

# HP 11850A POWER SPLITTER



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# HP 11850A POWER SPLITTER

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**1. GENERAL INFORMATION**

2. The Hewlett-Packard 11850A Power Splitter is a three-way power splitter for use in network measurements where one arm of the power splitter is used to supply a reference signal for leveling or ratio measurements.

3. Although designed specifically as an accessory for the HP 8505A Network Analyzer, the HP 11850A Power Splitter will provide excellent tracking and SWR characteristics in many other measurement systems.

4. This manual describes the power-splitting action of the HP 11850A Power Splitter as compared to the standard three-port three-resistor type, and the three-port two-resistor type power splitters. It also explains

how to use the power splitter, and describes tests to verify its specifications.

5. On the title page of this manual, below the manual part number, is a "Microfiche" part number. This number may be used to order 4 x 6-inch microfilm transparencies of this manual.

**6. Specifications**

7. Instrument specifications are listed in Table 1. These specifications are the performance standards, or limits, against which the instrument may be tested. Supplemental Characteristics are listed in Table 2. Supplemental Characteristics are typical operating characteristics included as additional information for the user; they are not specifications.

*Table 1. HP 11850A Specifications*

<b>SPECIFICATIONS</b>	
<b>Frequency Range:</b> DC to 1.3 GHz	<b>Maximum Input Power:</b> +20 dBm
<b>Impedance:</b> 50Ω	<b>Connectors:</b> 50Ω Type N Female on all Ports
<b>Tracking (Between any two Output Ports):</b> Magnitude: ≤0.1 dB Phase: ≤1.5°	<b>Dimensions:</b> 67 mm wide, 46 mm high, 67 mm deep; (2 5/8 in. x 1 7/8 in. x 2 5/8 in.)
<b>Port Match:</b> Equivalent Output Source Match (Ratio or Leveling): ≥ 32 dB Return Loss (≤1.05 SWR) Input Port Match: ≥ 20 dB Return Loss (≤1.22 SWR)	<b>Weight:</b> Net: 1.8 kg (4 lb) Shipping: 3.1 kg (7 lb)

*Table 2. HP 11850A Typical Operating Characteristics*

<b>TYPICAL OPERATING CHARACTERISTICS</b>	
<b>Frequency Response (Typical):</b> Input to Output: ≤ ±0.2 dB	<b>Insertion Loss (Nominal):</b> 9.54 dB

**8. Safety Considerations**

9. There are no voltages present in the HP 11850A Power Splitter which could cause bodily injury

**10 Description**

11. The HP 11850A is a four-port, four-resistor, three-way power splitter for use in network measurement systems where one output arm is used as the reference for the network analyzer in making ratio measurements and the other two output arms are test channels. A simplified diagram of a typical network analyzer system is shown in Figure 1.

12. Power splitters used for wide-frequency coverage are usually of the resistive type. A typical three-port, three-resistor, two-way power splitter is shown in Figure 2. For simple power-dividing, a resistance value of  $16 \frac{2}{3}$  ohms in each arm will give an input impedance of 50 ohms as shown in Figure 3, provided the output ports are terminated in the characteristic impedance of 50 ohms.

13. When a power splitter is used in a network analyzer system the node at the fork of the power splitter

(point A in Figure 2) will be kept at a fixed voltage by the AGC action of the reference channel of the network analyzer. Since this point is held at a constant voltage, a virtual ground is present. If a three-resistor power splitter, such as that shown in Figure 2, is used in leveling or ratio measurement applications, each output port will have an impedance of  $16 \frac{2}{3}$  ohms. This will be a 3:1 mismatch, causing significant measurement error. If a two-resistor power splitter, as shown in Figure 4, is used, the input impedance is still 50 ohms, as shown in Figure 5, but the output ports will also have an impedance of 50 ohms due to the virtual ground at the fork of the power splitter. This provides a better output SWR for leveling or ratio measurements.

14. The HP 11850A Power Splitter shown in Figure 6 provides two output ports with 50 ohms impedance when the third output port is used as a reference. It has a  $16 \frac{2}{3}$  ohm resistor in the input arm and a 50 ohm resistor in each of the output arms. The input impedance is 50 ohms as shown in Figure 7 and the output impedance of each arm is also 50 ohms due to the virtual ground at the fork of the power splitter when used for leveling or ratio measurements.

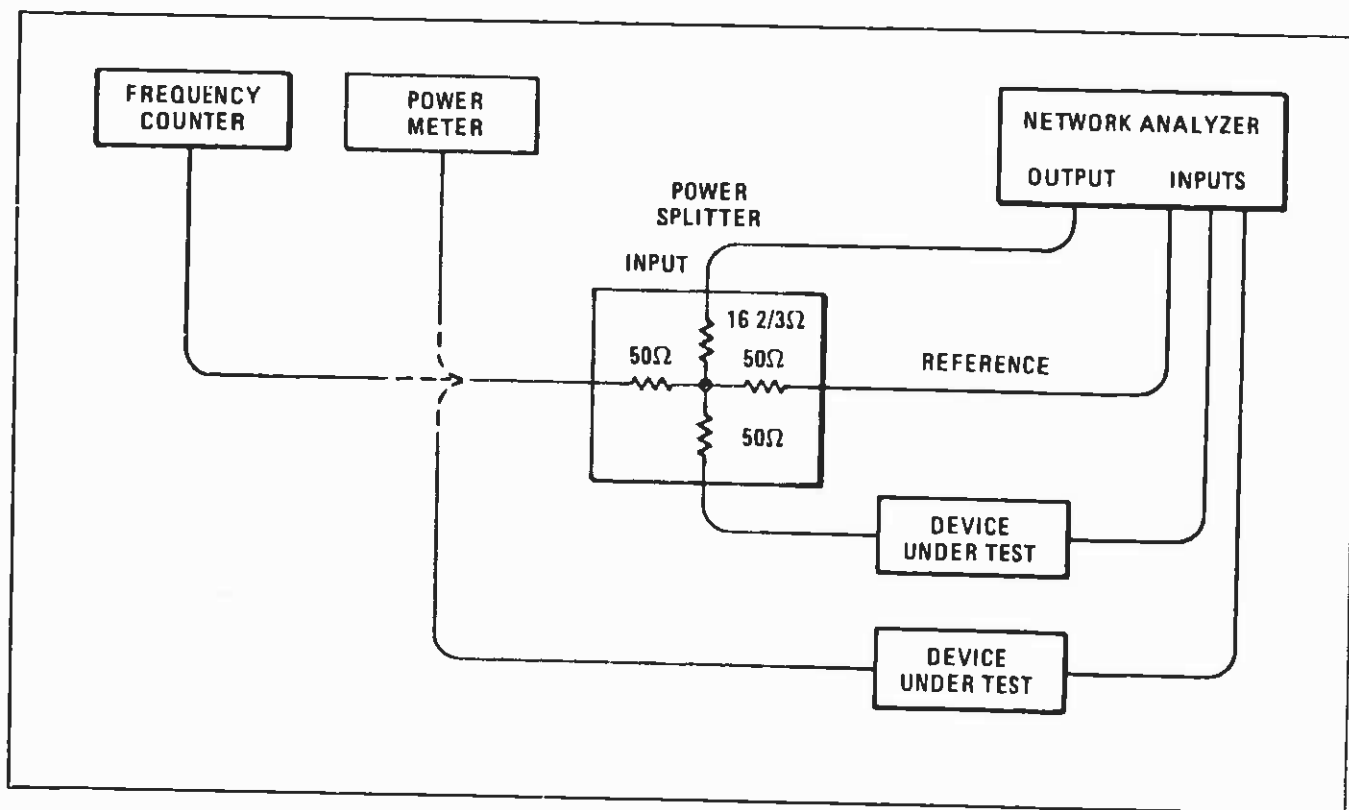


Figure 1. Simplified Diagram of Typical Network Analyzer System

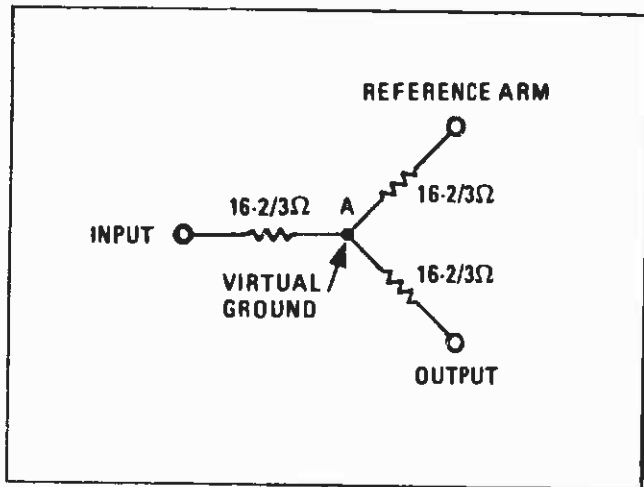


Figure 2. Three-Resistor Power Splitter

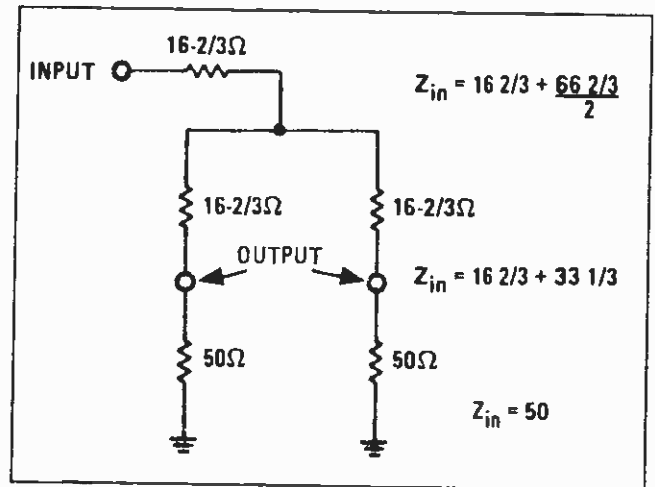


Figure 3. Equivalent Circuit of Three-Resistor Power Splitter

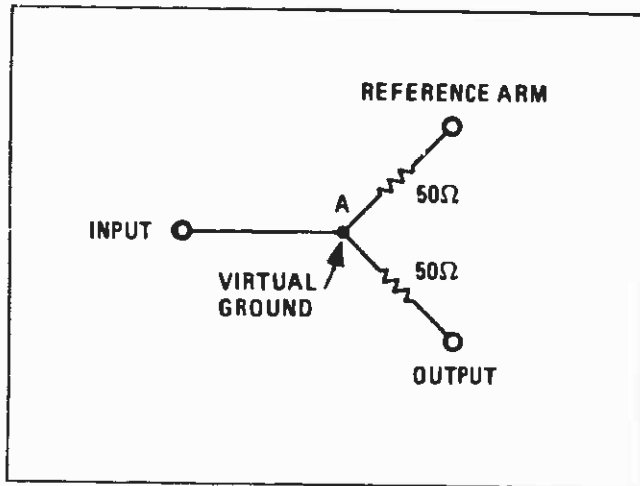


Figure 4. Two-Resistor Power Splitter

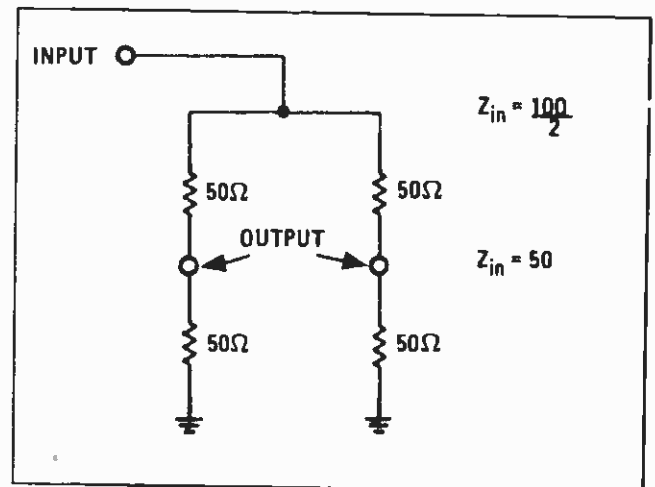


Figure 5. Equivalent Circuit of Two-Resistor Power Splitter

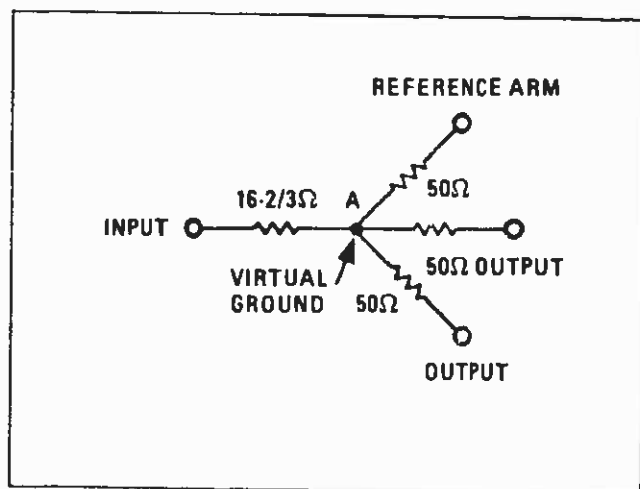


Figure 6. HP 11850A Power Splitter

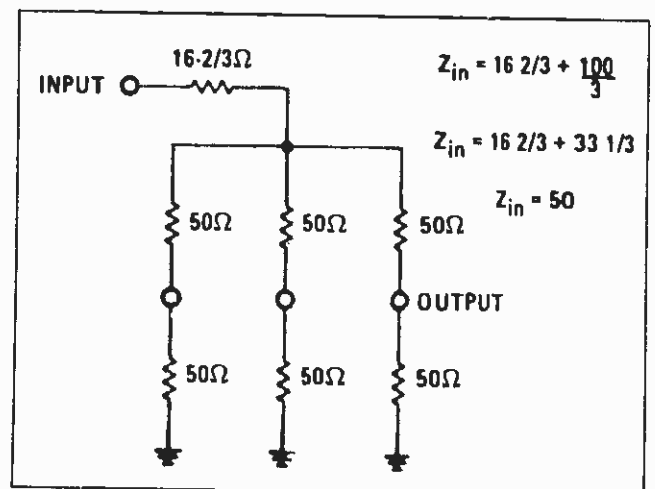
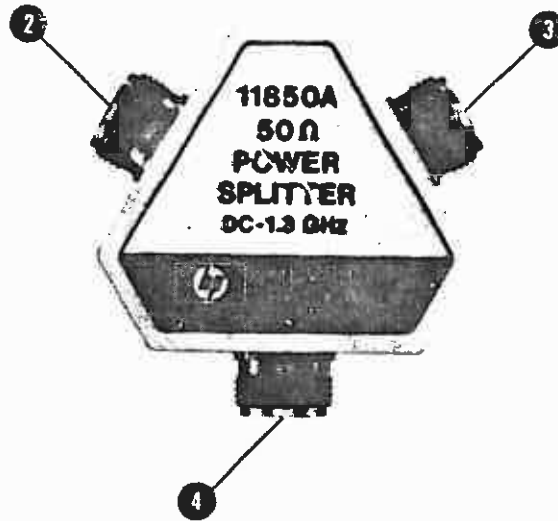


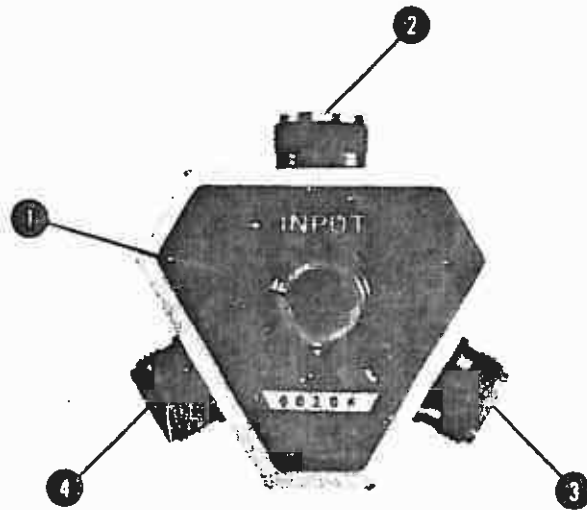
Figure 7. Equivalent Circuit of HP 11850A Power Splitter

**INSTRUMENT FEATURES**

**TOP VIEW**



**BOTTOM VIEW**



- ① **INPUT PORT** for incoming signal.
- ② ③ ④ **OUTPUT PORT** used as exit ports for outgoing signals. Output signal is typically 9.54 dB down in power from input signal. Any one of the three output ports may be used as either test or reference port since power is equal in all output ports.

*Figure 8. Instrument Features*



## 15. Recommended Accessories

16. The HP 11851A RF Cable Kit is recommended for use with the HP 11850A Power Splitter. The HP 11851A RF Cable Kit includes four RF cables, three of which are phase-matched. These phase-matched cables provide the symmetry between test ports needed when making network analyzer ratio measurements, and the shielding necessary for 100 dB dynamic range.

## 17. INSTALLATION

### 18. Initial Inspection

19. Inspect the shipping container for damage. If the shipping container or cushioning material is damaged, it should be kept until the contents of the shipment have been checked mechanically and electrically. Procedures for checking the electrical performance of the instrument are included in this manual under PERFORMANCE TESTS. If the content of the shipment is incomplete, if there is mechanical damage or defect, or if the instrument fails to meet specifications of electrical tests, notify the nearest Hewlett-Packard office. If the shipping container is damaged, or 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 HP office will, at their option, arrange for repair or replacement without waiting for claim settlement.

### 20. Preparation for Use

21. For equipment setup prior to measurement connect the equipment as shown in Figure 9, Operator's Check.

## 22. STORAGE AND SHIPMENT

### 23. Environment

24. The HP 11850A Power Splitter should be stored in a clean, dry environment. The following environmental limitations apply to both storage and shipment.

- a. Temperature:  $-40^{\circ}\text{C}$  to  $75^{\circ}\text{C}$
- b. Humidity:  $<95\%$  relative
- c. Pressure Altitude:  $<15,240$  metres (50,000 feet)

## 25. Packaging

26. **Original Packaging.** Containers and materials identical to those used in factory packaging are available through Hewlett-Packard offices. If the instrument is being returned to Hewlett-Packard for service or repair, attach a tag indicating the type of service required, return address, model number, and full serial number.

27. **Other Packaging.** The following general instructions should be used for re-packaging with commercially available materials.

- a. Wrap instrument in heavy paper or plastic. (If shipping to Hewlett-Packard office or service center attach a tag indicating type of service required, return address, model number, and full serial number.)
- b. Use a strong shipping container.
- c. Use enough shock-absorbing material around all sides of instrument to provide firm cushion and prevent movement inside container.
- d. Seal shipping container securely.
- e. Mark shipping container FRAGILE to ensure careful handling.

## 28. OPERATION

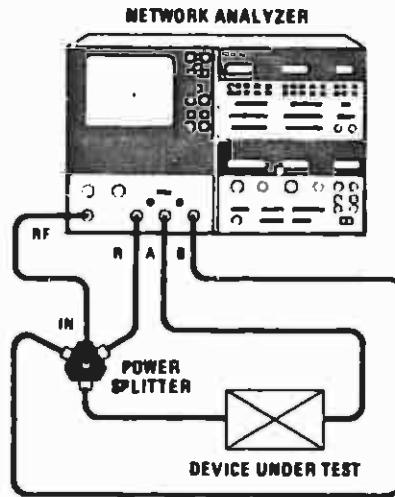
### 29. Environment

30. The following environment should be within the following limits.

- a. Temperature:  $0^{\circ}\text{C}$  to  $+55^{\circ}\text{C}$
- b. Humidity:  $<95\%$  relative
- c. Pressure Altitude:  $<4,572$  metres (15,000 feet)

### 31. Operator's Check

32. The operator's check in Figure 9 consists of performing a measurement on a known component. Successful insertion loss measurement of a known component verifies operation.



**EQUIPMENT:**

Network Analyzer ..... HP 8505A  
 Device Under Test ..... As Selected

**PROCEDURE:**

- a. Connect equipment as shown in test setup above except connect power splitter directly to network analyzer A input without Device Under Test.
- b. Set HP 8505A controls as indicated in Paragraph 37.
- c. Set HP 8505A LINE switch ON. Allow 30 minutes warm-up time.
- d. Adjust HP 8505A CH1 REF LINE POSITION to set reference line at center graticule line on CRT.
- e. Adjust Marker to center screen.
- f. Press CHANNEL 1 MKR then press ZRO on HP 8505A.
- g. Insert Device Under Test in Channel A input line.
- h. Read insertion loss directly on CHANNEL 1 display.

*Figure 9. Operator's Check*

# PERFORMANCE CHECK

### **33. PERFORMANCE TESTS**

34. The HP 11850A Power Splitter is tested against the electrical specifications of Table 1. These Performance Tests include:

- a. Input Return Loss
- b. Equivalent Output Source Match
- c. Magnitude Tracking
- d. Phase Tracking

### **35. Recommended Test Equipment**

36. Equipment required for PERFORMANCE TESTS and Operator's Check is listed in Table 3. Other equipment may be substituted if it meets or exceeds the critical specifications listed in the table.

37. Preliminary HP 8505A Network Analyzer Control Settings.

SOURCE/CONVERTER  
  OUTPUT LEVEL ..... -10  
  OUTPUT LEVEL VERNIER ..... 0  
  INPUT LEVEL ..... -10

FREQUENCY CONTROL  
  RANGE ..... .5 — 1300  
  MODE ..... LIN FULL  
  SCAN TIME ..... .1 — .01  
  TRIGGER ..... AUTO  
  MARKERS ..... 1  
  MARKER 1 ..... Mid-range

SIGNAL PROCESSOR  
  CHANNEL 1  
    INPUT ..... A/R  
    MODE ..... MAG  
    SCALE/DIV ..... 5 dB

  CHANNEL 2  
    MODE ..... OFF

  ELECTRICAL LENGTH  
    MODE ..... OFF

DISPLAY  
  BW ..... 10 kHz  
  VIDEO FILTER ..... Out

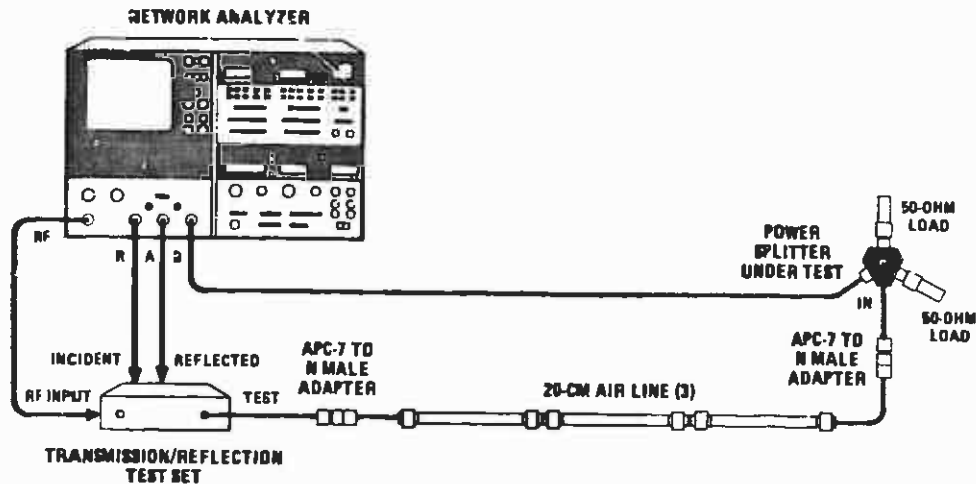
Table 3. Recommended Test Equipment

Instrument	Critical Specifications	Recommended Model
Network Analyzer	Frequency Range: Source: DC to 1.3 GHz Receiver: DC to 1.3 GHz  Resolution: Magnitude: .1 dB/DIV to 5 dB/DIV Phase: 1°/DIV	HP 8505A
Transmission / Reflection Test Set	Frequency Range: DC to 1.3 GHz  Directivity: $\geq 40$ dB	HP 8502A
Power Splitter	Frequency Range: DC to 1.3 GHz  Output SWR: 1.67:1  Connectors: Type N Female	HP 11667A
50 OHM Load (2 required)	Frequency Range: DC to 1.3 GHz Connector: Type N Male	HP 909A, Option 012
Adapter (2 required)	APC-7 to Type N Male	HP 11525A
Adapter	Type N Male to Type N Male	HP 1250-0778
Air Line (3 required)	20-cm long, APC-7 Connectors	HP 11567A
Cable Set	Four RF Cables, Three of Which are of Equal Length and Phase Matched	HP 11851A

**38. INPUT RETURN LOSS TEST**

**SPECIFICATION:**

Port Match: Input Port Match:  $\geq 20$  dB Return Loss ( $\leq 1.22$  SWR)



*Figure 10. Input Return Loss Test Setup*

**EQUIPMENT:**

Network Analyzer .....	HP 8505A
Transmission / Reflection Test Set .....	HP 8502A
20-cm Air Line (3 required) .....	HP 11567A
APC-7 to N Male Adapter (2 required) .....	HP 11525A
50 Ohm Load (2 required) .....	HP 909A, Option 012

**PROCEDURE:**

- a. Connect equipment as shown in Figure 10.
- b. Set HP 8505A controls as indicated in Paragraph 37.
- c. Set HP 8502A RF INPUT ATTENUATION to 0 dB.
- d. Set HP 8505A LINE switch ON. Allow 30 minutes warm-up time.
- e. Adjust HP 8505A CH1 REF LINE POSN for reference line at center graticule line on CRT. Adjust Marker to highest point on CRT display.
- f. Disconnect Air Lines from HP 8502A TEST port output. Press MKR ZRO.
- g. Reconnect Air Lines to HP 8502A TEST port output.
- h. Read HP 11850A Return Loss directly on CHANNEL 1 display.
- i. Return Loss should be  $\geq 20$  dB.

### 39. EQUIVALENT OUTPUT SOURCE MATCH TEST

#### SPECIFICATION:

Port Match: Equivalent Output Source Match (Ratio or Leveling):  
 $\geq 32$  dB Return Loss ( $\leq 1.05$  SWR)

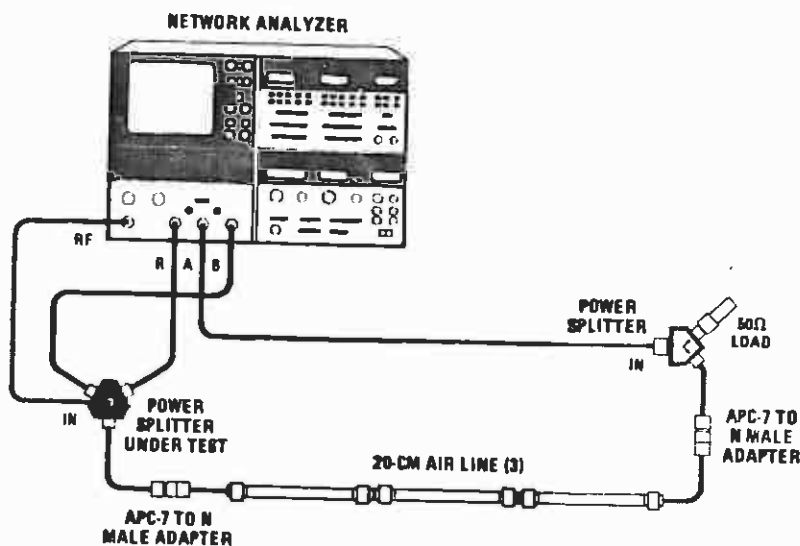


Figure 11. Equivalent Output Source Match Test Setup

#### EQUIPMENT:

Network Analyzer .....	HP 8505A
Power Splitter .....	HP 11667A
20-cm Air Line (3 required) .....	HP 11567A
APC-7 to N Male Adapter (2 required) .....	HP 11525A
50 Ohm Load .....	HP 909A, Option 012

#### PROCEDURE:

- Connect equipment as shown in Figure 11.
- Set HP 8505A controls as indicated in Paragraph 37.
- Set HP 8505A LINE switch ON. Allow 30 minutes warm-up time.
- Adjust HP 8505A CH 1 REF LINE POSN for reference line at center graticule line on CRT.
- Disconnect Air Lines from HP 11850A and connect port of HP 11850A being tested directly to HP 8505A input port A.
- Press HP 8505A CHANNEL 1 MKR then press ZRO. Set SCALE/DIV switch to .1 dB.
- Mark trace on CRT display with grease pencil to establish a reference.
- Disconnect HP 11850A from HP 8505A Port A. Reconnect HP 11667A to HP 8505A Port A and air line to HP 11850A as shown in Figure 11. Press HP 8505A Channel 1 DISPLAY MKR, then ZRO pushbuttons.



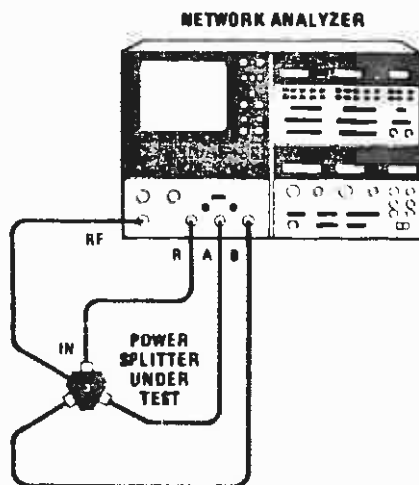
**39. EQUIVALENT OUTPUT SOURCE MATCH TEST (Cont'd)**

- i. The CRT trace should show a ripple display. Choose one cycle of ripple and set the marker first to the low-point, note the Channel 1 digital display, then set the marker to the high-point and note the digital display.
- j. Note the two points on the reference grease pencil trace that correspond to the high and low points noted in step i. If the reference trace is above the center line, subtract it, and if the trace is below the center line, add it to the appropriate high or low point noted in step i.
- k. Difference in display indication at low-point and high point of ripple should be  $\leq 0.104$  dB. This corresponds to  $\leq 1.05$  SWR.
- l. Connect Air Lines to a different output port on the HP 11850A connecting B and R channels to remaining output ports.
- m. Repeat steps d through k.
- n. Connect air lines to remaining output port of HP 11850A to be tested, connecting B and R channels to remaining output ports.
- o. Repeat steps d through k.

**40. MAGNITUDE TRACKING TEST**

**SPECIFICATION:**

Tracking (Between Any Two Output Ports): Magnitude:  $\leq 0.1$  dB



*Figure 12. Magnitude Tracking Test Setup*

**EQUIPMENT:**

Network Analyzer ..... HP 8505A.

**40. MAGNITUDE TRACKING TEST (Cont'd)****PROCEDURE:**

- a. Connect equipment as shown in Figure 12.
- b. Set HP 8505A controls as indicated in Paragraph 37.
- c. Set HP 8505A LINE switch ON. Allow 30 minutes warm-up time.
- d. Adjust CH 1 REF LINE POSN to set reference line at center graticule on CRT.
- e. Press HP 8505A CHANNEL 1 MKR then press ZRO.
- f. Set HP 8505A SCALE /DIV switch to .1 dB.
- g. Mark CRT trace with grease pencil.
- h. Reverse HP 8505A A and R inputs at HP 11850A. Note CRT display indication.
- i. Difference between indications noted in steps f and g is twice the actual tracking error. One-half of this difference should be  $\leq 0.1$  dB.
- j. Repeat steps d through i with HP 8505A A and R inputs connected in all possible HP 11850A output port combinations.

**41. PHASE TRACKING TEST****SPECIFICATION:**

Tracking (Between Any Two Output Ports): Phase:  $\leq 1.5^\circ$

41. PHASE TRACKING TEST (Cont'd)

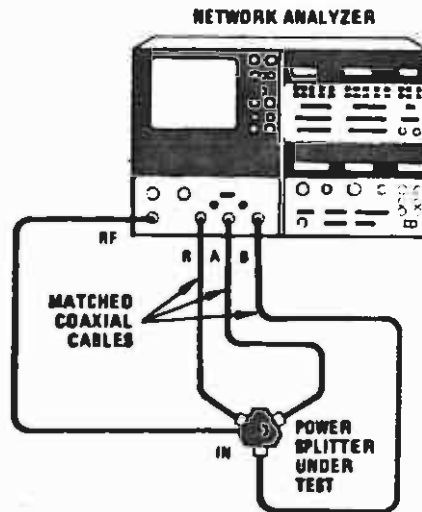


Figure 13. Phase Tracking Test Setup

EQUIPMENT:

Network Analyzer .....	HP 8505A
RF Cable Set .....	HP 11851A

PROCEDURE:

- a. Connect equipment as shown in Figure 13.
- b. Set HP 8505A controls as indicated in Paragraph 37.
- c. Set HP 8505A LINE switch ON. Allow 30 minutes warm-up time.
- d. Set HP 8505A CHANNEL 1 MODE to PHASE and SCALE/DIV to 1 DEG.
- e. Adjust HP 8505A CH1 REF LINE POSN to set reference line at center graticule line on CRT.
- f. Press HP 8505A CHANNEL 1 MKR then press ZRO.
- g. Mark CRT trace with grease pencil.
- h. Reverse HP 8505A A and R inputs at HP 11850A. Note CRT display indication.
- i. Difference between indications noted in steps g and h is twice the actual tracking error. One-half of this difference should be  $\leq 1.5^\circ$ .
- j. Repeat steps e through i with HP 8505A and R inputs connected in all possible HP 11850A output port combinations.

**42. ADJUSTMENTS**

43. The HP 11850A Power Splitter requires no electrical or mechanical adjustments.

**44. SERVICE**

45. **Repair**

46. The HP 11850A Power Splitter is not field repairable, due to critical manufacturing procedures and tooling necessary for repair. Because of this, a replaceable parts listing and any troubleshooting information has been excluded in this manual. Should your HP 11850A require service, contact your nearest Sales and Support Office (addresses and phone numbers are listed in the back of this manual).