CHAPTER X
44472A DUAL 4 CHANNEL VHF SWITCH

10-1 INTRODUCTION

This chapter contains installation information, performance testing information, troubleshooting information, and replaceable parts lists for the 44472A Dual 4 Channel VHF Switch.

The VHF switch consists of two 4 channel to 1 channel multiplexers with BNC connectors. Only the center conductor of each channel is switched. The outer conductors (shields) of all channels in a particular multiplexer are connected together and unswitched. A simplified schematic of the 44472A is shown in Figure 10-1.

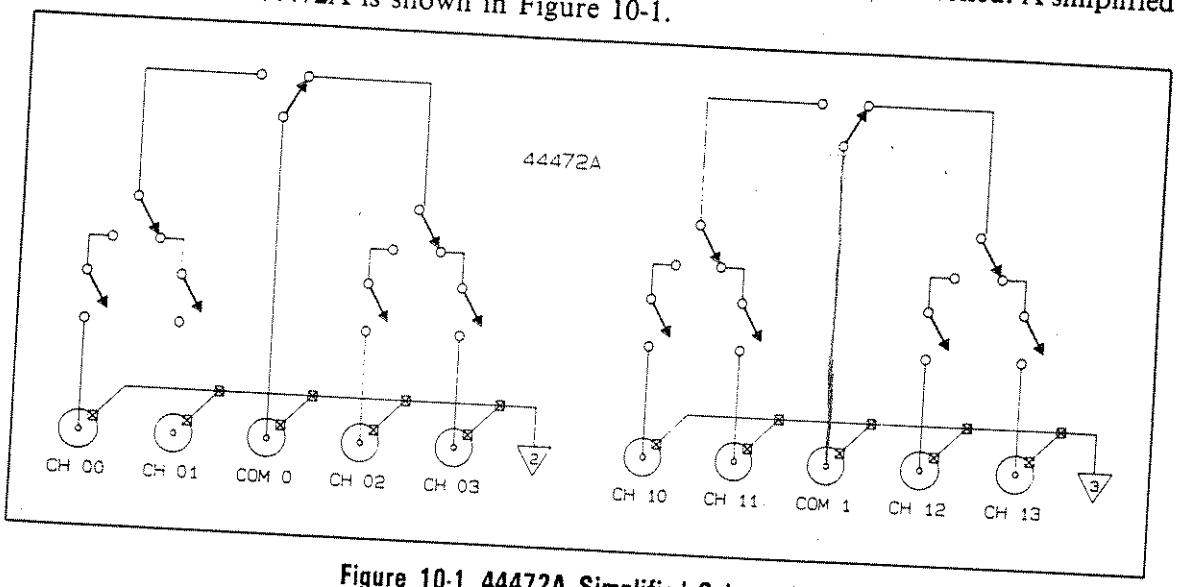


Figure 10-1 44472A Simplified Schematic

WARNING

Hazardous voltage may exist on the wiring and connectors of the 44472A 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.

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.

10-2 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 allowable voltage limits (center conductor-to-center conductor, or center conductor-to-shield) for the 44472A are 250Vdc or 30Vac rms (42Vac peak). The maximum allowable dc voltage limit (shield-to-chassis or shield-to-shield) for the 44472A is 42Vdc. The maximum current limits (per channel) are 30mA dc or 300mA ac rms.* Damage will occur to the 44472A and possibly the 3488A if any of the above limits are exceeded.*

10-3 PERFORMANCE TESTS

The following Performance Tests check the 44472A's dc isolation, thermal offset, insertion loss, VSWR, and channel to channel crosstalk specifications. The results of these tests, when coupled with the results of the 44472A Operation Verification Test, will verify whether or not the 44472A is operating within its critical specifications. The 44472A Operation Verification Test is located in Chapter 4 of this manual. Since the 44472A Operation Verification Test assesses the operability of the 44472A, it is important that it be performed prior to performing the Performance Tests.

* To maintain compliance with VDE class B or FTZ 1115/83 radiation limits, use semi-rigid or equivalent coax cable and limit the signal to $< 20\ V \times Hz$.

WARNING

If the 44472A 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).

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 44472A.

10-4 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.

HP 8505A RF Network Analyzer

HP 8503A (50 Ohm) S-Parameter Test Set

BNC-type Direct Feedthru Connector (Male Barrel)

BNC-type Shorting Connector

BNC-type 50 Ohm Termination

10-5 44472A 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 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 44472A 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 value will be referred to as R1.

3. Connect the test equipment as shown in Figure 10-2.

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.

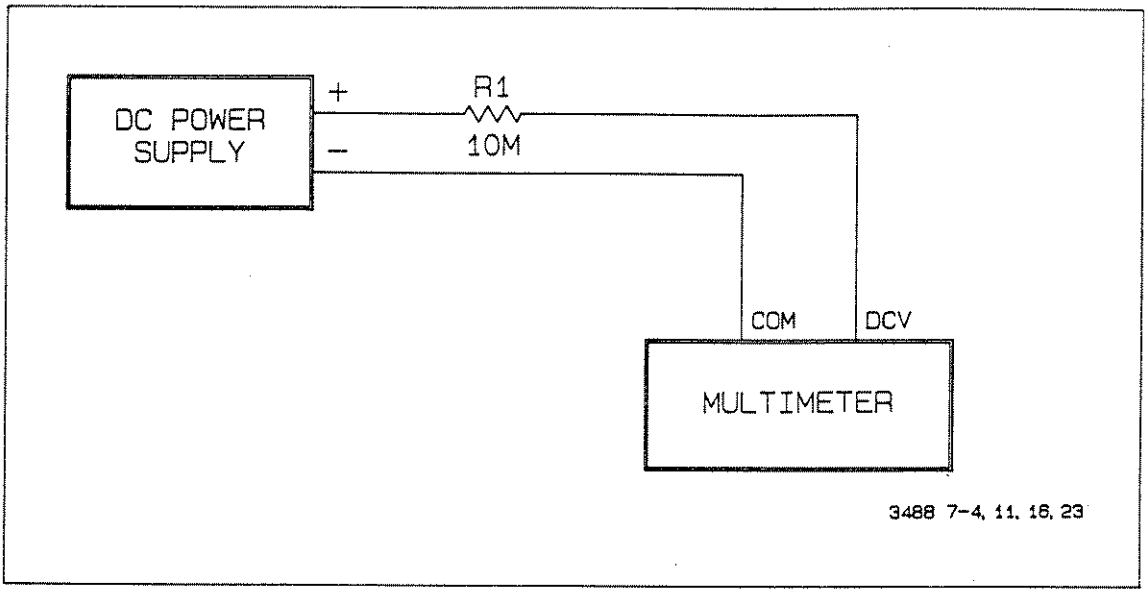


Figure 10-2 DC Isolation Test Set-Up

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. OPEN CHANNEL DC ISOLATION TEST: use the 3488A front panel keys to reset the 44472A and to establish the card monitor mode and a scan list 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 44472A.

c. Press the EXECUTE key.

d. Press the CARD MONITOR key followed by the numeral key corresponding to the slot occupied by the 44472A.

e. Press the EXECUTE key.

f. Press the SCAN LIST key followed by X00 through X13 (where X is the slot occupied by the 44472A and 00 through 13 are the channels to be scanned).

g. Press the EXECUTE key.

7. Connect the center conductor of the COM 0 connector into the test circuit as shown in Figure 10-3.

8. Connect the center conductor of the channel under test (channel 00 to start) into the test circuit as shown in Figure 10-3. Successively press the STEP key until the channel adjacent to the channel under test (channel 01 to start) appears in the display. Record the multimeter's dc voltage reading for the channel under test. This reading will be referred to as V3.

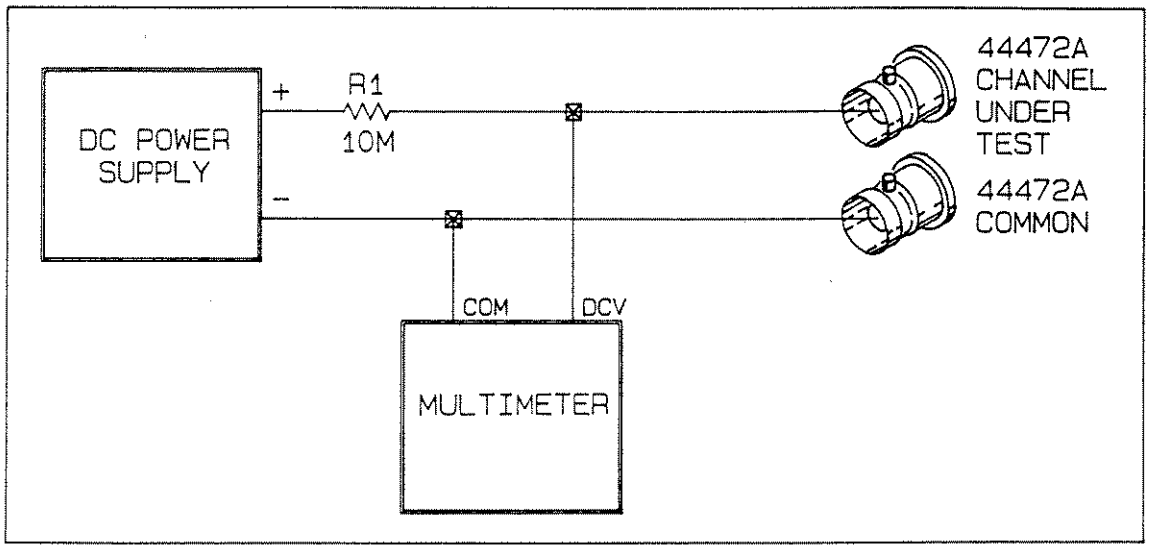


Figure 10-3 Open Channel DC Isolation Test

9. 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 must be greater than 10 megohms.

10. Repeat steps 8 and 9 for the Group 0 channels shown in Table 10-1.

Table 10-1 Channels Under Test/Adjacent Channels

GROUP 0 CHANNELS		GROUP 1 CHANNELS	
UNDER TEST	ADJACENT	UNDER TEST	ADJACENT
01	00	10	11
02	03	11	10
03	02	12	13
		13	12

11. Connect the center conductor of the COM 1 connector into the test circut as was done with COM 0 in step 7. Repeat steps 8 and 9 for the Group 1 channels shown in Table 10-1.

12. CHANNEL TO CHASSIS DC ISOLATION: Use the 3488A front panel keys to establish the card monitor mode and a scan list as follows:

a. Press the CARD MONITOR key followed by the numeral key corresponding to the slot occupied by the 44472A.

b. Press the EXECUTE key.

c. Press the SCAN LIST key followed by X00-X13 (where X is the slot occupied by the card under test and 00 through 13 are the channels to be scanned).

d. Press the EXECUTE key.

13. Connect the center conductor of the COM 0 connector and the 3488A backpanel chassis ground terminal into the test circuit as shown in Figure 10-4.

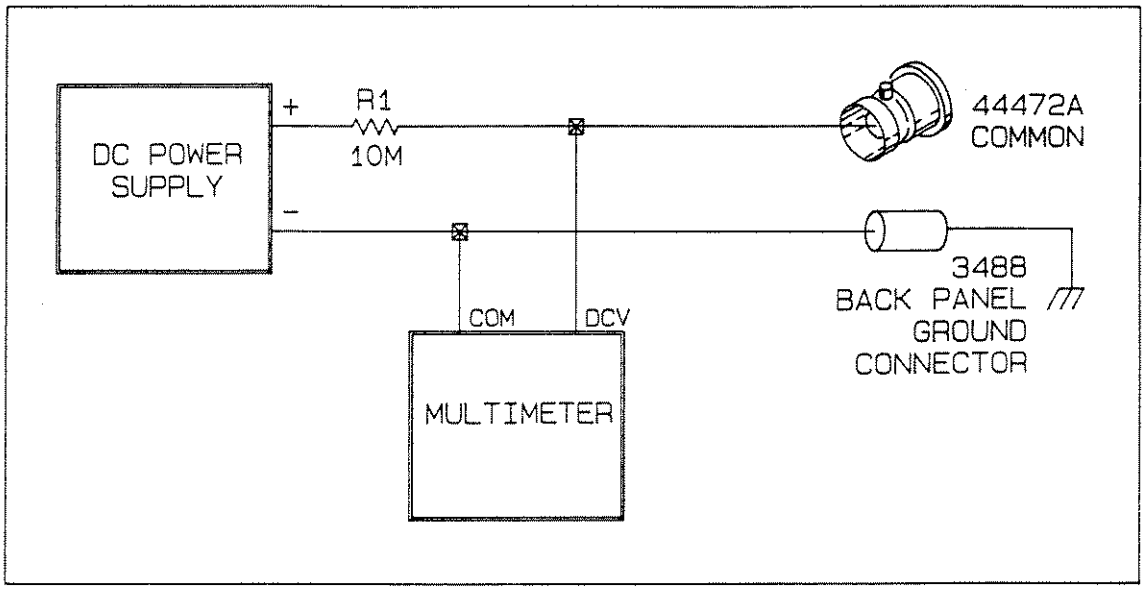


Figure 10-4 Channel to Chassis DC Isolation

14. Press the STEP key. Record the multimeter reading for the channel shown in the 3488A's display. This voltage will be referred to as V4.

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

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

The channel to chassis dc isolation should be greater than 10 megohms for each channel.

16. Repeat steps 14 and 15 for channels 01 through 03.

17. Connect the center conductor of the COM 1 connector into the test circuit as was done with COM 0 in step 13. Repeat steps 14 and 15 for channels 10 through 13.

18. HIGH TO LOW DC ISOLATION TEST: Use the 3488A front panel keys to establish the card monitor mode and a scan list as follows:

a. Press the CARD MONITOR key followed by the numeral key corresponding to the slot occupied by the 44472A.

b. Press the EXECUTE key.

c. Press the SCAN LIST key followed by X00-X13 (where X is the slot occupied by the card under test and 00 through 13 are the channels to be scanned).

d. Press the EXECUTE key.

19. Connect the COM 0 connector the test circuit as shown in Figure 10-5.

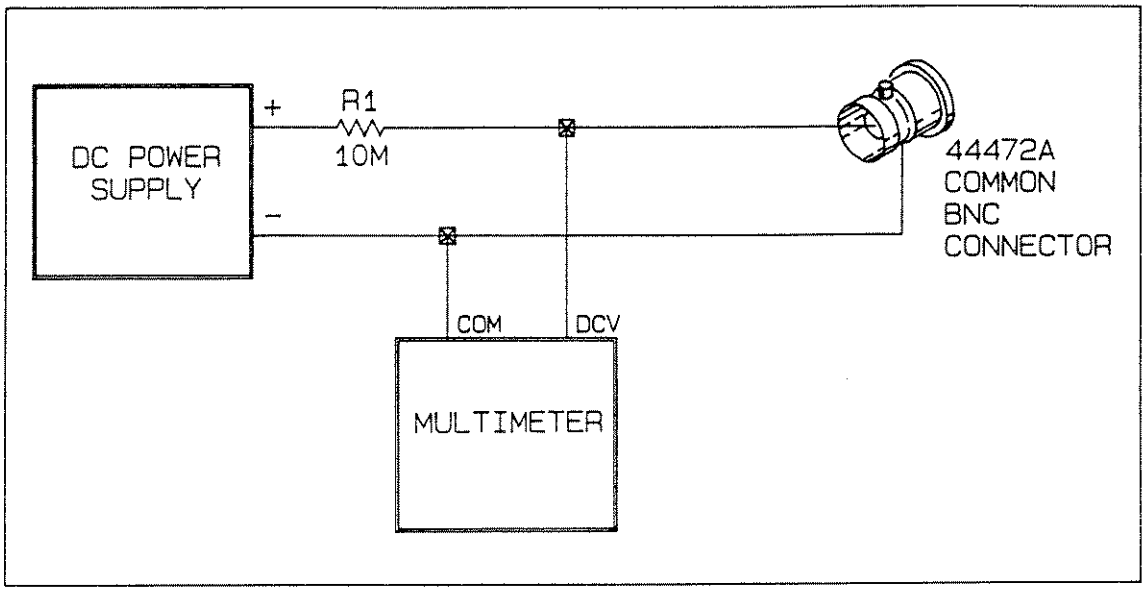


Figure 10-5 High To Low DC Isolation

20. Press the STEP key. Record the multimeter reading for the channel shown in the 3488A's display. This voltage 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 high to low dc isolation should be greater than 10 megohms for each channel.

22. Repeat steps 20 and 21 for channels 01 through 03.

23. Connect the COM 1 connector into the test circuit as was done with COM 0 in step 19. Repeat steps 20 and 21 for channels 10 through 13.

10-6 Corrective Action

An open channel isolation failure (step 9) is most likely caused by a failing relay or a dam-

aged or dirty 44472A printed circuit board. If damage is found, contact an HP Sales and Service Office for replacement information. If no damage is found, clean the board thoroughly (see Section 10-2).

A channel to chassis isolation failure (step 15) can be caused by electrical leakage from a relay contact through its drive coil to ground, or a damaged or dirty 44472A printed circuit board. If damage is found, contact an HP Sales and Service Office for 44472A replacement information. If no damage is found, clean the board thoroughly (see Section 10-2).

A high to low failure (step 21) is most likely caused by a damaged or dirty 44472A printed circuit board. If damage is found, contact an HP Sales and Service Office for 44472A replacement information. If damage is not found, clean the board thoroughly (see Section 10-2).

10-7 44472A Thermal Offset Test

This is a test of the thermally generated dc voltage present on the 44472A. 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 that the number of 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. Establish the card monitor mode and a scan list as follows:

a. Press the CARD MONITOR key followed by the numeral key corresponding to the slot occupied by the 44472A.

b. Press the EXECUTE key.

c. Press the SCAN LIST key followed by X00-X13 (where X is the slot occupied by the 44472A and 00-13 are the channels to be scanned.

d. Press the EXECUTE key.

3. Connect the multimeter's common test lead to the center conductor of the COM 0 connector.

4. Press the STEP key.

5. Measure the dc voltage on the center conductor of the channel shown in the display. This voltage will be referred to as V2. The difference between V1 and V2 must be less than 15μV.

6. Repeat steps 4 and 5 for channels 01 through 03.

7. Connect the multimeter's common test lead to the center conductor of the COM 1 connector.

8. Repeat steps 4 and 5 for channels 10 through 13.

10-8 Corrective Action

The most likely cause of a thermal offset failure is one or more of the relays in the failed channel. If a failure is found, replace the relay. The relay part number can be found by using the 44472A schematic (Figure 10-11) to determine the component designator for the relay and Table 10-2 to determine the HP part number of the relay. Contact an HP Sales and Service Office for part ordering information.

10-9 High Frequency Tests

The following insertion loss, VSWR, and crosstalk tests use an HP 8505A network Analyzer coupled with an HP 8503A S-parameter Test Set. Each test consists of (1) a setup sequence, (2) a calibration sequence, and (3) a measurement sequence. The setup sequence merely establishes the proper switch settings for the ensuing calibration sequence. The calibration sequence is done without the 44472A in the circuit and compensates for the effects caused by the hook-up cabling. After calibration, the 44472A is inserted into the circuit for the measurement sequence. To achieve an accurate test, it is very important that the cabling configuration for the calibration sequence be as similar as possible to the cabling configuration for the measurement sequence. In other words, the major difference in configuration between the calibration and the measurement sequences should be the insertion of the 44472A itself. Additionally, it is important that the shields be installed on the 44472A for these tests.

10-10 Insertion Loss Test

1. Set the S-PARAMETER SELECT Switch on the 8503A to the FORWARD position.

2. Set the signal levels on the 8505A as follows:

   a. Set the INPUT LEVEL dBm MAX Switch to the −10 position.

   b. Set the OUTPUT LEVEL dBm Switch to the +10 position.

   c. Set the OUTPUT LEVEL dBm Vernier to the 0 position.

3. Select the measurement on the 8505A as follows:

   a. Set the CHANNEL 1 INPUT Switch to the B/R position (this selects a transmission measurement).

   b. Set the MODE Switch to the MAG position (this selects the magnitude ratio).

   c. Set the SCALE/DIV Switch to the .1dB/division position.

   d. Set the CHANNEL 2 MODE Switch to the OFF position.

   e. Set the ELECTRICAL LENGTH MODE Switch to the OFF position.

4. Set the CRT display on the 8505A as follows:

   a. Press the REF LINE POSN/BEAM CENTER Switch to display the reference line. Rotate the CH1 vernier until the reference line is positioned on the center horizontal graticule.

5. Set the Frequency Sweep on the 8505A as follows:

a. Set the RANGE MHz Switch to the LIN .5-130 range.

b. Set the sweeper MODE Switch to the LIN EXPAND position.

c. Set the sweeper WIDTH Switch to the START/STOP 1 position.

d. Rotate the START FREQUENCY controls until the START FREQUENCY display reads .022.

e. Rotate the STOP FREQUENCY controls until the STOP FREQUENCY display reads 130.0.

6. Calibrate the 8505A as follows:

a. Connect the 8505A and the 8503A together as shown in Figure 10-6. Use a shorting connector to connect Port 1 and Port 2 of the 8503A together as shown in Figure 10-6.

b. Rotate the OUTPUT Vernier counterclockwise until the OVERLOAD light turns off.

c. Set the MARKERS Switch to position 1. Rotate the MARKERS 1 vernier to set the measurement marker to 100MHz.

d. Press the CHANNEL 1 MKR button. Press and hold the the ZRO button until the iterative zero process is complete and the trace moves to the reference line. This establishes the reference at 0dB.

7. Remove any external wiring from the rear of the 44472A.

8. Connect the 44472A's COM 0 connector to Port 1 of the 8503A.

9. Connect the 44472A's channel 00 connector to Port 2 of the 8503A.

10. Using the 3488A's front panel, close channel 00 as follows:

a. Press the LOCAL key.

b. Press the CLOSE key followed by X00 (where X is the slot occupied by the 44472A and 00 is the channel to be closed).

c. Press the EXEC key.

11. Press the MKR button to display the marker displacement (in dB) from the reference line. The marker displacement (insertion loss) should be $<.75$ dB at 100MHz.

12. Repeat steps 9 through 11 for channels 01, 02, and 03.

13. Connect the 44472A's COM 1 connector to Port 1 of the 8503A. Repeat steps 9 through 11 for channels 10, 11, 12, and 13.

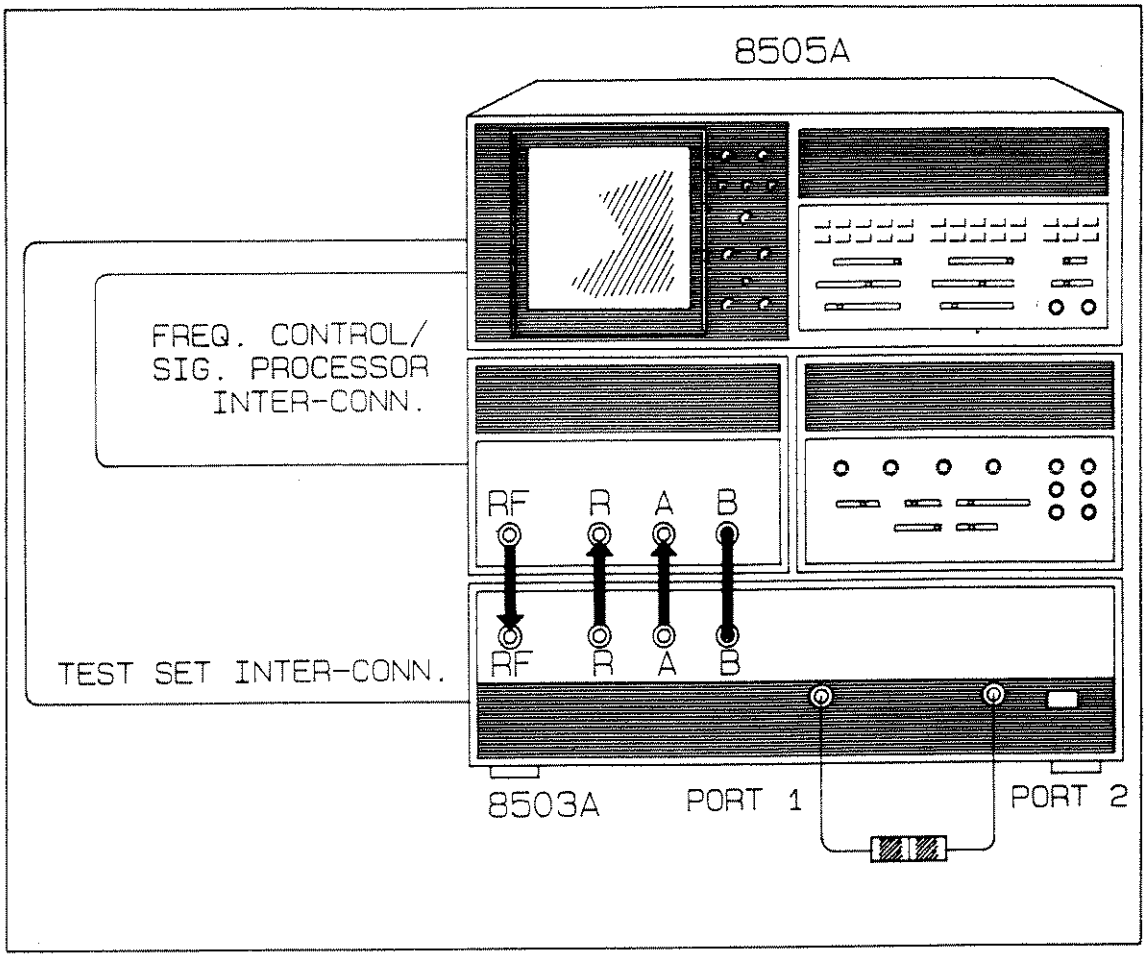


Figure 10-6 Insertion Loss Calibration Setup

NOTE

The above test checks insertion loss at 100MHz. Insertion loss can be tested at other frequencies by inserting those frequencies into steps 5a and 6c.

10-11 Corrective Action

An insertion loss failure is most likely caused by a higher than normal series resistance in the failed channel. Relay contact(s) and BNC connectors are the probable suspects. If an insertion loss failure is encountered, use Figure 10-11 (44472A schematic) to determine the component designator of the failing component and Table 10-2 to determine the HP part number of the component. Contact an HP Sales and Service Office for part ordering information.

10-12 Voltage Standing Wave Ratio (VSWR) Test

This test measures the return loss of the 44472A from which the voltage standing wave ratio (VSWR) is calculated.

NOTE

Connect the 8505A to the 8503A as shown in Figure 10-6.

1. Set the S-PARAMETER SELECT Switch on the 8503A to the FORWARD position.

2. Set the signal levels on the 8505A as follows:

   a. Set the INPUT LEVEL dBm MAX Switch to the −10 position.

   b. Set the OUTPUT LEVEL dBm Switch to the +10 position.

   c. Set the OUTPUT LEVEL dBm Vernier to the 0 position.

3. Select the measurement on the 8505A as follows:

   a. Set the CHANNEL 1 INPUT Switch to the A/R position.

   b. Set the MODE Switch to the MAG position (this selects the magnitude ratio).

   c. Set the SCALE/DIV Switch to the 10dB/division position.

   d. Set the CHANNEL 2 MODE Switch to the OFF position.

   e. Set the ELECTRICAL LENGTH MODE Switch to the OFF position.

4. Set the CRT display on the 8505A as follows:

   a. Press the REF LINE POSN/BEAM CENTER Switch to display the reference line. Rotate the CH1 vernier until the reference line is positioned on the center horizontal graticule.

5. Set the Frequency Sweep on the 8505A as follows:

   a. Set the RANGE MHz Switch to the LIN .5-130 range.

   b. Set the sweeper MODE Switch to the LIN EXPAND position.

   c. Set the sweeper WIDTH Switch to the START/STOP 1 position.

   d. Rotate the START FREQUENCY controls until the START FREQUENCY display reads .022.

   e. Rotate the STOP FREQUENCY controls until the STOP FREQUENCY display reads 130.0.

6. Calibrate the 8505A as follows:

   a. Connect a shorting connector to Port 1 of the 8503A.

   b. Rotate the OUTPUT Vernier counterclockwise until the OVERLOAD light turns off.

   c. Set the MARKERS Switch to position 1. Rotate the MARKERS 1 vernier to set the measurement marker to 100MHz.

   d. Press the CHANNEL 1 MKR button. Press and hold the the ZRO button until the iterative zero process is complete and the trace moves to the reference line. This establishes the reference at 0dB.

7. Remove any external wiring from the rear of the 44472A. Remove the shorting connector from Port 1 of the 8503A.

8. Connect the 44472A's COM 0 connector to Port 1 of the 8503A.

9. Connect the 50 Ohm termination to the 44472A's channel 00 connector.

10. Using the 3488A's front panel, close channel 00 as follows:

a. Press the LOCAL key.

b. Press the CLOSE key followed by X00 (where X is the slot occupied by the 44472A and 00 is the channel to be closed).

c. Press the EXEC key.

11. Press the MKR button to display the marker displacement (in dB) from the reference line. This is the return loss for the channel under test.

12. Use the following equation and the return loss measured in step 11 to calculate the VSWR for the channel under test.

$$p = 10^{D} \qquad \text{where } D = \frac{\text{Return Loss (in dB)}}{20}$$

$$\text{VSWR} = \frac{1 + p}{1 - p}$$

The VSWR should be < 1.12 at 100MHz.

13. Repeat steps 9 through 12 for channels 01, 02, and 03.

14. Connect the 44472A's COM 1 connector to Port 1 of the 8503A. Repeat steps 9 through 12 for channels 10, 11, 12, and 13.

NOTE

The above test checks VSWR at 100MHz. VSWR can be tested at other frequencies by inserting those frequencies into steps 5a and 6c.

10-13 Corrective Action

A VSWR failure is most likely caused by a higher than normal series resistance in the failed channel. Relay contact(s) and BNC connectors are the probable suspects. If a VSWR failure is encountered, use Figure 10-11 (44472A schematic) to determine the component designator of the failing component and Table 10-2 to determine the HP part number of the component. Contact an HP Sales and Service Office for part ordering information.

NOTE

Connect the 8505A and the 8303A together as shown in Figure 10-6.

1. SET UP SEQUENCE: Set the S-PARAMETER SELECT Switch on the 8503A to the REVERSE position.

2. Set the signal levels on the 8505A as follows:

   a. Set the INPUT LEVEL dBm MAX Switch to the −10 position.

   b. Set the OUTPUT LEVEL dBm Switch to the +10 position.

   c. Set the OUTPUT LEVEL dBm Vernier to the 0 position.

3. Select the measurement on the 8505A as follows:

   a. Set the CHANNEL 1 INPUT Switch to the A/R position.

   b. Set the CHANNEL 1 MODE Switch to the MAG position.

   c. Set the CHANNEL 1 SCALE/DIV Switch to the 20dB/division position.

   d. Set the CHANNEL 2 MODE Switch to the OFF position.

   e. Set the ELECTRICAL LENGTH MODE Switch to the OFF position.

4. Set the CRT display on the 8505A as follows:

   a. Press the REF LINE POSN/BEAM CENTER Switch to display the reference line. Rotate the CH1 vernier until the reference line is positioned on the center horizontal graticule.

5. Set the Frequency Sweep on the 8505A as follows:

   a. Set the RANGE MHz Switch to the LIN .5-130 range.

   b. Set the sweeper MODE Switch to the LIN EXPAND position.

   c. Set the sweeper WIDTH Switch to the START/STOP 1 position.

   d. Rotate the START FREQUENCY controls until the START FREQUENCY display reads .022.

   e. Rotate the STOP FREQUENCY controls until the STOP FREQUENCY display reads 130.0.

6. Remove any external wiring from the 44472A.

7. CHANNEL TO CHANNEL CROSSTALK TEST: Using the 3488A's front panel keys, establish the card monitor mode and a scan list as follows:

a. Press the LOCAL key.

b. Press the CARD MONITOR key followed by the numeral corresponding the slot occupied by the 44472A.

c. Press the EXECUTE key.

d. Press the SCAN LIST key followed by X00-X13 (where X is the slot occupied by the 44472A and 00 through 13 are the channels to be scanned).

e. Press the EXECUTE key.

8. Press the STEP key.

9. Calibrate the 8505A as follows:

a. Connect a 50 Ohm matched termination to the closed channel appearing in the 3488A's display (channel 00 to start).

b. Connect the 44472A's COM 0 connector to Port 1 of the 8503A.

c. Rotate the OUTPUT Vernier counterclockwise until the OVERLOAD light turns off.

d. Set the MARKERS Switch to position 1. Rotate the MARKERS 1 vernier to set the measurement marker to 100MHz.

e. Press the CHANNEL 1 MKR button. Press and hold the ZRO button until the iterative zero process is complete and the trace moves to the reference line. This establishes the reference at 0dB.

10. Connect the 44472A's COM 0 connector to Port 1 of the 8503A.

11. Connect one of the open channels in multiplexer group 0 to Port 2 of the 8503A.

12. Press the MKR button to display the marker displacement (in dB) from the reference line. This is the channel to channel crosstalk between the closed channel and the open channel under test. The crosstalk should be < -85dB.

13. Repeat steps 11 and 12 for the remaining open channels in group 0.

14. Repeat steps 8 through 13 until all channels in the group 0 multiplexer have been stepped through and tested.

15. Connect the 44472A's COM 1 connector to Port 1 of the 8503A.

16. Press the STEP key.

17. Calibrate the 8505A as follows:

a. Connect a 50 Ohm matched termination to the closed channel appearing in the 3488A's display (channel 10 to start).

b. Connect the 44472A's COM 1 connector to Port 1 of the 8503A.

c. Rotate the OUTPUT Vernier counterclockwise until the OVERLOAD light turns off.

d. Set the MARKERS Switch to position 1. Rotate the MARKERS 1 vernier to set the measurement marker to 100MHz.

e. Press the CHANNEL 1 MKR button. Press and hold the ZRO button until the iterative zero process is complete and the trace moves to the reference line. This establishes the reference at 0dB.

18. Connect the 44472A's COM 1 connector to Port 1 of the 8503A.

19. Connect one of the open channels in multiplexer group 1 to Port 2 of the 8503A.

20. Press the MKR button to display the marker displacement (in dB) from the reference line. The marker displacement (channel to channel crosstalk) should be < -85dB.

21. Repeat steps 19 and 20 for the remaining open channels in group 1.

22. Repeat steps 16 through 21 until all channels in the group 1 multiplexer have been stepped through and tested.

23. GROUP TO GROUP CROSSTALK TEST: Using the 3488A's front panel keys, close channels 03 and 10 as follows:

a. Press the LOCAL key.

b. Press the CARD MONITOR key followed by the numeral key corresponding to the slot occupied by the 44472A.

c. Press the EXECUTE key.

d. Press the CLOSE key followed by X03 (where X is the slot occupied by the 44472A).

e. Press the EXECUTE key.

f. Press the CLOSE key followed by X10 (where X is the slot occupied by the 44472A).

g. Press the EXECUTE key.

24. Calibrate the 8508A as follows:

a. Connect 50 Ohm matched terminations to channels X03 and X10 (these channels should be appearing in the 3488A's display).

b. Connect the 44472A's COM 0 connector to Port 1 of the 8503A.

c. Rotate the OUTPUT vernier counterclockwise until the OVERLOAD light turns off.

d. Set the MARKERS switch to position 1. Rotate the MARKERS vernier to set the measurement marker to 100 MHz.

e. Press the CHANNEL 1 MKR button. Press and hold the ZRO button until the iterative process is complete and the trace moves to the reference line. This establishes the reference at 0dB.

25. Connect the 44472A's COM 0 connector to Port 1 of the 8503A.

26. Connect the 44472A's COM 1 connector to Port 2 of the 8503A.

27. Press the MKR button to display the marker displacement (in dB) from the reference line. This is the group to group crosstalk. It should be <-85 dB.

NOTE

The above test checks the crosstalk at 100MHz. Crosstalk can be tested at other frequencies by inserting those frequencies into steps 5a and 9d.

10-15 Corrective Action

A channel to channel or group to group crosstalk failure is caused by electrical leakage between the failed channels. This can be caused by a dirty or damaged 44472A pc board. If a failure is encountered, inspect the 44472A pc board for damage. If damage is found, contact an HP Sales and Service Office for 44472A replacement information. If no damage is found, clean the board thoroughly (see Section 10-2).

10-16 REPLACEABLE PARTS

Table 10-2 lists the mechanical and electrical replaceable parts available for the 44472A. The mechanical parts are keyed to Figure 10-7. This figure also provides assembly and disassembly information. The electrical parts are keyed to the schematic and component locator in Figure 10-11. Table 5-2, in Chapter 5, lists manufacturers code numbers as they apply to the parts lists in Table 10-2.

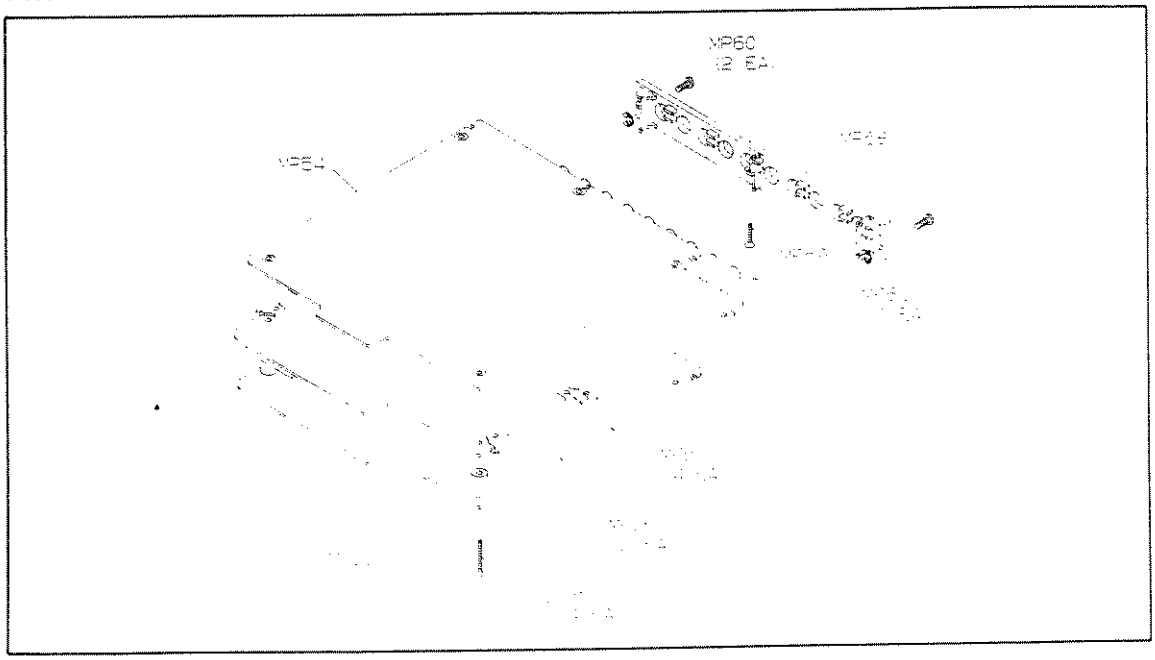


Figure 10-7 44472A Disassembly

Table 10-2 Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	44472-66501	2	1	VHF SWITCH ERC: 2605	28480	44472-66501
A1C701	0160-3847	9	22	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
A1C906	0160-5349	0	2	CAPACITOR-FXD 200PF +-5% 100VDC CER	28480	0160-5349
A1C907	0160-5349	0		CAPACITOR-FXD 200PF +-5% 100VDC CER	28480	0160-5349
A1C908	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C909	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C910	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C911	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C912	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C913	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C914	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C915	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C916	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C917	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C918	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C919	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C920	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C921	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C922	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C923	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C924	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C925	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C926	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C927	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C928	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C929	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C930	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1C931	0160-3847	9		CAPACITOR-FXD .01UF +100-0% 50VDC CER	28480	0160-3847
A1CR905	1901-0050	3	8	DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR906	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR907	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR908	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR909	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR910	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR911	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1CR912	1901-0050	3		DIODE-SWITCHING 80V 200MA 2NS DO-35	28480	1901-0050
A1DP901	1906-0229	8	2	DIODE-ARRAY 50V 400MA	01295	TID133
A1DP902	1906-0229	8		DIODE-ARRAY 50V 400MA	01295	TID133
A1J901	1250-1846	6	10	CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1846
A1J902	1250-1846	6		CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1846
A1J903	1250-1846	6		CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1846
A1J904	1250-1846	6		CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1846
A1J905	1250-1846	6		CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1846
A1J906	1250-1846	6		CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1846
A1J907	1250-1846	6		CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1846
A1J908	1250-1846	6		CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1846
A1J909	1250-1846	6		CONNECTOR-RF BNC FEM PC 50 OHM	28480	1250-1846
A1J910	1250-1846	6		CONNECTOR-RF BNC FEM PC 50-OHM	28480	1250-1846
A1K901	0490-1414	1	8	RLY-S2M-L2-5VH10	28480	0490-1414
A1K902	0490-1414	1		RLY-S2M-L2-5VH10	28480	0490-1414
A1K903	0490-1336	6	6	RELAY-S2EB-L2-5V	28480	0490-1336
A1K904	0490-1336	6		RELAY-S2EB-L2-5V	28480	0490-1336
A1K905	0490-1414	1		RLY-S2M-L2-5VH10	28480	0490-1414
A1K906	0490-1414	1		RLY-S2M-L2-5VH10	28480	0490-1414
A1K907	0490-1336	6		RELAY-S2EB-L2-5V	28480	0490-1336
A1K908	0490-1336	6		RELAY-S2EB-L2-5V	28480	0490-1336
A1K909	0490-1414	1		RLY-S2M-L2-5VH10	28480	0490-1414
A1K910	0490-1414	1		RLY-S2M-L2-5VH10	28480	0490-1414
A1K911	0490-1336	6		RELAY-S2EB-L2-5V	28480	0490-1336
A1K912	0490-1336	6		RELAY-S2EB-L2-5V	28480	0490-1336
A1K913	0490-1414	1		RLY-S2M-L2-5VH10	28480	0490-1414
A1K914	0490-1414	1		RLY-S2M-L2-5VH10	28480	0490-1414

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

Table 10-2 Replaceable Parts (Cont'd)

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
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	5	RESISTOR 10K 5% .25W FC TC=-400/+700	01121	CB1035
A1R905	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
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	0683-1065	7	2	RESISTOR 10M 5% .25W CC TC=-900/+1100	01121	CB1065
A1R919	0683-1065	7		RESISTOR 10M 5% .25W CC TC=-900/+1100	01121	CB1065
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
MP52	0515-0843	2	4	SCREW M2.5X20 LK	28480	0515-0843
MP54	44472-00601	5	1	SHIELD-VHF CKT	28480	44472-00601
MP55	44472-00602	6	1	SHIELD-VHF COMP	28480	44472-00602
MP56	5041-5213	0	2	GLIDE PC BOARD	28480	5041-5213
MP57	1480-0625	4	4	PIN-GRV 3/32X1/4	28480	1480-0625
MP58	44472-40201	5	1	PANEL-REAR VHF	28480	44472-40201
MP59	0515-0403	0	1	SCREW M2.5X8 LK	28480	0515-0403
MP60	5180-8269	9	2	SCREW, CAPTIVE	28480	5957-5138
MP61	0510-0043	4	2	RING, RETAINER 3.58	28480	0510-0043

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

10-17 44472A THEORY OF OPERATION

The 44472A VHF Card consists of an input buffer and latch, relay drive circuits, an address decoder, and a card-type buffer.

10-18 Input Buffer And Latch

The input buffer (U902 in Figure 10-11) provides isolation between the 44472A and the mainframe's data bus. An input buffer is present on each type of plug-in card and prevents excessive loading of the data bus by the plug-in cards.

The input latch (U903 and U905 in Figure 10-11) holds the output of the input buffer for application to the relay drive circuitry.

10-19 Relay Drive Operation

A simplified schematic diagram of one relay drive circuit is shown in Figure 10-8. 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 from the relay coil and the permanent magnetic field of the armature latches the contact in the closed state.

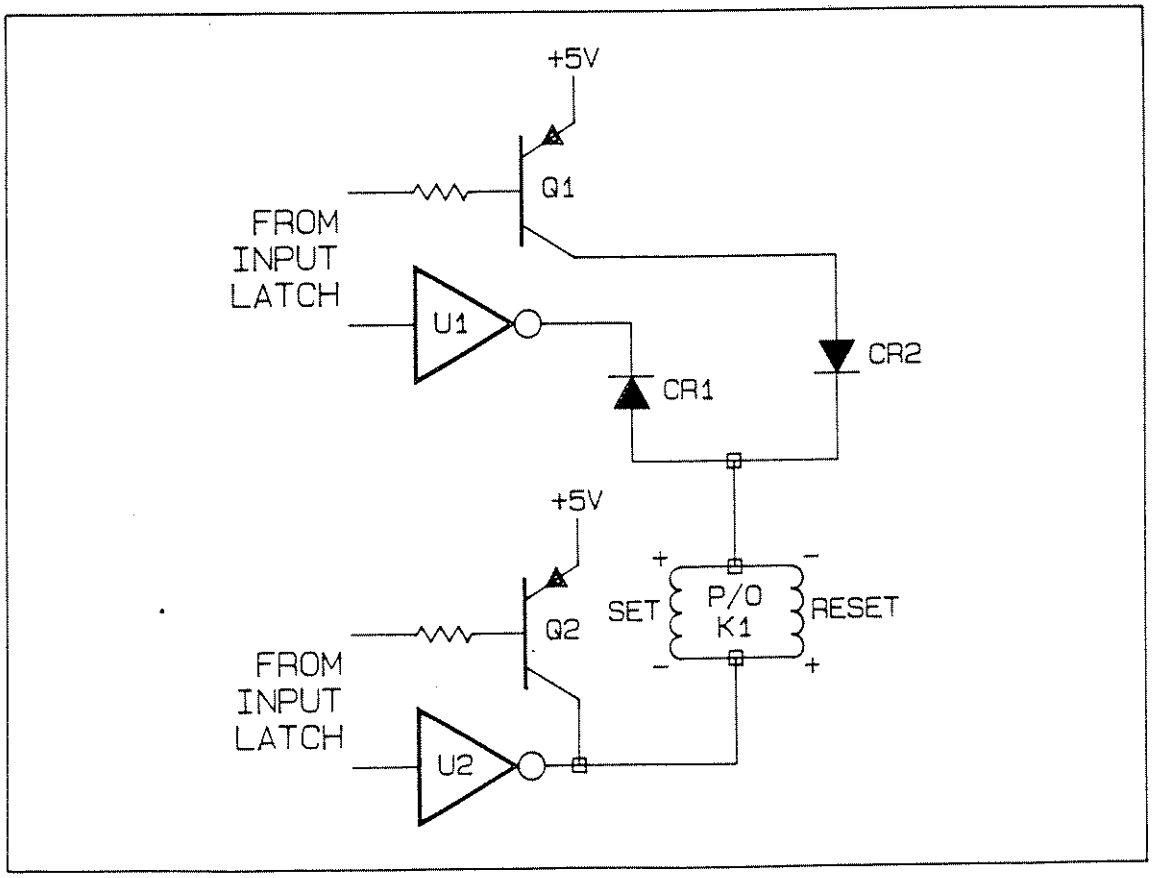


Figure 10-8 One Relay Drive Circuit

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 coil and the permanent magnetic field of the armature latches the contacts in the opened state.

10-20 Card-Type Buffer

The card-type buffer (U901 in Figure 10-11) indicates to the mainframe that a 44472A 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 buffer. By connecting one input to +5Vdc and three inputs to ground, a 4-bit code (0010) is created that is recognized by the mainframe as the unique identifier for the 44472A card.

10-21 Address Decoder

The address decoder (U907 in Figure 10-11) is enabled when the $\overline{CS}$ signal from the mainframe 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 mainframe. Figures 10-9 and 10-10 show the timing relationships between these control lines for both read and write operations.

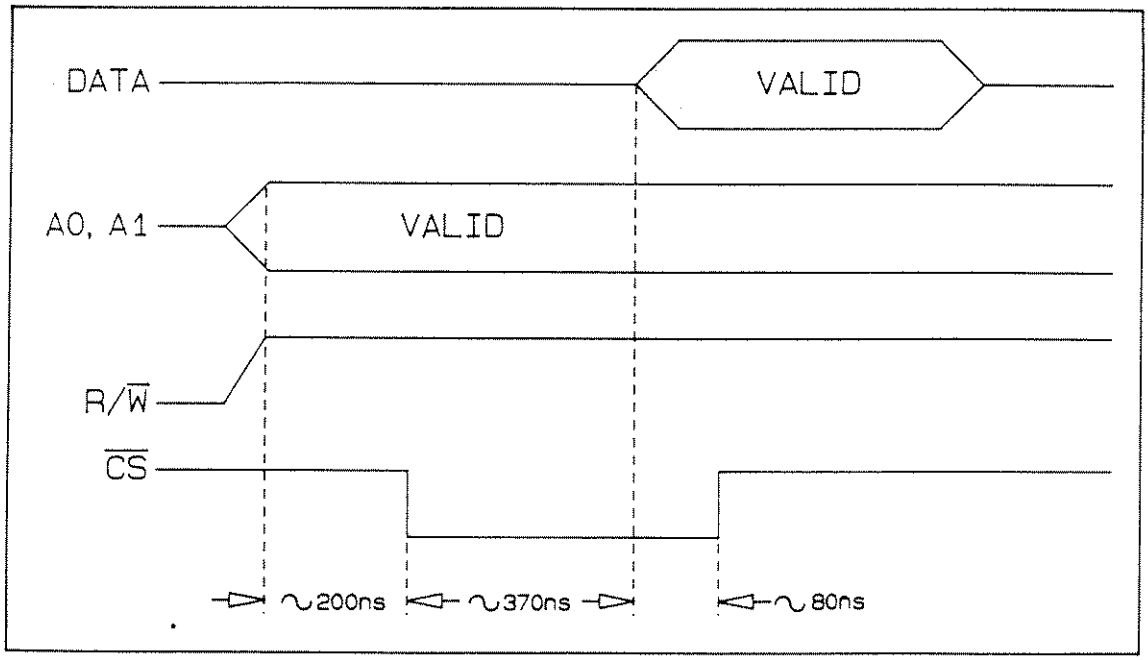


Figure 10-9 Control Line Timing (Read)

10-22 44472A TROUBLESHOOTING

10-23 Introduction

If the Performance Tests (Section 10-3) 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 10-11 (44472A Schematic) the problem may be isolated to a few components from the symptoms. The relays on the 44472A circuit board are 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; group 0 relays are common to columns 0 and 2. Group 1 relays are common to columns 1 and 3. Relays K913 and K914 are common to row 0. Note that not all relays need to change state to accomplish a channel to common connection.

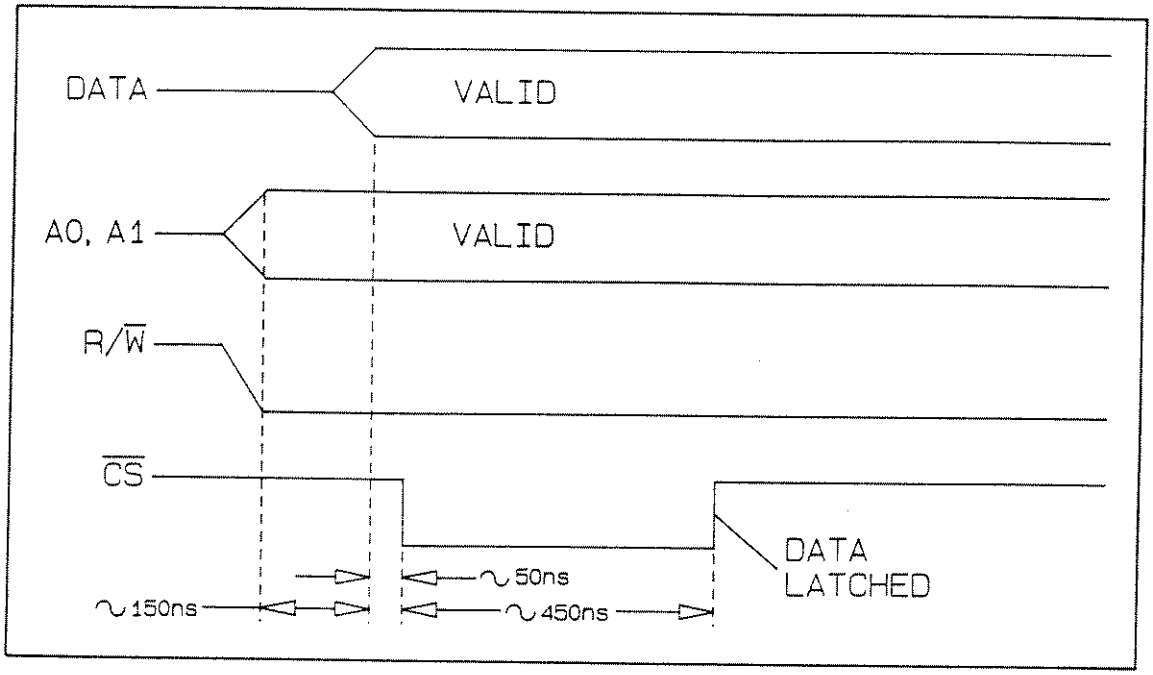


Figure 10-10 Control Line Timing (Write)

10-24 Equipment Required

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

10-25 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.

10-26 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 10-25 should be performed prior to this signature analysis procedure. Section 10-25 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 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 44472A are given in Table 10-3.

Table 10-3 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	NA	16	NA
2	NA	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	NA	14	NA
4	NA	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

K906 *

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

K911 *

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

K902 *

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

K907 *

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

K912 *

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

K903 *

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

K908 *

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

K913 *

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

K904 *

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

K909 *

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

K914 *

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

K905 *

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

K910 *

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

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

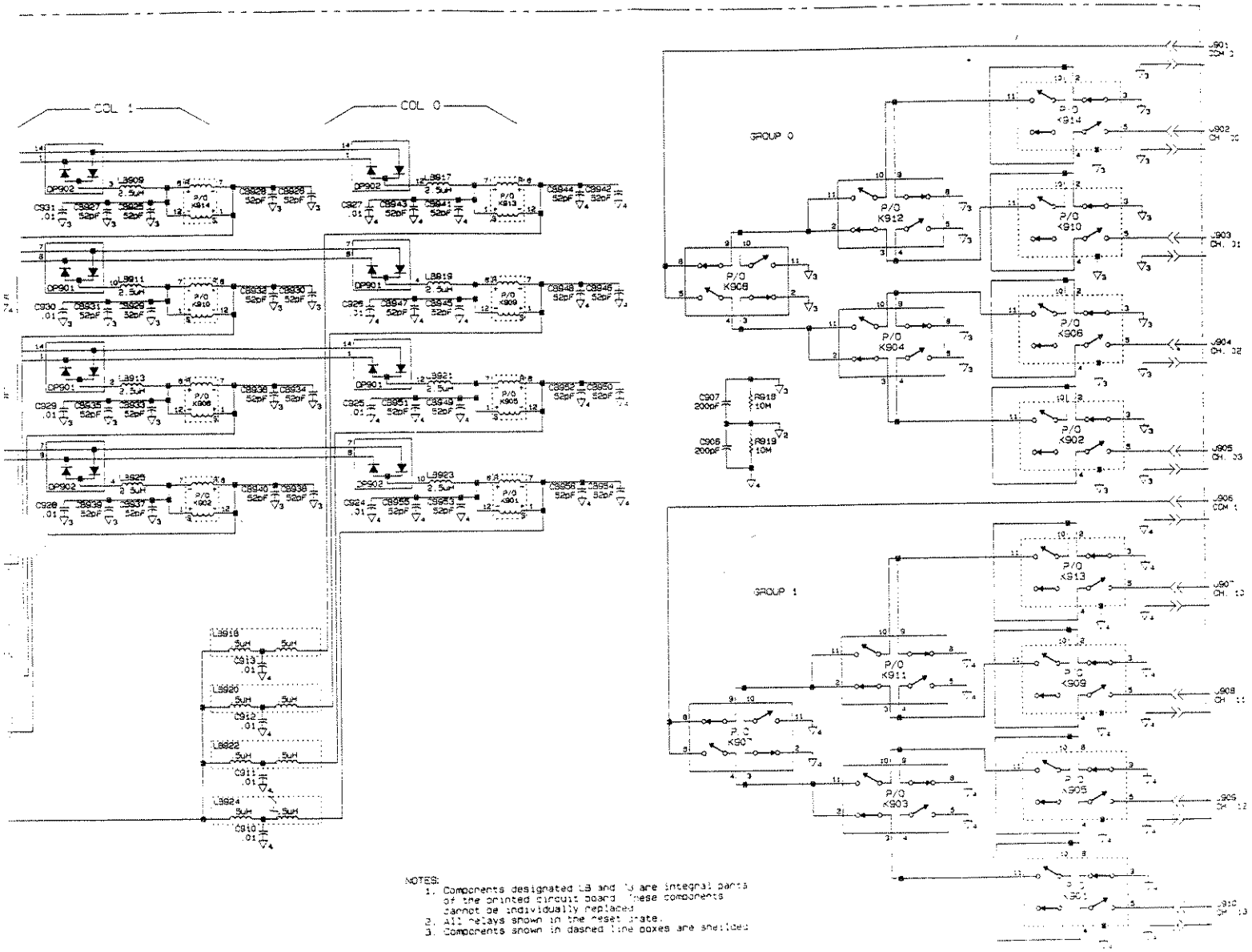
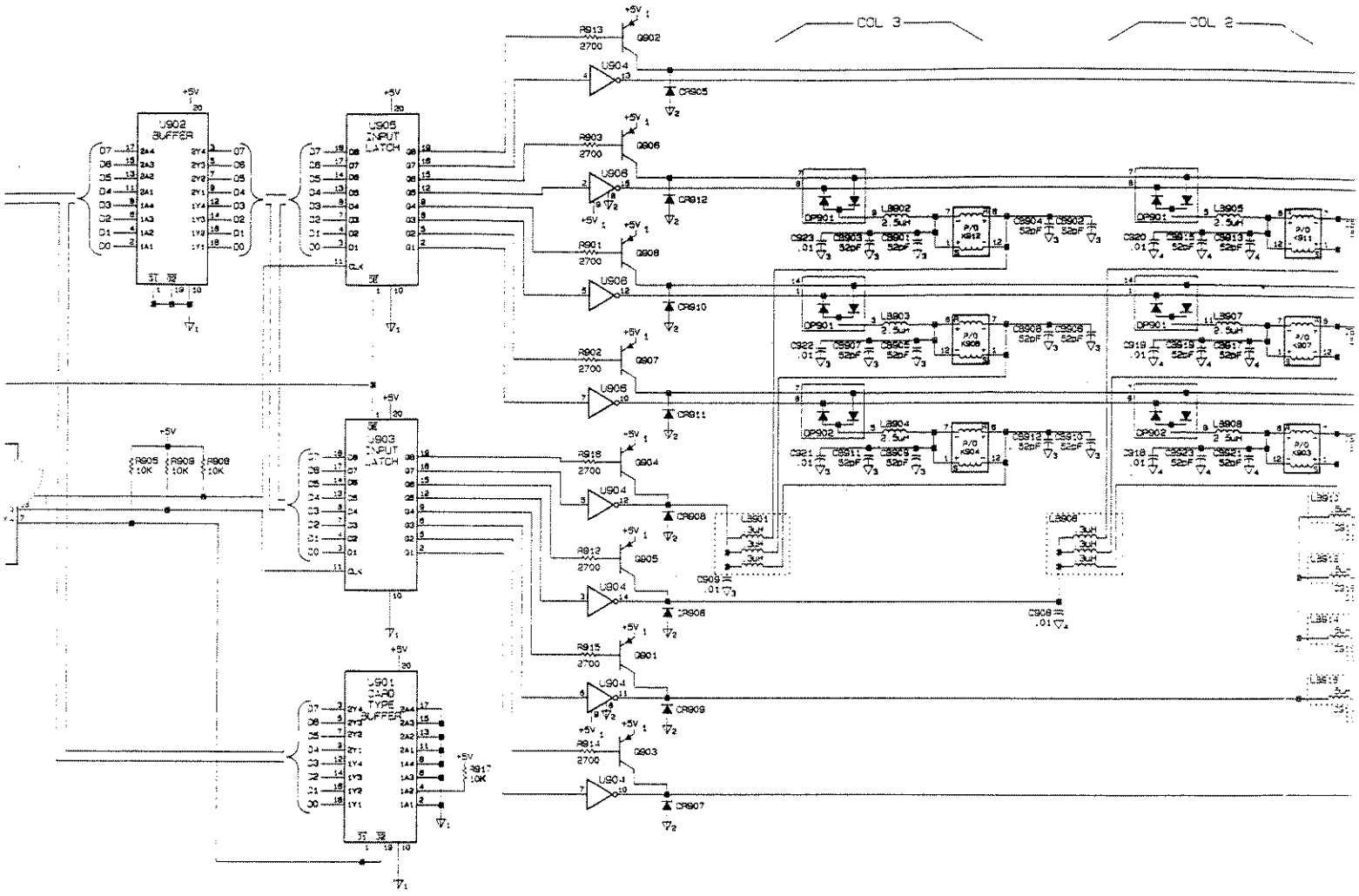
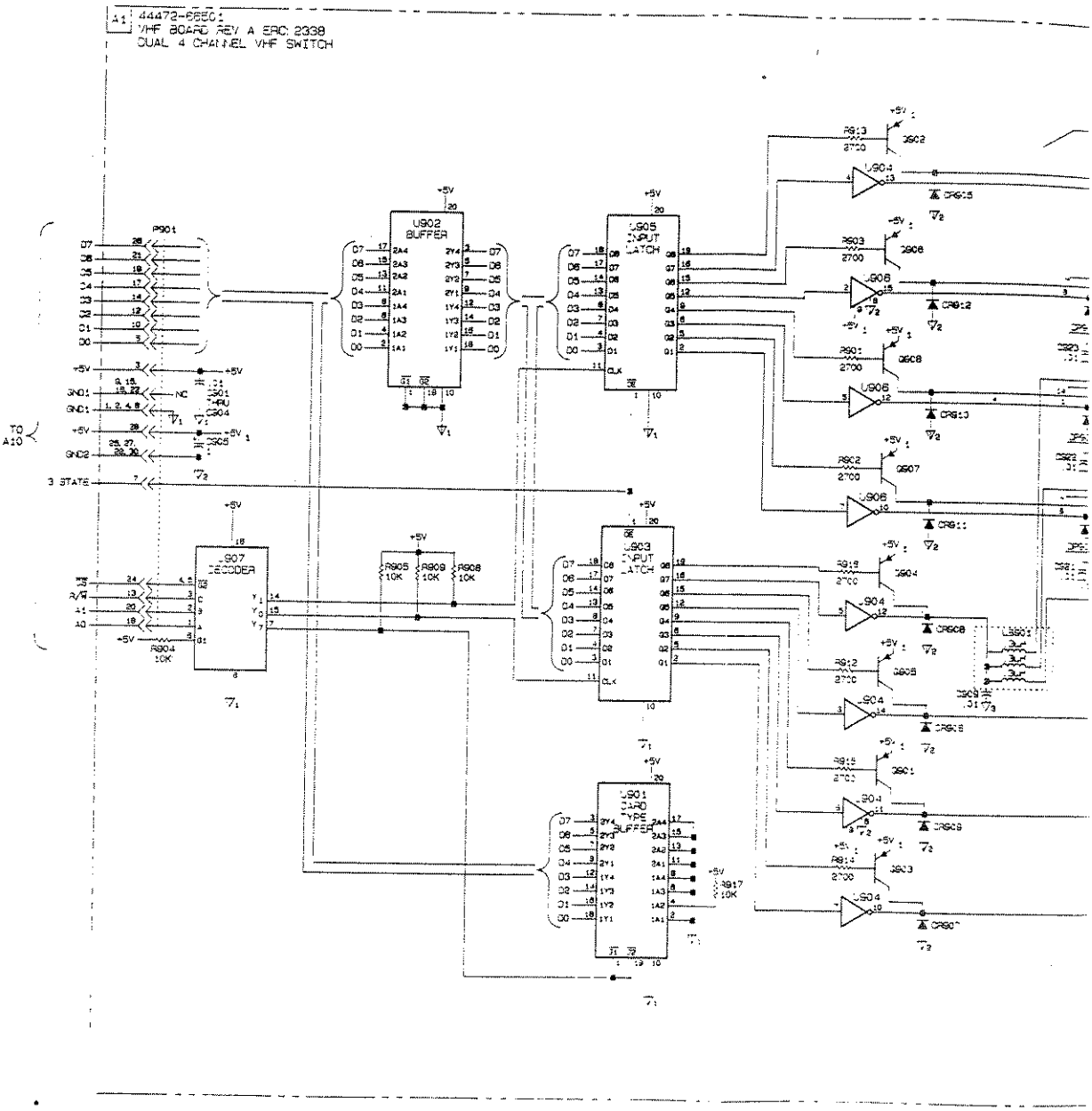


Figure 10-11 44472A Schematic
10-27/10-28

A EPC: 2338
VHF SWITCH





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Relay State Table

Group 0

	K902	K904	K906	K908	K910	K912	K914
CH00	RESET	RESET	RESET	RESET	RESET	SET	SET
CH01	RESET	RESET	RESET	RESET	SET	RESET	RESET
CH02	RESET	SET	SET	SET	RESET	SET	RESET
CH03	SET	RESET	RESET	SET	RESET	SET	RESET

Group 1

	K901	K903	K905	K907	K909	K911	K913
CH10	RESET	RESET	RESET	RESET	RESET	SET	SET
CH11	RESET	RESET	RESET	RESET	SET	RESET	RESET
CH12	RESET	SET	SET	SET	RESET	SET	RESET
CH13	SET	RESET	RESET	SET	RESET	SET	RESET