

## Errata

**Title & Document Type:** 8748A S-Parameter Test Set Operating and Service Manual

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**Agilent Technologies**

**OPERATING AND SERVICE MANUAL**

**8748A**  
**S-PARAMETER**  
**TEST SET**  
**4 MHz to 1.3 GHz**



**HEWLETT  PACKARD**



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# 8748A S-PARAMETER TEST SET

## SERIAL NUMBERS

This manual applies directly to HP Model 8748A S. Parameter Test Set having serial prefix number 1926A.

For additional important information about serial number see INSTRUMENTS COVERED BY MANUAL in Section I.

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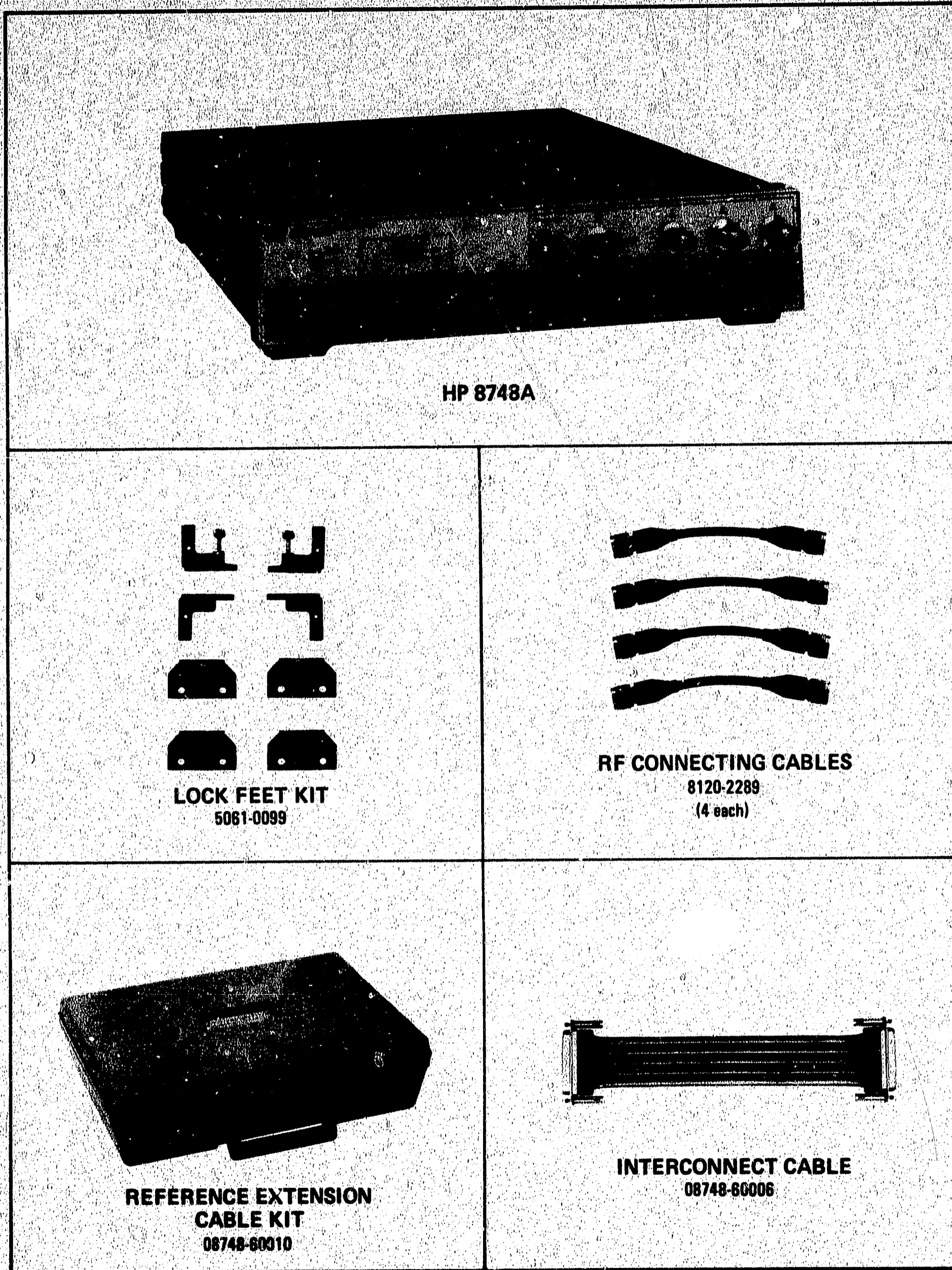


Figure 1-1. HP Model 8748A S Parameter Test Set with Accessories Supplied

## SECTION I GENERAL INFORMATION

### 1-1. INTRODUCTION

1-2. This Operating and Service Manual contains information required to install, operate, test, and service the Hewlett-Packard Model 8748A S-Parameter Test Set. Figure 1-1 shows the instrument and accessories supplied. This section covers instrument identification, description, options, accessories, specifications, and other basic information.

1-3. Supplied with this manual is an Operating Information Supplement. The Supplement, which is a copy of the first three sections of the manual, should be kept with the instrument for use by the operator.

1-4. Listed on the title page of this manual is a microfiche part number which can be used to order 4- by 6-inch microfilm transparencies of the manual. Each microfiche contains up to 60 photoduplicates of the manual pages. The microfiche package also includes the latest Manual Changes supplement as well as all pertinent Service Notes.

### 1-5. SPECIFICATIONS

1-6. Instrument specifications are listed in Table 1-1. These specifications are the performance standards or limits against which the instrument is tested. Table 1-2 lists supplemental performance characteristics. Performance characteristics are not specifications but are typical characteristics included as additional information for the user.

### 1-7. SAFETY CONSIDERATIONS

1-8. The HP 8748A instrument has been manufactured and tested according to international safety standards.

### 1-9. Safety Symbols



Instruction manual symbol. This symbol tells the user to refer to the manual to avoid damage to the instrument.



Indicates dangerous voltage.



Earth terminal.

**WARNING**

The **WARNING** sign denotes a hazard. It calls attention to a procedure, practice, or the like which, if not correctly performed or adhered to, could result in injury or loss of life. Do not proceed beyond a **WARNING** sign until the indicated conditions are fully understood and met.

**CAUTION**

The **CAUTION** sign calls attention to an operating procedure, practice, or the like which, if not correctly performed or adhered to, could result in damage to or destruction of the equipment. Do not proceed beyond a **CAUTION** sign until the indicated conditions are fully understood and met.

### 1-10. Service

1-11. Although the instrument has been manufactured in accordance with international safety standards, this manual contains information, cautions, and warnings which must be observed to insure safe operation and to avoid damage to the instrument. Cautions appear as appropriate throughout the manual. Service should be performed only by qualified personnel.



Table 1-1. HP Model 8748A S-Parameter Test Set Specifications

SPECIFICATIONS		
Frequency Range: 4–1300 MHz		
Directivity: >40 dB		
Frequency Response:		
Transmission <sup>1</sup> ( $S_{21}$ , $S_{12}$ ): $\pm 1$ dB, $\pm 8^\circ$		
Reflection <sup>1</sup> ( $S_{11}$ , $S_{22}$ ): $\pm 2$ dB, $\pm 15^\circ$		
Test Port 1 and 2 Open/Short Ratio:		
Frequency Range (MHz)	Magnitude	Phase
4–1000	$\pm 0.75$ dB	$\pm 6$ degrees
1000–1300	$\pm 0.9$ dB	$\pm 7.5$ degrees
Return Loss: $Z_0 = 50\Omega$		
PORT	Frequency Range (MHz)	Return Loss
Test 1,2	4–1300	26 dB
RF input	4–1300	20 dB
R, A, B	4–1000	23 dB
	1000–1300	20 dB

<sup>1</sup>  $\pm$  Degrees specified as deviation from Linear Phase.

Table 1-2. HP 8748A S-Parameter Test Set Performance Characteristics

SUPPLEMENTAL CHARACTERISTICS	
<b>NOTE:</b> Values in this table are not specifications but are typical characteristics included for user information.	
<b>Insertion Loss:</b>	
Input to Port 1, 2: 13 dB Nominal	
Input to Port A, B, or R: 19 dB Nominal	
<b>Frequency Response Difference Between:</b>	
$S_{21}$ and $S_{12}$ (Transmission) < 0.5 dB, < $4^\circ$	
$S_{11}$ and $S_{22}$ (Reflection) < 0.75 dB, < $6^\circ$	
Impedance: $50\Omega$	
<b>Connectors:</b>	
Test Ports: APC-7 <sup>®</sup>	
All other RF Ports: $50\Omega$ Type-N Female	
DC Bias Inputs: BNC Female	
DC Bias Input Range: $\pm 30$ Vdc, $\pm 200$ mA; some degradation in RF Specifications from 4 to 100 MHz Fused at 500 mA	
Damage Level: 1 watt (+30 dBm) CW RF Input	
Power: 20 Vdc, supplied from 8754A via interface cable (supplied).	
Dimensions: 432 mm wide, 90 mm high, 495 mm deep (17 in. X 3½ in. X 19½ in.)	
Weight: Net, 6.8 Kg (15 lb). Shipping, 9.1 Kg (20 lb)	

<sup>®</sup>A registered trademark of the Bunker Ramo Corporation.



## 1-12. INSTRUMENTS COVERED BY THE MANUAL

1-13. Attached to the rear panel of the instrument is a serial number plate that is similar to that shown in Figure 1-2. The serial number is in two parts, a prefix and a suffix. The first four digits and the letter (e. g., 1339A) are the serial number prefix. The prefix is the same for all identical instruments; it is changed only when the instrument is modified. However, the numbers in the suffix are consecutive, regardless of changes in the prefix. The suffix is different for each instrument.

The manual applies to instruments that have the serial number prefixes listed under SERIAL NUMBERS on the title page.

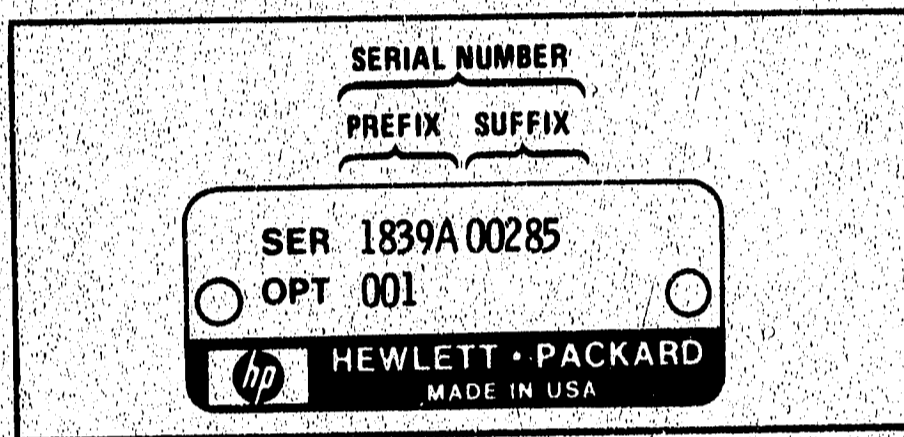


Figure 1-2. Typical Serial Number Plate

1-14. An instrument manufactured after the printing of this manual might have a serial number prefix that is not listed on the title page. This unlisted serial number prefix indicates that the instrument is different from that described in the manual. The manual for this newer instrument is accompanied by a yellow Manual Changes supplement, which contains change information that explains how to adapt the manual to the newer instrument.

1-15. In addition to change information, the supplement might contain information for correcting errors in the manual. Such errata information applies to all serial numbers.

1-16. To keep this manual as current and accurate as possible, Hewlett-Packard recommends that you periodically request the latest Manual Changes supplement. The supplement for this manual is identified with the original print date and the part number of the manual, both of which appear on the title page of the manual. Complimentary copies of the supplement are available from Hewlett-Packard. For information concerning a serial number prefix that is not listed on the title page or in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

## 1-17. DESCRIPTION

1-18. The HP Model 8748A S-Parameter Test Set is designed to interface with the HP Model 8754A Network Analyzer. The 8748A, when used with the 8754A, provides a convenient means of measuring reflection and transmission coefficients (scattering parameters) of a one-port or two-port device operating within the frequency range of 4 MHz to 1.3 GHz.

## 1-19. OPTIONS

### 1-20. Option 907, Front Handles

1-21. Option 907 instruments are supplied with a front handle kit. Refer to Section II for a detailed description of this kit and instructions for installation.

### 1-22. Option 908, Rack Flanges

1-23. Option 908 instruments are supplied with a rack flange kit. Refer to Section II for a detailed description of this kit and instructions for installation.

### 1-24. Option 909, Front Handles and Rack Flanges

1-25. Option 909 instruments are supplied with a front handle and rack flange kit. Refer to Section II for a detailed description of this kit and instructions for installation.

### 1-26. Option 910, Extra Manual

1-27. The standard instrument is supplied with one Operating and Service Manual. Option 910 instruments are supplied with two manuals.

## 1-28. ACCESSORIES SUPPLIED

1-29. Figure 1-1 shows the HP Model 8748A S-Parameter Test Set with the following accessories, which are supplied with the instrument:

- Rear panel lock feet kit
- (4) RF Connecting Cables
- Interconnect Cable
- Reference Extension Cables Kit



**1-30. EQUIPMENT REQUIRED BUT NOT SUPPLIED**

1-31. To provide a complete measurement system, the HP 8748A must be used with the 8754A Network Analyzer or equivalent.

**1-32. ACCESSORIES AVAILABLE****1-33. HP 11600B, Transistor Fixture**

1-34. This transistor fixture provides a convenient and accurate configuration for measuring s-parameters of bipolar and field-effect transistors, or other circuit elements such as diodes or resistors. Accepts TO-18/TO-72 packages. A HP 11858A Rigid Interconnect adapt is used to connect Transistor Fixture to Test Set.

**1-35. HP 11602B, Transistor Fixture**

1-36. This transistor fixture provides a convenient and accurate configuration for measuring s-parameters of bipolar and field-effect transistors, or other circuit elements such as diodes or resistors. Accepts TO-5/TO-12 packages. A HP 11858A Rigid Interconnect adapter is used to connect Transistor Fixture to Test Set.

**1-37. HP 11608A Transistor Fixture**

1-38. This transistor fixture provides the capability of completely characterizing stripline transistors in a 50-ohm stripline configuration. One of three different package-style options must be specified when ordering an HP 11608A Transistor Fixture.

**1-39. HP 11608A, Option 001.** This package-style option has a through-line microstrip and bolt-in grounding structure machinable by the customer to fit the required package.

**1-40. HP 11608A, Option 002.** Accepts TO-51 packages, diameter 6.350 mm (0.25 in.).

**1-41. HP 11608A, Option 003.** Accepts HPAC-200 packages, diameter 5.207 mm (approximately 0.21 in.).

**1-42. HP 11851A RF Cable Kit**

1-43. This cable kit includes three 61-cm (24-in.) cables which are phase matched to a standard within  $\pm 2$  degrees at 1300 MHz. These cables may be used to provide RF connections between

the HP 8754A and the HP 8748A when the S-Parameter Test Set is positioned on top of or off to one side of the Network Analyzer. One longer cable is also included to connect RF Output (8754A) to RF Input (8748A).

**1-44. HP 08503-60051 Interconnect Cable.** (Check Digit No. 5) This cable can be used to provide DC between the 8754A Program connector and the 8748A Network Analyzer Interconnect when this set is positioned away from Network Analyzer.

**1-45. HP 11853A 50-Ohm, Type N Accessory Kit**

1-46. The HP 11853A Accessory Kit furnishes the RF components generally required when measuring devices having 50-ohm, type N connectors (see Table 1-3). The HP 85032A Calibration Kit is also required for use with the HP 11853A Accessory Kit.

Table 1-3. 11853A 50 Ohm Type N Accessory Kit

Qty	Description	HP Part Number
1	Type N Female Short	11511A
1	Type N Male Short	11512A
2	Type N Male Barrel	1250-1475
2	Type N Female Barrel	1250-1472
1	Storage Case	

**1-47. HP 11854A 50-Ohm, BNC Accessory Kit**

1-48. The HP 11854A Accessory Kit furnishes the RF components generally required when measuring devices having 50-ohm, type BNC connectors (see Table 1-4). The HP 85032A Calibration Kit is also required for use with the HP 11854A Accessory Kit.

Table 1-4. 11854A 50 Ohm BNC Accessory Kit

Qty	Description	HP Part Number
2	Type N Male to BNC Female Adapter	1250-1476
2	Type N Male to BNC Male Adapter	1250-1473
2	Type N Female to BNC Male Adapter	1250-1477
2	Type N Female to BNC Female Adapter	1250-1474
1	BNC Male Short	1250-0929
1	Storage Case	



**1-49. HP 11857A Test Port Extension Cables**

1-50. The HP 11857A Test Port Extension Cables set contains two precision 61-cm (24-in.) cables with APC-7 connectors on both ends. These cables are designed to adapt the 8748A test port spacing to almost any two-port coaxial device.

**1-51. HP 11858A Rigid Interconnect Adapter**

1-52. The HP 11858A Rigid Interconnect Adapter provides a rigid RF cable interconnection (horizontal to vertical test port orientation) between the 8748A and the 11600B/11602B Transistor Fixture.

**1-53. HP 85031A Verification and APC-7 Calibration Kit**

1-54. The HP 85031A Verification and APC-7 Calibration Kit is recommended for measurement of devices having APC-7 RF connectors. (See Table 1-5.)

*Table 1-5. 85031A Verification and APC-7 Calibration Kit*

Qty	Description	HP Part Number
1	APC-7 50Ω Termination <1.005 SWR at 2 GHz	909A-H68
1	APC-7 Short	11565A
1	APC-7 3 dB Attenuator	8492A Opt 003
1	APC-7 50 dB Attenuator	8492A Opt 050
1	Storage Case	

**1-55. HP 85032A 50-Ohm, Type N Calibration Kit**

1-56. The HP 85032A 50-Ohm, Type N Calibration Kit is recommended for measurement of devices having Type N RF connectors. (See Table 1-6.)

*Table 1-6. 85032A 50 Ohm Type N Calibration Kit*

Qty	Description	HP Part Number
2	APC-7 to Type N Female Adapter	11524A
2	APC-7 to Type N Male Adapter	11525A
1	50Ω Type N Female Termination <1.005 SWR at 2 GHz	909A-H70
1	50Ω Type N Male Termination <1.005 SWR at 2 GHz	909A-H69
1	Type N Female Short	11511A
1	Type N Male Short	11512A
1	Storage Case	

**1-57. HP 85033A SMA Calibration Kit**

1-58. The HP 85033A Calibration Kit is recommended for measurement of devices having SMA RF connectors. (See Table 1-7.)

*Table 1-7. 85033A SMA Calibration Kit*

Qty	Description	HP Part Number
2	APC-7 to SMA Male Adapter	1250-1007
2	APC-7 to SMA Female Adapter	1250-1012
1	50Ω SMA Female Termination	0960-0050
1	50Ω SMA Male Termination	0960-0053
1	SMA Female Short	0960-0054
1	SMA Male Short	0960-0055
1	Storage Case	

**1-59. RECOMMENDED TEST EQUIPMENT**

1-60. Equipment required for operation verification, performance testing, adjustments, and troubleshooting of the Hewlett-Packard Model 8748A S-Parameter Test Set is listed in Table 1-8. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table.



Table 1-8 Recommended Test Equipment

Instrument	Critical Specifications	Recommended Model	Use*
Network Analyzer	No substitute	HP 8754A	O, P, A, T
Storage-Normalizer	No substitute	HP 8750A	P
Multimeter	Range DC 0 to 50V	HP 3476A	T
Transmission Reflection Test Set	Frequency Range: 4-1300 MHz Directivity: > 40 dB	HP 8502A	P
Oscilloscope	15 MHz Bandwidth	HP 1220A	T
3-Way Power Splitter	Frequency Range: 4-1300 MHz 50Ω Source Match > 32 dB Return Loss Tracking between any two output ports < 0.1 dB and < 1.5°	HP 11850A	P
Termination <sup>1</sup>	50Ω APC-7 Termination with < 1.005 SWR @ 2 GHz	HP 909A H68	O
Short <sup>1</sup>	APC-7	HP 1565A	O, P
Termination (2 Required)	50Ω Type-N male	HP 909A Opt 012	P
Cable Set	Type-N Cable Kit: 3 24" Matched cables 1 34" cable	HP 11851A	P
Cable Set	Two 50Ω 24" APC-7 coaxial matched cables	HP 11857A	P, A
Airline (2 Required)	50Ω 20 cm with APC-7 connectors	HP 11567A	P
Airline	50Ω 10 cm with APC-7 connectors	HP 11566A	P
Adapter (2 Required)	APC-7 to Type-N male	HP 11525A	P
Adapter	Type-N male to Type-N male	HP 1250-1475	P
Wrench (2 Required)	7/16" open end	HP 8710-0803	A

\*O = Operation Verification, P = Performance, A = Adjustment, T = Troubleshooting  
<sup>1</sup>Part of HP 85031 A Verification APC-7 Calibration Kit



# INSTALLATION



## SECTION II INSTALLATION

### 2-1 INTRODUCTION

2-2. This section includes information on the initial inspection, preparation for use, installation, storage and shipment, and operation verification of the HP Model 8748A S-Parameter Test Set.

### 2-3. INITIAL INSPECTION

2-4. Inspect the shipping container for damage. If the container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked for completeness and the instrument has received mechanical and electrical inspection. (Refer to the Operation Verification portion of this section for verification of electrical operation.) If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance tests, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or if the cushioning material shows signs of stress, notify

the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection. The Hewlett-Packard office will arrange for repair or replacement without waiting for a claim settlement.

### 2-5. PREPARATION FOR USE

#### 2-6. Power Requirements

2-7. The power source for the HP 8748A is +20 Vdc from the HP 8754A through the NETWORK ANALYZER INTERCONNECT cable. No other power supply is required.

#### 2-8. Mating Connectors

2-9. Front- and rear-panel connectors are listed in Table 2-1. An industry identification, Hewlett-Packard part number, and alternate source are given for the corresponding connector that mates with each connector on the instrument.

Table 2-1. HP 8748A Mating Connectors

Connector on Instrument	Mating Connector*		
	Industry Identification	HP Part No.	Alternate Sources
J8 RF J5 R J7 A J6 B J3 REF.EXT. J4	Type N, male connector, UG-21G/U	1250-0882	Amphenol Bendix Specialty Connector
A3 Port 1 A4 Port 2	Type APC-7 connector	1250-1183	Amphenol
J1 Bridge Bias 1 J2 Bridge Bias 2	Type BNC, male connector UG-88/U	1250-0256	Amphenol Bendix Specialty Connector
A2J1 and A2J2 Interconnect connector	Series D, 25 contact, male connector	1251-0063	Cinch Cannon

\*Connector on external cable that mates with connector on HP 8748A.

**2-10. Operating Environment**

**2-11. Temperature.** The instrument may be operated at temperatures from 0°C to +55°C.

**2-12. Humidity.** The instrument may be operated in environments with relative humidity of 5 percent to 95 percent at 0°C to +40°C. However, the instrument should also be protected from temperature extremes that could cause internal condensation.

**2-13. Altitude.** The instrument may be operated at altitudes up to 4572 metres (approximately 15,000 feet).

**2-14. INSTALLATION**

**2-15.** When used with the HP 8754A Network Analyzer, the test set may be positioned above or below the network analyzer. (The bottom position is preferred.) If the test set is on the bottom, use four short (19 cm) RF connecting cables, HP Part No. 8120-2289, supplied with the 8748A. When the test set is on top, the HP 11851A cable kit is required to provide RF connections between the test set and the network analyzer.

**2-16. Locking Units Together**

If it is desired to lock the 8754A and the 8748A together, (8748A below 8754A) use the hardware provided and proceed as follows:

- a. Remove the 8748A front frame top trim strip (see illustration of cabinet parts in Section VI).
- b. Fasten the four lock links (Part of HP Part No. 5061-0099) to the 8748A front frame using the eight 6-32 pozidrive screws provided. (There are eight threaded holes in the front frame.) The hook-shaped protrusions of the lock links must extend toward the rear of the 8748A.
- c. Remove the two bottom rear feet from the 8754A and install with two lock feet which contain thumb screws (Part of HP Part No. 5061-0099). There is a left one and a right one. See Figure 2-1 for proper placement.
- d. Set the 8754A on its side and remove the four bottom feet. To remove feet, lift tabs and slide in direction of arrows.
- e. Remove the two top rear feet from the 8748A and replace with lower left rear lock foot and lower right rear lock foot (Part of HP Part No. 5061-0099). See Figure 2-1 for proper placement.

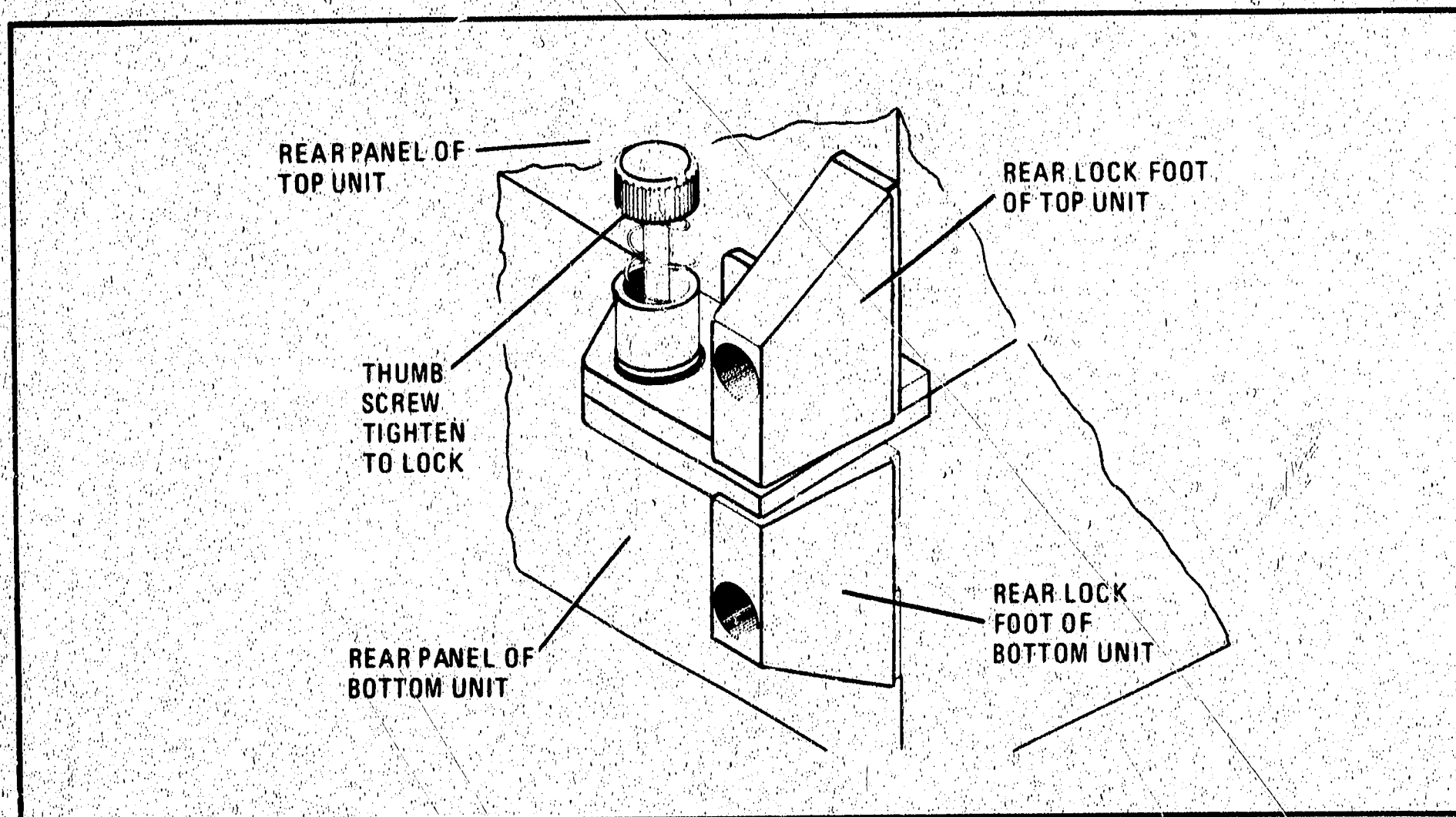


Figure 2-1. Lock Feet



- f. Set the network analyzer on top of the test set with the front edge of the network analyzer overhanging the front edge of the test set approximately 1/4 inch.
- g. Slide the network analyzer back until its front edge is even with the front edge of the test set. This should lock the fronts of the two units together. Make sure they are locked by carefully lifting the front of the network analyzer.
- h. Tighten the thumb screws on the upper rear lock feet of the 8754A into the lower rear lock feet of the 8748A.

### 2-17. Cable Connections

**2-18. NETWORK ANALYZER INTERCONNECT Cable.** Connect the NETWORK ANALYZER INTERCONNECT cable (HP Part No. 08748-60006) from the 8754A rear-panel PROGRAMMING connector to the 8748A rear-panel NETWORK ANALYZER INTERCONNECT connector.

**2-19. RF Connecting Cables.** Connect four short cables (HP Part No. 8120-2289) between the 8754A front-panel connectors and the corresponding connectors on the 8748A; that is, RF to RF, R to R, A to A, and B to B.

**2-20. Reference Plane Extension Cables.** To allow for the change in test path length when cables or transistor fixtures are used six Reference Plane Extension cables are provided. The selection of the cable to be used from this kit (08748-60010) is covered in section III of this manual.

### 2-21. Bench Operation

2-22. The instrument cabinet has plastic feet for convenience in bench operation. The plastic feet are shaped to make full-width modular instruments self-aligning when stacked.

### 2-23. Front Handles (Option 907)

2-24. Instruments with Option 907 are equipped with a Front Handle Kit, which supplies hardware and instructions to install front handles on the instrument. Installation instructions are the same as for Option 909 except only the starred parts in Figure 2-2 are used.

### 2-25. Rack Mounting (Options 908/909)

2-26. Instruments with Option 908 are equipped with a Rack Flange Kit, which supplies the hardware and instructions to install the instrument in a rack with a spacing of 482.5 mm (19 in.). Installation instructions are also given in Figure 2-2.

2-27. Instruments with Option 909 are equipped with a Rack Flange and Front Handle Kit, which supplies the hardware and instructions to install the instrument, with front handles, in a rack with a spacing of 482.5 mm (19 in.). Installation instructions are given in Figure 2-2.

### 2-28. STORAGE AND SHIPMENT

#### 2-29. Environment

2-30. The instrument may be stored or shipped with the following environments:

- Temperature . . . . . -40°C to +75°C
- Relative Humidity . . . . . 5 to 95 percent at 0°C to +40°C
- Altitude . . . . . To 15240 metres (50,000 feet)

The instrument should be protected from temperature extremes that might cause condensation within the instrument.

#### 2-31. Preparation for Shipment

2-32. Figure 2-3 illustrates the proper method of packaging the instrument for shipping using the original factory packaging materials. Part numbers and descriptions of the materials are presented in Figure 2-4.

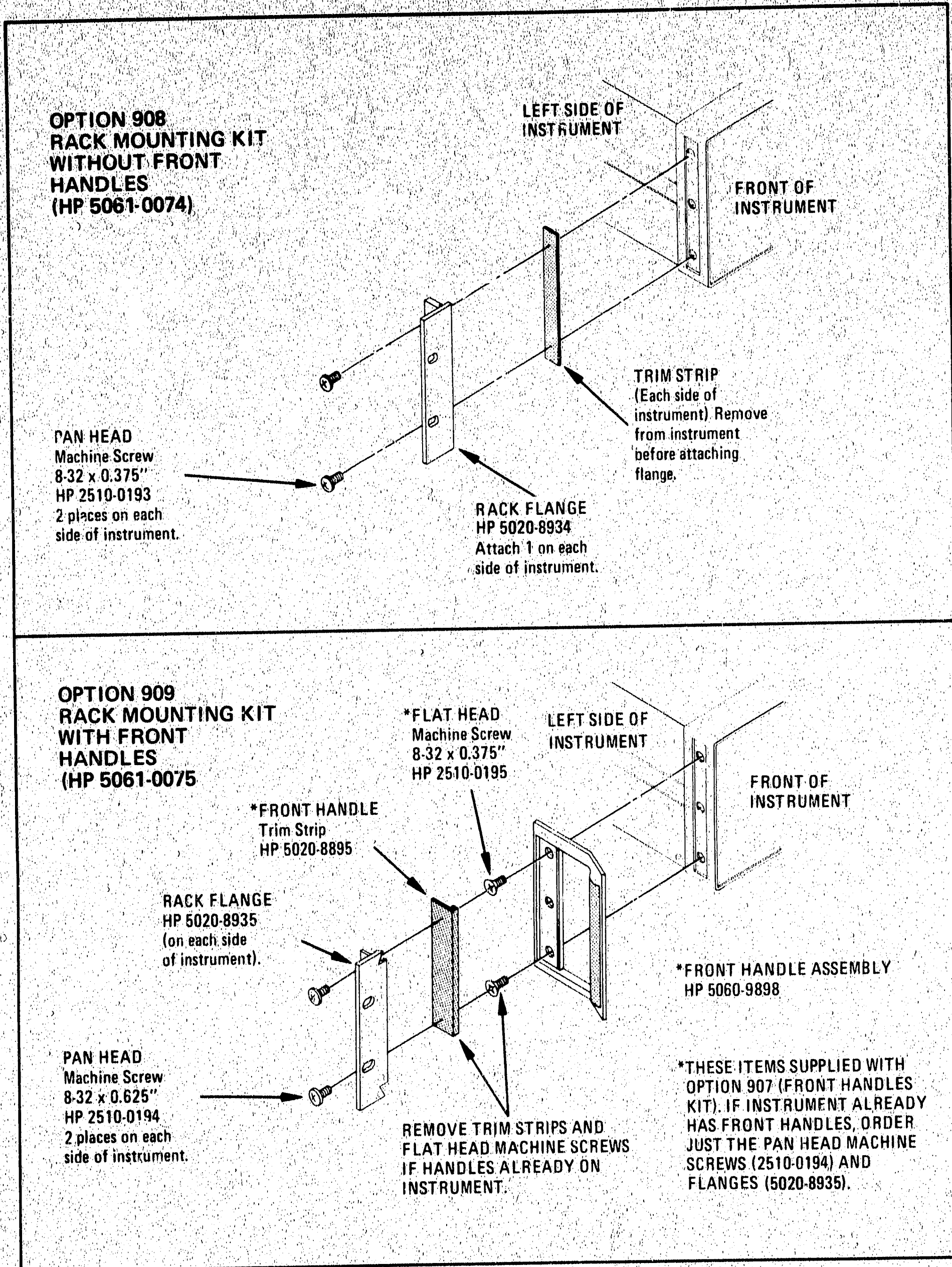
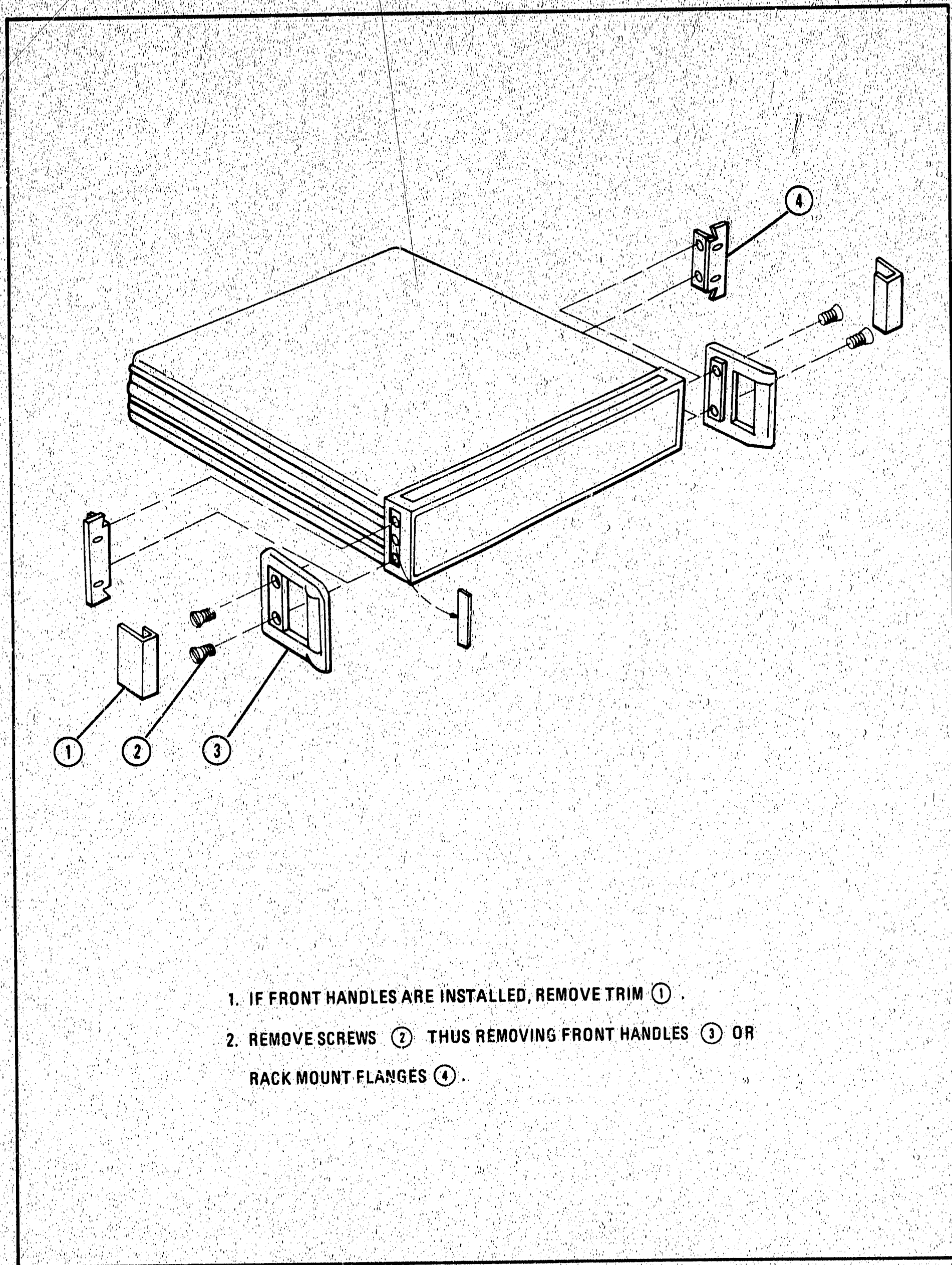


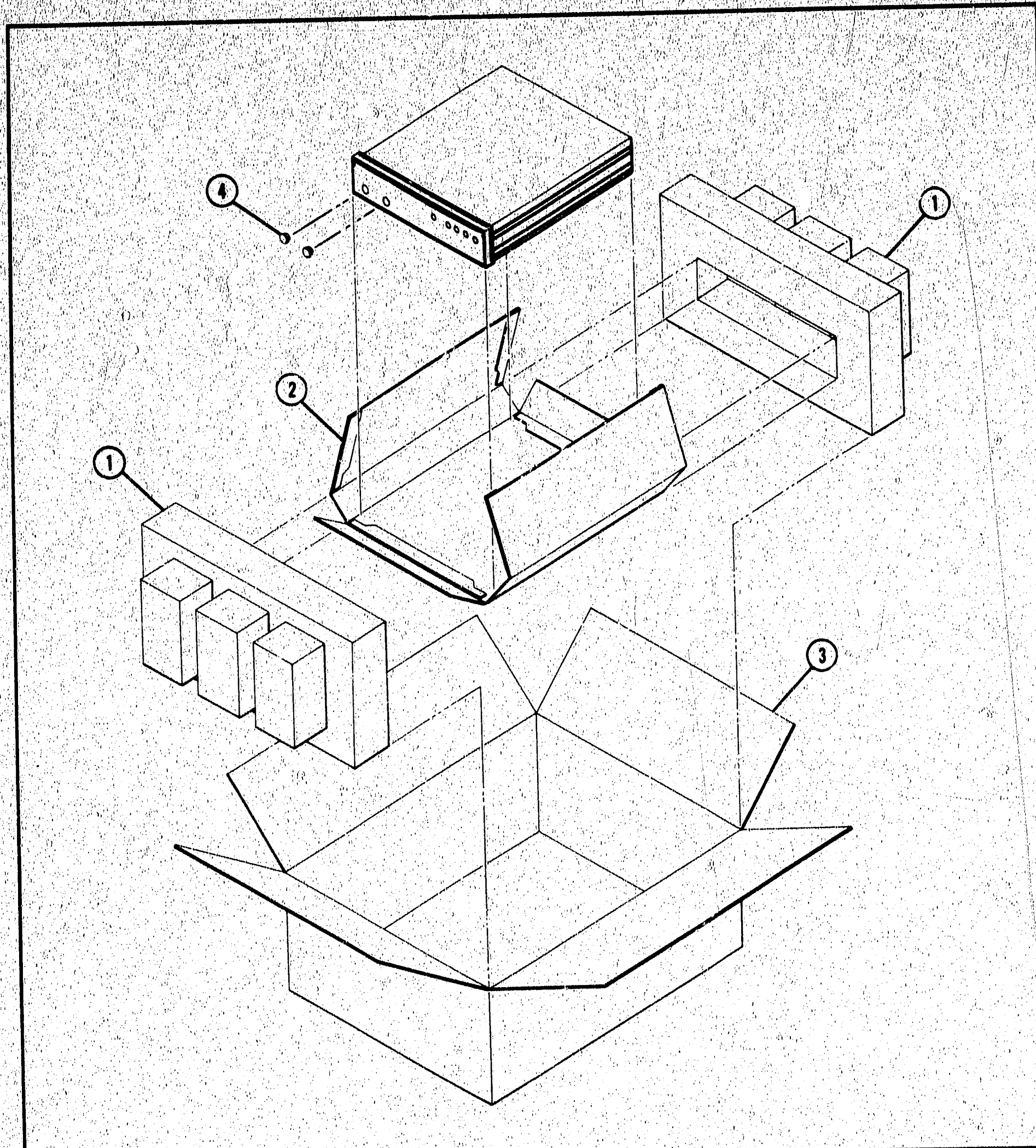
Figure 2-2. Installation of Rack Mounting Hardware and Handles





1. IF FRONT HANDLES ARE INSTALLED, REMOVE TRIM ① .
2. REMOVE SCREWS ② THUS REMOVING FRONT HANDLES ③ OR RACK MOUNT FLANGES ④ .

Figure 2-3. Preparation of Instrument for Shipment



Item	Qty	CD	HP Part No.	Description
1	2	1	9220-2802	SIDE PADS, FOAM
2	1	7	9220-2808	WRAP AROUND CARDBOARD
3	1	1	9211-2752	CARTON
4	2	1	1401-0123	CAP PLUG PROTECTIVE

Figure 2-4. Packaging for Shipment Using Factory Packaging Materials



**2-33. Original Packaging.** It is recommended that the original factory packaging materials be retained for later use. If original packaging material is not retained, identical material is available through Hewlett - Packard offices.

**2-34. Other Packaging.** If it is necessary to use materials different from the original factory packaging, the following general instructions should be observed:

- a. Wrap the instrument in heavy paper or plastic.
- b. Protect the front panel with double-wall, corrugated board.
- c. Place the instrument in a container with 8 to 10 cm (3 to 4 in.) of shock-absorbing material on each of the six sides to provide firm cushioning and to prevent movement inside

the container. The container should be a double-wall corrugated carton of 125 kg (275 lb.) bursting strength.

- d. Seal the container securely and mark FRAGILE.

**2-35. Return for Servicing.** If the instrument is being returned to Hewlett - Packard for servicing, a tag should be attached to the carton to indicate the type of service required, the return address, the model number, and the full serial number. In any correspondence, refer to the instrument by model number and full serial number.

**2-36. OPERATION VERIFICATION**

2-37. The following procedure is a means of checking the operation of the instrument without testing all the specifications listed in Table 1-1. Access to the interior of the instrument is not required.

**OPERATION VERIFICATION**

**EQUIPMENT:**

Network Analyzer .....	HP 8754A
APC-7 Short .....	HP 11565A
50Ω APC-7 Termination with < 1.005 SWR* .....	HP 909A - H68
*Part of HP 85031A Verification and APC-7 Calibration Kit.	

**PROCEDURE:**

- a. Set 8748A controls as follows:

S-PARAMETER SELECT .....	S <sub>11</sub> S <sub>21</sub>
ATTENUATION dB .....	0

- b. Set 8754A controls as follows:

OUTPUT dBm .....	10
Sweep Mode .....	FULL 4-1300
TUNING .....	Fully clockwise
SWEEP WIDTH MHz .....	0 CW
SWEEP .....	AUTO FAST
Sweep Rate .....	midrange
MARKERS .....	OFF
VIDEO FILTER 100Hz .....	OFF (OUT)

**CHANNEL 1:**

Measurement Select .....	A/R
Scale dB/DIV .....	2.5
REFERENCE .....	-00
REFERENCE OFFSET .....	OFF (OUT)

**OPERATION VERIFICATION (Cont'd)**

CHANNEL 2:  
 Measurement Select ..... OFF  
 POLAR A/R ..... OFF (OUT)  
 SWEEP (rear panel) ..... INT

**CAUTION**

Connect and separate the APC-7 connectors carefully to prevent striking the interconnector contact. Any damage to the mating surfaces causes discontinuities and increased SWR.

- c. Connect equipment as shown in Figure 2-5 test setup. R INPUT UNLOCKED lamp should not be lit. It is not important which reference plane extension cable is connected on rear of 8748A.

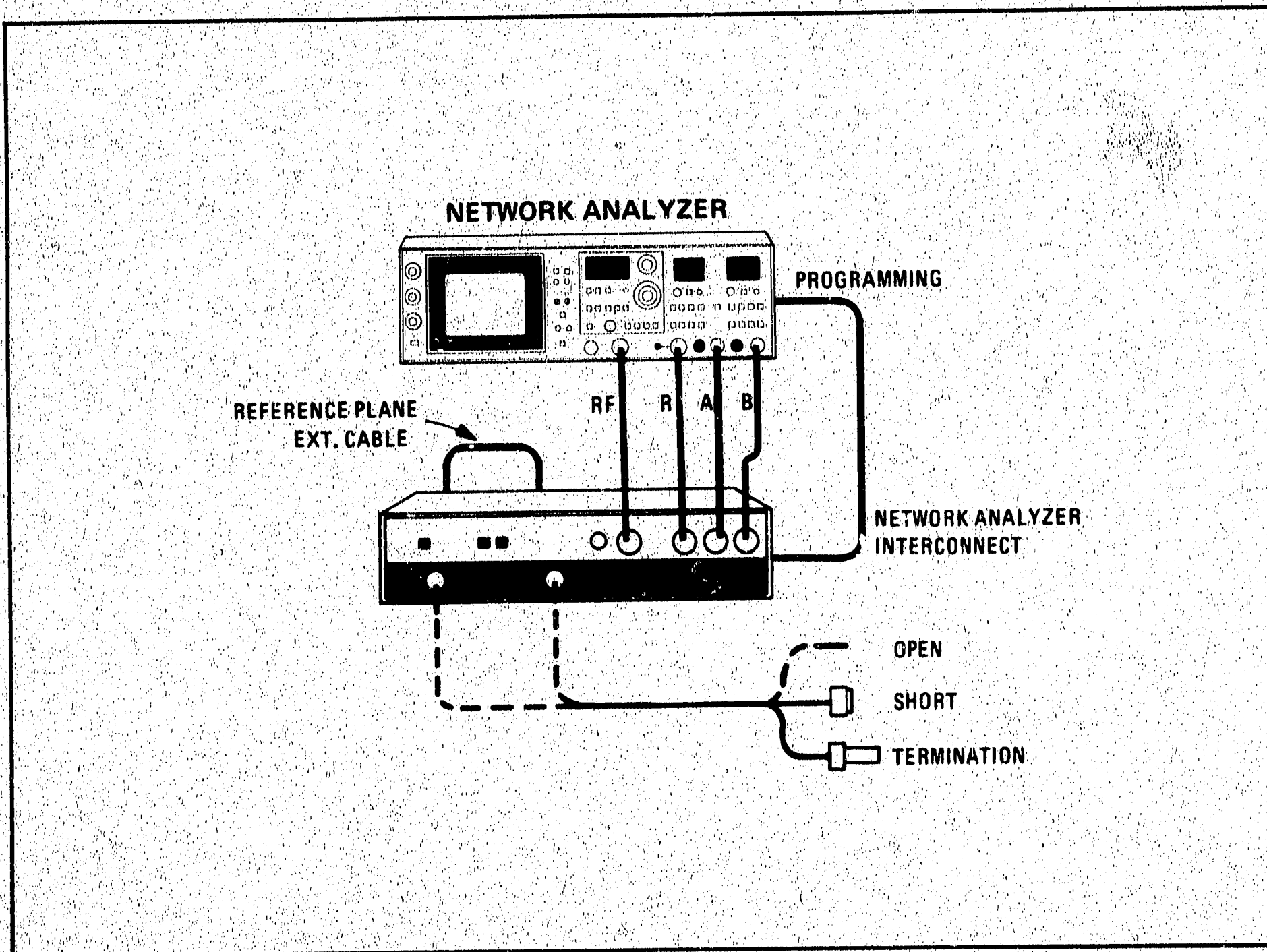


Figure 2-5. Operation Verification Test Setup



**OPERATION VERIFICATION (Cont'd)**

- d. Remove anything that may be connected to test PORT 1 and PORT 2.
- e. Depress 8754A REFERENCE POSITION CH1 pushbutton (IN). Adjust CH1  $\updownarrow$  control to position trace on center line of screen. Press REFERENCE POSITION CH1 pushbutton again to return system to normal operation (button out).
- f. To calibrate the system for directivity measurements lightly grease pencil over the trace on the CRT. Connect coaxial short to PORT 1 of the 8748A. Draw a heavy grease pencil line that averages the light grease pencil line and the trace with the short connected.

**NOTE**

In the following step, the termination must be properly seated in the connector with the tightening nut correctly aligned. If the termination is not properly seated, low directivity will be measured, and the measurement will not be repeatable.

- g. To measure the directivity of the 8748A, remove coaxial short and replace it with a  $50\Omega$  termination (HP909A - H68).
  - (1) Set 8748A CHANNEL 1 REFERENCE switches to -40 dB. The heavy grease pencil line now indicates the 40 dB directivity spec.
  - (2) Read worst - case directivity (the highest point on the trace). This point should be below the heavy grease pencil line.

**NOTE**

Return loss of load significantly affects measurement error: Example; if actual directivity is 40 dB and a 52 (1.005 SWR) dB load is used, the measured value may be from -38 dB to -42.5 dB.

- h. Set 8748A S - PARAMETER SELECT switch to  $S_{22} S_{12}$ .
- i. Erase the 8754A CRT grease pencil marks with a soft tissue. Repeat steps d through g for PORT 2 (connect short to PORT 2 instead of PORT 1).

# OPERATION



## SECTION III OPERATION

### 3-1. INTRODUCTION

3-2. This section explains the functions of the controls and indicators of the HP Model 8748A S-Parameter Test Set. It also describes typical operating modes in a measurement system.

### 3-3. PANEL FEATURES

3-4. Front- and rear-panel features are described in Figure 3-1.

**3-5. Reference Plane Extension.** The rear-panel Reference Plane Extension cables are provided with the test set to equalize the electrical lengths of the reference and test signal paths to achieve correct phase calibration. Six of these cables are provided. The cable to be connected between the REF PLANE EXTENSION connectors depends upon the method used to connect the device under test to the test ports. Figure 3-2 shows the six cables and their applications in order of increasing length.

### 3-6. OPERATING INSTRUCTIONS

3-7. Figure 3-3 shows the RF signal path during measurement of each of the s-parameters. Figure 3-4 provides general procedures for operation of the HP 8748A S-Parameter Test Set with the HP 8754A Network Analyzer.

### 3-8. REMOTE OPERATION

3-9. Remote Operation of the 8748A requires that the Programming connector (A2J2) on the

rear panel receive the following TTL voltages or contact closure. Refer to Service Sheet 2 note 3 for further explanation.

1. A2J2 pin 21 (L REM EN) Hold low ( $\leq 0.5$  volts).
2. A2J2 pin 24 (L REM TRIG) be pulsed low after L REM EN.
3. A2J2 pin 8 (L REM REV) voltage is held low for a  $S_{2,2}$   $S_{1,2}$  setting or allowed to go high ( $\geq 2.5$  volts) for a  $S_{1,1}$   $S_{2,1}$  setting.

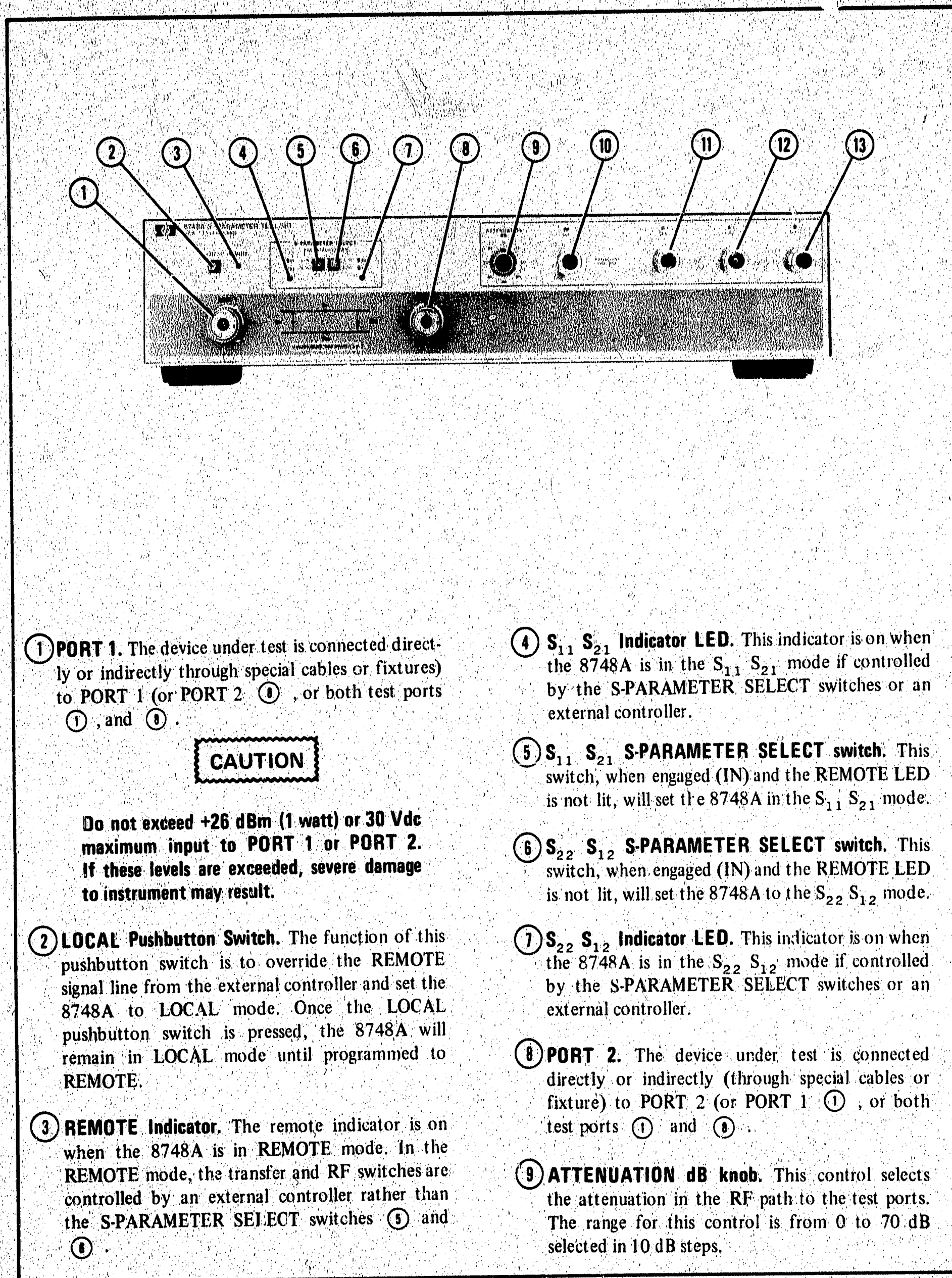
3-10. Information on the control of the 8754A programming functions is covered in the 8754A Operation Information manual.

3-11. Cable HP Part No. 8120-2883 (Check Digit No. 5) is available to connect the 8748A Programming connector to an HP 59301A ASCII-to-parallel converter.

### 3-12. OPERATOR'S MAINTENANCE

3-13. Fuses. The 8748A has two fuses which protect the bridges in the event of excess bias current, both mounted on the rear panel. The fuses may be removed by unscrewing the caps over the fuses and pulling them out. Replace with fuses of correct rating and type. See table 6-3 F1 and F2 for details.

3-14. APC-7 Connectors. Figure 3-5 shows use and care of APC-7 connector.



- ① **PORT 1.** The device under test is connected directly or indirectly through special cables or fixtures) to PORT 1 (or PORT 2 ⑧, or both test ports ①, and ⑧).

**CAUTION**

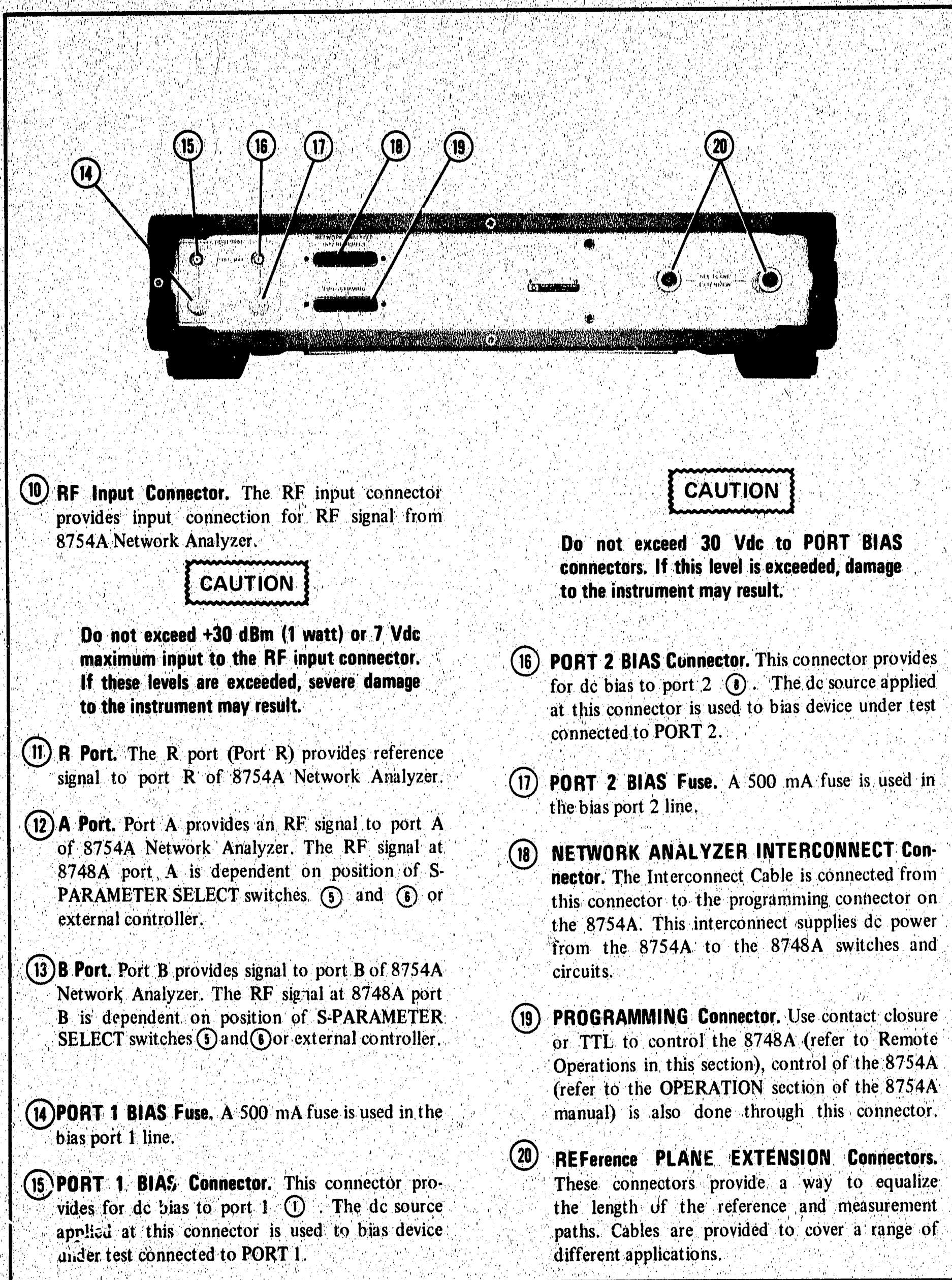
Do not exceed +26 dBm (1 watt) or 30 Vdc maximum input to PORT 1 or PORT 2. If these levels are exceeded, severe damage to instrument may result.

- ② **LOCAL Pushbutton Switch.** The function of this pushbutton switch is to override the REMOTE signal line from the external controller and set the 8748A to LOCAL mode. Once the LOCAL pushbutton switch is pressed, the 8748A will remain in LOCAL mode until programmed to REMOTE.
- ③ **REMOTE Indicator.** The remote indicator is on when the 8748A is in REMOTE mode. In the REMOTE mode, the transfer and RF switches are controlled by an external controller rather than the S-PARAMETER SELECT switches ⑤ and ⑥.

- ④  **$S_{11}$   $S_{21}$  Indicator LED.** This indicator is on when the 8748A is in the  $S_{11}$   $S_{21}$  mode if controlled by the S-PARAMETER SELECT switches or an external controller.
- ⑤  **$S_{11}$   $S_{21}$  S-PARAMETER SELECT switch.** This switch, when engaged (IN) and the REMOTE LED is not lit, will set the 8748A in the  $S_{11}$   $S_{21}$  mode.
- ⑥  **$S_{22}$   $S_{12}$  S-PARAMETER SELECT switch.** This switch, when engaged (IN) and the REMOTE LED is not lit, will set the 8748A to the  $S_{22}$   $S_{12}$  mode.
- ⑦  **$S_{22}$   $S_{12}$  Indicator LED.** This indicator is on when the 8748A is in the  $S_{22}$   $S_{12}$  mode if controlled by the S-PARAMETER SELECT switches or an external controller.
- ⑧ **PORT 2.** The device under test is connected directly or indirectly (through special cables or fixture) to PORT 2 (or PORT 1 ①, or both test ports ① and ⑧).
- ⑨ **ATTENUATION dB knob.** This control selects the attenuation in the RF path to the test ports. The range for this control is from 0 to 70 dB selected in 10 dB steps.

Figure 3-1. Front- and Rear-Panel Controls, Connectors, and Indicators (1 of 2)





- ⑩ **RF Input Connector.** The RF input connector provides input connection for RF signal from 8754A Network Analyzer.

**CAUTION**

Do not exceed +30 dBm (1 watt) or 7 Vdc maximum input to the RF input connector. If these levels are exceeded, severe damage to the instrument may result.

- ⑪ **R Port.** The R port (Port R) provides reference signal to port R of 8754A Network Analyzer.

- ⑫ **A Port.** Port A provides an RF signal to port A of 8754A Network Analyzer. The RF signal at 8748A port A is dependent on position of S-PARAMETER SELECT switches ⑤ and ⑥ or external controller.

- ⑬ **B Port.** Port B provides signal to port B of 8754A Network Analyzer. The RF signal at 8748A port B is dependent on position of S-PARAMETER SELECT switches ⑤ and ⑥ or external controller.

- ⑭ **PORT 1 BIAS Fuse.** A 500 mA fuse is used in the bias port 1 line.

- ⑮ **PORT 1 BIAS Connector.** This connector provides for dc bias to port 1 ①. The dc source applied at this connector is used to bias device under test connected to PORT 1.

**CAUTION**

Do not exceed 30 Vdc to PORT BIAS connectors. If this level is exceeded, damage to the instrument may result.

- ⑯ **PORT 2 BIAS Connector.** This connector provides for dc bias to port 2 ②. The dc source applied at this connector is used to bias device under test connected to PORT 2.

- ⑰ **PORT 2 BIAS Fuse.** A 500 mA fuse is used in the bias port 2 line.

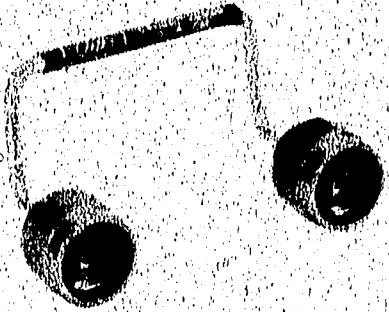
- ⑱ **NETWORK ANALYZER INTERCONNECT Connector.** The Interconnect Cable is connected from this connector to the programming connector on the 8754A. This interconnect supplies dc power from the 8754A to the 8748A switches and circuits.

- ⑲ **PROGRAMMING Connector.** Use contact closure or TTL to control the 8748A (refer to Remote Operations in this section), control of the 8754A (refer to the OPERATION section of the 8754A manual) is also done through this connector.

- ⑳ **REFERENCE PLANE EXTENSION Connectors.** These connectors provide a way to equalize the length of the reference and measurement paths. Cables are provided to cover a range of different applications.

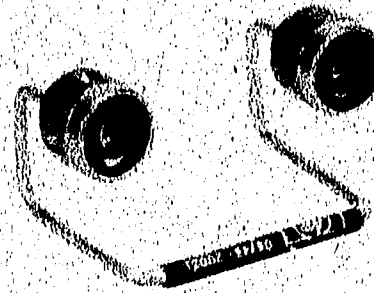
Figure 3-1. Front- and Rear-Panel Controls, Connectors, and Indicators (2 of 2)

**08748-20020**



This cable will allow from 0 to 6 cm of compensation when using connector adapter or connecting directly to Port 1 and 2 in making reflection measurements.

**08748-20021**



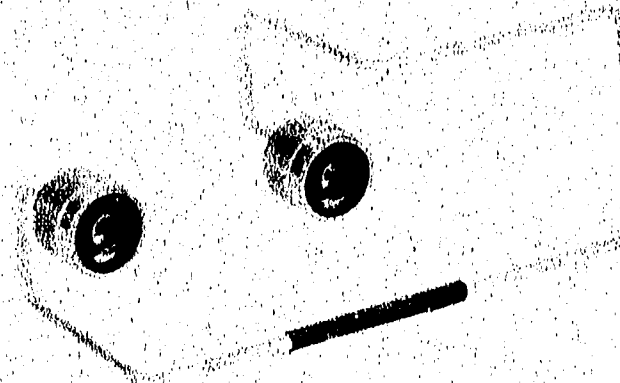
This cable will allow from 6 to 12 cm of compensation when using more than one adapter or a short cable to connect to Ports 1 and 2 in making reflection measurements.

**08748-20022**



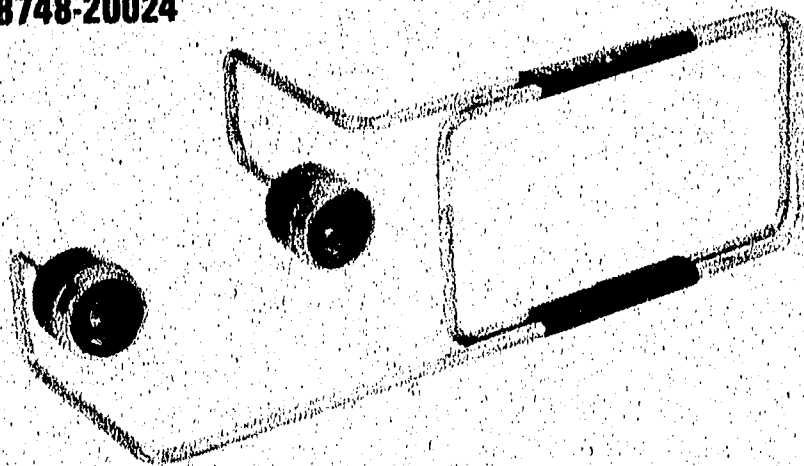
This cable may be used when using the 11608A Transistor Fixture for transmission or reflection measurements. This cable will also compensate when using cables with from 12–19 cm of electrical length for reflection measurements.

**08748-20023**



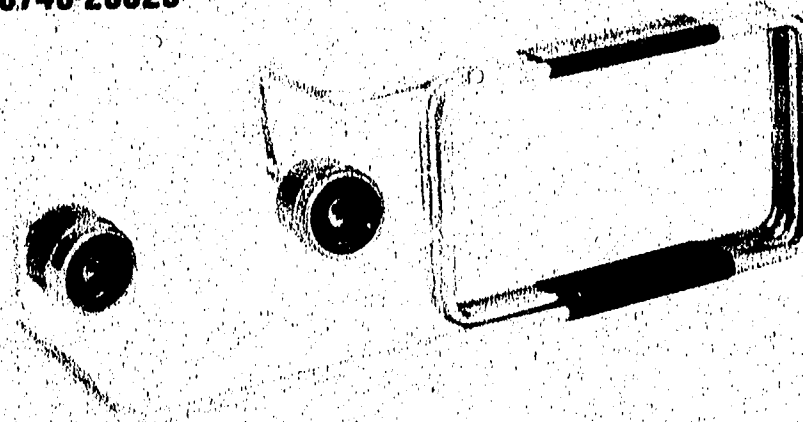
This cable will allow from 12 to 19 cm of compensation when using a cable with between 19 to 25 cm of electrical length on Ports 1 and 2 for reflection measurements.

**08748-20024**



This cable may be used when using the 11600B or 11602B Transistor Fixture Adapter for transmission or reflection measurements. This cable will also compensate when using cables with from 44 to 51 cm of electrical length for reflection measurements.

**08748-20025**



This cable may be used when the test device is connected between two 11857A (610 cm, 24") Test Port Extension cables for transmission or reflection measurements. This cable will also compensate when using cables with from 83 to 90 cm of electrical length for reflection measurements.

*Figure 3-2. Reference Plane Extension Cable Selection*



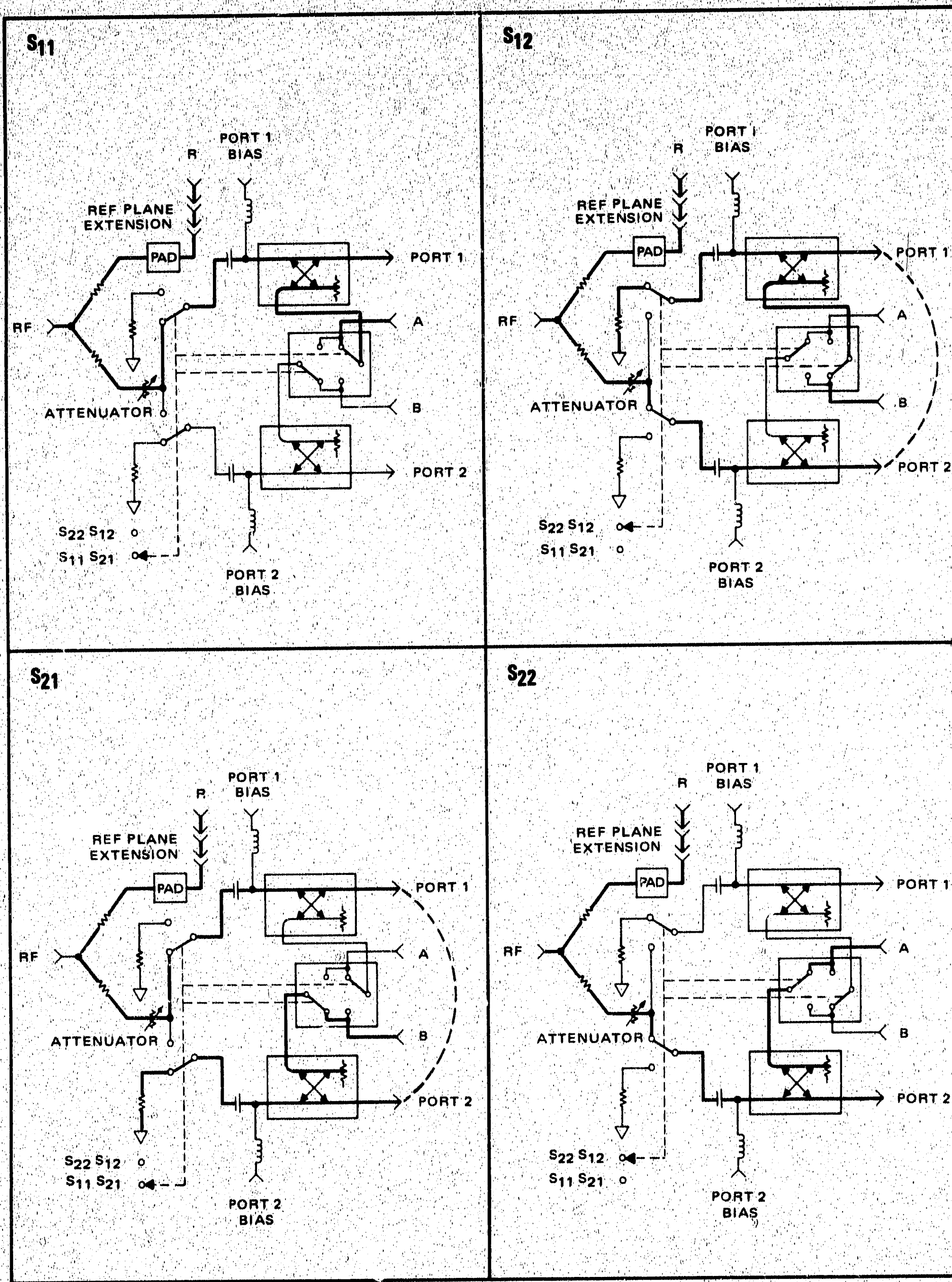


Figure 3-3. RF Signal Paths

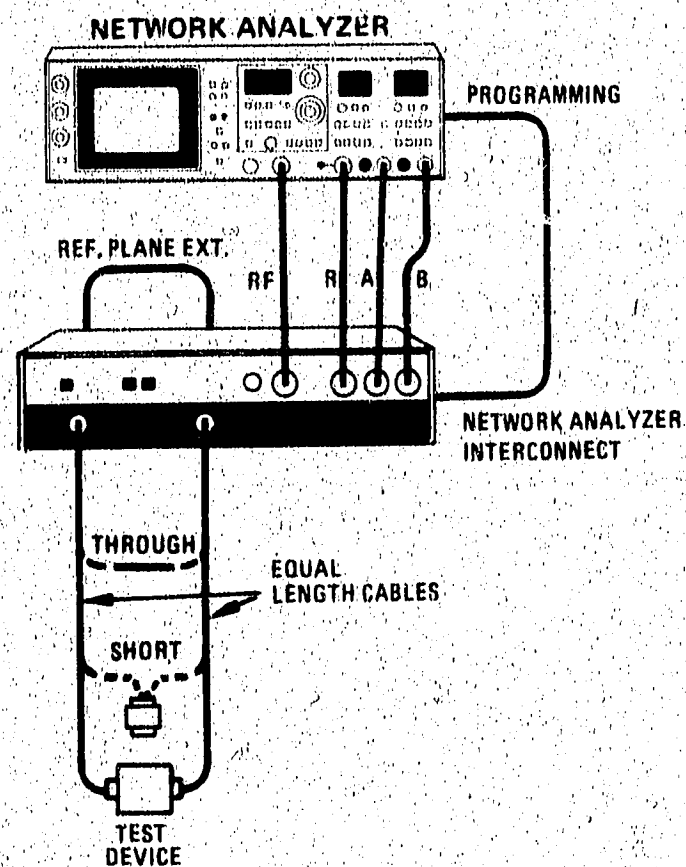
## OPERATING INSTRUCTION

### DESCRIPTION:

S-Parameters define the transmission and reflection magnitude and phase characteristics of the test device. Using the 8748A S-Parameter Test Set with the 8754A allows measurement of both forward and reverse S-Parameters without disconnecting the test device. The 8748A front panel S-PARAMETER SELECT buttons switch the incident RF to Port 1 in  $S_{11}$   $S_{21}$  or Port 2 in  $S_{22}$   $S_{12}$ . Figure 3-3 shows the signal path for the four S-Parameter measurements.

### S-PARAMETER MEASUREMENTS

#### INITIAL SETTING:



1. Connect four RF cables (8120-2289) and power interconnect cable (08748-60006) cables as described in Section II, Paragraph 2-17 through 2-19.
2. Connect test cables and or adapters from ports 1 and 2 to test device. Use 11857A cables or short, low-loss cables for best accuracy. To measure phase of both ports, use equal-length cables from ports 1 and 2.
3. Connect Reference Plane Extension cable that is within the electrical length of one of the equal length cables (Refer to Figure 3-2).
4. Set 8754A LINE switch to ON. Allow 1/2 hour warm-up time.
5. Engage REFERENCE POSITION 1 and 2 buttons (IN). Adjust REFERENCE POSITION CH 1  $\blacktriangle$  and CH 2  $\blacktriangle$  to place traces on center graticule. Disengage REFERENCE POSITION CH 1 and CH 2 pushbuttons (OUT).

Figure 3-4. Operating Instructions (1 of 7)



**S<sub>21</sub>-FORWARD TRANSMISSION MEASUREMENT:****Calibration**

6. Set Test Set to S<sub>11</sub> S<sub>21</sub>.
7. Set CRT display, frequency sweep and signal level.

**NOTE**

**If an amplifier is being measured whose gain is greater than 10 dB reduce RF input (8748A ATTENUATION and or 8754A OUTPUT) to avoid possible damage to Test Set or making a measurement error due to signal compression**

8. Select CHANNEL 1 B/R and CHANNEL 2 PHASE B/R.
9. Set CHANNEL 1 and 2 REFERENCEs to ±00.
10. Connect "through" as shown in above illustration.
11. Engage CHANNEL 1 REFERENCE OFFSET (switch IN) and adjust to move trace to reference position line.
12. Adjust CHANNEL 2 B/R LENGTH for constant 0° over sweep.

**NOTE**

**If constant 0° cannot be achieved then the Reference Plane Extension cable is not correct length. If trace slope down, install a longer extension cable.**

**Measurement**

13. Connect "test device".
14. Set CHANNEL 1 REFERENCE switch to move point of interest on trace to reference position line. Magnitude ratio = REFERENCE switch setting + trace displacement from reference position line.
15. Set CHANNEL 2 REFERENCE switch to move point of interest on trace to reference position line. Read phase angle from REFERENCE switch setting.

**S<sub>12</sub>-REVERSE TRANSMISSION MEASUREMENT:**

16. Repeat steps 9 through 15 with Test Set in S<sub>22</sub> S<sub>12</sub> mode.

*Figure 3-4. Operating Instructions (2 of 7)*

**S<sub>11</sub>-INPUT REFLECTION:****Calibration**

17. Set Test Set to S<sub>11</sub> S<sub>21</sub>.
18. Press POLAR A/R.
19. Set CRT display (POLAR CENTER).
20. Set both REFERENCE switches to  $\pm 00$ .
21. Connect short to Port 1 measurement plane.
22. Adjust CHANNEL 1 REFERENCE OFFSET to move trace to outer circle (OFFSET switch in).
23. Adjust POLAR A/R LENGTH for smallest cluster at  $\pm 180^\circ$ .

**NOTE**

If constant  $0^\circ$  cannot be achieved then the Reference Extension cable is not correct length. If circle rotates CW, install a longer Extension cable.

**Measurement**

24. Connect test device.
25. Set CHANNEL 1 REFERENCE switch to move point on trace to outer circle. The switch setting is Magnitude in dB.  
Set CHANNEL 2 REFERENCE switch to move point on trace to zero degrees. The switch setting is Phase in degrees.

**S<sub>22</sub>-OUTPUT REFLECTION:**

26. Repeat steps 22 through 25 with the short on port 2 and the Test Set set to S<sub>22</sub> S<sub>12</sub>.

**NOTE**

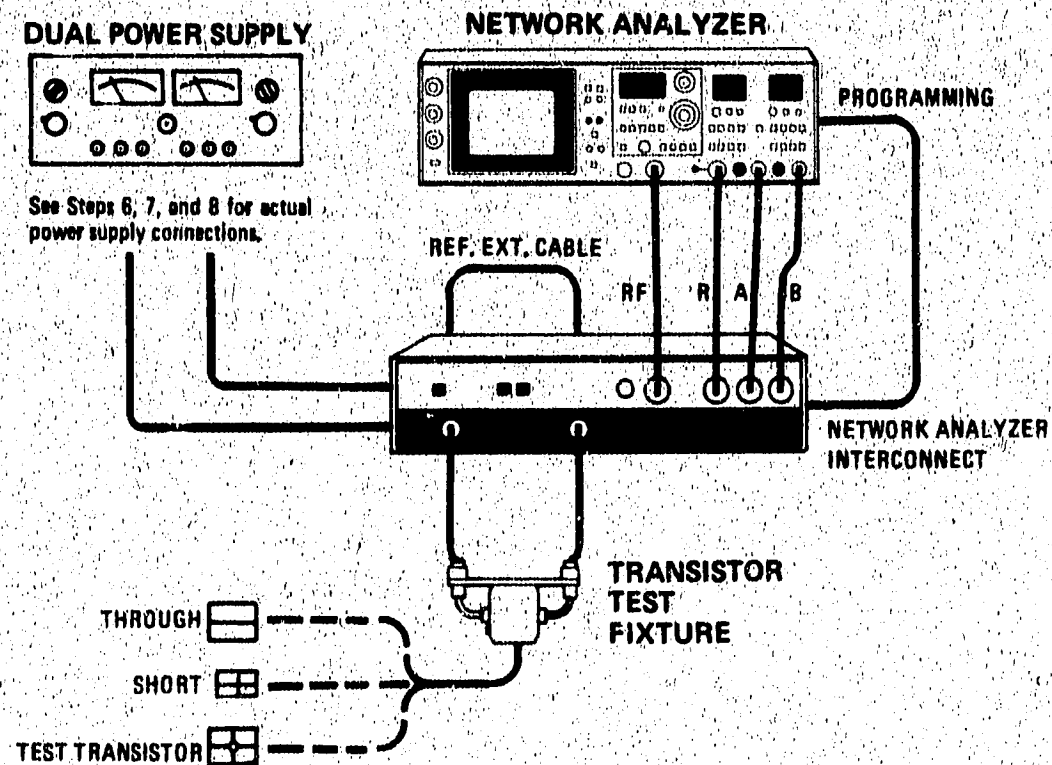
If S<sub>11</sub> and S<sub>22</sub> require a different setting of LENGTH control and/or Reference Extension cable then the electrical lengths of the test cables from ports 1 and 2 are not equal length and must be equalized.

Figure 3-4. Operating Instructions (3 of 7)



## S-PARAMETER TRANSISTOR MEASUREMENTS

## INITIAL SETTING:



1. Connect cables as described in Section II, Paragraph 2-14 through 2-19.
2. To measure stripline transistors, use an 11608A transistor fixture, and connect the 08748-20022 Ref. Ext. cable to rear panel. To measure TO-18/TO-5 transistors use an 11600B/11602B transistor fixture and a 11858A Fixture Adapter, and connect the 08748-20024 Ref. Ext. cable to rear panel. PORT 2 adjust laterally to properly align with transistor fixture ports.
3. Set 8754A LINE switch to ON. Allow 1/2 hour warm-up time.
4. Engage REFERENCE POSITION 1 and 2 buttons (IN). Adjust REFERENCE POSITION CH 1  $\blacktriangle$  and CH 2  $\blacktriangle$  to place trace on center graticule. Disengage REFERENCE POSITION CH 1 and CH 2 pushbuttons (OUT).

## Bias Setting

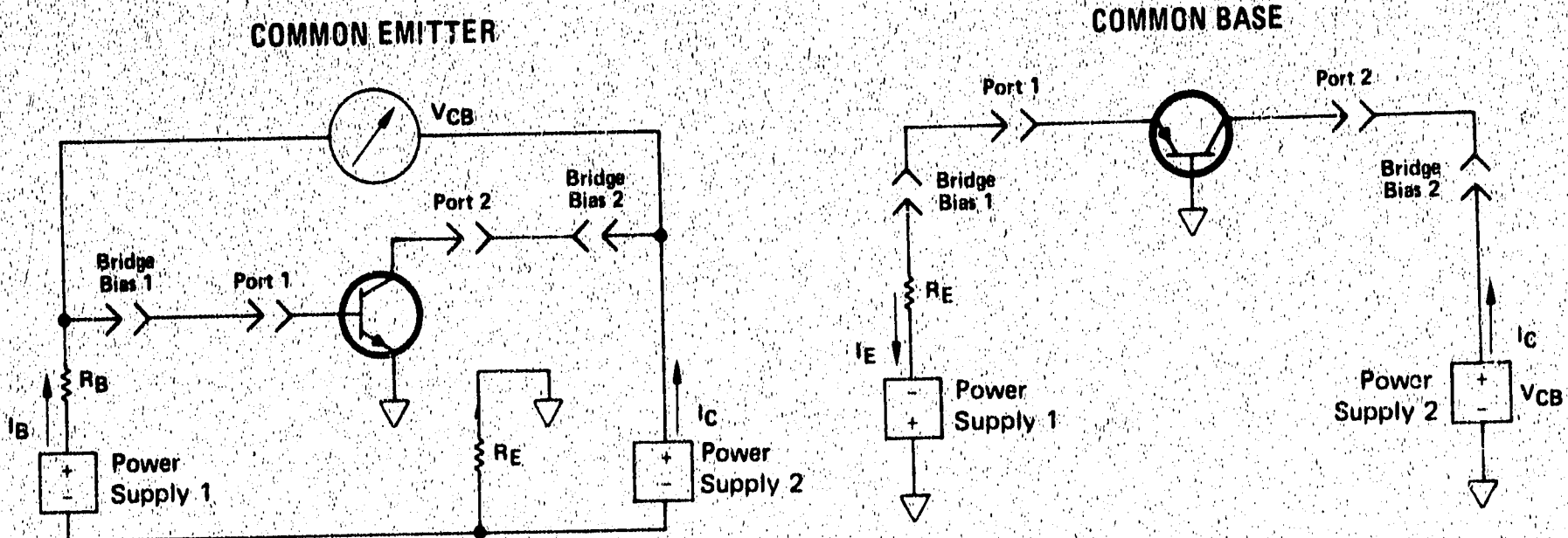
## NOTE

There may be some degradation in RF specifications from 4 to 100 MHz when the Bias ports are used.

5. PORT BIAS 1 and 2 on the 8748A rear panel provide connections for  $\pm 30\text{Vdc}$ ,  $\pm 200\text{mA}$  bias when measuring transistors.

Figure 3-4. Operating Instructions (4 of 7)

6. Use a dual dc power supply such as the HP 6205A that will deliver the required voltage and current. (The HP 8717B Transistor Bias Supply is not compatible with the 8748A; it is designed for bias tees optimized for microwave frequencies and may cause the test device to oscillate). The diagrams below show biasing connections for NPN devices. Reverse power supply polarities for PNP devices.



7. For common emitter, choose  $R_E$  for desired collector current with maximum voltage drop across  $R_E$  while maintaining forward bias voltage. (For example, with  $I_E = 20 \text{ mA}$ ,  $R_E = (10\text{V}/0.02) = 500\Omega$ .) Choose  $R_B$  to control oscillations (typically from 100 to 400 $\Omega$ ). Turn on Power Supply 2 first and set to  $V_{CE} + I_R$  drop across  $R_E$ , then turn on Power Supply 1 and set for desired  $I_E$ .
8. For the common base, choose  $R_E$  as above and  $R_B$  is not required. Turn on Power Supply 2 first and set to  $V_{CE} + I_R$  drop across  $R_E$ , then turn on Power Supply 1 and set for desired  $I_E$ . Reset Power Supply 2 for desired  $V_{CB}$ .
9. Turn off Power Supplies 1 then 2.

#### $S_{21}$ -FORWARD TRANSMISSION MEASUREMENT:

##### Calibration

10. Set Test Set to  $S_{11} S_{21}$ .
11. Set CRT display, frequency sweep and signal level.

##### NOTE

If transistor gain is greater than 10 dB reduce RF input (8748A ATTENUATION and or 8754A OUTPUT) to avoid possible damage to Test Set or making a measurement error due to signal compression

12. Select CHANNEL 1 B/R and CHANNEL 2 PHASE B/R.
13. Set CHANNEL 1 and 2 REFERENCES to  $\pm 00$ .
14. Connect "through" as shown in transistor fixture manual.

Figure 3-4. Operating Instructions (5 of 7)



15. Adjust CHANNEL 1 REFERENCE OFFSET to move trace to reference position line (offset switch in).
16. Adjust CHANNEL 2 B/R LENGTH for constant  $0^\circ$  over sweep.

#### NOTE

If constant  $0^\circ$  cannot be achieved then the Reference Plane Extension cable is not correct length.

#### Measurement

17. Connect "transistor device".
18. Turn on power supplies 2 then 1.
19. Set CHANNEL 1 REFERENCE switch to move point of interest on trace to reference position line. Magnitude ratio equals REFERENCE switch setting plus trace displacement from reference position line.
20. Set CHANNEL 2 REFERENCE switch to move point of interest on trace to reference position line.  
Read phase angle from REFERENCE switch setting.
21. Turn off Power Supplies 1 then 2.

#### $S_{12}$ -REVERSE TRANSMISSION MEASUREMENT:

22. Repeat steps 14 through 21 with Test Set in  $S_{22} S_{12}$  mode.

#### $S_{11}$ -INPUT REFLECTION:

#### Calibration

23. Set Test Set to  $S_{11} S_{21}$ .
24. Press POLAR A/R.
25. Set CRT display (POLAR CENTER).
26. Set both REFERENCE switches to  $\pm 00$ .
27. Connect short as shown in transistor fixture manual.
28. Adjust CHANNEL 1 REFERENCE OFFSET to move trace to outer circle (OFFSET switch in).
29. Adjust POLAR A/R LENGTH for smallest cluster at  $\pm 180^\circ$ .

Figure 3-4. Operating Instructions (6 of 7)

**Measurement**

30. Connect "transistor device".
31. Turn on Power Supplies 2 then 1.
32. Set CHANNEL 1 REFERENCE switch to move interest point on trace to outer circle. The switch setting is in Magnitude in dB.
33. Set CHANNEL 2 REFERENCE switch to move interest point on trace to zero degrees. The switch setting is in Phase in degrees.
34. Turn off Power Supplies 1 then 2.

**S<sub>22</sub>-OUTPUT REFLECTION:**

35. Repeat steps 27 through 34 with the test Set set to S<sub>22</sub> S<sub>12</sub>.

**NOTE**

If it is necessary to measure all four S-Parameter in polar format, refer to programming connector J7 pin 10 information in 8754A Operating Information manual.

Figure 3-4. Operating Instructions (7 of 7)



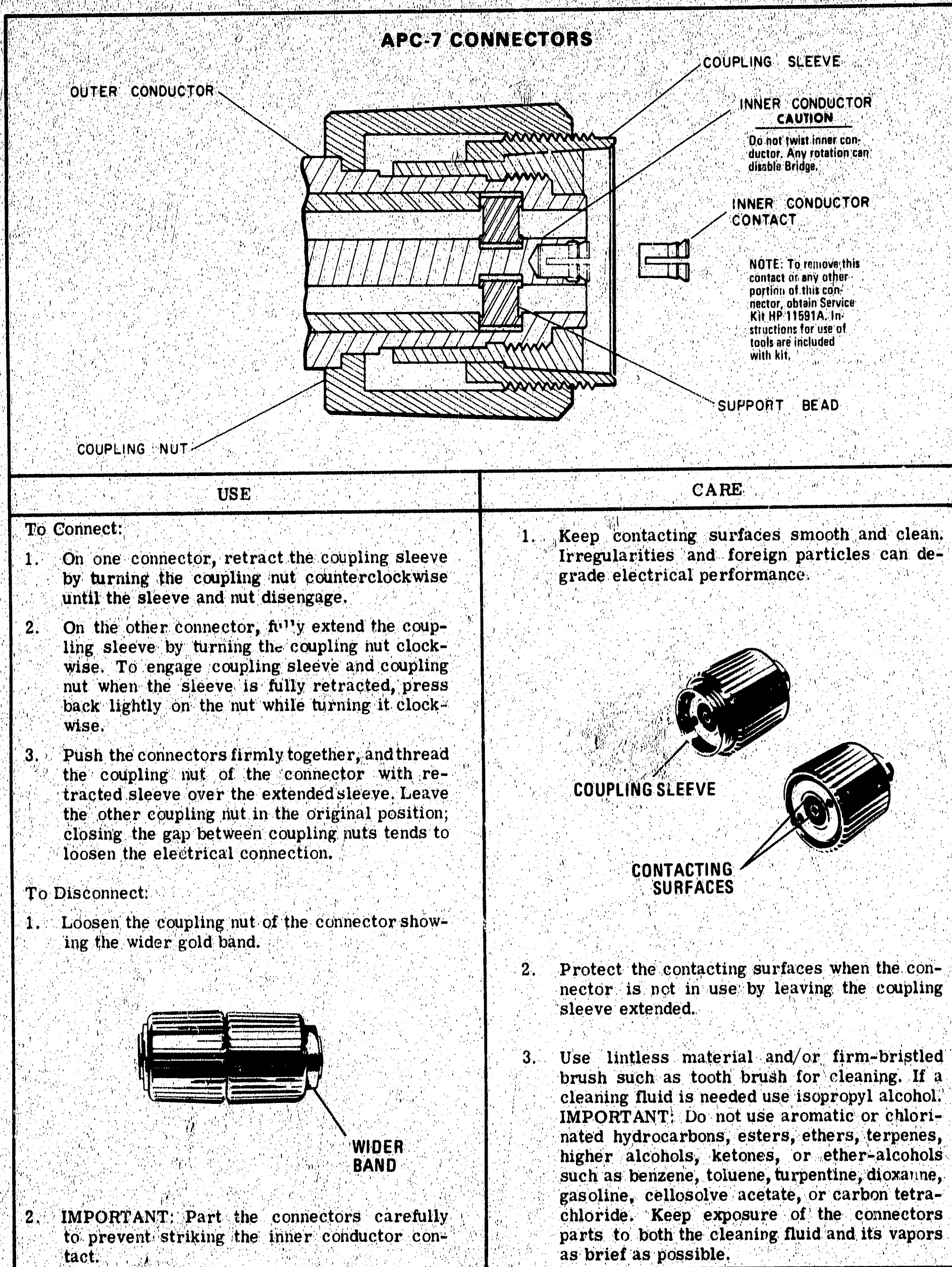


Figure 3-5. APC-7 Connectors

# PERFORMANCE CHECK



## SECTION IV PERFORMANCE TESTS

### 4-1. INTRODUCTION

4-2. The procedures in this section test the electrical performance of the instrument using the specifications in Section I as the performance standards. All tests can be performed without access to the interior of the instrument. To assure that the instrument is operating properly without testing all of the specifications listed in Table 1-1, the Operation Verification procedure given in Section II may be used.

4-3. The performance test procedures must be performed in the sequence given, since some procedures rely on satisfactory test results in foregoing procedures. If a test measurement is slightly out of tolerance, or if a function fails to operate, refer to Section VIII for troubleshooting information.

### 4-4. EQUIPMENT REQUIRED

4-5. Recommended test equipment required for performance tests is listed in Section I. Any equip-

ment that satisfies the critical specifications given in the table may be substituted for the recommended equipment.

### 4-6. PERFORMANCE TEST RECORD

4-7. Results of the performance tests may be recorded on the Performance Test Record at the end of this section. The Performance Test Record lists all of the tested specifications and their acceptable limits. Test results recorded during operation verification and performance tests can be used for comparison in periodic maintenance and troubleshooting as well as after repairs.

### NOTE

**Allow one – half hour warmup time for HP 8754A Network Analyzer before beginning performance tests.**

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## PERFORMANCE TESTS

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### 4-8. DIRECTIVITY

#### SPECIFICATION:

Directivity:  $\geq 40$  dB

#### DESCRIPTION:

Directivity is tested using the internal Bridge to measure the reflection coefficient of a standard termination ( $SWR \leq 1.005$ ). The termination return loss is much greater than the directivity; therefore, the resultant measurement is the approximate directivity of the coupler.

The Directivity Test has been used for the Operation Verification Test. The test setup, equipment and procedures needed to test the directivity specifications are found in Section II, Figure 2-5, Operation Verification Test.

**PERFORMANCE TESTS**

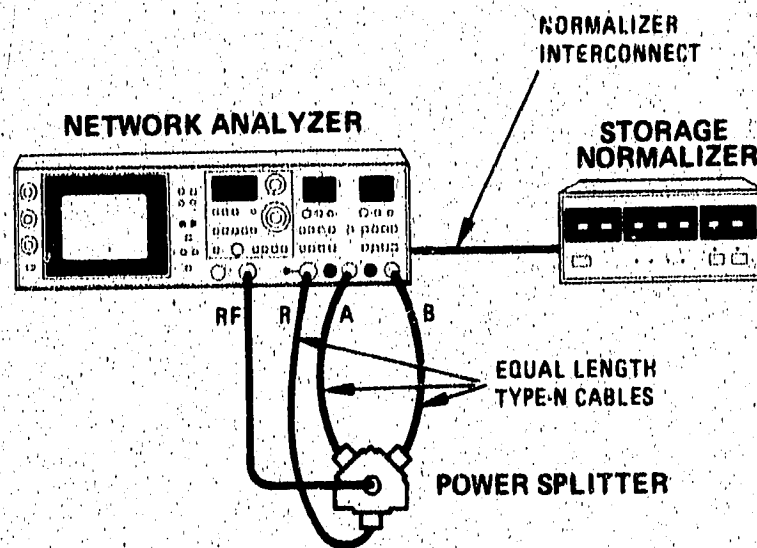
**4-9. FREQUENCY RESPONSE**

**SPECIFICATION:**

Transmission Frequency Response  $S_{21}, S_{12}$ :  $\pm 1 \text{ dB}, \pm 8^\circ$   
 Reflection Frequency Response  $S_{11}, S_{22}$ :  $\pm 2 \text{ dB} \pm 15^\circ$   
 from 4 MHz to 1300 MHz ( $\pm$  degrees specified as deviation from Linear Phase).

**DESCRIPTION:**

The frequency response of the HP 8754A Network Analyzer is first measured, using the 11850A 50 $\Omega$  power splitter, and is stored in the digital memory of the 8750A STORAGE-NORMALIZER. The HP8748A then replaces the 11850A POWER SPLITTER, a thru cable is installed from ports 1 to 2, and the transmission frequency response amplitude and phase is read on the 8754A Network Analyzer. The thru cable is removed from the 8748A and the process repeated for the reflected frequency response.



*Figure 4-1. Frequency Response Calibration Test Setup*

**EQUIPMENT:**

Network Analyzer .....	HP 8754A
Storage-Normalizer .....	HP 8750A
3-Way Power Splitter .....	HP 11850A
Matched Type N Male Coaxial Cable Kit .....	HP 11851A
Matched APC-7 50 $\Omega$ Coaxial Cables 24 in. ....	11857A
APC-7 Short .....	11565A

**PROCEDURE:**

- a. Perform the alignment in the Operation section of the 8750A Operating and Service Manual to match the 8754A with the 8750A.
- b. Connect equipment as shown in Figure 4-1. Use Reference Extension cable HP part No. 08748-20025 on the 8748A. Set equipment controls as follows:



**PERFORMANCE TESTS**

**4-9. FREQUENCY RESPONSE (Cont'd)**

HP 8748A:

S-PARAMETER SELECT .....  $S_{11}$   $S_{21}$   
 ATTENUATION dB ..... 0

HP 8750A:

CH 1 ..... Press and release  
 INPUT ..... Press and release

HP 8754A:

OUTPUT dBm ..... 10  
 SWEEP MODE ..... FULL 4-1300  
 TUNING ..... Fully Clockwise  
 SWEEP WIDTH MHz ..... 0CW  
 SWEEP ..... AUTO FAST  
 Sweep Rate ..... midrange  
 MARKERS ..... OFF  
 VIDEO FILTER 100Hz ..... OFF (OUT)  
 POLAR A/R ..... OFF (OUT)

CHANNEL 1:

Measurement Select ..... B/R  
 Scale dB/DIV ..... 1  
 REFERENCE ..... -00  
 REFERENCE OFFSET ..... OFF (OUT)

CHANNEL 2:

Measurement Select ..... PHASE B/R  
 Scale DEG/DIV (Green) ..... 10  
 REFERENCE ..... -00  
 REFERENCE OFFSET ..... OFF (OUT)

- c. Engage the REFERENCE POSITION CH1 and CH2 pushbuttons (in) and adjust CH1  $\blacklozenge$  and CH2  $\blacklozenge$  to place the traces on the centerline. Disengage the REFERENCE POSITION pushbuttons (out).
- d. Adjust 8754A PHASE B/R LENGTH control to level CHAN. 2 trace.
- e. On the 8750A, press in sequence CH 1, STORE INPUT, then INPUT - MEMORY. Channel 1 trace should become a straight line on the CRT. Press in sequence CH 2, STORE INPUT, and INPUT - MEMORY noting that channel 2 trace becomes a straight line at the same location as channel 1.
- f. Disconnect the 11850A POWER SPLITTER and connect the cables to the 8748A as shown in Figure 4-2 (Do not change or disconnect cables attached to 8754A). Install 11857A cables in series between PORTS 1 and 2.

## PERFORMANCE TESTS

## 4-9. FREQUENCY RESPONSE (Cont'd)

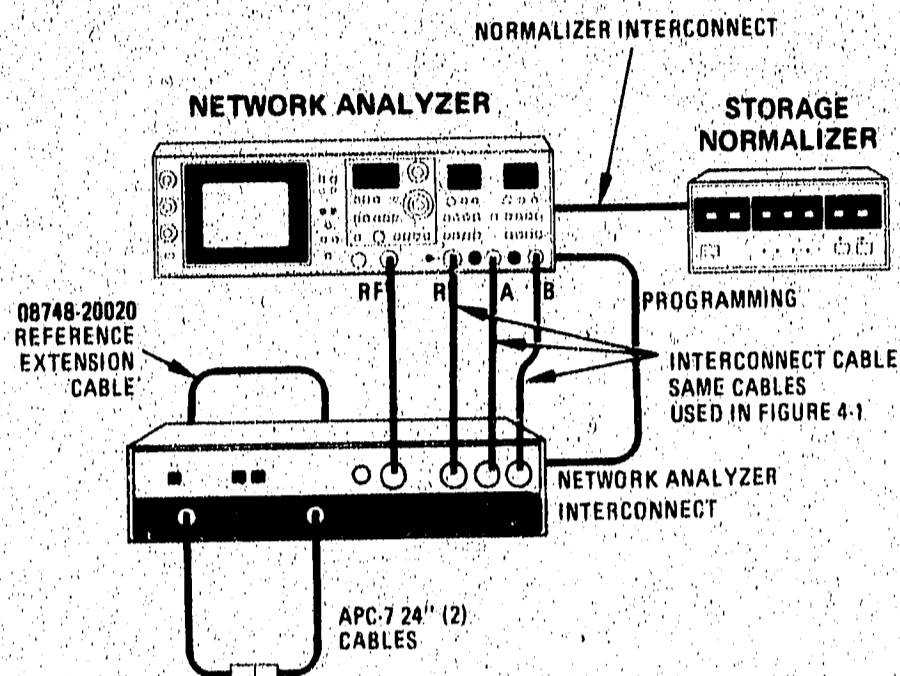


Figure 4-2. Frequency Response Transmission Test Setup

- g. Turn off CHANNEL 1 of the 8754A and switch between  $S_{11}$   $S_{21}$  and  $S_{22}$   $S_{12}$  on the 8748A and note overall variation of the two traces. Adjust the LENGTH control on the 8754A to compromise the variation of both traces.

## NOTE

If excessive slope difference between  $S_{12}$  and  $S_{21}$  then perform the delayline adjustment in Section V.

- h. Switch the 8748A to  $S_{11}$   $S_{21}$ . The trace variation must be less than 1.6 divisions peak to peak (transmission frequency response  $< \pm 8$  deg).
- i. Switch the 8748A to  $S_{22}$   $S_{12}$ . The trace variation must be less than 1.6 divisions peak to peak (transmission frequency response  $< \pm 8$  deg).
- j. Turn off 8754A CHANNEL 2 and select B/R in CHANNEL 1. The trace variation must be less than 2 divisions peak to peak (transmission frequency response  $< \pm 1$  dB).
- k. Switch the 8748A to  $S_{21}$   $S_{11}$ . The trace variation must be less than 2 divisions peak to peak (transmission frequency response  $< \pm 1$  dB).
- l. Disconnect the RF cable from the 8748A B output, and connect to A output as shown in Figure 4-3 (Do not disconnect the cables from the 8754A). Disconnect the 11857A cables from the 8748A. Connect the 11565A Short to PORT 1. Change the REFERENCE EXTENSION cable on the back of the 8748A to 08748-20020.



## PERFORMANCE TESTS

### 4-9. FREQUENCY RESPONSE (Cont'd)

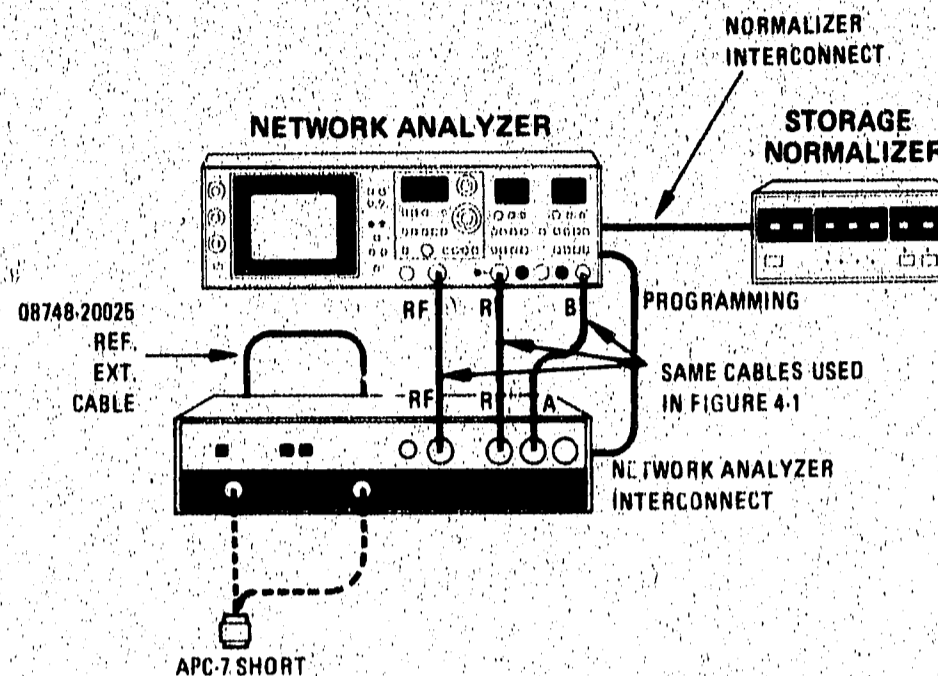


Figure 4-3. Frequency Response Reflection Test Setup

- m. Set the 8748A to  $S_{11} S_{12}$ . The trace variations must be less than 4 divisions peak to peak (reflection frequency response  $< \pm 2$  dB).
- n. Switch the 8748A to  $S_{22} S_{12}$  and move the 11565A Short to PORT 2. The trace variation must be less than 4 divisions peak to peak (reflection frequency response  $< \pm 2$  dB).
- o. Select PHASE B/R in CHANNEL 2 of the 8748A and turn off CHANNEL 1. Remove the 11565A APC-7 Short from PORT 2 (both Ports should be open).
- p. Switch between  $S_{11} S_{12}$  and  $S_{22} S_{21}$  and adjust the 8754A PHASE B/R LENGTH control to compromise the variation of both traces.
- q. Set the 8748A to  $S_{11} S_{21}$ . The trace variation must be less than 3 divisions peak to peak (reflection frequency response  $< \pm 15$  deg).
- r. Switch the 8748A to  $S_{22} S_{12}$ . The trace variation must be less than 3 divisions peak to peak (reflection frequency response  $< \pm 15$  deg).

### 4-10. TEST PORT OPEN/SHORT RATIO

#### SPECIFICATION:

##### Test Ports 1 and 2 Open/Short Ratio

$\leq \pm 0.9$  dB Magnitude and  $\leq \pm 7.5^\circ$  Phase from 1000 MHz to 1300 MHz

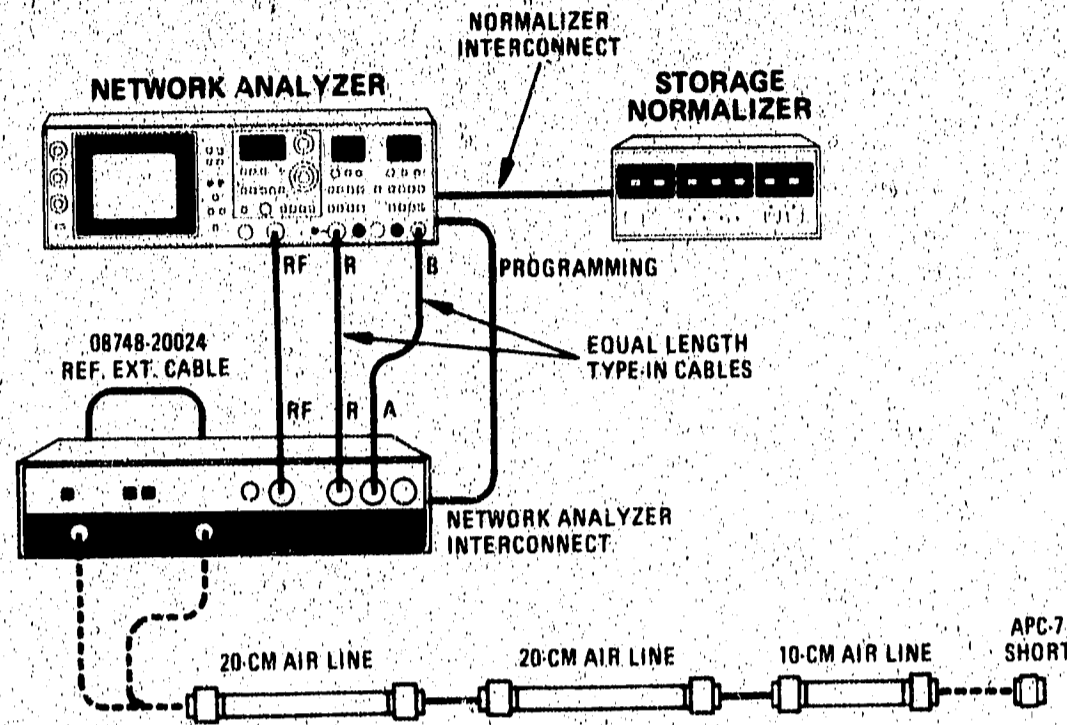
$\leq \pm 0.75$  dB Magnitude and  $\leq \pm 6^\circ$  Phase from 4 MHz to 1000 MHz

#### DESCRIPTION:

Magnitude and Phase open/short ratio is measured by normalizing the reflections from 50cm of air line and an open or short termination. The termination is changed (from open to short or short to open). The peak change as read on the 8754A Network Analyzer is related to the open/short ratio which test directivity and return loss.

**PERFORMANCE TESTS**

**4-10. TEST PORT OPEN/SHORT RATIO (Cont'd)**



*Figure 4-4. Test Port Open/Short Ratio Test Setup*

**EQUIPMENT:**

Network Analyzer .....	HP 8754A
Storage-Normalizer .....	HP 8750A
Matched Type N Coaxial Cable Kit .....	HP 11851A
20cm Air line Extension .....	(2) HP 11567A
10cm Air line Extension .....	HP 11566A
APC-7 Short .....	HP 11565A

**NOTE**

If the above air lines are not available a close approximation to the open/short ratio can be made by connecting directly to the 8748A PORT 1 and PORT 2 connectors (leaving off the air lines) to do this change Reference Plane Extension cable to 08748-20020.

**PROCEDURE:**

- a. Perform the alignment in the Operation section of the 8750A Operating and Service Manual to match the 8754A with the 8750A.
- b. Connect equipment as shown in Figure 4-4. Connect cable HP part No. 08748-20024 on the 8748A rear panel. Set equipment controls as follows:

**HP 8748A:**

S-PARAMETER SELECT .....  $S_{11}$   $S_{21}$   
 ATTENUATION dB ..... 0



**PERFORMANCE TESTS**

**4-10. TEST PORT OPEN/SHORT RATIO (Cont'd)**

**HP 8750A:**

CH 1 .....	Press and release
INPUT .....	Press and release
CH 2 .....	Press and release
INPUT .....	Press and Release

**HP 8754A:**

OUTPUT dBm .....	10
SWEEP MODE .....	FULL 4-1300
TUNING .....	1000 MHz
SWEEP WIDTH MHz .....	0CW
SWEEP .....	AUTO FAST
Sweep Rate .....	midrange
MARKERS .....	OFF
POLAR A/R .....	OFF (OUT)
VIDEO FILTER 100Hz .....	OFF (OUT)

**CHANNEL 1:**

Measurement Select .....	B/R
Scale dB/DIV .....	1
REFERENCE .....	-00
REFERENCE OFFSET .....	OFF (OUT)

**CHANNEL 2:**

Measurement Select .....	PHASE B/R
Scale DEG/DIV (Green) .....	10
REFERENCE .....	-00
REFERENCE OFFSET .....	OFF (OUT)

- c. Engage the REFERENCE POSITION CH1 and CH2 pushbuttons (in) and adjust CH1  $\blacklozenge$  and CH2  $\blacklozenge$  to place the traces on the centerline. Disengage the REFERENCE POSITION pushbuttons (out).
- d. Connect the Short and Air lines to PORT 1 and turn OFF CHANNEL 2 of the 8754. A trace with minor variations and a marker at 1000 MHz should be present near the center of the CRT.
- e. Press in sequence CH 1, STORE INPUT and INPUT-MEM on the 8750A. Note the flat reference line with marker on the CRT. If necessary adjust the 8750A VERT POSN to put this line at the center graticule.
- f. Remove the Short from the air lines and note the points of peak response (greatest distance from the center line) above and below the 1000 MHz marker. Refer to Figure 4-5 for a typical response on the CRT.

**NOTE**

**If the marker appears on a peak, move the marker noting the peak value, then return the marker to 1000 MHz.**

## PERFORMANCE TESTS

## 4-10. TEST PORT OPEN/SHORT RATIO (Cont'd)

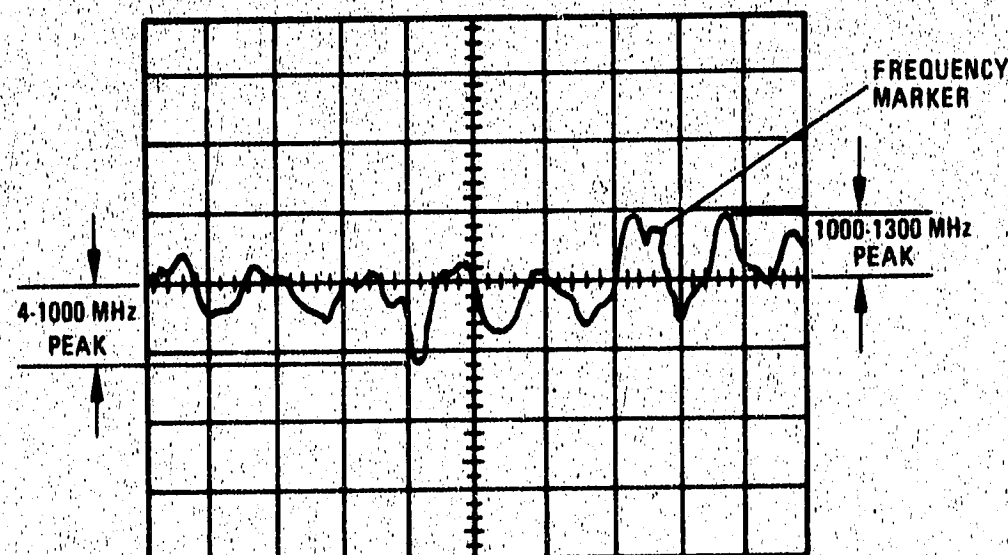


Figure 4-5. Typical Open/Short Response

- g. For 4-1000 MHz, the trace must not deviate from the center line more than 1.5 divisions (open/short ratio  $\leq \pm 0.75$  dB). For 1000 MHz, the trace must not deviate from the center line more than 1.8 divisions (open/short  $\leq \pm 0.9$  dB).
- h. Turn OFF CHANNEL 1 and select PHASE B/R on CHANNEL 2 on the 8754A.
- i. Press in sequence CH 2 then INPUT on the 8750A.
- j. Adjust PHASE B/R LENGTH control on the 8754A to level phase trace on CRT.
- k. On the 8750A press in sequence STORE INPUT then INPUT-MEM. A flat reference trace with marker at 1000 GHz should be seen.
- l. Rotate LENGTH control counterclockwise (reduce length) to tilt the trace down 4 degrees (2 minor divisions) at 1300 MHz.

## NOTE

The above phase adjustment is required because of characteristics of the APC-7 connector.

- m. Connect the APC-7 Short to the air lines and change 8754A CHANNEL 2 REFERENCE switches to  $-180$  degrees.
- n. Note the peak above and below the 1000 MHz marker as seen in example on Figure 4-5. For 4-1000 MHz, the trace must not deviate from the center line more than 1.2 divisions (open/short ratio  $\leq \pm 6$  deg). For 1000-1300 MHz, the trace must not deviate from the center line more than 1.5 divisions (open/short ratio  $\leq \pm 7.5$  deg).
- o. Turn off CHANNEL 2 and Select CHANNEL 1 B/R. Remove air lines and Short from PORT 1 and connect them to PORT 2 of the 8748A. Change S-PARAMETER SELECT switch to  $S_{22}/S_{12}$ . Repeat steps e through n for port 2 open/short ratio magnitude and phase.



**PERFORMANCE TESTS**

**4-11. PORT RETURN LOSS**

**SPECIFICATION:**

**PORT 1 and PORT 2 Return Loss:**

≥ 26 dB (≤ 1.11 SWR) from 4 to 1300 MHz

**RF Input Port:**

≥ 20 dB Return Loss (≤ 1.22 SWR) from 4 MHz to 1300 MHz

**Reference and Return Ports (R, A, B):**

≥ 23 dB Return Loss (≤ 1.15 SWR) from 4 MHz to 1000 MHz

≥ 20 dB Return Loss (≤ 1.22 SWR) from 1000 MHz to 1300 MHz

**DESCRIPTION:**

With the TRANSMISSION/REFLECTION TEST SET a 0 dB return loss calibration is set on the CRT. connect the 8502A with adapter to the 8748A port to be tested and 50Ω Termination on the appropriate port. The return loss is displayed on the 8754A.

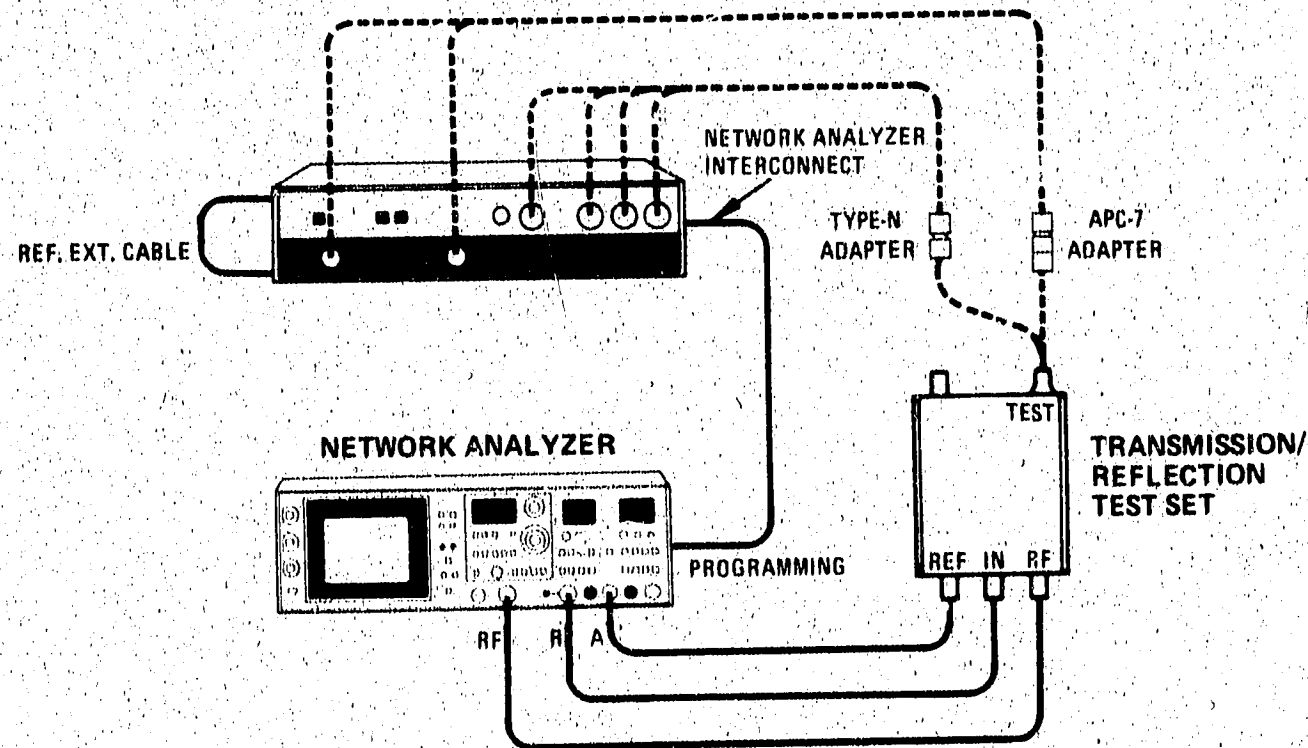


Figure 4-6. Return Loss Test Setup

**EQUIPMENT:**

Network Analyzer .....	HP 8754A
Transmission/Reflection Test Set .....	HP 8502A
Cable Kit Matched Type-N .....	HP 11851A
Termination 50Ω type-N .....	HP 908A
Termination 50Ω APC-7 .....	HP 909A
ADAPTER APC-7 to Type-N male .....	(2) HP 11525A
Adapter Type-N male to Type-N male .....	HP 1250-1475

**PERFORMANCE TESTS**

**4-11. PORT RETURN LOSS (Cont'd)**

**PROCEDURE:**

a. Connect equipment as shown in Figure 4-6. Connect any one of the Reference Plane Extension cable on rear of 8748A. Do not connect Adapters to 8502A TEST PORT.

b. Set the 8748A controls as follows:

S-PARAMETER SELECT..... as shown in Table 4-1  
 ATTENUATION dB ..... 20

c. Set the 8754A controls as follows:

OUTPUT dBm ..... 10  
 SWEEP MODE ..... FULL 4-1300  
 TUNING ..... set for 1000 MHz on LEDs  
 SWEEPWIDTH MHz ..... 0 CW  
 SWEEP ..... AUTO-FAST  
 Sweep Rate ..... midrange  
 MARKERS ..... OFF  
 VIDEO FILTER 100 Hz ..... OFF(OUT)  
 POLAR A/R ..... OFF (OUT)

**CHANNEL 1:**

Measurement Select ..... A/R  
 Scale dB/DIV ..... 2.5  
 REFERENCE ..... -00  
 REFERENCE OFFSET ..... OFF (OUT)

**CHANNEL 2:**

Measurement Select ..... OFF(OUT)  
 SWEEP (rear panel) ..... INT

d. Engage the REFERENCE POSITION CH 1 pushbutton (in) and adjust CH 1  $\blacklozenge$  to place the trace on the center line. Disengage the REFERENCE POSITION pushbutton (out).

e. Engage the CHANNEL 1 REFERENCE OFFSET and adjust the OFFSET vernier to center the average of the trace on the CRT centerline. With a grease pencil draw the trace on the CRT.

f. Connect the 8502A Transmission/Reflection Test Set to each 8748A port as listed in Table 4-1, using the appropriate adapter (APC-7 or Type-N). Set the 8748A S-PARAMETER switch, 8754A REFERENCE LEVEL switches and place load(s) as listed on Table 4-1.

**NOTE**

**If the 1000 MHz marker is above the centerline tune the marker away from 1000 MHz to check if the 1000 MHz area is above the centerline. Retune marker to 1000 MHz.**



**PERFORMANCE TESTS**

**4-11. PORT RETURN LOSS (Cont'd)**

**NOTE**

The following measurement uncertainty exist because of the directivity of the coupler (8502). For an actual 26 dB measurement the reading may be from 24.4 to 27.9. For an actual 23 dB measurement the reading may be from 21.9 to 24.3. For an actual 20 dB measurement the reading may be from 19.2 to 20.9.

- g. The highest point of the trace should be below the grease pencil line for the frequency range specified. Continue testing the other ports as listed in Table 4-1.
- h. Erase grease pencil line.

*Table 4-1. Port Return Loss Settings*

PORT Tested	8748A S-PARAMETER Selected Switch	50Ω Termination on PORT(s)	8754A REFERENCE LEVEL Switch	Frequency Range Spec. MHz
1	S <sub>11</sub> S <sub>21</sub>	A	-26 dB	4-1300
1	S <sub>22</sub> S <sub>12</sub>	B	-26 dB	4-1300
2	S <sub>22</sub> S <sub>21</sub>	B	-26 dB	4-1300
2	S <sub>11</sub> S <sub>21</sub>	A	-26 dB	4-1300
RF	*	R	-20 dB	4-1300
R	*	RF	-23 dB	4-1000
R	*	RF	-20 dB	1000-1300
A	S <sub>11</sub> S <sub>21</sub>	1	-23 dB	4-1000
A	S <sub>11</sub> S <sub>21</sub>	1	-20 dB	1000-1300
A	S <sub>22</sub> S <sub>12</sub>	2	-23 dB	4-1000
A	S <sub>22</sub> S <sub>21</sub>	2	-20 dB	1000-1300
B	S <sub>11</sub> S <sub>21</sub>	2	-23 dB	4-1000
B	S <sub>11</sub> S <sub>21</sub>	2	-20 dB	1000-1300
B	S <sub>22</sub> S <sub>21</sub>	1	-23 dB	4-1000
B	S <sub>22</sub> S <sub>12</sub>	1	-20 dB	1000-1300

\*Switch setting not important.

Table 4-2. Model 8748A Performance Test Record (1 of 2)

Hewlett-Packard Model 8748A S-Parameter Test Set		Test Performed By: _____	
Serial Number: _____		Date: _____	
Paragraph No.	Description	Test Limit	Measured Value
4-8.	<b>DIRECTIVITY TEST</b> PORT 1 PORT 2	$\geq 40$ dB $\geq 40$ dB	_____ _____
4-9.	<b>FREQUENCY RESPONSE</b> <i>Transmission Phase:</i> h. $S_{21}$ i. $S_{12}$  <i>Magnitude:</i> j. $S_{12}$ k. $S_{21}$  <i>Reflection Magnitude:</i> m. $S_{11}$ n. $S_{22}$  <i>Phase:</i> q. $S_{11}$ r. $S_{22}$	$\leq \pm 8$ degrees $\leq \pm 8$ degrees  $\leq \pm 1$ dB $\leq \pm 1$ dB  $\leq \pm 2$ dB $\leq \pm 2$ dB  $\leq \pm 1.5$ degrees $\leq \pm 1.5$ degrees	_____ _____ _____ _____ _____ _____ _____ _____ _____ _____
4-10.	<b>TEST PORT OPEN/SHORT RATIO</b>  <i>PORT 1 Magnitude:</i> g. 4-1000 MHz g. 1000-1300 MHz  <i>Phase:</i> m. 4-1000 MHz m. 1000-1300 MHz  <i>PORT 2 Magnitude:</i> g. 4-1000 MHz g. 1000-1300 MHz  <i>Phase:</i> m. 4-1000 m. 1000-1300	$\leq \pm 0.75$ dB (1.5 div) $\leq \pm 0.9$ dB (1.8 div)  $\leq \pm 6$ degrees (0.6 div) $\leq \pm 7.5$ degrees (0.75 div)  $\leq \pm 0.75$ dB (1.5 div) $\leq \pm 0.9$ dB (1.8 div)  $\leq \pm 6$ degrees (0.6 div) $\leq \pm 7.5$ degrees (0.75 div)	_____ _____ _____ _____ _____ _____ _____ _____ _____ _____



Table 4-2. Model 8748A Performance Test Record (2 of 2)

Paragraph No.	Description			Test Limit	Measured Value
4-11.	<b>RETURN LOSS</b>				
	<u>PORT</u>	<u>S-PARAMETER</u>	<u>Frequency</u>	<u>Return Loss</u>	
	1	S <sub>11</sub> S <sub>21</sub>	4-1300 MHz	≥26 dB	_____
	1	S <sub>22</sub> S <sub>12</sub>	4-1300 MHz	≥26 dB	_____
	2	S <sub>22</sub> S <sub>21</sub>	4-1300 MHz	≥26 dB	_____
	2	S <sub>11</sub> S <sub>21</sub>	4-1300 MHz	≥26 dB	_____
	RF	*	4-1300 MHz	≥20 dB	_____
	R	*	4-1000 MHz	≥23 dB	_____
	R	*	1000-1300 MHz	≥20 dB	_____
	A	S <sub>11</sub> S <sub>21</sub>	4-1000 MHz	≥23 dB	_____
	A	S <sub>11</sub> S <sub>21</sub>	1000-1300 MHz	≥20 dB	_____
	A	S <sub>22</sub> S <sub>21</sub>	4-1000 MHz	≥23 dB	_____
	A	S <sub>22</sub> S <sub>21</sub>	1000-1300 MHz	≥20 dB	_____
	B	S <sub>22</sub> S <sub>12</sub>	4-1000 MHz	≥23 dB	_____
	B	S <sub>11</sub> S <sub>21</sub>	1000-1300 MHz	≥20 dB	_____
B	S <sub>22</sub> S <sub>12</sub>	4-1000 MHz	≥23 dB	_____	
B	S <sub>22</sub> S <sub>12</sub>	1000-1300 MHz	≥20 dB	_____	
*Switch setting not important					

# ADJUSTMENTS



## SECTION V ADJUSTMENTS

### 5-1. INTRODUCTION

5-2. This section provides instructions for adjusting the 8748A. The only adjustment internal to the 8748A is the setting of the delay line length. This adjustment may be required if Performance Test 4 - 9 does not meet linear phase specifications or if A3, Directional Bridge/Power Splitter or A4, Directional Bridge are changed.

### 5-3. EQUIPMENT REQUIRED

5-4. A table of test equipment and test accessories required for the adjustment procedure is presented in Section I. The table includes the required minimum specifications and a suggested manufacturer's model number.

**NOTE**

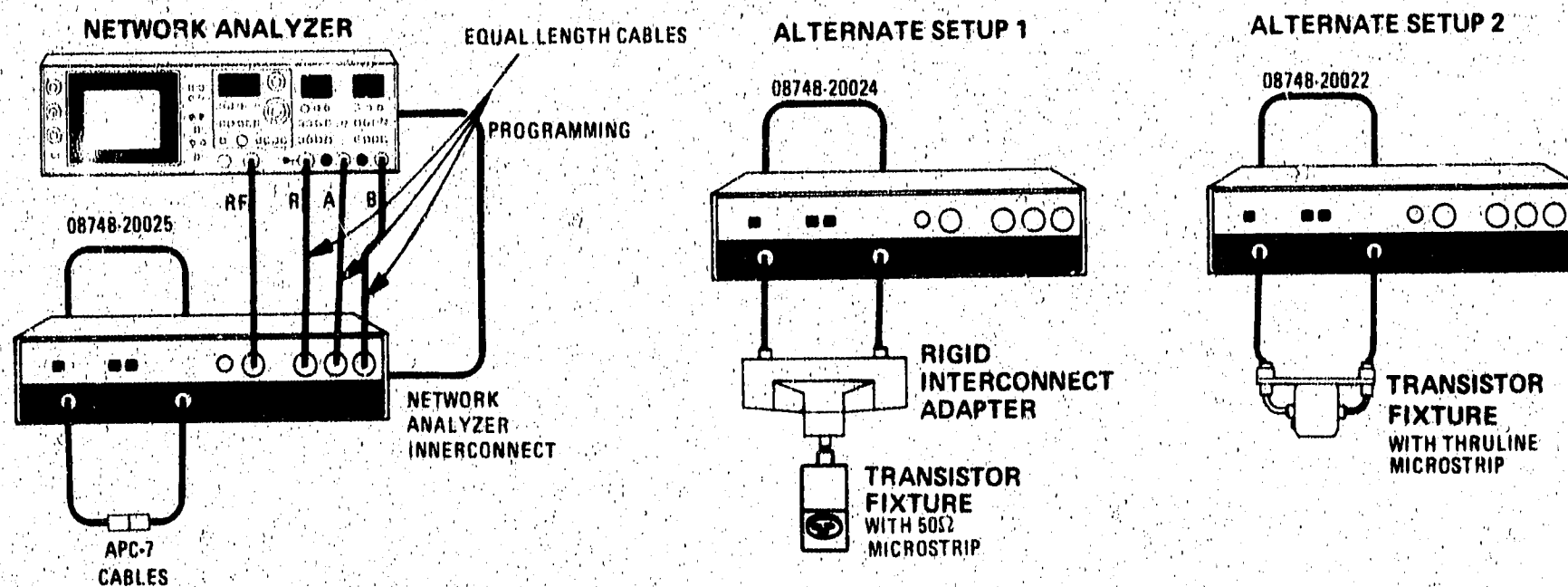
**Before performing this adjustment allow the 8754A one - half hour warm - up time.**

## ADJUSTMENTS

### 5-5. DELAY LINE ADJUSTMENT

REFERENCE: SERVICE SHEET 1, RF CIRCUIT SCHEMATIC DIAGRAM

DESCRIPTION: Adjust electrical lengths of PORT 1 AND PORT 2 to be equal.



*Figure 5-1. Delay Line Adjustment Test Setup*

**EQUIPMENT:**

Network Analyzer .....	HP 8754A
APC-7 Cables .....	11857A
Alternate 1 for 11857A is 11600B or 11602B and 11858A	
Alternate 2 for 11857A is 11608A	

## ADJUSTMENTS

## PROCEDURE:

- a. Connect equipment as shown in Figure 5-1. For access to the 8748A Delay Lines place the 8754A and 8748A on their sides.
- b. Remove from 8748A;
1. Bottom rear feet (item 11, figure 6-5).
  2. Bottom cover (item 16, figure 6-5).
  3. Cable clamps on delay lines (item 4, figure 6-4).
  4. Delay line brackets (item 5, figure 6-4).
- c. Set 8754A controls to:

SWEEP MODE ..... FULL 4 - 1300 MHz  
 SWEEP WIDTH MHz ..... not in EXT RF  
 SWEEP ..... AUTO FAST  
 Sweep Rate ..... midrange  
 OUTPUT dBm ..... 0

CHANNEL 1 ..... OFF

REFERENCE POSITION ..... CRT horizontal center line

CHANNEL 2

Measurement Select ..... PHASE B/R  
 Scale DEG/DIV (Green) ..... 2.5 DEG/DIV  
 REFERENCE Level ..... -00  
 REFERENCE OFFSET ..... OFF (OUT)

POLAR A/R ..... OFF (OUT)  
 VIDEO FILTER 100 Hz ..... OFF (OUT)  
 SWEEP (rear panel) ..... INT

- d. Set 8748A controls to:

ATTENUATION dB ..... 0  
 S-PARAMETER SELECT ..... S<sub>11</sub> S<sub>21</sub>

- e. Switch REFERENCE POSITION CH 2 to on (IN) adjust REFERENCE POSITION  $\blacklozenge$  to center trace. Set REFERENCE POSITION to off (OUT).
- f. Loosen nuts (A) and (C) as shown in Figure 5-2 on both Delay Lines.



## ADJUSTMENTS

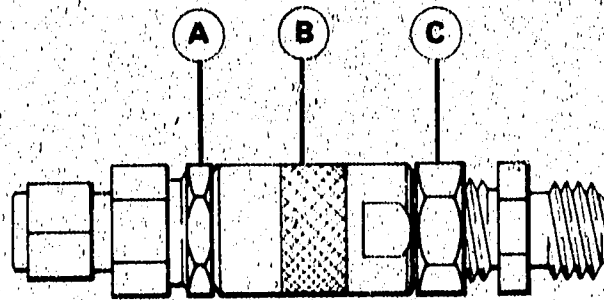


Figure 5-2. Delay Line Assembly

- g. Turn barrel (B) as shown on Figure 5-2 clockwise to shorten the overall length of the delay line on both delay lines to minimum.
- h. Adjust 8754A PHASE B/R LENGTH control to level displayed phase trace.
- i. Change 8748A S-PARAMETER SELECT switch to  $S_{22} S_{12}$  and note slope of displayed trace. If trace slopes up, lengthen delay line 2 by rotating barrel (B) counter-clockwise until the trace is level.
- j. If trace slopes down, readjust 8748A PHASE B/R LENGTH to level the trace. Return 8748A S-PARAMETER SELECT switch to  $S_{11} S_{21}$ . Displayed phase trace should now slope up. Lengthen delay line 1 by turning barrel (B) counter-clockwise until trace is level.
- k. Switch between  $S_{11} S_{21}$  and  $S_{22} S_{12}$  on 8748A and verify that the phase difference is minimized.
- l. Tighten nuts (A) and (C) and reverify that phase difference is minimized.
- m. Verify that the SMA RF connectors on each end of delay lines are still tight.
- n. Install on the 8748A;
  1. Delay line brackets.
  2. Cable clamps on delay lines.
  3. Bottom cover.
  4. Bottom rear feet.

# **PARTS LIST**



## SECTION VI REPLACEABLE PARTS

### 6-1. INTRODUCTION

6-2. This section contains information for ordering parts. Table 6-1 list assemblies available for exchange. Table 6-2 includes a list of reference designations and a list of abbreviations used in the parts list. Table 6-3 lists all replaceable parts in alpha-numerical order by reference designation. Table 6-4 contains names and addresses corresponding to the manufacturer code numbers in the parts list.

### 6-3 EXCHANGE ASSEMBLIES

6-4. Table 6-1 list assemblies within the instrument that may be replaced on an exchange basis, thus affording considerable cost savings. Exchange, factory-repaired and tested assemblies are available only on a trade-in basis, therefore the defective assemblies must be returned for credit. For this reason, assemblies required for spare parts stock must be ordered by the new part number.

### 6-4. REPLACEABLE PARTS LIST

6-5. Table 6-3, the list of replaceable parts, is organized as follows:

1. Electrical assemblies and their components in alpha-numerical order by reference designation.
2. Miscellaneous parts, at end of list for each major assembly.
3. Chassis-mounted parts, in alpha-numerical order by reference designation, at end of parts list.

6-6. The following information is listed for each part:

1. The Hewlett-Packard part number.
2. The part number check digit (CD).
3. The total quantity (Qty) in the instrument. This quantity is given only once, at the first appearance of the part in the list.
4. The description of the part.
5. A typical manufacturer of the part in a five-digit code.
6. The manufacturer part number.

### 6-7. ORDERING INFORMATION

6-8. To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number (with check digit), indicate the quantity required, and address the order to the nearest Hewlett-Packard office. The check digit will ensure accurate and timely processing of your order.

6-9. To order a part that is not listed in the replaceable parts table, include the instrument model number, instrument serial number, the description and function of the part, and the number of parts required. Address the order to the nearest Hewlett-Packard office.

*Table 6-1. Assemblies Available for Module Exchange*

Assembly	New Part No.	Exchange Part No.
A3 BRIDGE SPLITTER	5086-7320	5086-6320
A4 BRIDGE	5086-7321	5086-6321
A5 ATTENUATOR	08558-60003	08495-60004

Table 6-2. Reference Designators and Abbreviations (1 of 2)

REFERENCE DESIGNATIONS						
A.....	Assembly	FL.....	Filter	S.....	Switch	
AT.....	Attenuator, Isolator, Limiter, Termination	H.....	Hardware	T.....	Transformer	
B.....	Fan, Motor	HY.....	Circulator	TB.....	Terminal Board	
BT.....	Battery	J.....	Electrical Connector (Stationary Portion), Jack	TC.....	Thermocouple	
C.....	Capacitor	K.....	Relay	TP.....	Test Point	
CP.....	Coupler	L.....	Coil, Inductor	U.....	Integrated Circuit, Microcircuit	
CR.....	Diode, Diode Thyristor, Step Recovery Diode (SCR), Varactor	M.....	Meter	V.....	Electron Tube	
DC.....	Directional Coupler	MP.....	Miscellaneous Mechanical Part	VR.....	Breakdown Diode (Zener), Voltage Regulator	
DL.....	Delay Line	P.....	Electrical Connector (Movable Portion), Plug	W.....	Cable, Transmission Path, Wire	
DS.....	Annunciator, Lamp, Light Emitting Diode (LED), Signaling Device (Audible or Visible)	Q.....	Silicon Controlled Rectifier (SCR), Transistor, Triode Thyristor	X.....	Socket	
E.....	Miscellaneous Electrical Part	R.....	Resistor	Y.....	Crystal Unit (Piezoelectric, Quartz)	
F.....	Fuse	RT.....	Thermistor	Z.....	Tuned Cavity, Tuned Circuit	
<b>ABBREVIATIONS</b>						
A		G		MA.....		Milliamper
ATTEN.....	Attenuation, Attenuator	GP.....	General Purpose, Group	MACH.....	Machined	
B		H		MAX.....	Maximum	
BSC.....	Basic	HD.....	Hand, Hard, Head, Heavy Duty	MCD.....	Millicandela	
C		HEX.....	Hexadecimal, Hexagon, Hexagonal	MM.....	Magnetized Material (Restricted Code); Millimeter	
C-C.....	Center to Center	HLCI.....	Helical	MO.....	Metal Oxide, Milliounce, Molybdenum	
CER.....	Ceramic	I		MOM.....	Momentary	
CHAM.....	Chamfer	ID.....	Identification, Inside Diameter	MONOSTBL.....	Monostable	
COAX.....	Coaxial	IF.....	Forward Current, Intermediate Frequency	MTLC.....	Metallie	
CONT.....	Contact, Continuous, Control, Controller	IN.....	Inch, Indium	N		
D		INP.....	Input	NAND.....	Logic Not-AND	
D.....	Deep, Depletion, Depth, Diameter, Direct Current	INT.....	Integral, Intensity, Internal	NO.....	Normally Open, Number	
DAP-GL.....	Diallyl Phthalate Glass	INTL.....	Internal, International	NOR.....	Logic Not-OR	
DBL.....	Double	K		NYL.....	Nylon (Polyamide)	
DEG.....	Degree	K.....	Kelvin, Key, Kilo, Potassium	P		
DIA.....	Diameter	L		P.....	Peak, Phosphorus, Pico, Picosecond, Pitch, Plastic, Plug, Pole, Polyester, Power, Probe, Pure	
DIP.....	Dual In-Line Package	LED.....	Light Emitting Diode	PAN-HD.....	Pan Head	
DO.....	Package Type Designation	LG.....	Length, Long	POS.....	Position, Positive	
DPDT.....	Double Pole Double Throw	LK.....	Link, Lock	POZI.....	Pozidriv Recess	
DPSLDR.....	Dip Solder	LKWR.....	Lockwasher	PT.....	Part, Pint, Platinum, Point, Pulse Time	
E		LS.....	Loudspeaker, Low Power Schottky, Series Inductance	PW.....	Power Wirewound, Pulse Width	
EXT.....	Extended, Extension, External, Extinguish	LUM.....	Luminous	PWR.....	Power	
F		M		Q		
F.....	Fahrenheit, Farad, Female, Film (Resistor), Fixed, Flange, Flirt, Fluorine, Frequency	M.....	Male, Maximum, Mega, Mil, Milli, Mode, Momentary, Mounting Hole Centers, Mounting Hole Diameter	QUAD.....	Set of Four	
FEM.....	Female	R		R		
FF.....	Flange, Female Connection, Flip Flop	RECT.....	Rectangle, Rectangular, Rectifier	REPL.....	Replace, Replaceable, Replaced	
FL.....	Flash, Flat, Fluid					





Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A1	08748-60001	2	1	BOARD ASSEMBLY, FRONT PANEL SWITCH	28480	08748-60001
A1E1	1251-0600	0	4	CONNECTOR-SGL CONT PIN 1.14-MM-RSC-8Z 30	28480	1251-0600
A1E2	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-RSC-8Z 30	28480	1251-0600
A1E3	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-RSC-8Z 30	28480	1251-0600
A1E4	1251-0600	0		CONNECTOR-SGL CONT PIN 1.14-MM-RSC-8Z 30	28480	1251-0600
A1J1	1251-4669	9	1	CONNECTOR 14-PIN M POST TYPE	28480	1251-4669
A1MP1	1200-0010	9	3/4	SOCKET-TUBE 2-CONT	28480	1200-0010
A1MP2	1200-0010	9		SOCKET-TUBE 2-CONT	28480	1200-0010
A1MP3	1200-0010	9		SOCKET-TUBE 2-CONT	28480	1200-0010
A1R1	0757-0159	5	2	RESISTOR 1K 1% .5W F TC0+100	28480	0757-0159
A1R2	0757-0159	5		RESISTOR 1K 1% .5W F TC0+100	28480	0757-0159
A1R3	0698-3408	7	1	RESISTOR 2.15K 1% .5W F TC0+100	28480	0698-3408
A1S1	3101-2189	9	1	SWITCH-PB DPDT MOM .125A 115VAC	28480	3101-2189
A1S2	3101-2187	7	1	SWITCH-PB 2-STATION 10MM C-C SPACING	28480	3101-2187
A1XD81	1200-0010	9		SOCKET-TUBE 2-CONT	28480	1200-0010
A1XD82	1200-0010	9		SOCKET-TUBE 2-CONT	28480	1200-0010
A1XD83	1200-0010	9		SOCKET-TUBE 2-CONT	28480	1200-0010
A2	08748-60002	3	1	BOARD ASSEMBLY, REAR LOGIC & +5V REG.	28480	08748-60002
A2C1	0180-2486	2	1	CAPACITOR-FXD 470UF+20% 35VDC TA	06001	60F SERI LS
A2C2	0180-0291	3	2	CAPACITOR-FXD 1UF+10% 35VDC TA	56289	150D105X9035A2
A2C3	0180-0291	3		CAPACITOR-FXD 1UF+10% 35VDC TA	56289	150D105X9035A2
A2C4	0180-0197	8	4	CAPACITOR-FXD 2.2UF+10% 25VDC TA	56289	150D225X9020A2
A2C5	0180-0197	8		CAPACITOR-FXD 2.2UF+10% 25VDC TA	56289	150D225X9020A2
A2C6	0180-2055	9	1	CAPACITOR-FXD .01UF +R0-20% 100VDC CER	28480	0180-2055
A2C7	0180-0374	3	1	CAPACITOR-FXD 10UF+10% 25VDC TA	56289	150D106X9020B2
A2C8	0180-0197	8		CAPACITOR-FXD 2.2UF+10% 25VDC TA	56289	150D225X9020A2
A2C9	0180-0197	8		CAPACITOR-FXD 2.2UF+10% 25VDC TA	56289	150D225X9020A2
A2C10	0160-4084	8		CAPACITOR-FXD .1UF +20% 50VDC CER	56289	2C067104X0500C4
A2CR1	1901-0028	5	2	DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A2CR2	1901-0028	5		DIODE-PWR RECT 400V 750MA DO-29	28480	1901-0028
A2J1	1251-2416	0	24	CONNECTOR 25-PIN F D SERIES	28480	1251-2416
A2J2	1251-3153	4	50	CONTACT-CONN U/A-SUBMIN-D FEM DPSLDR	28480	1251-3153
A2J3	1251-2416	0		CONNECTOR 25-PIN F D SERIES	28480	1251-2416
A2J4	1251-3153	4		CONTACT-CONN U/A-SUBMIN-D FEM DPSLDR	28480	1251-3153
A2J5	1251-4591	6	1	CONNECTOR 14-PIN M POST TYPE	28480	1251-4591
A2MP1	0380-0156	3	6	STANDOFF-RVT-ON .375-IN-LG 6-32TMD	00000	ORDER BY DESCRIPTION
A2MP2	0380-0156	3		STANDOFF-RVT-ON .375-IN-LG 6-32TMD	00000	ORDER BY DESCRIPTION
A2MP3	0380-1162	3	12	STANDOFF-RVT-ON .35-IN-LG 4-40TMD	00000	ORDER BY DESCRIPTION
A2MP4	0380-1162	3		STANDOFF-RVT-ON .35-IN-LG 4-40TMD	00000	ORDER BY DESCRIPTION
A2MP5	0380-1162	3		STANDOFF-RVT-ON .35-IN-LG 4-40TMD	00000	ORDER BY DESCRIPTION
A2MP6	0380-1162	3		STANDOFF-RVT-ON .35-IN-LG 4-40TMD	00000	ORDER BY DESCRIPTION
A2MP7	1200-0173	0		INSULATOR-XSTR DAP-GL	28480	1200-0173
A2MP8	0360-0535	0		TERMINAL-TEST-POINT .330IN ABOVE	28480	0360-0535
A2MP9	0360-0535	0		TERMINAL-TEST-POINT .330IN ABOVE	28480	0360-0535
A2R1	0698-3628	1	1	RESISTOR 10 5% 2W PW TC0+400	28480	0698-3628
A2R2	0698-3628	3	1	RESISTOR 220 5% 2W MO TC0+200	28480	0698-3628
A2R3	0698-3444	1	3	RESISTOR 316 1% .125W F TC0+100	24546	C4-1/8-T0-316R-F
A2R4	0698-3444	1		RESISTOR 316 1% .125W F TC0+100	24546	C4-1/8-T0-316R-F
A2R5	0698-3444	1		RESISTOR 316 1% .125W F TC0+100	24546	C4-1/8-T0-316R-F
A2R6	0757-0401	0	2	RESISTOR 100 1% .125W F TC0+100	24546	C4-1/8-T0-101-F
A2R7	0757-0401	0		NOT ASSIGNED		
A2R8	0757-0461	2	3	RESISTOR 68.1K 1% .125W F TC0+100	24546	C4-1/8-T0-6812-F
A2R9	0698-3450	9	1	RESISTOR 42.2K 1% .125W F TC0+100	24546	C4-1/8-T0-4222-F
A2R10	0757-0401	0		RESISTOR 100 1% .125W F TC0+100	24546	C4-1/8-T0-101-F
A2R11	0757-0401	0		RESISTOR 100 1% .125W F TC0+100	24546	C4-1/8-T0-101-F
A2R12	0757-0317	7	1	RESISTOR 1.33K 1% .125W F TC0+100	24546	C4-1/8-T0-1331-F
A2R13	0698-3162	0		RESISTOR 46.4K 1% .125W F TC0+100	24546	C4-1/8-T0-4642-F
A2R14	0698-3162	0		RESISTOR 46.4K 1% .125W F TC0+100	24546	C4-1/8-T0-4642-F
A2U1	1826-0367	5	1	IC 74M05C V HGLTR TO-39	04713	MC74M05CG
A2U2	1820-1112	4	1	IC FF TTL LS D-TYPE POS-EDGE-TRIG	01295	SN74LS74N
A2U3	1820-1144	6	1	IC GATE TTL LS NOR QUAD 2-INP	01295	SN74LS02N
A2U4	1810-0206	8	1	NETWORK-RES R-SIP10,0K OHM X 7	01121	208A103
A2U5	1820-1197	9	1	IC GATE TTL LS NAND QUAD 2-INP	01295	SN74LS00N
A2U6	1820-1437	0		IC MV TTL LS MONOSTBL RETRIG DUAL	01295	SN74S221N
A2U7	1810-0231	9	1	NETWORK-RES R-SIP2,2K OHM X 7	01121	208A222
A2U8	1858-0047	5	1	TRANSISTOR ARRAY 16-PIN	13606	ULN-2003A
A2U9	1826-0026	3		IC COMPARTOR PRCN TO 99	01295	LM311L

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



Table 6-3. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
A3	5086-7320	A	1	50-OHM DIRECTIONAL BRIDGE & PWR SPLITTER	28480	5086-7320
	5086-6320	B	1	PERMILT-EXCHANGE NO. FOR 5086-7320	28480	5086-6320
A3W1				ORDER REPL CABLE BY MFR ON OLD CABLE		
A4	5086-7321	9	1	50-OHM DIRECTIONAL BRIDGE	28480	5086-7321
A4W1				ORDER REPL CABLE BY MFR ON OLD CABLE		
A5	0855A-60003	4	1	ATTENUATOR	28480	0855A-60003
	08495-60004	9	1	PERMILT-EXCHANGE NO. FOR 0855A-60003	28480	08495-60004
A6	08503-60035	7	1	SWITCH ASSEMBLY, RF	28480	08503-60035
A7	3106-0026	9	1	SWITCH ASSEMBLY, TRANSFER	28480	3106-0026
DL1	1250-1681	7	2	ADAPTER, PHASE ADJUST	28480	1250-1681
DL2	1250-1681	7	2	ADAPTER, PHASE ADJUST	28480	1250-1681
DS1	1990-0487	7	1	LED-VISIBLE LUM-INTRODUCD IF=20MA-MAX	28480	5082-4584
DS2	1990-0485	5	2	LED-VISIBLE LUM-INTRODUCD IF=30MA-MAX	28480	5082-4984
DS3	1990-0485	5	2	LED-VISIBLE LUM-INTRODUCD IF=30MA-MAX	28480	5082-4984
F1	2110-0046	1	1	FUSE .5AMP 125V .25X .27	71400	GMW-1/2
F2	2110-0046	1	1	FUSE .5AMP 125V .25X .27	71400	GMW-1/2
J1	1250-0118	3	3	CONNECTOR-RF BNC FEM HOLE-FR 50 OHM	28480	1250-0118
J2	1250-0118	3	3	CONNECTOR-RF BNC FEM HOLE-FR 50 OHM	28480	1250-0118
J3						
J4						
J5				SEE FIGURE 6-1		
J6						
J7						
JA						
W1	0874A-60007	A	1	WARRNESS, LOGIC SWITCH	28480	0874A-60007
W2				NOT ASSIGNED		
W10						
W11	0874A-20011	0	1	CABLE, RF INPUT TO A3J4	28480	0874A-20011
W12	0874A-20012	1	1	CABLE A3J5 TO A3J1	28480	0874A-20012
W13	0874A-20013	2	1	CABLE A5J2 TO A6J3	28480	0874A-20013
W14	0874A-20014	3	1	CABLE A6J2 TO DL1	28480	0874A-20014
W15	0874A-20015	4	1	CABLE A6J1 TO DL2	28480	0874A-20015
W16	0874A-20016	5	1	CABLE A7J2 TO J7	28480	0874A-20016
W17	0874A-20017	6	1	CABLE A3J3 TO J3	28480	0874A-20017
W18	0874A-20018	7	1	CABLE J4 TO J5	28480	0874A-20018
W19	0874A-20019	8	1	CABLE A7J3 TO J6	28480	0874A-20019
W20				NOT ASSIGNED		
W25						
W26	0874A-20026	7	1	CABLE A3J2 TO A7J4	28480	0874A-20026
W27	0874A-20027	8	1	CABLE A4J2 TO A7J1	28480	0874A-20027
				ACCESSORIES SUPPLIED		
	5061-0099	2	1	REAR PANEL LOCK KIT	28480	5061-0099
	A120-2289	5	1	CABLE ASSY-COAX 7.5-IN-LG	28480	A120-2289
	0874A-60006	7	1	CABLE ASSEMBLY, INTERCONNECT	28480	0874A-60006
	0874A-60010	3	1	KIT REFERENCE EXTENSION CABLES	28480	0874A-60010
P/O 08748-60010	0874A-20020	1	1	CABLE, REFERENCE EXT 0-6	28480	0874A-20020
P/O 08748-60010	0874A-20021	2	1	CABLE, REFERENCE EXT 6-12	28480	0874A-20021
P/O 08748-60010	0874A-20022	3	1	CABLE, REFERENCE EXT 12-19	28480	0874A-20022
P/O 08748-60010	0874A-20023	4	1	CABLE, REFERENCE EXT 19-25	28480	0874A-20023
P/O 08748-60010	0874A-20024	5	1	CABLE, REFERENCE EXT 44-51 (11502A)	28480	0874A-20024
P/O 08748-60010	0874A-20025	6	1	CABLE, REFERENCE EXT 83-90 (11857A)	28480	0874A-20025

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

Table 6-4. Manufacturer's Code List

Mfr. No.	Manufacturer Name	Address		Zip Code
00000	ANY SATISFACTORY SUPPLIER			
01121	ALLEN-BRADLEY CO	MILWAUKEE	WI	53204
01295	TEXAS INSTR INC SEMICONDCMPNT DIV	DALLAS	TX	75222
04713	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85602
06001	GE CO ELEK CAP & BAT PROD DEPT	IRMO	SC	29063
13606	SPRAGUE ELECT CO SEMICONDUCTOR DIV	CONCORD	NH	03301
24546	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701
27014	NATIONAL SEMICONDUCTOR CORP	SANTA CLARA	CA	95051
28480	HEWLETT-PACKARD CO CORPORATE HQ	PALO ALTO	CA	94304
56289	SPRAGUE ELECTRIC CO	NORTH ADAMS	MA	01247
71400	BUSSMAN MFG DIV OF MC GRAW-EDISON	ST LOUIS	MO	63017
75042	TRW INC PHILADELPHIA DIV	PHILADELPHIA	PA	19108

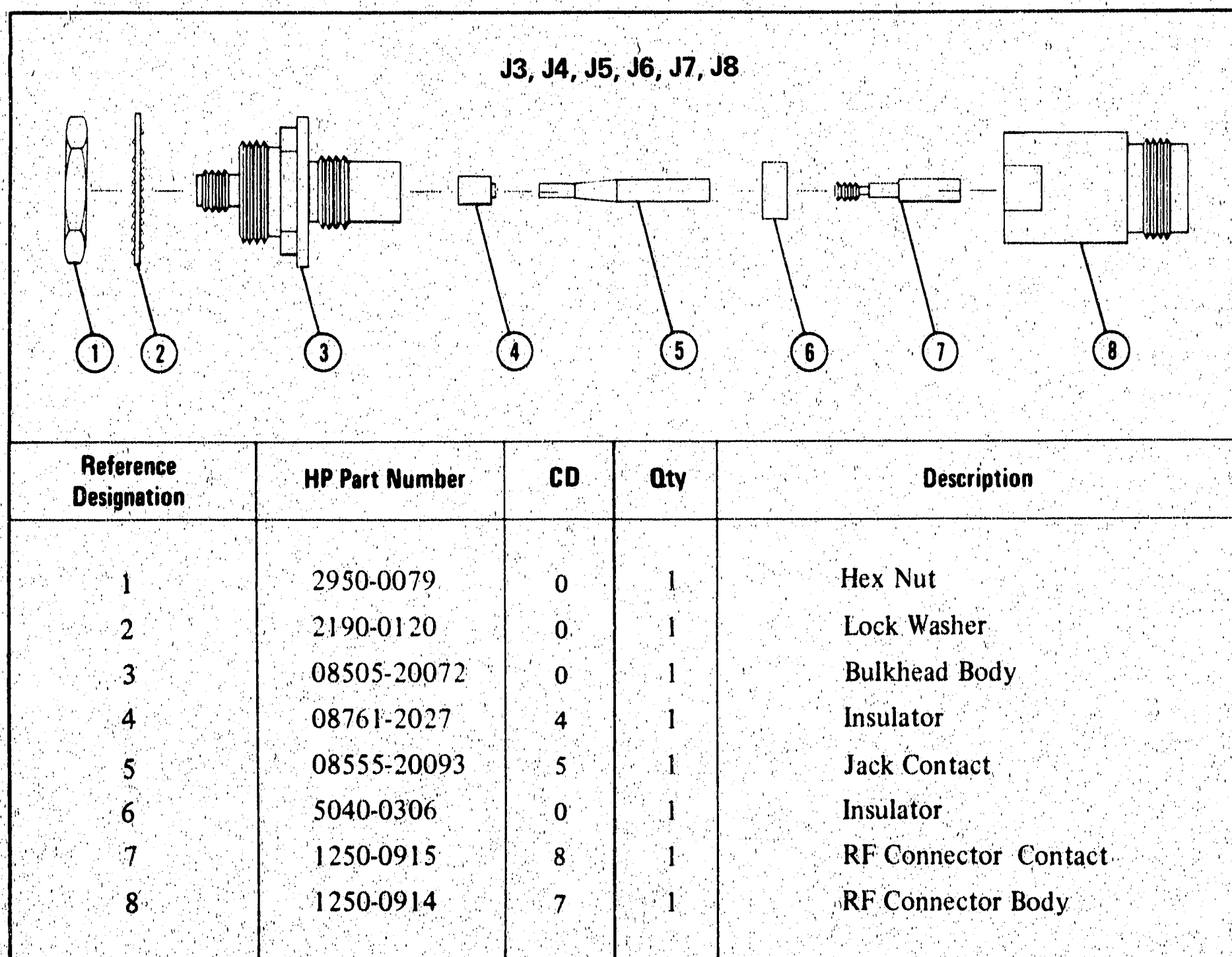
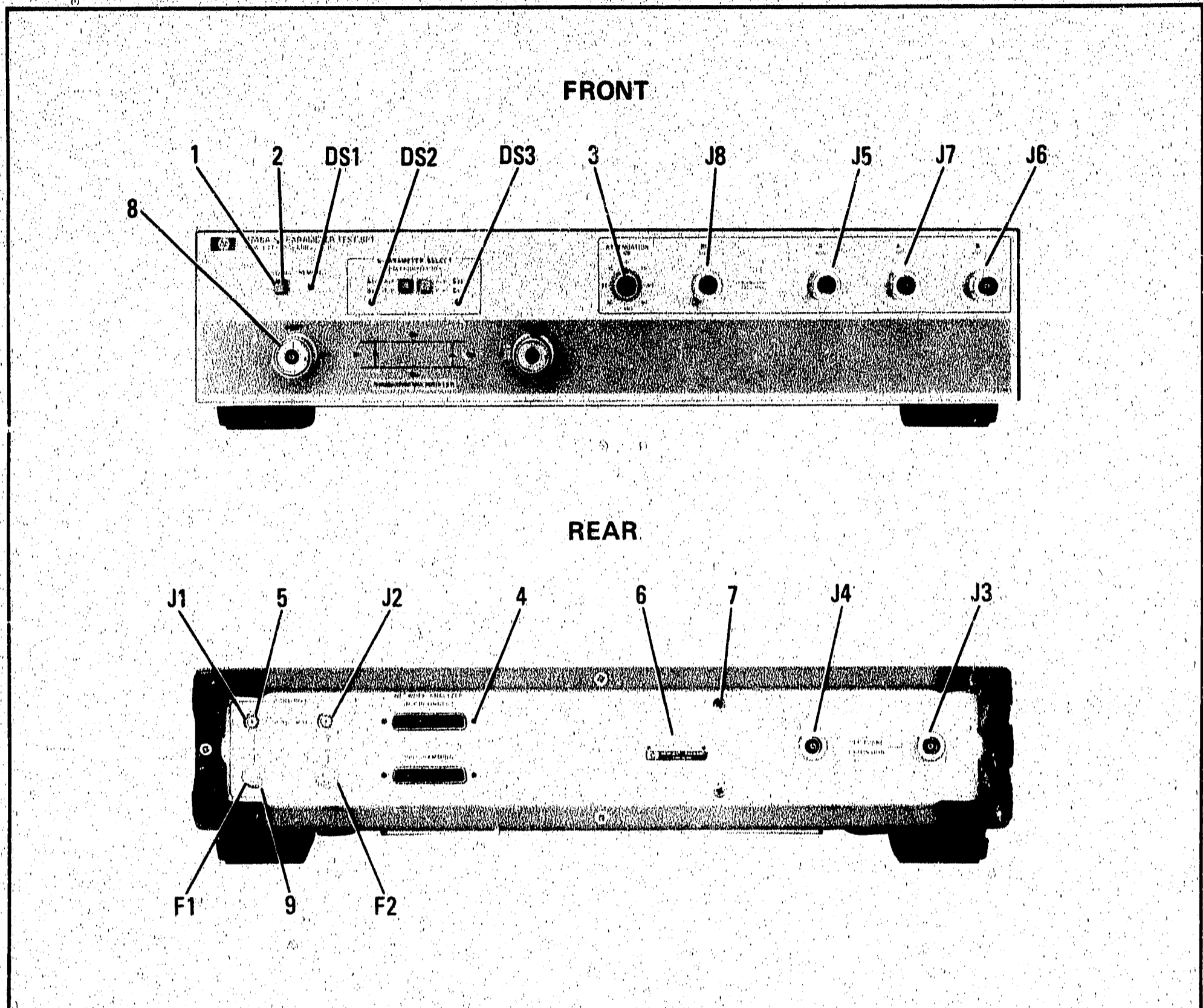


Figure 6-1. Type N 50-Ohm Connector Assembly, Exploded View





Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
1	0370-0606	7	3	Bezel-Pushbutton 0.330-In SQ: Jade Gray	28480	0370-0606
2	5040-8817	4	3	Pushbutton, Square, Jade Gray	28480	5040-8817
3	0370-2874	5	1	Knob-Pointer	28480	0370-2874
	3030-0051	9	2	Screw-Set 4-40 .094-In-Lg Small Cup-Pt	00000	Order by Description
4	1251-2942	7	4	Fastener	28480	1251-2942
5	2950-0001	2	2	Nut-Hex-Dbl-Cham 15/32-32-Thd	00000	Order by Description
	2190-0016	7	2	Washer-Lk Intl T 15/32 In .472-In-Id	28480	2190-0016
6	7120-6235	8	1	Label, ID Blank	28480	7120-6235
7	2360-0331	6	2	Screw-Mach 6-32 .25-In-Lg Pan-Hd-Pozi	28480	2360-0331
8	08748-20008	5	2	Washer	28480	08748-20008
9	1400-0110	4	2	Fuseholder Body	28480	1400-0110
	1400-0111	5	2	Fuseholder Nut Use With 1400-0110	28480	1400-0111
	1400-0112	6	2	Fuseholder Cap Use With 1400-0110	18480	1400-0112

Figure 6-2. Front and Rear Panel Parts Location

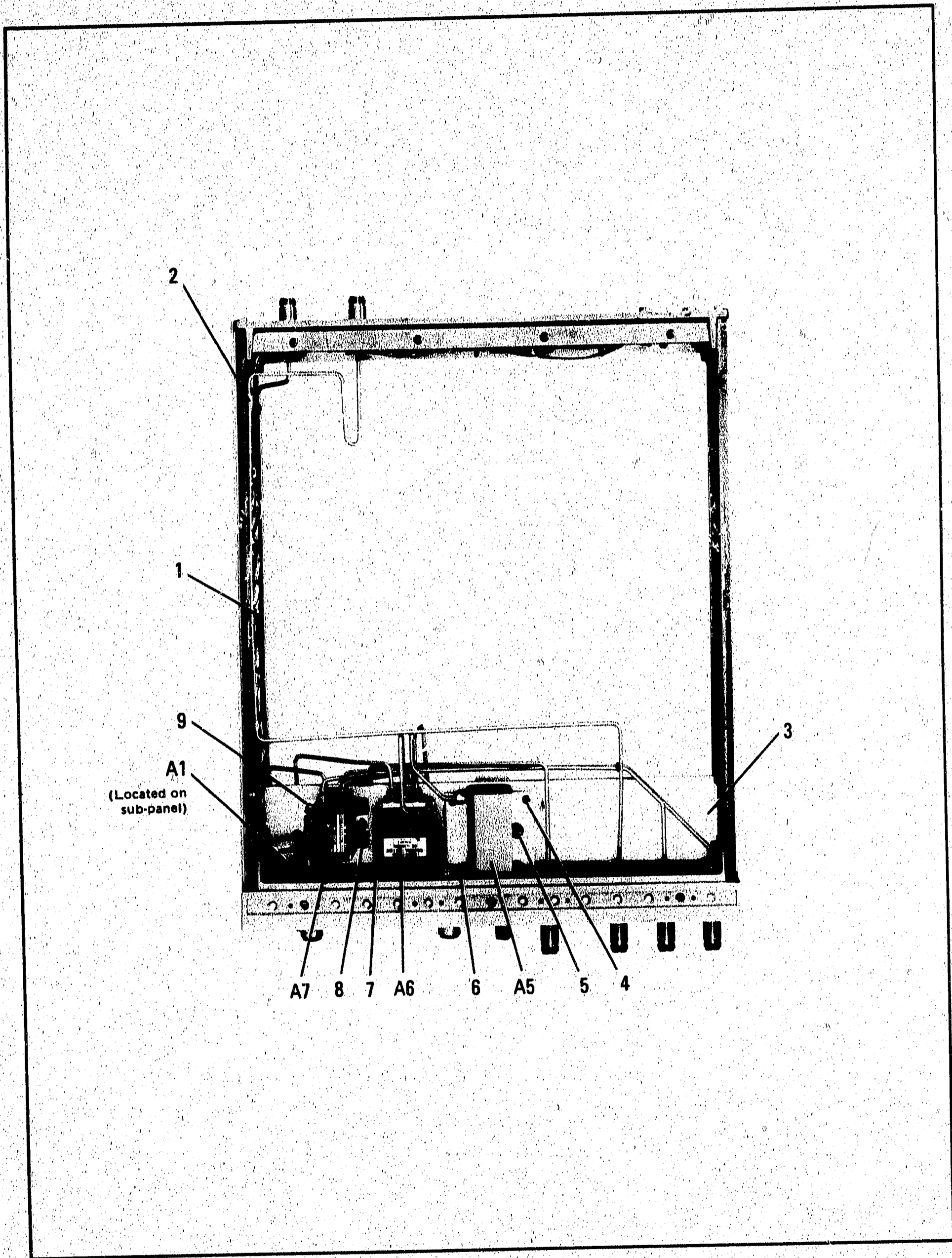
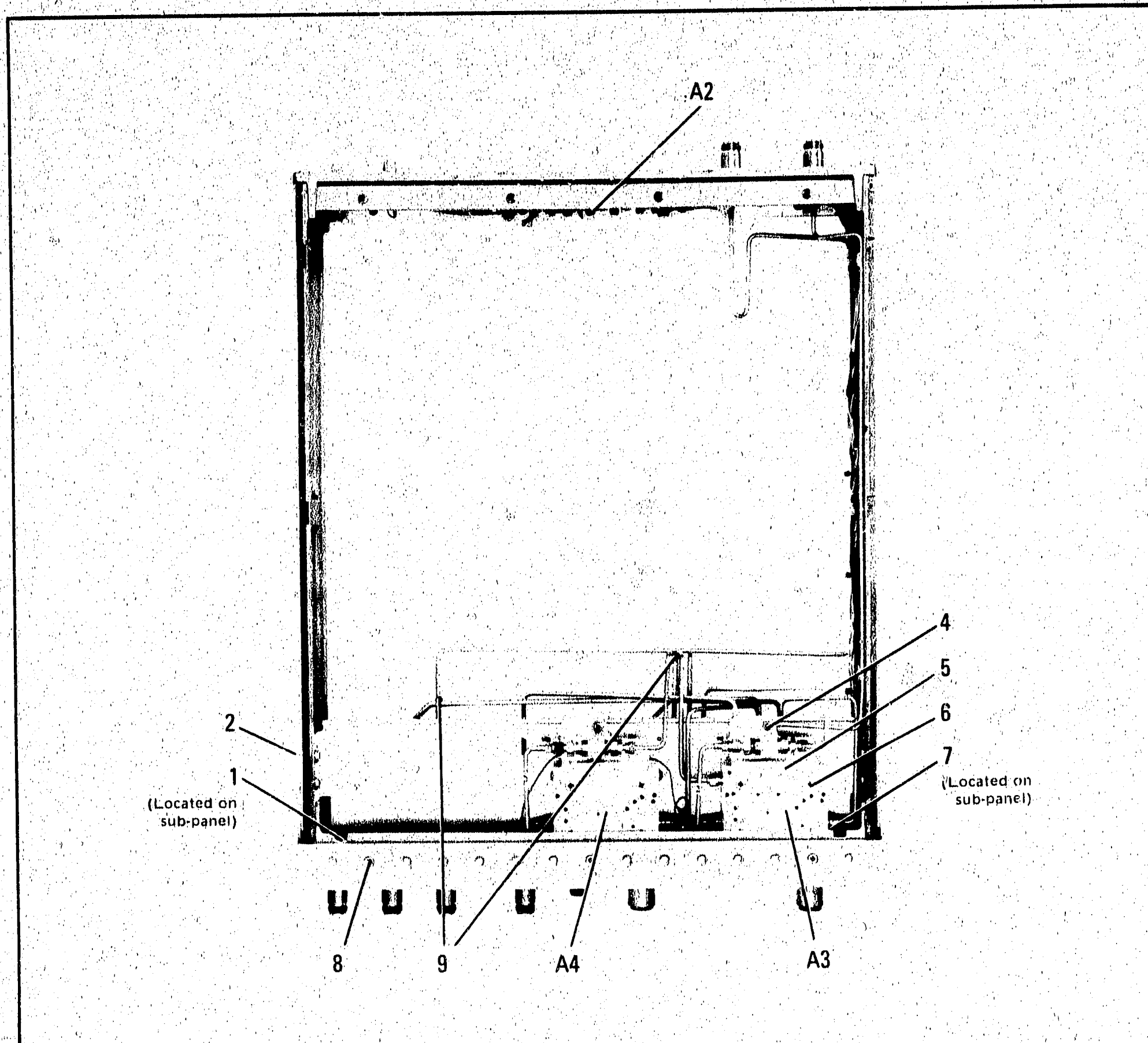


Figure 6-3. Top View Parts Locations (1 of 2)



Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
1	1400-0053	4	3	Clamp-Cable .172-Dia .375-WD NYL	28480	1400-0053
	2360-0119	8	3	Screw-Mach 6-32 .438-In-Lg Pan-Hd-Pozi	00000	Order by Description
	2420-0002	6	3	Nut-Hex-DbI-Cham 6-32-Thd .109-In-Thk	28480	2420-0002
	3050-0066	8	3	Washer-FL MTLC No. 6 .147-In-ID	28480	3050-0066
	2190-0006	1	3	Washer-Lk HLCL No. 6 .141-In-Id	28480	2190-0006
2	1400-0082	9	4	Clamp-Cable .125-Dia .375-WD NYL	28480	1400-0082
	2360-0119	8	4	Screw-Mach 6-32 .438-In-Lg Pan-Hd-Pozi	00000	Order by Description
	2420-0002	6	4	Nut-Hex-DbI-Cham 6-32-Thd .109-In-Thk	28480	2420-0002
	3050-0066	8	4	Washer-FL MTLC No. 6 .147-In-Id	28480	3050-0066
	2190-0006	1	4	Washer-Lk HLCL No. 6 .141-In-Id	28480	2190-0006
3	08748-00004	9	1	Deck	28480	08748-00004
4	2360-0330	5	19	Screw-Mach 6-32 .188-In-Lg Pan-Hd-Pozi 8 Used for Rear Panel, 4 Used to Hold A3 to Deck, 3 Used to Hold A1 to Front Panel, 4 Used to Hold Atten. Bracket to Deck.	28480	2360-0330
5	2360-0332	7	4	Screw-Mach 6-32 .312-In-Lg Pan-Hd-Pozi	28480	2360-0332
	3050-0066	8	4	Washer-FL MTLC No. 6 .147-In-Id	28480	3050-0066
	5021-1755	5	4	Washer, Shouldered	28480	5021-1755
6	08748-00005	0	1	Bracket, Attenuator	28480	08748-00005
7	2200-0151	0	2	Screw-Mach 4-40 .75-In-Lg Pan-Hd-Pozi	00000	Order by Description
	3050-0105	6	2	Washer-FL MTLC No. 4 .125-In-Id	28480	3050-0105
	2190-0003	8	2	Washer-Lk HLCL No. 4 .115-In-Id	28480	2190-0003
8	2420-0001	9	6	Nut Hex 6-32 with Lockwasher	28480	2420-0001
9	08748-00006	1	1	Plate, Switch Mount	28480	08748-00006
10	2200-0103	2	2	Screw-Mach 4-40 .25-In-Lg Pan-Hd-Pozi	00000	Order by Description

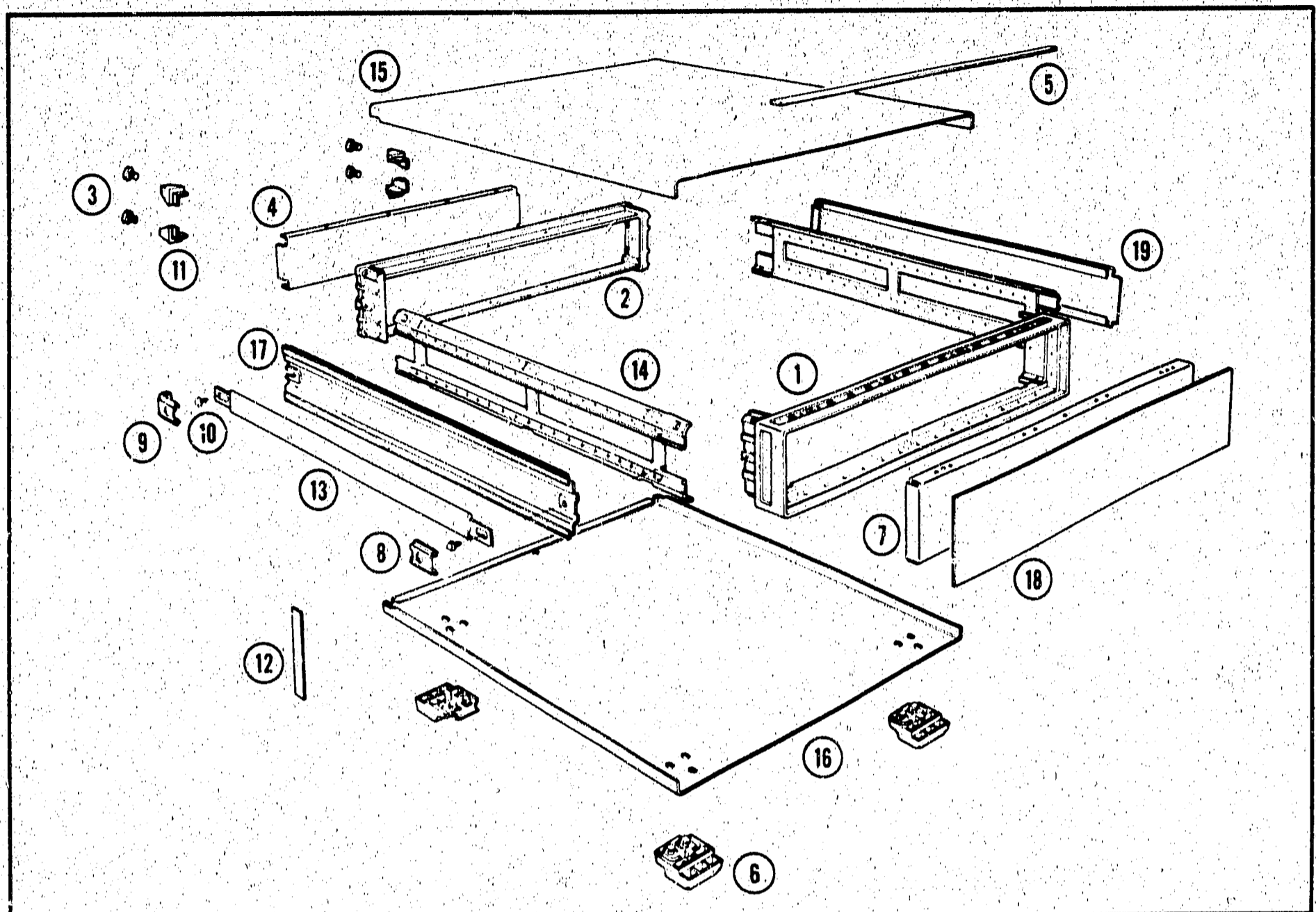
Figure 6-3. Top View Parts Location (2 of 2)



Reference Designation	HP Part Number	C D	Qty	Description	Mfr Code	Mfr Part Number
1	2420-6001	5	3	Nut-Hex-W/LKWR 6-32-Thd .109-In-Thk	00000	Order by Description
2	2360-0330	5	4	Screw-Mach 6-32 .188-In-Lg Pan-Hd-Pozi	28480	2360-0330
3	2510-0192	6	8	Screw-Mach 8-32 .25-In-Lg 100 Deg	28480	2510-0192
4	2360-0195	0	2	Screw-Mach 6-32 .312-In-Lg Pan-Hd-Pozi	00000	Order by Description
	1400-0018	1	2	Clamp-Cable .438-Dia .5-WD NYL	28480	1400-0018
	2190-0006	1	2	Washer-Lk HLCL No.6 .141-In-Id	28480	2190-0006
	3050-0066	8	2	Washer No.6 Flat	00000	Order by Description
5	08748-00007	2	2	Support, Delay Line	28480	08748-00007
6	2360-0181	4	4	Screw-Mach 6-32 .25-In-Lg 82 Deg	00000	Order by Description
7	2260-0009	3	4	Nut Hex 4-40 With Lock Washer	00000	Order by Description
8	2360-0333	6	6	Screw-Mach 6-32 .25-In-Lg Flat-Hd-Pozi	28480	2360-0333
9	1400-0577	7	2	Cable Tie .062-1.25-Dia .1-WD NYL	28480	1400-0577

Figure 6-4. Bottom View Parts Location .





Reference Designation	HP Part Number	C D	Qty	Description
1	5020-8801	4	1	Frame, Front
2	5020-8802	5	1	Frame, Rear
3	2360-0119	8	4	Screw, Machine 6-32 .438 in. long Pan Head-Pozi
4	08748-00003	8	1	Panel, Rear
5	5040-7202	9	1	Top Trim, Front Frame
6	5040-7201	8	4	Foot
7	08748-00002	7	1	Panel, Front Sub
8	5040-7219	8	1	Front Cap, Strap Handle
9	5040-7220	1	1	Rear Cap, Strap Handle
10	0570-1170	6	2	Retainer Screw, Strap Handle
11	5040-7221	2	4	Foot Rear
12	5001-0438	7	2	Side Trim Front Frame
13	5060-9804	3	1	Strap Handle Assembly
14	5020-8832	1	2	Side Strut
15	5060-9835	0	1	Cover, Top
16	5060-9847	4	1	Cover, Bottom
17	5060-9876	1	1	Cover, Side (Handle)
18	08748-00001	6	1	Panel, Front Dress
19	08748-00003	8	1	Panel, Rear

Figure 6-5. Cabinet Parts, Exploded View

**BACK DATING  
MANUAL  
CHANGES**



## SECTION VII MANUAL CHANGES

### 7-1. INTRODUCTION

7-2. This manual has been written for and applies directly to instruments with serial numbers prefixed as indicated on the title page. Earlier versions of the instrument (serial number prefixes lower than the one indicated on the title page) may be slightly different in design or appearance. The purpose of this section of the manual is to document these differences. With the information provided in this section, this manual can be corrected so that it applies to any earlier version or configuration of the instrument. Later versions of the instrument (serial number prefixes higher than

the one indicated on the title page) are documented in a yellow Manual Changes Supplement.

7-3. Since there are no earlier versions of the HP Model 8748A S-Parameter Test Set, there is no change information provided here. This manual applies directly to instruments with serial numbers prefixed as indicated on the title page. If your instrument serial number is different than the one on title page, it will be documented in a yellow Manual Changes Supplement. Complimentary copies of this supplement can be obtained from your nearest Hewlett-Packard Office. Refer to **INSTRUMENTS COVERED BY MANUAL** in section I for more information about serial number coverage.

**SERVICE  
INFORMATION**



## SECTION VIII SERVICE

### 8-1. INTRODUCTION

8-2. This section provides instructions for the troubleshooting and repair of the HP Model 8748A S-Parameter Test Set. Circuit descriptions and component location illustrations are included with the schematic diagrams of the assemblies. Schematic presentations in this manual show electrical circuit operation and are not intended to serve as wiring diagrams.

### 8-3. ASSEMBLY SERVICE SHEETS

8-4. The schematics are arranged by service sheet number, which appears in the lower right-hand corner of each schematic. (This is the large number above the assembly reference designation.) Included in the service sheet is the schematic as well as the accompanying circuit description, component-location illustration, and schematic-level troubleshooting information.

### 8-5. TROUBLESHOOTING

8-6. To troubleshoot the 8748A start with Service Sheet 1 using the 8754A to supply the signal (0 dBm). Check the output at each port with the 8748A in the  $S_{11}$   $S_{21}$  position. If the level at a port is not about the same as shown on the schematic then trace back the signal to the problem assembly. If the levels are correct then switch S-PARAMETER SELECT to  $S_{22}$   $S_{12}$ . The levels at ports 1, 2, A, and B should change to: Port 1 (no signal), Port 2 ( $\approx -13$  dBm), Port A (no signal), and Port B ( $\approx -19$  dBm). If one of these levels is not as noted then trace back to the problem assembly.

8-7. To isolate between a problem in the logic (A1, A2) and RF (A6, A7), check if LEDs function correctly and pulses are as noted on Service Sheet 2 A7 terminals 1 and 2. If one of these tests fail then the problem is in A1 or A2. Use the test points on A2 to isolate to the problem functional block.

### 8-8. RECOMMENDED TEST EQUIPMENT

8-9. Test equipment and accessories required for maintenance of the HP 8748A are listed in Section 1. If the equipment listed is not available, equipment that meets the minimum specifications may be substituted.

### 8-10. REPAIR

8-11. Module Exchange Program. A3-Splitter/Directional Bridge, A4-Directional Bridge, and A5-Attenuator are not field repairable. These assemblies are available at a lower cost under the module exchange program. The procedure to use this exchange is shown on Figure 8-1.

#### CAUTION

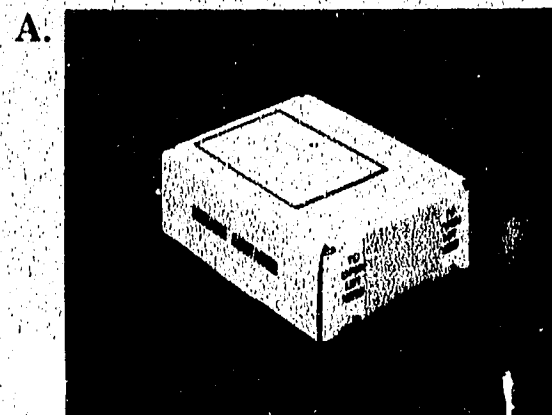
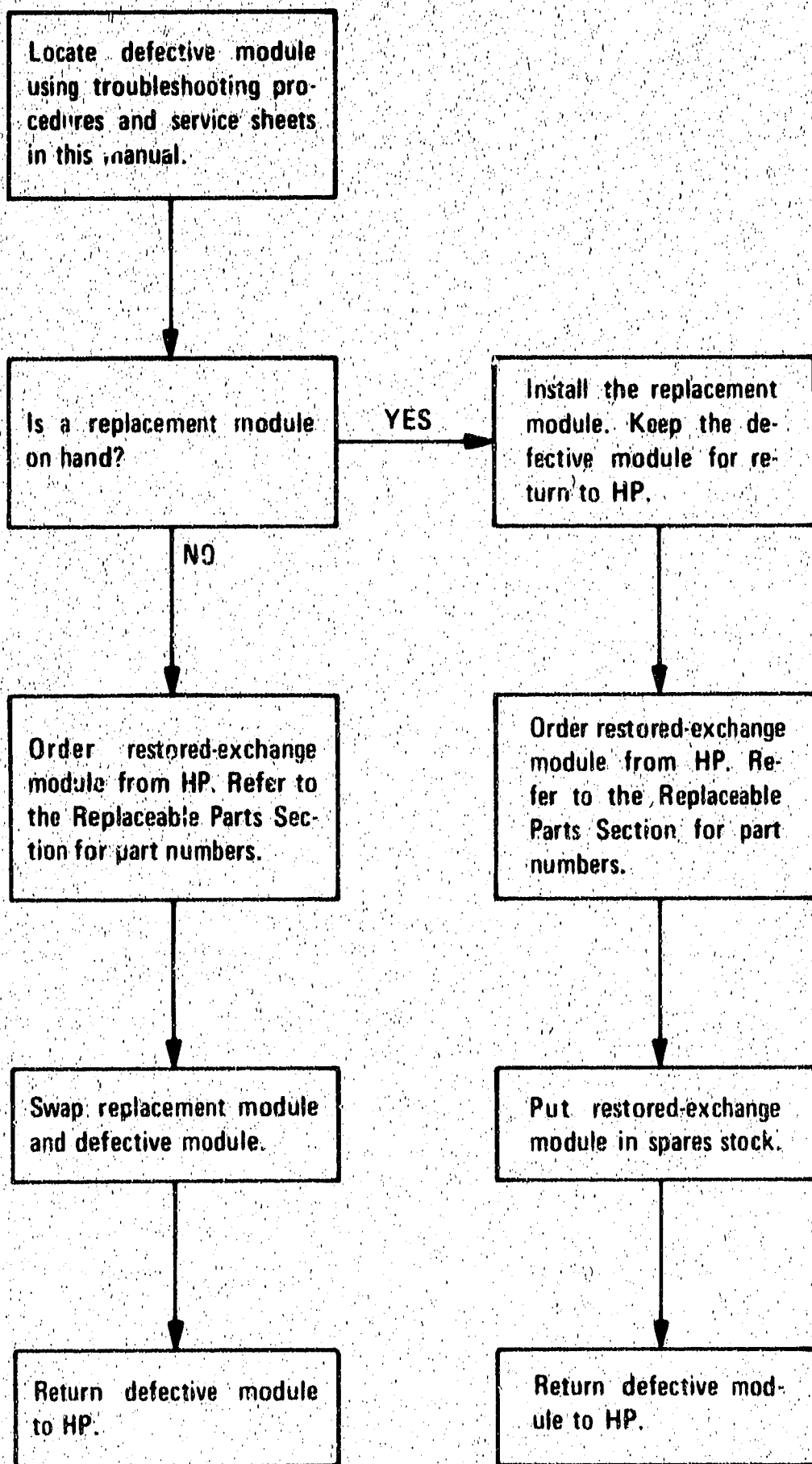
**The SMA connectors used in the instrument have low torque specifications 0.8-1.1 N.m (7-10 in-lb.) if this specification is exceeded damage may result to the assembly or connector.**

8-12. A6 Solenoid Contact Cleaning. If the solenoids in coaxial switch assembly A6 fail to actuate the problem may be caused by a deposit that builds up on the dc contacts. These contacts are easily cleaned by following the steps in figure 8-2.

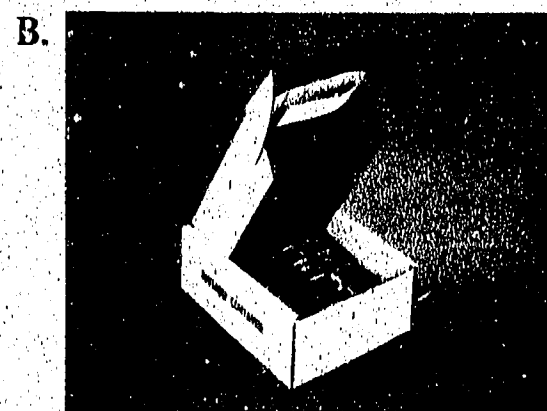
### 8-13. After-Service Product Safety Checks

8-14. Visually inspect the interior of the instrument for any signs of abnormal, internally generated heat, such as discolored printed circuit boards or components, damaged insulation, or evidence of arcing. Determine and then remedy the cause of any such condition.

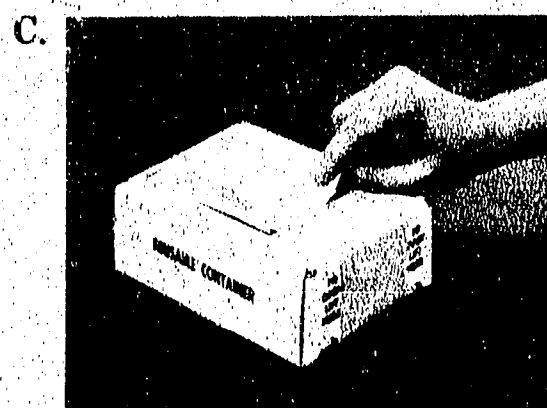
The module exchange program described here is a fast, efficient, economical method of keeping your Hewlett-Packard instrument in service.



Restored-exchange modules are shipped individually in boxes like this. In addition to the circuit module, the box contains:  
 Module repair report  
 Return address label  
 Tape for resealing box



Open box carefully - it will be used to return defective module to HP. Complete repair report. Place it and defective module in box. Be sure to remove enclosed return address label.

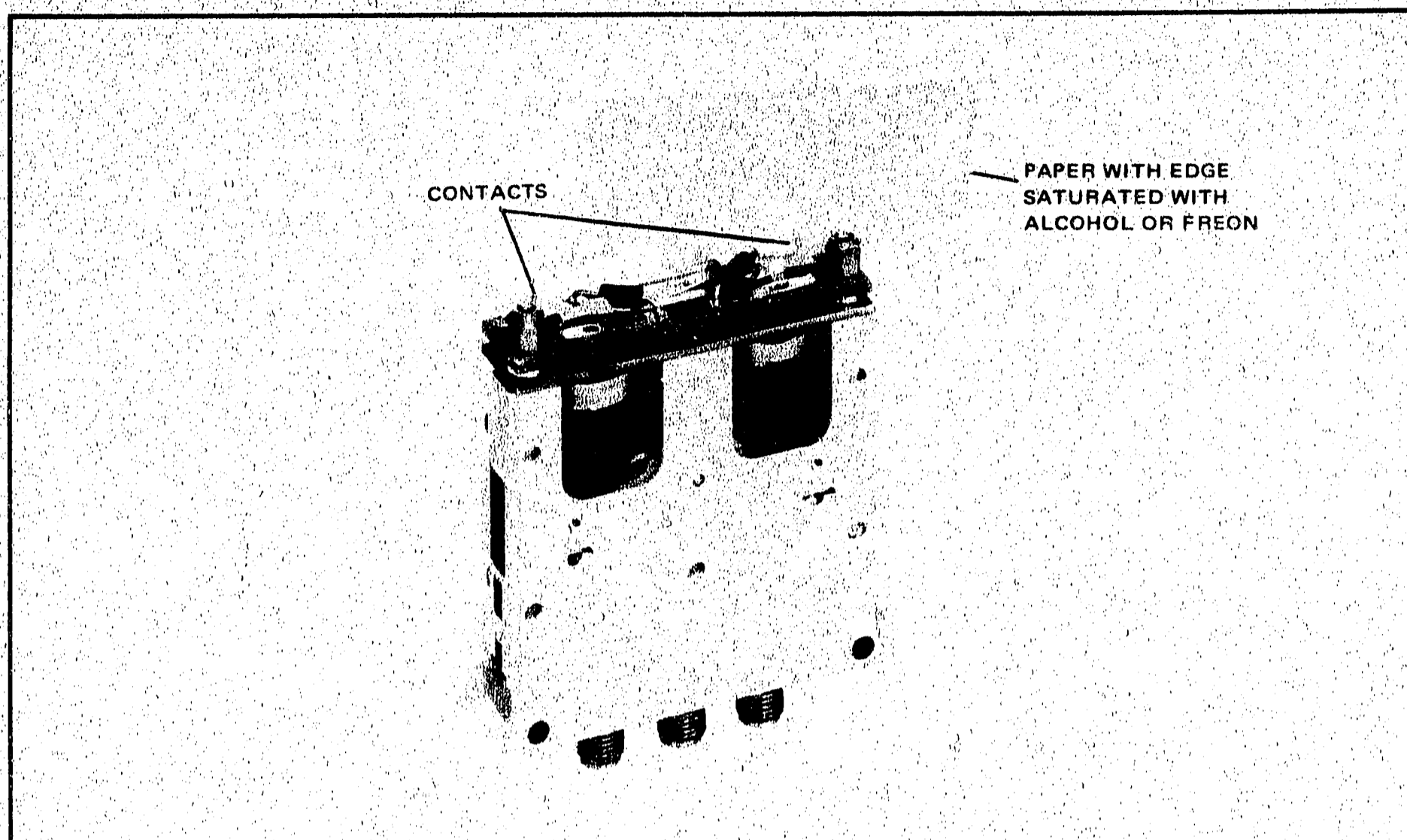


Seal box with tape provided. Inside U.S.A.\*, stick preprinted return address label over label already on box, and return box to HP. Outside U.S.A., do not use address label; instead, address box to the nearest HP office.

\*HP pays postage on boxes mailed in U.S.A.

Figure 8-1. Module Exchange Procedure





**Procedure:**

1. Remove two top rear feet and 8748A top cover.
2. Disconnect three semi-rigid cables to A6 coaxial switch and unsolder the three wires.
3. Remove A6 from 8748A.
4. Remove two screws on cover and remove cover of A6.
5. Saturate the edge of a sheet of writing paper with alcohol.
6. Insert paper under one of the contacts, and while pressing gently on contact, slide paper through. Note photo. Do this several times and repeat for other contact.

**NOTE**

**Do not allow paper to tear or shred.**

7. Saturate the edge of another sheet of paper with freon and repeat step 6.
8. Check that no shreds of paper have lodged in contacts.
9. Restall cover. Note the orientation of the feedthrough terminals on the cover with respect to the switch contacts.
10. Reinstall A6 by reversing procedure in steps 1 to 3.
11. Check switch operation.

*Figure 8-2. Cleaning A6 Solenoid Contacts*

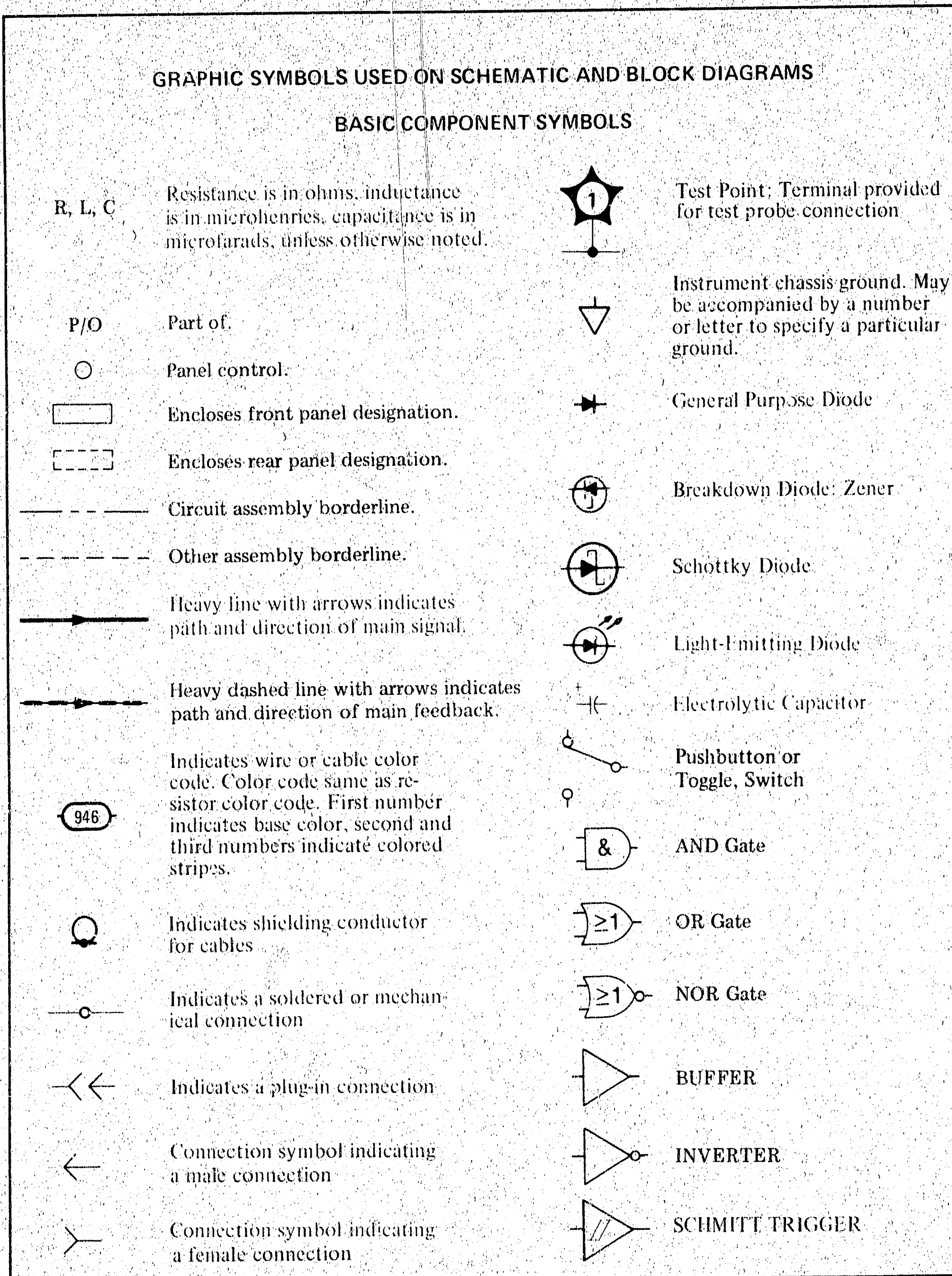


Figure 8-3. Schematic Diagram Notes



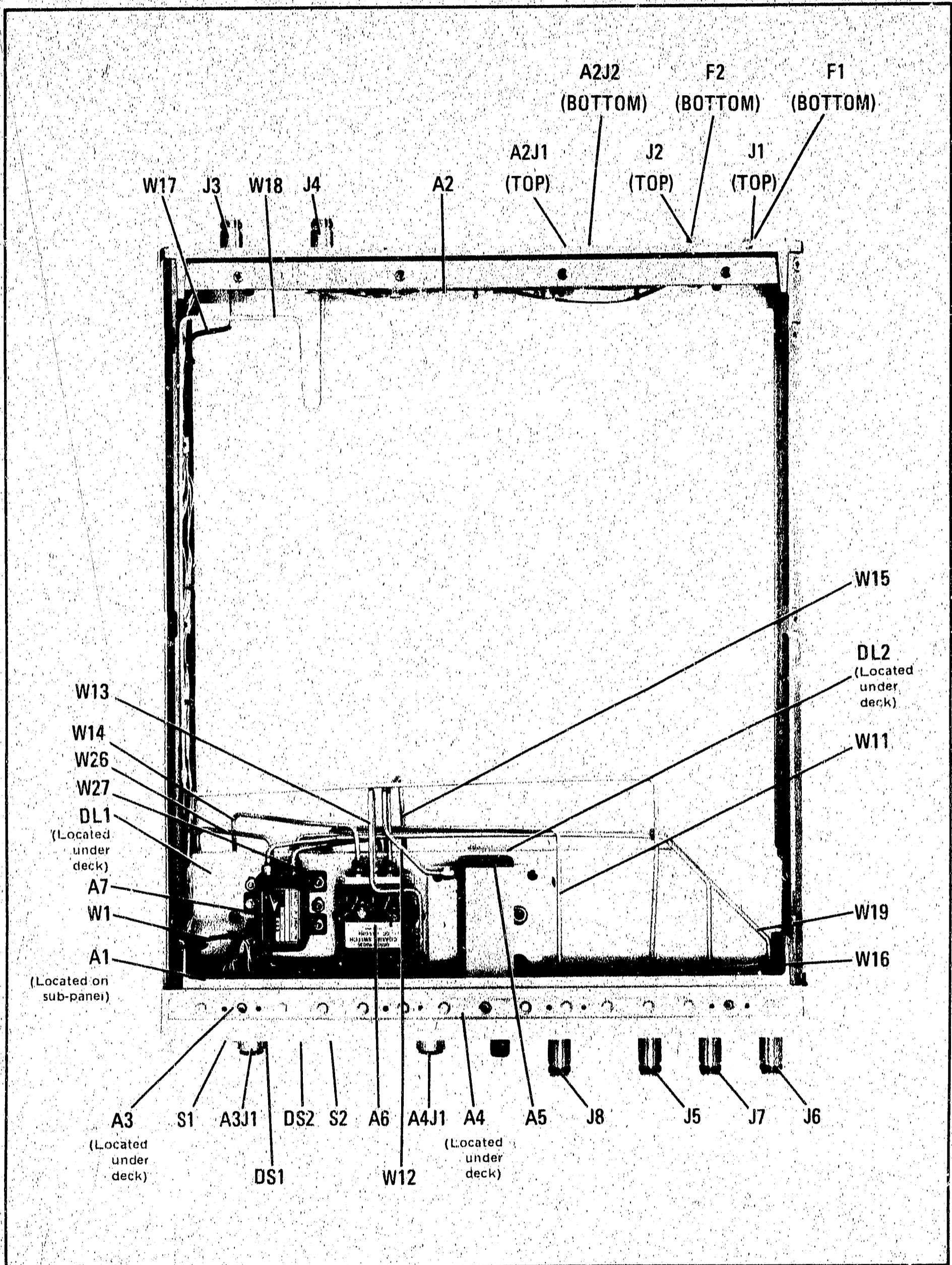


Figure 8-4. Major Assemblies, Cables, and Connector Locations

**SERVICE SHEET 1****RF SECTION, CIRCUIT DESCRIPTION**

The RF Section provides the circuitry for the measurement of transmission and reflection characteristics of two-port devices. It consists of the following major assemblies:

- A3 Power Splitter/Directional Bridge
- A4 Directional Bridge
- A5 Input Attenuator
- A6 RF Switch
- A7 Transfer Switch

A rear-panel Reference Plane Extension cable is provided to equalize the electrical lengths of the reference and signal paths to achieve correct phase calibration. Phase length adjustments DL1 and DL2 are associated with the two bridges.

**A3 Power Splitter/Directional Bridge**

**Power Splitter.** The Power Splitter divides the RF INPUT power between the measurement line to A5 INPUT ATTENUATOR and the reference line to port R. The pad in the reference line equalizes the power at port R to be approximately equal to that at ports A or B. The electrical length compensation is provided to insure that signals in the two paths are in phase.

**Directional Bridge.** The directional bridge passes the RF signal from its input connector A3J6 to the test port connector A4J1 and passes the returning (reflected) signal from the test port connector to the reflected output A4J2.

**NOTE**

The Directional Bridge is a high-directivity device (< 40 dB in the frequency range of 4 to 1300 MHz). This high directivity allows reflection measurements ( $S_{11}$ ,  $S_{22}$ ) with minimum ambiguity. Careful attention should be given to the proper maintenance of the PORT 1 and PORT 2 front-panel connectors. A damaged or dirty contact can degrade the directivity of the Directional Bridge, increasing the measurement error.

**A4 Directional Bridge**

**A4 Directional Bridge.** The directional bridge passes the RF signal from its input connector A4J3 to the test port connector A4J1 and passes the returning (reflected) signal from the test port connector to the reflected output A4J2.

**A5 Input Attenuator**

A5 Input Attenuator is a 70-dB step attenuator that regulates the incident signal level in 10-dB steps.

**A6 RF Switch**

A6 RF Switch routes the incident signal from attenuator A5 to either PORT 1 (via Bridge A3) or PORT 2 (via bridge A4). The unused port is terminated in  $50\Omega$ .



**A7 Transfer Switch**

A7 Transfer Switch routes the reflected outputs of the two bridges (A3 and A4) to the appropriate output ports (A and B), depending on the measurement selected.

**S-PARAMETER MEASUREMENTS**

The signal paths for the four S-Parameter measurements are shown in Figure 3-3. The approximate power levels for the RF circuitry are shown in Figure 8-5 with the following conditions: Input power 0 dBm, no connections at port 1 or 2 and Input Attenuator set to 0. In all cases, the input power is split equally between the signal path and the path through the Reference Plane Extension to port R. The four measurements are described in the following paragraphs.

**S11**

The RF signal is incident at PORT 1 and received by PORT 1. The incident power is transmitted through the Input Attenuator, the RF Switch, and the Directional Bridge to PORT 1. With no connection to port 1, the signal at PORT 1 is reflected back through the Directional Bridge and the RF Switch and terminated in the Power Splitter. A portion of the reflected signal is coupled off and transmitted through the Transfer Switch to port A.

**S21**

The signal is incident at PORT 1 and received by PORT 2. The incident power is transmitted through the Input Attenuator, the RF Switch, and the Directional Bridge to PORT 1. With a thru-line connected from PORT 1 to 2, the signal arriving at PORT 2 passes through the Directional Bridge and is terminated in the RF Switch. A portion of this signal is coupled off and transmitted through the Transfer Switch to port B.

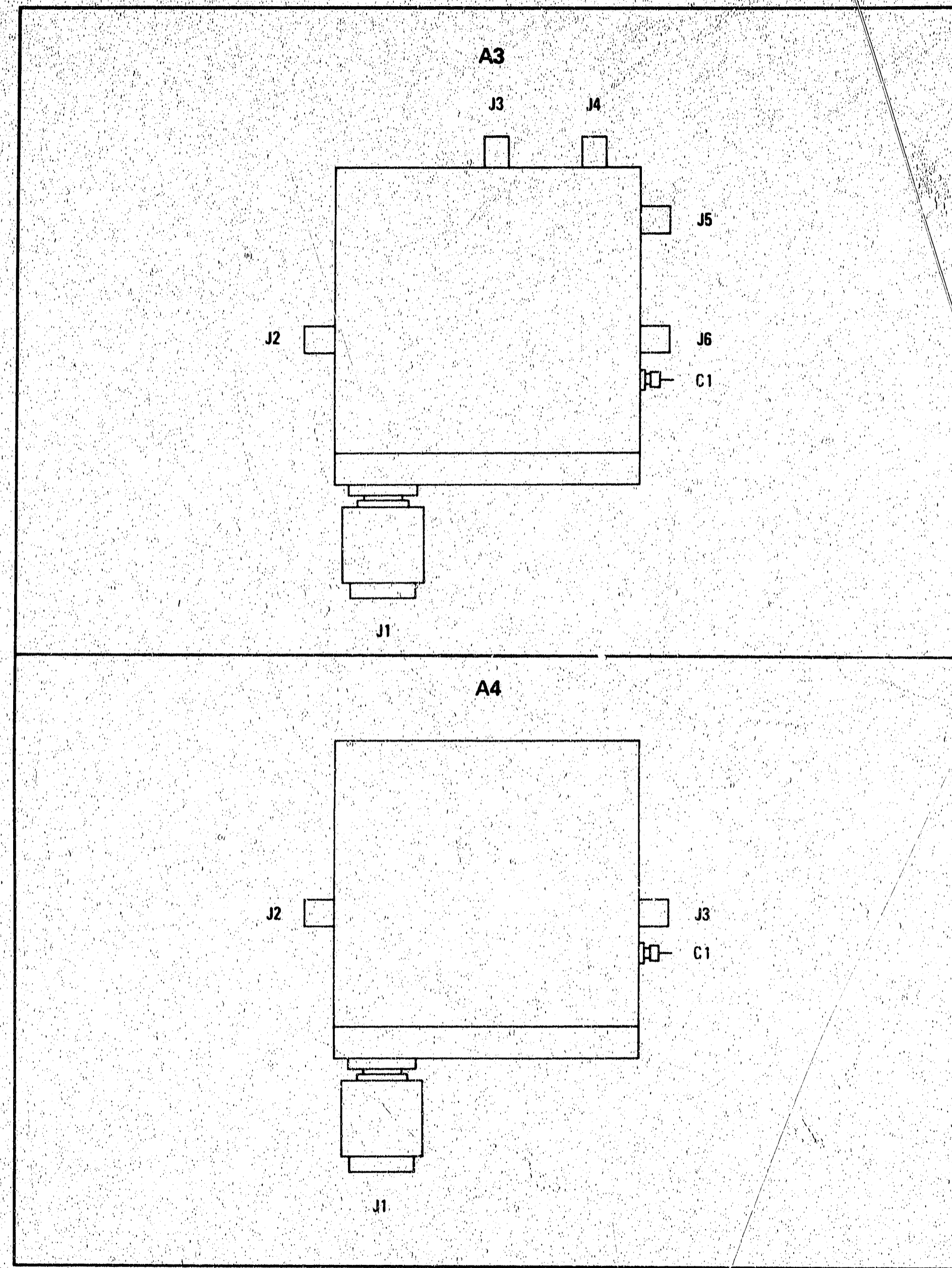
**S12**

The signal is incident at PORT 2 and received by PORT 1. The incident power is transmitted through the Input Attenuator, the RF Switch, and the Directional Bridge to PORT 2. With a thru-line connected from PORT 1 to 2, the signal arriving at PORT 1 passes through the Directional Bridge and is terminated in the RF Switch. A portion of this signal is coupled off and transmitted through the Transfer Switch to port B.

**S22**

The signal is incident at PORT 2 and reflected from PORT 2. The incident power is transmitted through the Input Attenuator and the RF Switch to PORT 2. With no connection on PORT 2, the signal at PORT 2 is reflected back through the Directional Bridge and the RF Switch and terminated in the Power Splitter. A portion of the reflected signal is coupled off and transmitted through the Transfer Switch to port A.





A3 Splitter/Directional Bridge and A4 Directional Bridge, Connector Locations

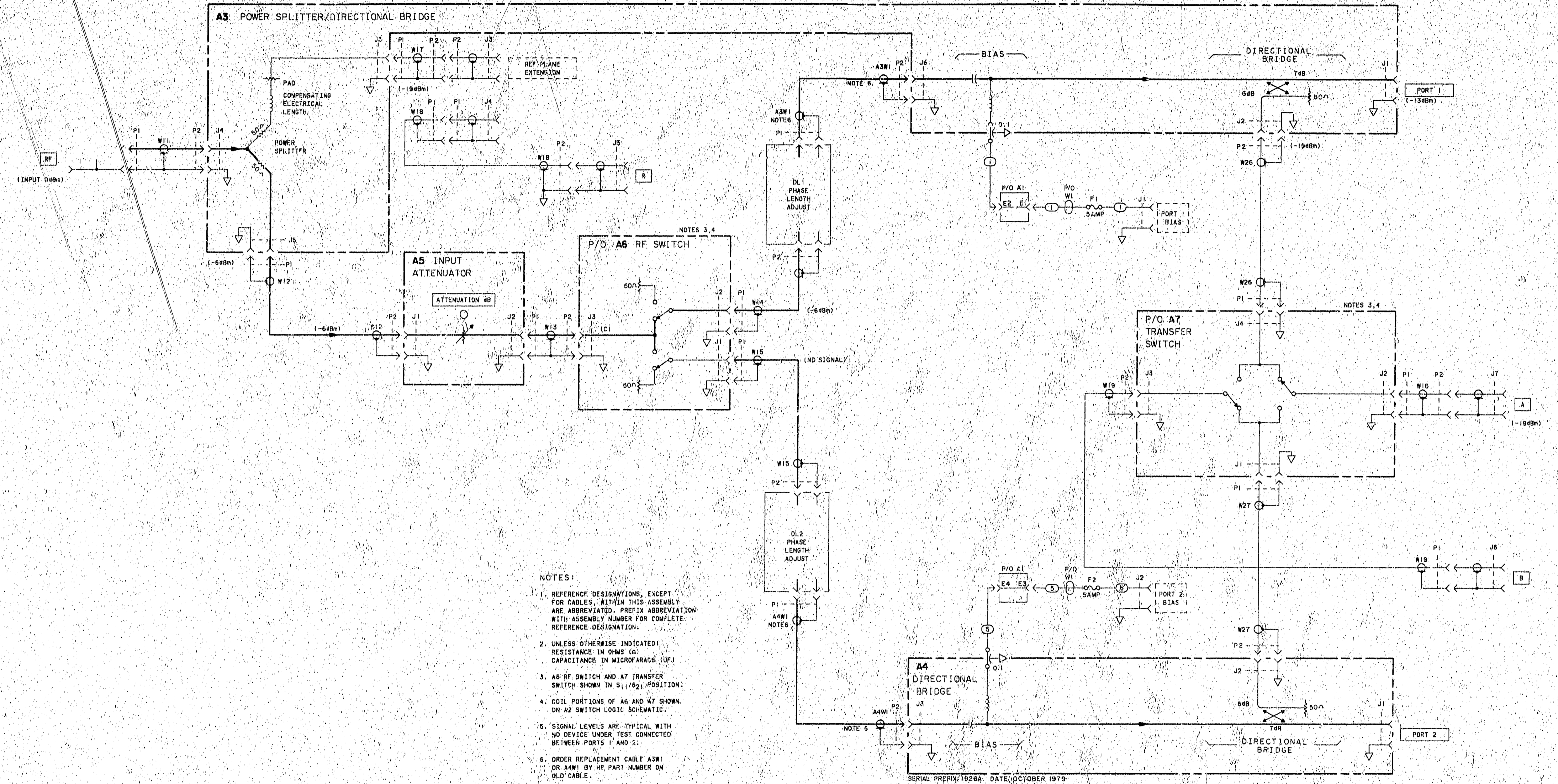


Figure 8-5: A3 Splitter/Directional Bridge, A4 Directional Bridge Connector Locations and RF Circuit Schematic



## SERVICE SHEET 2

## A2 SWITCH LOGIC ASSEMBLY, CIRCUIT DESCRIPTION

A2 Switch Logic Assembly and A1 Front Panel Assembly together provide the control functions to interface the HP 8748A with the HP 8754A for S-parameter measurements.

A2 receives the DC power to drive the RF switches and the following signals from the external control device via A2J2 (PROGRAMMING):

- L REM EN, when low, enables remote operation of the HP 8748A.
- L REM TRIG, when low, signals the HP 8748A that the HP 8754A is ready to perform a measurement sequence and switches the HP 8748A to remote operation, enabling L REM REV.
- L REM REV controls the selection of either  $S_{11} S_{21}$  or  $S_{22} S_{12}$  measurements in the HP 8748A.

The only output line is L REM, from A2J1 (NETWORK ANALYZER INTERCONNECT). It switches the HP 8754A to remote operation when both L REM EN and L REM TRIG are low.

## Control Logic A

**Remote/Local:** The Remote/Local circuit, consisting of NOR gates U3A and U3B and D flip-flop U2B, controls the transfer of operation of the S-Parameter Test Set from local (front-panel) to remote operation and provides for return to local operation.

When the L REM EN line to A2J2 is high, the HP 8748A is in local (front-panel) operation. U3A pin 3 is high and U3A pin 1 is low, holding D flip-flop U2B reset (cleared). U2B pin 8 is therefore high. U5A pin 1 is high, and the selection of either  $S_{11} S_{21}$  or  $S_{22} S_{12}$  measurements depends on the state of U5A pin 2, which is controlled by the position of the front-panel S-PARAMETER SELECT switch A1S2. At the same time, U2B pin 9 is low, in effect disabling U5B and inhibiting L REM REV.

When L REM EN is low, both inputs to U3A are low (because the front-panel LOCAL switch A1S1 is normally open), and the output (U3A pin 1) is high, allowing D flip-flop U2B to function. U3B pin 5 is also low. A negative-going pulse on the L REM TRIG line pulls U3B pin 6 low, and a positive-going pulse at U3B pin 4 clocks U2B. The D input (pin 12) of U2B is tied to +5V. Therefore, when the flip-flop is clocked, a high at the active high output (U2B pin 9) places a high on NAND gate U5B pin 5 in the Relay Control circuit. This allows the L REM REV line to control the selection of either  $S_{11} S_{21}$  or  $S_{22} S_{12}$  measurements;

The high at U2B pin 9 is inverted through U8G to light the REMOTE indicator A1DS3. The high at U2B pin 9 is also inverted through U3D, pulling the L REM EN line low and switching the HP 8754A to remote operation.

When the front-panel LOCAL switch A1S1 is pressed, the inputs to U3C are momentarily grounded. U3C goes high, U3A goes low, and D flip-flop U2B is reset (cleared). The test set will then remain in local operation even through the L REM EN line is low until another clock pulse is received from the L REM TRIG line.

**Relay Control.** The Relay Control circuit, consisting of Flip-Flop U2B, NAND gates U5A, U5B, U5C, and U5D, controls A6 RF Switch and A7 Transfer Switch by means of inputs to the Relay Driver circuit.

When the S-Parameter Test Set is in local (front-panel) operation, U5A pin 1 is high, and the state of U5A pin 2 controls the selection of either  $S_{11} S_{21}$  or  $S_{22} S_{12}$  measurements. When U5A pin 2 is also high (S-PARAMETER SELECT switch A1S2 set to  $S_{11} S_{21}$ ), U5A pin 3 is low. U5C pin 8 is therefore high, regardless of the state of U5C pin 9. (That is, the L REM REV line has no effect.) For  $S_{11} S_{21}$  measurements, the Relay Driver circuit requires a high at U5C pin 8 and a low at U5D pin 11.

When the S-Parameter Test Set is in remote operation, U5A pin 3 is high regardless of the state of U5A pin 2. (That is, the S-PARAMETER SELECT switch A1S2 has no effect.) Since U3B pin 5 is held high in remote operation, the state of U5C pin 8 now depends on the state of the L REM REV line.

When the L REM REV line is low, U5D pin 6 is high and U5C pin 8 is low, selecting  $S_{22} S_{12}$  measurements. When the L REM REV line is high, U5C pin 8 is also high, and  $S_{11} S_{21}$  measurements are selected.

## Relay Driver B

The Relay Driver circuit, which consists of a comparator, a dual monostable multivibrator, and four open-collector inverters, controls A6 RF Switch and A7 Transfer Switch. It also provides front-panel indications of the selected S-parameters.

The comparator is a turn-on delay which sets the multivibrator outputs to the correct state when DC power is applied to the 8748A.

When  $S_{11} S_{21}$  measurements are selected, the inputs to U6B pin 9 (monostable multivibrator) and U8D are high while the inputs to U8E and U6A pin 1 (monostable multivibrator) are low.

Pin C of A6 RF Switch is held at +20VF. The low at pin 2 of the switch (from U8D pin 13) and the corresponding high at pin 1 of the switch (from U8E pin 12) result in the selection of  $S_{11} S_{21}$  measurements.

A low at U8E pin 13 completes a current path to light LED A1DS1 when  $S_{11} S_{21}$  measurements are selected, while a low at U8E pin 12 lights LED A1DS2 for an indication of  $S_{22} S_{12}$  measurements.

## Power Supply C

The S-Parameter Test Set operates on +20V from the HP 8754A Network Analyzer via the PROGRAMMING and NETWORK ANALYZER INTERCONNECT connectors. The outputs from the Power Supply are +20VF and, via regulator U4, +5V.

## SOLENOID SWITCH OPERATION

## A6 RF Switch Operation

Assume that the switches were in the  $S_{22} S_{12}$  position. (A2TP3 low) and  $S_{11} S_{21}$  measurements are selected. A2TP3 goes high which opens the collector of U8E which drives pin 1 of A6 RF Switch and closes the collector of U8D which causes pin 2 of A6 to go low. Current then flows from +20 VF, through the coil in A6, through pin 2, and into U8D. After A6 has fully switched (20 msec) a contact inside A6 opens

so that no steady-state current is drawn, and the contact connected to pin 1 closes. When  $S_{22}$  measurements are selected, U8D collector opens and U8E collector closes, drawing current from +20 VF and through the coil connected to pin 1, and into U8E.

## A7 Transfer Switch Operation

Assume that the switches were in the  $S_{22} S_{12}$  position (A2TP3 low) and  $S_{11} S_{21}$  measurements are selected. A2TP3 goes high, causing the output of inverter U5D to go low. One shot U6A and U6B produce a 70-msec positive pulse when their respective inputs (U6 pins 1 and 9) go from high to low; hence a positive pulse is produced at U6A and the output of U6B is open, and the collector of U6A is closed, causing current to flow from +20 VF, through the coil of A7 connected to pin 1, and into U6A, for the duration of the pulse. When  $S_{22}$  measurements are selected, U8A collector is open, and U8F collector is closed for 70 msec, causing current to flow from +20 VF, through the A7 coil to pin 2, and into U8F.

## A1 FRONT PANEL, CIRCUIT DESCRIPTION

A1 Front Panel consists of the following switches and indicators:

- S-PARAMETER SELECT switch
- LOCAL switch
- $S_{11} S_{21}$  indicator
- $S_{22} S_{12}$  indicator
- REMOTE indicator

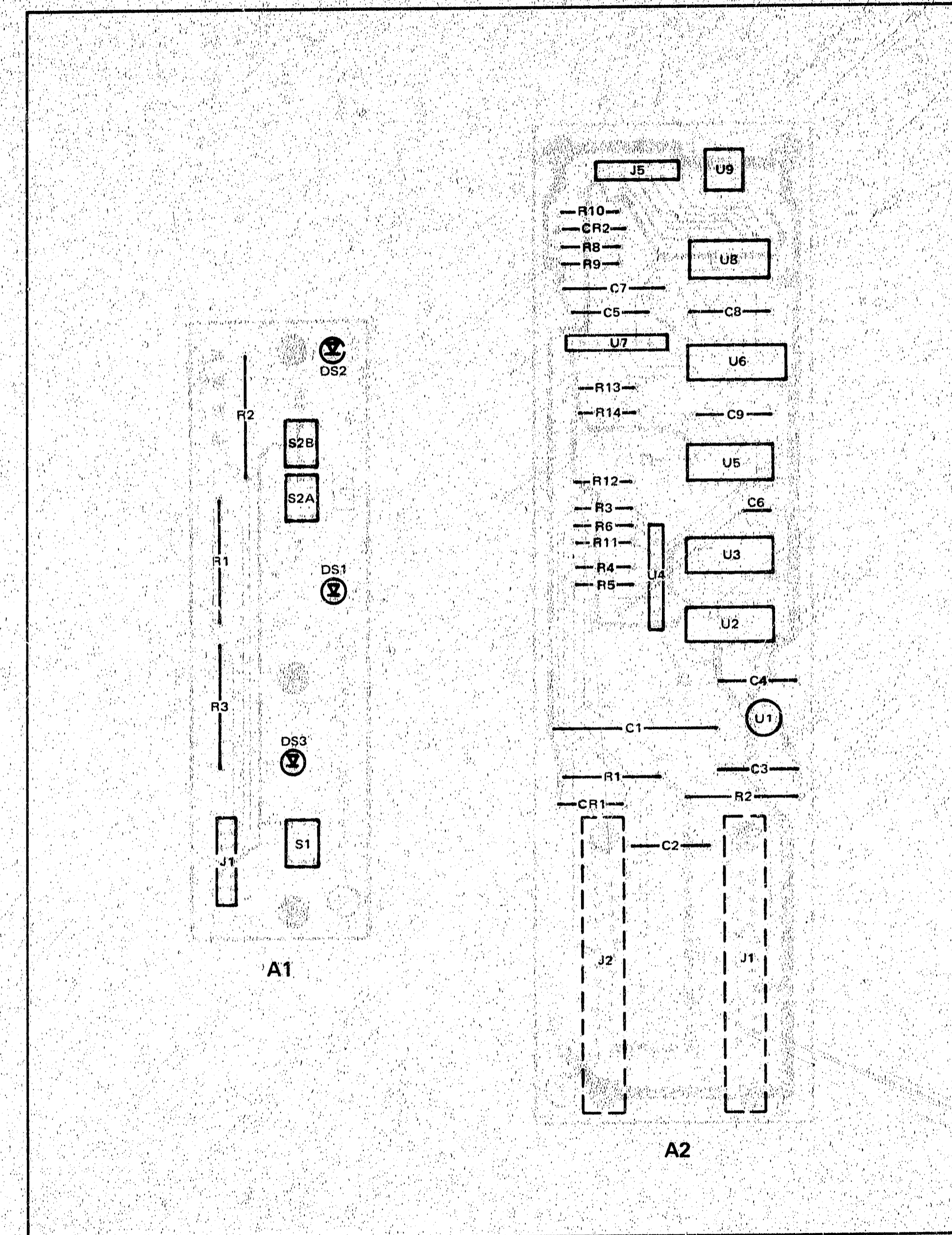
## S-PARAMETER SELECT Switch

The S-PARAMETER SELECT switch consists of two mechanically interlocking sections, S2A ( $S_{11} S_{21}$ ) and S2B ( $S_{22} S_{12}$ ). When S2A is depressed, the line to A2 Switch Logic is open; when S2B is depressed, the line is grounded. When the S-Parameter Test Set is in local operation, the switching of A6 RF Switch and A7 Transfer Switch are controlled by the S-PARAMETER SELECT switch. The switch has no effect in remote operation.

LOCAL switch S1 is a spring-loaded momentary switch that returns the S-Parameter Test Set to local operation. Its operation affects the Remote/Local logic circuitry in A2 Switch Logic.

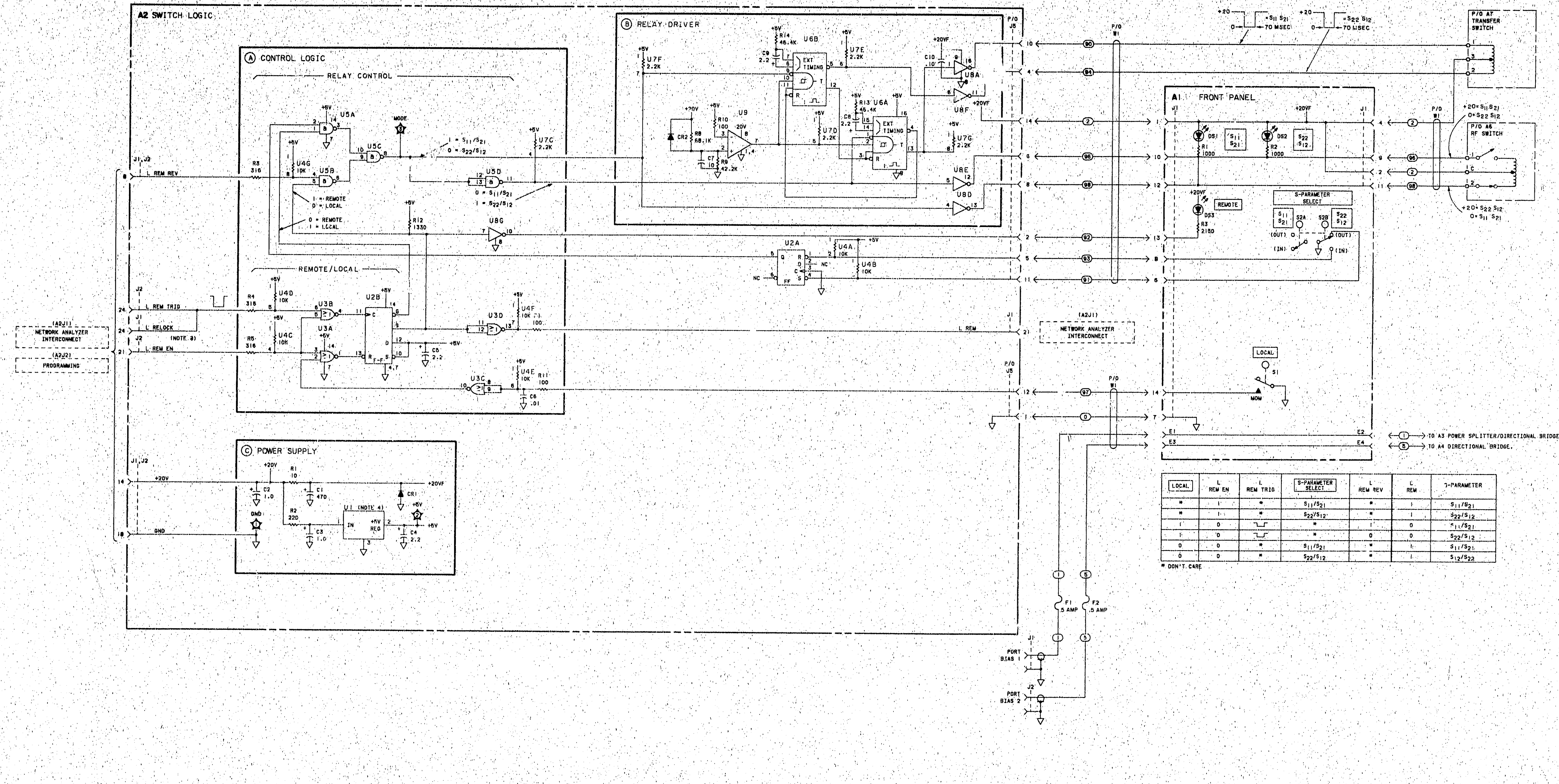
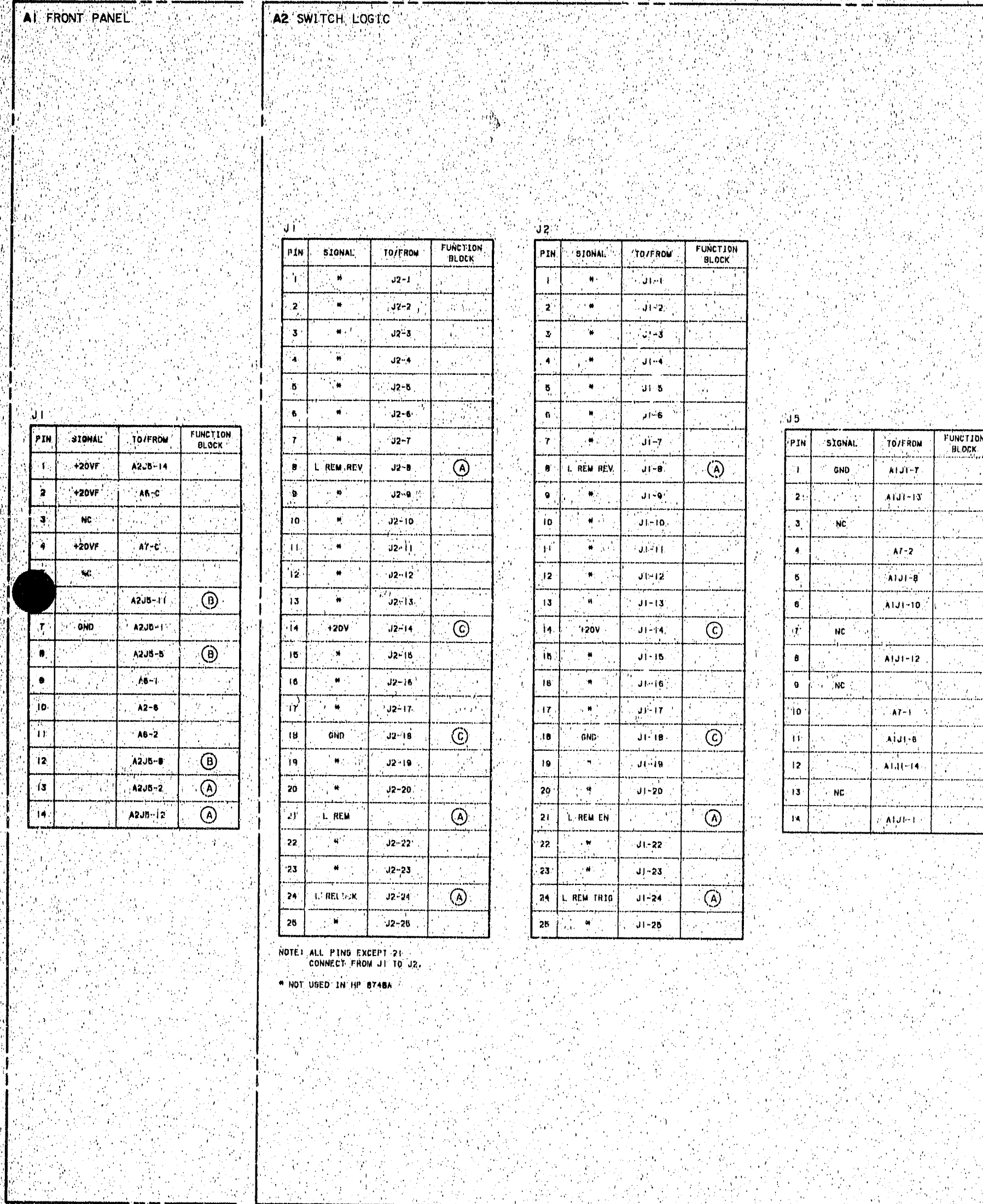
REMOTE indicator DS3 is an amber light-emitting diode (LED) that conducts when the line from A2 Switch Logic to its cathode goes low.

$S_{11} S_{21}$  indicator DS1 and  $S_{22} S_{12}$  indicator DS2 are green LEDs that light to indicate the measurement selected either by the S-PARAMETER SELECT SWITCH (local operation) or by the state of the external L REM REV line (remote operation).



A1 Front Panel and A2 Switch Logic Boards Component Locations





- NOTES:**
- REFERENCE DESIGNATORS, EXCEPT FOR CABLES, WITHIN THIS ASSEMBLY ARE ABBREVIATED. PREFIX ABBREVIATION WITH ASSEMBLY NUMBER FOR COMPLETE REFERENCE DESIGNATOR.
  - UNLESS OTHERWISE INDICATED, RESISTANCE IN OHMS, CAPACITANCE IN MICROFARADS.
  - MEMORIC TABLE:
- | MEMORIC    | DESCRIPTION                         |
|------------|-------------------------------------|
| L REM EN   | LOW - REMOTE OPERATION ENABLE       |
| L REM TRIG | LOW - HP 8748A TO REMOTE OPERATION  |
| L REM      | LOW - HP 8748A IN REMOTE OPERATION  |
| L REM REV  | LOW - S22/S12 MEASUREMENTS SELECTED |
- U1 IS A THREE-TERMINAL, +5V VOLTAGE REGULATOR.
- INPUT OUTPUT COMMON BOTTOM VIEW
- U4 & U7 PIN CONFIGURATION:
- U4 & U7 PIN CONFIGURATION
- | LOCAL | L REM EN | L REM TRIG | S-PARAMETER SELECT               | L REM REV | L REM | T-PARAMETER                      |
|-------|----------|------------|----------------------------------|-----------|-------|----------------------------------|
| w     | 1        | w          | S <sub>11</sub> /S <sub>21</sub> | w         | 1     | S <sub>11</sub> /S <sub>21</sub> |
| w     | 1        | w          | S <sub>22</sub> /S <sub>12</sub> | w         | 1     | S <sub>22</sub> /S <sub>12</sub> |
| 1     | 0        | 1          | *                                | 0         | 0     | S <sub>11</sub> /S <sub>21</sub> |
| 0     | 0        | 1          | *                                | 0         | 0     | S <sub>22</sub> /S <sub>12</sub> |
| 0     | 0        | 0          | S <sub>11</sub> /S <sub>21</sub> | w         | 1     | S <sub>11</sub> /S <sub>21</sub> |
| 0     | 0        | 0          | S <sub>22</sub> /S <sub>12</sub> | w         | 1     | S <sub>22</sub> /S <sub>12</sub> |
- \* DON'T CARE
- LOGIC LEVELS ARE TTL: +2.0V TO +5.0V = LOGIC "1" = HIGH; 0V TO +0.5V = LOGIC "0" = LOW.
  - L REL LOCK TO HP 8754A. L REM TRIG ONLY TO A2.

Figure 8-6. A1 Front Panel and A2 Switch Logic Boards Component Locations and Schematic