CHAPTER XI
44473A 4X4 MATRIX SWITCH

11-1 INTRODUCTION

This chapter contains installation information, performance testing information, trouble-shooting information and replaceable parts lists for the 44473A 4X4 Matrix Switch.

The 44473A consists of 16 double-pole single-throw (DPST) relays arranged in a 4 channel by 4 channel switching matrix. Each channel has a low line and a high line which are switched in unison. Figure 11-1 shows a simplified schematic of the 44473A.

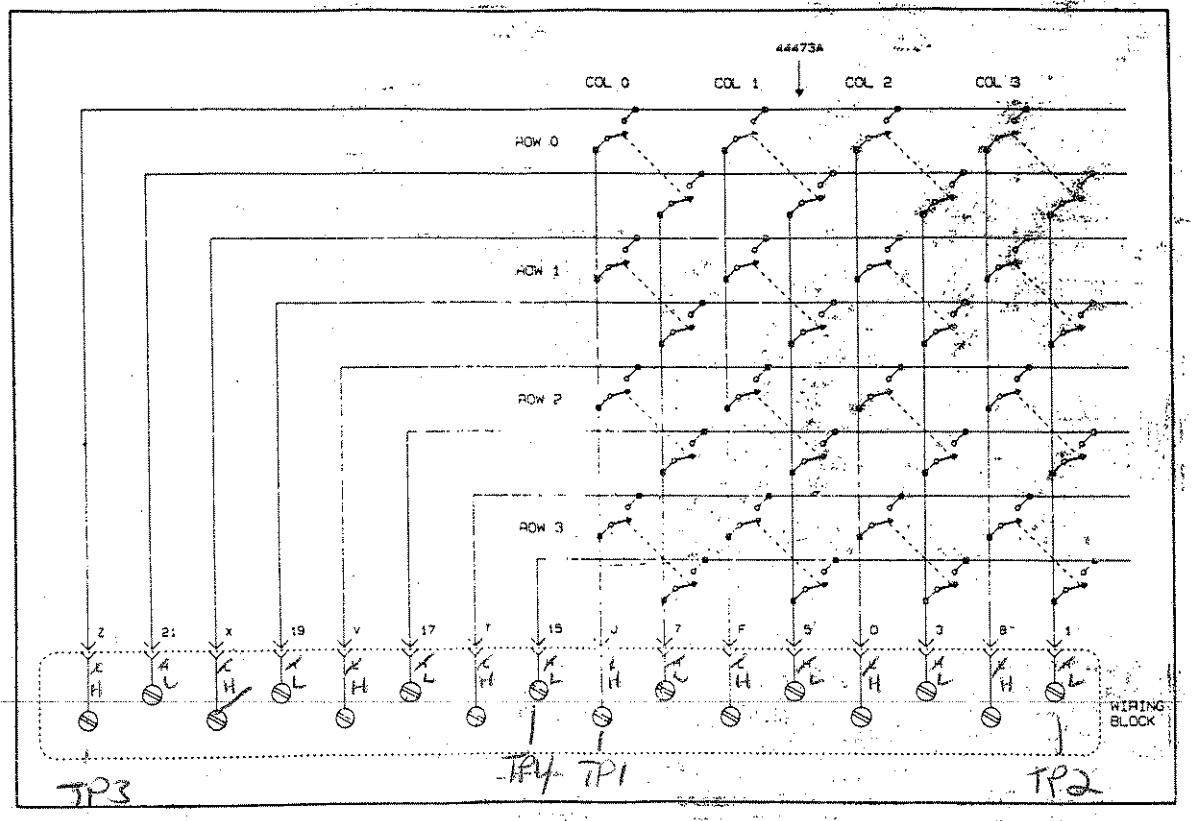


Figure 11-1 44473A Simplified Schematic

WARNING

Hazardous voltage may exist on the wiring and connectors of the 44473A plug-in card. Only service trained personnel with a knowledge of electronic circuitry and an awareness of the hazards involved should install, reconfigure, or make repairs to the 3488A and or the plug-in cards.

11-2 PLUG-IN CARD WIRING

Figure 11-2 shows the proper wiring procedures for the 44473A.

WARNING

Hazardous voltages may exist on the wiring and connectors of the 3488A's plug-in cards. Only Service Trained Personnel with a knowledge of electronic circuitry and an awareness of the hazards involved should install, reconfigure, or make repairs to the 3488A and/or the plug-in cards.

11-3 PLUG-IN CARD CLEANING

Printed circuit board contamination can affect the dc isolation and the high frequency performance of the plug-in cards. This contamination can come from dust accumulation, fingerprints, condensation, and so on. The plug-in card printed circuit boards are to be cleaned as follows:

CAUTION

Use anti-static pc board handling techniques during the following procedure.

1. Remove the shields from the plug-in card.

2. Use a stiff bristled camel hair brush (do not use a wire brush) soaked in isopropyl alcohol to wash the pc board.

CAUTION

DO NOT immerse the printed circuit board in any type of fluid.

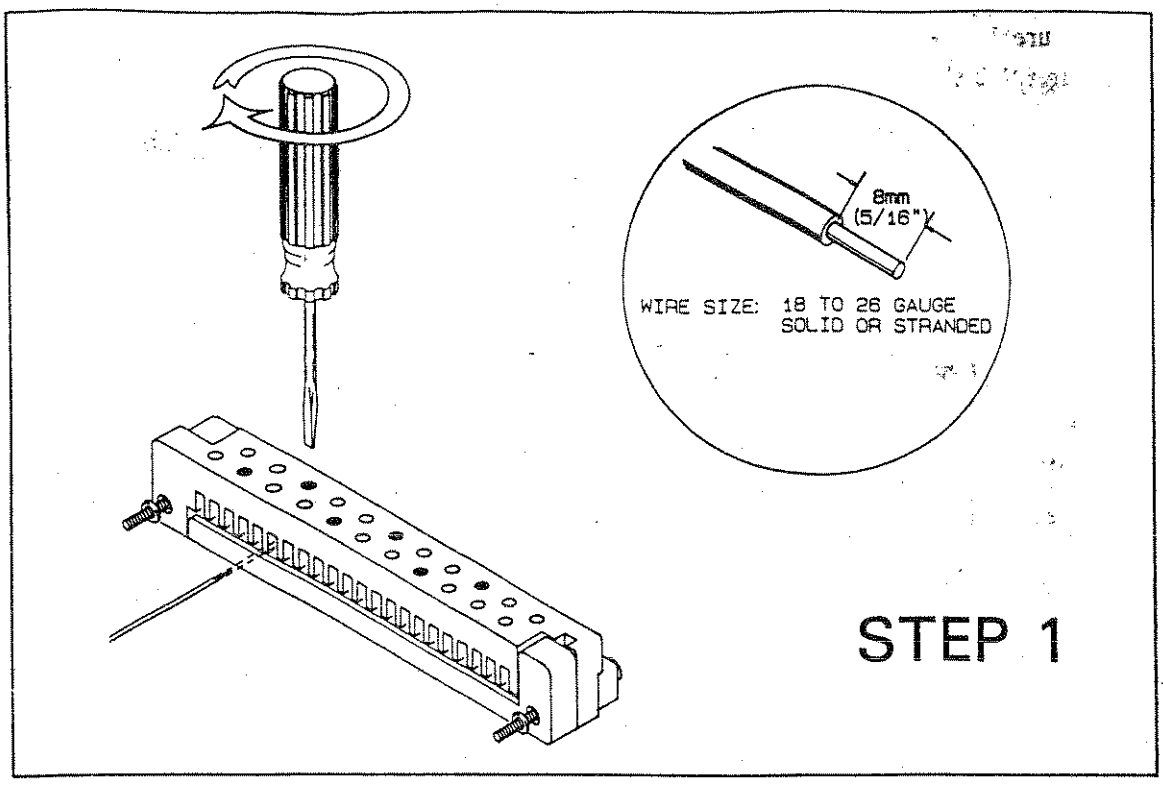
3. Use the stiff bristled brush soaked in deionized or distilled water, to remove any residue left by the alcohol.

4. Allow the printed circuit board to dry thoroughly.

5. Replace the shields.

CAUTION

The maximum terminal-to-terminal or terminal-to-chassis voltage limits for the 44473A are 250Vdc or 250Vac rms (350Vac peak). The maximum current limits per channel are 2Adc or 2Aac rms. The maximum current limits per card are 8Adc or 8Aac rms. The maximum power limits per channel are 60Wdc or 500VAac. The maximum power limits per card are 240Wdc or 2000VAac. Damage to the 44473A and possibly the 3488A will occur if any of the above limits are exceeded.



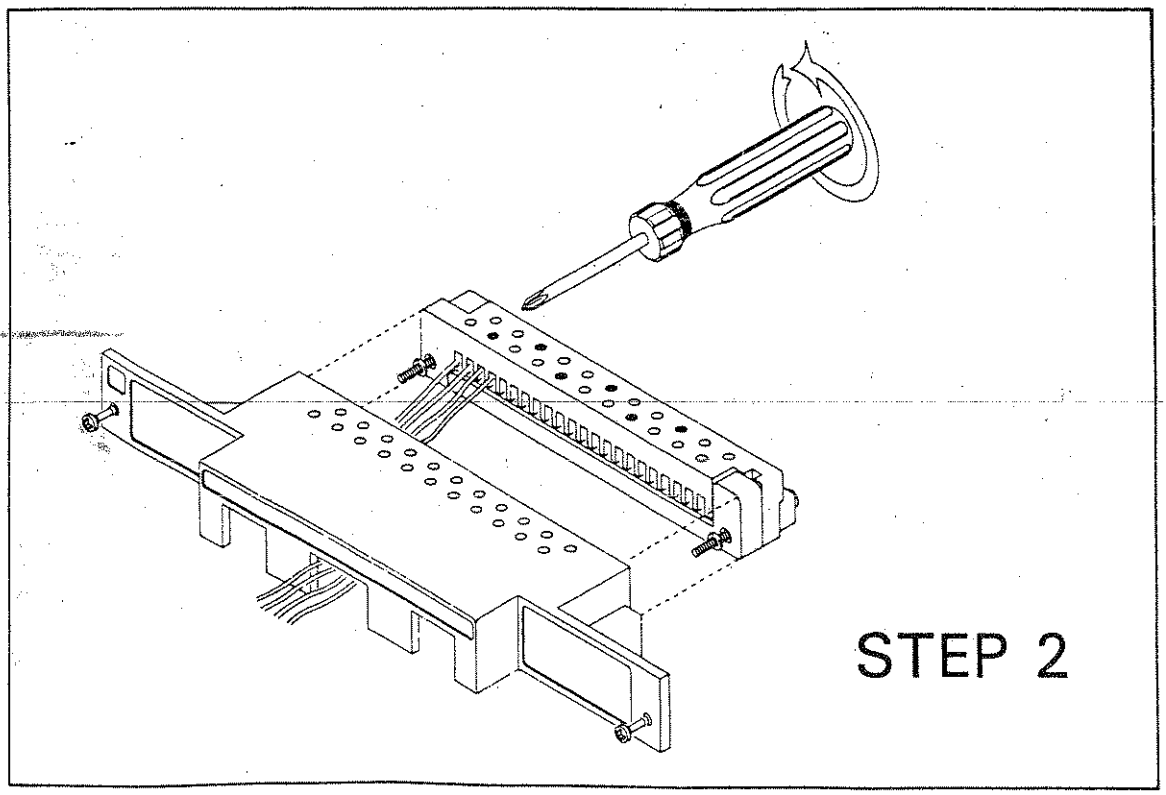


Figure 11-2 Plug-In Card Wiring

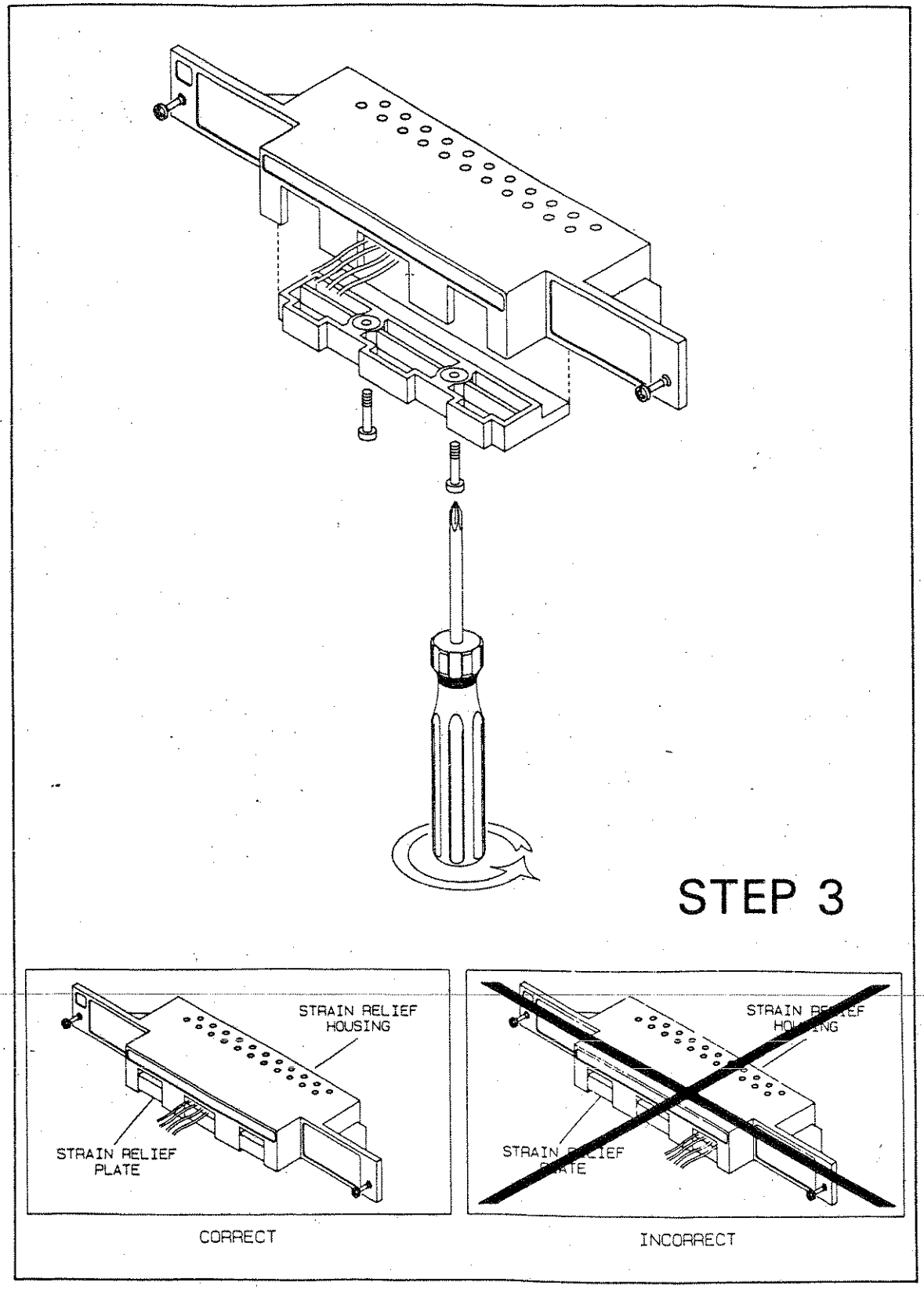
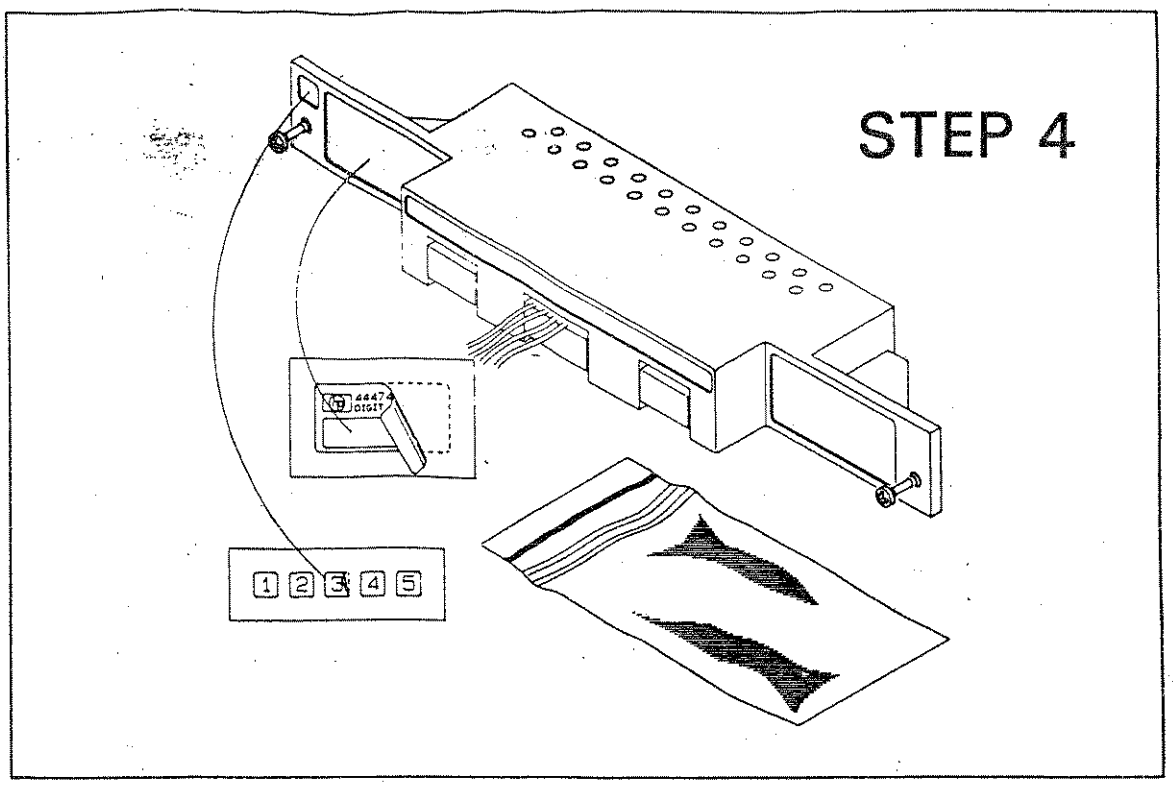


Figure 11-2. Plug-In Card Wiring (Cont'd)



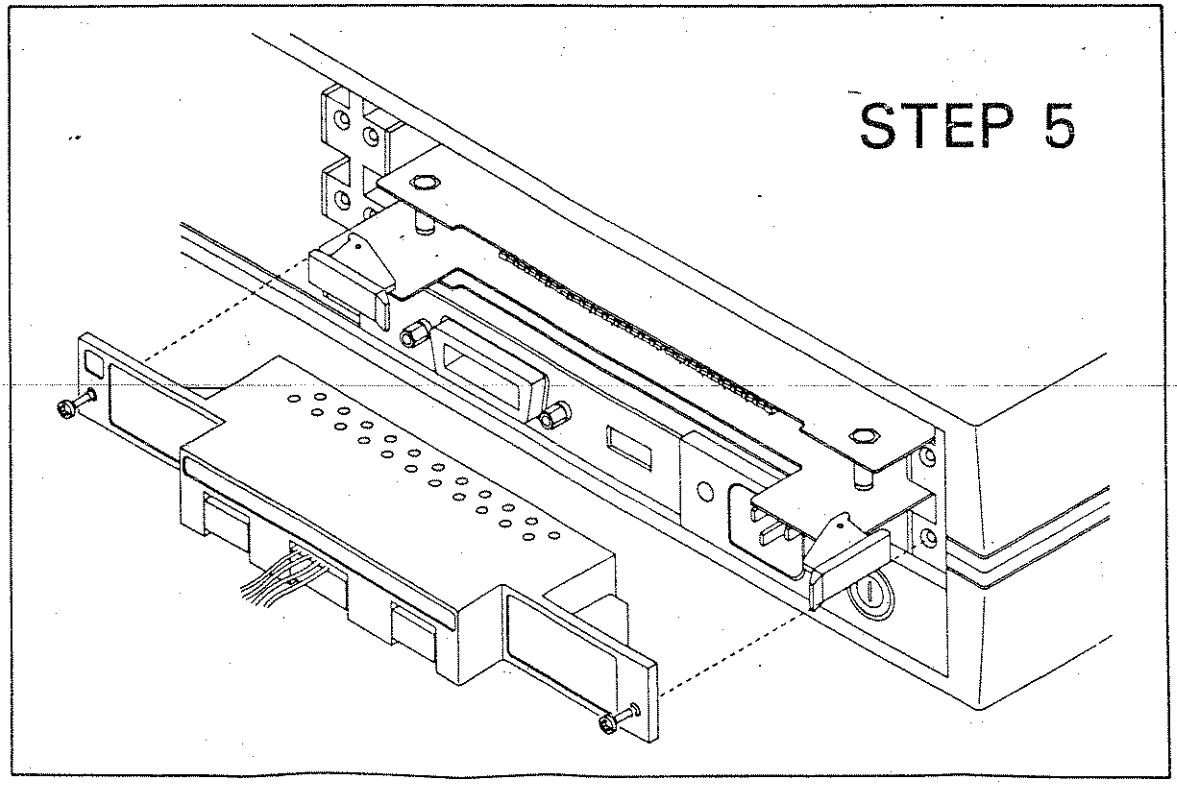


Figure 11-2. Plug-In Card Wiring (Cont'd)

11-4 TEST FIXTURE

A test fixture is required in order to perform the Operation Verification Tests for the 44473A (Chapter 4 of this manual). This fixture simplifies testing by eliminating the need to repeatedly connect and disconnect test leads and by acting as an interface between the 44473A and an ohmmeter.

The test fixture can be either of the following two types:

a. A test fixture is available from Hewlett-Packard (HP part number 03488-66501). The advantages of this fixture are (1) it requires no assembly and (2) it can be used to test the 44470A, the 44471A, the 44473A and the 44474A plug-in cards without modification.

b. A test fixture can be constructed by configuring an HP 44483A removable wiring block as shown in Figure 11-3. This particular test fixture can only be used to test the 44473A.

The test fixture consists of (1) a short circuit between all of the low line inputs, (2) a short circuit between all of the low line outputs, (3) a short circuit between all of the high line inputs, and (4) a short circuit between all of the high line outputs. With the test fixture installed, and an ohmmeter connected between the inputs and outputs of either the low lines or high lines, the card is tested by successively closing each relay while checking for the indication of a closure with the ohmmeter.

NOTE

The Performance Test procedures in this chapter are involved and time consuming. Since the most likely parameter to change with time is the series resistance of a channel, and since the series resistance is tested in the Operation Verification procedures (Chapter 4), it is not recommended that the Performance Tests be conducted unless one of the tested specifications is in question.

11-5 PERFORMANCE TESTS

The following Performance Tests check the 44473A's dc isolation and thermal offset specifications. The results of these tests, when coupled with the results of the 44473A Operation Verification Test, will verify whether or not the 44473A is operating within its critical specifications. The 44473A Operation Verification Test is located in Chapter 4 of this manual. Since the 44473A Operation Verification Test assesses the operability of the 44473A, it is important that it be performed prior to performing the Performance Tests.

WARNING

If the 44473A is currently installed into a system, it must be disconnected from the system in order to execute the Performance Tests. This presents two potential safety hazards:

a. It is possible for the user to come in contact with high voltage (if high voltage exists in the system).

WARNING

b. Equipment damage may occur should the wrong lines become accidentally connected or disconnected. The user must take the necessary precautions to prevent the above from happening before disconnecting the 44473A.

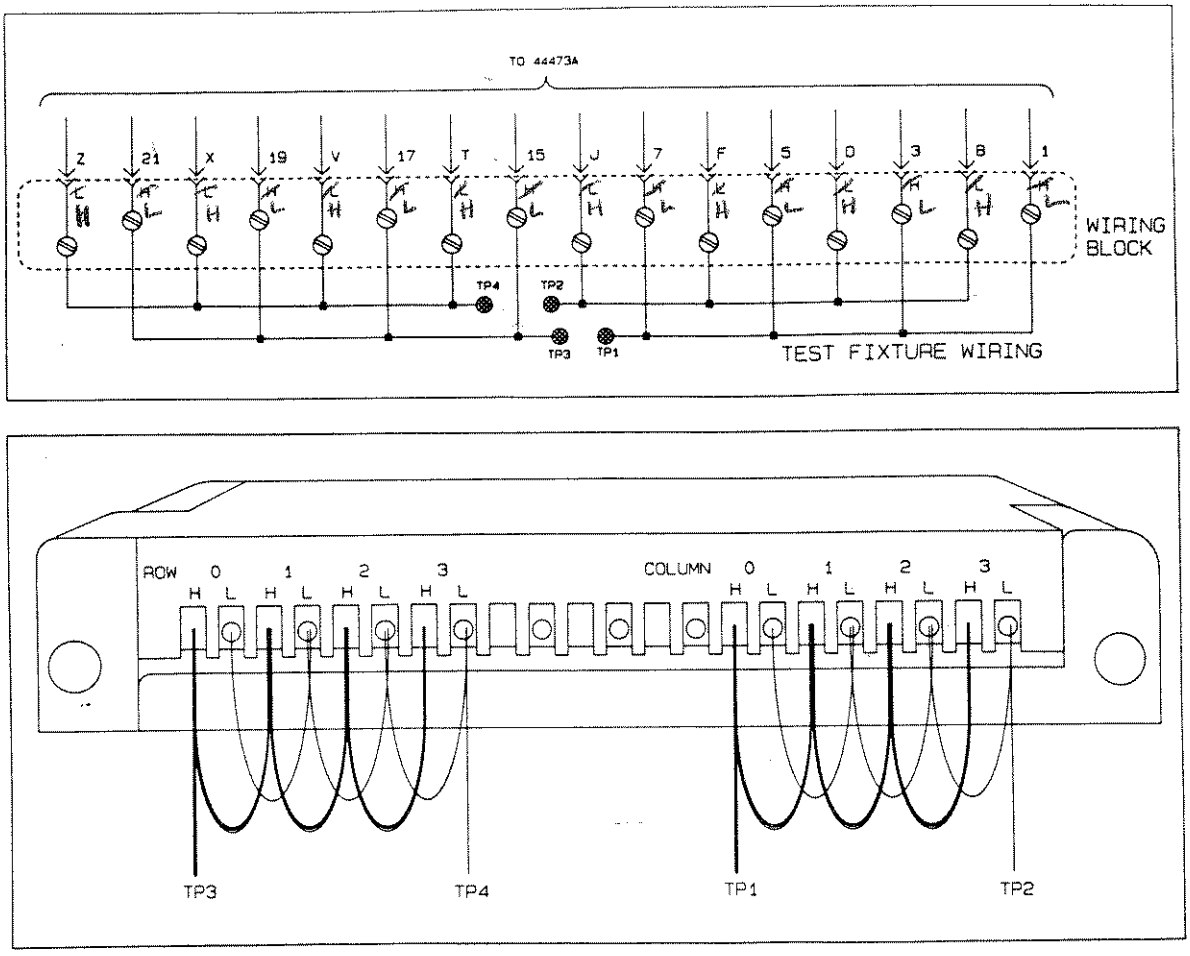


Figure 11-3 44473A Test Fixture

11-6 Required Test Equipment

DC Power Supply – HP 6216B or equivalent. The power supply must be able to deliver a stable +20Vdc at low current levels.

10 megohm resistor.

Digital Multimeter – HP 3478A or equivalent. The multimeter must have the resolution and accuracy to measure a 1μV differential dc voltage.

11-7 44473A DC Isolation Tests

The following dc isolation tests incorporate a dc power supply, a resistor of known value,

and a dc voltmeter. The first phase of the tests involves precisely setting the dc power supply's output voltage and connecting the resistor and the dc voltmeter in series with the dc power supply. In this configuration, the resistor and the internal resistance of the dc voltmeter form a voltage divider. The voltage drop across the dc voltmeter is measured and, with the value of the resistor and the power supply voltage being known, the internal resistance of the dc voltmeter is calculated.

NOTE

The best test results will be obtained when the value of the known resistor is equal to the internal resistance of the dc voltmeter.

The second phase of the tests consists of (1) placing the appropriate channel of the 44473A in parallel with the dc voltmeter, (2) measuring the voltage drop across the dc voltmeter/channel combination, and (3) calculating the channel's dc isolation.

1. SET-UP SEQUENCE: Set the digital multimeter to measure dc voltage. Connect the multimeter to the dc power supply. Set the dc power supply to deliver +20Vdc ±.01Vdc as measured on the multimeter. This voltage will be referred to as V1 in the following steps.

2. Use the multimeter to measure the exact resistance of the 10 megohm resistor. This resistance will be referred to as R1.

3. Connect the test equipment as shown in Figure 11-4.

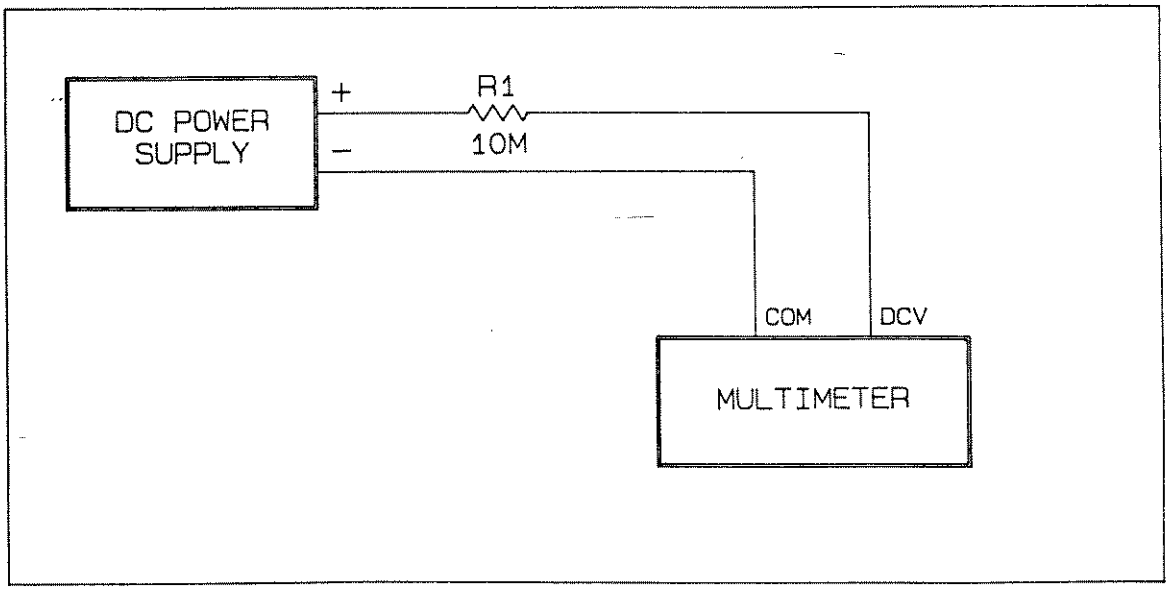


Figure 11-4 DC Isolation Test Set-Up

4. Set the multimeter to the 300Vdc range. Record the exact dc voltage reading 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 setting. For this reason, do not change the multimeter's range setting in the following steps.

6. ROW OR COLUMN TO CHASSIS TEST: Use the 3488A front panel to open all channels as follows:

a. Press the LOCAL key.

b. Press the CARD RESET key followed by the numeral key corresponding to the slot occupied by the 44473A.

c. Press the EXECUTE key.

7. Connect the 3488A backpanel ground terminal (chassis ground) and the low line of the channel under test (row 0 to start) into the test circuit as shown in Figure 11-5.

8. Record the multimeter's dc voltage reading. This reading will be referred to as **V3**.

9. Calculate the dc isolation (Rc) using the following equation:

$$Rc = \frac{V3 \bullet R1 \bullet Rm}{Rm \bullet (V1 - V3) - R1 \bullet V3}$$

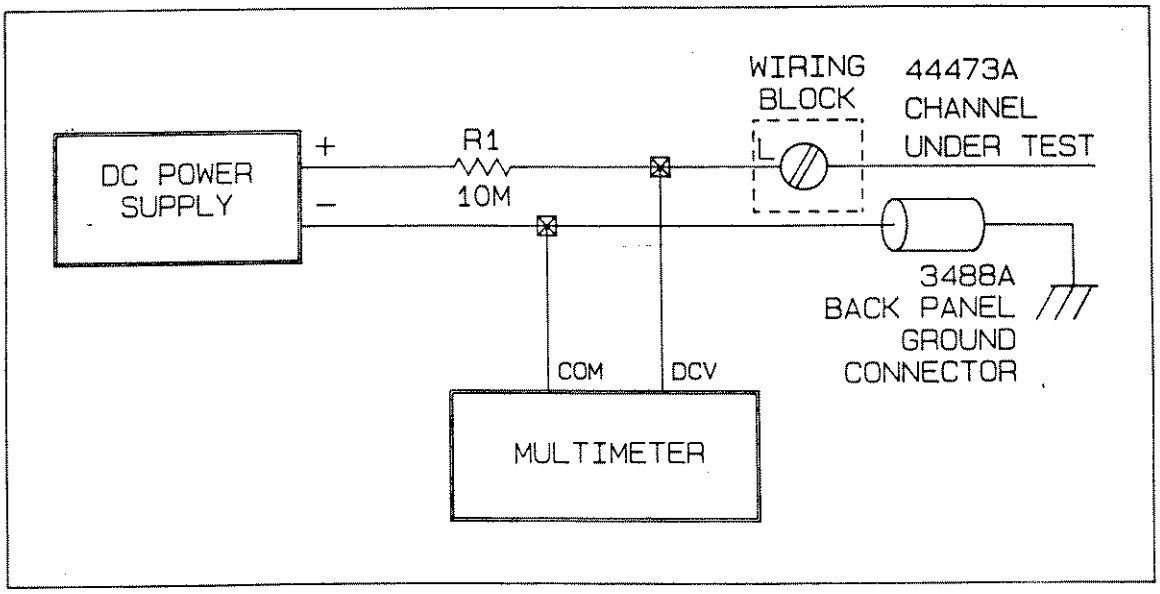


Figure 11-5 Row Or Column To Chassis DC Isolation Test

The row or column to chassis dc isolation should be greater than 500 megohms.

10. Repeat steps 7 through 9 for rows 1 through 3 and columns 0 through 3.

11. Connect the 3488A backpanel ground terminal (chassis ground) and the the high line of the channel under test (row 0 to start) into the test circuit as was done in step 7. Repeat steps 8 and 9 for the high lines of rows 0 through 3 and columns 0 through 3.

12. ROW OR COLUMN HIGH TO LOW DC ISOLATION TEST: Use the 3488A front panel keys to open all channels as follows:

a. Press the CARD RESET key followed by the numeral key corresponding to the slot occupied by the 44473A.

b. Press the EXECUTE key.

13. Configure a 44483A wiring block so that the high lines of all the rows and columns are shorted together as shown in Figure 11-6.

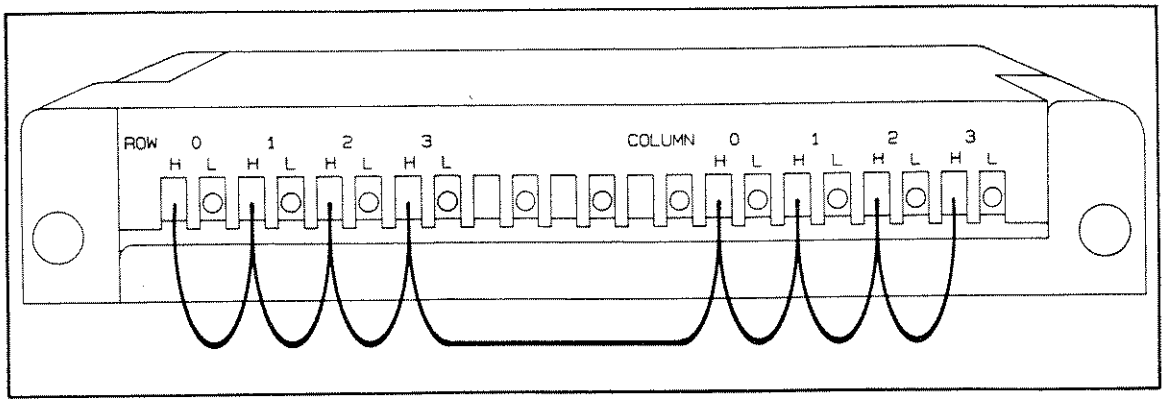


Figure 11-6 Row Or Column High To Low Test Wiring #1

14. Connect the shorted lines and the low line of the channel under test (row 0 to start) into the test circuit as shown in Figure 11-7.

15. Record the multimeter's dc voltage reading for the channel under test. This reading will be referred to as V4.

16. Calculate the dc isolation (Rc) using the following equation:

$$Rc = \frac{\overline{V4 \bullet R1 \bullet Rm}}{Rm \bullet (V1 - V4) - R1 \bullet V4}$$

The row or column high to low dc isolation should be greater than 100 megohms.

17. Repeat steps 14 through 16 for the low lines of rows 1 through 3 and columns 0 through 3.

18. Configure a 44483A wiring block so that the low lines of all the rows and columns are shorted together as shown in Figure 11-8.

19. Connect the shorted lines and the high line of the channel under test (row 0 to start) into the test circuit as shown in Figure 11-9.

20. Record the multimeter's dc voltage reading for the channel under test. This reading will be referred to as V5.

21. Calculate the dc isolation (Rc) using the following equation:

$$Rc = \frac{V5 \bullet R1 \bullet Rm}{Rm \bullet (V1 - V5) - R1 \bullet V5}$$

The row or column high to low dc isolation should be greater than 100 megohms.

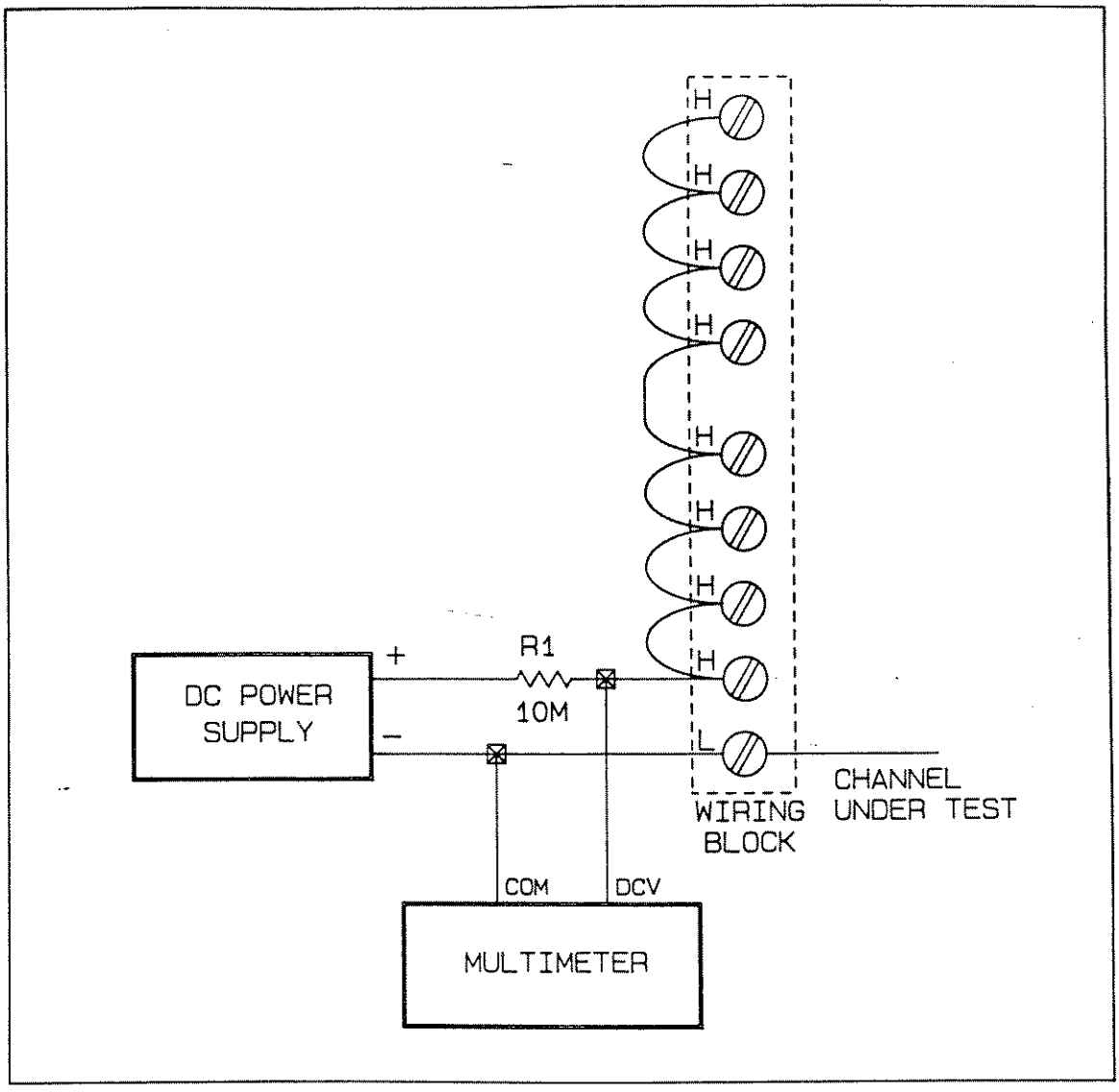


Figure 11-7 Row Or Column High To Low Test Circuit #1

22. Repeat steps 19 through 21 for the high lines of rows 1 through 3 and columns 0 through 3.

23. OPEN CONTACT DC ISOLATION TEST: Use the 3488A front panel keys to open all channels as follows:

a. Press the CARD RESET key followed by the numeral key corresponding to the slot occupied by the 44473A.

b. Press the EXECUTE key.

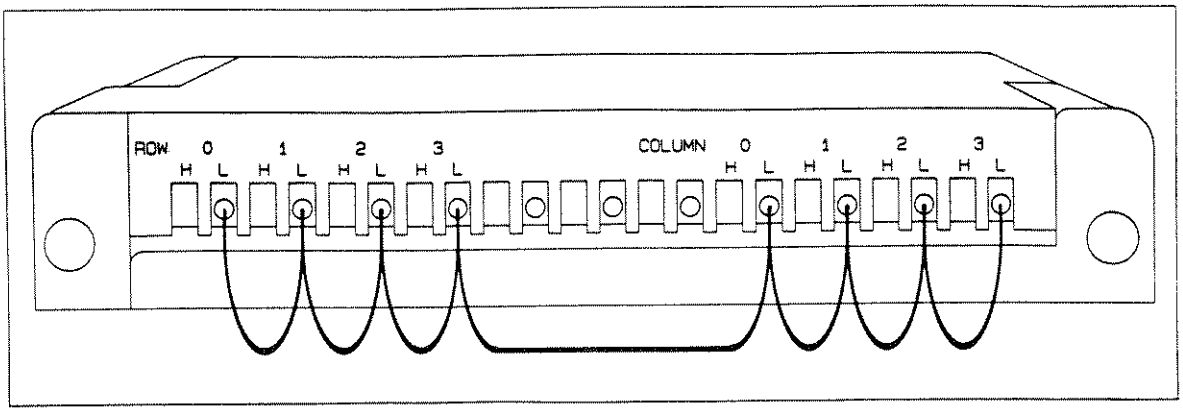


Figure 11-8 Row Or Column High To Low Test Wiring #2

24. Connect the low lines of the channels under test (row 0 and row 1 to start) into the test circuit as shown in Figure 11-10.

25. Record the multimeter's dc voltage reading for the channels under test. This reading will be referred to as V6.

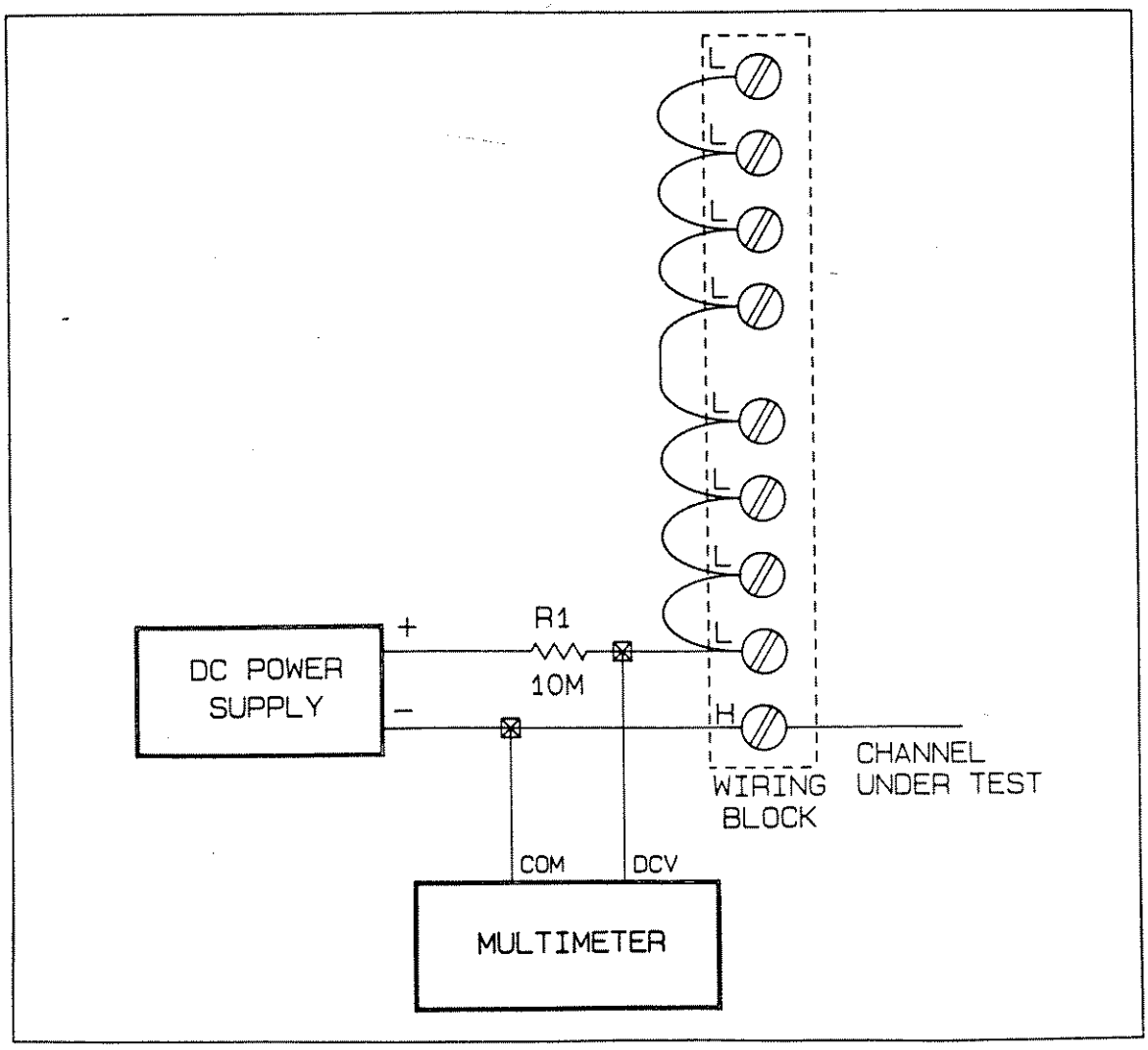


Figure 11-9 Row Or Column High To Low Test Circuit #2

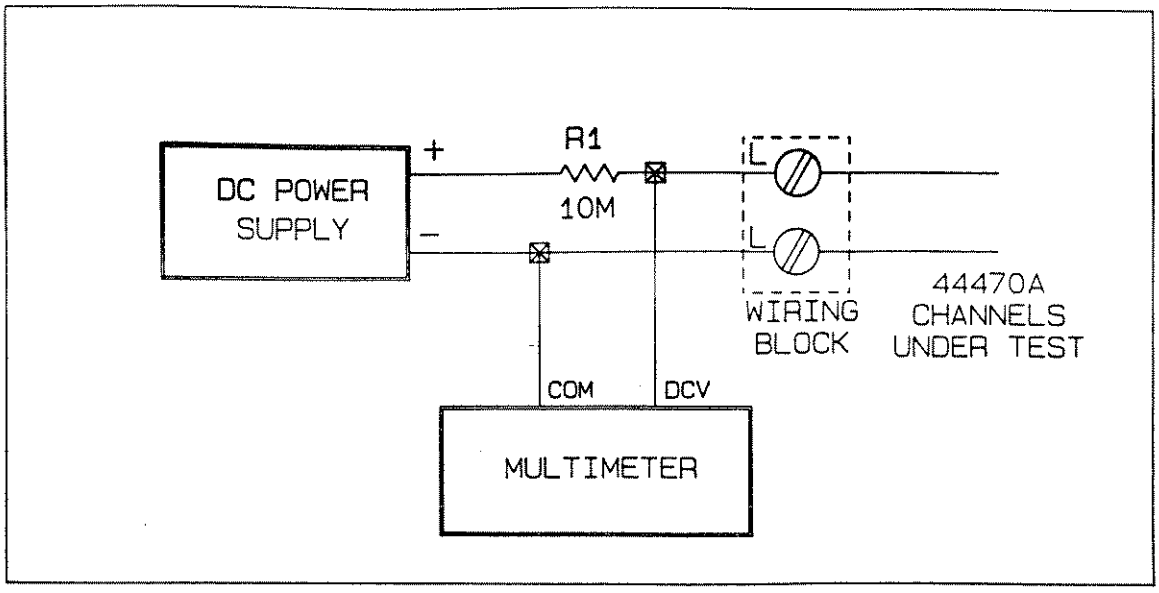


Figure 11-10 Open Contact DC Isolation Test

26. Calculate the dc isolation (Rc) using the following equation:

$$Rc = \frac{V6 \bullet R1 \bullet Rm}{Rm \bullet (V1 - V6) - R1 \bullet V6}$$

The open contact dc isolation should be greater than 1 gigohm.

27. Repeat steps 24 through 26 for the low lines of rows 1 and 2, rows 2 and 3, columns 0 and 1, columns 1 and 2, and columns 2 and 3.

28. Repeat steps 24 through 26 for the high lines of rows 0 and 1, rows 1 and 2, rows 2 and 3, columns 0 and 1, columns 1 and 2, and columns 2 and 3.

11-8 Corrective Action

A row or column to chassis dc isolation failure (step 9) can be caused by electrical leakage from a relay contact through its drive coil to ground, or by a damaged or dirty pc board. If damage is found, contact an HP Sales and Service Office for 44473A replacement information. If no damage is found, clean the board thoroughly (see Section 11-3).

A row or column high to low dc isolation failure (step 16 or 21) or an open contact dc isolation failure (step 26) is most likely caused by a damaged or dirty 44473A printed circuit board. If damage is found, contact an HP Sales and Service Office for 44473A replacement information. If damage is not found, clean the board thoroughly (see Section 11-3).

11-9 Thermal Offset Test

This is a test of the thermally generated dc voltage present on the 44473A. This test is very sensitive to ambient temperature changes and thermoelectricity generated at the junction of two dissimilar metals. For these reasons, it is important that this test be performed in an environment where the temperature is stable and the test lead connections are kept to a minimum.

1. Set the multimeter to its lowest dc voltage range. Connect the two multimeter test leads together and record the reference offset voltage. This voltage will be referred to as V1 in the following steps.

2. Set up a scan list and the card monitor mode as follows:

a. Press the SCAN LIST key followed by X00-X33 (where X is the slot occupied by the 44473A and 00-33 are the relays to be scanned).

b. Press the EXECUTE key.

c. Press the CARD MONITOR key followed by X (where X is the slot occupied by the 44473A).

d. Press the EXECUTE key.

3. Press the STEP key. Connect the multimeter between the low lines of the channels shown in the 3488A's display (row 0 and column 0 to start).

4. Record the dc voltage. This voltage will be referred to as V2. The difference between V1 and V2 must be less than 3μV for each relay.

5. Repeat steps 3 and 4 until all 16 relays have been tested.

6. Repeat steps 3 and 4 for the high lines of all relays.

11-10 Corrective Action

The most likely cause of a thermal offset failure is the relay. If a failure is found, use Figure 11-15 (44473A schematic) to determine the reference designator of the relay and Table 11-1 to determine the HP part number of the relay. Contact an HP Sales and Service Office for part ordering information.

11-11 REPLACEABLE PARTS

Table 11-1 lists the mechanical and electrical replaceable parts available for the 44473A. The mechanical parts are keyed to Figure 11-11. This figure also provides assembly and disassembly information. The electrical parts are keyed to the schematic and component locator in Figure 11-15. Table 5-2, in Chapter 5, lists manufacturers code numbers as they apply to the parts lists in Table 11-1.

11-12 44473A THEORY OF OPERATION

The 44473A Matrix Card consists of an input buffer and latch, relay drive and sense circuits, an address decoder, and a card-type/sense buffer. Refer to the 44473A schematic in the following discussion (Figure 11-15).

11-13 Input Buffer And Latch

The input buffer (U902 in Figure 11-15) provides isolation between the 44473A and the mainframe's data bus. An input buffer is present on each type of plug-in card an prevents excessive loading of the data bus by the plug-in cards.

The input latch (U903 and U905 in Figure 11-15) holds the output of the input buffer for application to the relay drive and sense circuitry.

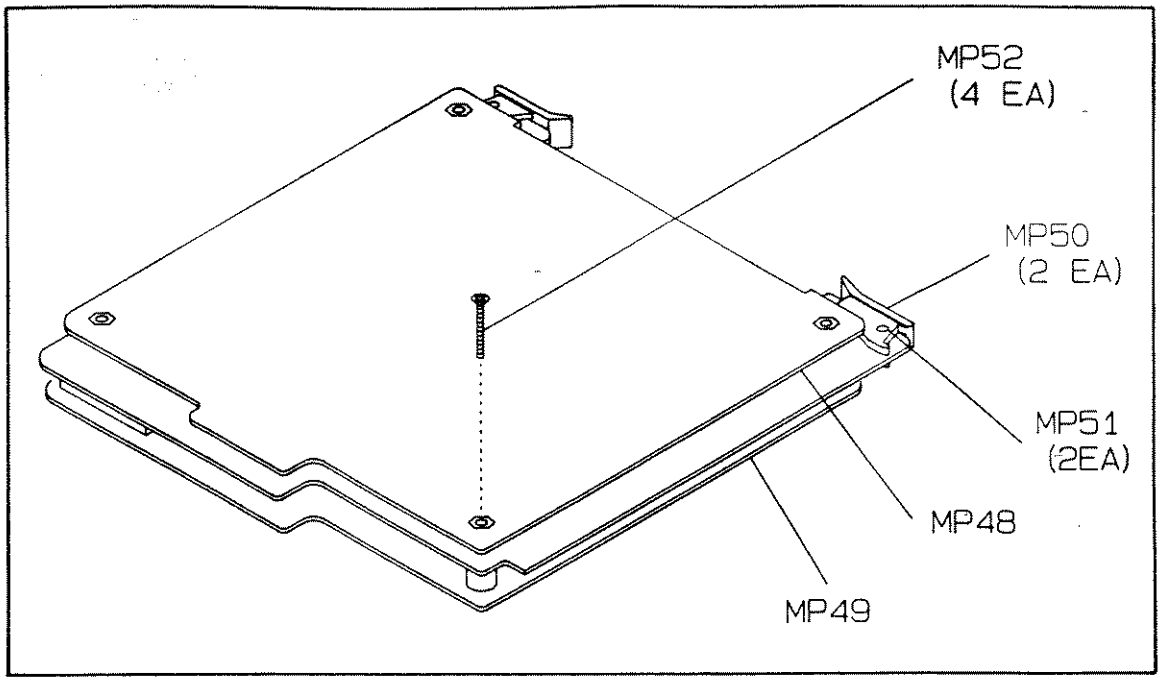


Figure 11-11 44473A Disassembly

11-14 Relay Drive And Sense Operation

A simplified schematic diagram of one relay drive and sense circuit is shown in Figure 11-12. When instructions are received over the data bus to set a relay (close a channel), a logic high level is applied to the base of Q2 and the input of U2 causing their outputs to go low. A logic low level is applied to the base of Q1 causing its output to go high. CR2 becomes forward biased allowing current to flow through both the set and reset coils of relay K1. The magnetic field generated around the coils interacts with the permanent magnetic field of the relay armature causing it to close the relay contacts. Once closed, the drive current is removed and the permanent magnetic field of the armature latches the contact in the closed state.

When instructions are received over the data bus to reset a relay (open a channel), a logic low level is applied to the base of Q2 and the input of U2 causing their outputs to go high. A logic high level is applied to the input of U1 causing its output to go low. CR1 becomes forward biased allowing current to flow through both the set and reset coils of relay K1. The magnetic field generated around the coils interacts with the permanent magnetic field of the relay armature causing it to open the relay contacts. Once opened, the drive current is removed from the relay and the permanent magnetic field of the armature latches the contacts in the opened state.

Notice that it is necessary to activate one of the upper drive elements (Q1 or U1) and the lower drive elements (Q2 and U2) in order to change a relay's state. If the elements in only the upper or lower drive are activated, no current flows through the relay coils and the relay retains its previous state. This aspect of operation is used by the mainframe in conjunction with the 44473A's relay sense circuitry to verify relay states following relay contact closures, a card reset, and an instrument reset.

When a relay state is being verified following a closure, a low is applied to the base of Q2

Table 11-1 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	44473-66501	3	1	MATRIX CARD ERC: 2712	28480	44473-66501
A1C901	0160-3847	9	4	CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C902	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C903	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C904	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C905	0160-0127	2	1	CAPACITOR-FXD 1UF +-20% 25VDC CER	28480	0160-0127
A1CR901	1901-0620	3	48	DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR902	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR903	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR904	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR905	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR906	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR907	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR908	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR909	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR910	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR911	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR912	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR913	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR914	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR915	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR916	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR917	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR918	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR919	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR920	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR921	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR922	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR923	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR924	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR925	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR926	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR927	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR928	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR929	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR930	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR931	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR932	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR933	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR934	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR935	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR936	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR937	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR938	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR939	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR940	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR941	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR942	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR943	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR944	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR945	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR946	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR947	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1CR948	1901-0620	3		DIODE-SWITCHING 60V 400MA DO-35	9N171	NDP250
A1J901	5180-6638	4	1	CONN-2X11 RT ANG	28480	44473-82102
A1K901	0490-1337	7	16	RELAY-S4EB-L2-5V	28480	0490-1337
A1K902	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1K903	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1K904	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1K905	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1K906	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1K907	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1K908	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1K909	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1K910	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1K911	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1K912	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1K913	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1K914	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1K915	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337

See introduction to this section for ordering information
*Indicates factory selected value

Table 11-1 Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1K916	0490-1337	7		RELAY-S4EB-L2-5V	28480	0490-1337
A1P901	5180-6697	9	1	CONN-RT ANG 2X15	28480	1251-8645
A1Q901	1853-0551	6	8	XSTR-TN4030-237	28480	1853-0551
A1Q902	1853-0551	6		XSTR-TN4030-237	28480	1853-0551
A1Q903	1853-0551	6		XSTR-TN4030-237	28480	1853-0551
A1Q904	1853-0551	6		XSTR-TN4030-237	28480	1853-0551
A1Q905	1853-0551	6		XSTR-TN4030-237	28480	1853-0551
A1Q906	1853-0551	6		XSTR-TN4030-237	28480	1853-0551
A1Q907	1853-0551	6		XSTR-TN4030-237	28480	1853-0551
A1Q908	1853-0551	6		XSTR-TN4030-237	28480	1853-0551
A1R901	0683-2725	8	8	RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A1R902	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A1R903	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A1R904	0683-1035	1	9	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R905	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R906	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R907	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R908	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R909	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R910	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R911	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R912	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A1R913	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A1R914	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A1R915	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A1R916	0683-2725	8		RESISTOR 2.7K 5% .25W FC TC=-400/+700	01121	CB2725
A1R917	0683-1035	1		RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R918	0683-4705	8	4	RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A1R919	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A1R920	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A1R921	0683-4705	8		RESISTOR 47 5% .25W FC TC=-400/+500	01121	CB4705
A1U901	1820-2537	3	2	IC DRVR CMOS LINE DRVR OCTL	27014	MM74C244N
A1U902	1820-2537	3		IC DRVR CMOS LINE DRVR OCTL	27014	MM74C244N
A1U903	1820-2216	5	2	IC FF CMOS D-TYPE POS-EDGE-TRIG OCTL	27014	MM74C374N
A1U904	1858-0047	5	2	TRANSISTOR ARRAY 16-PIN PLSTC DIP	13606	ULN-2003A
A1U905	1820-2216	5		IC FF CMOS D-TYPE POS-EDGE-TRIG OCTL	27014	MM74C374N
A1U906	1858-0047	5		TRANSISTOR ARRAY 16-PIN PLSTC DIP	13606	ULN-2003A
A1U907	1820-1216	3	1	IC DCDR TTL LS 3-TO-8-LINE 3-INP	01295	SN74LS138N
MP48	03488-00602	8	1	CARD SHIELD - CKT	28480	03488-00602
MP49	03488-00603	9	1	CARD CHIELD - COMP	28480	03488-00603
MP50	0403-0464	6	2	PC EXTRACTER WHT	28480	0403-0464
MP51	1480-0625	4	2	PIN-GRV 3/32 X 1/4	28480	1480-0625
MP52	0515-0843	2	4	SCREW M2.5 X 20 LK	28480	0515-0843
	5040-5193	3	1	STRAIN RELIEF HOUSING	28480	5040-5193
	5040-5194	4	1	STRAIN RELIEF PLATE	28480	5040-5194
				NOTE: HP PRODUCT NUMBER 44483A INCLUDES CONNECTOR TERMINAL BLOCK AND STRAIN RELIEF ASSEMBLY.		

See introduction to this section for ordering information
*Indicates factory selected value

and to the input of U2. This causes a high at the input of inverter U3 causing its output to go low. If the sense switch is in the correct state (closed) a low is applied, through the switch contacts, to the card-type/sense buffer. The controller recognizes this signal as being correct and no error message occurs.

If, following a closure, the sense switch is in the incorrect state (open), the pull-up resistor R1 applies a high to the card-type/sense buffer. The controller recognizes this as an incorrect state and displays ERR:8 LOGIC.

Relay sense operation following a card or instrument reset is similar to that described above with the exception that the controller interprets an open sense switch as the correct state and a closed sense switch as the incorrect state.

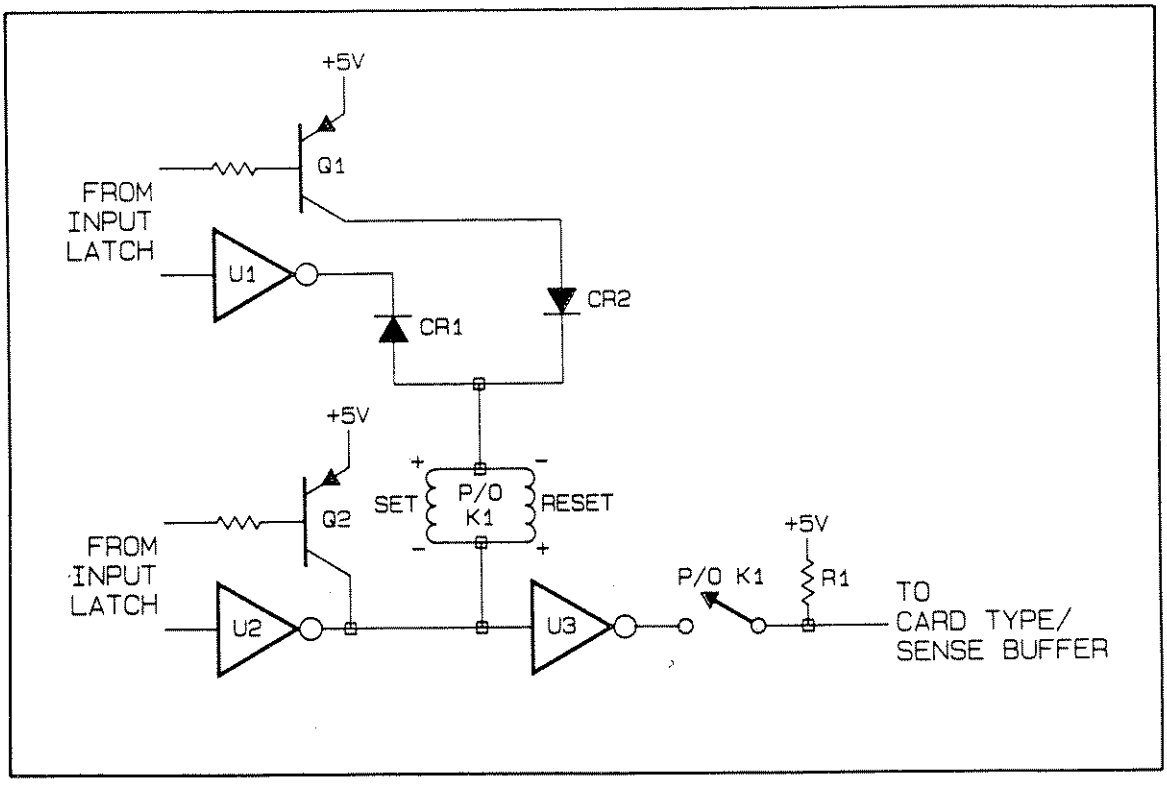


Figure 11-12 One Relay Drive and Sense Circuit

11-15 Card-Type/Sense Buffer

The card-type/sense buffer (U901 in Figure 11-15) indicates to the mainframe that a 44473A is in the particular card slot queried. The card type is determined by the wiring configuration of four of the input lines to the card-type/sense buffer. By connecting two inputs to +5Vdc and two inputs to ground, a 4-bit code (0011) is created that is recognized by the mainframe as the unique identifier for the 44473A card.

The card-type/sense buffer also provides isolation between the outputs of the sense circuits and the mainframe's data bus. In short, this buffer provides the necessary current to drive the data bus.

11-16 Address Decoder

The address decoder (U907 in Figure 11-15) is enabled when the $\overline{CS}$ signal from the main-

frame goes low. Once enabled, the address decoder is responsible for enabling the various IC's on the board in response to the instructions it receives via the R/$\overline{W}$, A0 and A1 signals from the controller. Figures 11-13 and 11-14 show the timing relationships between these control lines for both read and write operations.

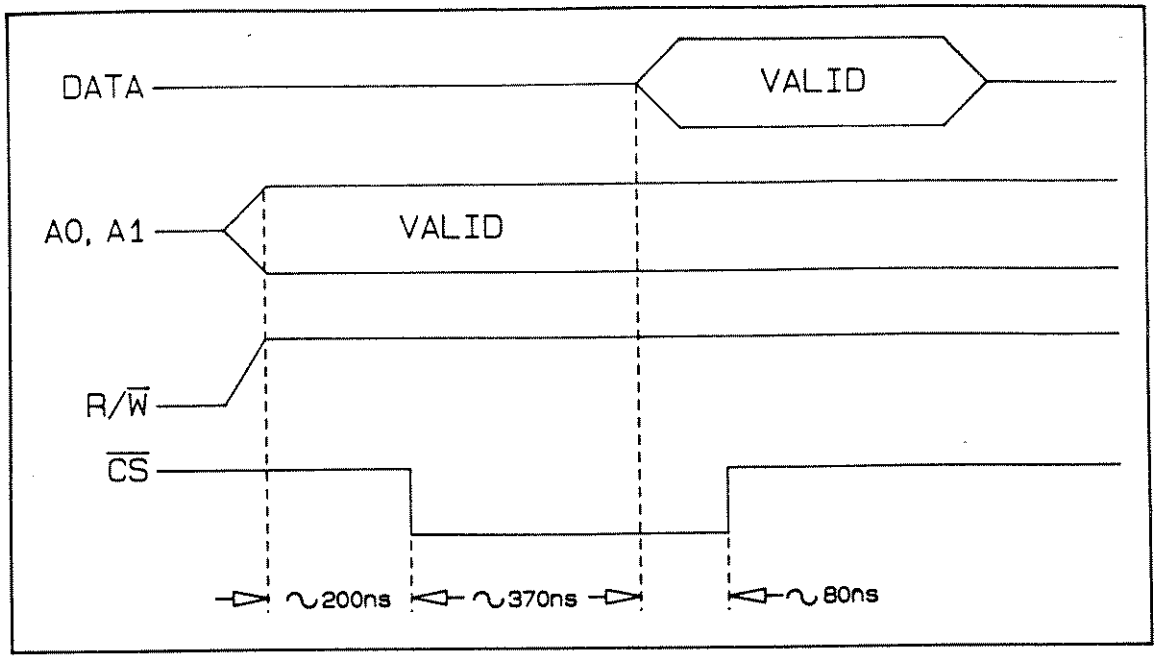


Figure 11-13 Control Line Timing (Read)

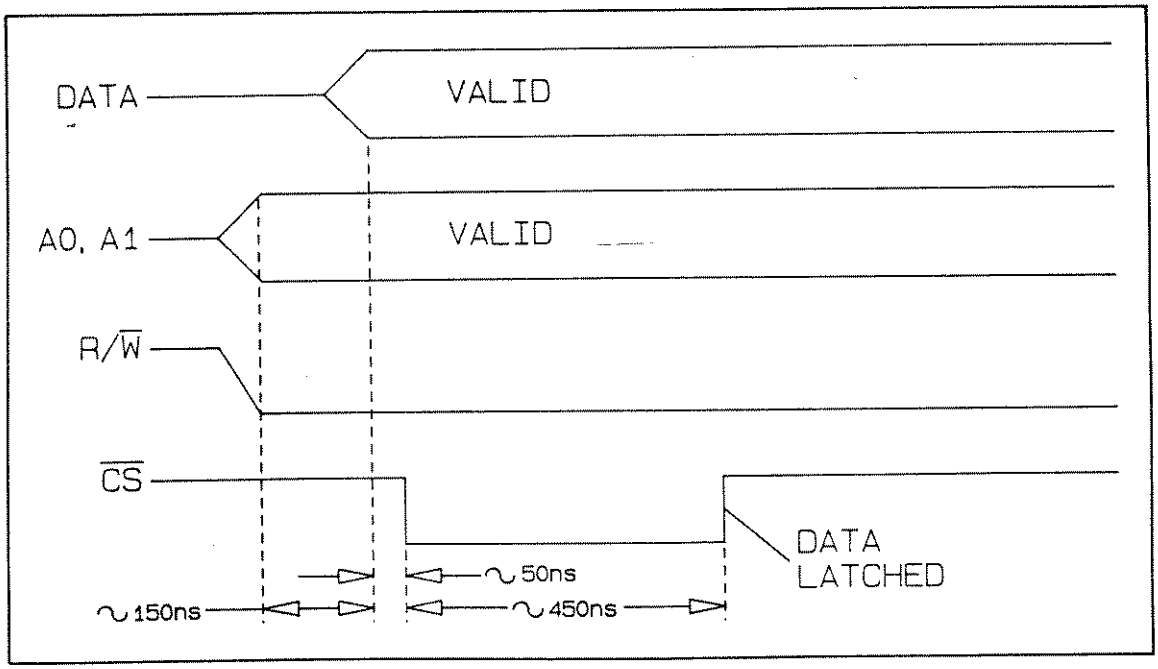


Figure 11-14 Control Line Timing (Write)

11-17 44473A TROUBLESHOOTING

11-18 Introduction

If the Performance Tests (Section 11-5) or Operational Verification tests (Chapter 4) have

indicated that a particular relay is failing, that relay is probably at fault. A failure of the relay contact resistance test indicates a bad relay.

If more than one relay failure is indicated, the associated drivers should be suspected. Using Figure 11-15 (44473A Schematic) the problem can be isolated to a few components from the symptoms. The relays on the 44473A circuit board are schematically arranged into four rows and four columns. To close a relay, both a row driver and a column driver must be active. Failures in the drivers, then, will exhibit symptoms that are common to a row or a column.

For example; suppose all relays in column 0 are failing to close. From the schematic, it is determined that column 0 relays correspond to K901, K905, K909 and K913. Further examination of the schematic reveals that all these relays are in the same column (column 0). The drivers Q903, U904, and U903 would be suspected.

As a another example; suppose all relays in row 2 are failing to close. This row corresponds to relays K909, K910, K911 and K912. These three relays are in a common row. The suspected drivers would be Q906, U906 and U905.

11-19 ERR 8: LOGIC SLOT X

The mainframe error most associated with the plug-in option cards is the ERROR 8: LOGIC error. This error is generated when the controller checks the relays sense circuitry after changing a relay state. The operation of the relay sense circuitry is described in Section 11-14.

The sense circuitry is used by the controller to indicate that a relay did not close when instructed or did not open when instructed. However, the controller does not always check each state. After a power-on reset, a front panel (or remote) reset, or a card reset, the controller checks the sense circuitry for open contacts. If one or more contacts is indicating the closed position, the controller will beep and display ERR 8: LOGIC. After a close command, the controller checks the sense circuitry to determine if the indicated relay is closed. If the sense circuitry indicates the relay is open the controller beeps and displays ERR 8: LOGIC. This action occurs for each relay closure including scan lists and stored set-ups. Following a relay opening, however, the controller does NOT check the sense circuitry for the open. This means that a relay may stick closed and the controller will not flag an error. This occurs for relays opened through the open command, scan lists, and stored set-ups.

In summary, the controller checks for open relays following power-on resets, front panel or remote resets, and card resets. It checks for closed relays following a close command (whether executed by the close command, a scan list or a stored set-up).

When troubleshooting a plug-in card that is generating ERROR: 8 LOGIC it is important to carefully observe the symptoms. If the error is generated when power is applied to the 3488A (controller checking for openings) check the relay contacts to determine if a relay is stuck closed. If no relay is stuck closed, suspect the sense circuitry. If the error is generated following a close command, check the relay contacts to determine if the relay is closed. If the relay is closed, suspect the sense circuitry.

11-20 Equipment Required

Signature Multimeter	HP 5005A or equivalent
Service Extender Cable	5061-1174
Service Extender Board	5061-1173

11-21 Initial Checks

The initial checks of a suspected plug-in card will require that the plug-in card shields be removed. Removal of the four screws in the plug-in shield allows both shields to be removed from the plug-in printed circuit board.

Once the shields have been removed, the card to be tested should be installed in slot 1 of the mainframe. There are two ways to do this. The first method uses the Service Extender Board (5061-1173) and the Service Extender Cable (5061-1174). With these two service tools the card may be electrically installed in the card slot but be physically located on the test bench.

If the service extender tools are not available, the card may be installed in slot 1 and the 3488A mainframe top cover removed. This will allow access to the non-component side of the plug-in card for servicing. 3488A top cover removal is described in Chapter 5.

Be sure that all other plug-in cards have been removed from the mainframe.

1. Apply power and measure the +5 Vdc on the plug-in board. There are two supplies to this board, both the supplies (and the grounds) are common on the backplane board. Connect the ground lead of the voltmeter to pin 10 of U901. Measure the voltage at pin 20 of U901. The voltage should be +5 Vdc ±0.5 Vdc. Measure the voltage at the emitter of any of the discrete transistors on the board (i.e., Q906). The transistors are mounted with the emitter lead in a square pad on the board. The voltage should be +5 Vdc ±0.5 Vdc.

If the voltages are correct, proceed to Step 2. If either or both of the voltages are incorrect, troubleshoot the +5 Vdc supply in the mainframe (it is possible that the plug-in card is loading the supply).

2. Observe the front panel symptoms to determine if the problem can be isolated to a few components. The Operational Verification tests is Chapter 4 may be used to identify a relay contact or closure problem. If a relay is closing (or opening) correctly, as determined by the relay contact tests, but the mainframe displays ERR 8: LOGIC, the relay sense circuitry is at fault. The mainframe will also display ERR 8: LOGIC if one or more relays are not functioning (refer to Section 11-19 for a discussion of the error message).

If a single relay (channel) is at fault, troubleshoot that relay. If one or more relays indicate a fault, the drivers should be suspected (refer to Section 11-18).

If the problem cannot be isolated easily, proceed to Step 3.

3. Check the mainframe and plug-in card data bus for activity. The data probe of the HP 5005A may be used to indicate activity on the data bus. A blinking probe light indicates state changes. Check the data bus at U902 pins 2, 4, 6, 8, 11, 13, 15 and 17. The plug-in card must be installed in slot 1 and power applied to the mainframe. No special test set-ups should be installed.

All eight data lines should show activity.

If activity is found, proceed to Step 4. If one or more of the lines are stuck, troubleshoot the backplane data bus or the inputs to buffers U901 and U902 on the plug-in card.

4. Check the outputs of U902 at pins 3, 5, 7, 9, 12, 14, 16 and 18 for activity. All eight pins should show activity.

If activity is found, proceed to Step 5. If no activity is found on one or more lines, troubleshoot U902, U905 or U903.

5. Check the backplane card select and decoding lines for activity. Check U907 pins 1, 2, 3, and 4 for activity. All lines should show activity.

If activity is found, proceed to Step 6. If no activity is found, troubleshoot the backplane or the inputs to U907 on the plug-in card.

6. If the problem has not been isolated, signature analysis procedures may be used to test the buffers, drivers, and relay coils. The procedure begins in Section 11-22.

11-22 Buffer, Driver, And Relay Signature Analysis

To perform the signature analysis tests the mainframe top cover and the controller shield must be removed. Procedures to remove the cover and shield are located in Chapter 5.

The HP 5005A has been recommended for this signature analysis test because it incorporates adjustable data thresholds. This feature allows signatures to be checked at the relay coils. If a different signature analyzer is being used, the signatures may only be checked up to the drivers.

Ensure the controller is set to the normal operating configuration (RP409 installed and all switches on SP401 set open) before performing these troubleshooting steps. All plug-in cards should be removed from the mainframe. The suspected plug-in card must be installed in slot 1.

The initial checks given in section 11-21 should be performed prior to this signature analysis procedure. Section 11-21 also describes the use of the service extender card and service extender cable.

1. Signature Analyzer set-up. Polarity: START _/‾, STOP and CLOCK ‾_. On the controller printed circuit board (A40), connect START/ST/SP to SA2, STOP/QUAL to SA2, CLOCK to SA3, Ground to SA4.

2. On the controller printed circuit board (A40), connect a jumper between SA6 (SERV FUNC) and ground (SA4).

3. If using the HP 5005A signature analyzer, set the data probe threshold to 2.80 H and 2.00 L.

4. Apply power to the 3488A. Press the TEST key on the front panel. Instead of performing the internal controller self-test, the display will prompt for a number. Enter 2 and press execute.

5. The signature analyzer should now be gating. The 3488A display will show RELAY S.A. The test selected cycles all data lines in a fixed pattern. This pattern will produce one of two signatures (depending upon inversion) that may be traced from the relay coils to the backplane data bus. These signature are: 36U6 and 6HPH.

6. The signatures for the inputs and outputs on the 44471A are given in Table 11-2.

11-23 Sense Circuit Troubleshooting

Problems with the sense circuitry will typically exhibit ERR 8: LOGIC in the display. A discussion of the error message as it applies to the plug-in card is given is Section 11-19. A theory of operation of the sense circuitry is given in section 11-14.

The drivers for the sense circuit, U904 and U906, are open collector drivers. This means that one of the relays sense contacts must be closed for the driver to operate. The driver may be manually tested by closing an appropriate relay to provide as current path and exercising the input to the driver.

Problems with the sense circuitry can also be isolated with a signature analysis procedure. This procedure begins in Section 11-24.

11-24 Sense Circuitry Signature Analysis

This procedure checks the signatures at the input to the buffer, U901. This buffer has four inputs from the sense circuitry, pins 11, 13, 15, and 17. Each of these inputs represents a composite signal obtained through several different relays and drivers. The signature analysis procedure is designed so that one column of relays is driven at a time (i.e., K901, K905, K909 and K913 are in column 0). Each relay in the column is sensed by a separate line. By observing the signatures obtained at the input to U901 and knowing which column is being driven to obtain the signature, a problem may be isolated to one driver and a set of relays. If all the signatures are incorrect for a given column, the drivers should be suspected. If only one signature is incorrect, the relay should be suspected.

To perform the signature analysis tests the mainframe top cover and the controller shield must be removed. Procedures to remove the cover and shield are located in Chapter 5.

Ensure the controller is set to the normal operating configuration (RP409 installed and all switches on SP401 set open) before performing these troubleshooting steps. All plug-in cards should be removed from the mainframe. The suspected plug-in card must be installed in slot 1.

The initial checks given in section 11-21 should be performed prior to this signature analysis procedure. Section 11-21 also describes the use of the service extender card and service extender cable.

1. Signature Analyzer set-up. Polarity: START ⎍⎺, STOP and CLOCK ⎺⎽. On the controller printed circuit board (A40), connect START/ST/SP to SA2, STOP/QUAL to SA2, CLOCK to SA3, Ground to SA4.

2. On the controller printed circuit board (A40), connect a jumper between SA6 (SERV FUNC) and ground (SA4).

3. Apply power to the 3488A. Press the TEST key on the front panel. Instead of performing the internal controller self-test, the display will prompt for a number. Enter 3 and press execute.

4. The signature analyzer should now be gating. The test selected drives on column of relays at a time. The 3488A display will show COLUMN 0 SA. Pressing the right arrow key on the front panel increments the column number. Pressing the left arrow key decrements the column number.

This test is very noisy as all the relays are being cycled.

5. The signatures for each column and input of U901 are given in Table 11-3a. Table 11-3b identifies the components that are being used to make up the correct signature.

Table 11-2 Buffer, Driver, And Relay Signatures (Test 2)

+5 Vdc signature: 5C1C

U902

pin	signature	pin	signature
1	NA	20	+5 Vdc
2	36U6	19	NA
3	36U6	18	36U6
4	36U6	17	36U6
5	36U6	16	36U6
6	36U6	15	36U6
7	36U6	14	36U6
8	36U6	13	36U6
9	36U6	12	36U6
10	NA	11	36U6

U903

pin	signature	pin	signature
1	L	20	+5 Vdc
2	6HPH	19	6HPH
3	36U6	18	36U6
4	36U6	17	36U6
5	6HPH	16	6HPH
6	6HPH	15	6HPH
7	36U6	14	36U6
8	36U6	13	36U6
9	6HPH	12	6HPH
10	NA	11	NA

U905

pin	signature	pin	signature
1	L	20	+5 Vdc
2	36U6	19	36U6
3	36U6	18	36U6
4	36U6	17	36U6
5	36U6	16	36U6
6	36U6	15	36U6
7	36U6	14	36U6
8	36U6	13	36U6
9	36U6	12	36U6
10	NA	11	NA

U904

pin	signature	pin	signature
1	36U6	16	NA
2	36U6	15	NA
3	6HPH	14	36U6
4	36U6	13	6HPH
5	6HPH	12	36U6
6	6HPH	11	36U6
7	6HPH	10	36U6
8	NA	9	+5 Vdc

U906

pin	signature	pin	signature
1	NA	16	NA
2	36U6	15	6HPH
3	36U6	14	NA
4	36U6	13	NA
5	36U6	12	6HPH
6	NA	11	NA
7	36U6	10	6HPH
8	NA	9	+5 Vdc

K901 *

pin	signature	pin	signature
1,7	36U6	6,12	6HPH

K907 *

pin	signature	pin	signature
1,7	6HPH	6,12	36U6

K912 *

pin	signature	pin	signature
1,7	6HPH	6,12	36U6

K902 *

pin	signature	pin	signature
1,7	6HPH	6,12	36U6

K908 *

pin	signature	pin	signature
1,7	36U6	6,12	6HPH

K913 *

pin	signature	pin	signature
1,7	6HPH	6,12	36U6

K903 *

pin	signature	pin	signature
1,7	36U6	6,12	6HPH

K909 *

pin	signature	pin	signature
1,7	36U6	6,12	6HPH

K914 *

pin	signature	pin	signature
1,7	36U6	6,12	6HPH

K904 *

pin	signature	pin	signature
1,7	6HPH	6,12	36U6

K910 *

pin	signature	pin	signature
1,7	6HPH	6,12	36U6

K915 *

pin	signature	pin	signature
1,7	6HPH	6,12	36U6

K905 *

pin	signature	pin	signature
1,7	6HPH	6,12	36U6

K911 *

pin	signature	pin	signature
1,7	36U6	6,12	6HPH

K916

pin	signature	pin	signature
1,7	36U6	6,12	6HPH

K906 *

pin	signature	pin	signature
1,7	36U6	6,12	6HPH

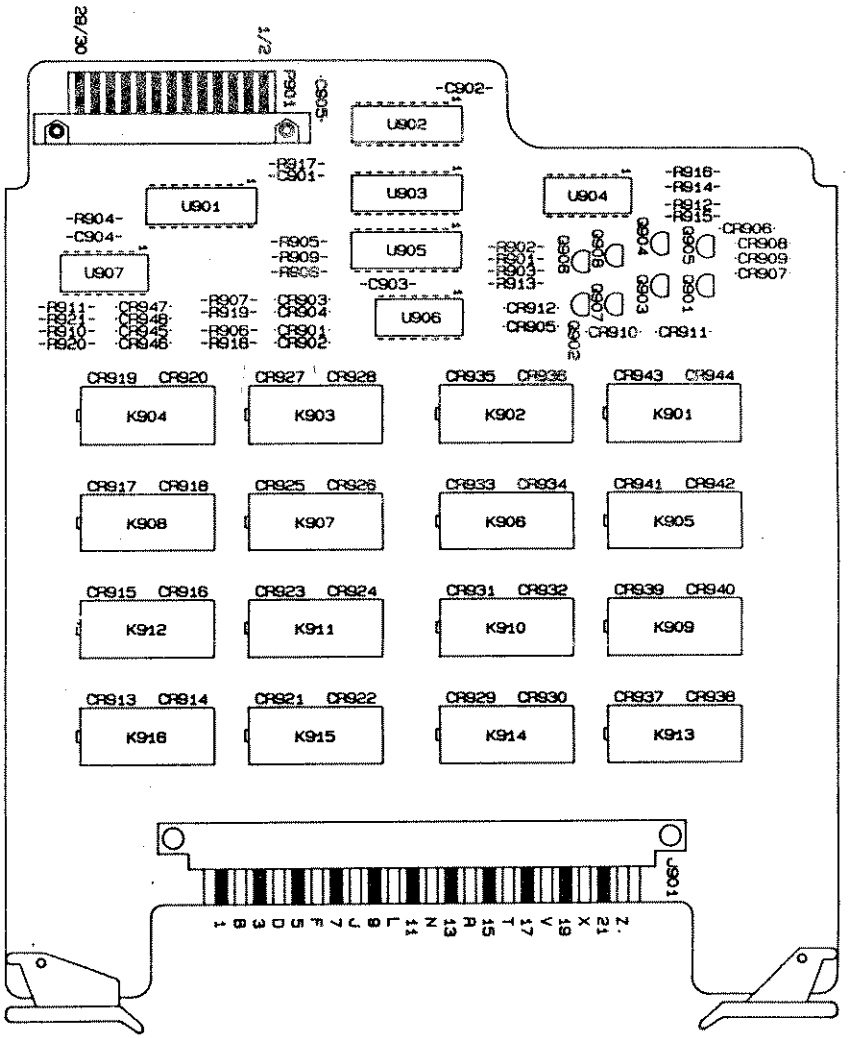
* these signatures have a data threshold of 2.80 H and 2.0 L.

Table 11-3a Sense Circuit Signatures

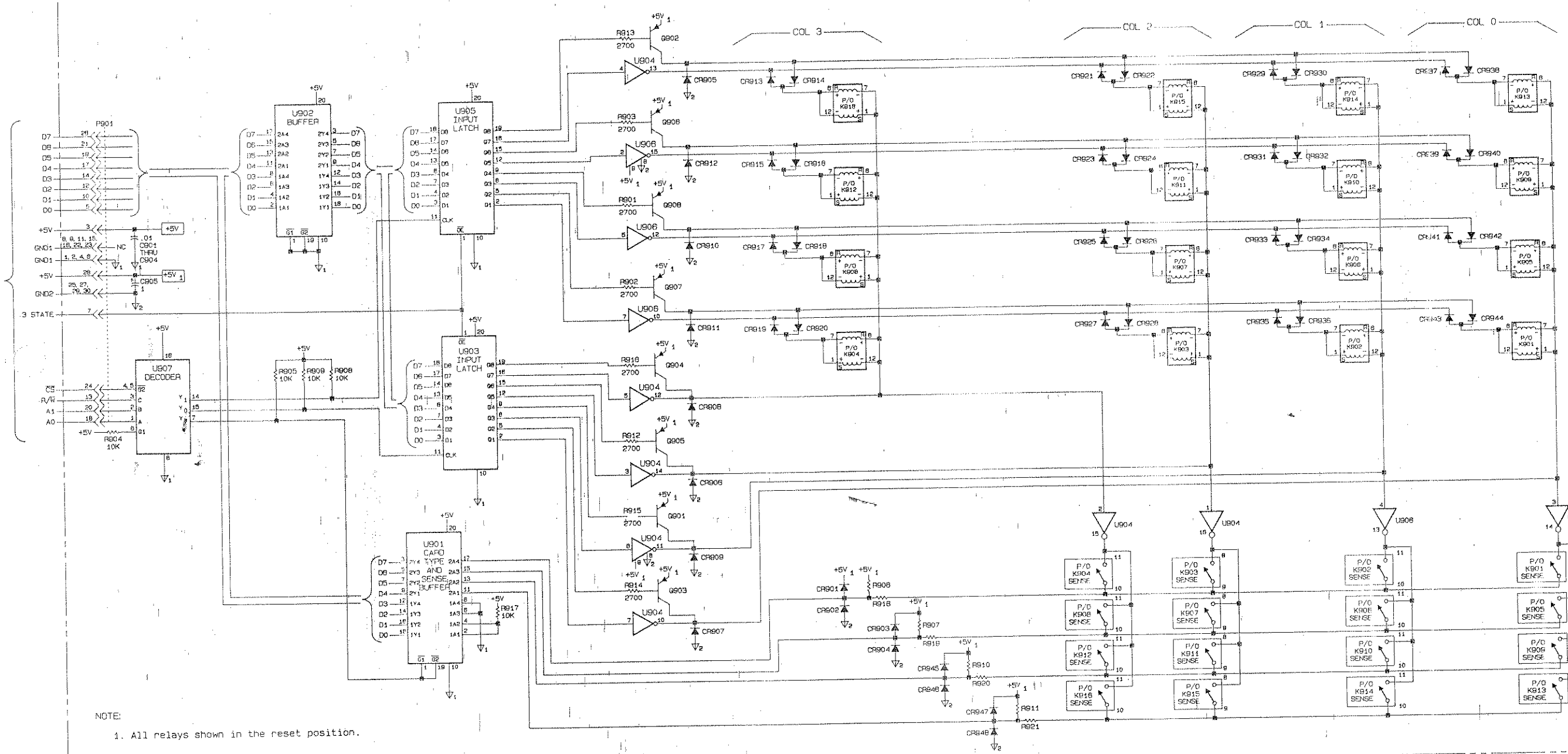
+5Vdc signature: 6592				
	column 0	column 1	column 2	column 3
U901 pin 17	474A	474A	474A	474A
U901 pin 15	2P64	2P64	2P64	2P64
U901 pin 13	PF66	PF66	PF66	PF66
U901 pin 11	003C	003C	003C	003C

Table 11-3b Components Used For Signatures

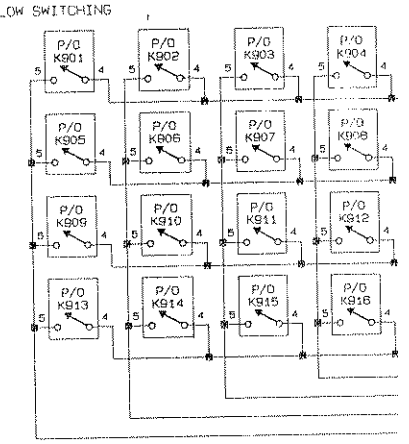
	column 0	column 1	column 2	column 3
U901 pin 17	U906 K901	U906 K902	U904 K903	U904 K904
U901 pin 15	U906 K905	U906 K906	U904 K907	U904 K908
U901 pin 13	U906 K909	U906 K910	U904 K911	U904 K912
U901 pin 11	U906 K913	U906 K914	U904 K915	U904 K916


28/30
1/2
P901
C905
C902
U902
U903
U904
U905
U906
U907
U901
R917
C901
R904
C904
R905
R909
R908
C903
R907
R919
R906
R918
CR903
CR904
CR901
CR902
CR907
CR912
CR905
CR910
CR911
R916
R914
R912
R915
CR906
CR908
CR909
CR907
C904
C905
C901
C903
C907
C902
CR919 CR920
K904
CR927 CR928
K903
CR935 CR936
K902
CR943 CR944
K901
CR917 CR918
K908
CR925 CR926
K907
CR933 CR934
K906
CR941 CR942
K905
CR915 CR916
K912
CR923 CR924
K911
CR931 CR932
K910
CR939 CR940
K909
CR913 CR914
K916
CR921 CR922
K915
CR929 CR930
K914
CR937 CR938
K913
J901

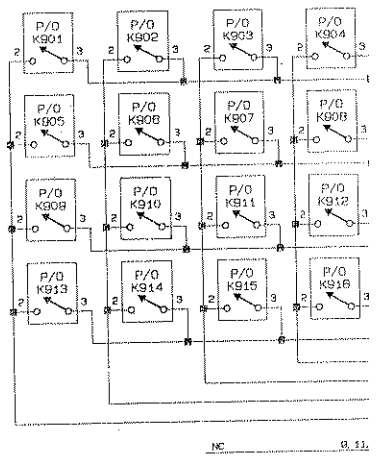
A1 44473-66501 REV A ERC: 2340
4X4 MATRIX SWITCH



LOW SWITCHING



HIGH SWITCHING



NOTE:

1. All relays shown in the reset position.

Figure 11