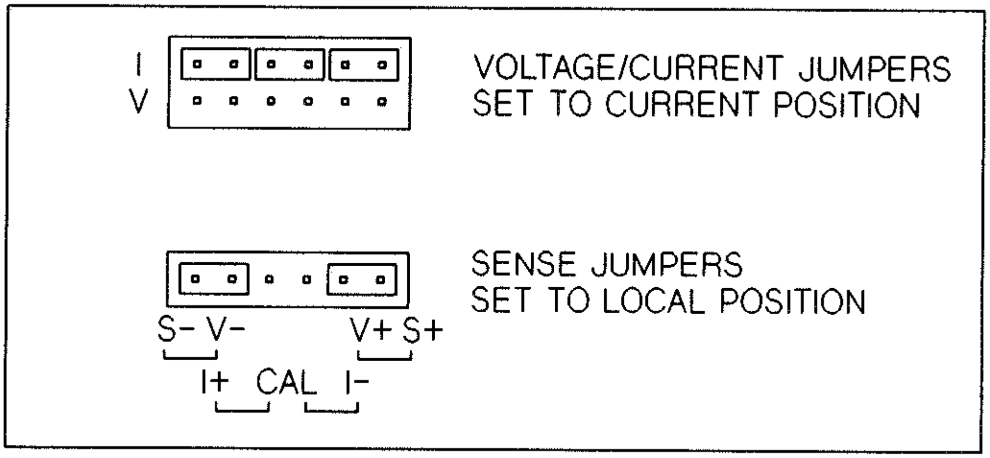


Figure 15-11 Configuration Jumpers set to Current/Local Positions

2. Set the multimeter to measure 4-wire ohms. Measure the value of a 600 to 630 ohm resistor with the multimeter. Record the value as R1.

3. Set the multimeter to measure dc volts. On the test fixure, connect the multimeter DCV input to the I+ connection and connect the COM input to the I- connection of the channel to be tested. Connect the 600 to 630 ohm resistor across the channel's I+ and I- connections. The connections are shown in Figure 15-12.

4. Set the channel to output an appropriate current value (I1) for a 12 V compliance level. Calculate the I1 current value using the following formula. (For example, for a 600 Ω resistor value, the I1 current is 0.02 A.)

$$I1 = \frac{12}{R1}$$

5. Output the I1 current by executing:

APPLY DCI ESXX,I1

(where E = extender number, S = slot number, XX = channel, I1 = current value)

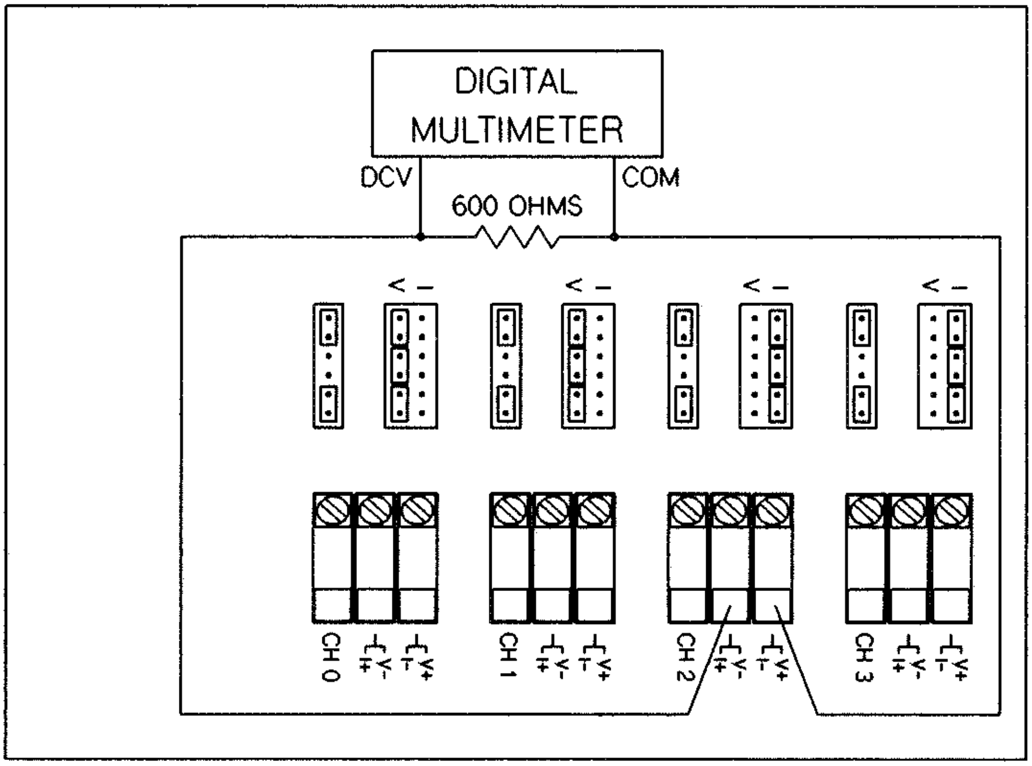


Figure 15-12 HP 44727A/B/C Current Compliance Test

6. Observe the indication on the multimeter. It should be +12.00000 ±.010 volts.

7. Repeat steps 5 and 6 for other channels configured for current.

15-30 RMS Noise Test. This test checks the output noise of channels configured for current.

1. Set the multimeter to measure ac volts. On the test fixure, connect the multimeter ACV input to the I+ connection and connect the COM input to the I- connection of the channel to be tested. Connect a 600 to 630 ohm resistor across the channel's I+ and I- connections. The connections are shown in Figure 15-13.

2. Output +20 mA by executing:

APPLY DCI ESXX,.02 (where E = extender number, S = slot number, XX = channel)

3. Observe the indication on the multimeter. It should be less than .0045 volts ac.

4. Repeat steps 1 through 3 for other channels configured for current.

5. Remove the 600 to 630 ohm resistor from the test fixure.

15-31 Load Regulation Test. This test checks the load regulation of the channels configured for current.

1. Set the multimeter to measure 4-wire ohms. Measure the value of a 125 ohm resistor with the multimeter. Record the value as R-Low.

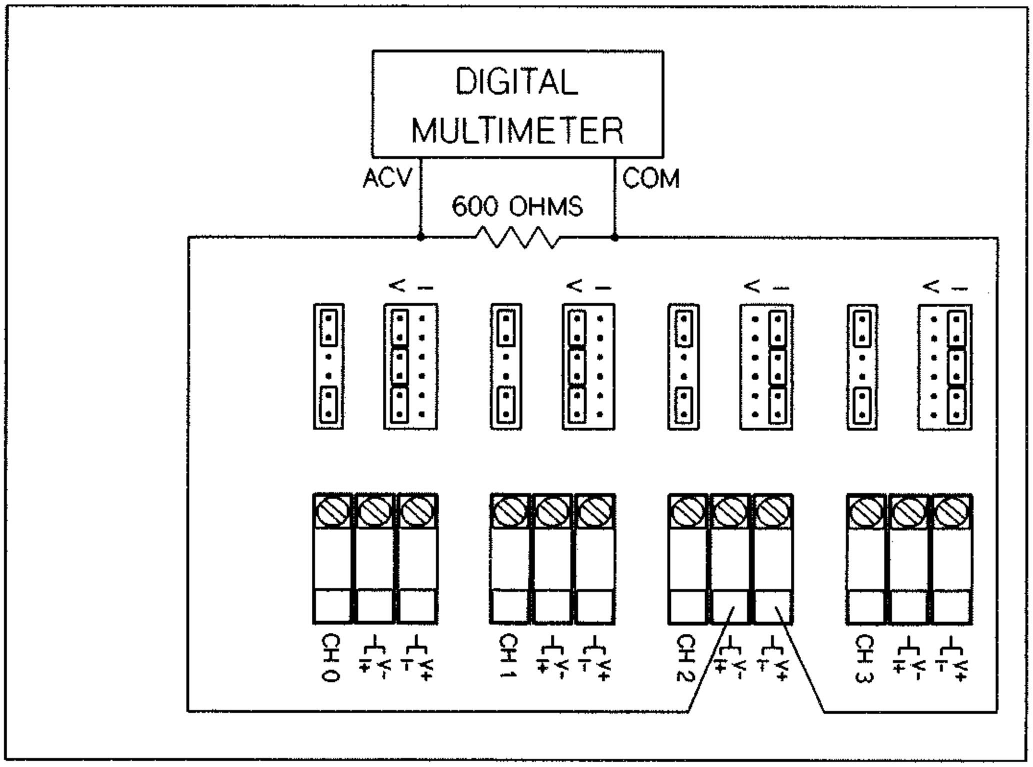


Figure 15-13 HP 44727A/B/C Current Noise Test

2. Set the multimeter to measure dc volts. On the test fixure, connect the multimeter DCV input to the I+ connection and connect the COM input to the I- connection of the channel to be tested. Connect the 125 ohm resistor across the channel's I+ and I- connections. The connections are shown in Figure 15-14.

3. Output +20 mA by executing:

APPLY DCI ESXX,.02 (where E = extender number, S = slot number, XX = channel)

4. Observe the indication on the multimeter. The reading should be approximately +2.5 volts (i.e., 20 mA * R-Low). Record the reading as V-Low.

5. Calculate the actual I-Low current by the following formula:

$$\text{I-Low} = \frac{\text{V-Low}}{\text{R-Low}}$$

6. Remove the multimeter and the 125 ohm resistor from the test fixure. Leave the channel output current at +20 mA.

7. Set the multimeter to measure 4-wire ohms. Measure the value of a 500 ohm resistor with the multimeter. Record the value as R-High.

8. Set the multimeter to measure dc volts. On the test fixure, connect the multimeter DCV input to the I+ connection and connect the COM input to the I- connection of the channel to be tested. Connect the 500 ohm resistor across the channel's I+ and I- connections. The connections are shown in Figure 15-15.

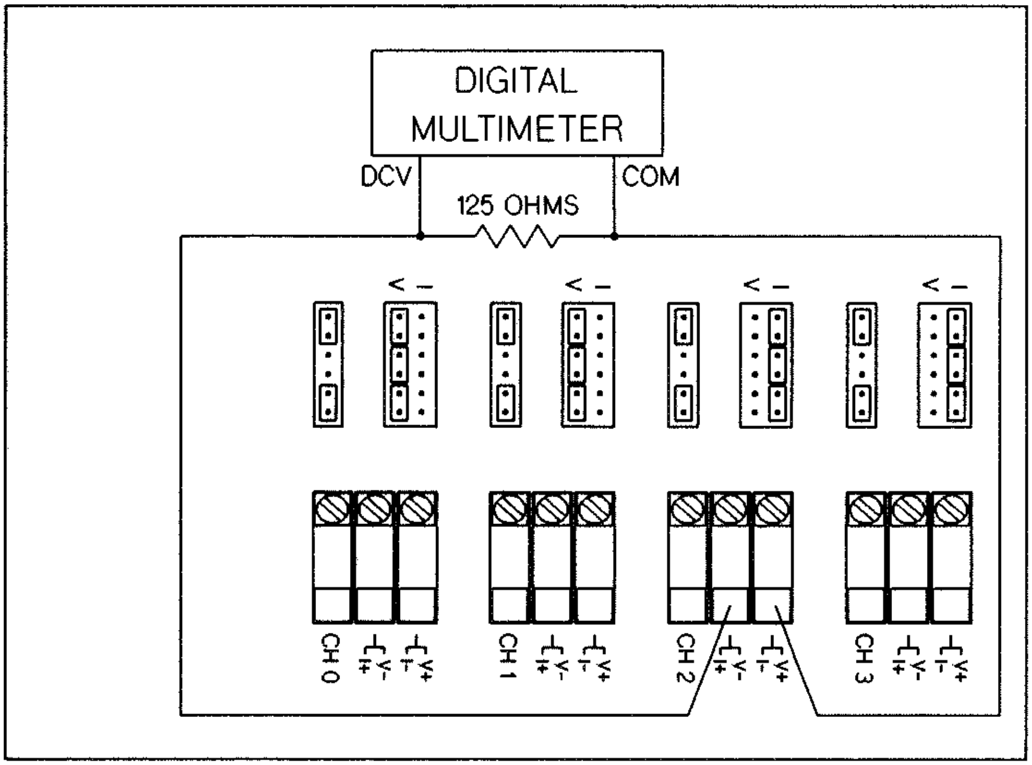


Figure 15-14 HP 44727A/B/C Load Regulation Low Connection

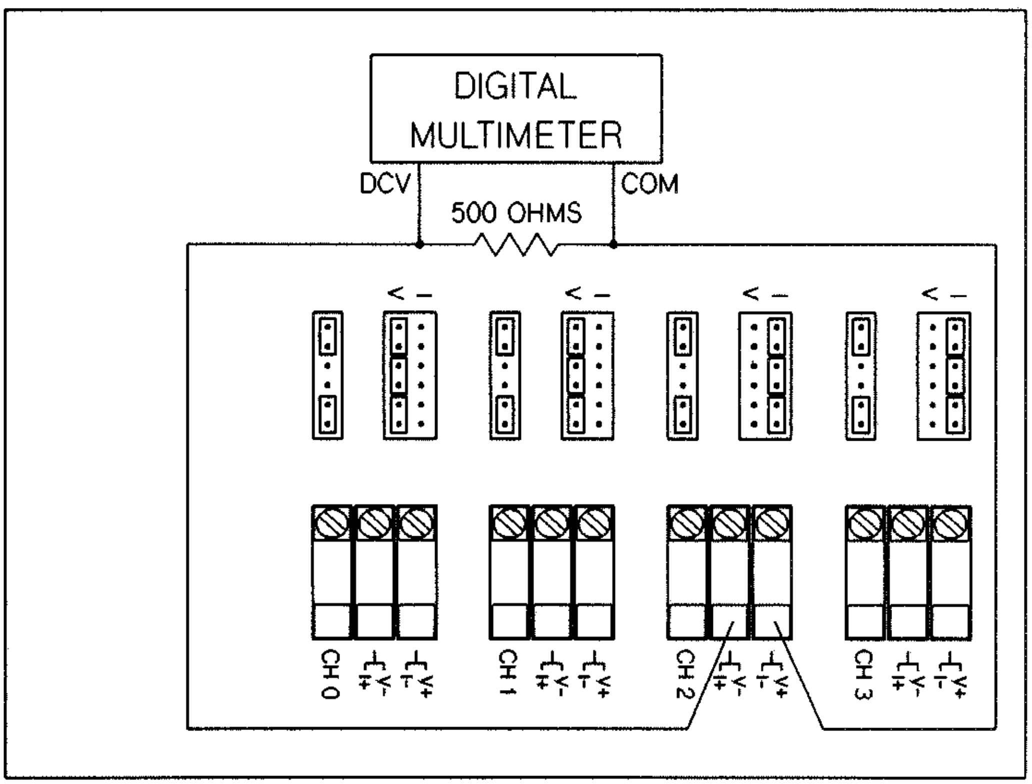


Figure 15-15 HP 44727A/B/C Load Regulation High Connection

9. Observe the indication on the multimeter. The reading should be approximately +10 volts (i.e., 20 mA * R-High). Record the reading as V-High.

10. Calculate the actual I-High current by the following formula:

$$\text{I-High} = \frac{\text{V-High}}{\text{R-High}}$$

11. The I-High current should not deviate more than ±2 μA from the I-Low current measured in step 5.

12. Repeat steps 2 through 11 for other channels configured for current.

13. Remove the resistor and multimeter from the test fixture.

15-32 HP 44727A/B/C CALIBRATION

Each channel of the HP 44727A/B/C can be calibrated for either voltage or current. To calibrate voltage channels, use the Voltage DAC Calibration procedure. To calibrate current channels, use the Current DAC Calibration procedure. The voltage channels can be calibrated in either the 0 to +10.235 V mode or the -10.235 V to +10.235 V mode. The current channels must be calibrated in the 0 to +20.16 mA mode. However, the channel can be reconfigured for the +4 mA to +20.16 mA mode after calibration, if necessary.

15-33 Equipment Required

The only test equipment required for calibration is a digital multimeter. The recommended model is the HP 3456A or equivalent.

15-34 HP 44727A/B/C Channel Configuration

The following procedures show how to determine channel configuration and how to reconfigure a channel for calibration or other uses.

Before calibrating a channel, the configuration of the channel needs to be determined. This is necessary to select the appropriate calibration procedure and to perform any needed reconfiguration of the channels.

15-35 Determining Channel Configuration

The channel configuration depends on the settings of various jumpers and switches on BOTH the terminal module and component module. It is important that both modules are configured to the same mode (i.e., voltage or current) for a particular channel. Use the following procedure to determine the configuration of the channels.

1. Remove power from the HP 3852A.

2. Remove the HP 44727A/B/C Accessory from the HP 3852A. Remove both the component module and the terminal module.

3. Remove the window on the terminal module.

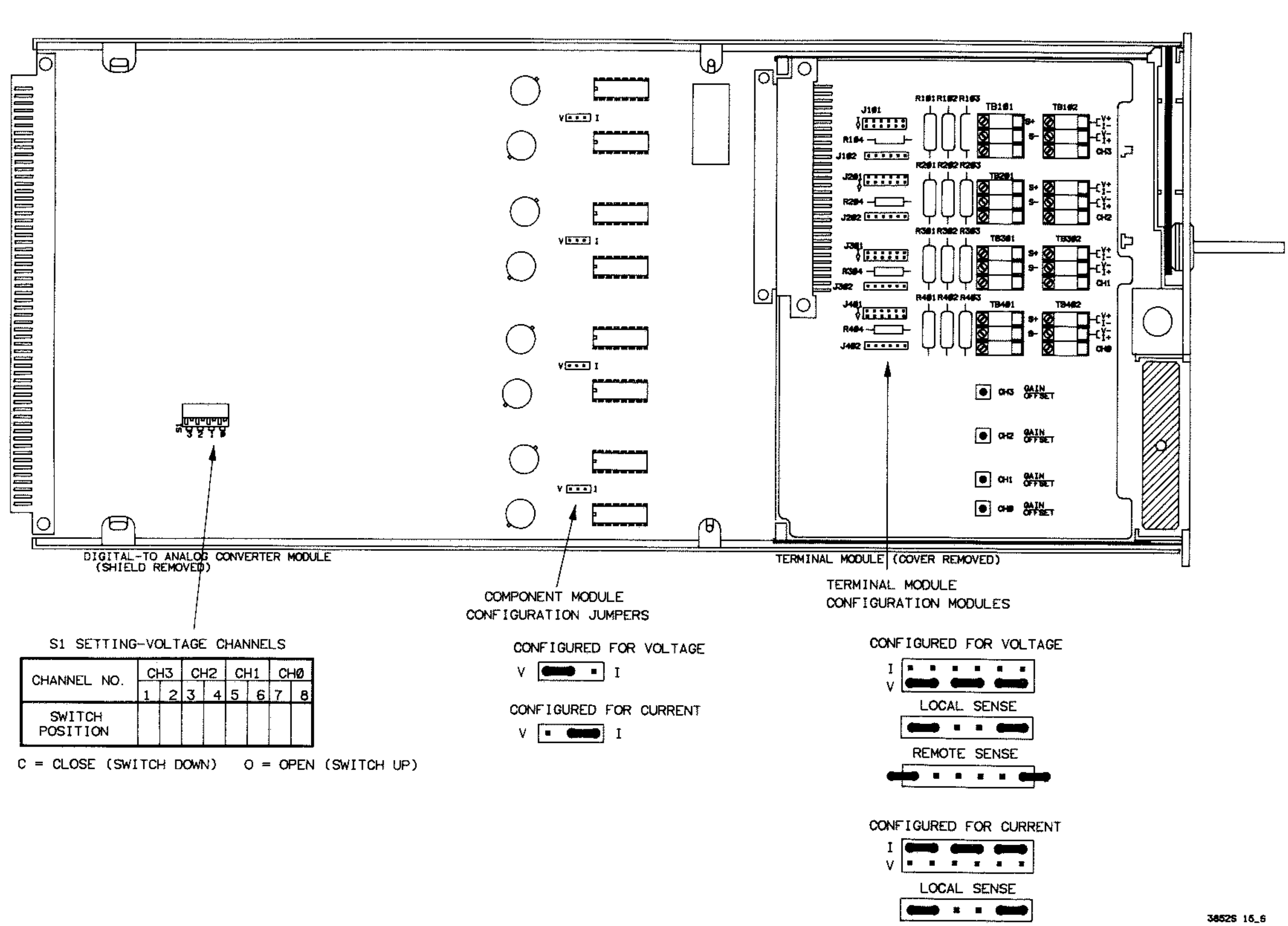
4. Remove the cover from the component module. Cover removal is accomplished by placing the module on its back and removing the four screws holding the cover in place.

5. Using Figure 15-16 as a guide, locate the configuration jumpers and switches on both the terminal module and component module. Note the settings of these jumpers and switches. This is important since the configuration jumpers and switches are normally returned to their original settings after calibration.

6. Figure 15-16 also shows the channel configurations for the different output modes. This is useful if a channel reconfiguration is desired other than for calibration. Use Table 15-5 to determine how to set the configuration switch to the four different output modes of all channels.

15-36 Setup Accessory for Calibration

The following shows how to setup the DAC accessory for calibration. Keep in mind that the +4 mA to +20.16 mA current channels need to be reconfigured to the 0 to +20.16 mA mode. The voltage channels do not need reconfiguration.



CHANNEL NO.	CH3		CH2		CH1		CHØ	
	1	2	3	4	5	6	7	8
SWITCH POSITION								

C = CLOSE (SWITCH DOWN)   O = OPEN (SWITCH UP)

Figure 15-16 Original Switch and Jumper Configuration

Table 15-5 Configuration Switch Settings

Channel Output Modes	Switch Position Channel 3		Channel 2		Channel 1		Channel 0	
	1	2	3	4	5	6	7	8
Voltage: 0 to +10.235 V	C	C	C	C	C	C	C	C
Voltage: -10.235 V to +10.235 V	C	O	C	O	C	O	C	O
Current: 0 to +20.16 mA	O	C	O	C	O	C	O	C
Current +4 mA to +20.16 mA	O	O	O	O	O	O	O	O
C = Close (switch down) O = Open (swtich up)								

1. To calibrate a channel in the voltage mode, the jumper and switch configurations must be as shown in Figure 15-17. Reconfigure the component module/terminal module jumpers and component module switch if necessary.

2. To calibrate a channel in the current mode, the jumper and switch configurations must be as shown in Figure 15-18. Reconfigure the component module/terminal module jumpers and component module switch if necessary.

3. If calibration is to be performed outside the mainframe, continue with step 4. If calibration of the accessory is to be performed inside the mainframe, do the following:

   a. Remove power from the 3852A.

   b. Replace the cover back on the component module.

   c. Install the terminal module on the component module.

   d. Install the component module in a convenient slot in the HP 3852A mainframe. Note the slot number where the module is installed for future reference.

   e. Apply power to the 3852A. Wait long enough for the temperature on the HP 44277A/B/C accessory to stabilize.

   f. Go to the appropriate calibration procedure for calibration.

4. If calibration of the accessory is to be performed outside the mainframe, do the following:

   a. Remove power from the 3852A.

   b. Install the HP 44743A Service Module in an convenient slot in the HP 3852A mainframe. Note the slot number where the module is installed for future reference.

   c. Replace the cover back on the component module.

   d. Install the terminal module on the component module.

   e. Install the component/terminal module combination on the Service Module.

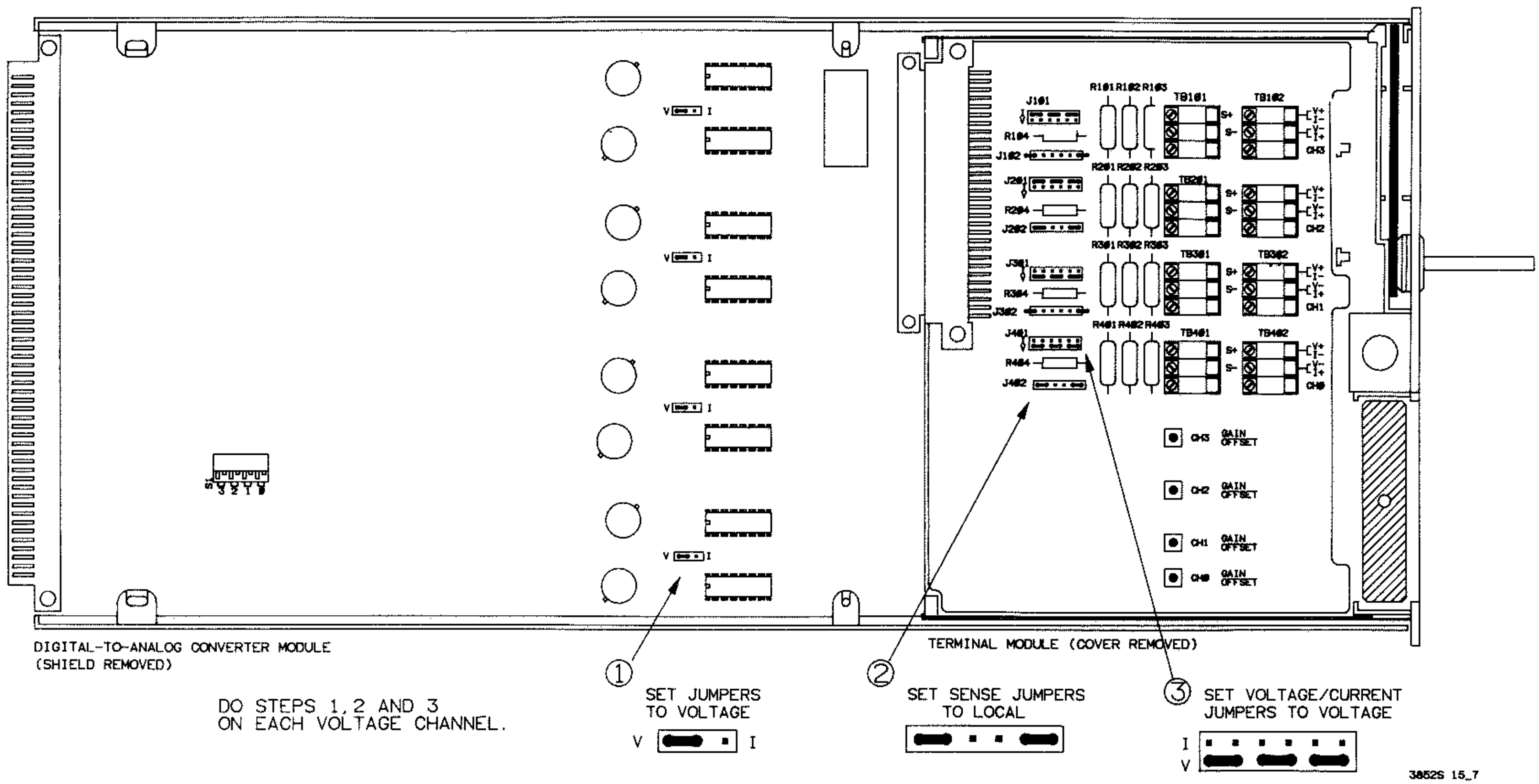


Figure 15-17 Voltage Calibration Configuration

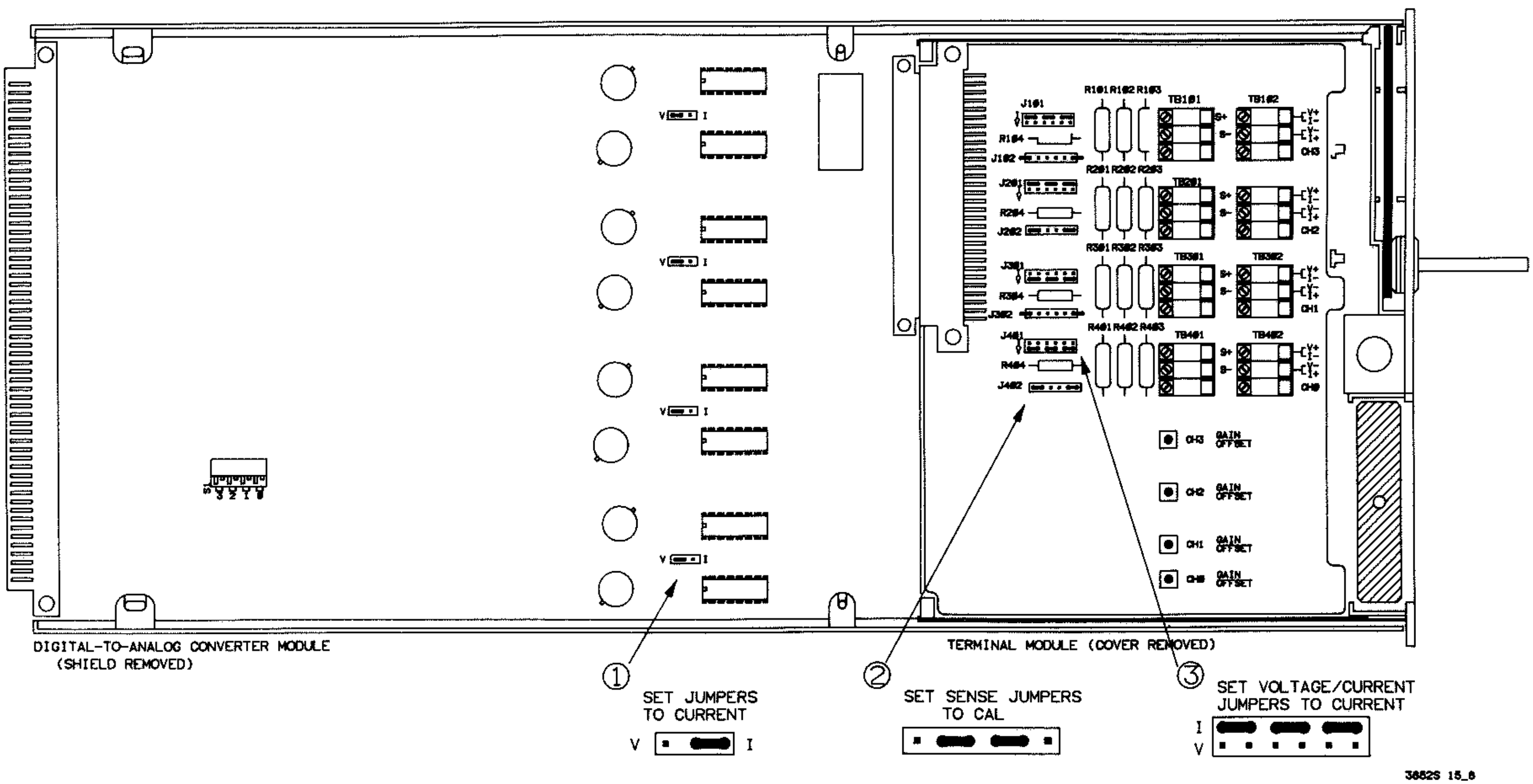


Figure 15-18 Current Calibration Configuration

f. Apply power to the 3852A. Wait long enough for the temperature on the HP 44277A/B/C accessory to stabilize.

g. Go to the appropriate calibration procedure for calibration.

15-37 Voltage DAC Calibration

Perform the following procedure only for channels configured for voltage.

NOTE

If attempting to perform voltage channel calibration on channels configured for current, the HP 3852A will display an "Invalid Command for Accessory" error.

NOTE

Make sure no external connections, other than the test equipment, is made to the channel to be calibrated or invalid calibration results may be obtained.

1. Set the HP 44727A/B/C channels to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

2. Set the multimeter to measure dc volts. On the terminal module, connect the multimeter DCV input to the V+ connection and connect the COM input to the V- connection of the channel to be calibrated. The connections are shown in Figure 15-19.

NOTE

In Figure 15-19, Channels 0 and 1 are configured for voltage, and Channels 2 and 3 are configured for current. Use Channels 0 and 1 jumper configuration for voltage calibration

3. Output 0 V by executing:

   APPLY DCV ESXX,0 (where E = extender number, S = slot number, XX = channel)

4. Adjust the OFFSET potentiometer on the channel being calibrated for a 0.00000 volts reading on the multimeter. A special tool is provided to easily access the potentiometer from the terminal module. Guide the adjustment tool on top of the test point in the terminal module for the specific channel being calibrated. The OFFSET potentiometer is the lower of the two potentiometers as shown in Figure 15-20.

5. Output +10 V by executing:

   APPLY DCV ESXX,10 (where E = extender number, S = slot number, XX = channel)

6. Adjust the GAIN potentiometer on the channel being calibrated for a +10.00000 volts reading on the multimeter. The GAIN potentiometer is the upper of the two potentiometers as shown in Figure 15-20.

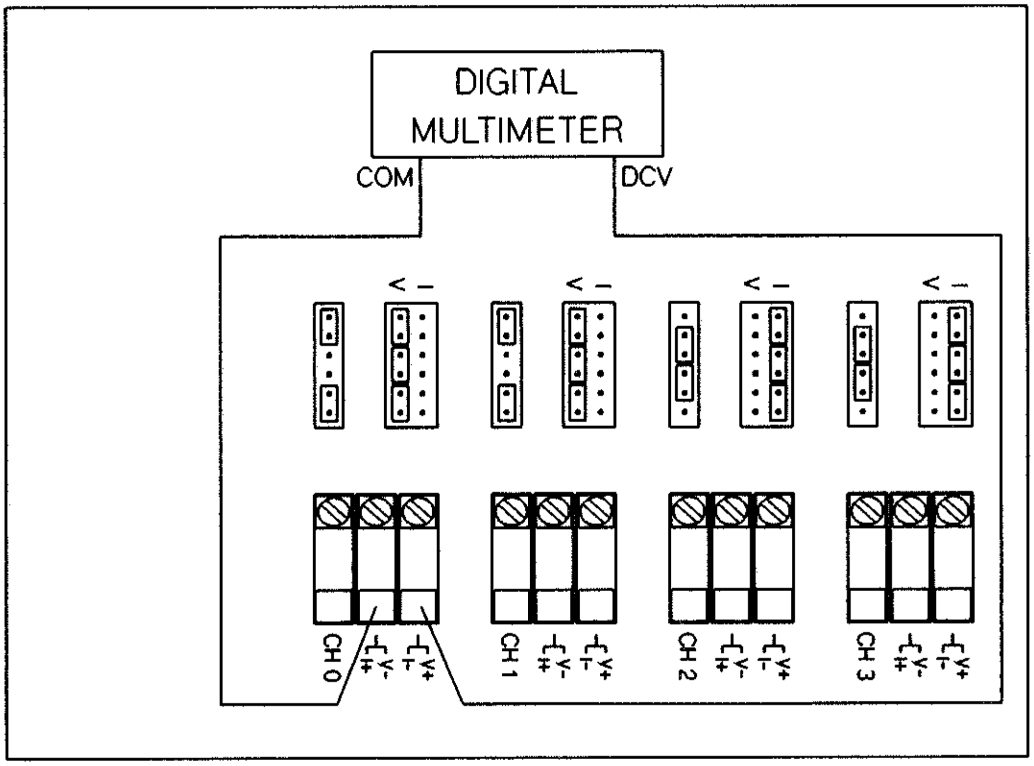


Figure 15-19 Voltage Calibration Connections

7. Repeat steps 2 through 6 for other channels configured for voltage.

8. Return the voltage channels to the original configuration noted in Figure 15-16, if necessary.

15-38 Current DAC Calibration

Perform the following procedure only for channels configured for Current.

NOTE

If attempting to perform current channel calibration on channels configured for voltage, the HP 3852A will display an "Invalid Command for Accessory" error.

NOTE

Make sure no external connections, other than the test equipment, is made to the channel to be calibrated or invalid calibration results may be obtained.

1. Set the HP 44727A/B/C channels to a known state by executing:

   RESET ES00   (where E = extender number, S = slot number)

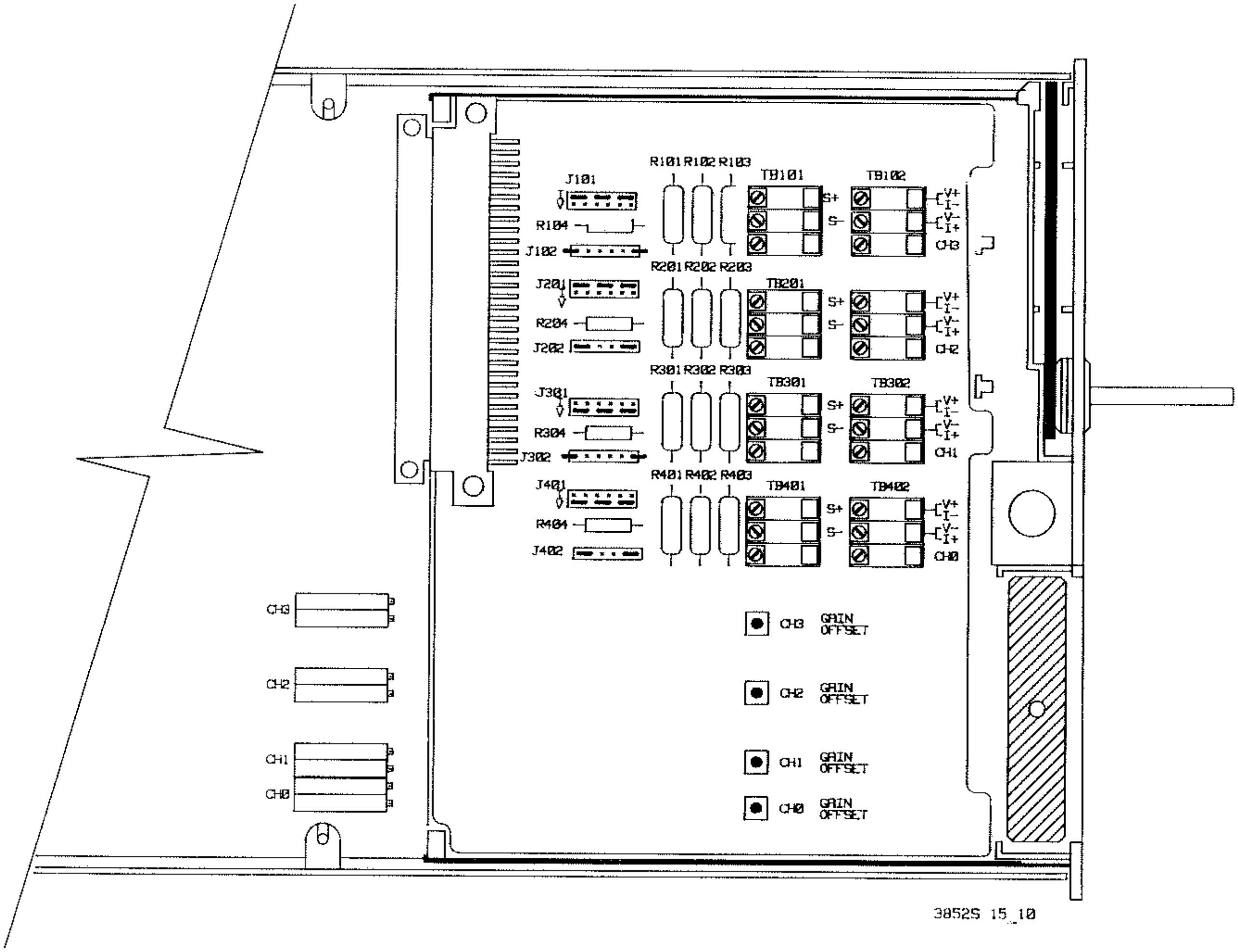


Figure 15-20 Calibration Potentiometer Locations

2. Set the multimeter to measure dc volts. On the terminal module, connect the multimeter DCV input to the I+ connection and connect the COM input to the I- connection of the channel to be calibrated. With these connections and the Sense jumpers on the terminal module set in the CAL position, the multimeter measures across a 250 ohm calibration resistor. The resistor is used in conjunction with the multimeter to calibrate the current output. The connections are shown in Figure 15-21.

NOTE

In Figure 15-21, Channels 2 and 3 are configured for current, and Channels 0 and 2 are configured for voltage. Use Channels 2 and 3 jumper configuration for current calibration

3. Output 0 mA by executing:

APPLY DCI ESXX,0 (where E = extender number, S = slot number, XX = channel)

4. Adjust the OFFSET potentiometer on the channel being calibrated for a 0.00000 volts reading on the multimeter. A special tool is provided to easily access the potentiometer from the terminal module. Guide the adjustment tool on top of the test point in the terminal module for the specific channel being calibrated. The OFFSET potentiometer is the lower of the two potentiometers as shown in Figure 15-20.

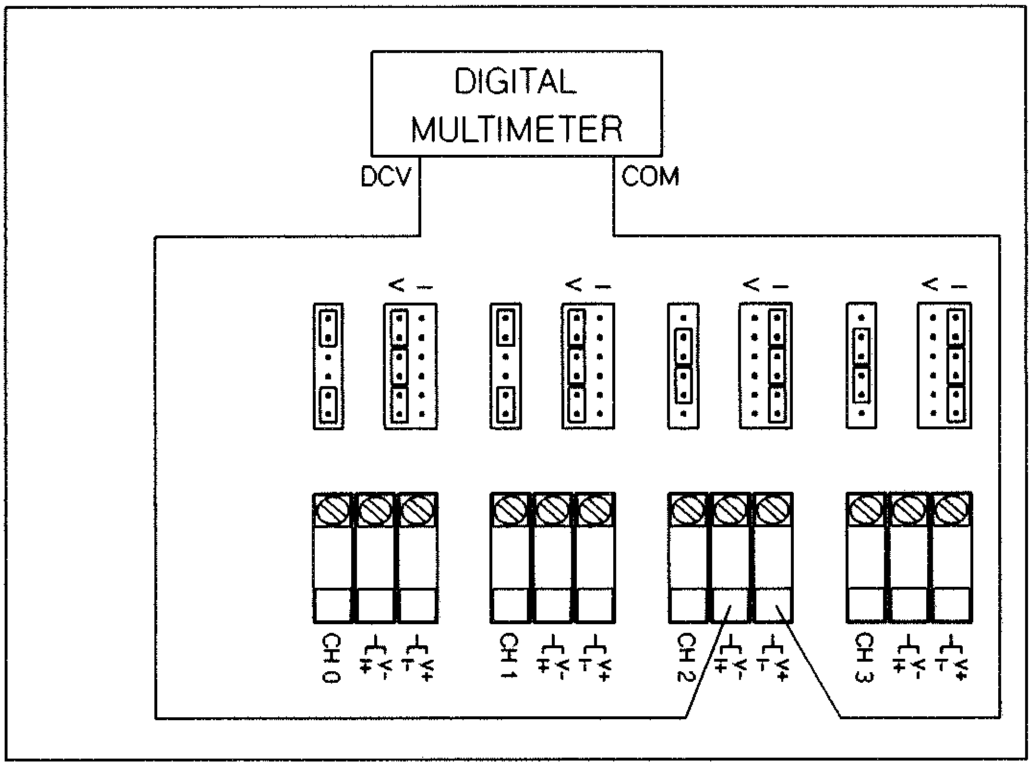


Figure 15-21 Current Calibration Connections

5. Output +20 mA by executing:

APPLY DCI ESXX,.02 (where E = extender number, S = slot number, XX = channel)

6. Adjust the GAIN potentiometer on the channel being calibrated for a +5.00000 volts reading on the multimeter. The GAIN potentiometer is the upper of the two potentiometers as shown in Figure 15-20.

7. Repeat steps 2 through 6 for other channels configured for current.

8. Return the current channels to the original configuration noted in Figure 15-16, if necessary.

15-39 REPLACEABLE PARTS

Figure 15-22 shows the mechanical breakdown of the HP44727A/B/C. The figure also provides the disassembly information. The parts shown in Figure 15-22 are keyed to the parts lists in Table 15-6.

To order a part listed in Table 15-6, quote the Hewlett-Packard part number, the quantity desired, the HP factory reference, and the check digit (abbreviated CD). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board for the HP 44727A/B/C is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

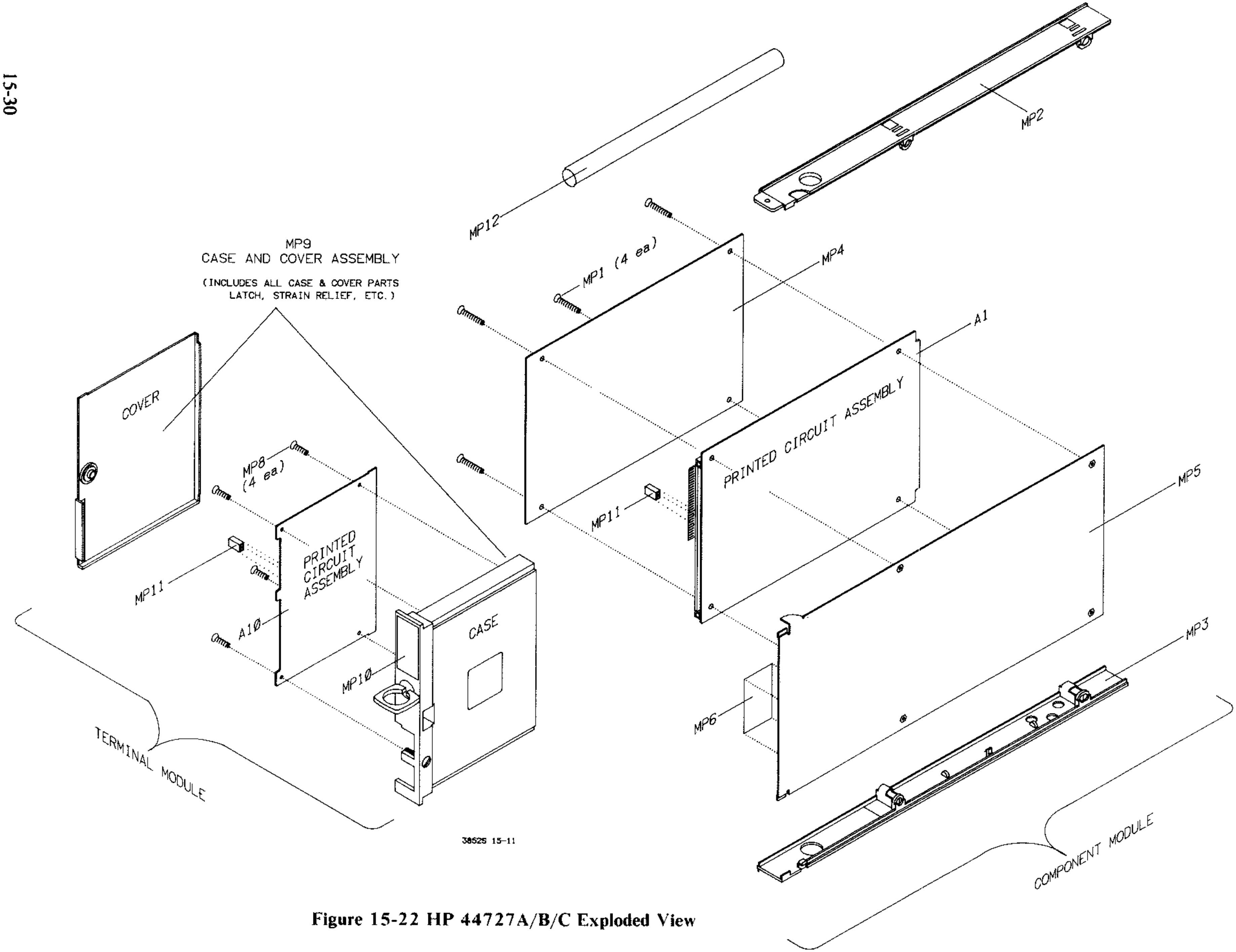


Figure 15-22 HP 44727A/B/C Exploded View

Table 15-6 HP 44727A/B/C 4 Channel Voltage/Current DAC

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44727A	Module; 4ch V/I DAC (configured: 4V)	1	44727-66201	7	MOD-DAC:4CH-VOLT
44727B	Module; 4ch V/I DAC (configured: 4I)	1	44727-66202	8	MOD-DAC:4CH-CURR
44727C	Module; 4ch V/I DAC (configrd:2V&2I)	1	44727-66203	9	MOD-DAC:2-V;2-I
A1	PCA; 4ch V/I DAC compnt (confgrd:4V)	1	44727-66501	1	PCA-DAC:4CH-VOLT
	PCA; 4ch V/I DAC compnt (confgrd:4I)	1	44727-66502	0	PCA-DAC:4CH-CURR
	PCA; 4ch V/I DAC cmp (confgrd:2V&2I)	1	44727-66503	2	PCA-DAC:2-V;2-I
A10	PCA; 4ch V/I DAC term (configrd: 4V)	1	44727-66510	1	PCA-DAC TERM:4-V
	PCA; 4ch V/I DAC term (configrd: 4I)	1	44727-66511	1	PCA-DAC TERM:4-I
	PCA; 4ch V/I DAC trm (confgrd:2V&2I)	1	44727-66512	1	PCA-DACTERM:2V2I
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44727A/B/C component module	1	44727-84320	9	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear pnl of term mod 44727ABC	1	44727-84325	4	LBL-ID,TERM ASSY
MP11	Jumper; removable, A1/A10 PCA	24	1258-0141	8	JMPR-REM .025P
MP12	Tool; calibration	1	8730-0011	0	TOOL-TUNING

Completely assembled HP 44727A, B, or C terminal modules can be ordered from your local HP Office by ordering Number 44727AT, 44727BT, or 44727CT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44727A	Module; 4ch V/I DAC (configured: 4V)		44727-69201	3	RBLT-44727-66201
44727B	(use reconfigured & recal'd 44727A)		44727-69201	3	RBLT-44727-66201
44727C	(use reconfigured & recal'd 44727A)		44727-69201	3	RBLT-44727-66201

Chapter 16
HP 44728A 8 Channel Relay
Actuator

CHAPTER 16
HP 44728A 8 CHANNEL RELAY ACTUATOR

CHAPTER 16
HP 44728A
8 CHANNEL RELAY ACTUATOR

16-1 INTRODUCTION

This chapter provides a technical description, a performance test procedure, relay troubleshooting procedures, and a replaceable parts list for the HP 44728A 8 Channel Relay Actuator.

16-2 Technical Description

The HP 44728A 8 Channel Relay Actuator is designed to switch moderate to high levels of voltage and current. The relays used are single-pole double-throw (SPDT) form C relays with normally open and normally closed contacts. The relays are not latching relays and return to the normally closed position after a reset, if power is removed, or following an OPEN command.

A block diagram of the HP 44728A is shown in Figure 16-1. Only two of the eight channels are shown in the diagram. The HP 44728A is made up of two main assemblies: a component module and a terminal module. The component module contains the backplane interface electronics, the channel relay drivers, the channel relays, and protection circuitry. The terminal module contains terminal blocks for connection to external wiring.

A varistor and a capacitor are used to protect each set of relay contacts from transients during switching. Each common connection of the relay is fused.

16-3 Read and Write Registers

The HP 3852A communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

SREAD and SWRITE are described in Chapter 2 of this manual. Table 16-1 shows the registers used by the HP 44728A accessory.

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessory. It is possible to program some plug-in accessories into illegal ant potentially damaging states with these commands. The commands are documented here for service purposes only.

16-4 Read Registers

16-5 Register 0. Read Register 0 contains the accessory identification. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data bus.

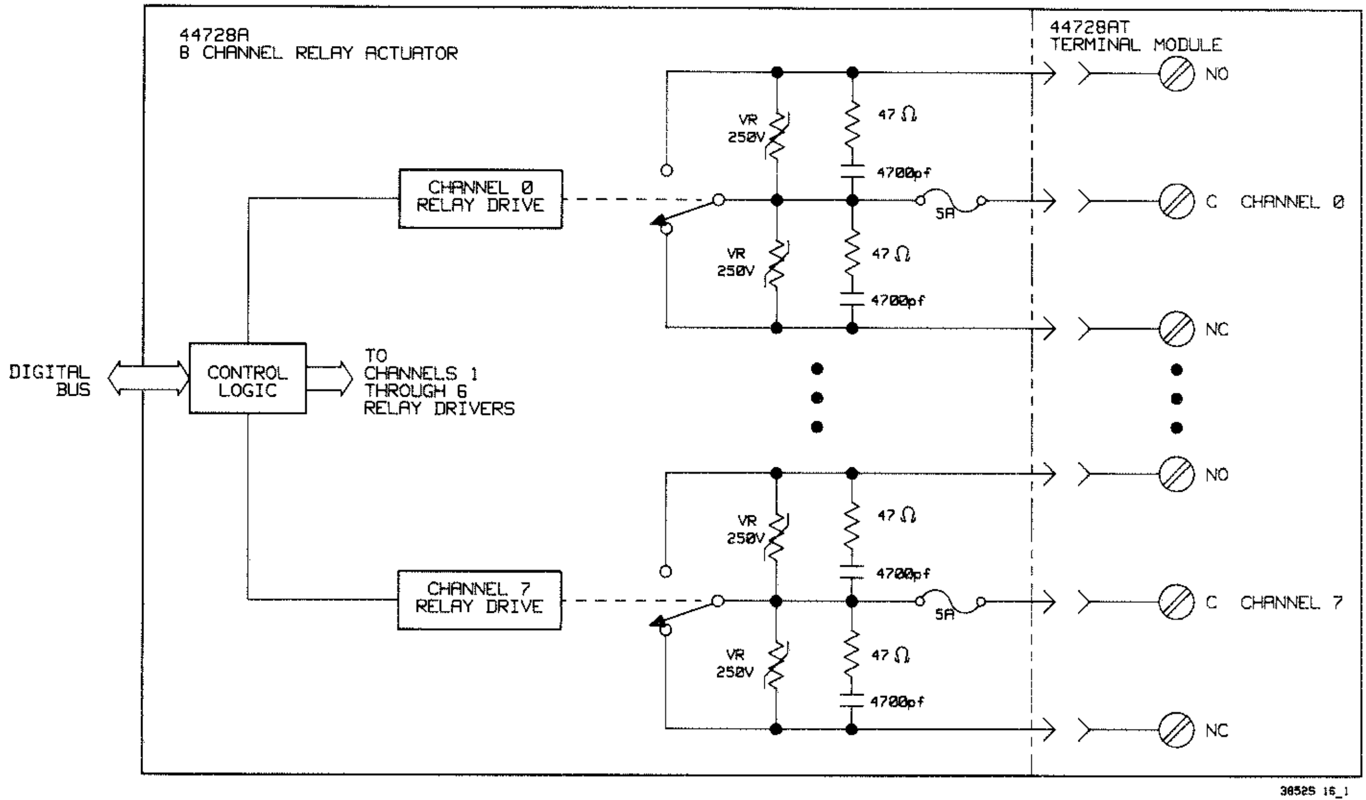


Figure 16-1 HP 44728A Block Diagram

Table 16-1 8 Channel Relay Actuator Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Reset
1	Always -239	Not Used
2	Not Used	Not used
3	Channels 0 through 7	Channels 0 through 7

The eight bit identification is in two parts. The five most significant bits identify the component module and the three least significant bits identify the type of terminal module installed. If a terminal module is not present, the lower three bits are set high by the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed.

Table 16-2 lists the decimal equivalent codes returned in response to an SREAD of Register 0.

16-6 Register 1. Read Register 1 is a hardwired register and will always return a decimal value of -239 in response to an SREAD.

Table 16-2 HP 44728A Identification Codes

Module Combinations	Codes
HP 44728A Component Module (no terminal module installed)	-209
HP 44728A Component Module, HP 44728AT Terminal Module installed	-214

16-7 Register 3. Read Register 3 is the status register. The register contains an eight bit status word, representing the last programmed state of the channel switches. The bits in the status word correspond one-to-one with the channel numbers (i.e., bit 7 represents channel 7). Figure 16-2 is an example of the status word. In the figure, it is presumed that channel 7 is closed.

```
Bits:       7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0
```

Figure 16-2 Read Register 3

NOTE

The decimal number returned after the execution of an SREAD command represents the two's compliment of the status word.

16-8 Write Registers

16-9 Register 0. Write Register 0 is the accessory reset register. Any data written to this register will cause a reset of the accessory and force all the channel switches open. A write to Register 0 has the same effect as a backplane accessory reset.

16-10 Register 3. Register 3 is the control register. An eight bit word is used to control the status of the channel switches. The bits in the command word correspond one-to-one to the channel number (i.e., setting bit 7 closes channel 7). Figure 16-3 is an example of the command word. In the figure, it is presumed that channel 7 is to be closed.

```
Bits:       7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0
```

Figure 16-3 Command Word

16-11 SPECIFICATIONS

Specifications for the HP 44728A are given in Table 16-3. Specifications are the performance standards or limits against which the accessory may be tested.

Table 16-3 HP 44728A Specifications

Maximum Input Voltage (Vmax) per channel:	300 V DC or 250 V RMS
Maximum Input Current:	2 A DC, 3 A RMS per channel (5 A fuse protection)
Maximum Sum of the Squared RMS Currents in Each Channel (per module; for any type load):	26 A^2
Closed Channel Path Resistance:	500 mΩ
Switch Life:	At Full Load, 10^5
Maximum Input Power per channel:	60 W DC (Vmax <=30 V DC) 45 W DC (Vmax >30 V DC) 750 VA RMS
Maximum Snubber Circuit Leakage:	1 mA per channel @ 250 V RMS
Maximum Wire Size:	14 AWG

16-12 PERFORMANCE TEST

16-13 Introduction

The following Performance Test checks the operation of the HP 44728A component module. Performance Tests are not given for the terminal modules. Successful completion of the test in this chapter provides a high confidence level that the Relay Actuator is meeting its listed specifications.

16-14 Equipment Required

The following test equipment is required to run the Performance Test.

1. Test Fixture (as described in Section 16-15)

2. Digital Multimeter -- HP 3456A or equivalent

3. Test Leads and Jumpers

4. Service Module -- HP 44743A

NOTE

Either of the accessory plug-in voltmeters (HP 44701A or HP 44702A/B) may be used for this test. This test does not describe the specific steps required to use the plug-in voltmeters. A description of the plug-in voltmeters can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

16-15 Test Fixture

A test fixture is required to run the Performance Test. A schematic of the required test fixture is shown in Figure 16-4a. A test fixture can be manufactured using an HP 44728AT terminal module (see Figure 16-4b). Because wiring the test fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44728AT terminal module, it is important that the terminal ID lines, shown in Figure 16-4a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

The test fixture consists of: a short circuit between all channel NC (Normally Closed) lines, a short circuit between all channel NO (Normally Open) lines, and a short circuit between all channel C (Common) lines. The use of the test fixture minimizes the number of test lead connections required for the tests.

16-16 Test Procedure

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

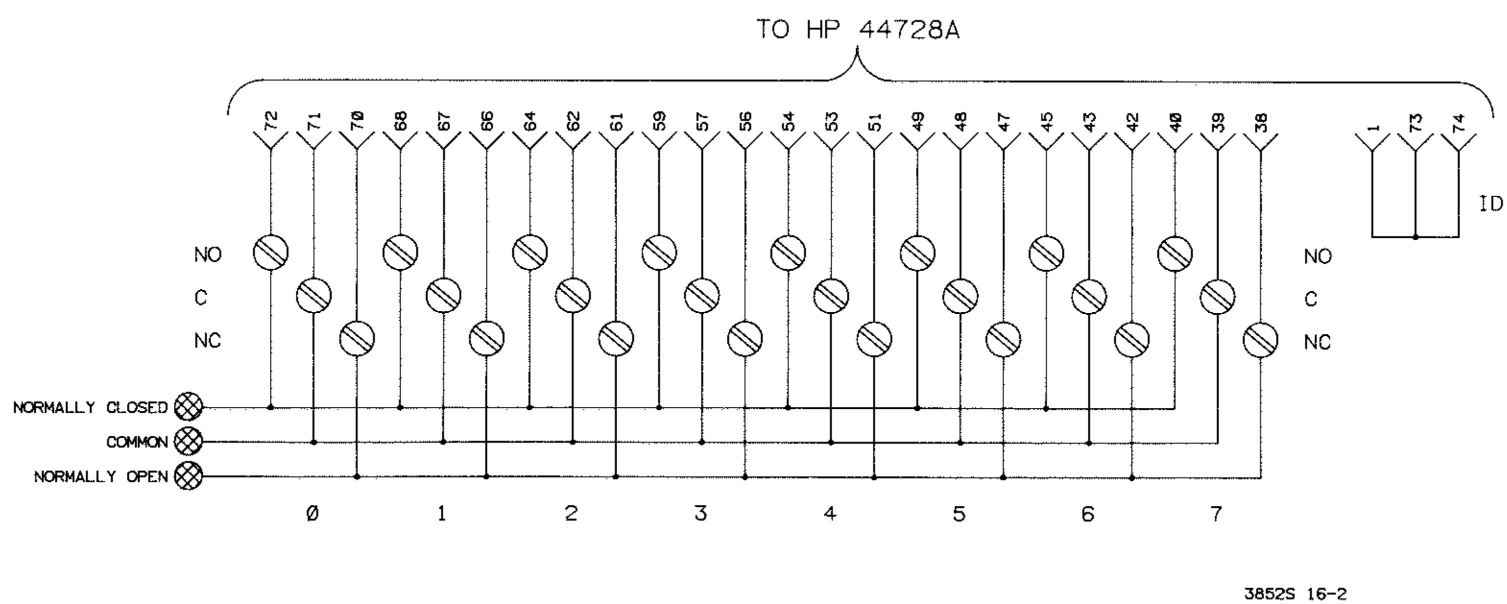


Figure 16-4a HP 44728A Test Fixture Schematic

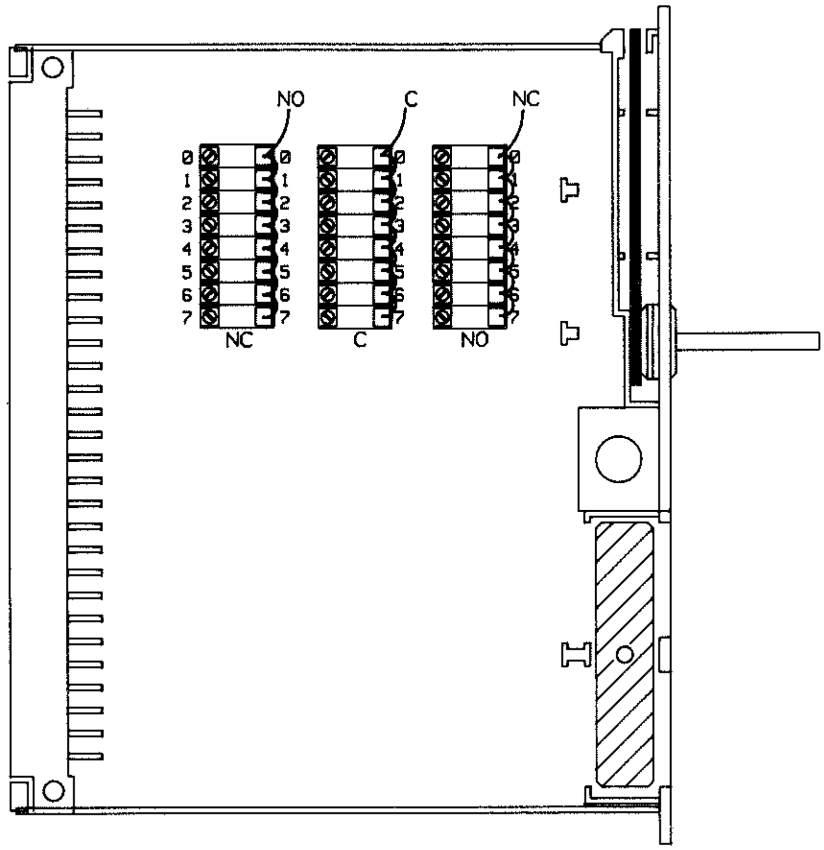


Figure 16-4b HP 44728A Test Fixure

16-17 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the Relay Actuator component module and install the test fixture. Note the slot number where the Relay Actuator under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

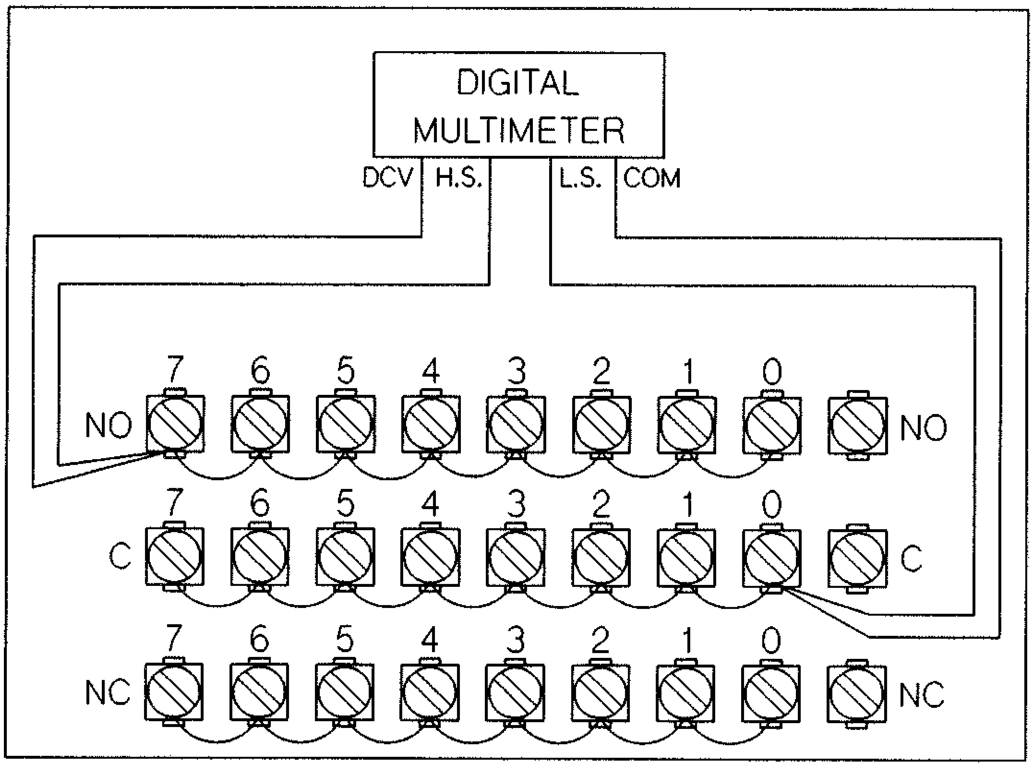


Figure 16-5 HP 44728A NO Channels Contact Resistance Test

c. Verify that the HP 3852A right display shows:

44728

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

16-18 Contact Resistance Test

1. NORMALLY OPEN CONTACT RESISTANCE TEST: This test checks the contact resistance of the normally open relay contacts. Since these contacts are normally open, a CLOSE command closes the contacts and an OPEN command opens the contacts.

2. Set all HP 44728A channel relays to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

3. Set the multimeter to measure four-wire ohms. Connect the multimeter DCV input and high SENSE leads to the NO (Normally Open) connection on the test fixture. Connect the multimeter COM input and low SENSE leads to the C (Common) connection on the test fixture. The connections are shown in Figure 16-5.

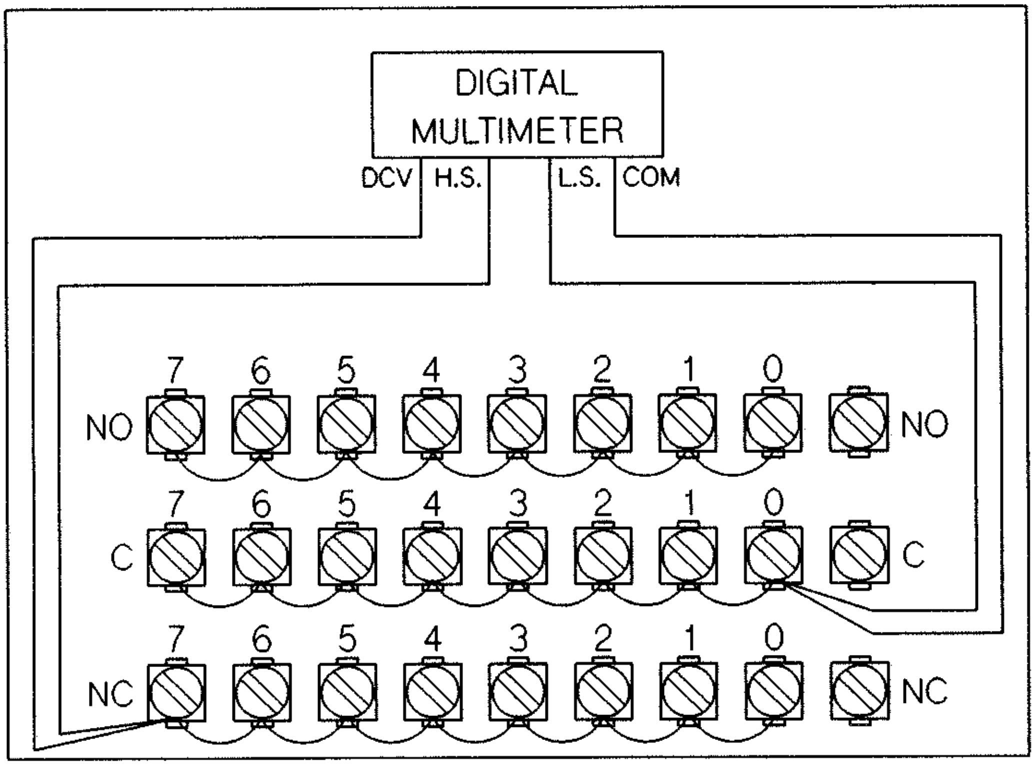


Figure 16-6 HP 44728A NC Channels Contact Resistance Test

4. Close channel 00 by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The multimeter should indicate a resistance less than 0.5 ohms. If the contact resistance is above 0.5 ohms, check and make sure the protection fuse in the C (Common) path is not causing the failure.

6. Open channel 00 by executing:

   OPEN ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. The multimeter should indicate an open circuit (>10^7 ohms). It is important to perform this step to ensure that none of the relays are stuck closed. If the multimeter does not indicate an open, troubleshooting will be necessary to locate the stuck relay. Section 16-19 describes locating a stuck relay.

8. Repeat steps 4, 5, 6, and 7 for channels 01 through 07. In the CLOSE and OPEN command the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

9. NORMALLY CLOSED CONTACT RESISTANCE TEST: This test checks the contact resistance of the normally closed relay contacts. Since these contacts are normally closed, a CLOSE command opens the contacts and an OPEN command closes the contacts.

10. Connect the multimeter DCV input and high SENSE leads to the NC (Normally Closed) connection on the test fixture. Connect the multimeter COM input and low SENSE leads to the C (Common) connection on the test fixture. The connections are shown in Figure 16-6.

11. Open all channels by executing:

CLOSE ES00-ES07 (where E = extender number, S = slot number)

The multimeter should indicate an open circuit (>10^7 ohms).

12. Close channel 00 by executing:

OPEN ES00 (where E = extender number, S = slot number)

13. Observe the indication on the multimeter. The multimeter should indicate a resistance of less than 0.5 ohms.

14. Open channel 00 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

15. Observe the indication on the multimeter. The multimeter should indicate an open circuit (>10^7 ohms). It is important to perform this step to ensure that none of the relays are stuck closed. If the multimeter does not indicate an open, troubleshooting will be necessary to locate the stuck relay. Section 16-19 describes locating a stuck relay.

16. Repeat steps 12, 13, 14, and 15 for channels 01 through 07. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

16-19 RELAY TROUBLESHOOTING

This section describes relay troubleshooting. The troubleshooting procedures first determine if the problem is located in the relays, or in the control logic. If the problem is determined to be in the control logic, complete replacement of the printed circuit board is required. Individual relays may be replaced.

The Performance Test provides a starting point for problem isolation. The Performance Test is described in Section 16-12.

A single failing channel indicates a failing channel relay. Table 16-4 is the relay cross reference table showing the relationship between channel numbers, relay numbers, and relay drivers and their corresponding input/output pin numbers. The table also shows the NC, NO, and C pin numbers on the component module connector.

Figure 16-7 shows the location of the relays on the component module board. Figure 16-8 shows a simplified schematic of one relay and associated circuitry. Since all the relay circuitry is the same, only one relay circuit is shown in the figure. Also shown in Figure 16-8 is a package outline and pinout diagram of the type of relay used. Use both Figures 16-7 and 16-8, and Table 16-4 for the following troubleshooting procedures.

CAUTION

To prevent equipment circuit damage always set the line power switch to off before removing or replacing any assembly. To prevent static zap of ICs always observe anti-static handling techniques when assemblies are handled or stored.

Table 16-4 HP 44728A Relay Cross Reference Table

Channel Number	Relay Number	Relay Driver Input/Output Input	Output	Component Module Connector Pins NC	NO	C
0	K1	U10 pin 1	U10 pin 18	72	70	71
1	K2	U10 pin 2	U10 pin 17	68	66	67
2	K3	U10 pin 3	U10 pin 16	64	61	62
3	K4	U10 pin 4	U10 pin 15	59	56	57
4	K5	U10 pin 5	U10 pin 14	54	51	53
5	K6	U10 pin 6	U10 pin 13	49	47	48
6	K7	U10 pin 7	U10 pin 12	45	42	43
7	K8	U10 pin 8	U10 pin 11	40	38	39

16-20 Control Logic Problem Isolation

The following control logic test writes relay closing patterns to the Relay Actuator and then checks for an indication of the relay state in the status register (Read Register 3). Electrically, this test checks that the correct relay drive lines were enabled. It does not actually check the drive lines. The test does provide an indication that the control logic is performing as required and can communicate with the HP 3852A local controller.

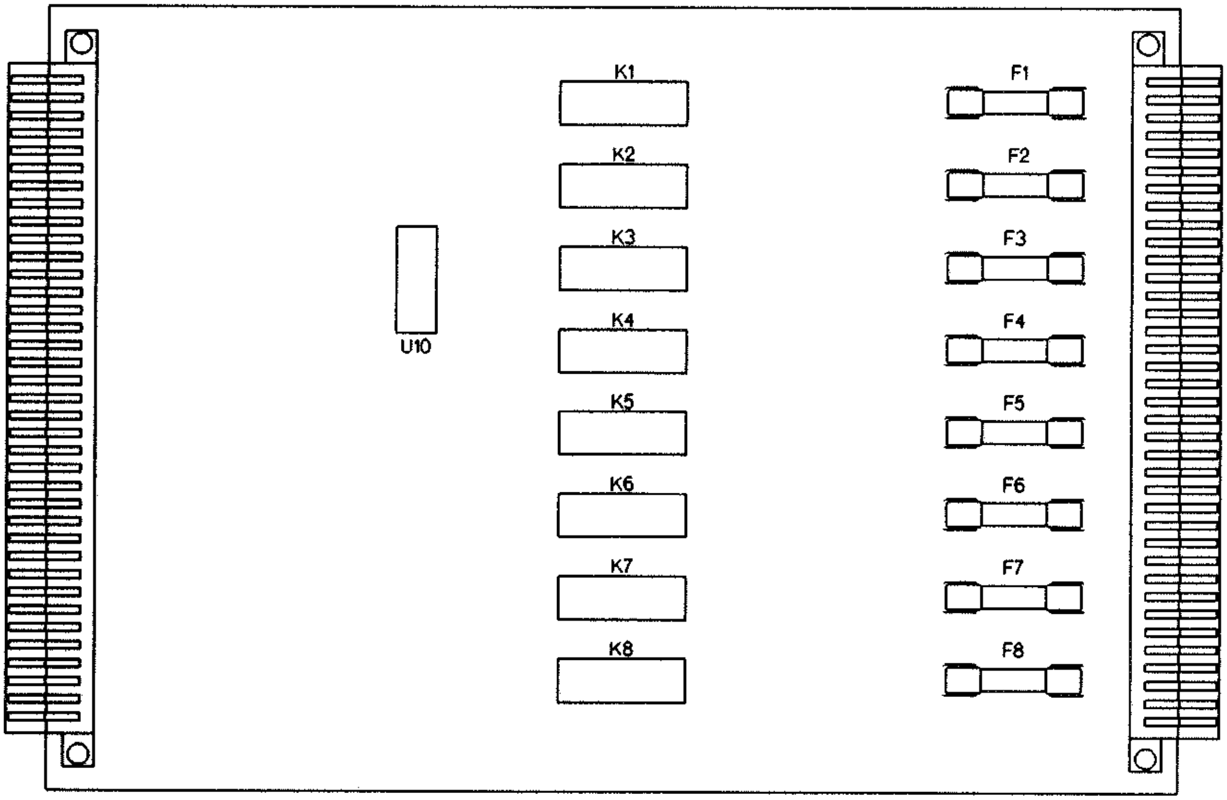


Figure 16-7 Relay Component Locator

NOTE

If using an HP 9000 Series 300 or Series 300 computer to perform this test, it may be necessary to program a delay between the SWRITE and SREAD commands (steps 2, 4, and 5) to allow time for the relay states to be latched into the status register.

1. Reset the HP 44728A Relay Actuator by executing:

   RESET ES00 (where E = extender number, S = slot number)

2. Read the status register by executing:

   SREAD ES00 (where E = extender number, S = slot number)

3. Verify that the right display shows:

   -256

If the display shows -256 (all channels open), the HP 44728A has been reset. Proceed to Step 4. If a number other than -256 is displayed, cycle power on the HP 3852A and perform steps 2 and 3 again. If the number is still incorrect, a failure exists with the HP 44728A control logic or with the HP 3852A. If the HP 3852A seems to operate normally (see Chapter 5 for HP 3852A problem isolation), the fault most likely exists in the HP 44728A switch control logic.

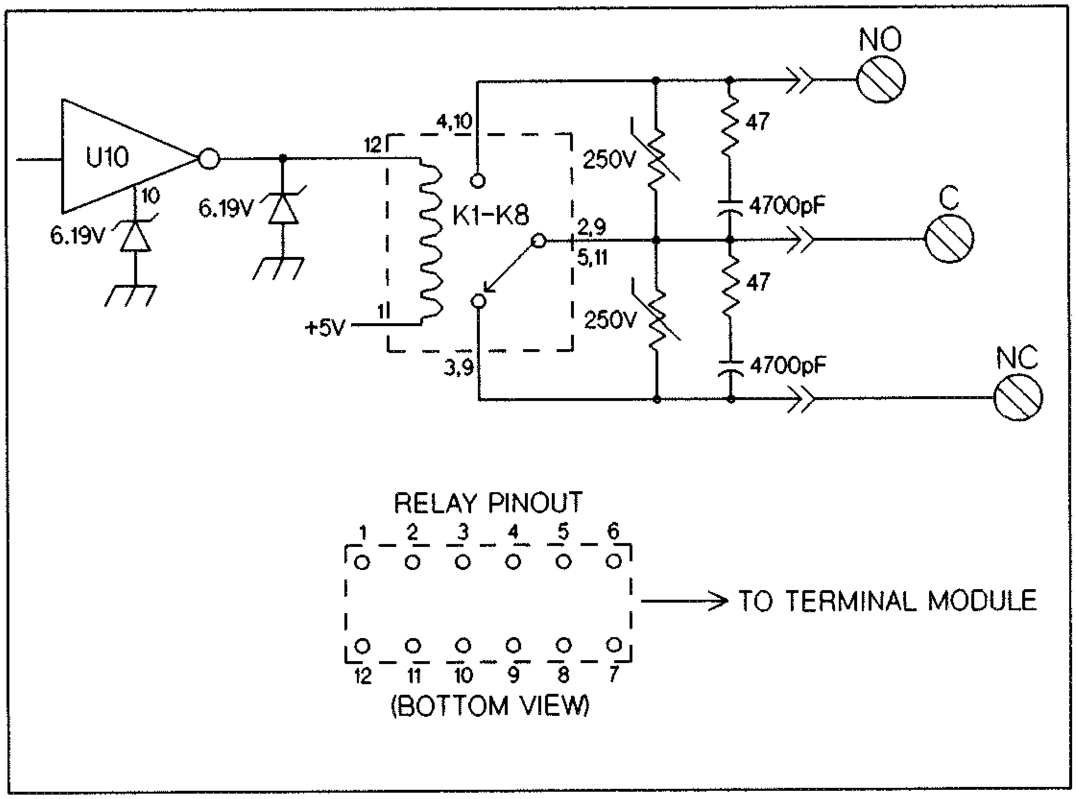


Figure 16-8 Relay Simplified Schematic

4. Close all relays by executing:

   SWRITE ES00,3,-1 (where E = extender number, S = slot number)

5. Read the status register by executing:

   SREAD ES00,3 (where E = extender number, S = slot number)

6. Verify that the right display shows:

   -1

7. Reset the HP 44728A Relay Actuator by executing:

   RESET ES00 (where E = extender number, S = slot number)

CAUTION

This procedure sets illegal and potentially damaging states on the HP 44728A Relay Actuator. Be sure to execute the RESET command in Step 7 to clear these states.

If the control logic test passed and a relay is not closing or opening, relay replacement is indicated. Since the control logic test is unable to check the actual relay drive lines, an additional test can be performed. With a digital multimeter, check the voltage across the faulty relay coil. The multimeter should indicate a steady state voltage of approximately 4.0 Vdc when the relay is open. The multimeter should indicate less than 0.2 Vdc when the relay is closed. The resistance across the relay coil should be approximately 130 Ω.

16-21 Stuck Relay Troubleshooting

When a relay contact is stuck in the closed position it cannot be isolated with the test fixture installed. The test fixture parallels all the relays together. However, the test fixture, or a terminal module, must be installed to allow the HP 3852A to normally communicate with the component module.

There are two ways to isolate the stuck relay. The first, and easiest means is to install a regular terminal module on the failing component module. Each channel of the multiplexer can then be checked with an ohmmeter. Measure between the faulty NO or NC terminal (depending on which contact is stuck) and the corresponding C terminal on the terminal module. Once the stuck channel is isolated, Table 16-4 identifies the stuck relay.

The second means to isolate a stuck relay involves checking for the stuck contacts on the component module connector. This method is not recommended for general use. To use this method, the test fixture or a terminal module must be installed and the HP 3852A power applied. When the wake-up sequence has completed, the test fixture or terminal module is removed. Removing the module after the wake-up sequence will allow commands to be processed since the local controller only queries the slots for accessory identification after power-on or reset.

It is recommended that the entire component module be replaced if the relays are at or near the relay maximum specified life cycle (shown in Table 16-3) and the relays are sticking or the contact resistance is out of specification.

16-22 REPLACEABLE PARTS

Figure 16-9 shows the mechanical breakdown of the HP 44728A. This figure also provides assembly and disassembly information. The parts shown in Figure 16-9 are keyed to the parts list in Table 16-5.

To order a part listed in Table 16-5, quote the Hewlett-Packard part number, the check digit (abbreviated CD in Table 16-5), and the quantity desired. Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

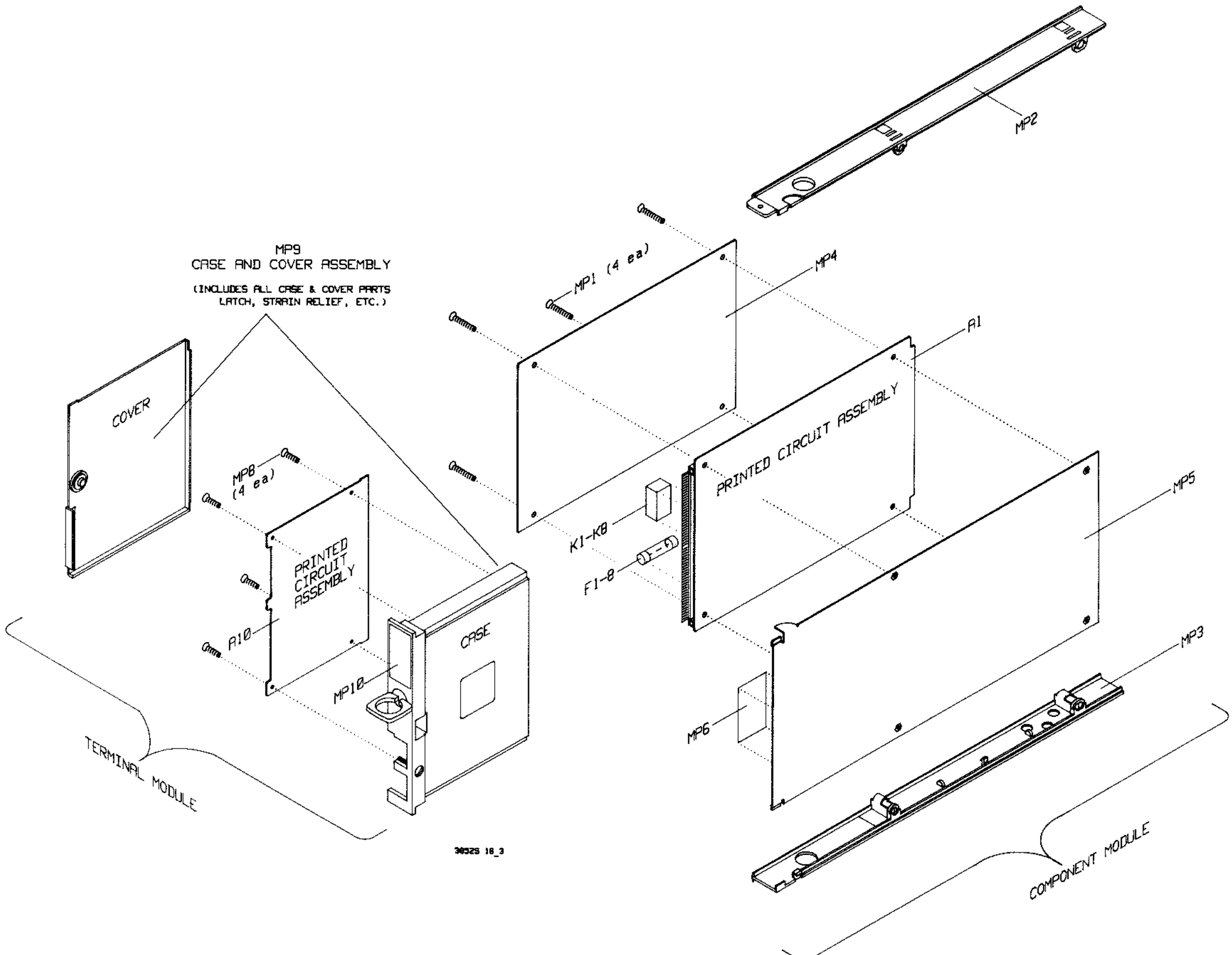


Figure 16-9 HP 44728A Exploded View

Table 16-5 HP 44728A 8 Channel Relay Actuator

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44728A	Module; 8ch relay actuator component	1	44728-66201	8	MOD-8CH RLY ACTR
A1	PCA; 8 chan relay actuator component	1	44728-6650	1	PCA-8CH RLY ACTR
A10	PCA; 8 chan relay actuator terminal	1	44728-66510	2	PCA-8CH ACT TERM
K1-8	Relay; A1 PCA	8	0490-1512	0	RLY-S2EB-5V
F1-8	Fuse; 5A, 250V fast blow, A1 PCA	8	2110-0010	9	FUSE-5AMPS NB
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44728A component module	1	44728-84320	0	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44728A	1	44728-84325	5	LBL-ID,TERM ASSY

Completely assembled HP 44728A terminal modules can be ordered from your local HP Office by ordering Number 44728AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Chapter 17
HP 44728A 8 Channel Power
Controller

CHAPTER 17
HP 44729A 8 CHANNEL POWER CONTROLLER

CHAPTER 17
HP 44729A
8 CHANNEL POWER CONTROLLER

17-1 INTRODUCTION

This chapter provides a technical description, a performance test procedure, and replaceable parts lists for the HP 44729A 8 Channel Power Controller.

17-2 Technical Description

The HP 44729A has two main assemblies; a component module and a terminal module. The component module contains the backplane interface electronics, the channel drivers, the channel switches, protection circuitry, and noise reduction circuitry. The terminal module contains an AC line filter, output protection fuses, and terminals for connection to external wiring.

A simplified schematic of the HP 44729A is shown in Figure 17-1. Only two of the eight channels are shown. The control logic interfaces the HP 3852A or HP 3853A digital bus with the individual channel switches. The control logic decodes the commands received on the digital bus and turns on or off the appropriate channel drivers. Each channel driver has two outputs; a thyristor gate drive line and a relay coil drive line.

The channel drivers are further controlled by the phase control circuit. This circuit synchronizes the channel drivers so that output switching occurs at the points of the AC line input cycle which minimizes arcing across the relay contacts and minimizes RFI generation.

The output switching is accomplished by an SCR and a relay in parallel. This parallel arrangement provides extended relay contact life with low transient generation. In operation, when a channel is commanded to turn on, the SCR is turned on slightly before the relay is closed. The SCR is gated on when the AC input voltage crosses zero (going positive). The SCR then conducts all the current in the channel. The relay closure occurs and the relay contacts begin to conduct. The relay contacts may bounce when first closed and the SCR conducts the channel current during this bounce period. When the AC line voltage again crosses zero (going negative), the SCR is turned off and all the channel current is conducted through the relay contacts.

When a channel is commanded to turn off, the SCR is again gated on and takes up the channel current while the relay contacts open. The channel is turned off at the zero current crossing of the AC line input voltage.

Short circuit protection is provided by a fuse in each channel on the terminal module. Voltage transient protection is provided on each channel by a pair of inductors, Metal Oxide Varistors (MOV's) and capacitors that limit the amplitude and rise time of the transients.

17-3 Read and Write Registers

The HP 3852A local controller communicates with each plug-in accessory by using read and write registers. High level commands are translated into appropriate register commands. The SREAD and SWRITE commands can be used to directly control each register.

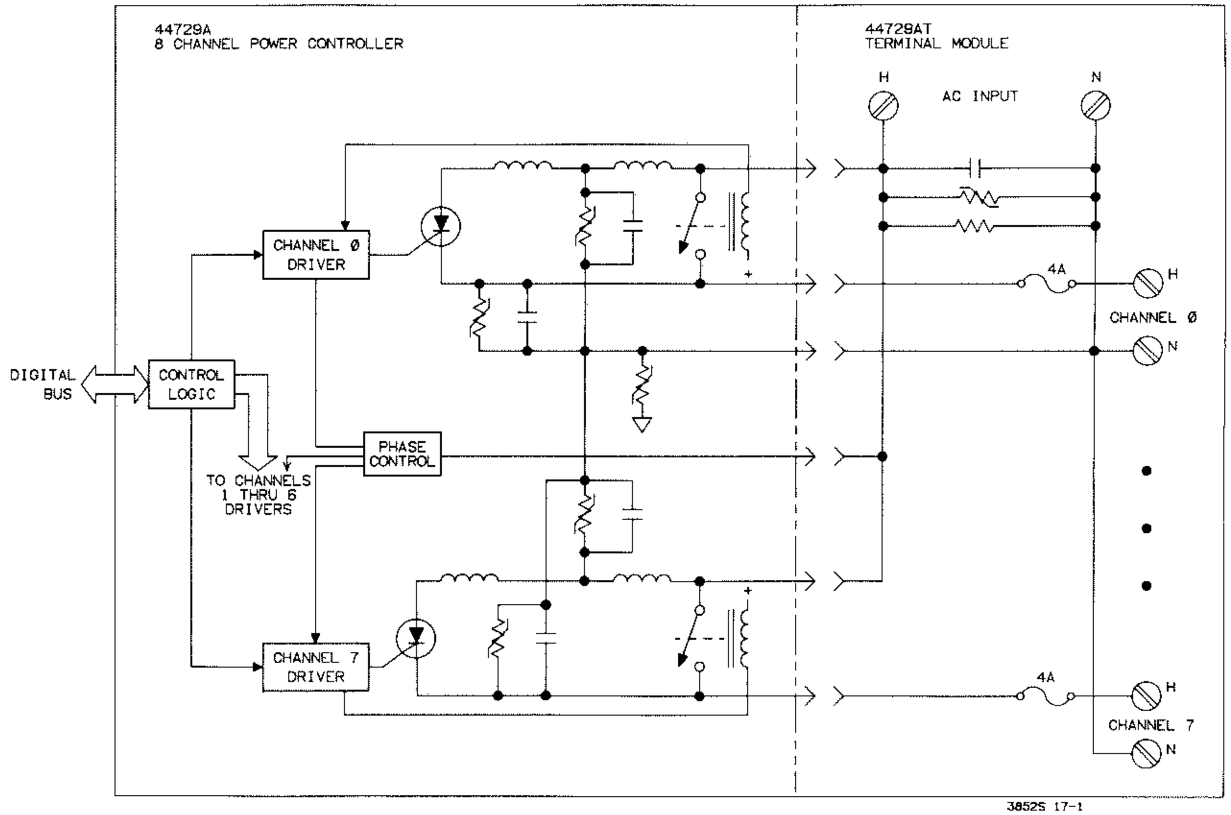


Figure 17-1 HP 44729A Block Diagram

SREAD and SWRITE are described in Chapter 2 of this manual. Table 17-1 shows the registers used by the HP 44729A.

CAUTION

Using the primitive commands (SREAD and SWRITE) may cause unexpected and undesirable effects on the plug-in accessories. It is possible to program some plug-in accessories into illegal and potentially damaging states with these commands. The commands are documented here for service purposes only.

Table 17-1 Power Controller Read and Write Registers

Register #	READ Registers	WRITE Registers
0	Accessory Identification	Accessory Reset
1	Always -240	Not Used
2	Channels 0 through 7	Channels 0 through 7
3	Channels 0 through 7	Channels 0 through 7

17-4 Read Registers

17-5 Register 0. Read Register 0 contains the accessory identification. Eight bits are used to uniquely identify the accessory. The eight bits are output on the lower eight bits of the backplane data lines.

The eight bit identification is in two parts. The five most significant bits identify the component module and the three least significant bits identify the type of terminal module installed. If a terminal module is not present, the lower three bits are set high by the component module. The HP 3852A local controller can thus identify the type of plug-in accessory installed and determine if a terminal module is installed.

Table 17-2 lists the decimal equivalent codes returned in response to an SREAD of Register 0 for all combinations of the accessory.

Table 17-2 HP 44729A Identification Codes

Module Combinations	Codes
HP 44729A Component Module (no terminal module installed)	-81
HP 44729A Component Module, HP 44729AT Terminal Module installed	-88

17-6 Register 1. Read Register 1 is a hardwired register and will always return a decimal value of -240 in response to an SREAD.

17-7 Registers 2 and 3. Read Registers 2 and 3 are status registers. The two registers are identical. The registers contain an eight bit status word, representing the last programmed state of the channel switches. The bits in the status word correspond one-to-one with the channel numbers (i.e., bit 7 represents channel 7). Figure 17-2 is an example of the status word. In the figure, it is presumed that channel 7 is closed.

```
Bits:       7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0
```

Figure 17-2 Read Register 3

17-8 Write Registers

17-9 Register 0. Write Register 0 is the accessory reset register. Any data written to this register will cause a reset of the accessory and force all the channel switches open. The opening of the channel switches may be delayed until the zero current crossing of the AC line input occurs. A write to Register 0 has the same effect as a backplane reset.

17-10 Registers 2 and 3. Write Registers 2 and 3 are control registers. The two registers are identical. An eight bit word is used to control the status of the channel switches. The bits in the command word correspond one-to-one to the channel numbers (i.e., setting bit 7 closes channel 7). Figure 17-3 is an example of the command word. In the figure, it is presumed that channel 7 is to be closed.

```
Bits:       7  6  5  4  3  2  1  0
Bit Value:  1  0  0  0  0  0  0  0
```

Figure 17-3 Command Word

17-11 SPECIFICATIONS

Specifications for the HP 44729A are given in Table 17-3. Specifications are the performance standards or limits against which the accessory may be tested.

Table 17-3 HP 44729A Specifications

Maximum Input Voltage per channel:	250 V RMS 350 V peak
Maximum Input Current:	2.5 A RMS per channel (3 A RMS is module is limited to 16 A RMS total; 4 A fuse fuse protection per channel)
Closed Channel Path Resistance:	125 mΩ @ 3 A RMS 200 mΩ @ 100 mA RMS
Switch Life:	At Full Load, $5*10^6$
Minimum Voltage:	12 V RMS for proper operation
Surge Current:	50 A non-repetetive
Maximum Off Leakage:	0.5 mA per channel
Maximum Wire Size:	12 AWG

17-12 PERFORMANCE TEST

17-13 Introduction

The following Performance Test checks the operation of the HP 44729A component module. Performance Tests are not given for the terminal modules. Successful completion of the test in this chapter provides a high confidence level that the Power Controller is meeting its listed specifications.

The Performance Test makes use of a function generator to provide an AC line input voltage. The use of a function generator allows the test to be performed with a less than lethal AC line input voltage.

17-14 Equipment Required

The following test equipment is required to run the Performance Test.

1. Test Fixture (as described in Section 17-15)

2. Digital Multimeter -- HP 3456A or equivalent.

3. Function Generator -- HP 8116A or equivalent

4. Test Leads and Jumpers

5. Service Module -- HP 44743A

NOTE

The integrating plug-in voltmeter (HP 44701A) may be used for this test. This test does not describe the specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

17-15 Test Fixture

A test fixture is required to perform the Performance Test. A schematic of the required test fixture is shown in Figure 17-4a. A test fixture can be made using an HP 44729AT Terminal Module (see Figure 17-4b). Because wiring the fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

If the test fixture is to be fabricated from other than an HP 44729AT Terminal Module, it is important that the terminal ID lines, shown in Figure 17-4a, be correctly wired. The HP 3852A local controller will not allow the execution of some commands with an incorrect terminal ID.

On the test fixture, in addition to a line input, all channel outputs are connected together (all channels share a common neutral connection).

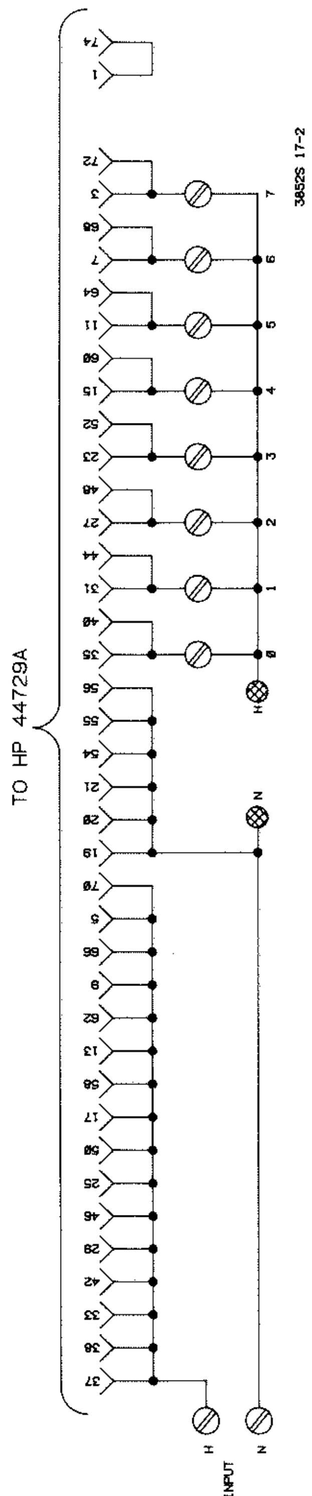


Figure 17-4a HP 44729A Test Fixure Schematic

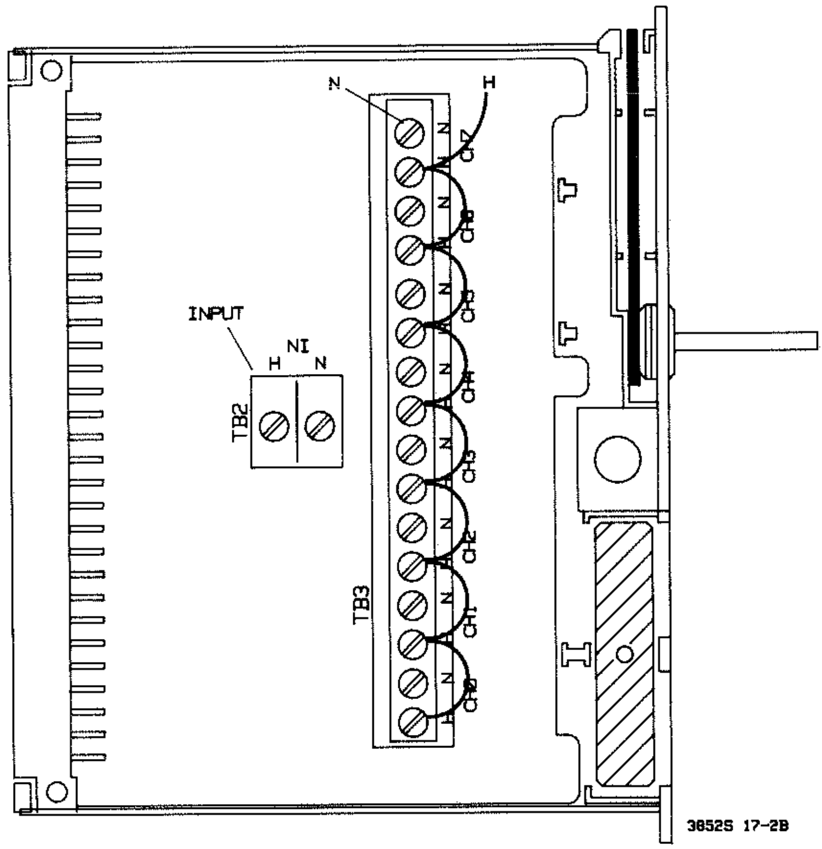


Figure 17-4b HP 44729A Test Fixure

17-16 Test Procedure

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

17-17 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the HP 44729A component module and install the test fixture. Note the slot number where the HP 44729A under test is installed.

3. Verify the correct connections and slot numbers:

a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

b. Execute:

ID? ES00 (where E = extender number, S = slot number)

c. Verify that the HP 3852A right display shows:

44729A

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

17-18 Channel Functional Test

1. Set the HP 44729A to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

2. Set the function generator to output a 14.14 V peak (28.28 V peak-to-peak) sine wave at a 60 Hz rate. Connect the function generator output to the H and N AC input terminals on the test fixture. The connections are shown in Figure 17-5.

3. Set the multimeter to measure AC Volts (RMS). Connect the multimeter DCV input to the shorted HIGH channel connections. Connect the multimeter COM input to any channel neutral connection, as shown in Figure 17-5.

4. Close channel 00 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. The multimeter should indicate 10 VAC (RMS).

6. Open channel 00 by executing:

OPEN ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. The multimeter should indicate less than 0.5 VAC (RMS).

8. Repeat steps 4, 5, 6, and 7 for channels 01 through 07. In the CLOSE and OPEN commands the last two digits are the channel number (i.e., CLOSE ES01 for channel 01).

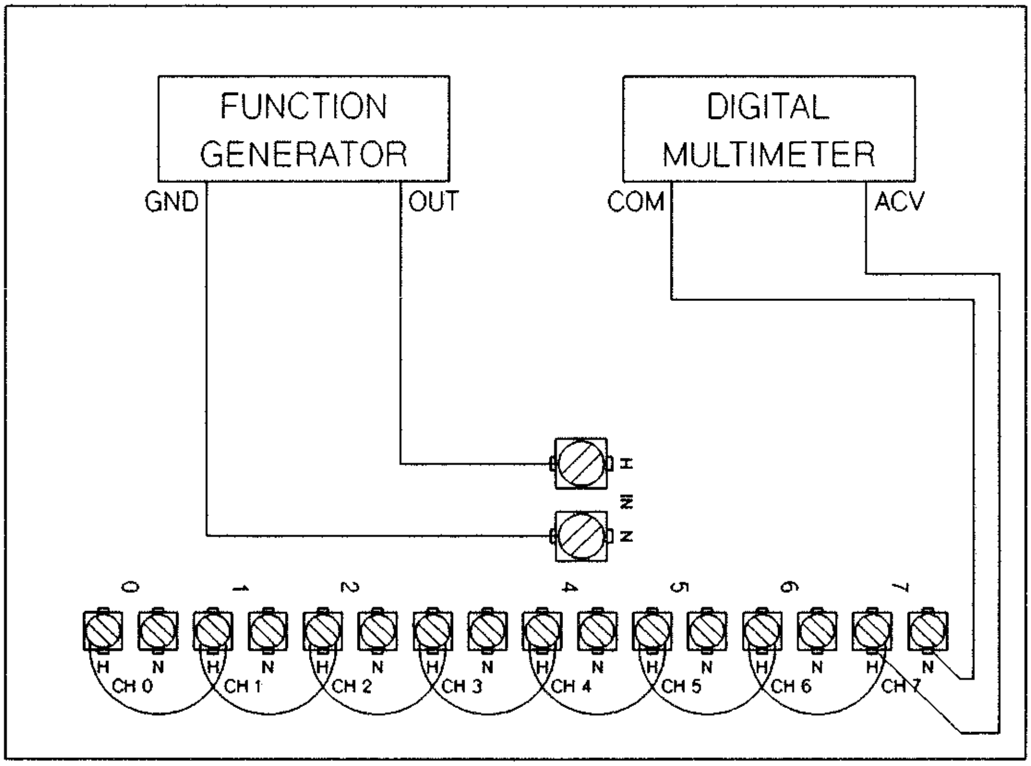


Figure 17-5 HP 44729A Channel Functional Test

17-19 REPLACEABLE PARTS

Figure 17-6 shows the mechanical breakdown of the HP 44729A. The figure also provides assembly and disassembly information. The parts shown in Figure 17-6 are keyed to the parts list in Table 17-4.

To order a part listed in Table 17-4, quote the Hewlett-packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 17-4). Address the order to the nearest Hewlett-packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

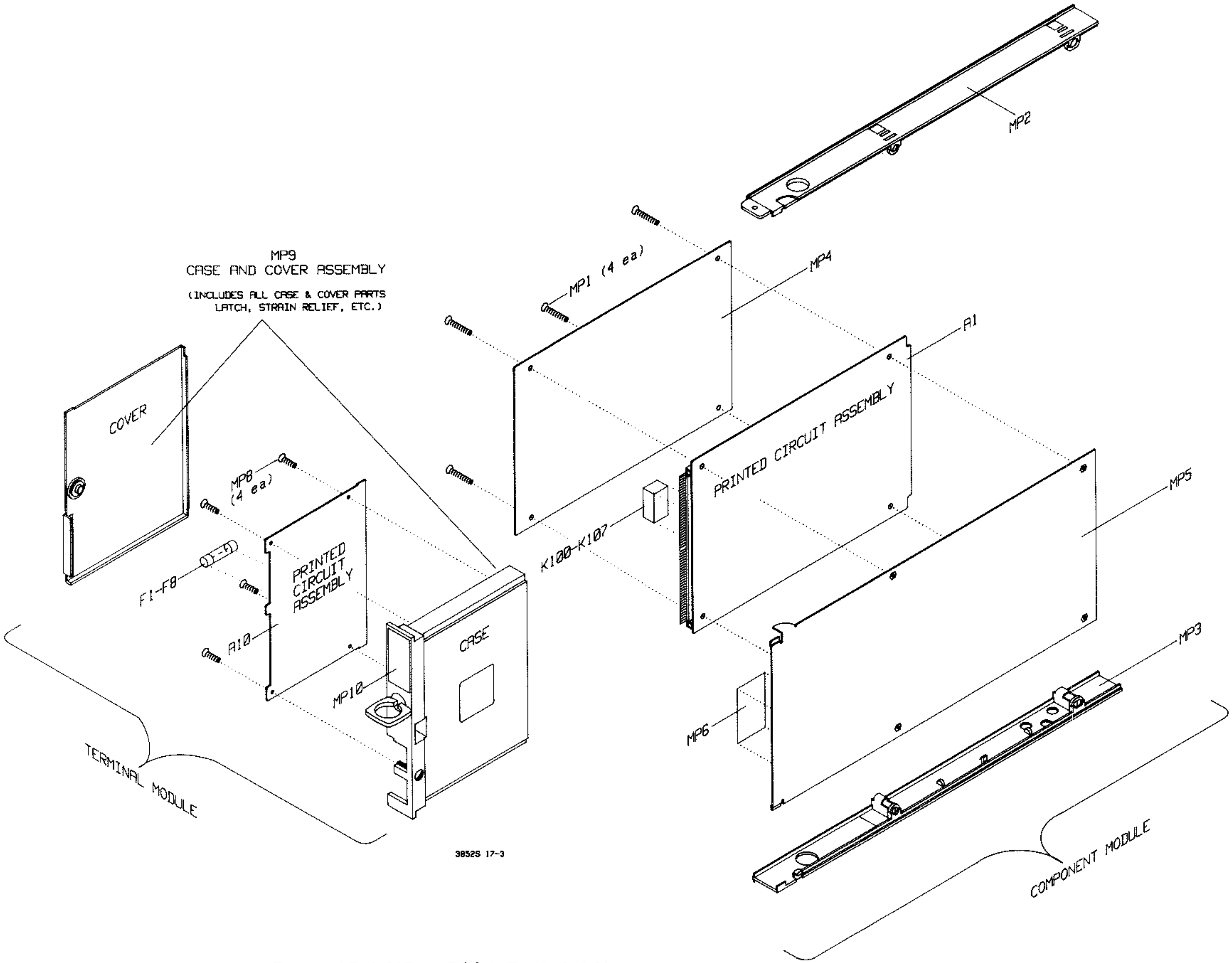


Figure 17-6 HP 44729A Exploded View

Table 17-4 HP 44729A 8 Channel Power Controller

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44729A	Module; 8ch pwr controller component	1	44729-66201	9	MOD-8CH PWR CTRL
A1	PCA; 8 ch power controller component	1	44729-66501	2	PCA-8CH PWR CTRL
A10	PCA; 8 ch power controller terminal	1	44729-66510	3	PCA-PWRCTRL TERM
K100-107	Relay; A1 PCA	8	0490-1517	5	RLY-ST1E-DC12V
F1-8	Fuse; 4A, 250V fast blow, A10 PCA	8	2110-0055	2	FUSE-4AMPS NB
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44729A component module	1	44729-84320	1	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44729A	1	44729-84325	6	LBL-ID,TERM ASSY

Completely assembled HP 44729A terminal modules can be ordered from your local HP Office by ordering Number 44729AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program at a discount. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44729A	Module; 8ch pwr controller component		44729-69201	5	RBLT-44729-66201

Chapter 18

HP 44736A Stepper Motor Controller

CHAPTER 18
HP 44714A 3-CHANNEL STEPPER MOTOR CONTROLLER/PULSE OUTPUT

CHAPTER 18
HP 44714A
3-CHANNEL
STEPPER MOTOR CONTROLLER
PULSE OUTPUT

18-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, and replaceable parts lists for the HP 44714A Stepper Motor Controller/Pulse Output Accessory.

NOTE

The Stepper Motor Controller/Pulse Output Accessory can only be used with instruments having a firmware revision of 3.0 or above. Determine the firmware revision by sending the **IDN?"** *command.*

18-2 Technical Description

The HP 44714A Stepper Motor Controller/Pulse Output Accessory has three channels that provide: isolated and non-isolated pulse outputs, halt/limit switches inputs, and quadrature counter inputs. The isolated outputs are isolated from chassis ground using opto-isolators. The inputs are not isolated. All channels operate independent from each other.

The width and frequency of the output pulses are selected by the user. The quadrature counter can be reset programmatically or by an index pulse on the stepper motor's shaft encoder. Triggering of the channels to initiate output pulses is done by software commands or the backplane trigger input.

The PVCC input is used to bias the opto-isolator; it is also located on the terminal module. The bias voltage can either be supplied by an internal power supply (PVCC jumper on terminal module in NON ISOLATED position) or by the user (jumper in ISOLATED position). If supplied by the user, the voltage must range from at least +5 V to no greater than +20 V.

Refer to Figure 18-1. The HP 44714A has two main assemblies; a component module and a terminal module. The component module includes the backplane interface electronics, a master clock, and various registers. The component module also has for each channel circuitry to develop the pulse outputs, to read the limit switches, and a quadrature counter. The terminal module contains the terminal blocks for connecting external wring to the accessory.

Each channel on the accessory has its own microprocessor, delay circuitry, pulse width circuitry, and output drivers to develop and output the stepper motor pulses. The microprocessor receives commands and data from the command and data registers to output pulses with the pulse width and frequency set by the user.

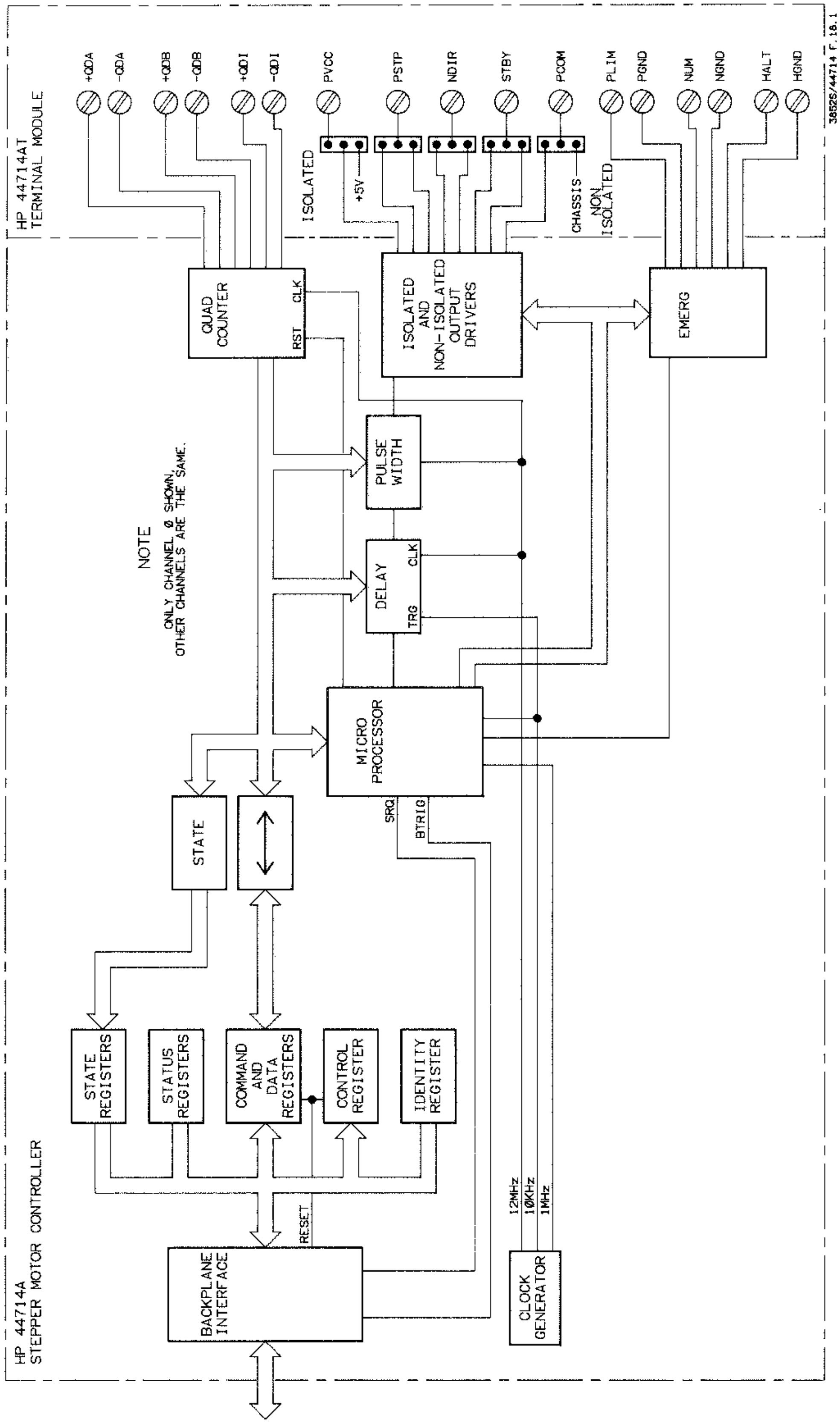


Figure 18-1 HP 44714A Simplified Block Diagram

The pulses are developed using the delay and pulse width circuitry and output by the output drivers. Data is transferred between the microprocessor and the command and data registers using a transceiver. The registers receive their instructions from the backplane logic which receives its instructions from the mainframe.

The microprocessor can be triggered using the BTRIG line from the mainframe via the backplane logic. The microprocessor can also interrupt the mainframe, using the SRQ line, if instructed to do so by the user. An interrupt can be developed when a stepper motor move is completed.

The isolated and non-isolated outputs are selected by jumpers on the terminal module. Each of the channel's outputs can be configured for two different modes. In one mode, the pulses appear on the PSTP output while the NDIR output controls direction. In the other mode, the pulses appearing on PSTP is one direction and the pulses on NDIR is for the other direction.

The halt/limit switch input circuitry (EMERG) consist of two limit switch inputs (one for each direction) and a halt switch input. The microprocessor constantly queries this circuitry to determine if a halt/limit condition exists.

The quadrature counter is always active but its contents are not used until requested by the mainframe. The data is then transferred to the command and data registers through the transceiver. The counter can be reset via the microprocessor by the user.

The pulse width and frequency accuracy, and stability is determined by the clock generator. The clock generator generates three clock frequencies: 12 MHz, 1 MHz, and 10 kHz. The 12 MHz clock is used to run the processor and to develop the other frequencies. The 10 kHz clock is used to synchronize the delay circuitry with the processor. The 1 MHz clock is used to clock the delay and pulse width circuitry, and the quadrature counter.

Other circuitry on the component module are the state, status, control, and identity registers. All these registers receive and transfer data to the backplane interface logic.

The state register is used to determine the specific state of a channel. This data is latched from the channel's microprocessor to the state register via the STATE latch.

The status register is used by the mainframe to determine what a channel is doing and what it has done. These instructions come from the microprocessor using various control lines.

The control register is used by the mainframe to perform certain overriding functions on the accessory. These include reset and selecting channels.

The identity register is used by the mainframe to identify the accessory and to determine its location (i.e., the slot).

Included on the component module is also the QPWR power supply. The supply is rated at 5 Vdc and is used to power the shaft encoders in a stepper motor system. The power supply return is QGND.

The test jumper on the terminal module configures the accessory for a complete self-test. To perform the test, the module should also be wired according to the instructions given in paragraph 18-8. When the jumper is in the TEST position, a complete test is performed. When the jumper is in the NORM position, only a partial test is performed. Since the output and other lines are toggled during a complete self-test, no external connections should be made to the terminal module. Damage or personal injury may result if these instructions are not followed.

18-3 SPECIFICATIONS

Specifications for the HP 44714A are given in Table 18-1. Specifications are the performance standards or limits against which the accessory may be tested.

Table 18-1 HP 44714A Specifications

OUTPUT CHARACTERISTICS

Trapezoidal Motion Profile:

Pulse Output Terminals:

Terminals Terminals	Description
PVCC	+5 V to +42 V relative to PCOM*
PSTP	Positive/Step Output Channel
NDIR	Negative/Direction Output Channel
STBY	Removes Power when No Output
PCOM	Common Return

* = supplied by the user (isolated operation) or supplied by the module (non-isolated operation). +42 V is the absolute maximum voltage that can be applied; +30 V is the recommended maximum voltage.

Isolation: Channels are isolated from each other. PVCC, PSTP, NDIR, and STBY outputs on each channel have a common return.

Between outputs (PSTP, NDIR, STBY) and common (PCOM): 15 V
Between channels: 42 V
Between channel and ground: 42 V

Stepper Motor Configuration:

Two outputs per channel - PSTP & NDIR. These outputs can be configured in one of two modes

(1) PSTP - outputs pulses
NDIR - determines direction

(2) PSTP - pulses for one direction (e.g. CW)
NDIR - pulses for other direction (e.g. CCW)

	Maximum	Resolution
Pulse Rate	10 kHz	2.5 µHz**
Pulse Rate of Change	1 MHz/sec	25 mHz/sec
Pulse Width	65.535 msec	1 µsec
Pulse Width Rate of Change	1 sec/sec	1 µsec/sec

** = An average pulse rate can be selected to this resolution, but period elements will be based on a 1 µsec time base.

Table 18-1 HP 44714A Specifications (Cont.)

	Jitter	Accuracy
Pulse Rate	1 μsec	0.01%
Pulse Width	1 μsec	0.01% ±200 nsec***

*** = Applies to non-isolated outputs (otherwise 0.01% ±1 μsec). Must be properly terminated.

Total number of output pulses per channel in burst mode is ±2,147,483,647.

INPUT CHARACTERISTICS

Quadrature Counter:

(1) TTL Compatible
(2) +5 V (180 mA) or 0 to 15 V with an external power supply available.
(3) Differential inputs (0 to 15 V) are filtered for noisy environment.

The minimum time interval between any pulse edge on channel QDA to any pulse edge on channel QDB of a particular channel is 2 μsec.

Limit Switch Inputs:

(1) Schmitt trigger inputs filter noise and sense input state
(2) Causes an immediate halt of output pulses

Limit Switch Characteristics:

The limit switch inputs are TTL compatible and require a >50 μsec pulse width. The accessory supplies a +5 V and a 10 kohm pull-up resistor for switch closure sensing.

	Counter	Limit Switches
Maximum Input Voltage	15 V	5 V
Maximum Input Current	3.5 mA	-1 mA
Thresholds:		
Vlow (max)	0.5 V	1.0 V
Vhigh (min)	2.5 V	3.85 V
Number of Counts	±2,147,483,647	N/A
Counter Accuracy	±0.5 counts	N/A

Table 18-1 HP 44714A Specifications (Cont.)

SUPPLEMENTAL CHARACTERISTICS

This section contains characteristics that are intended to provide information useful in applying the system by giving typical or nominal, but non-warranted performance parameters.

Response Time:

Command over HP-IB to start/stop pulses:	35 msec
Command from a subroutine to start/stop pulses:	10 msec
Backplane Trigger to start pulses:	150 µsec
Limit Switch to stop pulses:	100 µsec

MISCELLANEOUS CHARACTERISTICS

Relative Power Consumption: 1.0

For multiple modules, check that the sum of relative power used does not exceed 8 for the HP 3852A or 10 for the HP 3853A.

18-4 PERFORMANCE TESTS

18-5 Introduction

The following Performance Tests check the operation of the HP 44714A component module. Performance Tests are not given for the terminal modules. Successful completion of the tests in this chapter provides a high confidence level that the Stepper Motor Controller/Pulse Output Accessory is meeting its listed specifications.

The performance tests should be performed in the order they are presented. The completion of each test increases the confidence level in the accessory. A minimum set of tests is given as the Operational Verification Test. This test is described in Section 18-6.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Test yields a 90% confidence level that the accessory is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

18-6 Operational Verification

The first test in this section is the minimum test recommended for the HP 44714A Accessory. This test is designed to test the functionality of the accessory. Successful completion of the Operational Verification Test provides a 90% confidence level that the HP 44714A Accessory is operating normally and is within specifications.

The Operational Verification Test consists of the following:

Section 18-10 - Set-Up Procedure
Section 18-11 - Self-Test

18-7 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first item is required for the Operational Verification Test.

1. Test Fixture (as described in Section 18-8)

2. Test Leads and Jumpers

3. Digital Multimeter -- HP 3456A

4. Resistor -- 28 ohms, 1 W

5. Counter -- HP 5316A

NOTE

The integrating plug-in voltmeter (HP 44701A) may be used for the Voltage Output Test in the Performance Test Procedures. This test does not describe the specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

18-8 Test Fixture

A test fixture is required to run the Performance Tests. The test fixture can be manufactured using an HP 44714AT terminal module (see Figure 19-2). Because wiring the fixture will make the terminal module unusable in an application, an additional terminal module should be ordered for service purposes.

The connections on the test fixure are as follows. The same connections are used for each channel.

1. +QDI connects to HALT and STBY.

2. +QDA connects to NLIM and NDIR.

3. +QDB connects to PLIM and PSTP.

4. QPWR connects to PVCC.

5. PCOM connects to GND

6. NORM/TEST jumper in Test position.

18-9 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

18-10 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the Stepper Motor Controller/Pulse Output Accessory component module and install the test fixture. Note the slot number where the accessory under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows:

      44714A

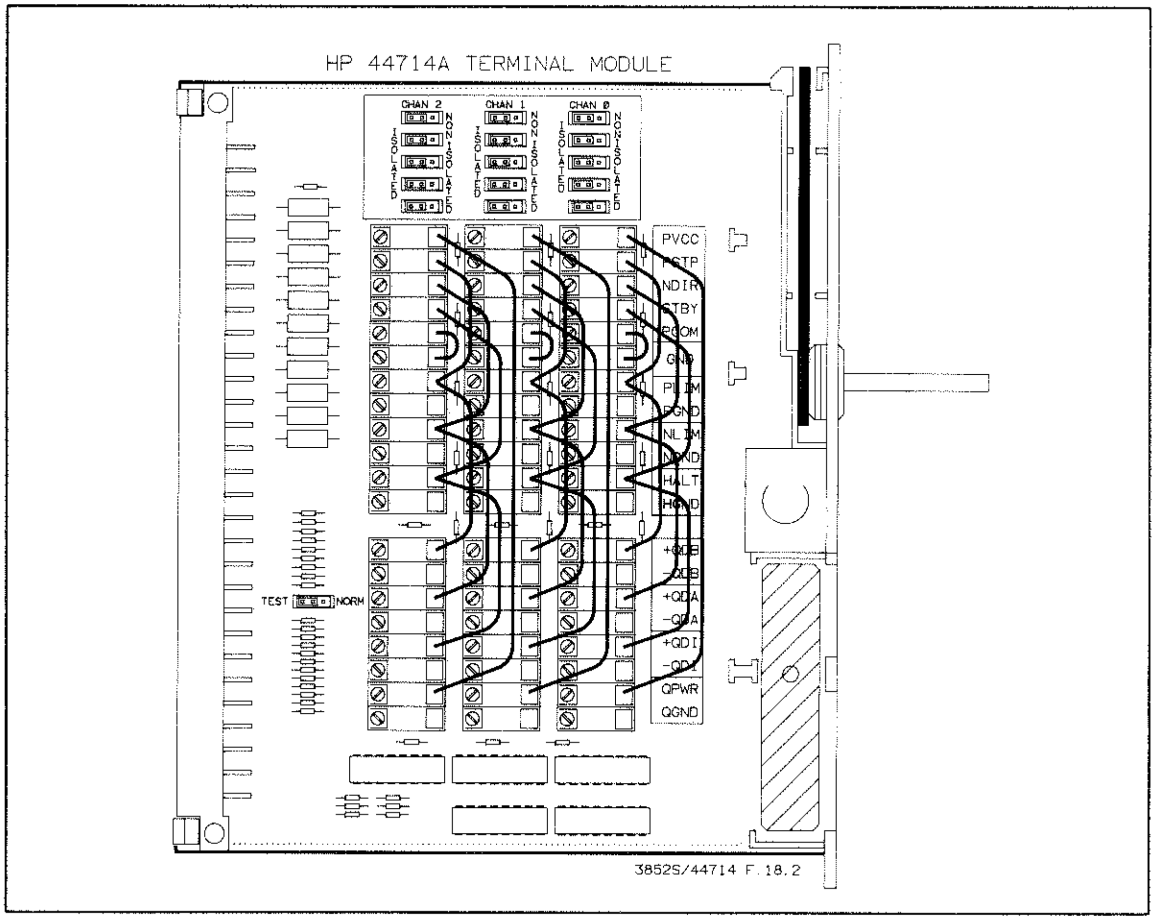


Figure 18-2 HP 44714A Test Fixure

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture is either not installed or the ID lines on the fixture are incorrectly wired.

18-11 Self-Test

This test checks most of the circuitry on the component module.

1. Use the wired test fixure shown in Figure 18-2 for the self-test. Make sure the NORM/TEST jumper is in the test position.

WARNING

The **NORM/TEST** *jumper is only used to test the accessory.* **DO NOT** *place the jumper in the test position if the accessory has any external connections, other than the test connections, or personal injury and/or damage to equipment may result.*

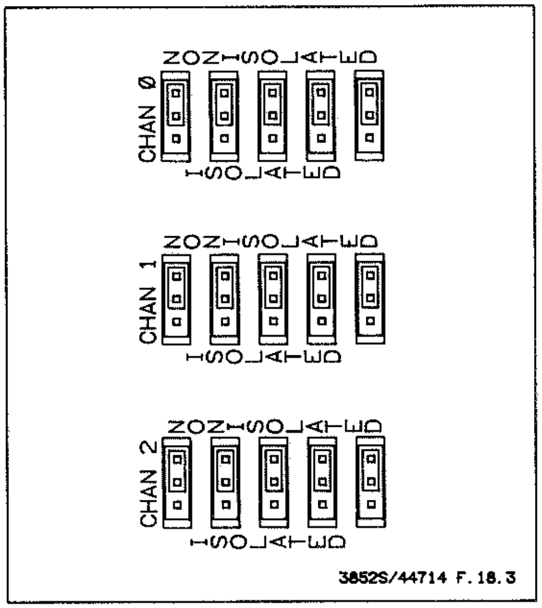


Figure 18-3 Non Isolated Output Self Test Setup

2. Locate the ISOLATED/NON ISOLATED jumpers on the terminal module (see Figure 18-2). If ONLY the Operational Verification Test is to be performed, place the jumpers in the position in which the accessory is to be used (e.g., NON ISOLATED for non isolated output, etc.). If the complete performance test is to be performed, place the jumpers in the ISOLATED position as shown in Figure 18-2.

3. Perform the HP 44714A self-test by executing:

   TEST ES00 (where E = extender number, S = slot number)

4. After the test routine is completed, the HP 3852A right display should show:

   SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44714A Accessory may be failing its self-test. Test the accessory again by executing the command in step 3.

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE PERFORMANCE TESTS.

18-12 Non Isolated Output Self Test

1. Make sure the NORM/TEST jumper is in the test position as shown in Figure 18-2.

2. Place the ISOLATED/NON ISOLATED jumpers on the terminal module in the NON ISOLATED position as shown in Figure 18-3.

3. Perform the HP 44714A self-test by executing:

   TEST ES00 (where E = extender number, S = slot number)

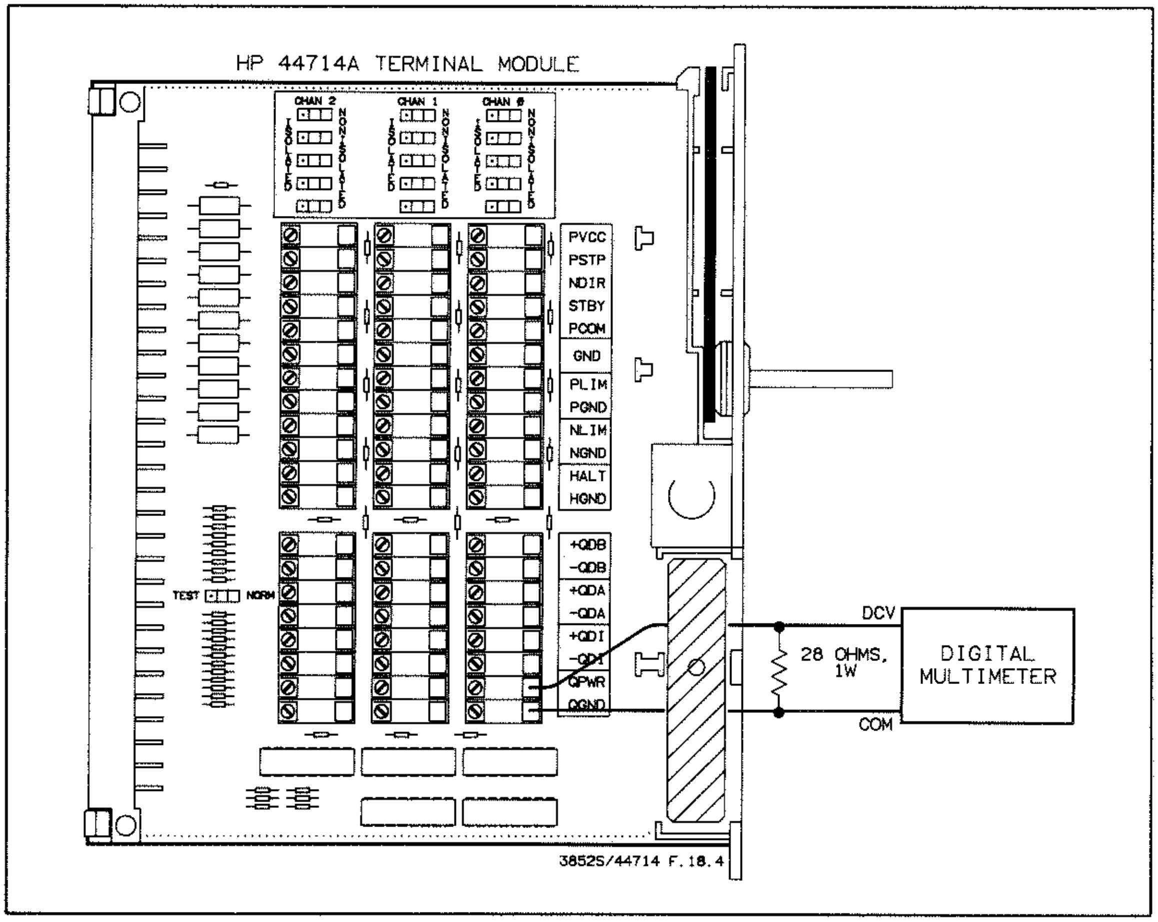


Figure 18-4 QPWR Power Supply Test Connection

4. After the test routine is completed, the HP 3852A right display should show:

SELF TEST OK

18-13 QPWR Power Supply Test

This test checks the output voltages of the QPWR power supplies under full load.

1. Setup a digital multimeter to measure dc volts in autorange.

2. Refer to Figure 18-4. Connect a 28Ω, 1 W resistor between the DCV (HI) and COM (LO) terminals of a digital multimeter. Connect the DCV input of the multimeter to the QPWR connection and the COM (LO) input to the QGND connection on the terminal module.

3. Make sure the dc volts reading on the digital multimeter is +5 V ±0.50 V.

4. Remove the digital multimeter from the terminal module. Remove the resistor from the digital multimeter.

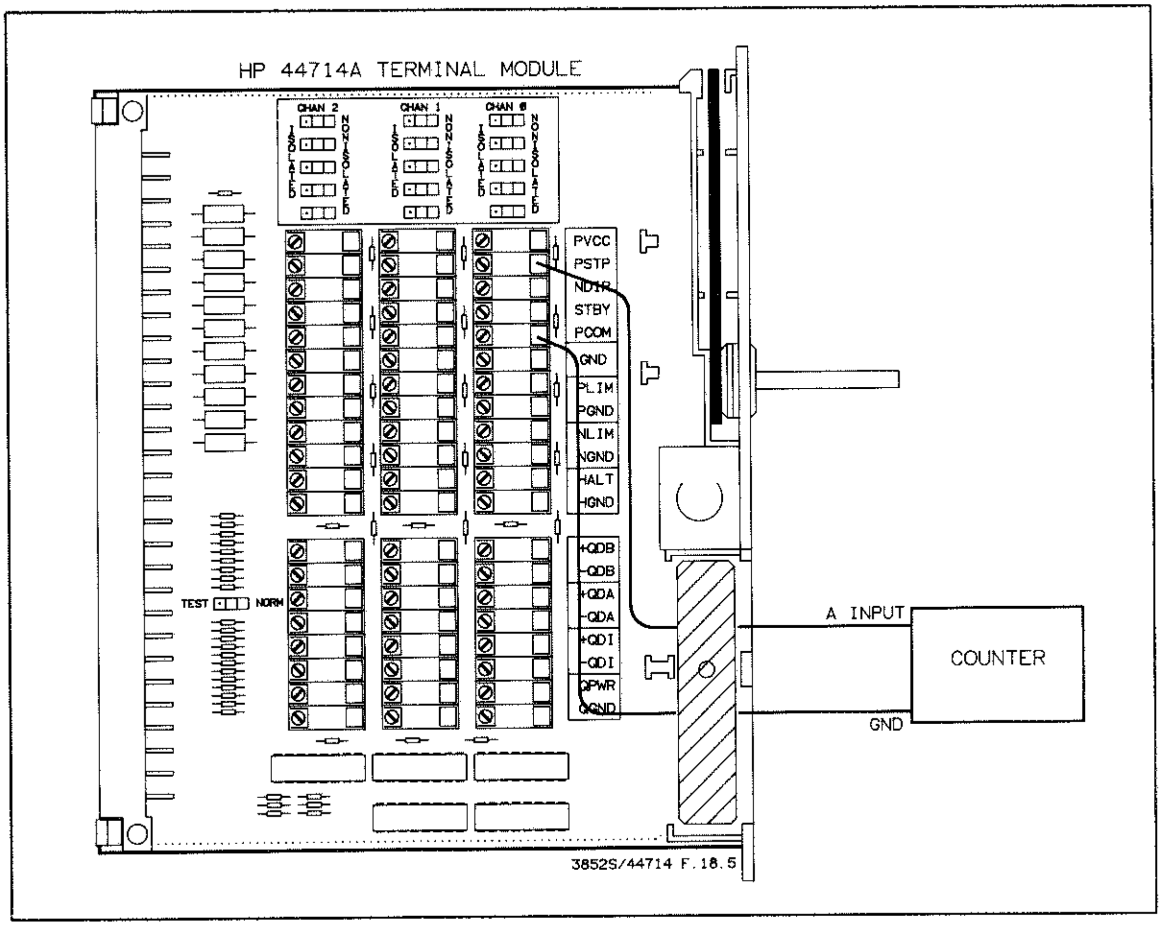


Figure 18-5 Frequency and Pulse Accuracy Test Connection

18-14 Frequency and Pulse Width Accuracy Test

This test checks the accuracy of the pulse outputs. Since the pulse accuracy depends on the accessory's internal clock accuracy, used by all channels, only one channel is tested.

1. Place the NORM/TEST jumper into the norm position, as shown in Figure 18-5.

2. On the terminal module, remove the wire on the PSTP terminal for channel 0. (This wire was connected to perform the accessory's self-test.)

3. Refer To Figure 18-5. Connect the High input (A input if using the recommended counter) of a counter to the PSTP terminal that is for channel 0 and the Low (Gnd) input to the PCOM terminal on the terminal module.

4. Set the HP 44714A to continually output pulses at a frequency of 10 kHz by executing:

```
USE ES00   (where E = extender number, S = slot number)
TRIG AUTO
PROFILE FREQ 0 10E3 10E3 1E-6
SUSTAIN 10E3
```

5. If using the recommended counter, set it up as follows:

Function Switch -- FREQ A
Channel A Slope Switch -- Position IN ( )
Trigger Level Switch -- Position IN (Sensitivity)
*Level/Sensitivity Control -- Position CENTER
Rest of Switches -- Position OUT

*The Level/Sensitivity Control may need adjustment for a stable reading on the counter.

6. Make sure the frequency reading of the counter is within the following range:

9.99900E3 to 10.00100E3

7. Stop outputting pulses by executing:

HALT

8. Set the HP 44714A to continually output pulses at a width of 65 mS by executing:

PROFILE WIDTH 0 65E-3 65E-3 10 100E-3
SUSTAIN 65E-3

9. Setup the counter to the following:

Function -- T1 A->B
Channel A Input Slope Switch -- Position IN ( )
Channel B Input Slope Switch -- Position OUT ( )
Trigger Level Switches -- Both Chan. A and B Position IN (Sensitivity)
Level/Sensitivity Controls -- Both Chan. A and B Position CENTER
Sep/Com A Switch -- Position IN (COM A)
**Attenuator Switches -- Both Chan. A and B Position IN (X20)
Rest of Switches -- Position OUT

** A 10:1 oscilloscope probe can be used for the counter input instead of placing the attenuator switches in the X20 position. Either one is necessary for a stable reading on the counter. The Level/Sensitivity Controls may also need adjustment.

10. Make sure the pulse width reading on the counter is within the following range:

64.9925E3 to 65.0075E3

11. Stop outputting pulses by executing:

HALT

12. Remove the counter from the terminal module. This completes the performance test of the HP 44714A.

18-15 REPLACEABLE PARTS

Figure 18-6 shows the mechanical breakdown of the HP 44714A. The figure also provides assembly and disassembly information. The parts shown in Figure 18-6 are keyed to the parts list in Table 18-2.

To order a part listed in Table 18-2, quote the Hewlett-Packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 18-2). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

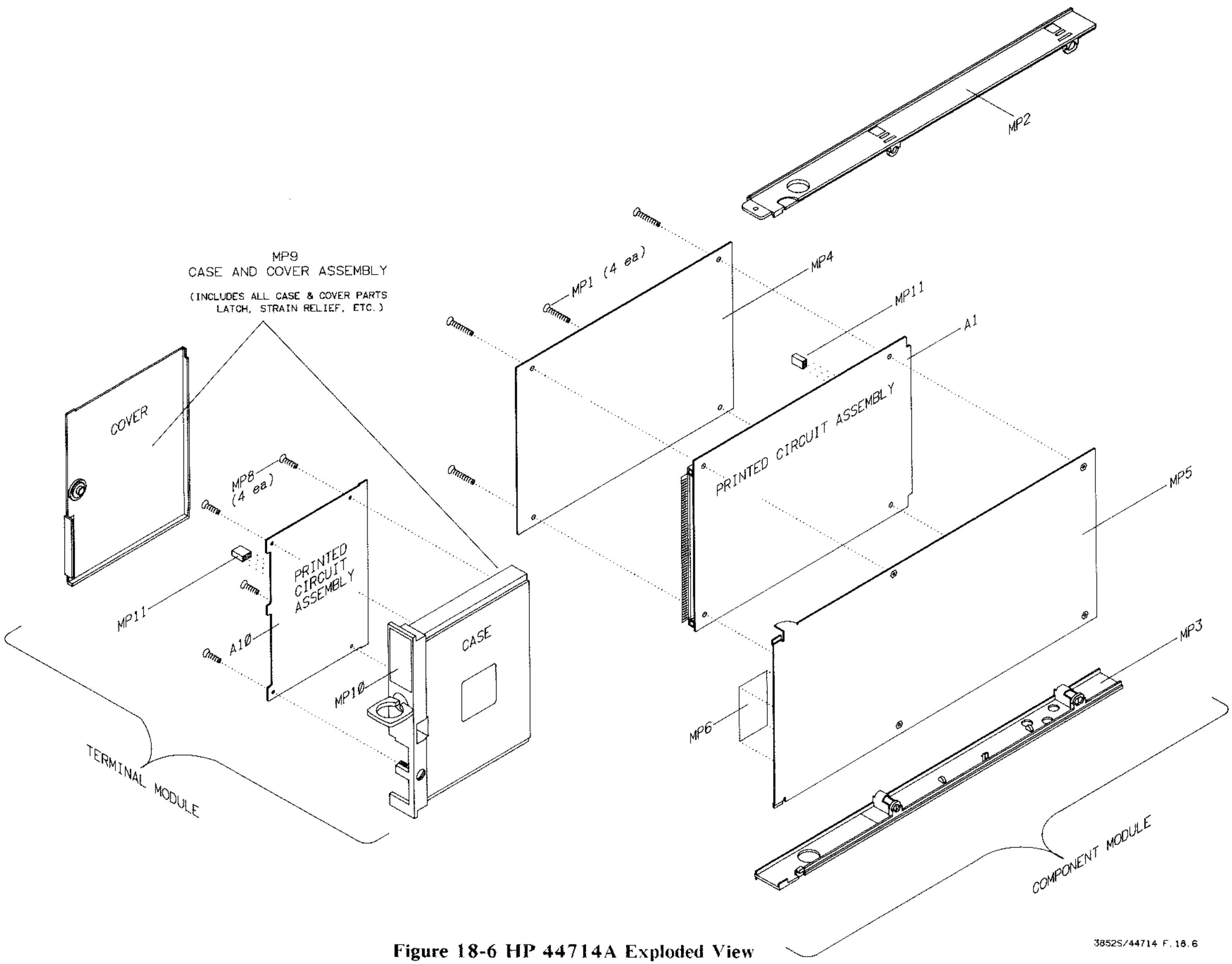


Figure 18-6 HP 44714A Exploded View

Table 18-2 HP 44714A Stepper Motor Controller/Pulse Output

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44714A	Module; Stepper Motor Controller	1	44714-66201	2	MOD-STEPPER
A1	PCA; 3ch Stepper Motor component	1	44714-66501	5	PCA-STPR MOT
A10	PCA; 3ch Stepper Motor terminal	1	44714-66510	6	PCA-STPR TERM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44714A component module	1	44714-84320	4	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear pnl of term mod 44714A	1	44714-84325	9	LBL-ID,TERM ASSY
MP11	Jumper; removable, A10 PCA	16	1258-0141	8	JMPR-REM .025P

Completely assembled HP 44714A terminal modules can be ordered from your local HP office by ordering Number 44714AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details see Section 4-9.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44714A	Module; 3ch Stepper Motor Controller		44714-69201	8	RBLT-44714-66201

Chapter 19
HP 44723A Fast Digital I/O

CHAPTER 19
HP 44723A FAST DIGITAL I/O

CHAPTER 19
HP 44723A
FAST DIGITAL I/O

19-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, and replaceable parts lists for the HP 44723A Fast Digital I/O Accessory.

NOTE

The Fast Digital I/O Accessory can only be used with instruments having a firmware revision of 3.0 or above. Determine the firmware revision by sending the mainframe command: **IDN?**.

19-2 Technical Description

The HP 44723A Fast Digital I/O Accessory has 16 output channels, 16 input channels, and three trigger inputs/outputs. The outputs (excluding the trigger outputs) are jumper selectable for 5 V TTL or 30 V, 40 mA open collector outputs. The inputs (including trigger inputs) are jumper selectable for 5 V, 12 V, and 24 V input levels. All output/input channels are non-isolated.

Refer to Figure 19-1. The HP 44723A has two main assemblies: a component module and a terminal module. The component module includes the backplane interface electronics, the input/output registers, output drivers, trigger circuitry, and interrupt circuitry. The terminal module contains the terminal blocks for connecting external wiring, the selection jumpers, and trigger input/output terminals.

The backplane circuitry interfaces with the the HP 3852A or HP 3853A backplane. The circuitry accepts commands from the HP 3852A mainframe to turn the output drivers on or off as indicated in the commands. The circuitry also transfers digital input signals to the mainframe.

The HP 44723A uses a two-rank design to output data. Data from the backplane logic is transferred to the first rank register after a 2nd rank output trigger occurs. The data is then latched to the second rank register which latches it to the TTL and open collector output circuitry. The two rank design allows the most recent data to be output.

The HP 44723A also uses a two-rank design for the input circuitry. The input data from the terminal module is latched into the first rank register after this register is triggered. No data is latched into the register before the trigger occurs. This data is then latched into the second rank register after this register is triggered. The data is then transferred to the backplane logic.

The HP 44723A has five user selectable trigger modes: backplane, internal, single, external, and hold. Except for hold, all of the trigger modes can be used to trigger the first rank input register, second rank input register, and second rank output register. The backplane trigger is generated from an input at the "System Trigger In" port on the rear panel of the HP 3852A mainframe. The internal and single triggers, and hold are generated on the accessory's component module. The external triggers are generated from inputs on the the trigger input terminals on the terminal module.

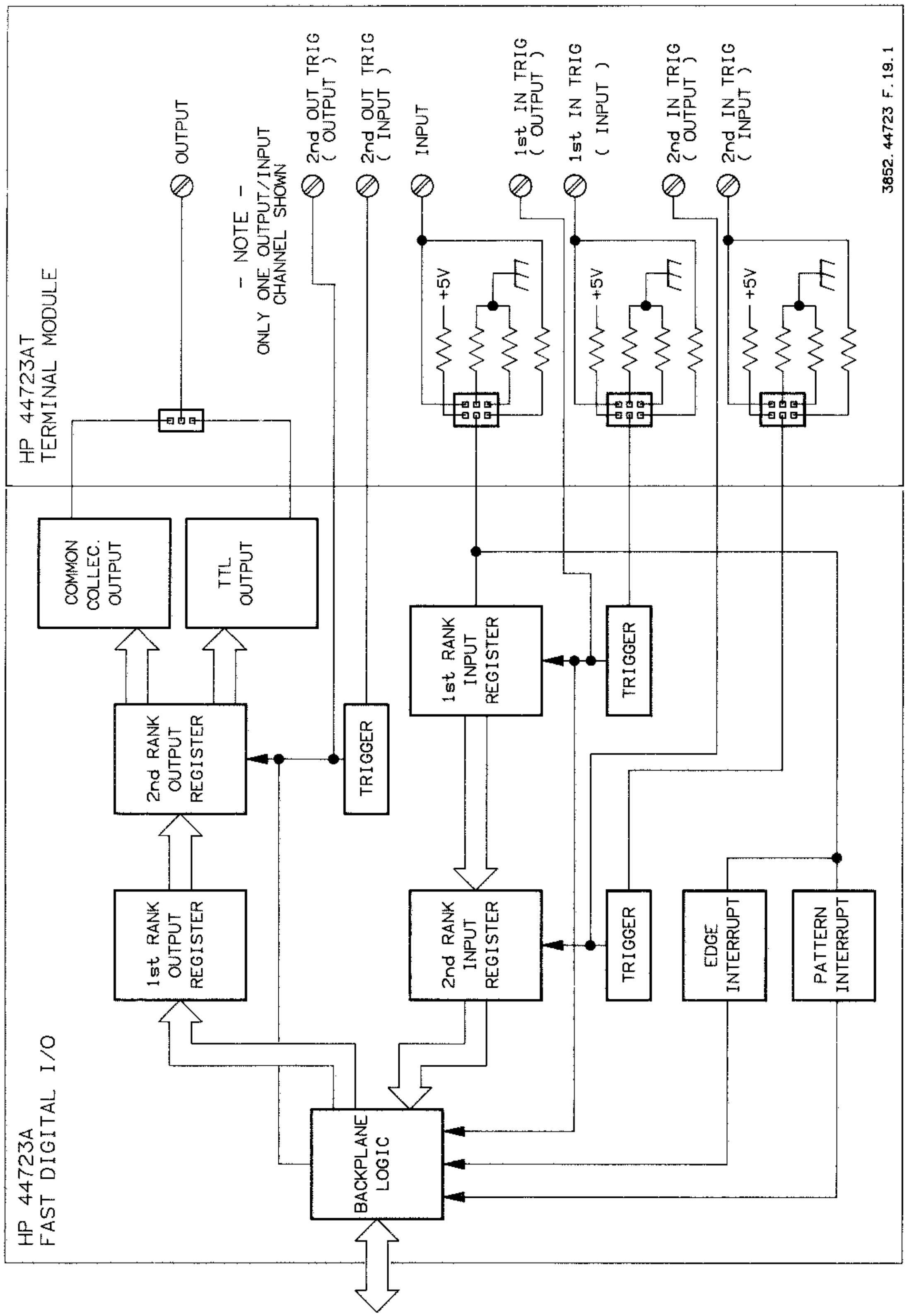


Figure 19-1 HP 44723A Simplified Block Diagram

The trigger pulses for external triggers are applied at the input terminals on the 1ST IN TRIG, 2ND IN TRIG, and 2ND OUT TRIG terminal blocks. The trigger pulses are used to trigger the first rank input register (1ST IN TRIG), second rank input register (2ND IN TRIG), and/or second rank output register (2ND OUT TRIG), respectively. When a register is triggered, either internally or externally, 2 µS output trigger pulses for that register are generated by the accessory. These pulses are output at the corresponding trigger output (OUT) terminals on the terminal module. The trigger outputs for the first rank input, second rank input, and second rank output registers are output on the terminasls of the 1ST IN TRIG, 2ND IN TRIG, and 2ND OUT TRIG terminal blocks, respectively.

Four types of interrupts are generated by the HP 44723A: input, output, input edge, and input pattern. Input interrupts are generated by a valid first rank input trigger. Output interrupts are developed by a valid second rank output trigger.

The input edge and input pattern interrupts are generated from the input applied at the terminal module. Input edge interrupts can be selected for positive, negative, or both edges. Input pattern interrupt can be programmed for arbitrary patterns on any set of bits and for either equal or non-equal conditions. The input edge and input pattern interrupts are user-selectable and are generated by the Interrupt Edge and Interrupt Pattern circuitry on the component module.

19-3 SPECIFICATIONS

Specifications for the HP 44723A are given in Table 19-1. Specifications are the performance standards or limits against which the accessory may be tested.

Table 19-1 HP 44723A Specifications

SPECIFICATIONS

Operating Range:

	Nominal Voltage (Vdc) 5*	12	24
Threshold Voltage (V): Vlow (max)	0.79	1.89	3.80
Vhigh (min)	2.06	4.92	9.90
Input Current (mA) at Nominal Voltage	0.001	1.39	3.77
Minimum Pulse Width (nS)	600	420	355

* = Also Includes PULLUP position

Maximum Input Voltage: ±24 Vdc (between any terminal and chassis)

Maximum Voltage/Current: (Open Collector Output) ±24 Vdc (max) @ 600 Ω. Low-level voltage/current = 0.4 Vdc @ 40 mA

Maximum Voltage/Current: (TTL Output) 5.5 Vdc (max) @ 5.2 mA. Low level voltage/current = 0.4 Vdc @ 48 mA

Trigger Terminals Outputs:

With TRIGMODE FIRST: 5 Vdc (CMOS) negative (HL) edge (Does not apply to Second Rank Input Trigger Output)

With TRIGMODE ALL: 5 Vdc negative TTL pulse. Nominal value = 2 µS. Range = 1.70 µS to 2.80 µS.

Maximum Wire Size: 16 AWG

Relative Power Consumption: 0.7 W**

** = For multiple accessories, ensure that the sum of the relative power consumption does not exceed 8 for the HP 3852A or 10 for an HP 3853A

SPEED CHARACTERISTICS

This part provides supplemental characteristics which show TYPICAL or NOMINAL, but Non-Warranted performance parameters.

Input Speeds: Rates (reading/sec) to program and execute reads of digital inputs and to transfer readings.

Table 19-1 HP 44723A Specifications (Cont.)

Readings to Mainframe Memory (rdgs/sec):

Packed Format:	176,000
IN16 Format:	176,000

Readings to Controller via HP-IB (rdgs/sec):

Packed Format:	2550
IN16 Format:	2550
IASC Format:	625

Output Speeds: Times to program and execute digital writes (16 channels at one time).

	Commands from Downloaded Subroutine	Commands from HP Series 200/ 300 Controller via HP-IB
Response Time (mS)	0.5	4.0
Continuous Operation (transition/second)	189,000	110

Interrupts: Time (mS) between event occurance and resulting action for a single interrupt and the maximum continuous interrupt rate (interrupt occurs, is serviced and reenabled, and the sequence repeats)

Interrupt Condition	Resulting Action		
	Max time for single call to interrupt subroutine (mS)	Max time to enable SRQ line once (mS)	Max continuous Max continuous (interrupt/sec)
Digital Input:			
Edge Occurance	2.6	0.4	400
Bit Pattern	2.6	0.4	400
Input Trigger	2.6	0.4	320

Table 19-1 HP 44723A Specifications (Cont.)

Set-Up and Hold Times: Time (nS) from occurance of digital input to generation of first rank input trigger

Source	LOW (0)	HIGH (1)	Setup Time (nS)	Hold Time (nS)
5 V	0 V	3 V	500	700
12 V	0 V	7 V	300	500
24 V	0 V	14 V	225	425

Input Trigger Timing: Minimum time (nS) between first and second rank input trigger.

5 V:	590 nS
12 V:	390 nS
24 V:	320 nS

Trigger Output Delays:

Delay time from reception of an external trigger into the IN trigger terminal to generation of a trigger output from the OUT trigger terminal or to generation of valid output data.

1ST IN TRIG IN to 1ST IN TRIG OUT
2ND IN TRIG IN to 2ND IN TRIG OUT [1]
2ND OUT TRIG IN to 2ND OUT TRIG OUT
2ND OUT TRIG OUT to valid data output [2]

[1] = add 600 nS if a "collision" occurs between the first and second rank input triggers (i.e., the second rank input trigger occurs too soon after the first rank input trigger). See "Input Trigger Timing" for minimum times.

[2] = add 600 nS if a "collision" occurs between the write to the first rank output register and generation of a second rank output trigger.

5 V:	800 nS
12 V:	600 nS
24 V:	530 nS

19-4 PERFORMANCE TESTS

19-5 Introduction

The following Performance Tests check the operation of the HP 44723A component module. Performance Tests are not given for the terminal modules. Successful completion of the tests in this chapter provides a high confidence level that the Fast Digital I/O is meeting its listed specifications.

The performance tests should be performed in the order they are presented. The completion of each test increases the confidence level in the Fast Digital I/O Accessory. A minimum set of tests is given as the Operational Verification Tests. These tests are described in Section 19-6.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence level that the Fast Digital I/O Accessory is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

19-6 Operational Verification

The first tests in this section are the minimum set of tests recommended for the Fast Digital I/O Accessory. These tests are designed to test the functionality of the accessory. Successful completion of the Operational Verification Tests provide a 90% confidence level that the Fast Digital I/O Accessory is operating normally and is within specifications.

The Operational Verification Tests consist of the following:

Section 19-10 - Set-Up Procedure
Section 19-11 - Self-Test
Section 19-12 - Input/Output Pattern Test
Section 19-13 - Trigger Test

19-7 Equipment Required

The following test equipment is required to run the Performance Testa. Only the first three items are required for the Operational Verification Tests.

1. Test Fixture (as described in Section 19-8)
2. Test Leads and Jumpers (including 2 ea BNC-to-cliplead cables)
3. Digital Multimeter -- HP 3456A
4. Service Module -- HP 44743-66203
5. 0 to 10 V Power Supply -- HP 6214B
6. 500 ohm 5%, 1/4 W Resistor
7. 100 ohm 5%, 1/4 W Resistor

19-8 Test Fixture

A test fixture is required to run the Performance Tests. The test fixture can be manufactured using an HP 44723AT terminal module. The test fixure is shown in Figure 19-2.

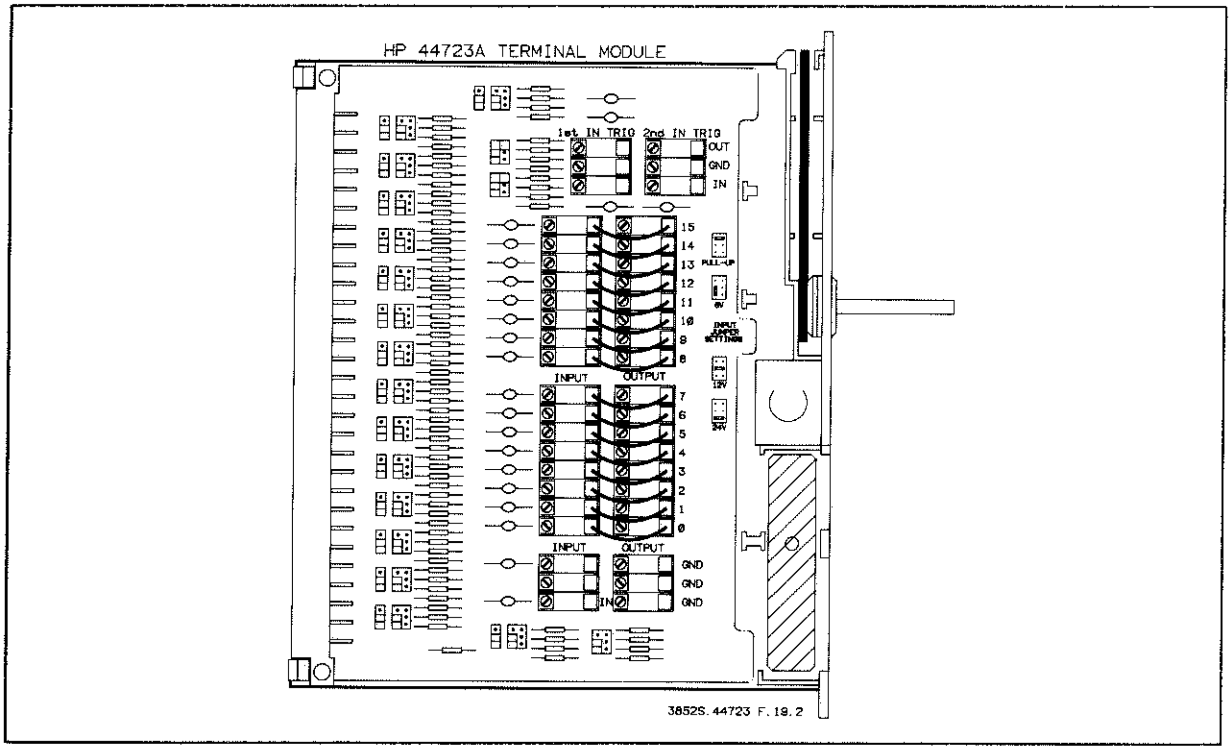


Figure 19-2 HP 44723A Test Fixture

On the test fixture, the output of each channel is connected to the corresponding input of the channel. All Input Jumpers are set to the 5 V position. The test fixture configuration is shown in Figure 19-2.

19-9 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

19-10 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Remove the terminal module from the rear of the Fast Digital I/O Accessory component module and install the test fixture. Note the slot number where the accessory under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

b. Execute:

ID? ES00 (where E = extender number, S = slot number)

c. Verify that the HP 3852A right display shows:

44723A

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture may not be installed.

19-11 Self-Test

This test checks most of the circuitry on the component module.

1. Perform the HP 44723A self-test by executing:

TEST ES00 (where E = extender number, S = slot number)

2. The HP 3852A right display should show:

SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44723A accessory may be failing its self-test. Test the accessory again by executing the command in step 1. If the accessory still fails, exchange it with a working one.

19-12 Input/Output Pattern Test

This test verifies that all the accessory's channels can correctly output and input TTL level patterns. A pattern that alternately sets the output channels high and low (i.e., from channel 0 to 15) is selected and then read. A pattern that alternately sets the output channels Low and High is next output and then read.

1. HIGH/LOW PATTERN. This test uses a High/Low pattern to test the channels.

2. Make sure the output of each output channel is connected to its corresponding input channel, as shown in Figure 19-2. Make sure that all output and input jumpers are selected for +5 V TTL, as shown in the figure. It is important that the jumpers are in the correct positions, or the test will fail.

3. Set all HP 44723A channels to a known state by executing:

RESET ES00 (where E = extender number, S = slot number)

4. Output a pattern that alternately sets the channels high (1) and low (0) by executing:

WRITE ES00,21845 (where E = extender number, S = slot number)

5. Trigger and read all channels by executing:

READ ES00 (where E = extender number, S = slot number)

6. Verify that the HP 3852A right display shows:

   21845

7. LOW/HIGH PATTERN. This test uses a Low/High pattern to test the channels.

8. Output a pattern that alternately sets the channels low (0) and high (1) by executing:

   WRITE ES00,-21846 (where E = extender number, S = slot number)

9. Trigger and read all channels by executing:

   READ ES00 (where E = extender number, S = slot number)

10. Verify that the HP 3852A right display shows:

    -21846

19-13 Trigger Test

This test checks all trigger operations of the accessory. A subroutine is set up to output certain pulses at the Pacer Output that are used as trigger pulses for the Digital I/O Accessory. The subroutine also sets up the mainframe to wait for an event to occur. The test routine is as follows:

•Pulses from the mainframe's PACER OUT is applied to the Input Terminal of the 1ST IN TRIG block on the terminal module.

•The trigger pulse generated at the Output Terminal of the 1ST IN TRIG block is applied to the Input Terminal of the 2ND IN TRIG block.

•The trigger pulse generated at the Output Terminal of the 2ND IN TRIG block is applied to the Input Terminal of the 2ND OUT TRIG block.

•The trigger pulse generated at the Output Terminal of the 2ND OUT TRIG block is applied to mainframe's EVENT IN input. When this pulse is detected, the subroutine is completed.

1. Refer to Figure 19-3 and make the following connections.

   a. Using a BNC-to-cliplead cable, connect the PACER OUT on the mainframe's rear panel to the Input Terminal of the terminal module's 1ST IN TRIG terminal block.

   b. Using another BNC-to-cliplead cable, connect EVENT IN on the mainframe's rear panel to the Output Terminal of the terminal module's 2ND OUT TRIG terminal block.

   c. On the terminal module, connect the Output Terminal of 1ST IN TRIG block to the Input Terminal of 2ND TIN TRIG block.

   d. Connect the Output Terminal of 2ND OUT TRIG block to the Input Terminal of 2ND OUT TRIG block.

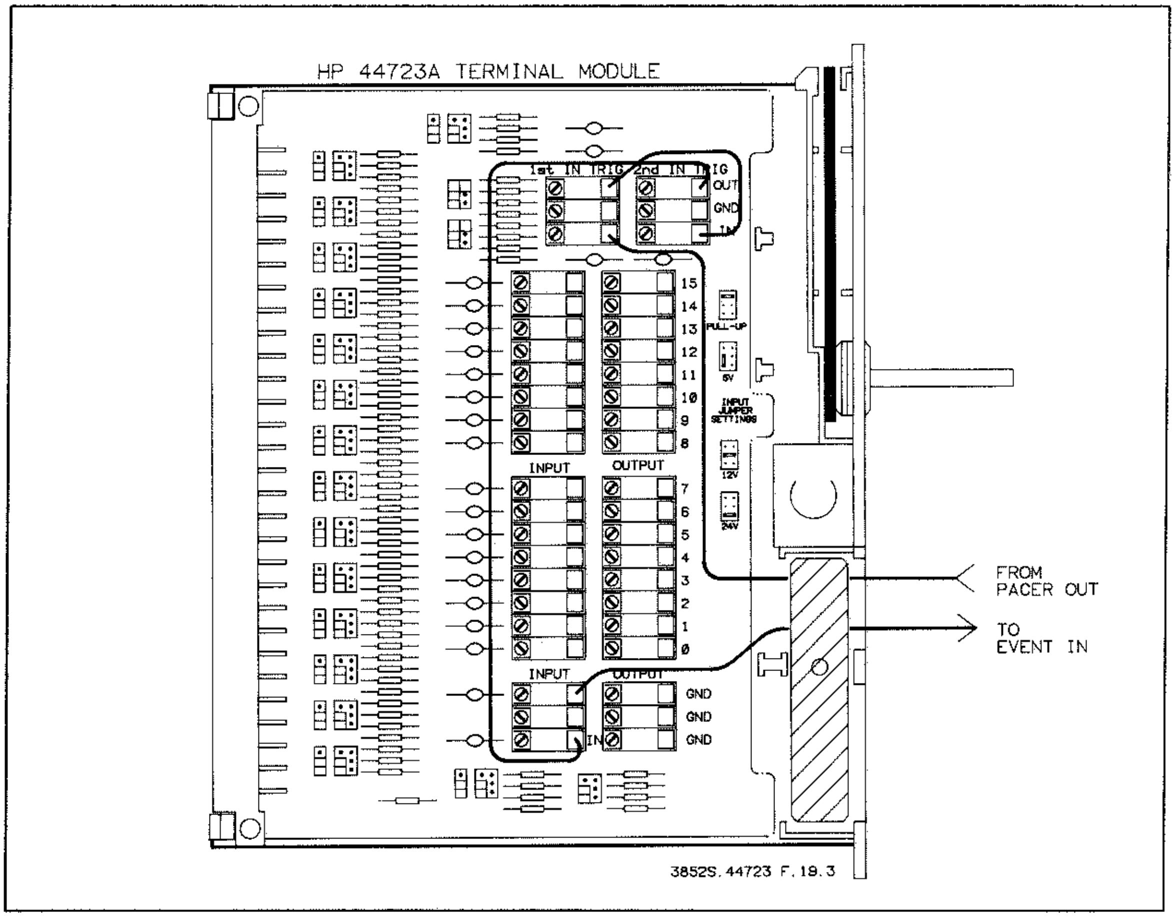


Figure 19-3 HP 44723A Trigger Test

2. Setup the accessory by executing:

   USE ES00 (where E = extender number, S = slot number)
   TRIGMODE ALL
   TRIG EXT
   SRTRIG EXT
   SRTRIG EXT USE ES16 (where E = extender number, S = slot number)

With this setup, each of the accessory's trigger inputs and outputs are set to receive an external trigger and output a trigger pulse.

3. Setup the following subroutine in the HP 3852A memory.

   SUB A
   PACER 1E-6, 1
   PDELAY .1
   PTRIG SGL
   WAITFOR EVENT
   BEEP
   SUBEND

The subroutine sets up the mainframe to output certain pulses at the pacer output and wait for an event to occur. When the event occurs, the mainframe beeps and displays the message SUBEND.

4. Call the entered subroutine by executing:

CALL A

5. After executing the subroutine, the HP 3852A should "beep" and the message SUBEND should be displayed on the front panel's left display.

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE PERFORMANCE TESTS.

19-14 Input Voltage Test

This test checks the ability of the accessory to detect the correct High (1) and Low (0) input levels.

1. Use the recommended service module to perform the following tests.

2. Remove power from the HP 3852A and unplug the HP 44723A Digital I/O Accessory to be tested. Install the service module in a convenient slot in the HP 3852A. Note the slot number where the service module is installed. Install the HP 44723A accessory on the service module. If not installed, install the terminal module on the HP 44723A accessory.

3. Make sure the input jumpers on the terminal module are selected for +5 V TTL levels on all channels (see Figure 19-4). Also be sure to remove any connections between the output and input terminals.

4. Setup the accessory to trigger internally by executing:

USE ES00 (where E = extender number, S = slot number)
TRIG INT
SRTRIG INT

5. Setup a power supply to output 0.79 Vdc.

6. Refer to Figure 19-4. Connect the DCV (HI) and COM (LO) inputs of a digital multimeter to the positive (+) and negative (-) outputs of the power supply.

7. Adjust the power supply for a 0.79 Vdc reading on the digital multimeter.

8. Connect the + output of the power supply to the High input of channel 0 on the terminal module. Connect the negative (-) output of the power supply to Gnd on the terminal module.

9. Read all channels by executing:

READ ES00 (where E = extender number, S = slot number)

10. Verify that the HP 3852A right display shows:

0

11. Repeat steps 8, 9, and 10 for channels 1 through 15. Be sure to connect the power supply to the correct input terminals on the terminal module.

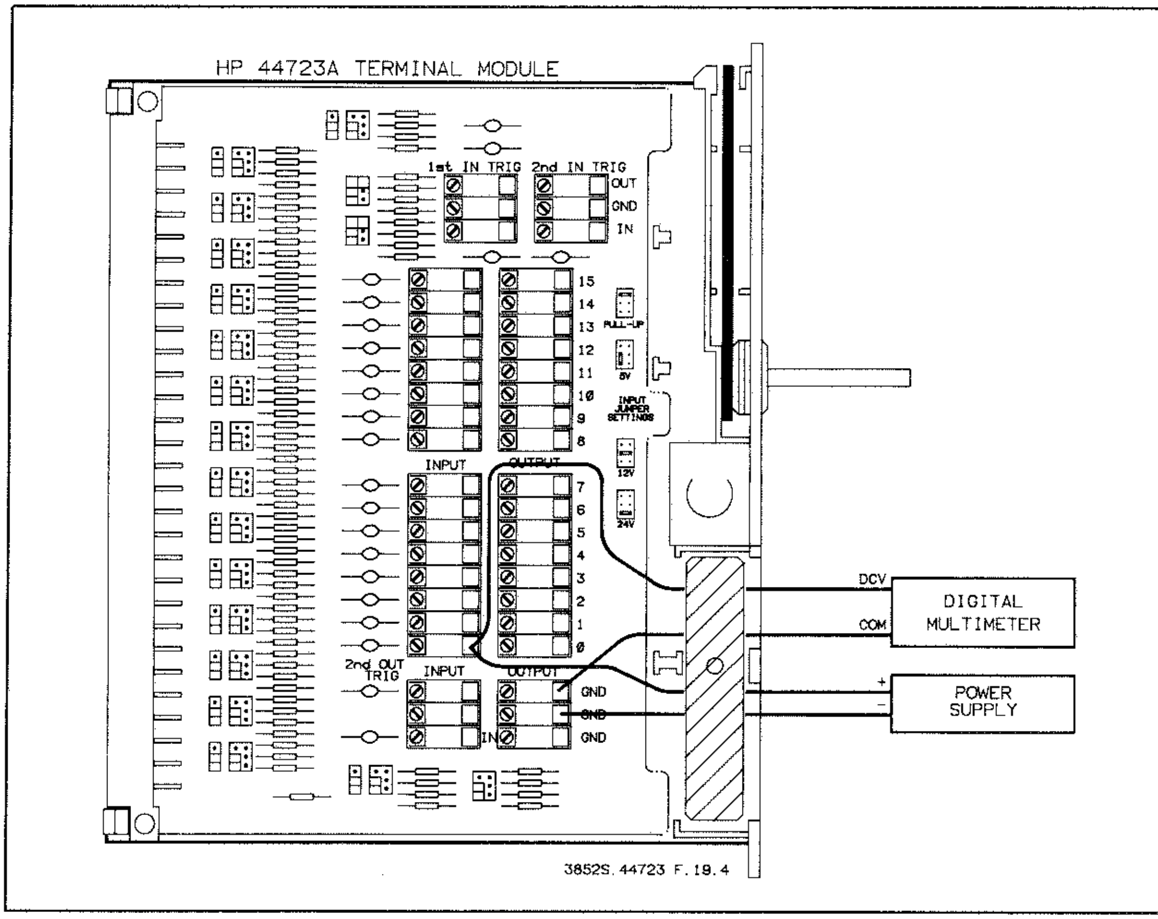


Figure 19-4 Input Voltage Test

12. After all channels are tested, remove the power supply from channel 15.

13. Adjust the power supply for a 2.6 Vdc reading on the digital multimeter.

14. Connect the power supply to the channel 0 input terminals.

15. Read channel 0 by executing:

    READ ES00 (where E = extender number, S = slot number)

16. Verify that the HP 3852A right display shows:

    1

17. Repeat steps 14 and 15 for channels 1 through 15 Be sure to connect the power supply to the correct input terminals on the terminal module. The reading on the display for channels 1 through 15 should be as follows:

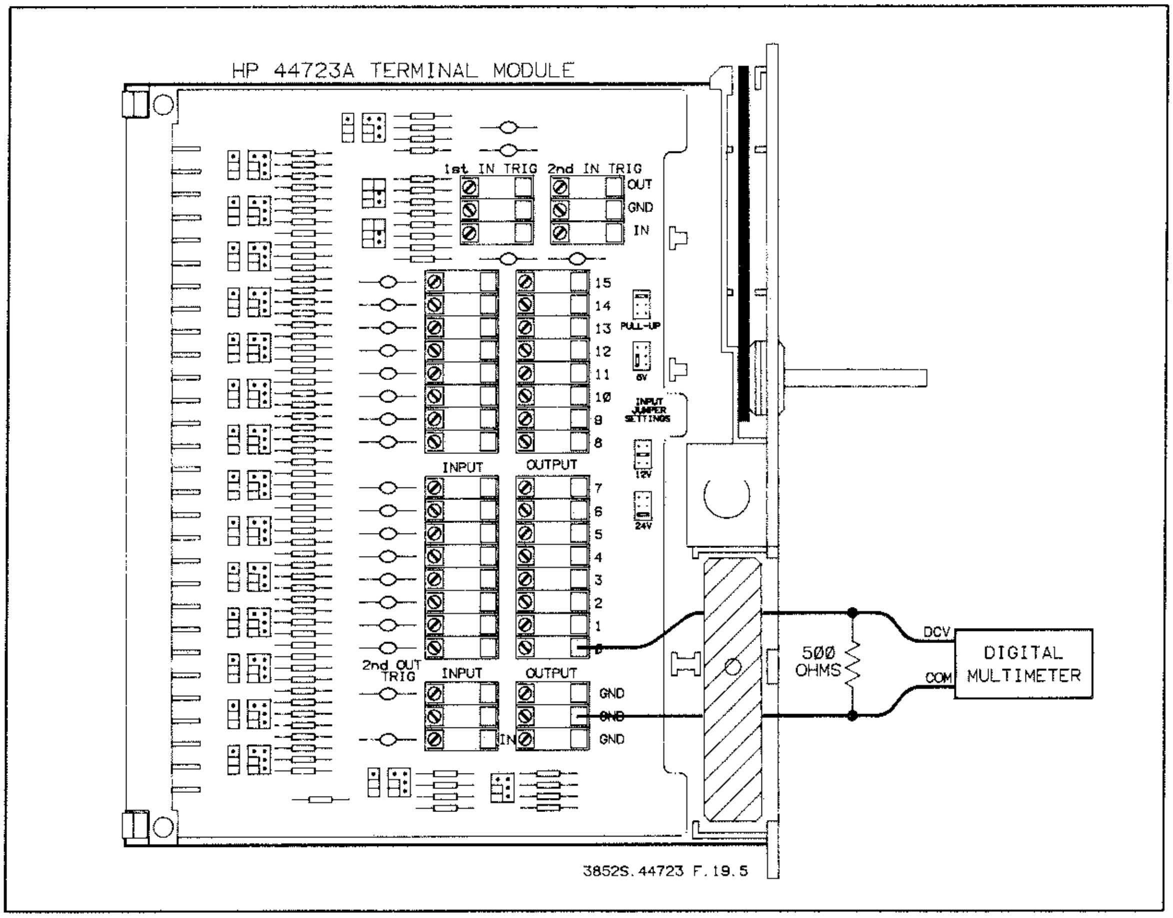


Figure 19-5 Output Driver Test

Channel No.	Reading	Channel No.	Reading
1	2	8	256
2	4	9	512
3	8	10	1024
4	16	11	2048
5	32	12	4096
6	64	13	8192
7	128	14	16384
		15	-32768

17. Leave the service module connected to the accessory. Disconnect the power supply from the accessory. Disconnect the digital multimeter from the power supply.

19-15 Output Driver Test

This test checks the current output and sink capability of the TTL output, the current sink capability of the open collector output drivers, and the input leakage of the open collector drivers.

1. TTL OUTPUT HIGH LEVEL DRIVE TEST. This test checks the output current capabilities of the TTL output drivers.

2. Make sure the output jumpers on the terminal module are selected for TTL outputs on all channels (see Figure 19-5).

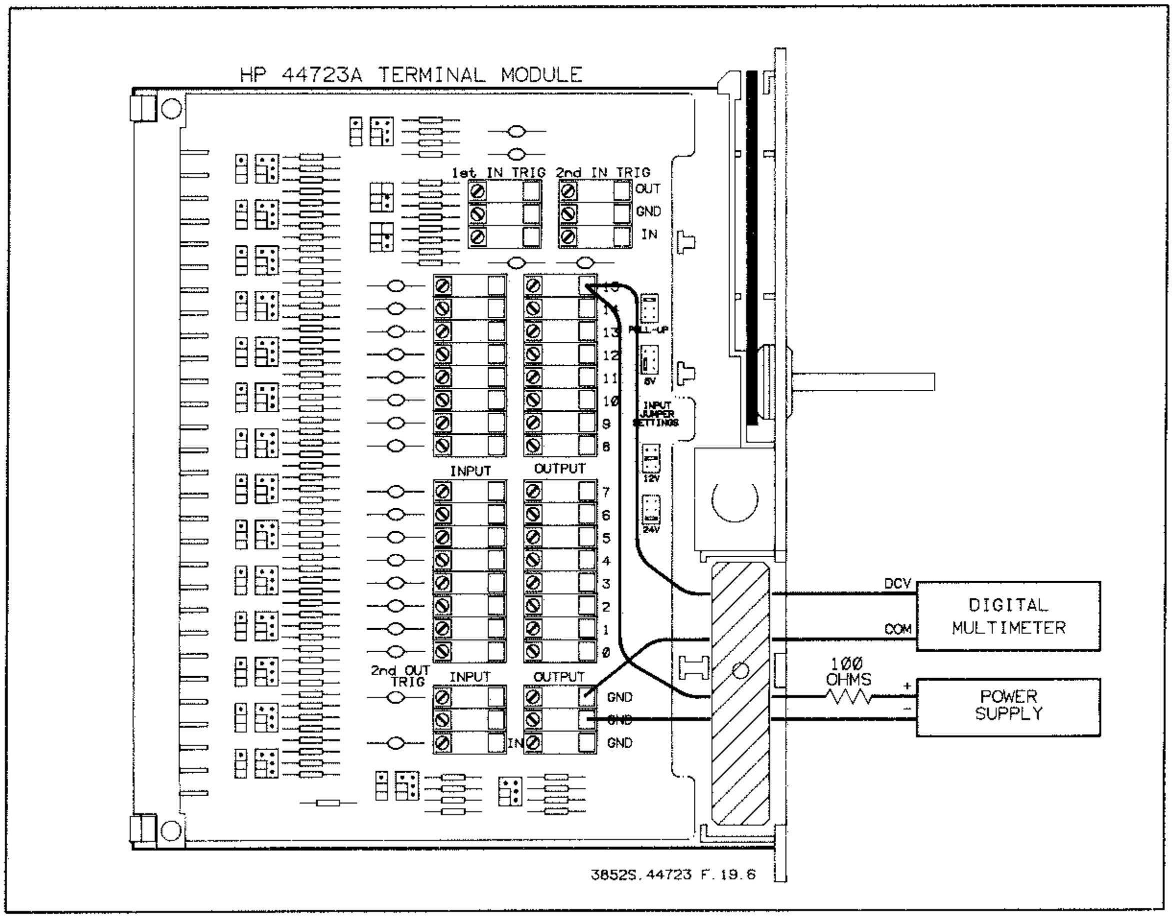


Figure 19-6 TTL Sink Current Test

3. Set all channels high (1) by executing:

   WRITE ES00,-1 (where E = extender number, S = slot number)

4. Refer to Figure 19-5. Connect a 500 Ω, 1/4 W resistor across the digital multimeter's DCV (HI) and COM (LO) input terminals. Setup the digital multimeter for dc volts and autorange.

5. Connect the digital multimeter's DCV input to the HIGH output terminal of channel 0 on the terminal module. Connect the COM input to GND on the terminal module. The setup is shown in Figure 19-5.

6. Verify that the digital multimeter displays greater than or equal to 2.4 Vdc.

7. Repeat steps 5 and 6 for channels 1 through 15. Be sure to connect the multimeter to the appropriate output terminals on the terminal module.

8. At the conclusion of this test, remove the resistor from the digital multimeter. Leave the multimeter connected for the next test (it should be connected to the output terminals of channel 15).

9. TTL OUTPUT SINK CURRENT TEST. This test checks the sink current capability of the TTL output drivers.

10. Set all channels low (0) by executing:

WRITE ES00,0 (where E = extender number, S = slot number)

11. Refer to Figure 19-6. Set a power supply to output +5 V. Connect the negative (-) output to GND on the terminal module. Connect the positive (+) output of the power supply to a 100 Ω, 1/4 W resistor.

12. Connect the other end of the resistor to the high output terminal of channel 15 on the terminal module. The setup is shown in Figure 19-6.

13. Verify that the digital multimeter displays less than or equal 0.4 V.

14. Repeat steps 12 and 13 for channels 14 through 0. Be sure to connect the multimeter and resistor to the appropriate output terminals on the terminal module.

15. Leave the digital multimeter, power supply, and resistor connected to the terminal module (on output terminal of channel 0).

16. OPEN COLLECTOR OUTPUT SINK CURRENT TEST. This test checks the sink current capability of the open collector output drivers.

17. Change the power supply output to 4 V.

18. Change ALL output jumpers on the terminal module to open collector outputs as shown in Figure 19-7.

19. Verify that the digital multimeter displays less than or equal to 0.4 V.

20. Repeat steps 18 and 19 for channels 1 through 15. Be sure to connect the multimeter to the appropriate output terminals on the terminal module.

21. At the completion of this test, remove the multimeter, power supply, and resistor from the terminal module.

19-16 REPLACEABLE PARTS

Figure 19-8 shows the mechanical breakdown of the HP 44723A. The figure also provides assembly and disassembly information. The parts shown in Figure 19-8 are keyed to the parts list in Table 19-2.

To order a part listed in Table 19-2, quote the Hewlett-Packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 19-2). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

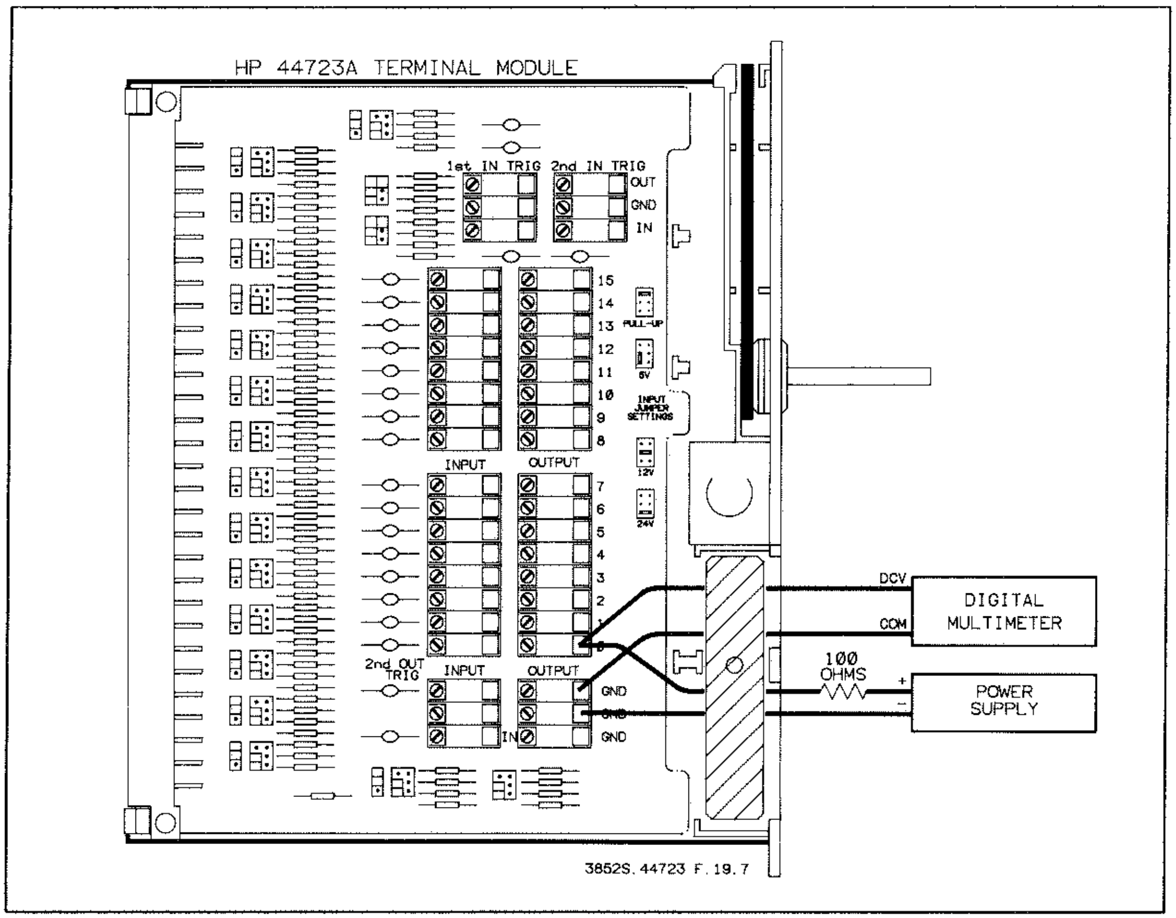


Figure 19-7 Open Collector Sink Current Test

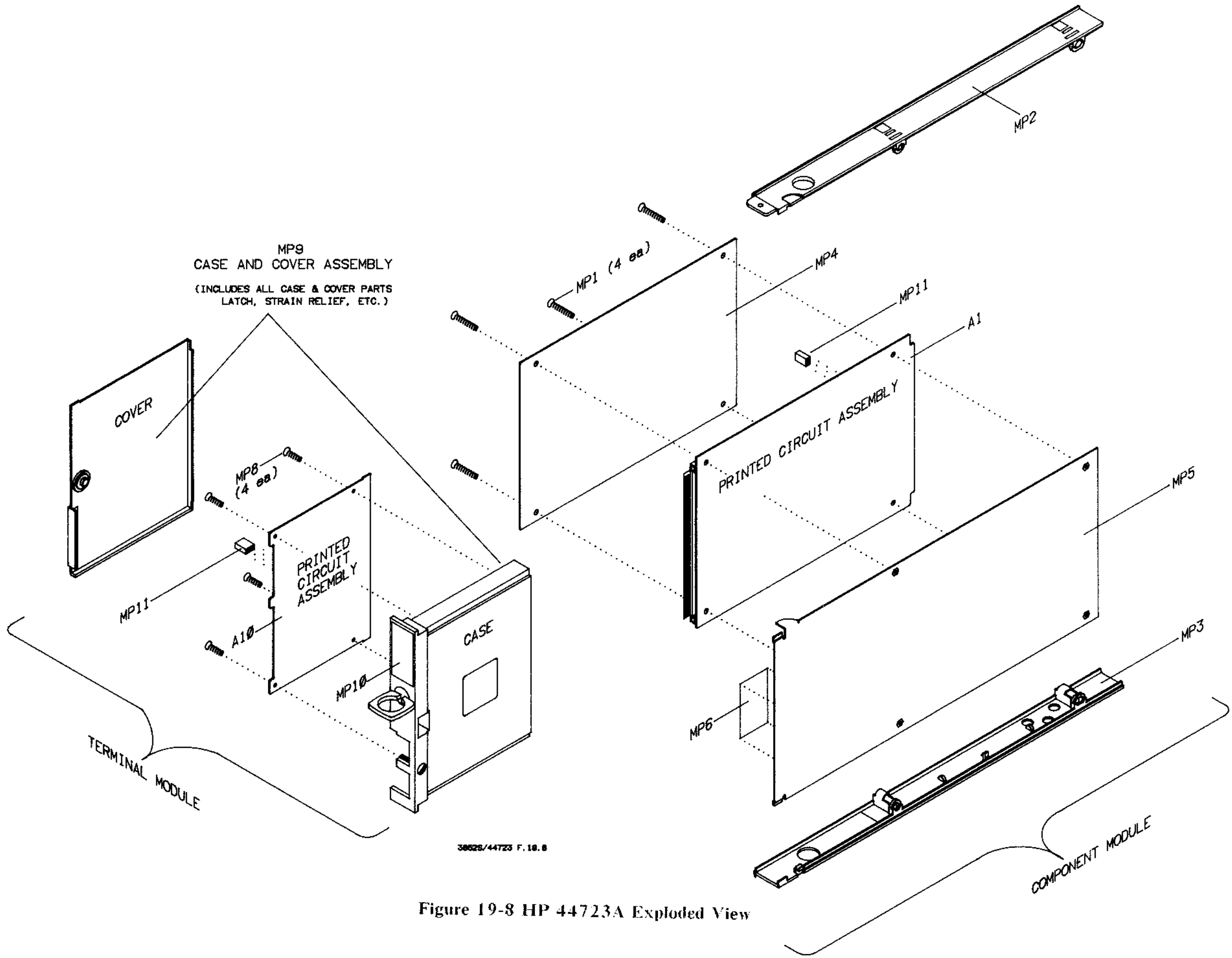


Figure 19-8 HP 44723A Exploded View

Table 19-2 HP 44723A Fast Digital I/O

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44723A	Module; 16ch Fast Digital I/O	1	44723-66201	3	MOD-DIG.SEN CONT
A1	PCA; 16ch Fast Digital I/O component	1	44723-66501	6	PCA-FST DGTL I/O
A10	PCA; 16ch Fast Digital I/O terminal	1	44723-66510	7	PCA-FST DGTL TERM
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44723A component module	1	44723-84320	5	LBL-I/O OPTIONS
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear pnl of term mod 44723A	1	44723-84325	0	LBL-ID,TERM ASSY
MP11	Jumper; removable, A10 PCA	35	1258-0141	8	JMPR-REM .025P

Completely assembled HP 44723A terminal modules can be ordered from your local HP office by ordering Number 44723AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details see Section 4-9.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44723A	Module; 16ch Fast Digital I/O		44723-69201	9	RBLT-44723-66201

Chapter 20
HP 44730A/32A/33A
Track/Hold

CHAPTER 20

HP 44730A 4 CHANNEL TRACK/HOLD WITH SIGNAL CONDITIONING
HP 44732A/44733A 4 BRIDGE DYNAMIC STRAIN GAGE

CHAPTER 20
HP 44730A
TRACK/HOLD WITH
SIGNAL CONDITIONING
HP 44732A/44733A
STRAIN GAGE

20-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, calibration procedures, and a replaceable parts list for the HP 44732A Track/Hold with Signal Conditioning Accessory (called the Signal Conditioning Accessory). Also included are the replaceable parts lists of the HP 44732A 120 ohm and HP 44733A 350 ohm Dynamic Strain Gages.

NOTE

The Signal Conditioning Accessory can only be used with instruments having a firmware revision of 3.5 or above. Determine the firmware revision by sending the mainframe command: **IDN?**.

20-2 HP 44730A Technical Description

The HP 44730A Track/Hold with Signal Conditioning Accessory has four channels for signal conditioning and four channels for measuring transducer exitation supply voltages. The accessory also has four +4.6 V power supplies that can be used for transducer exitation voltages.

Included on the accessory are trigger input terminals for triggering the track/hold or peak detection circuitry. Also supplied are output terminals for making measurements with an externally connected device (e.g., a voltmeter) and calibration terminals for connecting calibration signals.

The accessory can be connected via a ribbon cable to an HP 44702A High Speed Voltmeter for high speed measurements. The High Speed Voltmeter can also be used to trigger the accessory and to transfer measurement data to the voltmeter.

Refer to Figure 20-1. The HP 44730A has two main assemblies: a component module and a terminal module. The component module includes the input amplifier and associated circuitry, various multiplexers, track/hold and peak detection circuitry, backplane control logic, ribbon cable control logic, and the +4.6 V power supplies. The terminal module has the terminal blocks for connecting external wiring to the accessory.

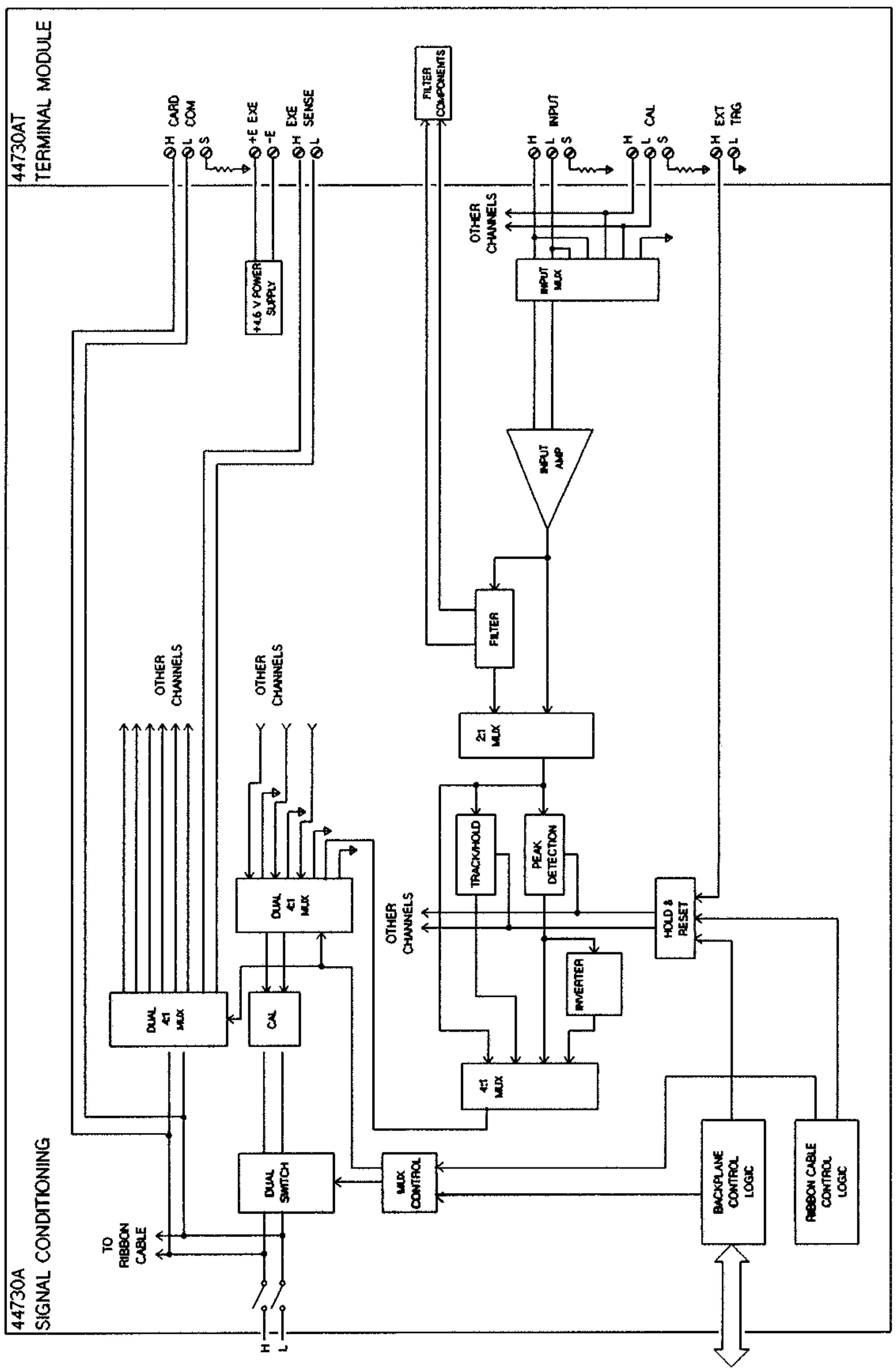


Figure 20-1 HP 44730A Simplified Block Diagram

The following paragraphs explain the operation of the accessory. Except where noted, only one channel is explained since the operation is the same for all channels.

The input signal is applied to the High (H) and Low (L) input terminals on the terminal module. (The Shield (S) terminal is used as a termination for a shielded cable that also serves as a bias current return path.) The input signal is then applied to the input multiplexer which connects it to the input amplifier. The multiplexer also performs other functions. It connects the input signal to an inverter for negative peak detection measurements only. It also connects the amplifier inputs to ground for an autozero measurement and connects the calibration signal to the input amplifier for calibration.

The input amplifier consists of a differential amplifier with three selectable gains: 1, 10, and 100. The amplifier's input voltage levels are ±10.24 V. The amplifier is calibrated programatically by applying a calibration signal to the input amplifier and then adjusting the amplifier's offset and gain with digital-to-analog converters (DACs). Calibration constants are then calculated and stored in an EEPROM.

The output of the amplifier is applied either directly to the track/hold amplifier, positive and negative peak detection circuitry, and the output multiplexer, or to the same circuitry through a filter. A 2:1 multiplexer is used to connect the filter between the amplifier and the different circuitry. The output of the amplifier (either direct or through the filter), or the output of the track/hold amplifier and the peak detection circuitry is connected to the output multiplexer circuitry via a 4:1 multiplexer. The output of the output multiplexer circuitry becomes the actual output of the accessory, after signal conditioning. The output multiplexer circuitry consists of a dual 4:1 multiplexer, the calibration circuitry, and a dual switch switch.

The filter is resistor programmable with its response determined by user selectable passive components on the terminal module.

The track/hold amplifier provides simultaneous sampling of all channels. The hold state is triggered either by the backplane trigger (on the mainframe), by the HP 44702A High Speed Voltmeter via the ribbon cable, or from the trigger input on the terminal module. The different triggers are user selectable.

The peak detection circuitry can perform both positive and negative peak detection. The same circuitry is used for both operations. To perform positive peak detection, the accessory's input signal is inverted before it is applied to the input amplifier. The input amplifier inverts the signal again. This applies a non-inverted signal to the peak detection circuitry. The output signal of the amplifier then in effect becomes a positive output signal. This signal is then inverted following the peak detection stage and inverted again in the calibration stage. This restores the final signal to the original polarity.

For negative peak detection, the signal is inverted in the input amplifier, peak detected, and re-inverted in the calibration stage.

The output multiplexer circuitry scans all four signal conditioning channels and the four channels used to measure the transducer exitation voltages. This makes the output of all channels available to the backplane through isolation relays, the High Speed Voltmeter via the ribbon cable, and the output terminals on the terminal module. The scanning of the channels is controlled by either the backplane control logic (i.e., the mainframe) or the ribbon cable control logic (i.e., HP 44702A High Speed Voltmeter).

The +4.6 V powers supplies are regulated supplies that are capable of supplying 45 mA each.

The backplane control logic interfaces the mainframe with the accessory. It is used to select the gain of the input amplifier, enables/disables the filter, selects the track/hold and peak detection circuitry, and controls the calibration of the accessory.

20-3 HP 44732A and HP 44733A Technical Description

The HP 44732A and HP 44733A Strain Gage terminal modules work in conjunction with the HP 44730A Signal Conditioning Accessory to make strain gage measurements. The HP 44732A is used for 120 Ω strain gage measurements and the HP 44733A is for 350 Ω measurements. The modules have terminal strips for making external connections for quarter, half, and/or full bridge configurations.

Figure 20-2 shows a simplified schematic of the HP 44732A and 44733A strain gage modules, and also shows the different strain gage configurations. The actual strain gage measurements are made by a voltmeter via the HP 44730A Signal Conditioning Accessory. Either the HP 44702A High Speed Voltmeter (via the ribbon cable), or the HP 44701A DC Voltmeter or an externally connected voltmeter connected to either the analog bus or the CARD COM terminals (on the strain gage module) can be used for measurements. The exitation voltage for the strain gage bridge is supplied by +4.6 V power supplies (one for each channel) on the HP 44730A component module. The +4.6 V supplies are measured by connecting the +E and -E2 EXC terminals to the corresponding H and L EXC SENSE terminals on the strain gage module. Like the strain gage measurements, the +4.6 V supplies are measured using the HP 44702A High Speed Voltmeter, the HP 44701A DC Voltmeter, or an externally connected voltmeter.

20-4 SPECIFICATIONS

Specifications for the HP 44730A are given in Table 20-1. Specifications are the performance standards or limits against which the accessory may be tested.

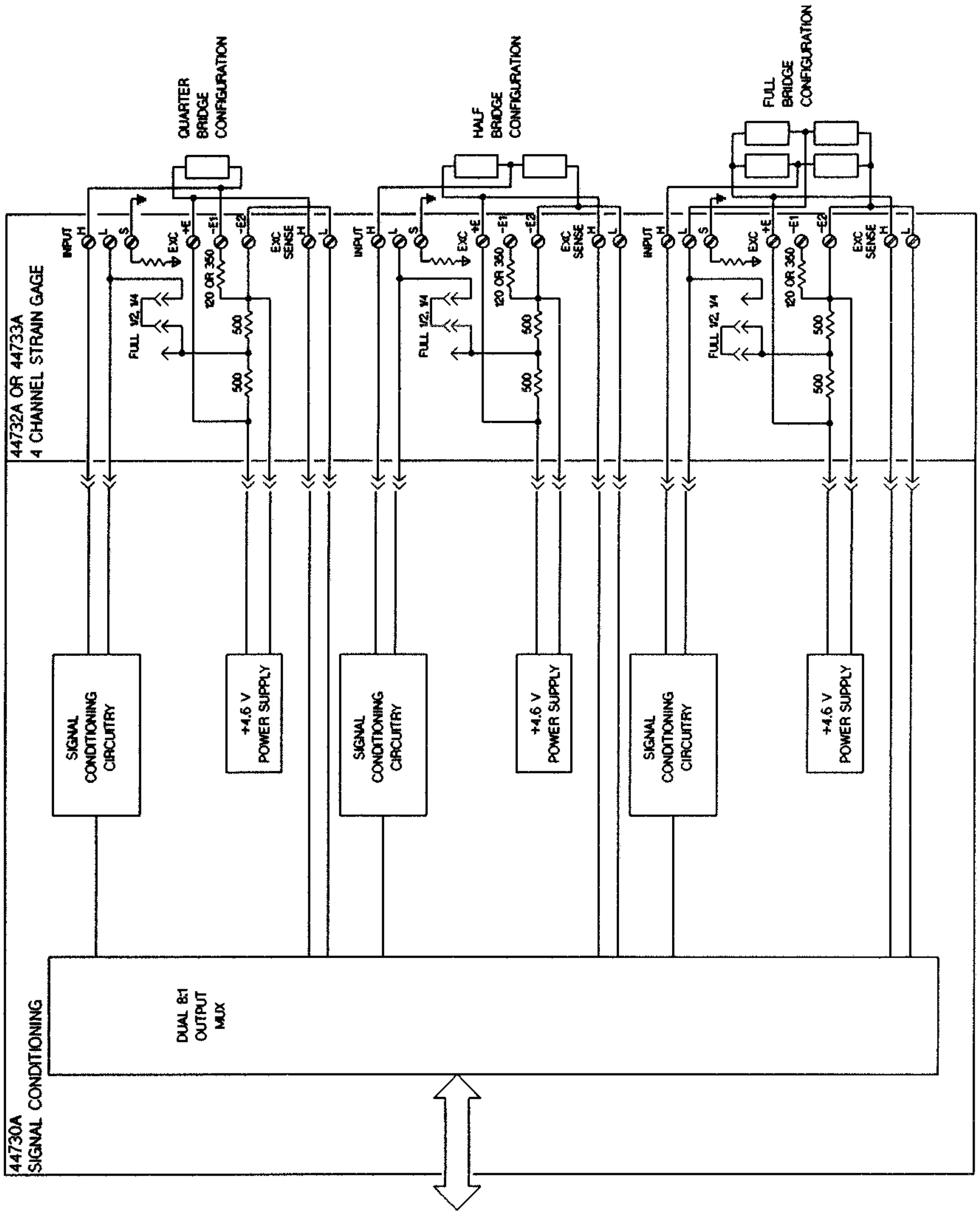


Figure 20-2 HP 44732A/44733A Simplified Schematic

Table 20-1 HP 44730A/44732A/44733A Specifications

Channel Inputs:

Maximum Sample Rate: 100 kHz (using HP 44702A/B Voltmeter)
Maximum Input Voltage: ±12 V
Maximum Input Current: 15 mA

Input Impedance:

Impedance	Terminals High to Low	Terminals High or Low to Chassis
Power On Resistance (Ω)	>10^8	>10^8
Power Off Resistance (Ω)	>1000	>1000
Max. Capacitance (pF) at 1MHz	50	50

DC Accuracy: ±(% of reading + offset) referred to the input. Specified with autozero (nulling for strain) performed within one minute of measurement.

90 days, 18° to 28°C

	Gain 1	Gain 10	Gain 100
Multiplexer only	0.02% + 1mV	0.02% + 0.1mV	0.03% + 20µV

Add an additional error for each of the following functions:

	Gain 1	Gain 10	Gain 100
Filter	0.005% + .3mV	0.005% + 0.03mV	0.005% + 3µV
Track/Hold	0.005% + 5mV	0.005% + 0.5mV	0.005% + 50µV
Peak Detect	0.005% + 20mV	0.005% + 2mV	0.005% + 200µV
Strain (all type)*	0% + 0.5mV	0% + 0.05mV	0% + 5µV

Temperature Coefficient: Add as an additional accuracy error per °C for an operating temperature outside of 18° to 28°C but within 0 to 55°C for all configurations.

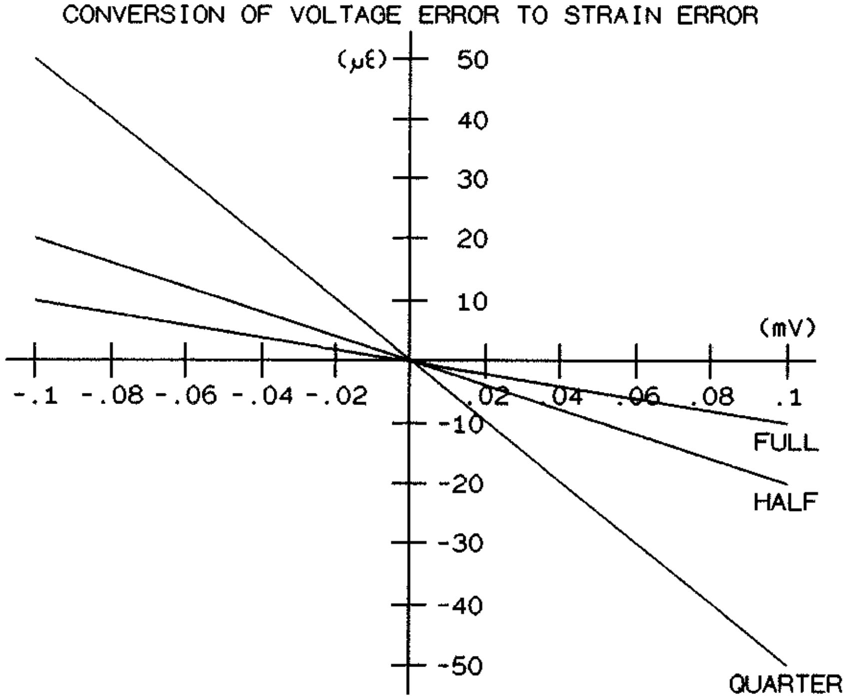
Table 20-1 HP 44730A/44732A/44733A Specifications (Cont.)

Gain 1	10	100
0.002% + 0.01mV	0.002% + 0.001mV	0.004% + 0.1μV

* All strain specifications are made using internal power supplied on the plug-in module.

Voltage To Strain Error Conversion:

The following figure shows conversion of voltage error (mV) to equivalent strain error (με) for 1/4 (QUARTER), 1/2 (HALF), and full (FULL) bridge measurements for a gage factor (GF) of 2.



Gain:

Using the HP 44702A/B High Speed Voltmeter. Cross-talk specified for channel-to-channel with 50 Ω source and 1 MΩ termination @ 10 kHz.

Table 20-1 HP 44730A/44732A/44733A Specifications (Cont.)

	Gain 1	10	100
Bandwidth (3dB point)	1.0 MHz	500 kHz	250 kHz
Cross-talk (dB)	-50	-70	-80
CMRR (dB, 1 kohm unbalance):			
@ DC	70	85	100
@ 60 Hz	60	80	90
@ 10 kHz	30	40	45

Filter:

The accessory is shipped with a four-pole Bessel filter with default bandwidth of 10 kHz. Filter characteristics can be changed by changing component values on the terminal module. Default bandwidth = 10 kHz.

Track/Hold:

	Trigger Internal	External
Acquisition time (µS)**	2	2
Aperture time (nS)	25	25
Aperture delay time (nS)	105	60
Aperture jitter (nS)	0.5	0.5
Time skew between channels (nS)	1.2	1.6
Time skew between cards (nS)	1.5	2.5
Droop rate @ 25°C (V/S)***	0.5	0.5

** Acquisition time to within 0.01% of full-scale. Refer to Appendix B in HP 3852A Configuration and Programming Manual for parameter definitions.
*** Doubles every 6.5°C above 25°C.

Peak Detect: Minimum duration (µS) of a square wave (without the filter) to attain system accuracies listed above OR to attain an accuracy of 1% of full-scale.

	Gain 1	10	100
System accuracies	50	50	70
Accuracies at full scale	5	5	10

Table 20-1 HP 44730A/44732A/44733A Specifications (Cont.)

Strain Gage: Resolution (με) using the internal 4.6 V supply, a gain of 100, and the HP 44702A/B High Speed Voltmeter on the 2.56 V range.

	Bridge 1/4	Bridge 1/2	Bridge Full
Resolution (με)	2.7	1.4	0.7

Relative Power Consumption: 3.0 using power supplies with HP part number 03852-66202. 1.0 using power supplies with HP part number 03852-66212.

Maximum Wire Size: 16 AWG

20-5 PERFORMANCE TESTS

20-6 Introduction

The following Performance Tests check the operation of the HP 44730A component module. Performance Tests are not given for the terminal modules. Successful completion of the tests in this chapter provides a high confidence level that the Signal Conditioning Accessory is meeting its listed specifications.

The performance tests should be performed in the order they are presented. The completion of each test increases the confidence level in the Signal Conditioning Accessory. A minimum set of tests is given as the Operational Verification Tests. These tests are described in Section 20-7.

The Performance Test procedures described in this chapter are involved and time consuming. Since the Operational Verification Tests yield a 90% confidence level that the Signal Conditioning Accessory is operating normally, it is not recommended that all the Performance Tests be performed unless one of the tested specifications is in question.

20-7 Operational Verification

The first tests in this section are the minimum set of tests recommended for the Signal Conditioning Accessory. These tests are designed to test the functionality of the accessory. Successful completion of the Operational Verification Tests provide a 90% confidence level that the Signal Conditioning Accessory is operating normally and is within specifications.

The Operational Verification Tests consist of the following:

Section 20-11 - Set-Up Procedure
Section 20-12 - Self-Test
Section 20-13 - DCV Test
Section 20-14 - Nulling Functionality Test
Section 20-15 - Peak Detection Functionality Test
Section 20-16 - Ribbon Cable Test

20-8 Equipment Required

The following test equipment is required to run the Performance Tests.

1. Test Fixture (as described in Section 20-9).

2. Test Leads and Jumpers.

3. Digital Multimeter -- HP 3456A.

4. Stable DC Voltage Source -- Any stable dc voltage source that can output 0.1 V, 1.0 V, 4.9 V, and 10 V.

In the dc volts test procedures, the dc voltages applied to the HP 44730A must be accurate and stable. Good accuracy and stability are needed to meet the accessory's accuracy requirements.

With the above in mind, there are two ways of performing the test procedures.

a. Use the recommended digital multimeter to adjust the dc voltage source output to the correct accessory input. Do this by connecting the dc voltage source to the digital multimeter and then adjust the voltage source to the appropriate accessory input voltage. Use the reading on the digital multimeter to adjust for the correct voltage. Then connect the dc voltage source to the accessory for testing.

The test procedures are written using the above procedure. If you plan to use this procedure, keep the following in mind.

The dc voltage source must have good short term stability. This is needed since it takes time to manually perform the test procedures. Any drift in the dc source may make the tests invalid.

The dc source must be adjustable so you can adjust it to the correct input voltage, as read on the digital multimeter.

b. Use an accurate and stable dc voltage standard, like the Datron Model 4000/4000A. You can directly connect one of these standards to the HP 44730A input without adjusting the standard's output voltage on the digital multimeter. It has sufficient accuracy and short term stability to test the HP 44730A.

5. Function Generator -- HP 3325A.

6. HP 44702A/B High Speed Voltmeter (only required for full performance test or if the Ribbon Cable Test in Section 20-16 is to be performed).

NOTE

The integrating plug-in voltmeter (HP 44701A) may be used for the Performance/Operational Verification Test Procedures. The tests do not describe specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

20-9 Test Fixure

A test fixure is recommended to run the Performance Tests. The test fixure can be manufactured using an HP 44730AT terminal module. Make sure the filter components on the terminal module are the ones installed by the factory. Any changes made to the filter components invalidates the following filter tests. The use of the fixure minimizes the number of test connections required for the tests.

On the test fixure, the H (High) and L (Low) inputs of each channel are connected to each other. The test fixure configuration is shown in Figure 20-3.

20-10 Test Procedures

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

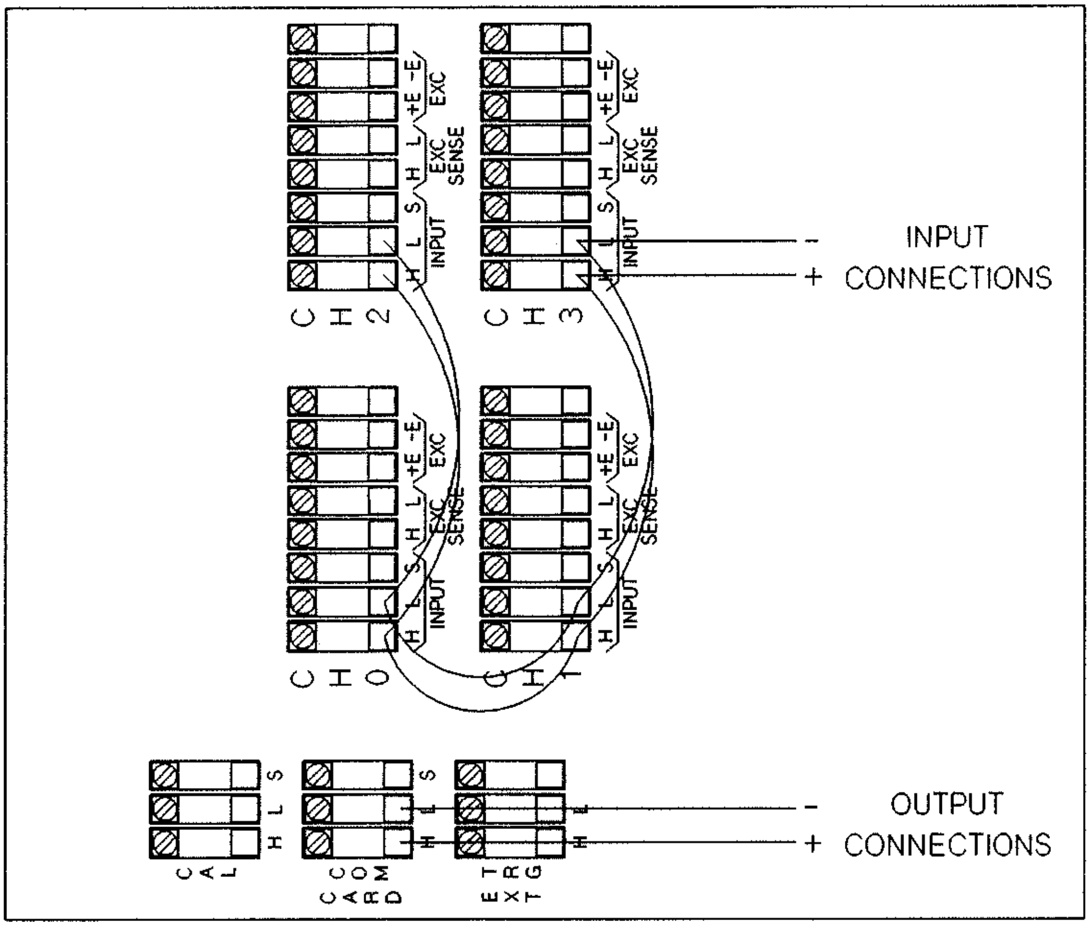


Figure 20-3 HP 44730A Test Fixure

20-11 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Make sure a terminal module is installed in the accessory. Note the slot number where the accessory under test is installed.

3. Verify the correct connections and slot numbers:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows the following:

      44730A

NOTE

If the HP 3852A right display shows a different accessory number, the slot number used may not be correct. If the HP 3852A display shows 447XXX, the test fixture may not be installed.

20-12 Self-Test

This test checks most of the accessory's digital circuitry.

1. Perform the HP 44730A self-test by executing:

   TEST ES00 (where E = extender number, S = slot number)

2. The HP 3852A right display should show:

   SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44730A accessory may be failing its self-test. Test the accessory again by executing the command in step 1. If the accessory still fails, exchange it with a working one.

20-13 DCV Test

This test is in three parts. One part checks the full scale dc volts accuracy of the accessory. Another part checks the filter. The last part checks the isolation relays.

1. Set the HP 44730A accessory to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

2. Set the digital multimeter to dc volts and autorange. Then connect it to the dc voltage source.

3. Set the dc voltage source for a 10.0000 V output, as shown on the digital multimeter.

4. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L Input Connections on the test fixure.

5. Set the channel 0 gain to "1" and turn on autozero by executing:

   FUNC AMPLIFY,1 USE ES00 (where E = extender number, S = slot number)
   AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

6. Close channel 0 by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. It should indicate 10.0000 V ± 0.003 V.

8. Enable the filter and autozero by executing:

   FILTER ON, USE ES00 (where E = extender number, S = slot number)
   AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

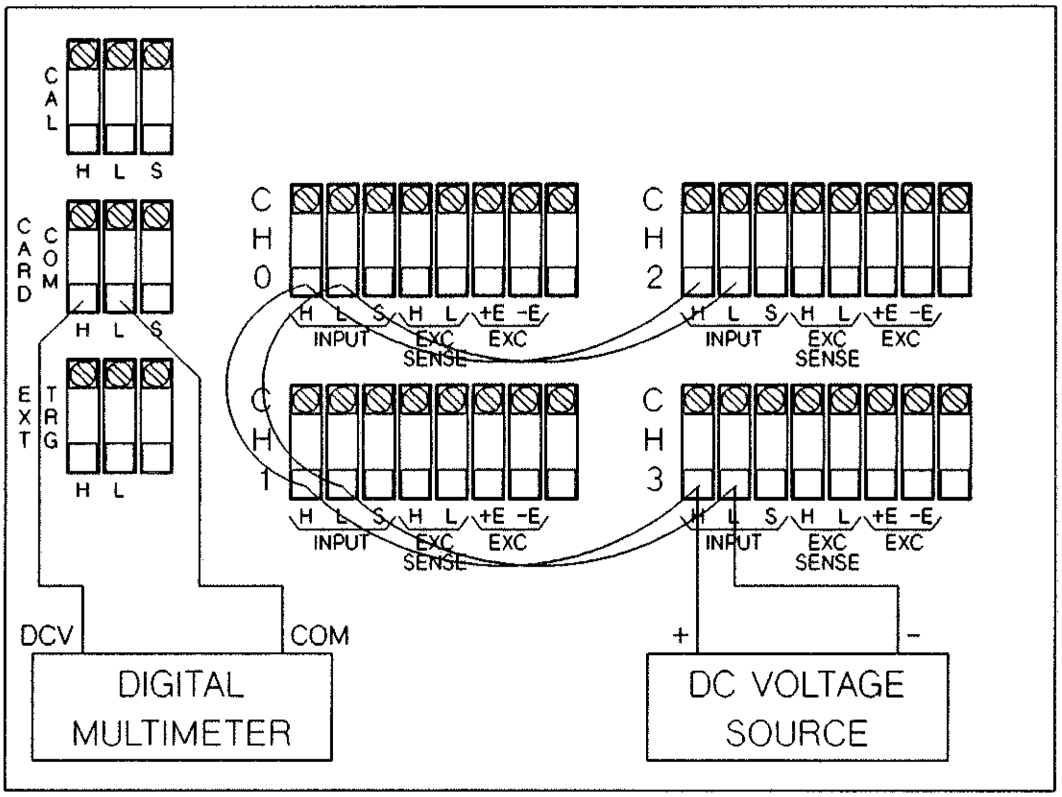


Figure 20-4 DC Voltage Source Connections

9. Observe the indication on the multimeter. It should indicate 10.0 V ± 0.0038 V.

10. Turn the filter off by executing:

FILTER OFF, USE ES00 (where E = Extender number, S = slot number)

11. Repeat steps 5 through 10 for channels 1, 2, and 3. In the USE, CLOSE, and FILTER commands in steps 5, 6, 8, and 10, the last two digits are the channel number (e.g., USE ES02 for channel 2).

12. Remove the dc voltage source from the test fixture. Connect the digital multimeter to the dc voltage source.

13. Set the dc voltage source for a 1.0000 V output, as shown on the digital multimeter.

14. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixture. Connect the dc voltage source to the H and L Input Connections on the test fixture.

15. Set the channel 0 gain to "10" and turn on autozero by executing:

FUNC AMPLIFY, 10 USE ES00 (where E = extender number, S = slot number)
AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

16. Close channel 0 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

17. Observe the indication on the multimeter. It should indicate 10.0000 V ± 0.003 V.

18. Repeat steps 15, 16, and 17 for channels 1, 2, and 3. In the USE and CLOSE commands in steps 15 and 16, the last two digits are the channel number (e.g., USE ES02 for channel 2).

19. Remove the dc voltage source from the test fixure. Connect the digital multimeter to the dc voltage source.

20. Set the dc voltage source for a 0.10000 V output, as shown on the digital multimeter.

21. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L Input Connection on the test fixure.

22. Set the channel 0 gain to "100" and turn on autozero by executing:

FUNC AMPLIFY, 100 USE ES00 (where E = extender number, S = slot number)
AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

23. Close channel 0 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

24. Observe the indication on the multimeter. It should indicate 10.0000 V ± 0.005 V.

25. Repeat steps 22, 23, and 24 for channels 1, 2, and 3. In the USE and CLOSE commands in steps 22 and 23, the last two digits are the channel number (e.g., USE ES02 for channel 2).

26. Note the last reading taken on the digital multimeter.

27. Refer to Figure 20-5. Remove the digital multimeter from the test fixure and connect its to the Analog Bus Connector. Connect the DCV input to the Analog Bus Connector's SENSE BUS HIGH terminal and the COM input to the SENSE BUS LOW terminal.

28. Close the isolation relay by executing:

CLOSE ES90 (where E = extender number, S = slot number)

29. Observe the reading on the digital multimeter. It should be the same noted in step 26.

30. Remove the digital multimeter from the Analog Bus Connector.

20-14 Nulling Functionality Test

This test checks the nulling capability of the accessory.

1. Make sure the digital multimeter is set to dc volts and autorange.

2. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L Input Connections on the test fixure.

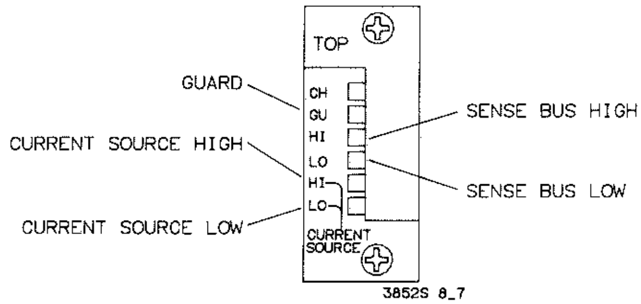


Figure 20-5 Analog Bus Connector

3. Set the dc voltage source for a +4.9 V output.

4. Set the channel 0 gain to "1" by executing:

   FUNC AMPLIFY, 1 USE ES00 (where E = extender number, S = slot number)

5. Null channel 0 by executing:

   NULL, USE ES00 (where E = extender number, S = slot number)

6. Close channel 0 by executing:

   CLOSE ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. It should indicate 0 V ± 0.001 V.

8. Set the dc voltage source for a -4.9 V output.

9. Null channel 0 by executing:

   NULL, USE ES00 (where E = extender number, S = slot number)

10. Observe the indication on the multimeter. It should indicate 0 V ± 0.001 V.

11. Repeat steps 3 through 10 for channels 1, 2, and 3. In the USE, NULL, and CLOSE commands in steps 4, 5, 6, and 9 the last two digits are the channel number (e.g., USE ES02 for channel 2).

12. Disconnect the digital multimeter and dc voltage source from the test fixure.

20-15 Peak Detection Functionality Test

This test verifies the peak detection capability of the accessory.

Do not perform this test if you plan to do the complete Performance Test procedures. A more extensive Peak Detection test is given later in the Performance Test procedures.

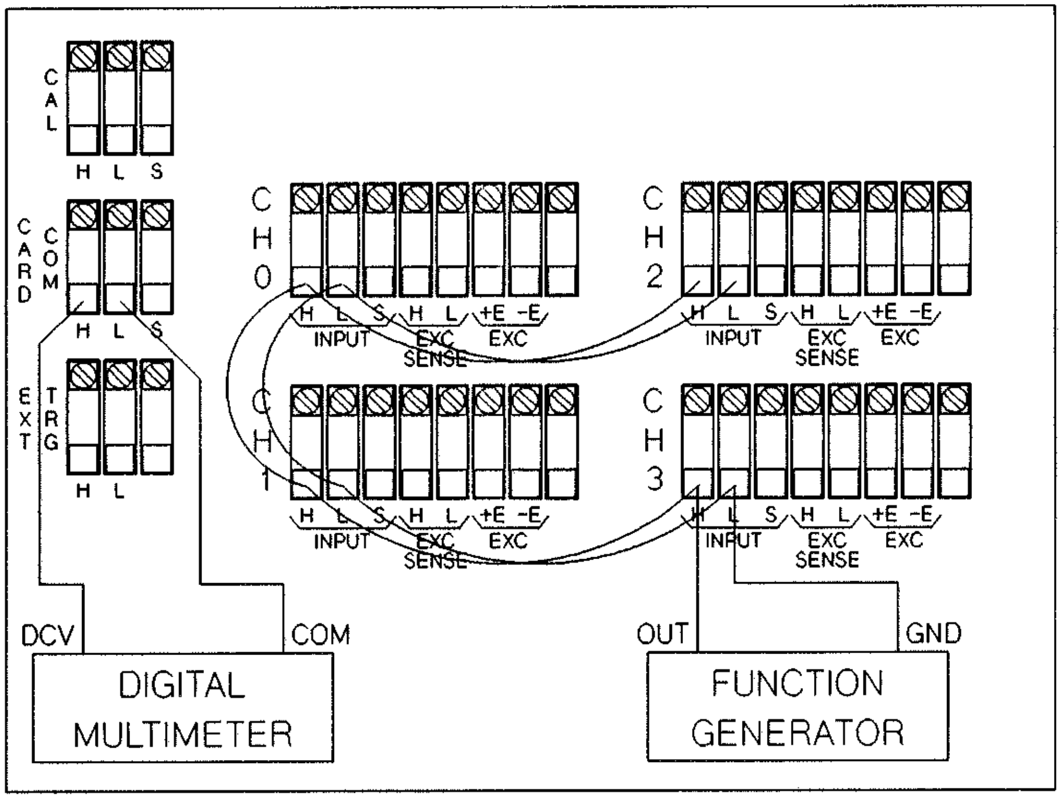


Figure 20-6 Function Generator Test Connections

1. Setup a function generator for a 100 Hz 1 V peak-to-peak sine wave. If using the recommended function generator, set it up as follows:

Function -- Sine Wave
Frequency -- 100 Hz
Amplitude -- 1.0 V p-p
DC Offset -- 0 V

2. Refer to Figure 20-6. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the function generator to the H and L Input Connections on the test fixure.

3. Set channel 0 gain to "1" and to positive peak detection and turn on autozero by executing:

FUNC POSPEAK, 1 USE ES00 (where E = extender number, S = slot number)
AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

4. Close channel 0 by executing:

CLOSE ES00 (where E = extender number, S = slot number)

5. Observe the indication on the multimeter. It should indicate approximately 1.0 V.

6. Set channel 0 to negative peak detection and turn on autozero by executing:

> FUNC NEGPEAK, 1 USE ES00 (where E = extender number, S = slot number)
> AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. It should indicate approximately -1.0 V.

8. Repeat steps 3, 4, 5, 6, and 7 for channels 1, 2, and 3. In the USE and CLOSE commands in steps 3, 4, and 6, the last two digits are the channel number (e.g., USE ES02 for channel 2).

9. Disconnect the function generator from the test fixture.

20-16 Ribbon Cable Test

This test verifies that the HP 44730A accessory can be controlled by an HP 44702A/B. It also verifies that measurement results can be transferred to the voltmeter over the ribbon cable.

Do not perform this test if you plan to perform the complete Performance Test procedures. Ribbon cable operation will automatically be checked in some of the following Performance Test procedures. Also, if the HP 44730A accessory is not used with an HP 44702A/B High Speed Voltmeter, this test may not be necessary.

1. Remove power from the HP 3852A.

2. Set the HP 44730A component module next to an HP 44702A/B High Speed Voltmeter accessory to enable connection between the two accessories. Connect the ribbon cable between the accessory and the HP 44702A/B. Then install both accessories into the mainframe. Note the slot number where the HP 44730A under test is installed and the slot number where the HP 44702A/B is installed.

3. Install the test fixture on the HP 44730A.

4. Apply power to the HP 3852A.

5. Set up the mainframe and HP 44702A/B by executing:

> FASTDISP OFF
> USE ES00 (where E = extender number, S = slot number of High Speed Voltmeter)
> SCANMODE ON
> TERM RIBBON

6. Set the dc voltage source for 1.0 V output. Connect the dc voltage source to the H and L input connection on the test fixture.

7. Setup the HP 44730A accessory to the RIBBON trigger mode by executing:

> TRIG RIBBON, USE ES00 (where E = extender number, S = HP 44730A slot number)

8. Enter, but do not execute, the following command:

> CONFMEAS DCV ES00-ES03 (where E = extender number, S = HP 44730A slot number)

9. When the command entered in step 8 is executed, the HP 44702A/B performs a dc voltage measurement the HP 44730A's channels (i.e., all). With the FASTDISP off, each measurement will appear in the HP 3852A's right display. The HP 3852A left display will indicate each channel as it is scanned. Observe the HP 3852A display and press execute. The voltage indicated in the right display, for all channels, should be approximately 1.0 V dc. The scan list can be repeated, if desired, by pressing the RECALL ENTRY key and ENTER key.

10. Remove the dc voltage source from the HP 44730A. If you wish to continue with the Performance Test Procedures, leave the HP 44702A/B High Speed Voltmeter connected.

THIS CONCLUDES THE OPERATIONAL VERIFICATION PORTION OF THE PERFORMANCE TESTS.

20-17 Linearity Test

This test checks the linearity of the signal conditioning amplifiers on the HP 44730A accessory.

1. Set the HP 44730A accessory to a known state by executing:

    RESET ES00 (where E = extender number, S = slot number)

2. Set the digital multimeter to dc volts and autorange.

3. Connect the digital multimeter to the dc voltage source.

4. Set the dc voltage source for a 1.0 V output, as shown on the digital multimeter. This is the accessory's input voltage.

5. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L Input Connection

6. Close channel 0 by executing:

    AZERO ES00 (where E = extender number, S = slot number)
    CLOSE ES00 (where E = extender number, S = slot number)

7. Observe the indication on the multimeter. It should indicate 1.0 V ±0.0012 V, as listed in Table 20-2.

8. Remove both the digital multimeter and dc voltage source from the test fixure.

9. Repeat steps 3, 4, 5, 7, and 8 for input voltages of 2.0, 3.0, 4.0, 5.0, 6.0, 7.0, 8.0, and 9.0, volts. Make sure the dc voltage source in step 4 is set to the correct voltage (i.e., the accessory's input voltage). Use Table 20-2 for the correct voltage settings and multimeter readings.

9. Connect the digital multimeter to the dc voltage source.

10. Set the dc voltage source for a 0.1 V output, as shown on the digital multimeter. This is the accessory's input voltage.

Table 20-2 HP 44730A Linearity Test Limits

Input Voltage	Gain of Channel	Multimeter Reading High	Multimeter Reading Low	Input Voltage	Gain of Channel	Multimeter Reading High	Multimeter Reading Low
1.0	1	1.0012	0.9988	0.6	10	6.0022	5.9978
2.0	1	2.0014	1.9986	0.7	10	7.0024	6.9976
3.0	1	3.0016	2.9984	0.8	10	8.0026	7.9974
4.0	1	4.0018	3.9982	0.9	10	9.0028	8.9972
5.0	1	5.0020	4.9980	0.01	100	1.0023	0.9977
6.0	1	6.0022	5.9978	0.02	100	2.0026	1.9974
7.0	1	7.0024	6.9976	0.03	100	3.0029	2.9971
8.0	1	8.0026	7.9974	0.04	100	4.0032	3.9968
9.0	1	9.0028	8.9972	0.05	100	5.0035	4.9965
0.1	10	1.0012	0.9988	0.06	100	6.0038	5.9962
0.2	10	2.0014	2.9986	0.07	100	7.0041	6.9959
0.3	10	3.0016	2.9984	0.08	100	8.0044	7.9956
0.4	10	4.0018	3.9982	0.09	100	9.0047	8.9953
0.5	10	5.0020	4.9980				

11. Set the channel 0 gain to "10" by executing:

    AZERO USE ES00 (where E = extender number, S = slot number)
    FUNC AMPLIFY, 10 USE ES00 (where E = extender number, S = slot number)

12. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L Input Connection

13. Observe the indication on the multimeter. It should indicate 1.0 V ±0.0012 V, as shown in Table 20-2.

14. Repeat steps 9, 10, 12, and 13 for input voltages of 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, and 0.9, volts. Make sure the dc voltage source in step 10 is set to the correct voltage (i.e., the accessory's input voltage). Use Table 20-2 for the correct voltage settings and multimeter readings.

15. Connect the digital multimeter to the dc voltage source.

16. Set the dc voltage source for a 0.01 V output, as shown on the digital multimeter. This is the accessory's input voltage.

17. Set the channel 0 gain to "100" by executing:

    AZERO USE ES00 (where E = extender number, S = slot number)
    FUNC AMPLIFY, 100 USE ES00 (where E = extender number, S = slot number)

18. Refer to Figure 20-4. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L Input Connection

19. Observe the indication on the multimeter. It should indicate 1.0 V ±0.0023 V, as shown in Table 20-2.

20. Repeat steps 15, 16, 18, and 19 for input voltages of 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, and 0.09, volts. Make sure the dc voltage source in step 16 is set to the correct voltage (i.e., the accessory's input voltage). Use Table 20-2 for the correct voltage settings and multimeter readings.

21. Repeat steps 1 through 20 for channels 1, 2, and 3. In the USE and CLOSE commands in steps 6, 11, and 17, the last two digits are the channel number (e.g., USE ES02 for channel 2).

22. Disconnect the digital multimeter and dc voltage source from the test fixure.

20-18 Filter Test At 10 kHz

This test checks the operation of the switchable filter. Be sure to use the test fixure to run this test. Any filter component changes on the terminal module makes the test results unusable.

1. Set the HP 44730A accessory to a known state by executing:

    RESET ES00 (where E = extender number, S = slot number)

2. Setup a function generator for a 100 Hz 1 V peak-to-peak sine wave. If using the recommended function generator, set it up as follows:

    Function -- Sine Wave
    Frequency -- 100 Hz
    Amplitude -- 1.0 V p-p
    DC Offset -- 0 V

3. Setup the digital multimeter to ac volts and autorange.

4. Refer to Figure 20-6. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the function generator to the H and L Input Connection

4. Close channel 0 by executing:

    CLOSE ES00 (where E = extender number, S = slot number)

5. Turn the filter on by executing:

    FILTER ON, USE ES00 (where E = extender number, S = slot number)

6. Observe the indication on the multimeter. It should indicate approximately 0.707 V ac.

7. Change the function generator output to a 50 kHz 1 V peak-to-peak sine wave. If using the recommended function generator, set it up as follows:

    Function -- Sine Wave
    Frequency -- 50 kHz
    Amplitude -- 1.0 V p-p
    DC Offset -- 0 V

8. Observe the indication on the multimeter. It should indicate approximately 5.61 mV ac.

9. Repeat steps 2, 4, 5, 6, 7, and 8 for channels 1, 2, and 3. In the USE, CLOSE, and FILTER commands in steps 4 and 5, the last two digits are the channel number (e.g., USE ES02 for channel 2).

10. Disconnect the function generator and digital multimeter from the test fixure.

20-19 Track/Hold Droop Test

In this test, the HP 44702A/B is used to trigger the HP 44730A accessory and take a reading. The accessory is triggered again after a 100 mS delay and another reading is taken. The droop is then calculated from this data.

1. Remove power from the HP 3852A.

2. Set the HP 44730A component module next to an HP 44702A/B High Speed Voltmeter accessory to enable connection between the two accessories. Connect the ribbon cable between the accessory and the HP 44702A/B. Then install both accessories into the mainframe. Note the slot number where the HP 44730A under test is installed and the slot number where the HP 44702A/B is installed.

3. Install the test fixure on the HP 44730A.

4. Apply power to the HP 3852A.

5. Set the dc voltage source for 10.0 V output. Connect the dc voltage source to the H and L input connection on the test fixure.

6. Dimension variable A to store two readings by executing:

   DIM A(1)

7. Setup the accessory for track/hold bye executing:

   FUNC SAMPLE, 1 USE ES00 (where E = extender number, S = HP 44730A slot number)

8. Setup the HP 44730A accessory for RIBBON trigger by executing:

   TRIG RIBBON USE ES00 (where E = extender number, S = HP 44730A slot number)

9. Setup the HP 44702A/B High Speed Voltmeter to scan the HP 44730A accessory and to take two readings with a 100 mS delay by executing:

   USE ES00 (where E = extender number, S = HP 44702A/B slot number)
   SCANMODE ON
   CONF DCV
   PRESCAN 2
   SPER 0.1

10. Set channel 0 to be scanned by executing:

    CLWRITE ES00 (where E = extender number, S = HP 44730A slot number)

11. Trigger the HP 44702A/B by executing:

    SCTRIG INT

12. The HP 44702A now takes the two readings. Transfer the readings into variable A by executing:

    XRDGS ES00 INTO A (where E = extender number, S = HP 44702A/B slot number)

13. Determine the first reading by executing:

VREAD A(0)

The first reading is displayed on the HP 3852A right display. Note this reading.

14. Determine the second reading by executing:

VREAD A(1)

The second reading is displayed next on the HP 3852A right display. Note this reading.

15. Calculate the droop using the A(0) and A(1) readings noted in steps 13 and 14 using this formula:

$$\frac{A(0) - A(1)}{0.100}$$

16. Make sure the droop is less than 0.5 (with an ambient temperature greater than or equal to 25°C).

17. Repeat steps 6, 7, 10, 11, 12, 13, 14, 15, and 16 for channels 1, 2, and 3. In the CLWRITE command in step 9 and the USE command in step 7, the last two digits indicate the channel number (e.g., USE ES02 is for channel 2).

18. Remove the dc voltage source from the HP 44730A accessory.

20-20 Peak Detection Test

This test verifies the operation of the Peak Detection circuitry for all channels.

1. Reset the HP 3852A and its accessories by pressing the RESET button on the HP 3852A front panel.

2. Setup a function generator for a 100 Hz 1 V peak-to-peak sine wave. If using the recommended function generator, set it up as follows:

Function -- Sine Wave
Frequency -- 100 Hz
Amplitude -- 1.0 V p-p
DC Offset -- 0 V

3. Refer to Figure 20-6. Connect the digital multimeter to the H and L CARD COM Output Connections. Connect the function generator to the HP 44730A's H and L Input Connections.

4. Define variable A and dimension the variable for 2000 readings by executing:

REAL MIN,MAX,MEAN,STDD
DIM A(1999)

5. Setup the HP 44730A accessory by executing:

FUNC AMPLIFY,1 USE ES00 (where = extender number, S = slot number)
AZERO ONCE USE ES00 (where E = extender number, S = slot number)

6. Setup the HP 44730A accessory for RIBBON trigger by executing:

   TRIG RIBBON, USE ES00 (where E = extender number, S = HP 44730A slot number)

7. Setup the HP 44702A/B High Speed Voltmeter to scan the HP 44730A accessory and take 2000 readings by executing:

   USE ES00 (where E = extender number, S = HP 44702A/B slot number)
   SCANMODE ON
   CONF DCV
   NRDGS 2000

8. Set channel 0 to be scanned by executing:

   CLWRITE ES00 (where E = extender number, S = HP 44730A slot number)

9. Trigger the HP 44702A/B by executing:

   SCTRIG INT

10. The HP 44702A now takes the 2000 readings. Transfer the readings into variable A by executing:

    XRDGS ES00 INTO A (where E = extender number, S = HP 44702A/B slot number)

11. Determine the highest and lowest readings in variable A by executing:

    STAT MIN,MAX,MEAN,STDD,A

12. Display the highest reading by executing:

    VREAD MAX

The highest reading is displayed on the HP 3852A right display. Note this reading.

13. Display the lowest reading by executing:

    VREAD MIN

The lowest reading is displayed next on the HP 3852A right display. Note this reading.

14. Setup channel 0 of the HP 44730A for positive peak detection by executing:

    FUNC POSPEAK, 1 USE ES00 (where E = extender number, S = slot number)
    AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

15. Close channel 0 by executing:

    CLOSE ES00 (where E = extender number, S = slot number)

16. The digital multimeter reading should be the high reading in step 12 ± 0.02005 V.

17. Setup channel 0 of the HP 44730A for negative peak detection by executing:

FUNC NEGPEAK, 1 USE ES00 (where E = extender number, S = slot number)
AZERO ONCE, USE ES00 (where E = extender number, S = slot number)

18. The digital multimeter reading should be the low reading in step 13 ±0.02005 V.

19. Repeat steps 4 and 5, and 8 through 18 for channels 1, 2, and 3. In the USE, CLWRITE, and CLOSE commands in steps 5, 8, 14, 15, and 17, the last two digits are the channels numbers (e.g., USE ES02 for channel 2).

20. Remove the digital multimeter and function generator from the accessory.

20-21 CALIBRATION

20-22 Introduction

The calibration procedure in this section calibrates the accessory's input amplifiers of all channels.

The HP 44730A is calibrated programatically; no external adjustments are performed. Calibration is performed as follows:

1. A known calibration signal is applied to the HP 44730A's CAL inputs.

2. The channel's gain is set to its lowest calibration value by using FUNC CALLO command.

3. This voltage is read by the digital multimeter connected to the CARD COM output terminals.

4. The channel's gain is set to its highest calibration value by using FUNC CALHI command.

5. This voltage is read by the digital multimeter connected to the CARD COM output terminals.

6. Using the values in steps 1, 3, and 5, the accessory is then calibrated.

20-23 Calibration Cycle

Periodic calibration should be performed to ensure that the accessory is meeting its accuracy specifications. The accessory should be calibrated every 90 days. Calibration should also be performed if determined by the Performance Test procedures that calibration is needed.

20-24 Calibration Environment

The HP 44730A accessory may be calibrated in a "bench" environment or system cabinet. For best accuracy, the temperature of the calibration environment should be within ±5° C of the actual operating environment. The HP 44730A was calibrated at the factory at an environment temperature of 23° C.

20-25 Equipment Required

The following test equipment is required to calibrate the HP 44730A.

1. Test leads.

2. Digital Multimeter -- HP Model 3456A.

3. Stable DC Voltage Source -- Any stable dc voltage source that can output 0.1 V, 1.0 V, and 10 V.

In the following calibration procedures, the dc voltages applied to the HP 44730A must be accurate and stable. Good accuracy and stability are needed to meet the accessory's accuracy requirements.

With the above in mind, there are two ways of performing the calibration procedures.

a. Use the recommended digital multimeter to adjust the dc voltage source output to the correct accessory input. Do this by connecting the dc voltage source to the digital multimeter and then adjust the voltage source to the appropriate accessory input voltage. Use the reading on the digital multimeter to adjust for the correct voltage. Then connect the dc voltage source to the accessory for calibration.

The calibration procedures are written using the above procedure. If you plan to use this procedure, keep the following in mind.

The dc voltage source must have good short term stability. This is needed since it takes time to manually perform the calibratopn procedures. Any drift in the dc source may make calibration invalid.

The dc source must be adjustable so you can adjust it to the correct input voltage, as read on the digital multimeter.

b. Use an accurate and stable dc voltage standard, like the Datron Model 4000/4000A. You can directly connect one of these standards to the HP 44730A input without adjusting the standard's output voltage on the digital multimeter. It has sufficient accuracy and short term stability to calibrate the HP 44730A.

NOTE

The integrating plug-in voltmeter (HP 44701A) may be used for the Calibration Procedure. The procedure does not describe specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

20-26 Calibration Procedure

20-27 Set-Up Procedure

1. Apply power to the HP 3852A and allow the HP 44730A accessory a 15 minute warm-up period inside the mainframe.

2. Press the RESET button on the HP 3852A front panel. Perform the HP 44730A self-test by executing:

   TEST ES00 (where E = extender number, S = slot number)

3. The HP 3852A right display should show:

   SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44730A accessory may be failing its self-test. Test the accessory again by executing the command in step 1. If the accessory still fails, exchange it with a working one.

20-28 DCV Calibration

All gains of each channel will be calibrated individually.

1. Set the digital multimeter to dc volts and autorange. Then connect it to the dc voltage source.

2. Set the dc voltage source for a 9.0 V to 10.0 V output, as shown on the digital multimeter. Note this reading. This is the *true* reading.

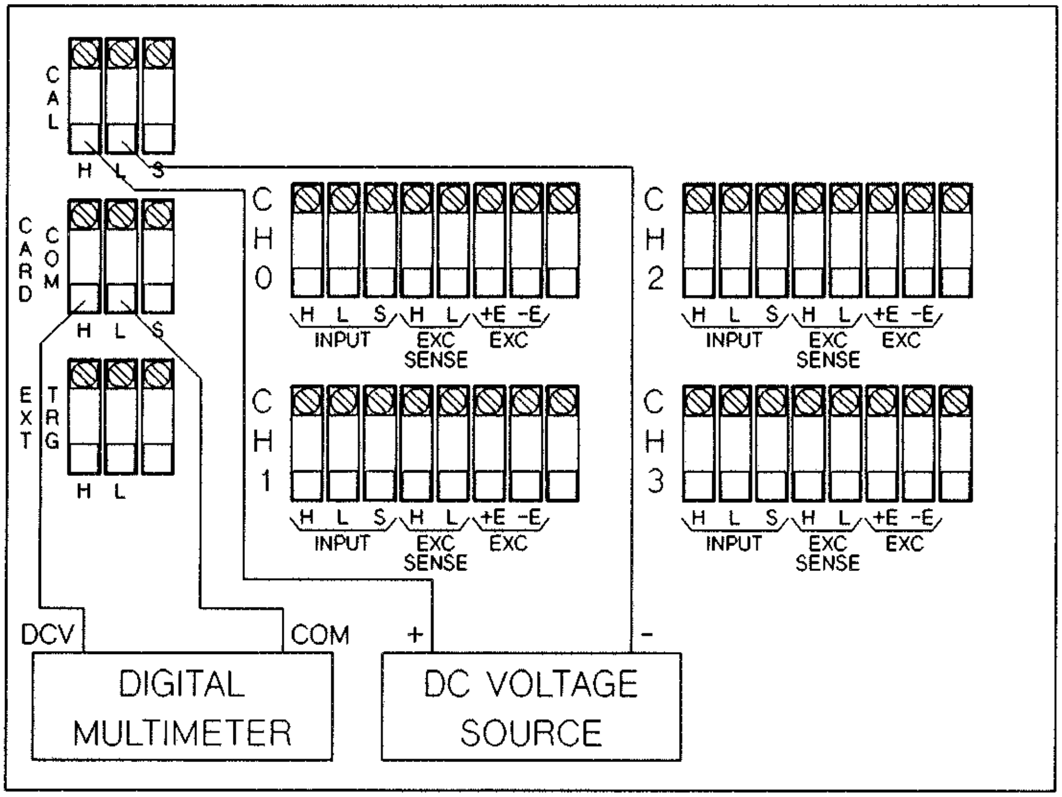


Figure 20-7 Calibration Connections

3. Refer to Figure 20-7. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L CAL Terminals.

4. Perform the channel 0 offset calibration by executing:

```
USE ES00   (where E = extender number, S = slot number)
FUNC AMPLIFY, 1
CAL 0
```

5. Make a "low" measurement by executing:

```
FUNC CALLO, 1
```

6. Note the reading on the digital multimeter. This is the *low* reading.

7. Make a "high" measurement by executing:

```
FUNC CALHI, 1
```

8. Note the reading on the digital multimeter. This is the *high* reading.

9. Using the values of the *true*, *low*, and *high* readings noted in steps 2, 6, and 8, respectively, calibrate the HP 44730A gain by executing:

CAL *true*, LO *low*, HI *high*

10. Repeat steps 4, 5, 6, 7, 8, and 9 for channels 1, 2, and 3. In the USE command in step 4, the last two digits are the channel number (e.g., ES02 for channel 2).

11. Connect the digital multimeter to the dc voltage source.

12. Set the dc voltage source for a 0.9 V to 1.0 V output, as shown on the digital multimeter. Note this reading. This is the *true* reading.

13. Refer to Figure 20-7. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L CAL Terminals.

14. Set channel 0 to a gain of "10" and perform an offset calibration by executing:

USE ES00 (where E = extender number, S = slot number)
FUNC AMPLIFY, 10
CAL 0

15. Make a "low" measurement by executing:

FUNC CALLO

16. Note the reading on the digital multimeter. This is the *low* reading.

17. Make a "high" measurement by executing:

FUNC CALHI

18. Note the reading on the digital multimeter. This is the *high* reading.

19. Using the values of the *true*, *low*, and *high* readings noted in steps 12, 16, and 18, respectively, calibrate the HP 44730A gain by executing:

CAL *true*, LO *low*, HI *high*

20. Repeat steps 14, 15, 16, 17, 18, and 19 for channels 1, 2, and 3. In the USE command in step 14, the last two digits are the channel number (e.g., ES02 for channel 2).

21. Connect the digital multimeter to the dc voltage source.

22. Set the dc voltage source for a 0.09 V to 0.1 V output, as shown on the digital multimeter. Note this reading. This is the *true* reading.

23. Refer to Figure 20-7. Connect the digital multimeter to the CARD COM H and L output terminals on the test fixure. Connect the dc voltage source to the H and L CAL Terminals.

24. Set channel 0 to a gain of "100" and perform an offset calibration by executing:

USE ES00 (where E = extender number, S = slot number)
FUNC AMPLIFY, 100
CAL 0

25. Make a "low" measurement by executing:

FUNC CALLO

26. Note the reading on the digital multimeter. This is the *low* reading.

27. Make a "high" measurement by executing:

FUNC CALHI

28. Note the reading on the digital multimeter. This is the *high* reading.

29. Using the values of the *true*, *low*, and *high* readings noted in steps 12, 16, and 18, respectively, calibrate the HP 44730A gain by executing:

CAL *true*, LO *low*, HI *high*

30. Repeat steps 24, 25, 26, 27, 28, and 29 for channels 1, 2, and 3. In the USE command in step 24, the last two digits are the channel number (e.g., ES02 for channel 2).

31. Remove the digital multimeter and dc voltage source from the accessory.

20-29 REPLACEABLE PARTS

Figure 20-8 shows the mechanical breakdown of the HP 44730A. The figure also provides assembly and disassembly information. The parts shown in Figure 20-8 are keyed to the parts list in Table 20-3.

To order a part listed in Table 20-3, quote the Hewlett-Packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 20-3). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

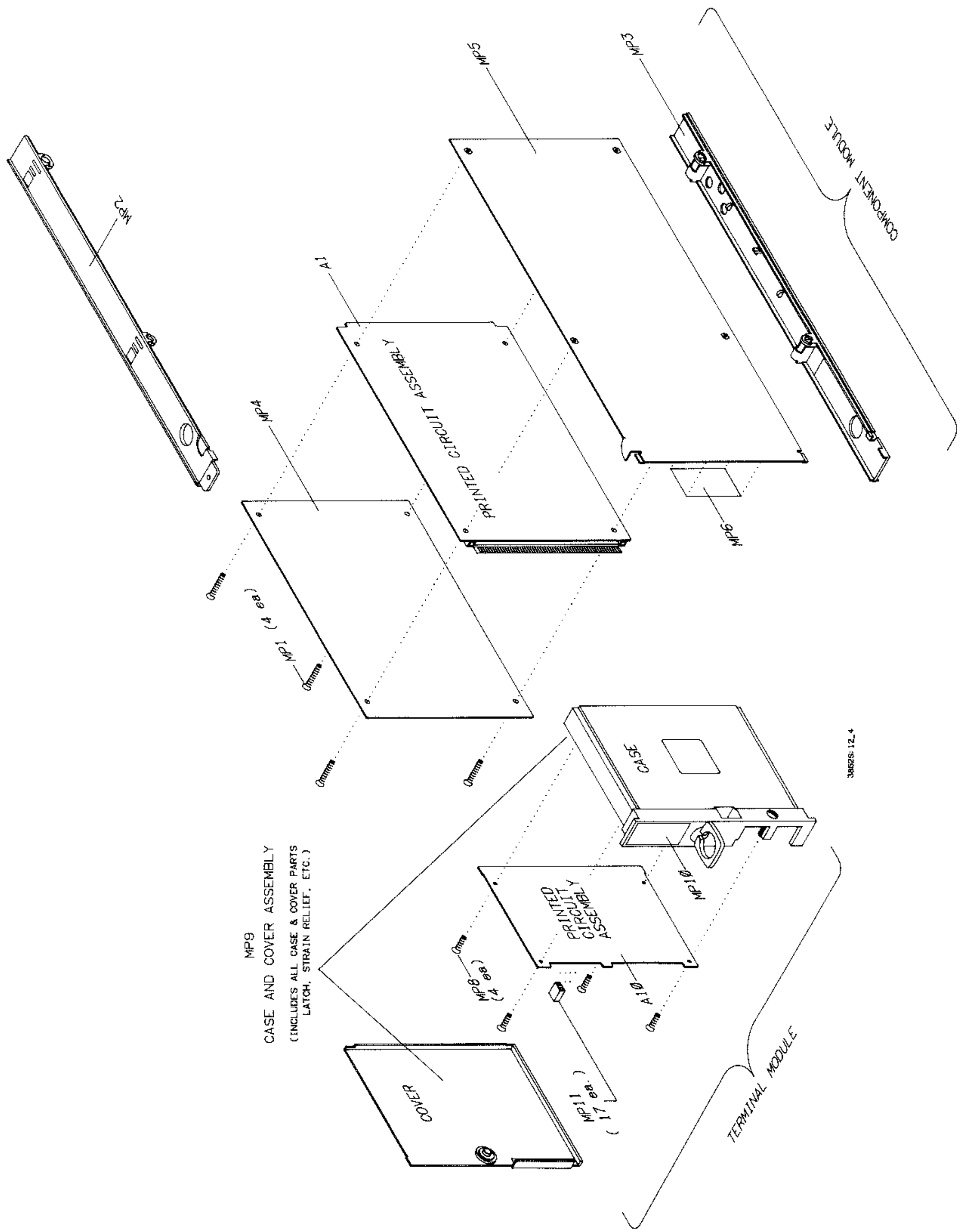


Figure 20-8 HP 44730A Exploded View

Table 20-3a HP 44730A 4 Channel Track/Hold with Signal Conditioning

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44730A	Module; 4 chan. sig. cond. component	1	44730-66201	2	MOD-SMPLE/HLD SIG
A1	PCA; 4 channel sig. cond. component	1	44730-66501	5	PCA-SIG COND
A10	PCA; 4 channel sig. cond. terminal	1	44730-66510	6	PCA-TERM CD
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44730A component module	1	44730-84320	4	LBL-I/O SIG COND
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44730A	1	44730-84325	9	LBL-ID,SIG COND

Completely assembled HP 44730A terminal modules can be ordered from your local HP Office by ordering Number 44730AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details, see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44730A	Module; 4 chan. sig. cond. component		44730-69201	8	RBLT-44730-66201

Table 20-3b HP 44732A 4 Bridge 120 ohm Strain Gage Track/Hold

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44730A	Module; 4 chan. sig. cond. component	1	44730-66201	2	MOD-SMPLE/HLD SIG
A1	PCA; 4 channel sig. cond. component	1	44730-66501	5	PCA-SIG COND
A10	PCA; 4 channel 120 ohm str. gage term	1	44732-66510	6	PCA-TERM CD
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44730A component module	1	44730-84320	4	LBL-I/O SIG COND
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44732A	1	44730-84325	9	LBL-ID,SIG COND

Completely assembled HP 44732A terminal modules can be ordered from your local HP Office by ordering Number 44732AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details, see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44730A	Module; 4 chan. sig. cond. component		44730-69201	8	RBLT-44730-66201

Table 20-3c HP 44733A 4 Bridge 350 ohm Strain Gage Track/Hold

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44730A	Module; 4 chan. sig. cond. component	1	44730-66201	2	MOD-SMPLE/HLD SIG
A1	PCA; 4 channel sig. cond. component	1	44730-66501	5	PCA-SIG COND
A10	PCA; 4 channel 350 ohm str. gage term	1	44733-66510	8	PCA-TERM CD
MP1	Screw; cover	4	0515-1322	4	SCR-FH M3.0X30LK
MP2	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP3	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP4	Cover; left (aluminum)	1	03852-04101	2	0601 CVR-ACC LT
MP5	Cover; right (aluminum)	1	03852-04102	3	0601 CVR-ACC RT
MP6	Label; 44730A component module	1	44730-84320	4	LBL-I/O SIG COND
MP7	(NOT USED)				
MP8	Screw; A10 PCA	4	0515-0886	3	SCR-PH M3.0X6 LK
MP9	Term box; case,cover,latch & str rlf	1	03852-84410	4	ASSY-TERM,LG OPN
MP10	Label; rear panel of term mod 44733A	1	44730-84325	9	LBL-ID,SIG COND

Completely assembled HP 44733A terminal modules can be ordered from your local HP Office by ordering Number 44733AT.

"447xx-662xx" and "447xx-692xx" part numbers are replacement components only and do not include a terminal module.

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange Program. For details, see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44730A	Module; 4 chan. sig. cond. component		44730-69201	8	RBLT-44730-66201

Chapter 11
HP 8770A
Arbitrary Waveform

CHAPTER 21

HP 44726A 2 CHANNEL ARBITRARY WAVEFORM DAC

CHAPTER 21
HP 44726A
2 CHANNEL ARBITRARY WAVEFORM DAC

21-1 INTRODUCTION

This chapter provides a technical description, performance test procedures, calibration procedures, and a replaceable parts list for the HP 44726A 2 Channel Arbitrary Waveform DAC Accessory (also called the Arbitrary Waveform DAC Accessory).

NOTE

The Arbitrary Waveform DAC Accessory can only be used with instruments having a firmware revision of 3.5 or above. Determine the firmware revision by sending the mainframe command: **IDN?**.

21-2 HP 44726A Technical Description

The HP 44726A Arbitrary Waveform DAC Accessory is used to generate and output arbitrary waveforms that are generated from user supplied data. The data can be a maximum of 32,400 points on a waveform. The channels can be programmed for one cycle or for a continuous output.

The waveforms are generated using voltage outputs from a 16 bit digital-to-analog converter. The maximum specified voltage output of the converter is ±10.235 V with .3125 mV resolution. By specifying the different voltages (i.e., the points on the waveform) and the time the voltages are output, almost any type waveform is possible. These include sine waves, square waves, ramps, pulses, etc.

The accessory can also store data to generate single or multiple waveforms. A maximum of 32,400 data points can be stored. This data is lost whenever the mainframe is turned off or reset, the accessory is reset, or a self-test is performed on the accessory.

Refer to Figure 21-1. Since both channels of the HP 44726A accessory are the same, the figure shows one channel. The HP 44726A accessory has 2 channels with each channel having DAC OUT, SYNC OUT, and EXT IN connectors. The waveforms are output by the DAC OUT connector, the sync signals are output by the SYNC OUT connector, and the external trigger signal are input to the EXT IN connector. The connectors are all BNC that are referenced to chassis ground.

Each channel of the HP 44726A has two main circuits. One circuit consists of analog circuitry and the other of digital circuitry. The analog circuitry includes the digital-to-analog converter (DAC), a filter, and output buffers. The digital circuitry controls the DAC outputs, stores user entered data to generate waveforms, generates the clock signal to output the waveforms, and interfaces with the mainframe.

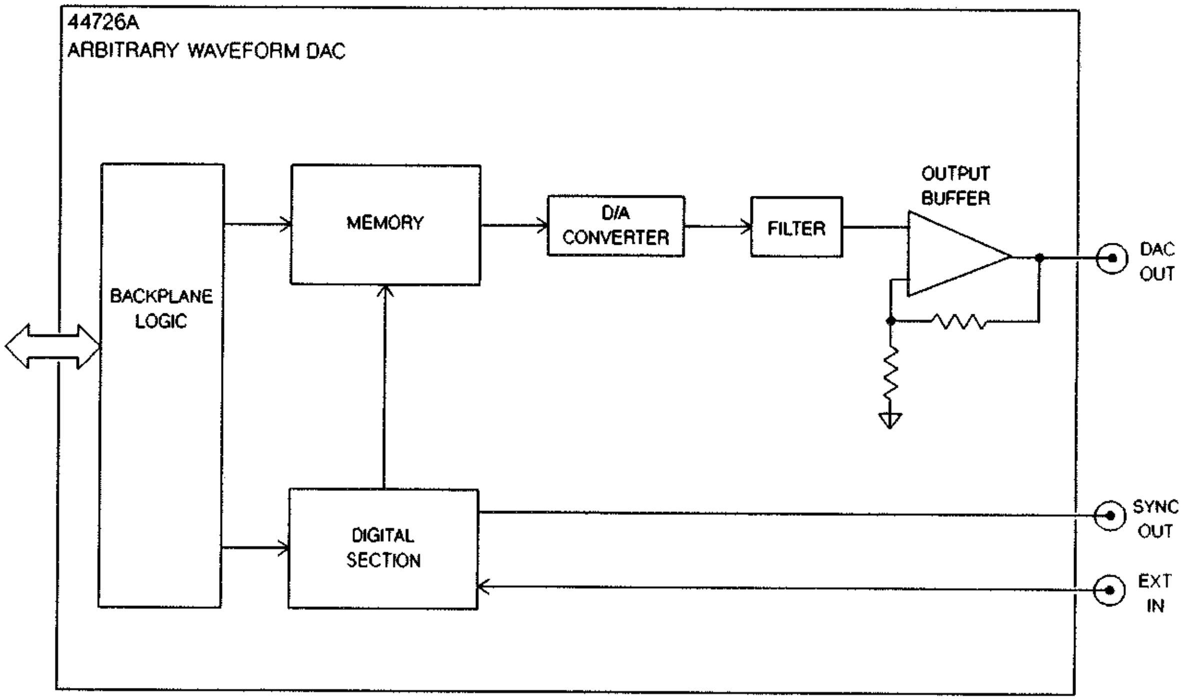


Figure 21-1 HP 44730A Simplified Block Diagram

The data that generates the waveforms comes from the mainframe via the backplane logic. This data is stored into memory which in turn outputs the data to the DAC to generate the actual waveform.

The digital section controls the timing of the waveform using internally and externally (i.e., EXT IN) applied trigger signals. It also generates the different sync signals.

21-3 SPECIFICATIONS

Specifications for the HP 44726A are given in Table 21-1. specifications are the performance standards or limits against which the accessory may be tested.

Table 21-1 HP 44726A Specifications

Maximum Step Rate: 800 kHz

Settling Time (resistive load):

8 µS (12 bits- 5 mV). Typically 10 µS (14 bits - 1.25 mV)

Range: ±10.235 V

Resolution: 15 bits plus sign, 0.3215 mV (Uses a 16-bit DAC that is monotonic to 14 bits - 1.25 mV)

Memory (per channel):

Points: 32,400
Maximum # of waveforms: 64 (Up to a total of 32,400 points)

DC Accuracy:

90 days - using a resistive load after a one-hour warm-up (18° to 28° C): 0.026% %3.6 mV
Outside of 18° to 28° C but between 0 to 18° C or 28° to 55° C, add the following accuracy error: (.0017% ±0.21 mV)/C

Max Output Current: 5 mA

Programmable Time Base:

Range: 1.25 µS to 16.384 mS
Resolution: 0.25 µS
Accuracy: 0.01%

Trigger Characteristics:

Trigger inputs are TTL compatible and require pulse widths of >0.4 µS.

The Sync Outputs can drive CMOS/HCMOS, one TTL load, or two LSTTL loads.

Relative Power Consumption: 2.0 using power supplies with HP part number 03852-66202.

21-4 PERFORMANCE TESTS

21-5 Introduction

The following Performance Tests check the operation of the HP 44726A. Successful completion of the tests in this chapter provides a high confidence level that the Arbitrary Waveform DAC Accessory is meeting its listed specifications.

The performance tests should be performed in the order they are presented. The completion of each test increases the confidence level in the accessory. A minimum set of tests is given as the Operational Verification Tests. These tests are described in Section 21-6.

The Operational Verification Tests yield a 90% confidence level that the accessory is operating normally. These tests are very extensive and, in most instances, will be more than sufficient. The two additional tests included in the Performance Tests should only be performed if the monotonicity and/or dc accuracy under full load specifications are in question.

21-6 Operational Verification

The first tests in this section are the minimum set of tests recommended for the HP 44726A accessory. These tests are designed to test the functionality of the accessory. Successful completion of the Operational Verification Tests provide a 90% confidence level that the accessory is operating normally and is within specifications.

The Operational Verification Tests consist of the following:

Section 21-9 - Set-Up Procedure
Section 21-10 - Self-Test
Section 21-11 - SYNC Output and TRIG Input Functionality Tests
Section 21-12 - DC Volts Accuracy Test

21-7 Equipment Required

The following test equipment is required to run the Performance Tests. Only the first three items are required for the Operational Verification Tests.

1. Test Leads and Jumpers (includes a BNC-to-Banana and BNC-to-cliplead cables).

2. Digital Multimeter -- HP 3456A or equivalent.

3. Oscilloscope -- HP 1740A or equivalent (dual trace with 1µS resolution).

4. Resistor -- 2.1 kohm, .5 W, ±5%.

NOTE

The integrating voltmeter (HP 44701A) may be used for the Performance Test Procedures. The procedures do not describe specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

21-8 Test Procedure

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

21-9 Set-Up Procedure

1. Remove power from the HP 3852A.

2. Note the slot number where the accessory under test is installed.

3. Verify the correct slot number:

   a. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence. Verify that the READY annunciator is on and the ERR annunciator is off.

   b. Execute:

      ID? ES00 (where E = extender number, S = slot number)

   c. Verify that the HP 3852A right display shows:

      44726A

NOTE

If the HP 3852A right display shows a different number, the slot number used may not be correct.

21-10 Self-Test

This test checks most of the accessory's digital circuitry.

CAUTION

Executing the self-test will destroy all waveform data loaded into memory.

1. Perform the HP 44726A self-test by executing:

   TEST ES00 (where E = extender number, S = slot number)

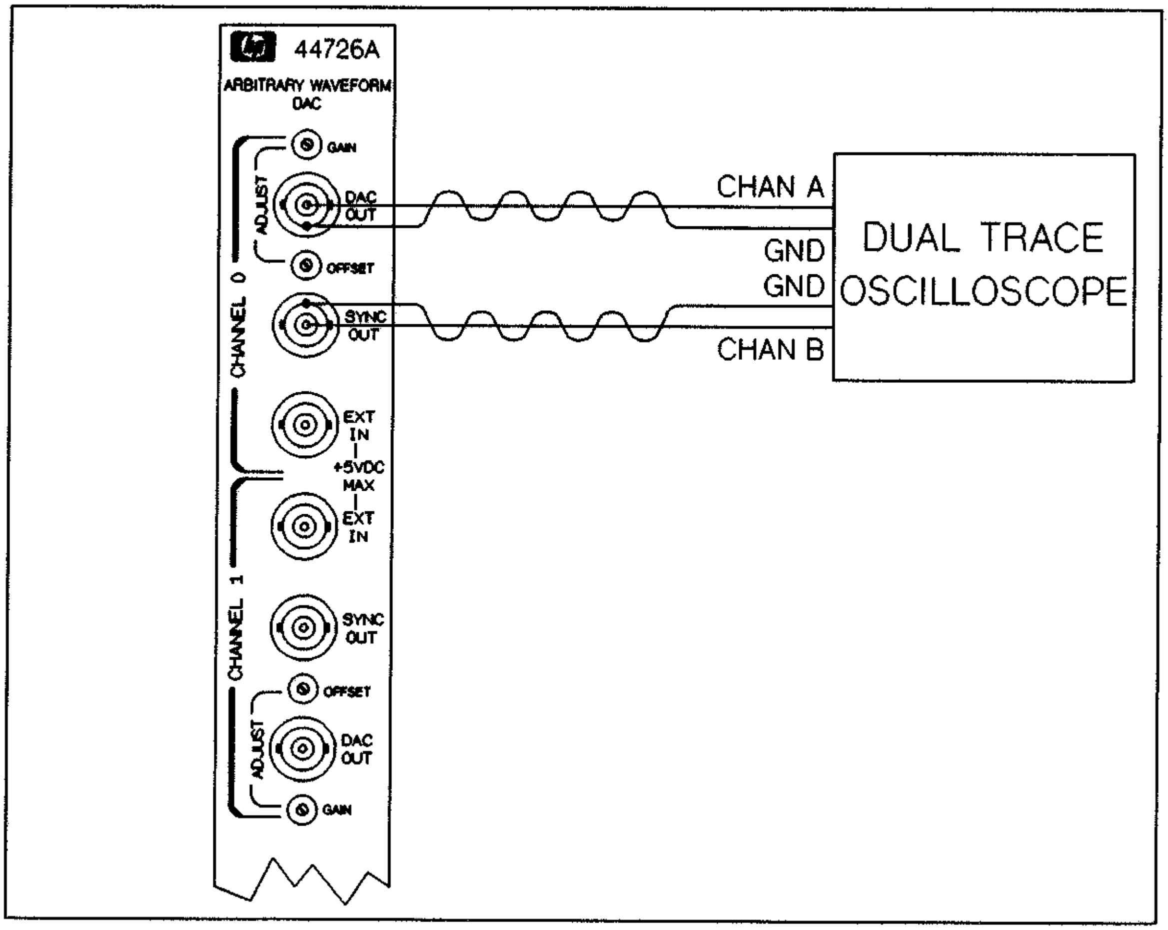


Figure 21-2 Channel 0 Sync Output Test Setup

2. The HP 3852A right display should show:

   SELF TEST OK

If the display shows a different message, or if the ERR annunciator is on, the HP 44726A accessory may be failing its self-test. Test the accessory again by executing the command in step 1. If the accessory still fails, exchange it with a working one.

21-11 SYNC Output and TRIG Input Functionality Tests

This test verifies that the accessory can output all the correct sync signals and that it can accept an external trigger input.

1. CHANNEL 0 SYNC OUTPUT TEST. This test verifies that channel 0 can output all sync signals.

2. Set the HP 44726A to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

3. Refer to Figure 21-2. Connect channel A of the oscilloscope to the accessory's DAC OUT connector on channel 0. Connect channel B of the oscilloscope to the accessory's SYNC OUT connector on channel 0.

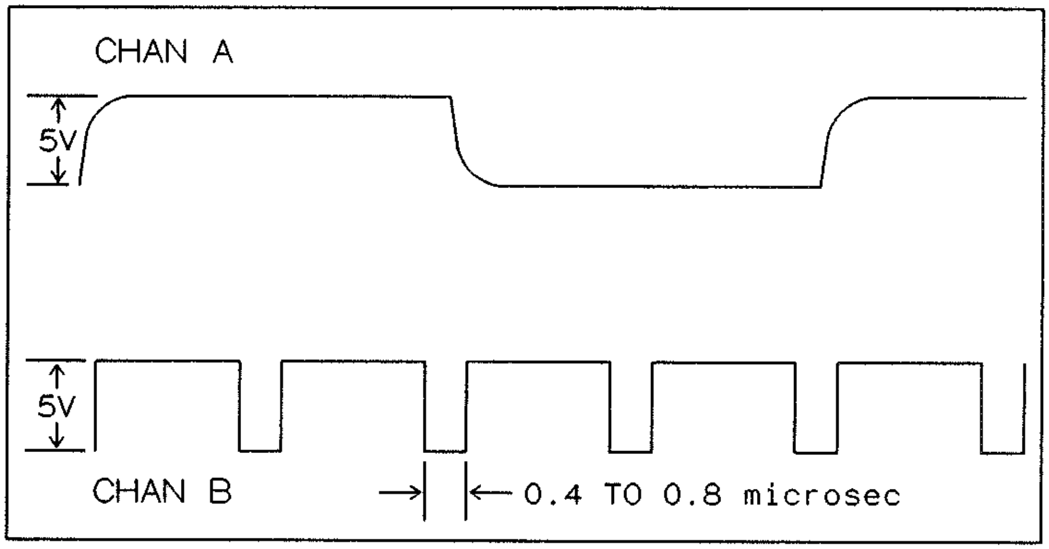


Figure 21-3 SYNC TRIG Waveforms

4. Setup the oscilloscope as follows:

   Dual Trace
   Channel A -- DC, 0.5 Volts/Div (if using 10:1 probes)
   Channel B -- DC, 0.5 Volts/Div (if using 10:1 probes)
   Trigger -- Internal
   Trig Comp -- Channel A
   Vertical Display -- Alternate
   Time -- 1 µS/Div

5. Output a 5 V peak-to-peak, 8 µS square wave from channel 0 of the accessory by executing:

   USE ES00 (where E = extender number, S = slot number)
   WFWRITE SQV, 1, 5, TBASE 2E-6
   APPLY WFV, ES00, 1 (where E = extender number, S = slot number)
   TRIG INT
   TARM AUTO
   SYNC TRIG

6. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-3. The sync pulse shown on channel B of the oscilloscope is between 0.4 µS and 0.8 µS.

7. Setup channel 0 for SYNC WF by executing:

   SYNC WF

8. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-4. The sync pulse on channel B of the oscilloscope should go low approximately 4 µS before the output pulse goes high.

9. Setup channel 0 for SYNC DAC by executing:

   SYNC DAC

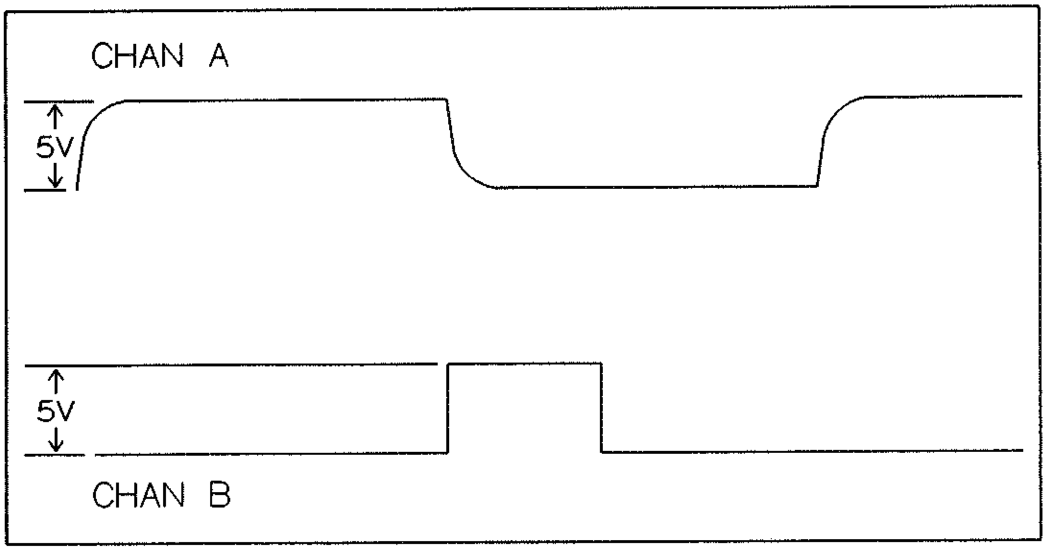


Figure 21-4 SYNC WF Waveforms

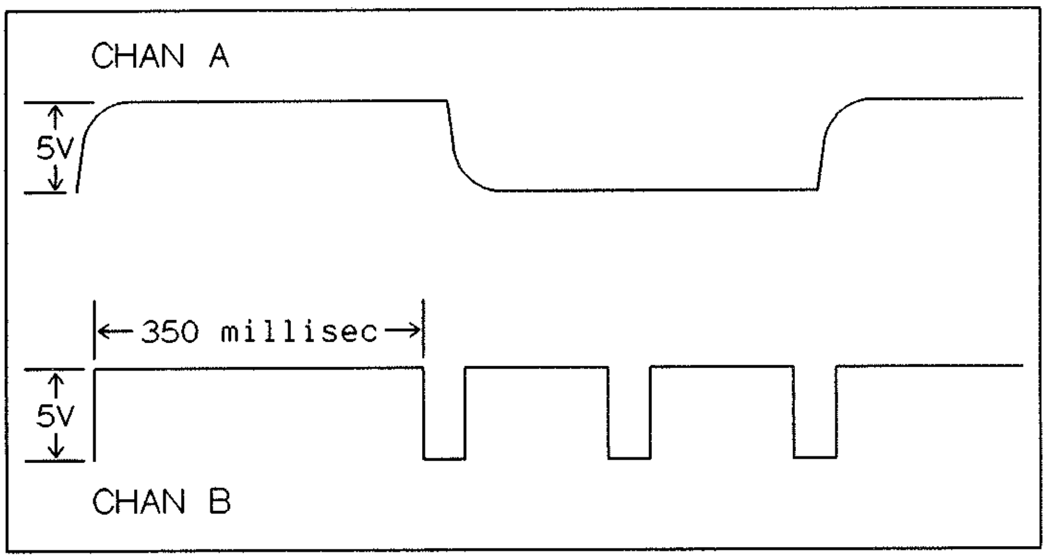


Figure 21-5 SYNC DAC Waveforms

10. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-5. The sync pulse on channel B of the oscilloscope should consist of three pulses for every output pulse. The uneven spaced pulses should be approximately 350 nS wide.

11. Setup channel 0 for SYNC HOLD by executing:

    SYNC HOLD

12. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-6. Channel B of the oscilloscope should display a constant +5 V level.

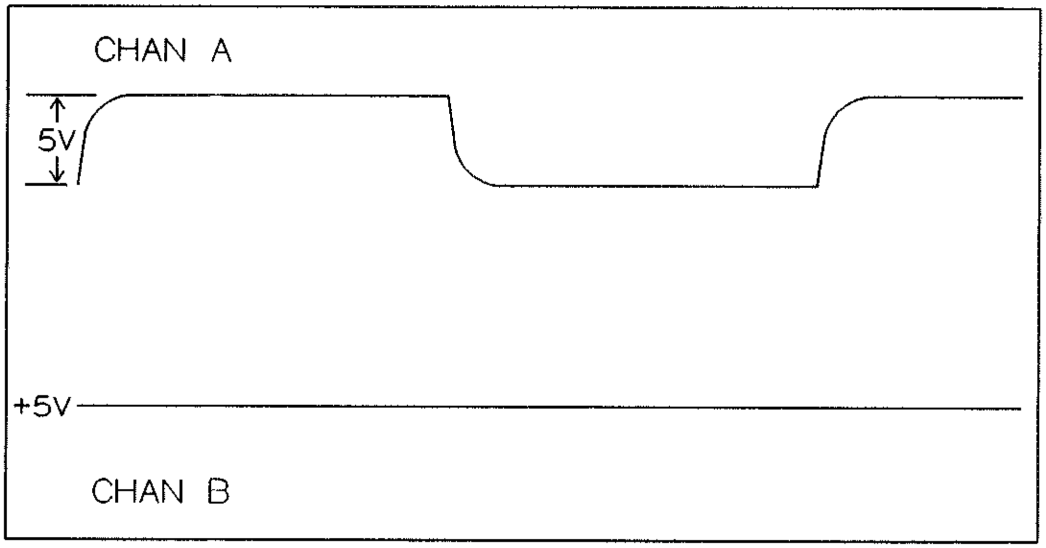


Figure 21-6 SYNC HOLD Waveforms

13. CHANNEL 0 TRIG INPUT TEST. This test verifies that channel 0 can execute an external trigger input.

14. Refer to Figure 21-7. Connect channel A of the oscilloscope to the accessory's DAC OUT connector on channel 0. Connect channel B of the oscilloscope to the accessory's EXT IN connector on channel 0. Also connect the accessory's DAC OUT connector on channel 1 to the EXT IN connector on channel 0.

15. Set channel 0 of the accessory for external trigger by executing:

```
TRIG EXT
```

16. Output a 5 V peak-to-peak, 8 µS square wave from channel 1 of the accessory by executing:

```
WFWRITE SQV, 1, 5, TBASE 2E-6, USE ES01
APPLY WFV ES01, 1   (where E = extender number, S = slot number)
TARM AUTO, USE ES01
SYNC WF, USE ES01
```

Note: In the USE commands above, E = extender number, S = slot number.

17. Change the oscilloscope Time setting to 2 µS/Div. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-8.

18. Change the oscilloscope Time setting back to 1 µS/Div. Remove the oscilloscope from the HP 44726A accessory. Also remove the connection between DAC OUT of channel 1 and EXT IN of channel 0.

19. CHANNEL 1 SYNC OUTPUT TEST. This test verifies that channel 1 can output all sync signals.

20. Set the HP 44726A to a known state by executing:

```
RESET ES00   (where E = extender number, S = slot number)
```

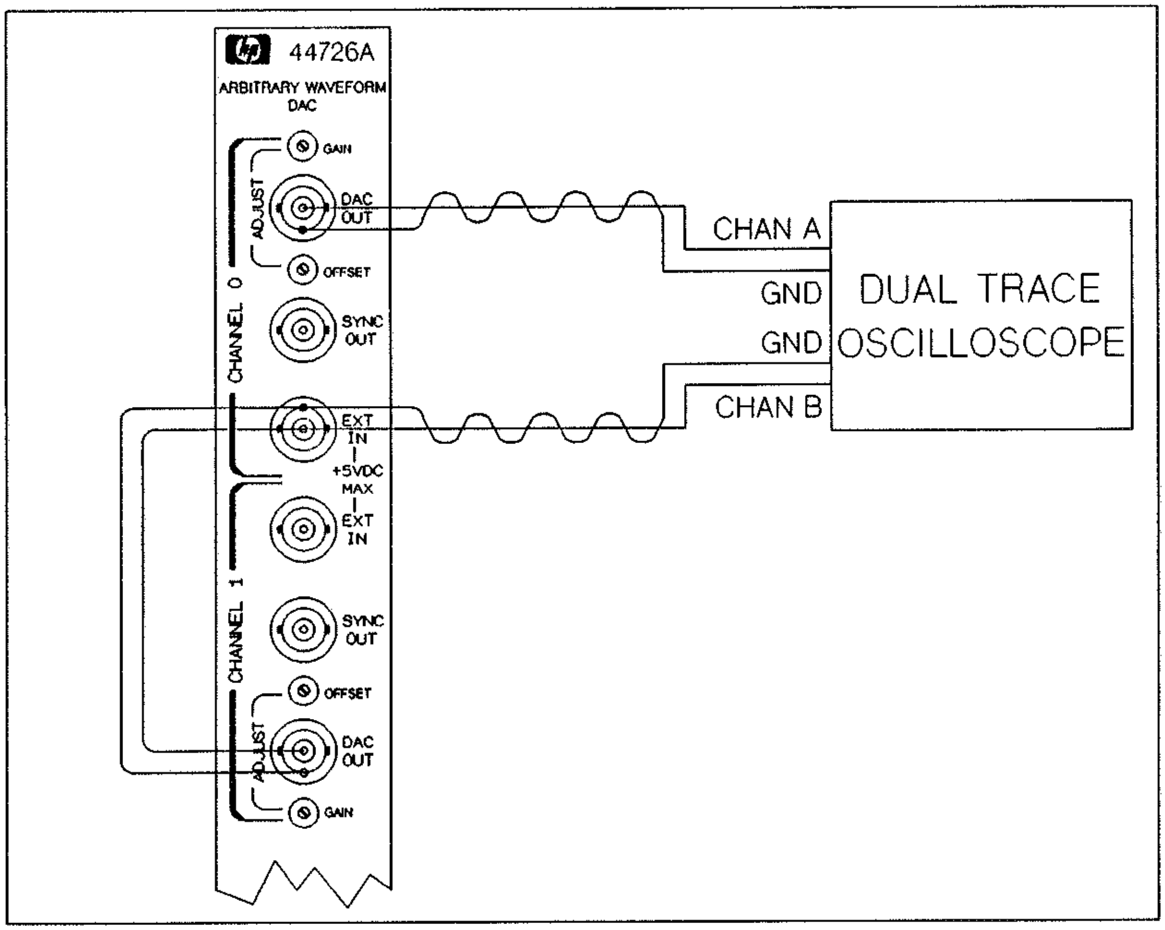


Figure 21-7 Channel 0 Trig Input Test Setup

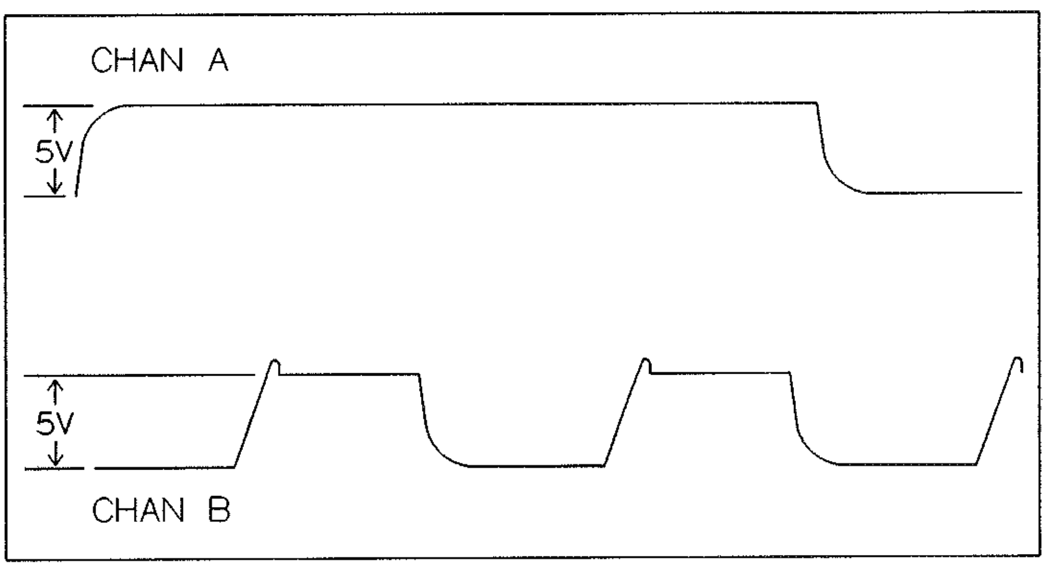


Figure 21-8 Trigger Input Test Waveforms

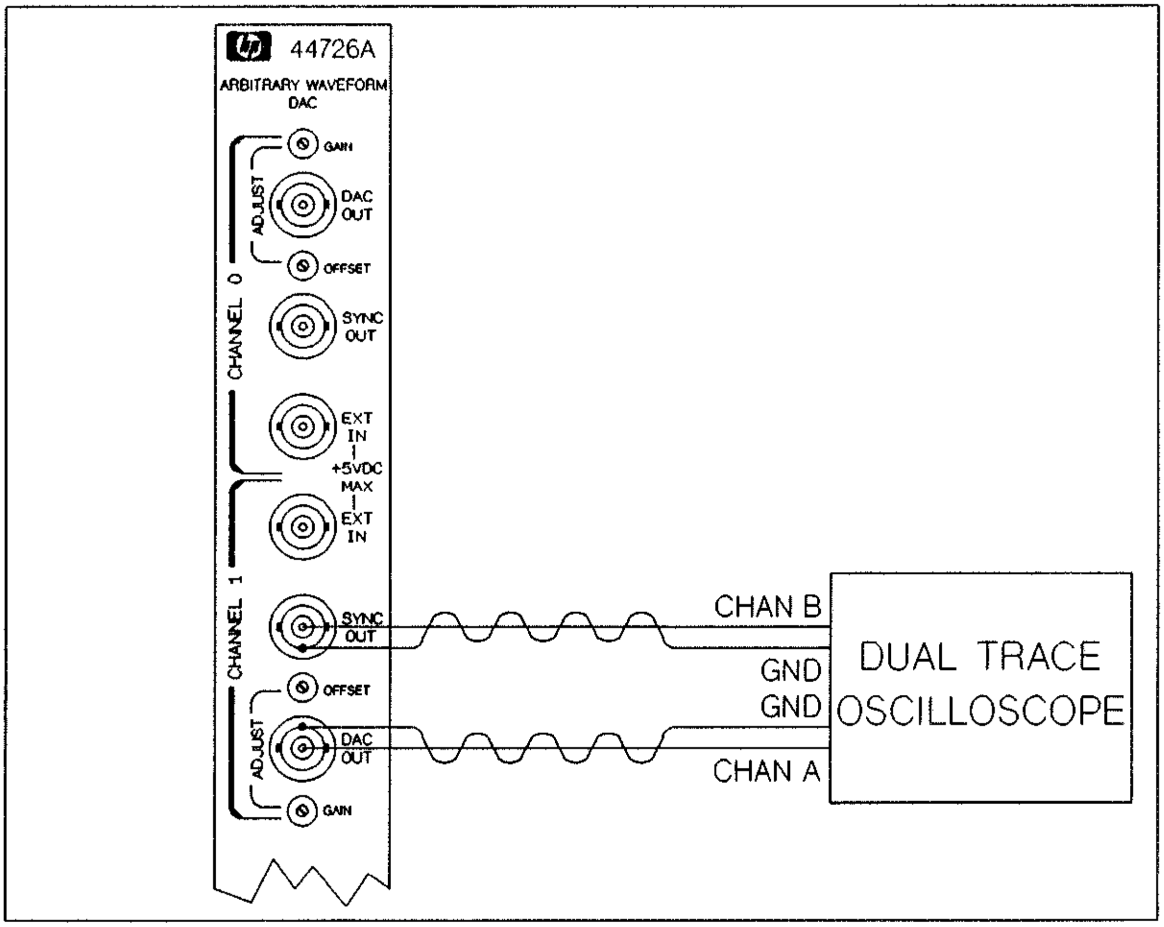


Figure 21-9 Channel 1 Sync Output Test Setup

21. Refer to Figure 21-9. Connect channel A of the oscilloscope to the accessory's DAC OUT connector on channel 1. Connect channel B of the oscilloscope to the accessory's SYNC OUT connector on channel 1.

22. Output a 5 V peak-to-peak, 8 µS square wave from channel 1 of the accessory by executing:

```
USE ES01   (where E = extender number, S = slot number)
WFWRITE SQV, 1, 5, TBASE 2E-6
APPLY WFV, ES01, 1   (where E = extender number, S = slot number)
TRIG INT
TARM AUTO
SYNC TRIG
```

23. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-3. The sync pulse shown on channel B of the oscilloscope is between 0.4 µS and 0.8 µS.

24. Setup channel 1 for SYNC WF by executing:

```
SYNC WF
```

25. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-4. The sync pulse on channel B of the oscilloscope should go low before the output pulse goes high.

26. Setup channel 1 for SYNC DAC by executing:

SYNC DAC

27. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-5. The sync pulse on channel B of the oscilloscope should consist of three pulses for every output pulse. The uneven spaced pulses should be approximately 350 nS wide.

28. Setup channel 1 for SYNC HOLD by executing:

SYNC HOLD

29. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-6. channel B of the oscilloscope should display a constant high level (+5.0 V).

30. CHANNEL 1 TRIG INPUT TEST. This test verifies that channel 1 can execute an external trigger input.

31. Refer to Figure 21-10. Connect channel A of the oscilloscope to the accessory's DAC OUT connector on channel 1. Connect channel B of the oscilloscope to the accessory's EXT IN connector on channel 0. Also connect the accessory's DAC OUT connector on channel 0 to the EXT IN connector on channel 1.

32. Set channel 1 of the accessory for external trigger by executing:

TRIG EXT

33. Output a 5 V peak-to-peak, 8 μS square wave from channel 0 of the accessory by executing:

WFWRITE SQV, 1, 5, TBASE 2E-6, USE ES00
APPLY WFV ES00, 1 (where E = extender number, S = slot number)
TARM AUTO, USE ES00
SYNC WF, USE ES00

Note: In the USE commands above, E = extender number, S = slot number.

34. Change the oscilloscope Time setting to 2 μS/Div. Verify that the waveform displayed on the oscilloscope is as shown in Figure 21-8.

35. Remove the oscilloscope from the HP 44726A accessory. Also remove the connection between DAC OUT of channel 0 and EXT IN of channel 1.

21-12 DC Volts Accuracy Test

This test checks the dc offset voltage and full scale accuracy of both channels. A one hour warm-up of the accessory is required to perform the test. If any portion of the test fails, perform the calibration procedure in Section 21-15.

1. CHANNEL 0 DC VOLTS TEST. This test checks the offset and full scale accuracy of channel 0.

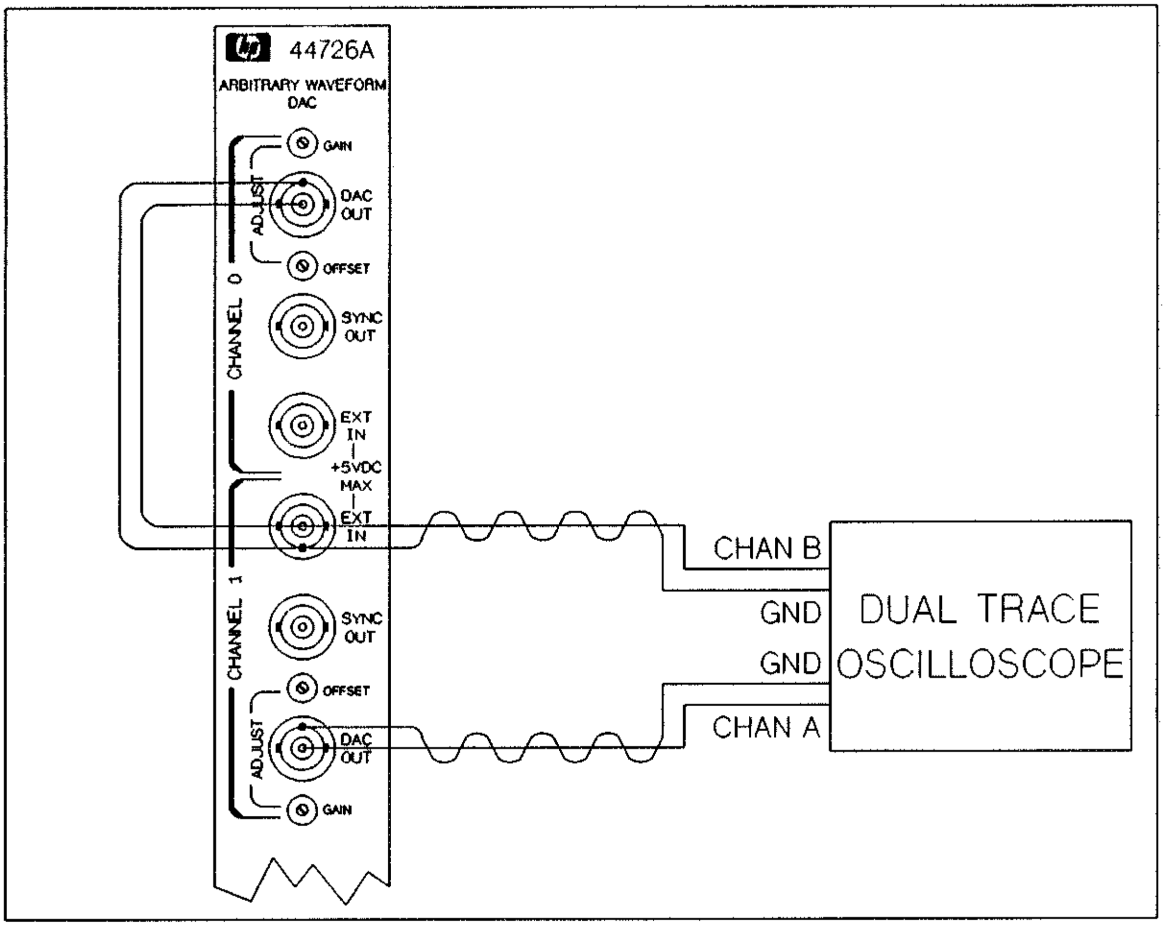


Figure 21-10 Channel 1 Trig Input Test Setup

2. Set the HP 44726A to a known state by executing:

   RESET ES00 (where E = extender number, S = slot number)

3. Set the digital multimeter for dc volts and autorange.

4. Refer to Figure 21-11. Connect the digital multimeter to the accessory's DAC OUT connector on channel 0.

5. Set channel 0 to output 0 V by executing:

   APPLY DCV ES00, 0 (where E = extender number, S = slot number)

6. Observe the reading on the digital multimeter. It should indicate 0 V ±3.6 mV.

7. Set channel 0 to output -10.235 V by executing:

   APPLY DCV ES00, -10.235 (where E = extender number, S = slot number)

8. Observe the reading on the digital multimeter. It should indicate between -10.2287 V and -10.2413 V.

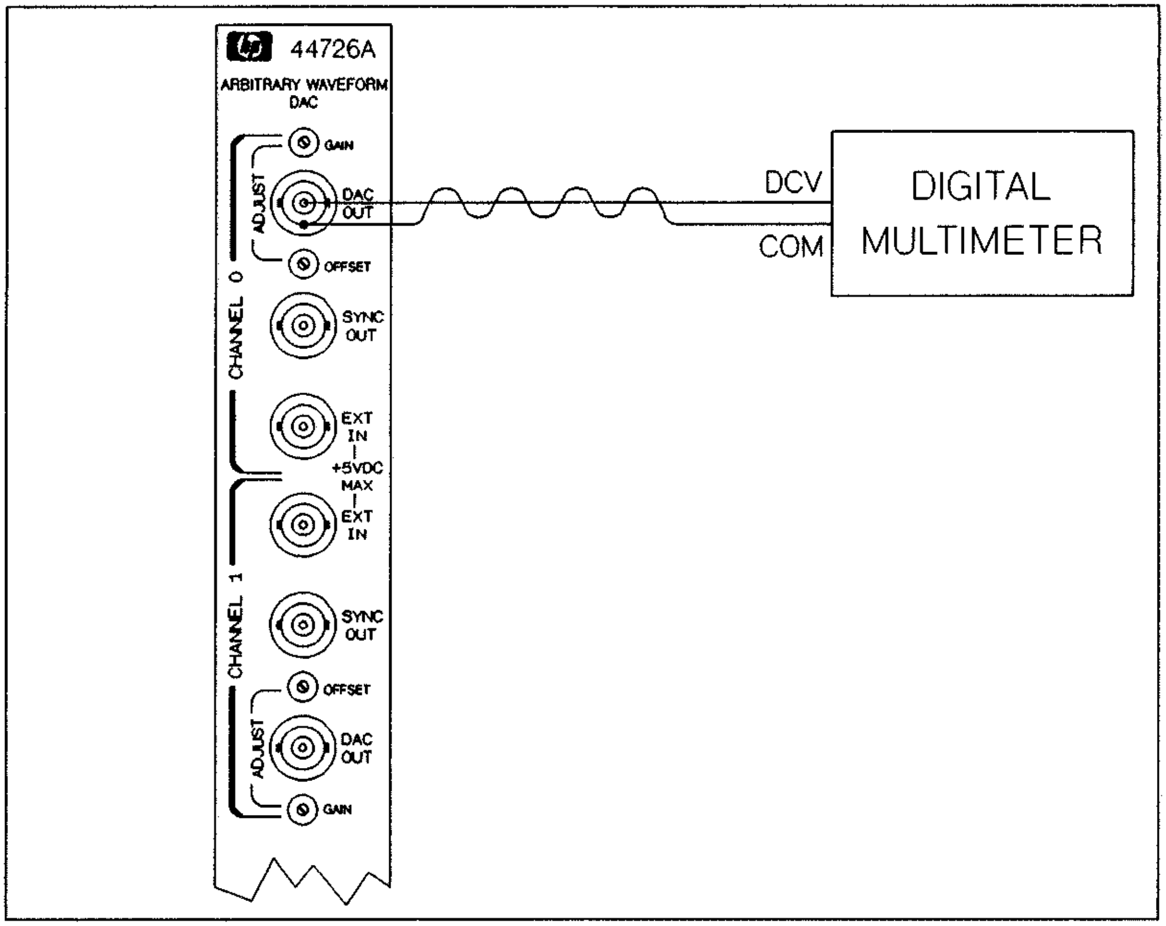


Figure 21-11 Channel 0 DC Volts Test Connection

9. Set channel 0 to output +10.235 V by executing:

    APPLY DCV ES00, 10.235 (where E = extender number, S = slot number)

10. Observe the reading on the digital multimeter. It should indicate between +10.2287 V and +10.2413 V.

11. CHANNEL 1 DC VOLTS TEST. This test checks the offset and full scale accuracy of channel 1.

12. Refer to Figure 21-12. Remove the digital multimeter from channel 0 and connect it to the accessory's DAC OUT connector on channel 1.

13. Set channel 1 to output 0 V by executing:

    APPLY DCV ES01, 0 (where E = extender number, S = slot number)

14. Observe the reading on the digital multimeter. It should indicate 0 V ±3.6 mV.

15. Set channel 1 to output -10.235 V by executing:

    APPLY DCV ES01, -10.235 (where E = extender number, S = slot number)

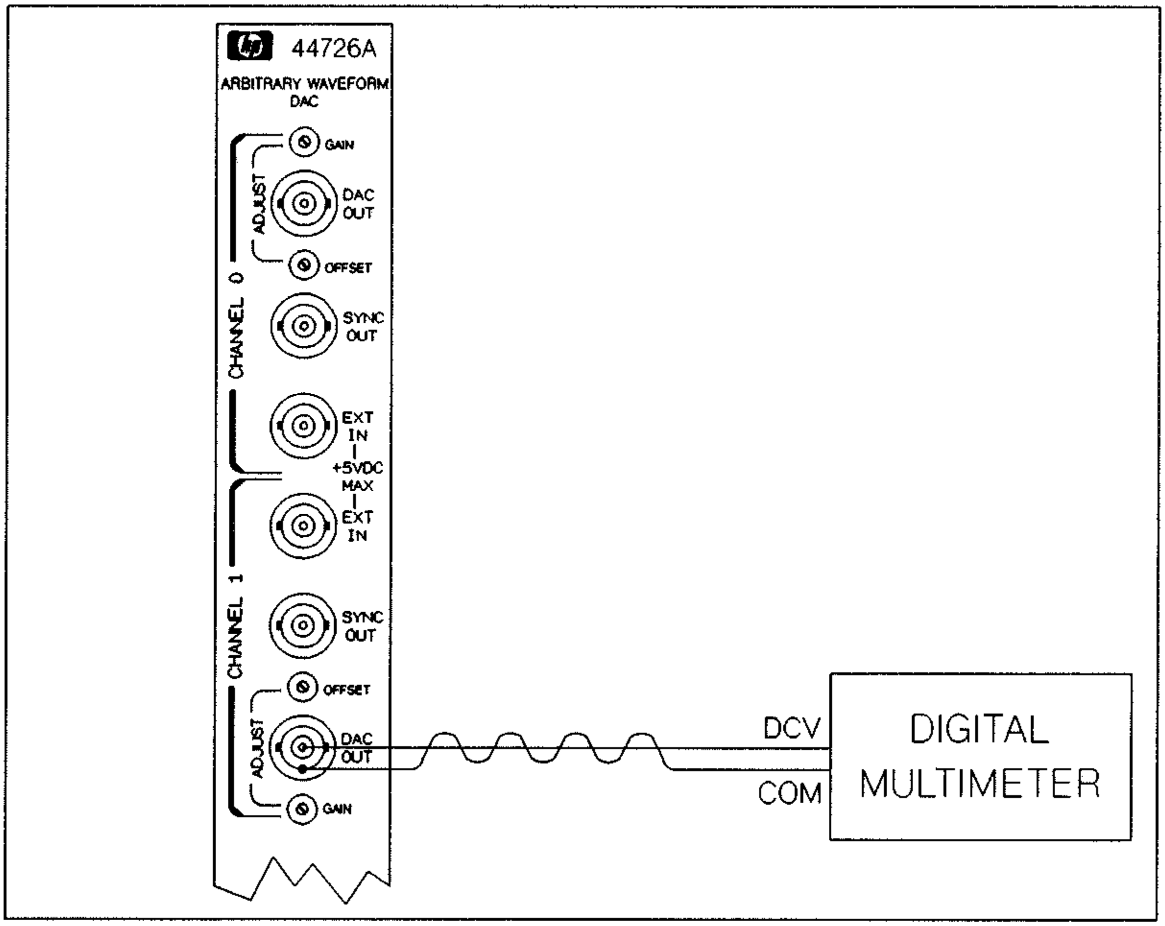


Figure 21-12 Channel 1 DC Volts Test Connection

16. Observe the reading on the digital multimeter. It should indicate between -10.2287 V and -10.2413 V.

17. Set channel 1 to output 10.235 V by executing:

    APPLY DCV ES01, 10.235 (where E = extender number, S = slot number)

18. Observe the reading on the digital multimeter. It should indicate between +10.2287 V and +10.2413 V.

19. If you wish to do the rest of the performance test, leave the digital multimeter connected and continue with section 21-13. Otherwise remove the digital multimeter from the HP 44726A accessory. This completes the DC Volts Accuracy Test.

THIS COMPLETES THE OPERATIONAL VERIFICATION PORTION OF THE HP 44726A PERFORMANCE TESTS.

21-13 DC Volts Accuracy Test Under Full Load

This test checks the dc full scale accuracy under full load of both channels. If any portion of the test fails, perform the calibration procedure in Section 21-15.

1. CHANNEL 1 DC VOLTS TEST. This test checks the full scale accuracy under full load of channel 1.

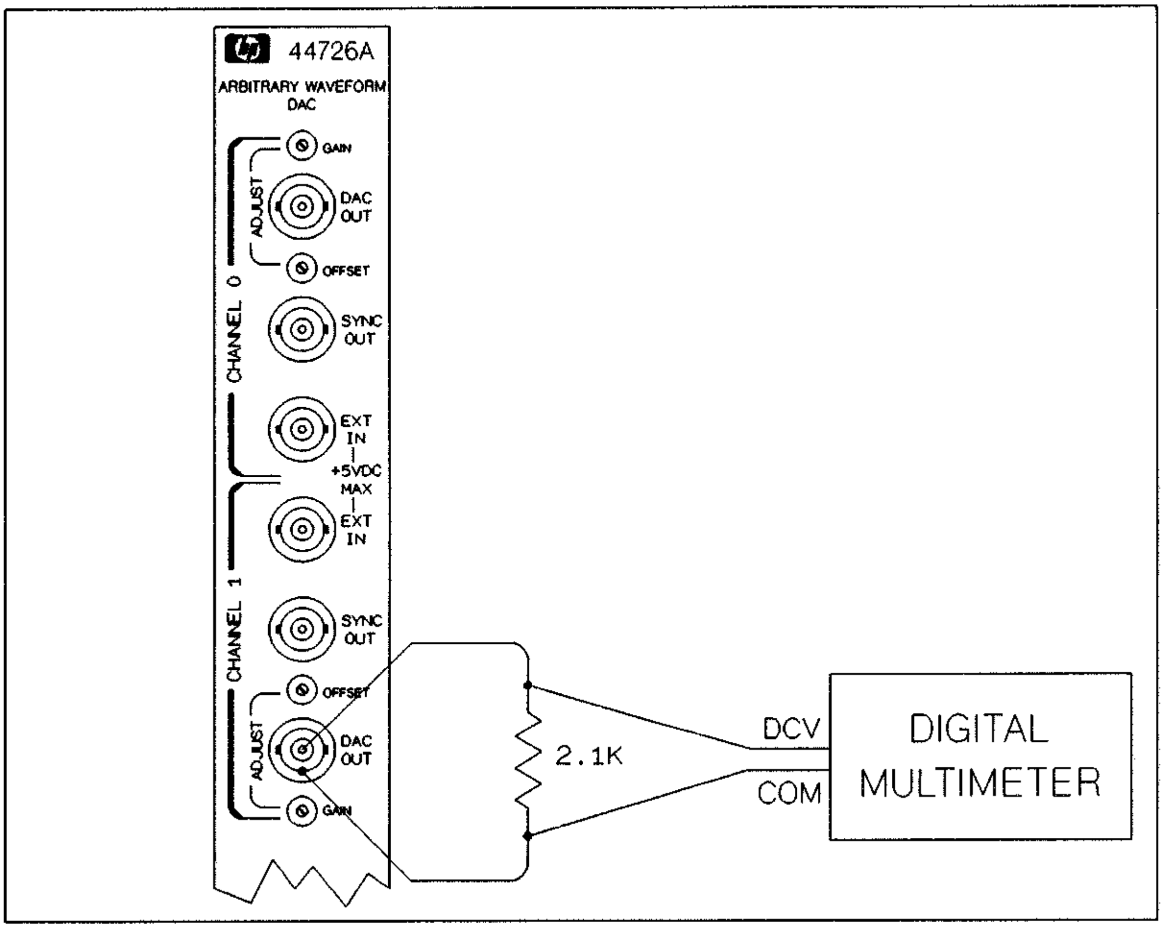


Figure 21-13 Channel 1 Full Load DC Volts Test Connection

2. If the DC Volts Accuracy test in Section 21-12 has not been previously performed, do the following:

   a. Set the HP 44726A to a known state by executing:

      RESET ES00 (where E = extender number, S = slot number)

   b. Set the digital multimeter for dc volts and autorange.

   c. Refer to Figure 21-13. Connect the digital multimeter to the accessory's DAC OUT connector on channel 1.

3. Connect a 2.1 kohm resistor across the channel 1 DAC OUT connector, as shown in Figure 21-13.

4. If the DC Volts Accuracy test in Section 21-12 has not been performed previously, execute the following. Otherwise, continue with step 5.

   APPLY DCV ES01, 10.235 (where E = extender number, S = slot number)

5. Observe the reading on the digital multimeter. It should indicate between +10.2287 V and +10.2413 V.

6. Set channel 1 to output -10.235 V by executing:

APPLY DCV ES01, -10.235 (where E = extender number, S = slot number)

7. Observe the reading on the digital multimeter. It should indicate between -10.2287 V and -10.2413 V.

8. CHANNEL 0 DC VOLTS TEST. This test checks the full scale accuracy under full load of channel 0.

9. Refer to Figure 21-14. Connect the digital multimeter to the accessory's DAC OUT connector on channel 1.

10. Connect a 2.1 kohm resistor across the channel 0 DAC OUT connector, as shown in Figure 21-14.

11. Set channel 0 to output -10.235 V by executing:

APPLY DCV ES00, -10.235 (where E = extender number, S = slot number)

12. Observe the reading on the digital multimeter. It should indicate between -10.2287 V and -10.2413 V.

13. Set channel 0 to output 10.235 V by executing:

APPLY DCV ES00, 10.235 (where E = extender number, S = slot number)

14. Observe the reading on the digital multimeter. It should indicate between +10.2208 V and +10.2492 V.

15. Remove the digital multimeter and resistor from the HP 44726A accessory. This completes the DC Volts Accuracy Test under Full Load.

21-14 Monotonicity Test

This test verifies that both channels meet the monotonicity specifications.

Monotonicity guarantees that with a voltage increase of 0.00125 V, the output voltage may only have a 0.0 V or above change. If it is negative or zero, it is increased by .000125 V. The Monotonicity Test is illustrated as follows:

a. If the output voltage is presently at +10.235000 V, the HP 44726A accessory is next setup to output +10.236250 V (i.e., +10.235000 + .00125 = +10.236250).

b. The new output voltage must then be equal to or above +10.235000 V (the original voltage). If the voltage would go below +10.235000 V, the monotonicity test would fail.

Do the following:

1. Set the digital multimeter for dc volts and autorange.

2. Refer to Figure 21-11. Connect the digital multimeter to the accessory's DAC OUT connector on channel 0.

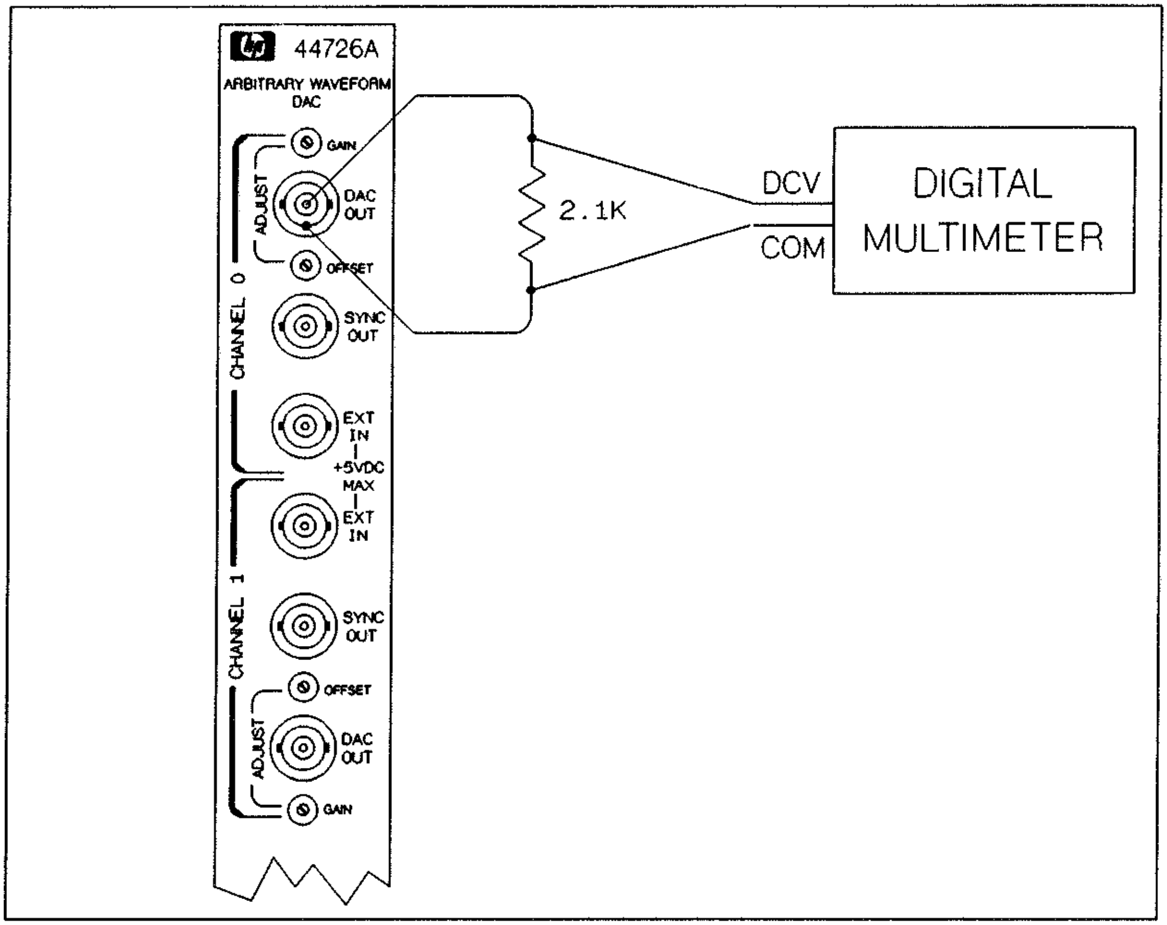


Figure 21-14 Channel 0 Full Load DC Volts Test Connection

3. Using the data in Table 21-2, set channel 0 to output the voltage from the "Output Voltage" column in Table 21-2. Output the voltage by executing:

APPLY DCV ES00, DD (where E = extender number, S = slot number, DD = input voltage)

4. Note the reading on the digital multimeter.

5. Using the command in step 3, set channel 0 to output the voltage from the "Step Voltage" column that corresponds to the "Output Voltage" column in step 3. Output the voltage by executing:

APPLY DCV ES00, DD (where E = extender number, S = slot number, DD = input voltage)

6. Verify that the new reading on the digital multimeter is within the reading noted in step 4 plus 0.003125 V. Use the "Error" column in Table 21-2 to determine the change in output voltage.

Note, monotonicity only guarantees that the output will not go lower with a 0.00125 V increase. This in effect makes the "High" Error column in Table 21-2 unnecessary. However, if the high limits in the column are exceeded, it may indicate a failure in the digital-to-analog converter.

7. Repeat steps 3, 4, 5, and 6 for the rest of the voltages in the "Output Voltage" column of Table 21-2. In the APPLY DCV ES00 DD command in steps 3 and 5, be sure to change the "DD" digits to the appropriate values listed in the "Output Voltage" and "Step Voltage" columns of Table 21-2.

8. Refer to Figure 21-12. Connect the digital multimeter to the accessory's DAC OUT connector on channel 1.

9. Repeat steps 3, 4, 5, 6, and 7 for channel 1. In the APPLY DCV ES00 command in steps 3 and 5, be sure to change the last two digits to ES01 for channel 1.

Table 21-2 Monotonicity Test Limits

Output Voltage	Step Voltage	Error Low	Error High
10.235000	10.236250	0.0	0.003125
10.230000	10.231250	0.0	0.003125
10.220000	10.221250	0.0	0.003125
10.200000	10.201250	0.0	0.003125
10.160000	10.161250	0.0	0.003125
10.080000	10.081250	0.0	0.003125
9.920000	9.921250	0.0	0.003125
9.600000	9.601250	0.0	0.003125
8.960000	8.961250	0.0	0.003125
7.680000	7.681250	0.0	0.003125
5.120000	5.121250	0.0	0.003125
2.560000	2.561250	0.0	0.003125
0.000000	0.001250	0.0	0.003125
-0.000312	0.001562	0.0	0.003125
-0.000625	0.000625	0.0	0.003125
-0.001250	0.000000	0.0	0.003125
-0.002500	-0.001250	0.0	0.003125
-2.560000	-2.558750	0.0	0.003125
-5.120000	-5.118750	0.0	0.003125
-7.680000	-7.678750	0.0	0.003125

21-15 CALIBRATION

21-16 Introduction

The calibration procedure in this section calibrates the accessory's output amplifiers of both channels.

Calibration is performed by adjusting two potentiometers for each channel. One potentiometer adjusts the offset voltage and the other the full scale voltage.

21-17 Calibration Cycle

Periodic calibration should be performed to ensure that the accessory is meeting its accuracy specifications. The accessory should be calibrated every 90 days. Calibration should also be performed if determined by the Performance Test procedures that calibration is needed.

21-18 Calibration Environment

The HP 44726A accessory may be calibrated is a "bench" environment or system cabinet. For best accuracy, the temperature of the calibration environment should be within ±5° C of the actual operating environment. The HP 44726A was calibrated at the factory at an environment temperature of 23± C.

21-19 Equipment Required

The following test equipment is required to calibrate the HP 44726A.

1. Test Leads and Jumpers (includes a BNC-to-Banana cable).

2. Digital Multimeter -- HP 3456A or equivalent.

NOTE

The integrating voltmeter (HP 44701A) may be used for the Calibration Procedure. The procedure does not describe specific steps required to use the plug-in voltmeter. A description of the plug-in voltmeter can be found in the Plug-In Accessories Configuration and Programming Manual (HP part number 03852-90002).

21-20 Calibration Procedure

21-21 Set-Up Procedure

1. Apply power to the HP 3852A and allow the HP 44726A accessory a one hour warm-up period inside the mainframe.

2. Press the RESET button on the HP 3852A front panel. Perform the HP 44726A self-test by executing:

   TEST ES00 (where E = extender number, S = slot number)

3. The HP 3852A right display should show:

   SELF TEST OK

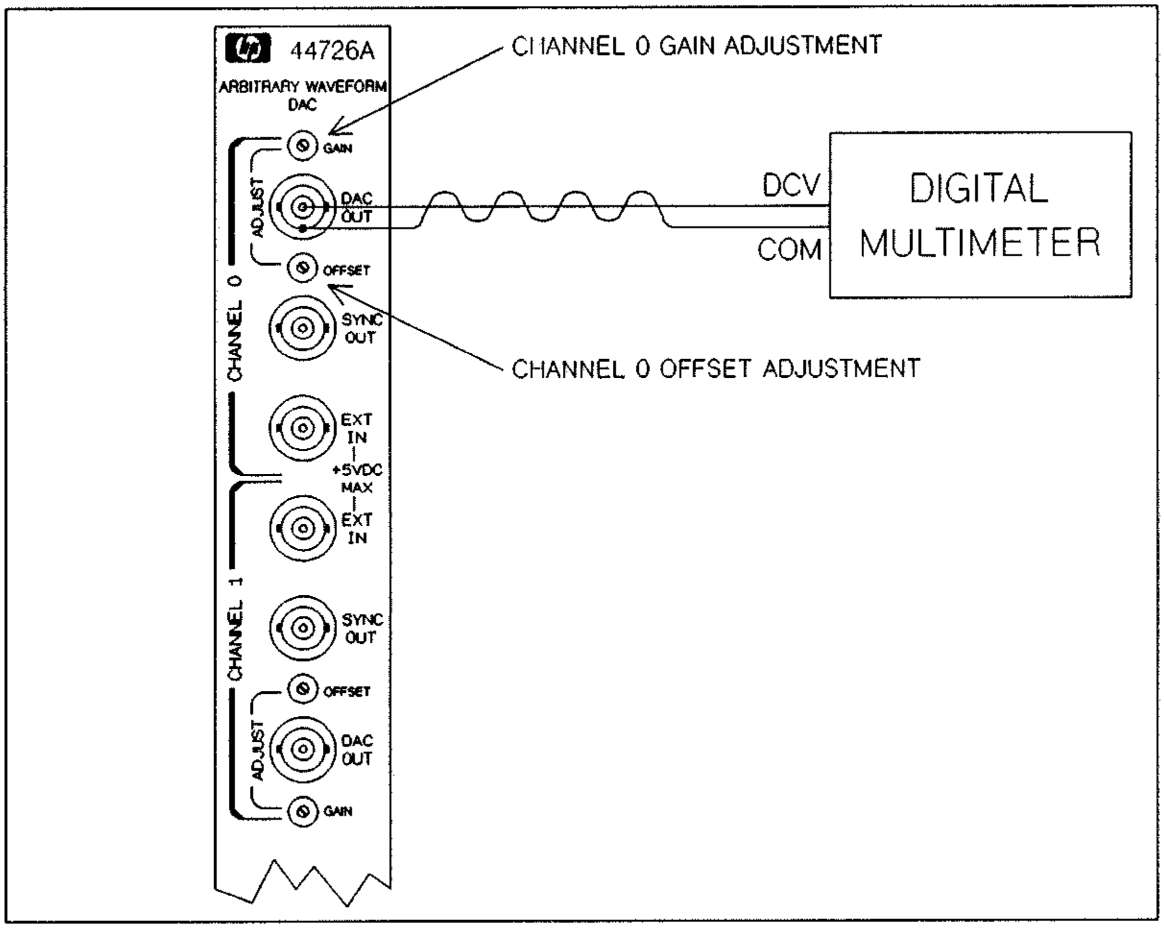


Figure 21-15 Channel 0 Calibration

If the display shows a different message, or the ERR annunciator is on, the HP 44726A accessory may be failing its self-test. Test the accessory again by executing the command in step 1. If the accessory still fails, exchange it with a working one.

21-22 Offset/Gain Calibration

Both of the accessory's channels are calibrated individually.

1. Set the digital multimeter to dc volts and autorange.

2. Refer to Figure 21-15. Connect the digital multimeter to the accessory's DAC OUT connector on channel 0.

3. Set channel 0 to output 0 V by executing:

   APPLY DCV ES00, 0 (where E = extender number, S = slot number)

4. Refer to Figure 21-15 to locate the "OFFSET" potentiometer. Using a small flat blade screwdriver, adjust the potentiometer for a 0 V reading on the digital multimeter.

5. Set channel 0 to output +10.235 V by executing:

APPLY DCV ES00, 10.235 (where E = extender number, S = slot number)

6. Refer to Figure 21-15 to locate the "GAIN" potentiometer. Using a small flat blade screwdriver, adjust the potentiometer for a +10.235 V reading on the digital multimeter.

7. Set channel 0 to output -10.235 V by executing:

APPLY DCV ES00, -10.235 (where E = extender number, S = slot number)

8. Note the reading on the digital multimeter. Determine the calibration error by subtracting the reading from -10.235 V. Then adjust the "GAIN" potentiometer to correct for one half of the error between the ideal voltage (-10.235 V) and the actual voltage. This is illustrated in the following example:

a. If the reading on the digital multimeter is -10.236 V, the error voltage will be:

(-10.235) - (-10.236) = 0.001

b. Adjust the "GAIN" potentiometer for a reading on the digital multimeter that equals the ideal voltage minus one half the error voltage. In this example, the reading would be:

(-10.235) - (0.001/2) = (-10.235) - (0.0005) = -10.2355

9. Set channel 0 to output +10.235 V by executing:

APPLY DCV ES00, 10.235

10. Make sure the reading on the digital multimeter is the ideal reading (+10.235 V) ±0.5 mV. In the example in step 8, the reading would be +10.2355 V. If the reading is wrong, perform the channel 0 calibration procedure again.

11. Using the previous procedure (steps 1 through 10), calibrate channel 1. Refer to Figure 21-16 for the calibration connections and gain/offset adjustment locations. The APPLY DCV commands in steps 3, 5, 7, and 9 should reflect channel 1 (e.g., APPLY DCV ES01, -10.235).

12. Remove the digital multimeter from the accessory.

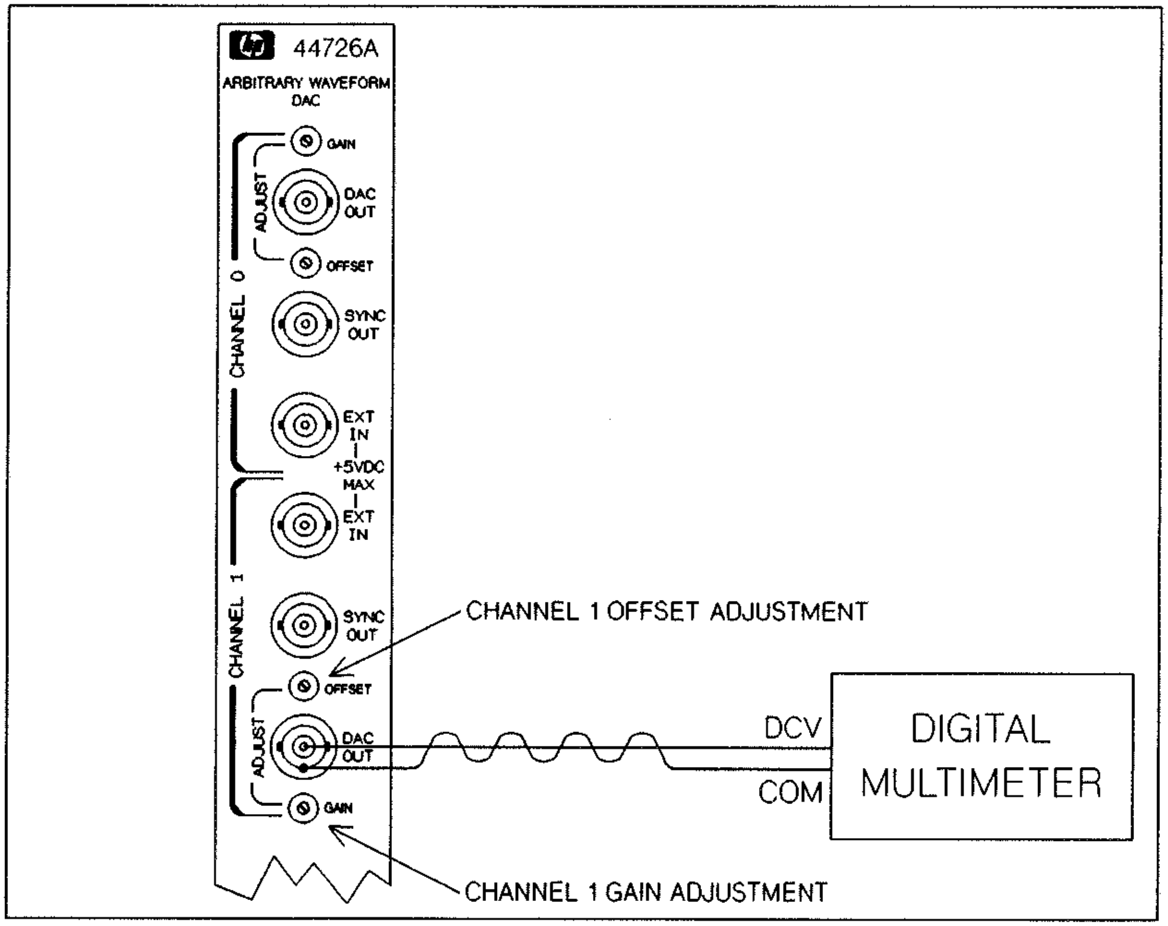


Figure 21-16 Channel 1 Calibration

21-23 REPLACEABLE PARTS

Figure 21-17 shows the mechanical breakdown of the HP 44726A. The figure also provides assembly and disassembly information. The parts shown in Figure 21-17 are keyed to the parts list in Table 21-3.

To order a part listed in Table 21-3, quote the Hewlett-Packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 21-3). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The component module printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

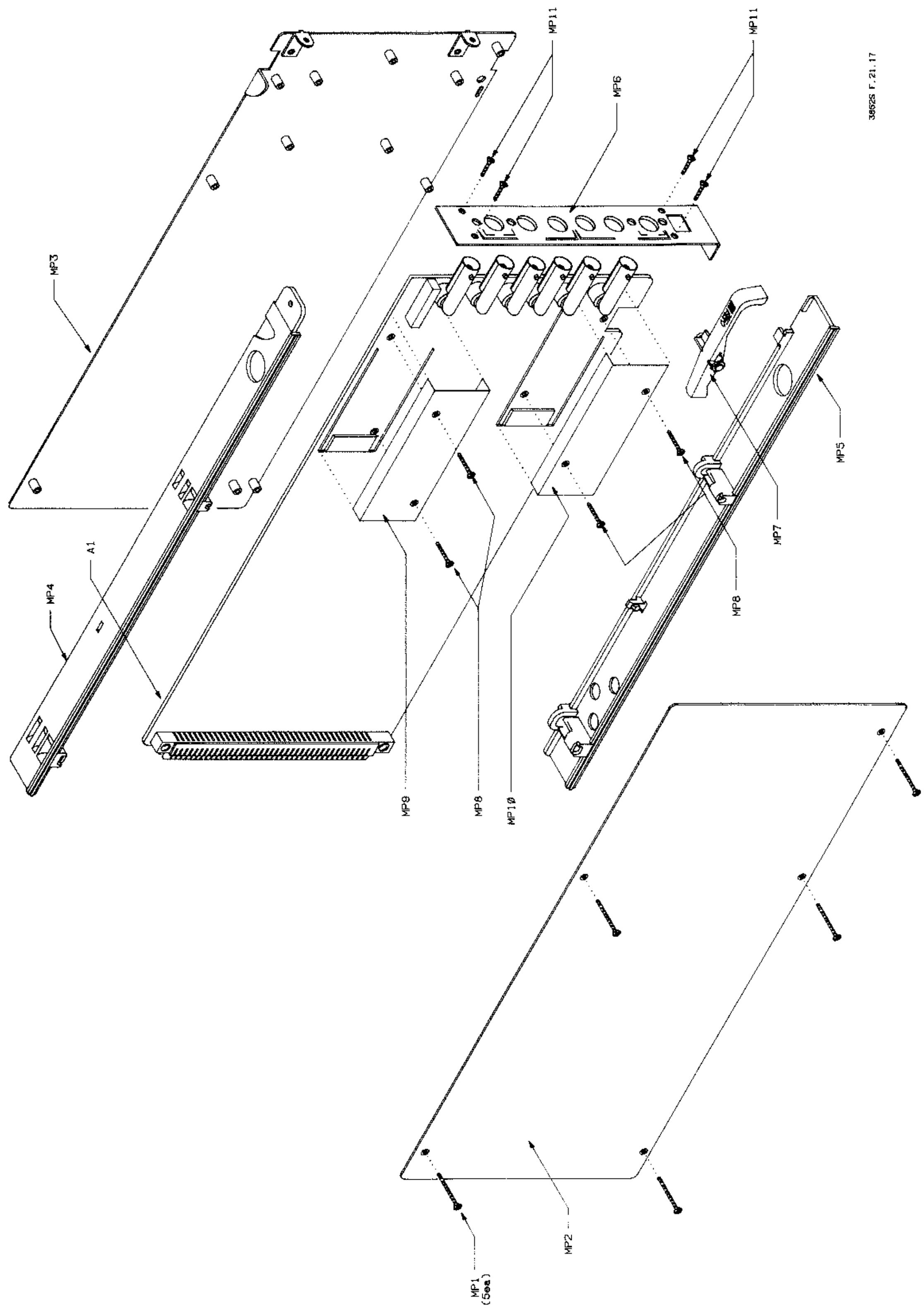


Figure 21-17 HP 44726A Exploded View

Table 21-3 HP 44726A Arbitrary Waveform DAC

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44726A	Arbitrary waveform DAC	1	44726A	7	FAST DAC
A1	PCA; arbitrary waveform DAC	1	44726-66501	9	PCA-FAST DAC
MP1	Screw; cover	5	0515-1322	4	SCR-FH M3.0X30LK
MP2	Cover; left (aluminum)	1	44726-04101	5	CVR-DAC LT
MP3	Cover; right (aluminum)	1	44726-04102	6	CVR-DAC RT
MP4	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP5	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP6	Panel; rear (molded)	1	44726-60201	4	PNL-RR,FAST DAC
MP7	Pull lever; (molded)	1	03852-45002	8	MLD-PULL LEVER
MP8	Screw; shield (top & bottom)	4	0515-1441	8	SCR-PH M3.0X20LK
MP9	Shield (top)	1	44726-00601	2	SHLD-TP
MP10	Shield (bottom)	1	44726-00602	3	SHLD-BT
MP11	Screw; rear panel	4	0515-0886	3	SCR-PH M3.0X6LK

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44726A	Arbitrary waveform DAC		44726-69201	2	RBLT-44726A

CHAPTER 22

HP 44788A 2 HP-IB CONTROLLER

CHAPTER 22
HP 44788A
HP-IB CONTROLLER

22-1 INTRODUCTION

This chapter provides a description, operational check, and a replaceable parts list for the HP 44788A HP-IB Controller Accessory.

NOTE

The HP-IB Controller Accessory can only be used with instruments having a firmware revision of 3.5 or above. Determine the firmware revision by sending the mainframe command: **IDN?**.

22-2 HP 44788A Description

The HP-IB accessory may be used as a stand-alone HP-IB controller for disc drive, printer, and instrument control through a local HP-IB port without the need of a system controller. The accessory normally receives programming instructions from an externally connected disc drive. It can also receive instructions from the mainframe using data entered from the front panel.

The accessory can not be used in slot 0 of the HP 3852A mainframe. It must be used in slots 1 through 7. However, it can be used in any slot of an HP 3853A Extender.

22-3 OPERATIONAL CHECK

22-4 Introduction

Only an operational check is performed on the accessory. A performance test is not needed. Successful completion of the check provides a high confidence level that the HP-IB Controller Accessory is operating properly.

22-5 Equipment Required

A short HP-IB cable (e.g., HP 10833D). It needs to be long enough to connect the HP 44788A accessory to the mainframe HP-IB connector.

22-6 Procedure

WARNING

Even with power removed from the HP 3852A, high voltages, generated in other parts of the system, may be present at the terminal module of each accessory. Service personnel should ensure that all external power is removed from the system before installing, removing, testing or repairing any plug-in accessory.

1. Remove power from the HP 3852A.

2. Install the HP 44788A accessory into any slot, except slot 0 of the HP 3852A.

3. Apply power to the HP 3852A. Wait for the HP 3852A to complete its wake-up sequence.

4. Once the wake-up sequence is completed, the HP 3852A will normally display an error message. The reason for the message is that the HP 44788A is looking for an autostart program on a disc drive. Since no drive is connected to it, the above message will be displayed. This is normal.

5. Connect the HP-IB cable between the HP-IB connector of the accessory and the HP-IB connector on the mainframe.

6. Be sure the HP 3852A HP-IB address is set to "9". If different, change ES09 in step 7 to reflect the address (e.g., for an address of "11", ES09 becomes ES11).

7. Execute the following:

   INTEGER I
   OUTPUT ES09 "VREAD 12345" (where E = extender number, S = slot number)*
   LOCAL (i.e., the LOCAL key on the HP 3852A front panel)

*The quotation marks are entered into the display by pressing the "E" key on the right number keyboard several times until the quotation mark is displayed.

8. Read the mainframe by executing:

   ENTER ES09 I (where E = extender number, S = slot number)

9. Display the value of variable I on the HP 3852A display by executing:

   VREAD I

10. Variable I should now be displayed on the right display of the HP 3852A. It should be shown as:

    1.234500E+4

11. This completes the operational check.

22-7 REPLACEABLE PARTS

Figure 22-1 shows the mechanical breakdown of the HP 44788A. The figure also provides assembly and disassembly information. The parts shown in Figure 22-1 are keyed to the parts list in Table 22-1.

To order a part listed in Table 22-1, quote the Hewlett-Packard part number, the quantity desired, the HP system description, and the check digit (abbreviated CD in Table 22-1). Address the order to the nearest Hewlett-Packard Sales Office. Hewlett-Packard Sales Offices are listed geographically at the back of this manual.

CAUTION

The accessory printed circuit board is a static sensitive device. Refer to Chapter 5 for additional information about handling static sensitive printed circuit boards.

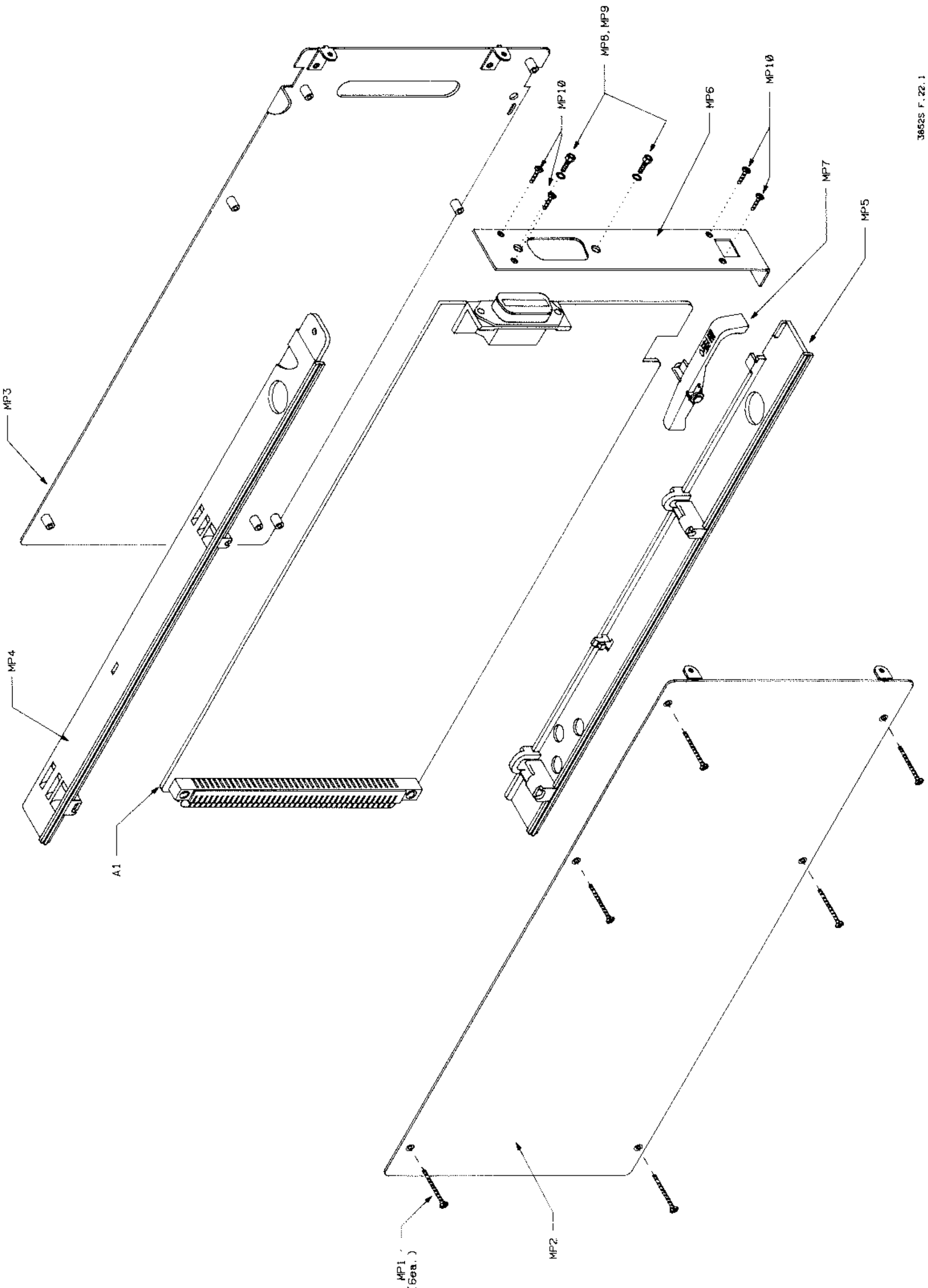


Figure 22-1 HP 44788A Exploded View

Table 22-1 HP 44788 HP-IB Controller

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44788A	HP-IB controller	1	44788A	1	HP-IB CONT
A1	PCA; HP-IB controller	1	44788-66501	3	PCA-HP-IB CONT
MP1	Screw; cover	6	0515-1322	4	SCR-FH M3.0X30LK
MP2	Cover; left (aluminum)	1	44750-04101	5	CVR-MOD LT
MP3	Cover; right (aluminum)	1	44750-04102	6	CVR-MOD RT
MP4	Guide rail; top (molded)	1	03852-41201	1	MLD-RAIL,TOP
MP5	Guide rail; bottom (molded)	1	03852-41202	2	MLD-RAIL,BOTTOM
MP6	Panel; rear (molded)	1	44788-60201	8	PNL-RR,HP-IB CONT
MP7	Pull lever; (molded)	1	03852-45002	8	MLD-PULL LEVER
MP8	Standoff; HP-IB connector	2	5180-6650	5	STANDOFF-HEX
MP9	Washer; HP-IB connector	2	2190-0577	1	WSHR-LK SCR-10
MP10	Screw; rear panel	4	0515-0886	3	SCR-PH M3.0X6LK

Restored Assemblies/Modules

The following restored assemblies/modules are available through the HP Exchange. For details see Section 1-19.

REF DESIG	DESCRIPTION	QTY	HP PART NUMBER	C D	HP FACTORY REFERENCE
44788A	HP-IB controller		44788-69201	6	RBLT-44788A