HEWLETT PACKARD

OPERATING AND SERVICE MANUAL

DETECTOR

11664B

SERIAL NUMBERS

This manual applies directly to instruments with serial numbers prefixed 1840A.

For additional important information concerning serial numbers, see INSTRUMENTS COVERED BY MANUAL in Section I.

Manual Part No. 11664-90025
Microfiche Part No. 11664-90030

Printed: DECEMBER 1978

CAUTION

Take care when connecting or disconnecting the 11664B. Always ground yourself by touching the system ground before touching the outer shell of the 11664B OR ANY DEVICE CONNECTED TO THE OUTER SHELL. Another method is to wear non-porous gloves. If this is not done, the diode in the 11664B may burn out. Additional operating precautions and instructions are included in Section III of this manual.

SECTION I
GENERAL INFORMATION

1-1. INTRODUCTION

1-2. This manual contains operating and service information for the Hewlett-Packard Model 11664B Detector. The instrument is shown in Figure 1-1.

1-3. Instrument specifications are listed in Table 1-1. These specifications are performance standards or limits against which the instrument may be tested. Table 1-2 lists supplemental characteristics. Supplemental characteristics are not specifications but are typical characteristics included as additional information for the user.

1-4. INSTRUMENTS COVERED BY MANUAL

1-5. This instrument has a two-part serial number. The first four digits and the letter comprise the serial number prefix. The last five digits form the sequential suffix that is unique to each instrument. The contents of this manual apply directly to instruments having the same serial number prefix as listed under SERIAL NUMBERS on the title page.

1-6. An instrument manufactured after the printing of this manual may have a serial prefix that is not listed on the title page. This unlisted serial prefix indicates that the instrument is different from those documented in this manual. The manual for this instrument is supplied with a yellow Manual Changes supplement that contains "change information" that documents the differences.

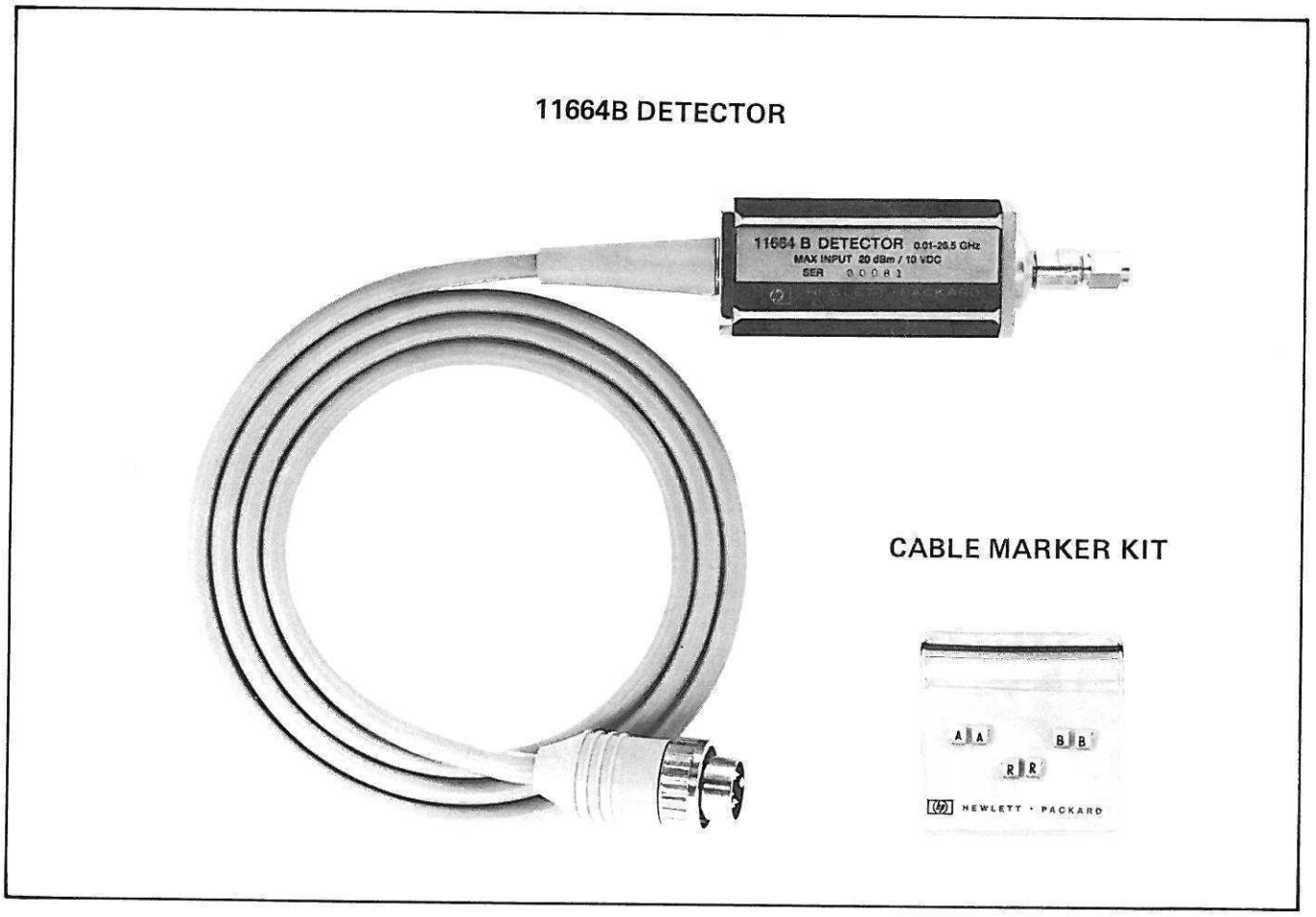


Figure 1-1. HP Model 11664B Detector

Table 1-1. Specifications

SPECIFICATIONS

FREQUENCY

Frequency Range: 10 MHz to 26.5 GHz

REFLECTION

Return Loss:

10 MHz to 40 MHz:	≥10 dB (≤1.92 SWR)
40 MHz to 4 GHz:	≥16 dB (≤1.38 SWR)
4 GHz to 6 GHz:	≥14 dB (≤1.50 SWR)
6 GHz to 12.4 GHz:	≥10 dB (≤1.92 SWR)
12.4 GHz to 26.5 GHz:	≥8.5 dB (≤2.20 SWR)

GENERAL

Temperature Range: Operation, 0 to 55 degrees C; Storage, –40 degrees C to 75 degrees C

Connector: APC-3.5 male

Dimensions: Cable length is 122 cm (48 inches)

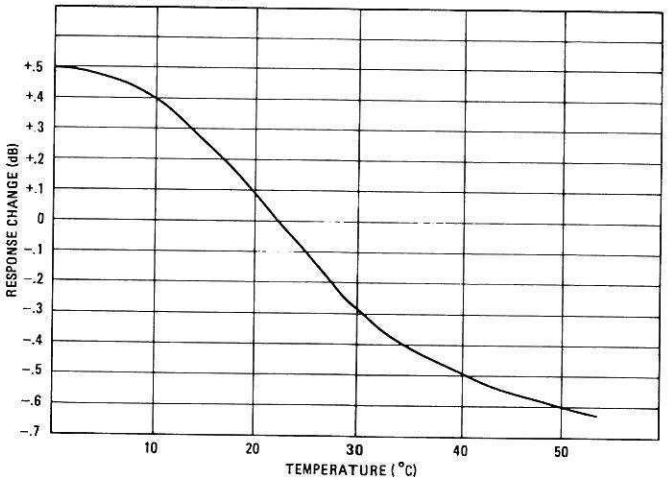
Weight: Net 0.17 kg (6 oz)

Table 1-2. Supplemental Characteristics

SUPPLEMENTAL CHARACTERISTICS

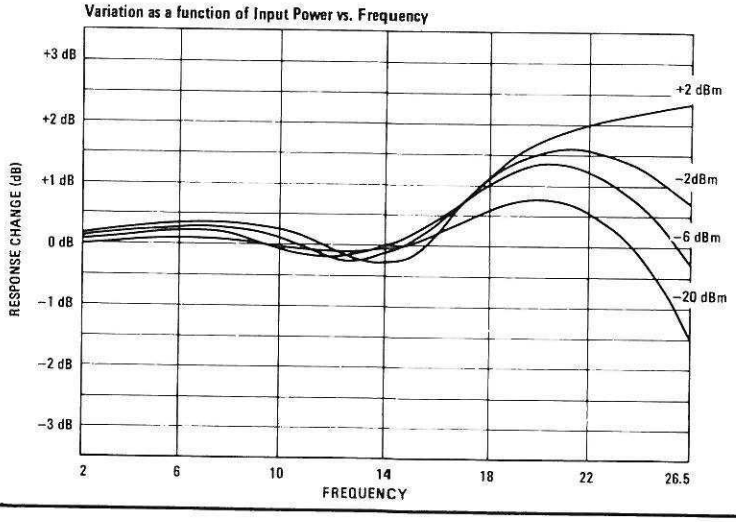
AMPLITUDE RESPONSE

Variation due to Temperature



AMPLITUDE RESPONSE

Variation as a function of Input Power vs. Frequency



GENERAL

Measurement Range:
+10 dBm to –50 dBm

Input Damage Level:
+20 dBm (100 mW) RF power or ±10 VDC

Input Impedance:
50 ohms nominal

Tracking:
Within 5 dB between detectors at all power levels. Within 2 dB at –6 dBm input to detectors.

1-7. In addition to change information, the supplement contains information for correcting errors in the manual. 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 keyed to this manual's print date and part number, both of which appear on the title page. Complimentary copies of the supplement are available from Hewlett-Packard.

1-8. For information concerning a serial number listed in the Manual Changes supplement, contact your nearest Hewlett-Packard office.

1-9. EQUIPMENT SUPPLIED

1-10. The equipment supplied is shown in Figure 1-1. A set of lettered snap-on clips is included. These clips may be used to identify the ends of each of the 11664B Detectors.

1-11. DESCRIPTION

1-12. The Model 11664B Detector is used with the HP Model 8755A/B Swept Amplitude Analyzer. Normally three 11664B Detectors are used with the Model 8755A/B to make reflection and transmission measurements simultaneously. The 11664B Detectors are used in an ac- coupled system in the 8755A/B so that any 11664B may be interchanged with any other 11664B without any necessity of recalibration.

1-13. EQUIPMENT REQUIRED BUT NOT SUPPLIED

1-14. To use the instrument with an HP Model 8755A/B, two or three 11664B Detectors and the following equipment are required:

1. HP Model 8755A/B Swept Amplitude Analyzer
2. HP Model 180-series Oscilloscope mainframe
3. Directional coupler, such as HP Model 778D, 11692D, or K752 series
4. Sweep Oscillator, such as HP Model 8620-series or 8690-series

1-15. Swept Amplitude Analyzer

1-16. The Model 8755A/B Swept Amplitude Analyzer with two or three 11664B Detectors measures amplitude levels of −50 to +10 dBm and amplitude ratios of 60 dB over a frequency range of 0.01 to 26.5 GHz. The Model 8755A/B plugs into the Model 180-series Oscilloscopes. The Model 8755A must be modified if the Model 8750A Storage-Normalizer is to be used. The modification kit is HP Part Number 08755-60027.

1-17. Oscilloscope

1-18. The Model 8755A/B Swept Amplitude Analyzer must be plugged into a Model 180-series Oscilloscope to be useful. The Model 180 acts as a display indicator and power supply for the Model 8755A/B. When modified for use with the HP Model 8750A Storage-Normalizer, the Model 180TR and 182T Oscilloscopes are not compatible with time domain plug-ins. Call your local HP sales office for further information.

1-19. Directional Couplers

1-20. To separate the incident and reflected signals, directional couplers or bridges are usually used with the Model 8755A/B. Either one dual directional coupler or two single directional couplers or bridges connected as a dual directional coupler can be used. The sweep frequency of the measurement is limited by the frequency range of the directional coupler.

1-21. Sweep Oscillator

1-22. Sweep Oscillators are needed to furnish the RF input signal. Either the HP Model 8620-series or Model 8690-series Sweep Oscillators may be used.

1-23. EQUIPMENT AVAILABLE

1-24. The following accessories are available:

Model 11679A: 25-foot Extension Cable
Model 11679B: 200-foot Extension Cable

1-25. RECOMMENDED TEST EQUIPMENT

1-26. Table 1-3 lists recommended test equipment. This equipment is used in performance testing or troubleshooting the Model 11664B. Other equipment may be substituted, provided its specifications equal or exceed the specifications given under Critical Specifications.

Table 1-3. Recommended Test Equipment (1 of 2)

Instrument Type	Critical Specifications	Suggested Model	Use*
Sweep Oscillator	Frequency: 10 MHz to 26.5 GHz	HP Model 8620C mainframe with: 86222A (.01 to 2.4 GHz) 86290A/B (2 to 18 GHz) HP Model 8690B mainframe with: 8696A (18 to 26.5 GHz)	P, T
Leveling Amplifier	Permits HP 432A to level output of HP 8690 plug-ins	HP 8404A	P, T
Power Meter	Compatible with Thermistor Mount	HP 432A	P, T
Thermistor Mount	Frequency: 18 to 26.5 GHz	HP K486A	P, T
Swept Amplitude Analyzer	Provides 27.8 kHz modulation Powers three 11664B Detectors Processes and displays the detected signals	HP 8755A[1]/B	P, T
Storage-Normalizer		HP 8750A	P, T
Dual Directional Coupler	Frequency: 100 MHz to 2 GHz Directivity: >36 dB (.1 - 1 GHz) >32 dB (1 - 2 GHz) Test Port Connector: APC-7	HP 778D Option 011	P, T
Dual Directional Coupler	Frequency: 2 to 18 GHz Directivity: >30 dB (2 - 8 GHz) >26 dB (8 - 18 GHz)	HP 11692D	P, T P, T
Directional Coupler	Frequency: 18 to 26.5 GHz Directivity: >40 dB	HP K752C	P, T
Directional Bridge (2 required)	Frequency: 10 to 100 MHz Directivity: >40 dB	HP 8721A	P, T
Air Line Extension	Reflection Coefficient: <.04 at 18 GHz Length: 20 cm	HP 11567A	P, T
Detectors (2)	Frequency: 10 MHz to 26.5 GHz	HP 11664B	P, T
Power-Splitter	Frequency: 18 to 26.5 GHz	HP Part Number 08747-60012	P, T
Coaxial Short	SMA male	HP Part Number 0960-0055	P, T
Variable Attenuator	Frequency: 18 to 26.5 GHz	HP K382A	P, T
Adapter (2 required)	Waveguide to SMA female Frequency: 18 to 26.5 GHz SWR ≤1.25 (18-26 GHz) ≤1.35 (26-26.5 GHz)	Omni Spectra Part Number 2000-6256-00	P, T
Adapter (2 required)	Type N male to SMA female	HP Part Number 1250-1250	P,T
Adapter	Type N male to BNC female	HP Part Number 1250-0780	P,T

*P=Performance Testing T=Troubleshooting

[1] The 8755A requires modification for use with the 8750A. Order HP Part Number 08755-60027 for the modification kit.

Table 1-3. Recommended Test Equipment (2 of 2)

Instrument Type	Critical Specifications	Suggested Model	Use*
Adapter (3 required)	Type N female to BNC male	HP Part Number 1250-0077	P, T
Adapter	BNC male to BNC male	HP Part Number 1250-0216	P, T
Adapter (3 required)	BNC male to SMA female	Omni Spectra Part Number 21180	P, T
Adapter	APC-7 to SMA female	HP 11534A	P,T
Oscilloscope	Vert. Bandwidth: ≥250 kHz Vert. Sensitivity: >1 mV/cm	HP 182A/1801A/1820C	T
Audio Oscillator	Frequency: 27.8 kHz Output: > 10 mV adjustable	HP 200CD	T
*P=Performance Testing T=Troubleshooting			

SECTION II
INSTALLATION

2-1. INTRODUCTION

2-2. This section contains information concerning initial inspection, preparation for use, mating connectors, and storage and shipment.

2-3. INITIAL INSPECTION

2-4. If the shipping 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 been checked mechanically and electrically. The contents of the shipment should be as shown in Figure 1-1. Procedures for checking electrical performance are given in Section IV. If the contents are incomplete, if there is mechanical damage or defect, or if the instrument does not pass the electrical performance test, notify the carrier as well as the Hewlett-Packard office. Keep the shipping materials for the carrier's inspection. The HP office will arrange for repair or replacement without waiting for claim settlement.

2-5. PREPARATION FOR USE

2-6. Power Requirements

2-7. Power for the Model 11664B Detector is obtained from the Model 8755A/B Swept Amplitude Analyzer. Each Detector requires 0.35 watts. The Model 8755A/B normally powers up to three Detectors requiring a maximum of 1.05 watts.

2-8. Detector Lead Identification

2-9. Lettered snap-on clips are furnished for lead identification. Place matching clips on both ends of the cable.

2-10. Connecting the 11664B Detector

2-11. To connect the 11664B to the 8755A/B, proceed as follows:

a. Insert the 11664B dc connector into the 8755A/B mating connector. The connector is keyed and the plug should be inserted with the key facing downwards.

b. Secure the dc connector in the 8755A/B by turning the outer shell clockwise. This tightens the connector.

c. Before connecting the RF Input connector read paragraphs 3-7 and 3-9 . Do not exceed the torque specifications listed under CAUTION in paragraph 3-7 when tightening the RF Input connector.

2-12. Mating Connectors

2-13. Mating connectors for APC-3.5 connectors are other APC-3.5 connectors. SMA connectors also mate with APC-3.5 connectors. SMA connectors are usable to 18 GHz.

2-14. Operating Environment

2-15. Temperature. The instrument may be operated in temperatures from −25°C to +55°C.

NOTE

See Table 1-2 for response variation due to temperature.

2-16. Humidity. The instrument may be operated in environments with humidity up to 95%. However, the instrument should also be protected from temperature extremes which cause condensation within the 11664B.

2-17. Altitude. The instrument may be operated at altitudes up to 7,620 meters (25,000 feet).

2-18. STORAGE AND SHIPMENT

2-19. Environment

2-20. The instrument may be stored or shipped in environments within the following limits:

Temperature: 0°C to +75°C
Humidity: Up to 95%
Altitude: Up to 7,620 meters (25,000 feet)

The instrument should also be protected from temperature extremes which cause condensation within the instrument.

2-21. Packaging

2-22. 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 servicing, attach a tag indicating the type of service required, return address, model number, and full serial number. Also, mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and full serial number.

2-23. Other Packaging. The following general instructions should be used for re-packaging with commercially available materials:

a. Wrap the instrument in heavy paper or plastic. If shipping to a Hewlett-Packard office or service center, attach a tag indicating the type of service required, return address, model number, and full serial number.

b. Use a strong shipping container. A double-wall carton made of 350-pound test material is adequate.

c. Use enough shock-absorbing material (3- to 4-inch layer) around all sides of the instrument to provide firm cushion and prevent movement inside the container.

d. Seal the shipping container securely.

SECTION III
OPERATION

3-1. INTRODUCTION

3-2. This section contains information concerning operation of the Model 11664B Detector.

3-3. FEATURES

3-4. Features of the Model 11664B are shown in Figure 3-1.

3-5. OPERATOR'S CHECK

3-6. An Operator's Check of the 11664B is included in the Operator's Check for the Model 8755A/B given in the Operating and Service Manual for the Model 8755A/B Swept Amplitude Analyzer.

3-7. OPERATING PRECAUTIONS

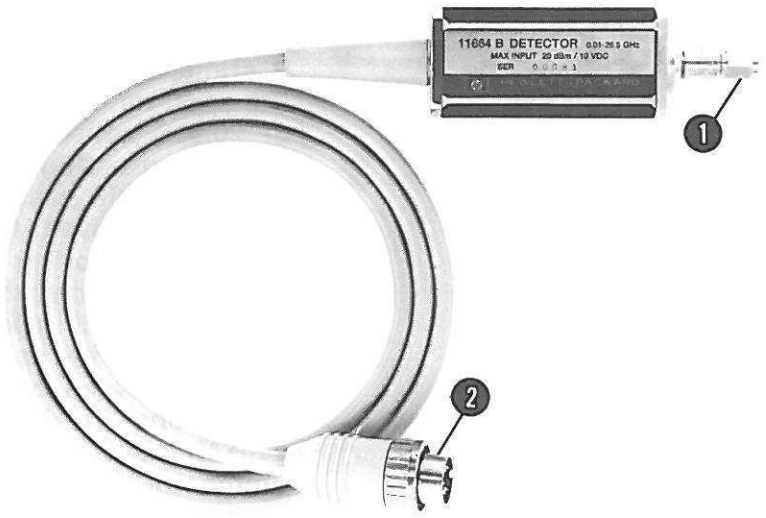
3-8. Tighten the connectors only with the fingers. Do not use a wrench with APC-3.5 connectors, except for permanent installation.

CAUTION

For frequently used connections do not apply more than 0.25 newton-meters (2 inch-pounds) of torque when tightening the connectors. For permanent installation 0.8-1.1 newton-meters (7-10 inch-pounds) is acceptable. Greater torque may deform the mating surfaces.

3-9. OPERATING INSTRUCTIONS

3-10. Operating instructions are given in the Operating and Service Manual for the Model 8755A/B Swept Amplitude Analyzer. A typical measurement setup for use to 18 GHz using the



Note: Numbers shown are keyed to paragraph numbers.

1. **RF Input Connector.** This connector accepts the RF Input signal. The RF Input connector is an APC-3.5 male.

2. **DC Connector.** This connector supplies the necessary dc voltage for operation of the Model 11664B and feeds the detector output signal to the Model 8755A/B.

Figure 3-1. Model 11664B Features

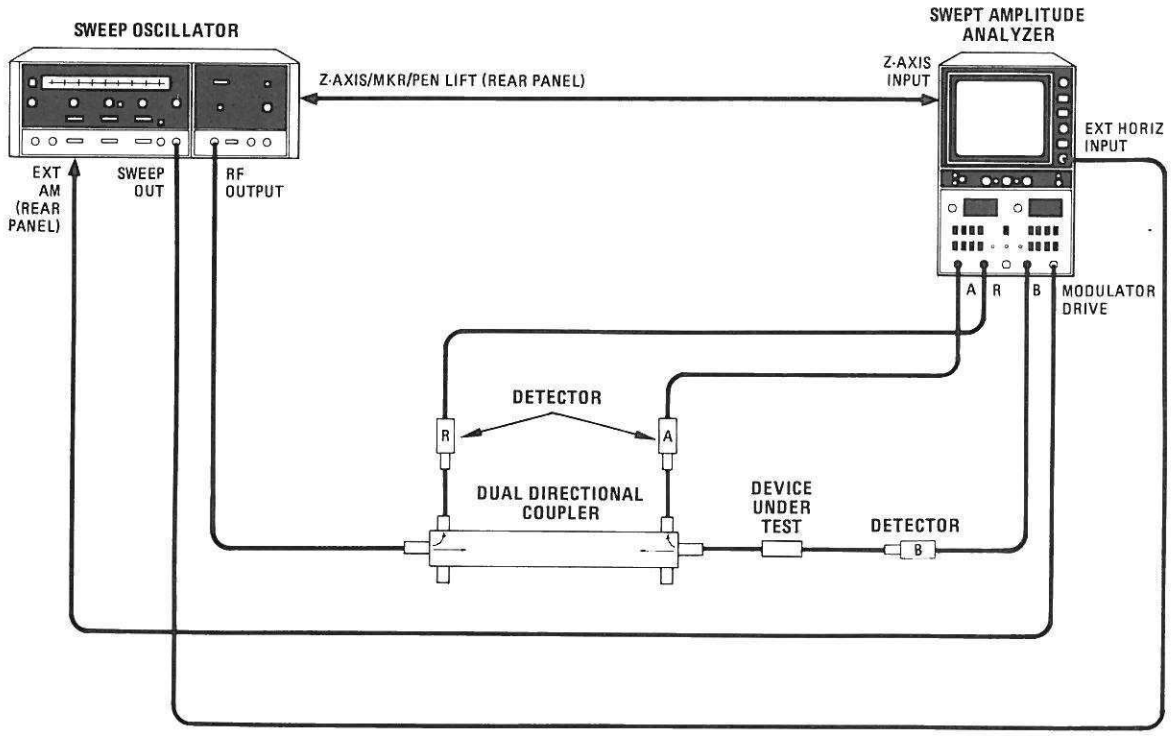


Figure 3-2. Model 8755B Typical Measurement Setup for Frequencies up to 18 GHz

Model 8755A/B is shown in Figure 3-2. For a typical measurement setup for the 18 to 26.5 GHz range, see Figure 4-3 in the Performance Tests section of this manual. Be sure to read all the following cautions before operating the 8755A/B/11664B system.

CAUTION

Do not apply more than +20 dBm RF CW power or more than ±10 volts dc into the 11664B. If more than this power or voltage is applied, the 11664B may be damaged.

If connecting a cable, always discharge cable center conductor static electricity to instrument ground before connecting RF connector. Static electricity stored in cables can easily burn out the diode.

Do not drop the 11664B or subject it to mechanical shock. The diode can be damaged easily.

Take care when connecting or disconnecting the 11664B. Always ground yourself by touching the system ground before touching the outer shell of the 11664B OR ANY DEVICE CONNECTED TO THE OUTER SHELL. Another method is to wear non-porous gloves. If this is not done, the diode in the 11664B may burn out.

If static discharges are noticed by the operator, they indicate a voltage of 20,000 volts or more, which is more than enough to burn out the diode. In this case, some thought should be given to reducing the hazard by removing carpeting, wearing clothing other than nylon, or by adding a shunting path to ground on the 11664B. This consists of a piece of wire soldered to a ground lug held under one of the screws in the 11664B case, nearest the RF input connector. Another method, used here at Hewlett- Packard, is to have the operator wear a light, removable, copper bracelet to ground any static electricity on the body. The bracelet is permanently grounded to the system ground. This has been found to be the surest method of protecting the 11664B, since it does not depend on the operator grounding himself.

SECTION IV
PERFORMANCE TESTS

4-1. INTRODUCTION

4-2. The procedures in this section test the instrument's electrical performance using the specifications of Table 1-1 as the performance standards. All tests can be performed without access to the interior of the instrument.

4-3. EQUIPMENT REQUIRED

4-4. Equipment required for the performance tests is listed in the Table 1-3. Any equipment that satisfies the critical specifications given in the table may be substituted for the recommended model.

4-5. TEST RECORD

4-6. Results of the performance tests may be tabulated on the Test Record at the end of the procedures. The Test Record lists all of the tested specifications and their acceptable limits. Test results recorded at incoming inspection can be used for comparison in periodic maintenance and troubleshooting and after repair.

PERFORMANCE TESTS

4-7. RETURN LOSS

SPECIFICATIONS:

Return Loss:

10 MHz to 40 MHz:	$\geq$10 dB ($\leq$1.92 SWR)
40 MHz to 4 GHz:	$\geq$16 dB ($\leq$1.38 SWR)
4 GHz to 6 GHz:	$\geq$14 dB ($\leq$1.50 SWR)
6 GHz to 12.4 GHz:	$\geq$10 dB ($\leq$1.92 SWR)
12.4 GHz to 26.5 GHz:	$\geq$8.5 dB ($\leq$2.20 SWR)

DESCRIPTION: For return loss measurements to 18 GHz, two 11664A/B Detectors are used with an 8755A/B Swept Amplitude Analyzer and a dual directional coupler or two directional bridges in a reflectometer test setup. The reflectometer is calibrated using a short. The 11664B Detector is connected and the return loss measured.

From 18 to 26.5 GHz, return loss is measured by RF substitution using a K382A Variable Attenuator as the reference standard in a leveled waveguide system.

4-7. RETURN LOSS (cont'd)

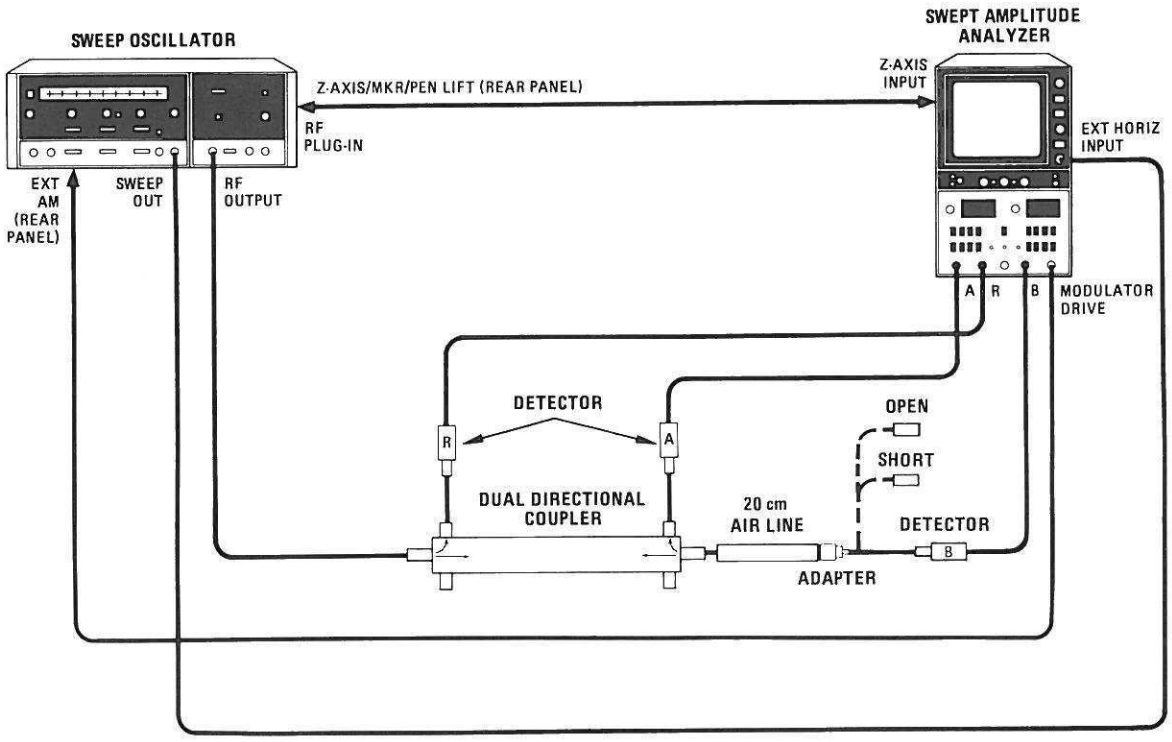


Figure 4-1. Return Loss Test Setup for Measurement to 18 GHz

Return Loss Measurement from 10 MHz to 18 GHz

EQUIPMENT

Sweep Oscillator	HP Model 8620C
RF Plug-in (0.01 to 2.4 GHz)	HP 86222A
RF Plug-in (2 to 18 GHz)	HP 86290A/B
Directional Bridge (2 required)	HP 8721A (10 to 100 MHz)
Dual Directional Coupler[1]	HP 778D Option 011 (100 MHz to 2 GHz)
Dual Directional Coupler[1]	HP 11692D (2 to 18 GHz)
Detectors (2 required)	HP 11664B[2]
Swept Amplitude Analyzer/Oscilloscope	HP 8755A/B/182T
Coaxial Short	HP Part Number 0960-0055(SMA male)
Air Line (20 cm)	HP 11567A
Adapter APC-7 to SMA female	HP 11534A

[1]Two single directional couplers connected as a dual directional coupler can also be used.

[2]Two HP 11664A Detectors can be used.

PERFORMANCE TESTS

4-7. RETURN LOSS (cont'd)

PROCEDURE

1. Connect the equipment as shown in Figure 4-1 with the short connected. For measurements below 100 MHz two directional bridges connected as a dual directional coupler are used. For measurements above 2 GHz a 20 cm air line is connected between the test port of the directional coupler and the 11664B Detector under test.

NOTE

Several front panel control names vary between the 8755A and the 8755B. The procedures are written for the 8755B. The differences are noted below.

8755B	8755A
CHANNEL 1	CHANNEL A
REFERENCE LEVEL dB	OFFSET dB
REFERENCE LEVEL VERNIER	OFFSET CAL
VIDEO FILTER	SMOOTHING
REFERENCE POSITION	POSITION

2. Set the 8755B CHANNEL 1 REFERENCE LEVEL dB control to 0 dB.
3. Set CHANNEL 1 REFERENCE LEVEL VERNIER switch to OFF.
4. Press CHANNEL 1 REFERENCE POSITION pushbutton.
5. Adjust CHANNEL 1 screwdriver adjustment marked REFERENCE POSITION to place trace on the center graticule.
6. Place short on reflectometer.
7. Press CHANNEL 1 pushbuttons marked DISPLAY R and 10 dB/DIV.
8. Set the Sweep Oscillator to sweep the band of interest.
9. Adjust the Sweep Oscillator output power level to place the trace on the second graticule below the center graticule. (Power input is −20 dBm to the R detector.)
10. Press CHANNEL 1 pushbutton marked DISPLAY A/R.
11. Turn CHANNEL 1 REFERENCE LEVEL VERNIER to ON and adjust the REFERENCE LEVEL VERNIER to place the trace on the first graticule below the top of the display. See Figure 4-2.

4-7. RETURN LOSS (Cont'd.)

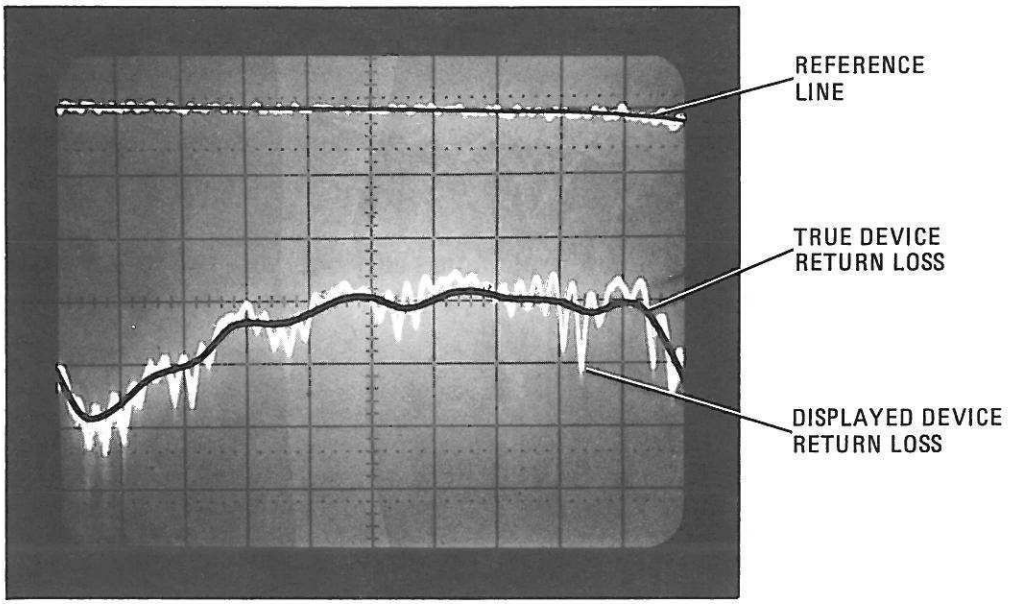


Figure 4-2. Return Loss Measurement Using Air Line Technique

12. Increase the dB/DIV resolution to 5 dB/DIV. If necessary, adjust the REFERENCE LEVEL VERNIER to return the trace to the first graticule below the top of the display.

PROCEDURE FOR DETERMINING REFERENCE LINE FOR 10 MHz TO 2 GHz.

13. With a black grease pencil, draw the trace onto the CRT.

14. Disconnect the short from the directional coupler test port.

15. With a black grease pencil, draw the additional trace caused by the open onto the CRT.

16. The reference line is the average of the black grease penciled traces caused by the open and short. Draw the reference line on the CRT using a red grease pencil. Continue the return loss measurement at step 22.

PROCEDURE FOR DETERMINING REFERENCE LINE FOR 2 GHz TO 18 GHz

17. Connect 20cm air line to directional coupler test port.

PERFORMANCE TESTS

4-7. RETURN LOSS (Cont'd.)

18. Connect APC-7 to SMA female adapter to end of 20 cm air line.

19. Connect SMA short to adatper.

20. Repeat steps 7 thru 12 before doing next step.

21. The reference line is the average of the ripples on the trace. (See Figure 4-2.) With a black grease pencil, draw the reference line on the CRT display. The 20cm air line allows the open-short reference line to be determined without actually using an open. Every quarter wavelength on a transmission line a short is transformed into an open.

22. Connect the 11664B under test to the reflectometer test port.

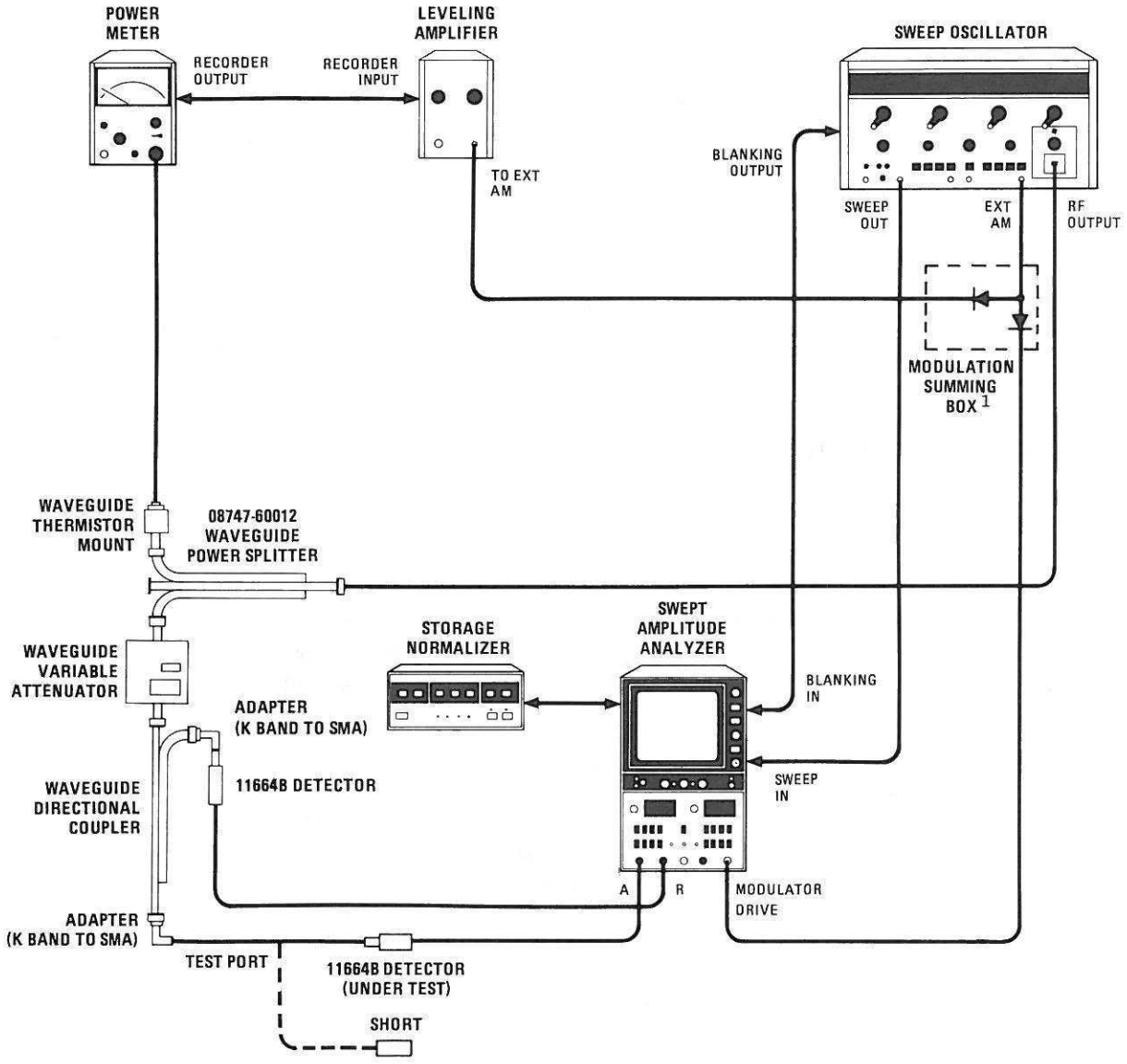
23. Read the return loss. Return loss is the difference between the reference line and the response of the detector under test. For frequencies above 2 GHz when the 20 cm air line is used, a ripple results in the device response. The true response is the average of the ripples. See Figure 4-2.

24. Provided that the test equipment meets the critical specifications listed in Table 1-3, the return loss should be equal to or greater than the following limits:

Frequency	Specification	Measurement Uncertainty
10 to 40 MHz	≥10 dB	±0.9 dB
40 to 100 MHz	≥16 dB	±1.6 dB
0.1 to 1 GHz	≥16 dB	±0.8 dB
1 to 2 GHz	≥16 dB	±1.1 dB
2 to 4 GHz	≥16 dB	±1.5 dB
4 to 6 GHz	≥14 dB	±1.2 dB
6 to 12.4 GHz	≥10 dB	±1.3 dB
12.4 to 18 GHz	≥8.5 dB	±1.25 dB

The measurement uncertainty includes the effects of error due to coupler directivity, adapter mismatches and transmission loss of the 20 cm air line.

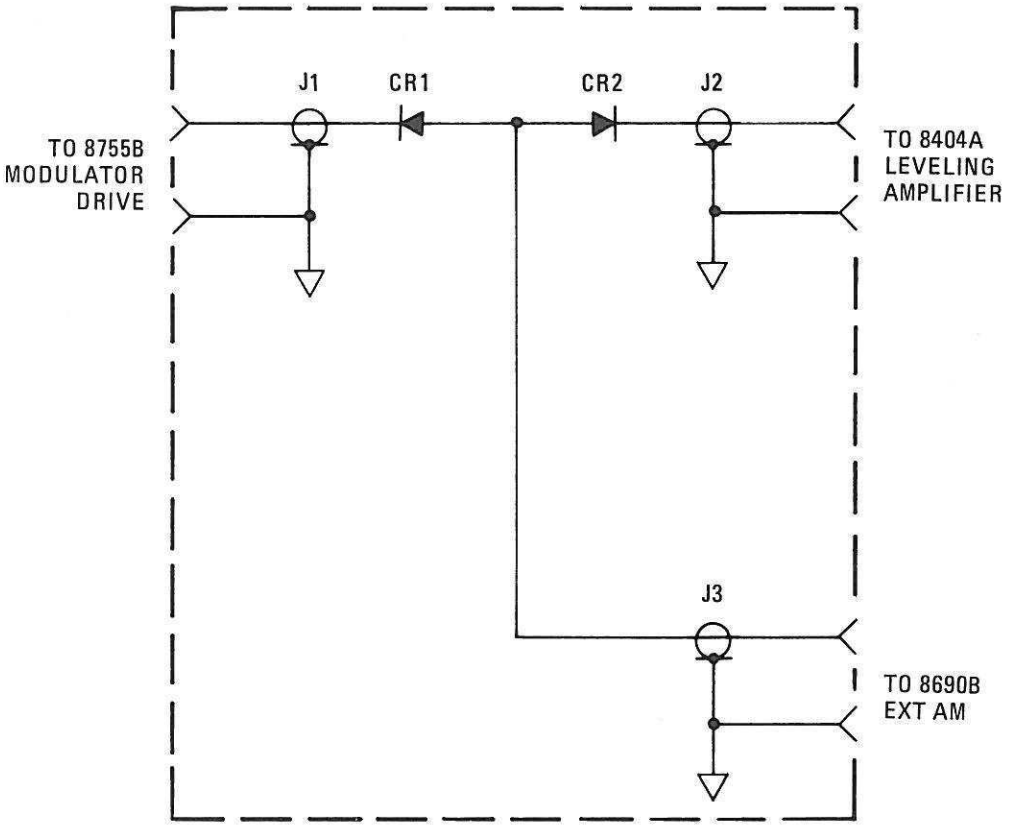
25. If the return loss appears to not meet the specifications but is within the measurement uncertainty range, a vector impedance measurement with error correction must be made. At Hewlett-Packard this is accomplished by using either the HP 8507B or the HP 8409A Automatic Network Analyzers. Further information is available in the HP 85030B Applications Pac and Application Note 221.



[1]See Figure 4-4 for details

Figure 4-3. Return Loss Test Setup for Measurements from 18 to 26.5 GHz

MODULATION SUMMING BOX



Reference Designator	HP Part Number	C D	Description	Mfr Part Number
CR1	1901-0518	8	DIODE-SCHOTTKY	1901-0518
CR2	1901-0518	8	DIODE-SCHOTTKY	1901-0518
J1			P/O SHIELDED BOX	
J2			P/O SHIELDED BOX	
J3			P/O SHIELDED BOX	
MP1			SHIELDED BOX	POMONA ELECTRONICS[1] MODEL 3239

[1] Pomona Electronics, 1500 E. Ninth St., Pomona, CA, 91766

Figure 4-4. Modulation Summing Box

4-7. RETURN LOSS (Cont'd.)

Return Loss Measurement from 18 to 26.5 GHz

EQUIPMENT

Sweep Oscillator	HP 8690B
RF Plug-in 18 to 26.5 GHz	HP 8696A
Leveling Amplifier	HP 8404A
Power Meter/Thermistor Mount	HP 432A/K486A
Directional Coupler	HP K752C
Power Splitter	HP Part Number 08747-60012
Adapter (Waveguide to SMA)(2 required)	Omni Spectra Part Number 2000-6256-00
Detector	HP 11664B
Swept Amplitude Analyzer/Oscilloscope	HP 8755B/182T*
Storage-Normalizer	HP 8750A
Variable Attenuator	HP K382A
Coaxial Short (SMA male)	HP Part Number 0960-0055

PROCEDURE

1. Connect equipment as shown in Figure 4-3 with an 11664B connected to Test Port. Then allow 1 hour warm-up time.

2. Set Instrument controls as follows:

8690B/8696A:	START/CW:	full counterclockwise (approximately 18 GHz)
	STOP/ΔF:	full clockwise (approximately 26.5 GHz)
	Sweep Selector:	AUTO
	Function:	START/STOP
	EXT AM:	On
	Sweep Time:	approximately 2 seconds
	RF power level:	full clockwise
	LINE:	STANDBY
8404A:	GAIN:	full counterclockwise
	POWER LEVEL:	full counterclockwise
	VERNIER:	mid range
K382A Attenuator:	0 dB	
8750A:	CH 1 BYPASS	
8755B: CHANNEL 1		
	REFERENCE LEVEL:	0 dB
	VERNIER:	Off
	DISPLAY A,	5DB/DIV
	VIDEO FILTER:	On

*An 8755A can be used if it has been modified for use with the 8750A. See Table 1-3 for modification information. Refer to note on page 4-3 for information on differences in front panel control names between the 8755B and the 8755A.

PERFORMANCE TESTS

4-7. RETURN LOSS (Cont'd.)

POWER LEVELING ADJUSTMENTS

3. Zero the 432A Power Meter.

4. Set the 432A to the +5 dBm RANGE.

5. Turn LINE switch on the 8690B to RF position.

6. Adjust 8404A Leveling Amplifier GAIN control as far clockwise as possible to minimize the ripple on the trace displayed on the 8755B while causing no oscillations. Trace should be approximately flat.

7. Adjust 8404A POWER LEVEL control for a reading of 0 dBm on the Power Meter. This corresponds to −5 on the dBm scale.

8. On 8755B press pushbutton for 1 dB/DIV and turn CHANNEL 1 REFERENCE LEVEL VERNIER on. Adjust REFERENCE LEVEL VERNIER to place trace near center of display. If necessary, re-adjust Leveling Amplifier GAIN control as far clockwise as possible to minimize ripple on the trace while causing no oscillations.

RETURN LOSS MEASUREMENT

9. Set K382A Variable Attenuator to 30 dB. This is the reference setting. (Trace is not on display.)

10. Connect SMA short to Test Port.

11. On 8755B press pushbutton for CHANNEL 1 DISPLAY R and set the CHANNEL 1 REFERENCE LEVEL thumbwheel switches to −32 dB. Adjust CHANNEL 1 REFERENCE LEVEL VERNIER control to place trace near center graticule.

12. On 8750A Storage-Normalizer press the STORE INPUT pushbutton. After STORE INPUT LED turns off, press INPUT-MEM pushbutton. The trace is a straight line.

13. Place the trace on the center graticule with the REFERENCE LEVEL VERNIER, if necessary.

14. Disconnect the short.

15. Reconnect the 11664B Detector to the Test Port.

16. Rotate Variable Attenuator knob to place peak of trace on center graticule. (Variable Attenuator setting is approximately 21 dB.)

17. Return loss is the difference between the reference setting in step 9 and the reading in step 16.

NOTE

Average input power to the 11664B Detector must be from −20 to −23 dBm during the Performance Test. Input power to the Detector is the difference between the present Power Meter reading and the Variable Attenuator setting in step 16. This may require that the Variable Attenuator setting in step 9 be changed so that the input power to the Detector is within these limits. If this is necessary, repeat steps 9 thru 17.

PERFORMANCE TESTS

4-7. RETURN LOSS (Cont'd.)

18. Provided that the test equipment meets the critical specifications listed in Table 1-3, the return loss should be equal to or greater than the following limits:

Frequency	Specification	Measurement Uncertainty
18 to 26 GHz	≥8.5 dB	±0.8 dB
26 to 26.5 GHz	≥8.5 dB	±1.0 dB

The measurement uncertainty includes the effects of error due to coupler directivity and mismatch of the waveguide to SMA adapters.

19. If the measured return loss appears to not meet the specifications but is within the measurement uncertainty range, a vector impedance measurement with error correction will have to be made.

Table 4-1. Performance Test Record

Hewlett-Packard Model 11664B Detector

Tested by _____

Serial No. _____

Date _____

Paragraph Number	Test		Min.*	Actual	Max.
4-7.	Return Loss	(10 to 40 MHz)	10 dB	_____	
		(40 MHz to 4 GHz)	16 dB	_____	
		(4 to 6 GHz)	14 dB	_____	
		(6 to 12.4 GHz)	10 dB	_____	
		(12.4 to 26.5 GHz)	8.5	_____	

*Does not include tolerances due to directional coupler directivity error and adapter mismatch uncertainty.

SECTION V
ADJUSTMENTS

5-1. The Hewlett-Packard Model 11664B Detector has no adjustments or factory selected components.

SECTION VI
REPLACEABLE PARTS

6-1. INTRODUCTION

6-2. This section contains information for ordering parts. Table 6-1 lists abbreviations used in the parts list and throughout the manual. Table 6-2 lists all replaceable parts in reference designator order. Figure 6-1 contains an illustration and parts listing for the mechanical parts found in the instrument. Table 6-3 gives all the manufacturer's code numbers that are used in the parts list.

6-3. REPLACEABLE PARTS LIST

6-4. Table 6-2 is the list of replaceable parts and is organized by listing electrical assemblies and their components in alpha-numerical order by reference designation.

The information given for each part consists of the following:

a. The Hewlett-Packard part number.

b. The check digit.

c. The total quantity (Qty) in the instrument.

d. The description of the part.

e. The typical manufacturer of the part in a five-digit code.

f. Manufacturer code number for the part.

The total quantity for each part is given only once — at the first appearance of the part number in the list.

6-5. ORDERING INSTRUCTIONS

6-6. To order a part listed in the replaceable parts table, quote the Hewlett-Packard part number and check digit, indicate quantity required, and address the order to the nearest Hewlett-Packard office.

6-7. 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.

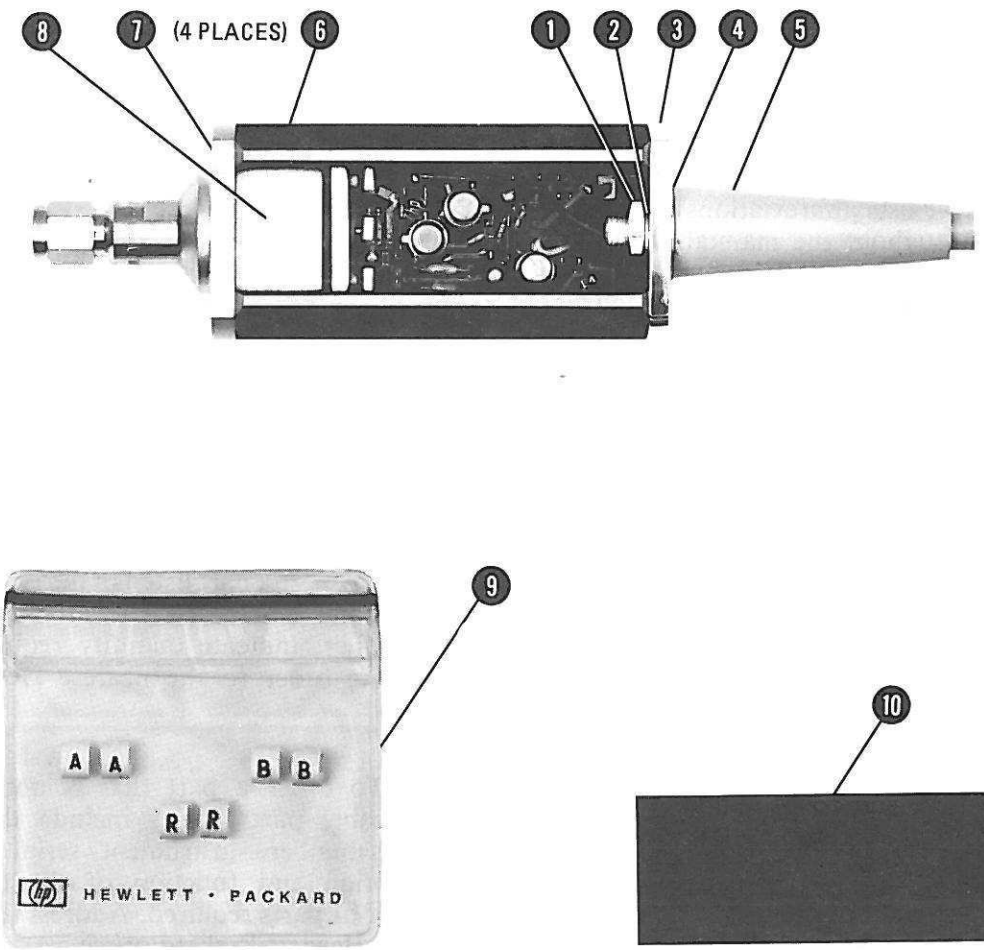
Table 6-1. Reference Designators and Abbreviations Used in Manual

REFERENCE DESIGNATORS

A	assembly	CR	diode	P	plug	R	resistor
C	capacitor	J	jack	Q	transistor	W	cable

ABBREVIATIONS

ASSY	assembly	G	giga = 10^9	MET FLM	metal film	SI	silicon
CER	ceramic	H	henries	MFR	manufacturer	TANT	tantalum
F	farads	K	kilo = 10^3	MHz	mega Hertz	VDCW	dc working volts
FLM	film	m	milli = 10^{-3}	P	pico = 10^{-9}	W	watts
FXD	fixed	M	meg = 10^6				



Item	HP Part Number	CD	Qty	Description	Mfr Code	Mfr Part Number
1	2950-0001	8	1	NUT-HEX-DOUBLE CHAMFER	28480	2950-0001
2	2190-0016	3	1	WASHER-LOCK INTERNAL TOOTH 3/8 IN .377-IN-ID	28480	2190-0016
3	11664-20004	7	1	END PLATE	28480	11664-20004
4				WASHER, P/O W1		
5	8120-1788	7	1	CABLE ASSEMBLY W1 (INCLUDES P1)	28480	8120-1788
6	11664-20005	8	1	DETECTOR HOUSING	28480	11664-20005
7	2200-0164	5	4	SCREW-MACHINE 4-40 .188-IN-LONG 82 DEGREE	28480	2200-0164
8	11664-60013	2	1	A2 RF INPUT ASSEMBLY (INCLUDES RF INPUT CONNECTOR)	28480	11664-60013
9	5061-1044	9	1	CABLE MARKER KIT	28480	5061-1044
10	11664-00001	2	1	BOTTOM COVER	28480	11664-00001

Figure 6-1 Replaceable Parts

Table 6-2. Replaceable Parts

Reference Designation	HP Part Number	C D	Qty.	Description	Mfr. Code	Mfr. Part Number
A1	11664-60001	8	1	BOARD ASSEMBLY: PREAMPLIFIER	28480	11664-60001
A1C1	0160-3878	6	1	CAPACITOR — FXD 1000 PF + −20% 100 VDC CER	28480	0160-3878
A1C2	0180-2492	6	1	CAPACITOR — FXD 2.7 UF + −10% 20 VDC TA	28480	0180-2492
A1C3	0180-2492	0		CAPACITOR - FXD 2.7 UF + −10% 20 VDC TA	28480	0180-2492
A2CR1	1901-0025	2	2	DIODE - GENERAL PURPOSE 100V 200 MA DO-7	28480	1901-0025
A1CR2	1901-0025	2		DIODE - GENERAL PURPOSE 100 V 200 MA DO-7	28480	1901-0025
A1J1	0363-0070	4	3	CONTACT- ELECTRICAL BE CU: DIM (IN): .125	28480	0363-0070
A1Q1	1854-0019	3	1	TRANSISTOR NPN SI TO-I8 PD + 360 MW	28480	1854-0019
A1Q2	1853-0007	7	2	TRANSISTOR PNP 2N3251 SI	02037	2N3251
A1Q3	1854-0071	7	1	TRANSISTOR NPN SI PD = 300 MW FT = 200 MHZ	28480	1854-0071
A2Q4	1853-0007	7		TRANSISTOR PNP 2N3251 SI TO-18 PD = 360 MW	02037	2N3251
A1R1	0698-7249	2	1	RESISTOR 3.48 K 1% .05 W F TC = 0 + - 100	03292	C3-1/8-TO-3481-G
A1R2	0698-7279	8	1	RESISTOR 61.9K 1% .05W F TC = 0 + - 100	03292	C3-1/8-TO-6192-G
A1R3	0698-8273	4	1	RESISTOR 133 .5% .05W F TC = 0 + - 100	02995	MF3C-1/20-133R-D
A1R4	0698-7236	7	1	RESISTOR 1K 1% .5W F TC = 0 + - 100	03292	C3-1/8-TO-1001-G
A1R5	0698-7238	9	1	RESISTOR 1.21K 1% .05W F TC = 0 + - 100	03292	C3-1/8-TO-1211-G
A1R6	0698-8274	5	1	RESISTOR 348 .5% .05W F TC = 0 + - 100	02995	MF3C 1/20 - 348R-D
A1R7	0698-7205	0	2	RESISTOR 51.1 1% .05W F TC = 0 + - 100	03292	C3-1/8-TO-51R1-G
A1R8	0698-7205	0		RESISTOR 51.1 1% .05W F TC = 0 + - 100	03292	C3-1/8-TO-51R1-G
A2	11664-60013	2	1	RF INPUT ASSEMBLY (INCLUDES RF INPUT CONNECTOR)	28480	11664-60013

See introduction to this section for ordering information

Table 6-3. Manufacturers Code List

MFR. NO.	MANUFACTURER NAME	ADDRESS		ZIP CODE
28480	HEWLETT-PACKARD CO. CORPORATE HQ	PALO ALTO	CA	94304
02037	MOTOROLA SEMICONDUCTOR PRODUCTS	PHOENIX	AZ	85036
02l995	MEPCO/ELECTRA CORP	MINERAL WELLS	TX	76067
03292	CORNING GLASS WORKS (BRADFORD)	BRADFORD	PA	16701

SECTION VII
MANUAL BACKDATING 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 11664B Detector, 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 the 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.

SECTION VIII
SERVICE

8-1. INTRODUCTION

8-2. This section contains troubleshooting and repair information. The general organization of this section is:

a. text covering repair procedures.

b. a troubleshooting flowgraph to find troubles.

c. a Service Sheet containing parts identification, principles of operation, and a schematic diagram.

8-3. PRINCIPLES OF OPERATION

8-4. A circuit description keyed to the schematic diagram is given opposite the schematic. This is helpful in understanding each major circuit function.

8-5. TROUBLESHOOTING

8-6. Troubleshooting is presented in easy to follow, block-style flowgraph diagrams. The first step in troubleshooting is to refer to TROUBLESHOOTING PROCEDURES. Here the trouble will first be isolated to a particular 11664B in the test setup. Then trouble is further isolated to the RF Input Assembly or the Preamplifier section of the 11664B. The trouble is then further isolated to the individual component. If special repair procedures are needed for replacing the individual component, these will be found under REPAIR.

8-7. RECOMMENDED TEST EQUIPMENT

8-8. Equipment recommended to test and maintain the instrument is listed in Table 1-3.

8-9. REPAIR

8-10. This section gives detailed step-by-step repair procedures for some individual components where special care is necessary. Figure 8-1 shows the major assemblies.

8-11. Printed Circuit Board And Cable Assembly Removal

8-12. To remove the printed circuit board assembly or the cable assembly, proceed as follows:

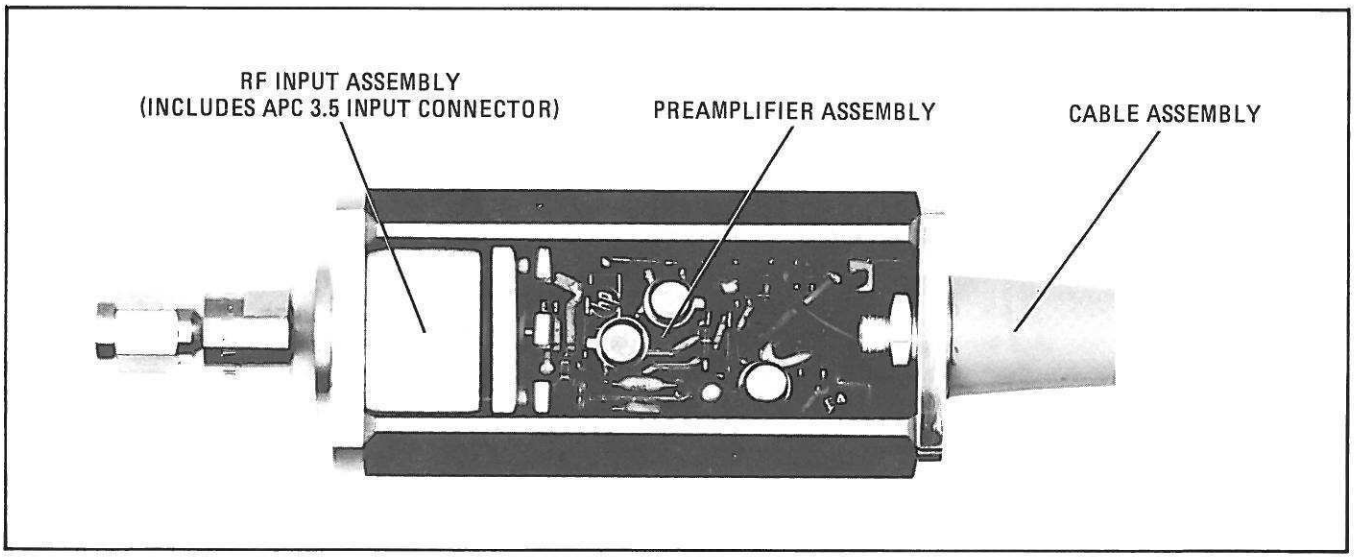


Figure 8-1 Major Assemblies

a. Remove the two posi-drive screws on the cable end of the 11664B.

b. Slide the assembly out of the housing by carefully pulling on the cable. The bottom cover of the 11664B may also be removed if desired.

8-13. Soldering Cable Leads

8-14. When unsoldering or soldering cable leads to the printed circuit board use extreme care so that plastic insulation on cable wires is not damaged. Always use a heat sink, such as a pair of long-nosed pliers, between the insulation and connection. Always use the minimum amount of heat necessary to make the connection. The connections are:

a. Shield wire to Ground (near E2)

b. Violet wire to E4

c. Red wire to E2

d. White wire to E3.

8-15. Installing the Printed Circuit Board

8-16. When installing the printed circuit board assembly into the 11664B, check that all cable wires are connected to the board just before tightening the cable end of the 11664B. These wires are delicate and should be checked each time the 11664B is reassembled. Refer to Figure 8-2.

8-17. Soldering to Etched Circuit Boards

8-18. The etched circuit board in the Detector is of the plated-through type consisting of metallic conductors bonded to both sides of the insulating material. The metallic conductors are extended through the component mounting holes by a plating process. Soldering can be done from either side of the board with equally good results. Following are recommendations and precautions pertinent to etched circuit repair work:

a. Avoid unnecessary component substitution. It can result in damage to the circuit board and/or adjacent components.

b. Do not use a high-wattage soldering iron on etched circuit boards. Excessive heat may lift a conductor or damage the board.

c. Use a suction device or wooden toothpick to remove solder from component mounting holes. DO NOT USE A SHARP METAL OBJECT SUCH AS AN AWL OR TWIST DRILL FOR THIS PURPOSE. SHARP OBJECTS MAY DAMAGE THE PLATED-THROUGH CONDUCTOR.

d. After soldering, remove excess flux from the soldered areas and apply a protective coating, such as Krylon No. 1302, to prevent contamination and corrosion.

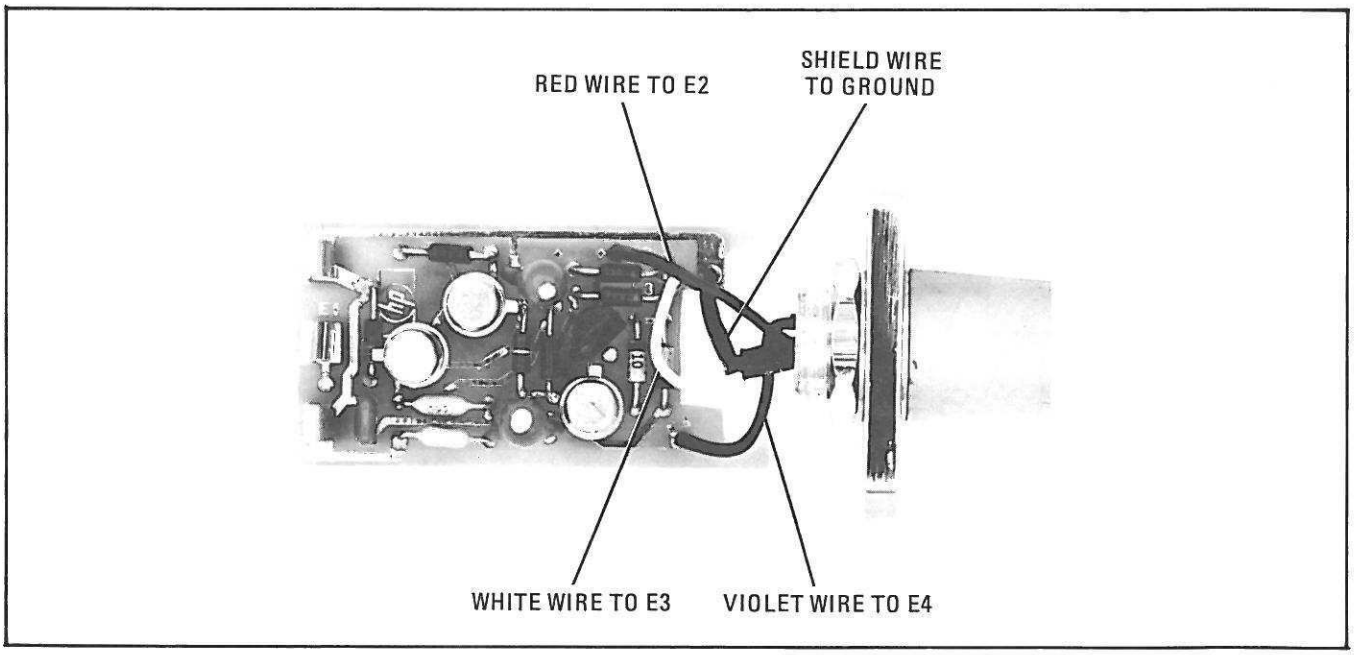


Figure 8-2. Cable Connections

8-19. Component Replacement

8-20. To replace a defective component, proceed as follows:

a. Remove defective component from circuit board.

b. Remove solder from mounting holes using a suction desoldering aid or wooden toothpick.

c. Shape leads of replacement component to match mounting hole spacing.

d. Insert component leads into mounting holes, and position component as original was positioned. DO NOT FORCE LEADS OF REPLACEMENT COMPONENT INTO MOUNTING HOLES. Sharp lead ends may damage plated-through conductor.

8-21. Transistor Replacement

8-22. In addition to the above precautions, observe the following when replacing a transistor:

a. Do not apply excessive heat.

b. Use a heat sink, such as long-nosed pliers, between transistor body and hot soldering iron.

c. When installing a replacement transistor, ensure sufficient lead length to dissipate heat of soldering by maintaining about the same length of exposed lead as used for the original transistor.

8-23. Removal of RF Input Assembly

8-24. The RF Input Assembly can be replaced as follows:

a. Remove the two screws on the RF Input end of the 11664B using a posi-drive screwdriver. Remove the assembly by pulling on the RF input connector.

CAUTION

Do not remove the two gold-plated screws from the rear of the RF Input Assembly. The RF Input Assembly contains no field replaceable parts.

If the APC-3.5 connector or the Hot Carrier Diode is damaged, the RF Input Assembly must be replaced.

8-25. Installation of RF Input Assembly

8-26. Insert RF Input Assembly into the end of the 11664B. Insert and tighten the two pozi-drive screws to secure it to the 11664B.

8-27. Transistor Lead Identification

8-28. The emitter lead of each transistor in the 11664B is marked with an E printed on the circuit board. Looking at the bottom of the transistor, the leads are emitter-base-collector reading clockwise from the emitter. Reference designation of the individual transistor is printed on the bottom of the board.

8-29. Diode Lead Identification

8-30. The diode symbol is printed on the board beneath each diode. There are two diodes on the printed circuit board side by side. These two diodes are oriented in different directions.

8-31. TROUBLESHOOTING PROCEDURES

8-32. Troubleshooting the 11664B can be performed in the following order:

a. Isolate the trouble to either the Detector or the Model 8755A/B using the procedures in Figure 8-3.

b. Isolate the trouble to either the RF Input Assembly or the Preamplifier using the procedures in Figure 8-4.

c. Isolate the trouble to an individual component using the procedures in Figure 8-6.

8-33. TROUBLESHOOTING HINTS

8-34. In order to troubleshoot the Preamplifier a Dummy Input Circuit (Figure 8-5) must be connected to the input of the Preamplifier. This must be done to place the proper bias on the input transistor. In normal operation the Hot Carrier Diode in the RF Input Assembly loads down the input circuit of the Preamplifier.

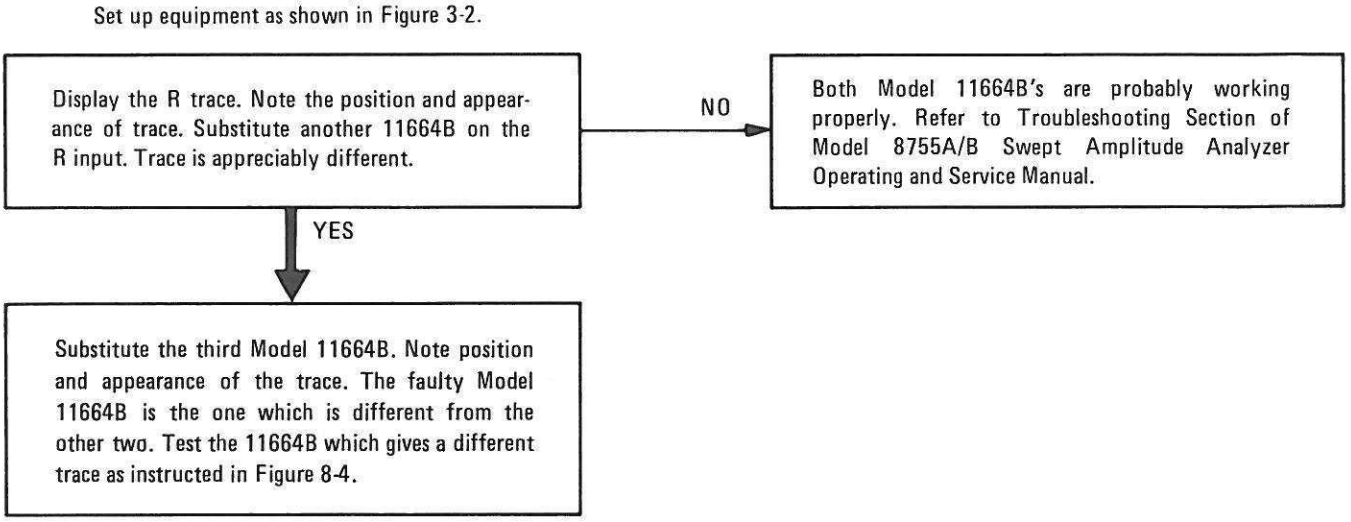


Figure 8-3. Preliminary Troubleshooting

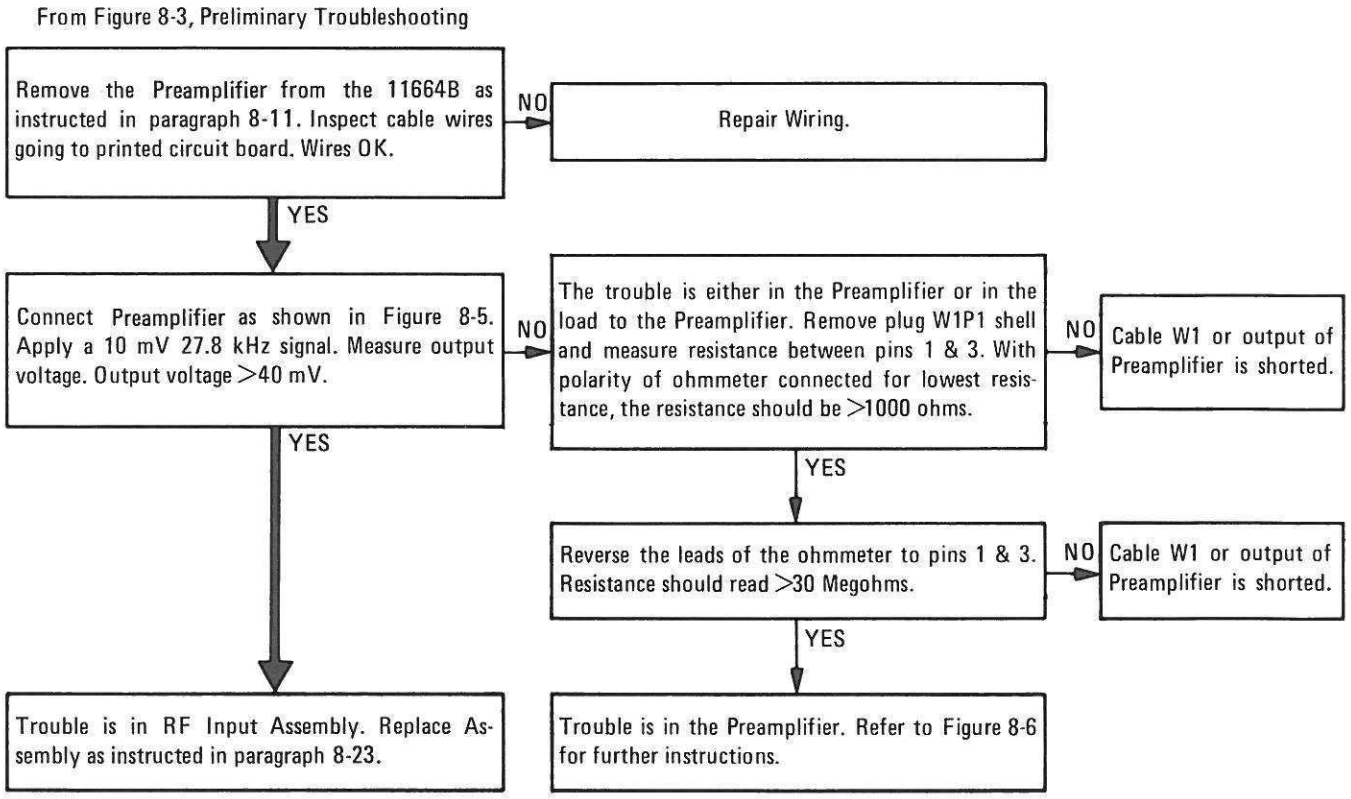


Figure 8-4. Isolating Trouble to A2 RF Input Assembly or A1 Preamplifier

NOTE

When troubleshooting the Preamplifier without the RF Input Assembly connected, the Dummy Input Circuit must be used.

8-35. If the equipment used in Fig. 8-5 is not available, dc measurements may be used. The same Dummy Input Circuit may be used to preserve the input bias. Any trouble will most likely shift the dc-coupled voltages far from their normal values. Start by measuring the input bias. If this voltage is >50% high or low, the voltages in the entire amplifier may be off. From this point on, standard transistor troubleshooting techniques may be used. For instance, measure the emitter-base voltage of Q1. Substitution of Q1 is an easy operation as it has plug-in terminals.

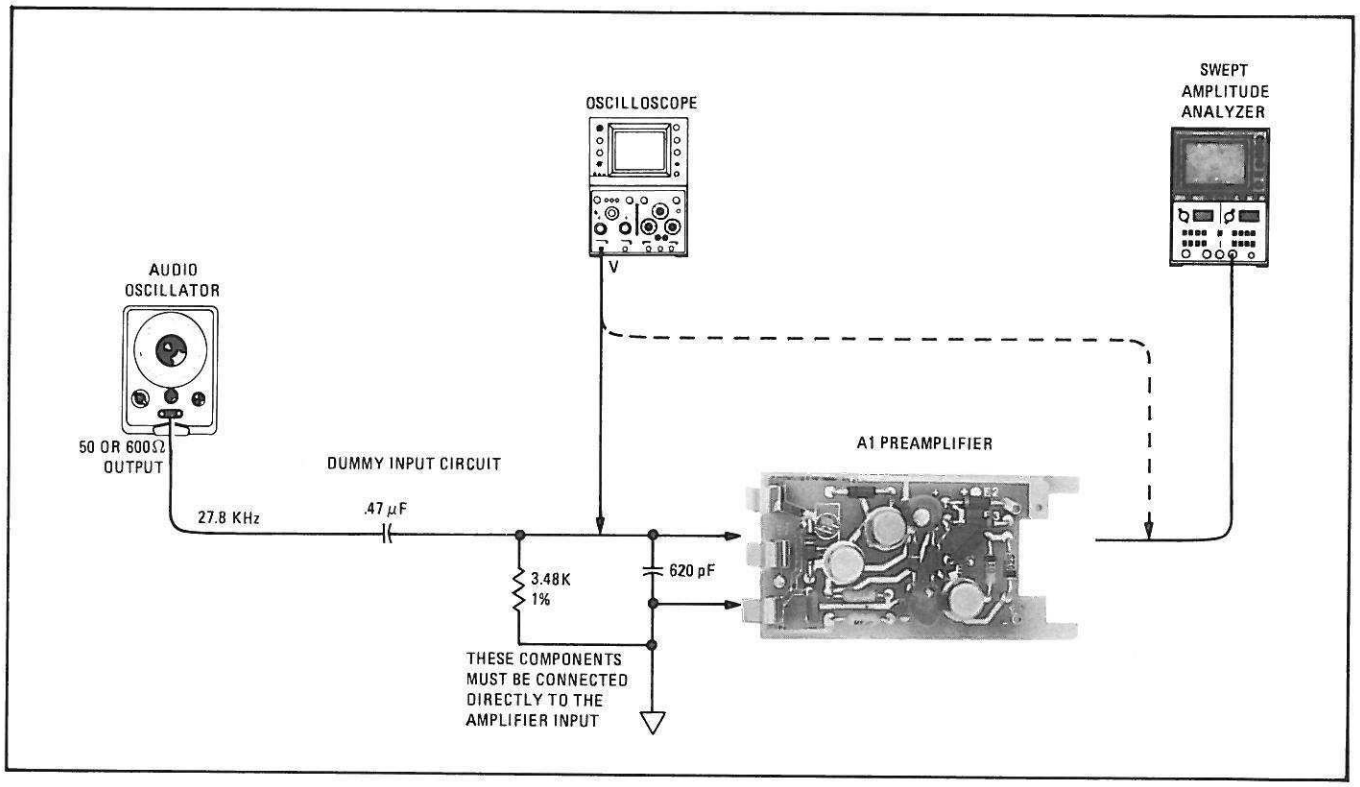


Figure 8-5. Test Setup for Measuring AC Gain

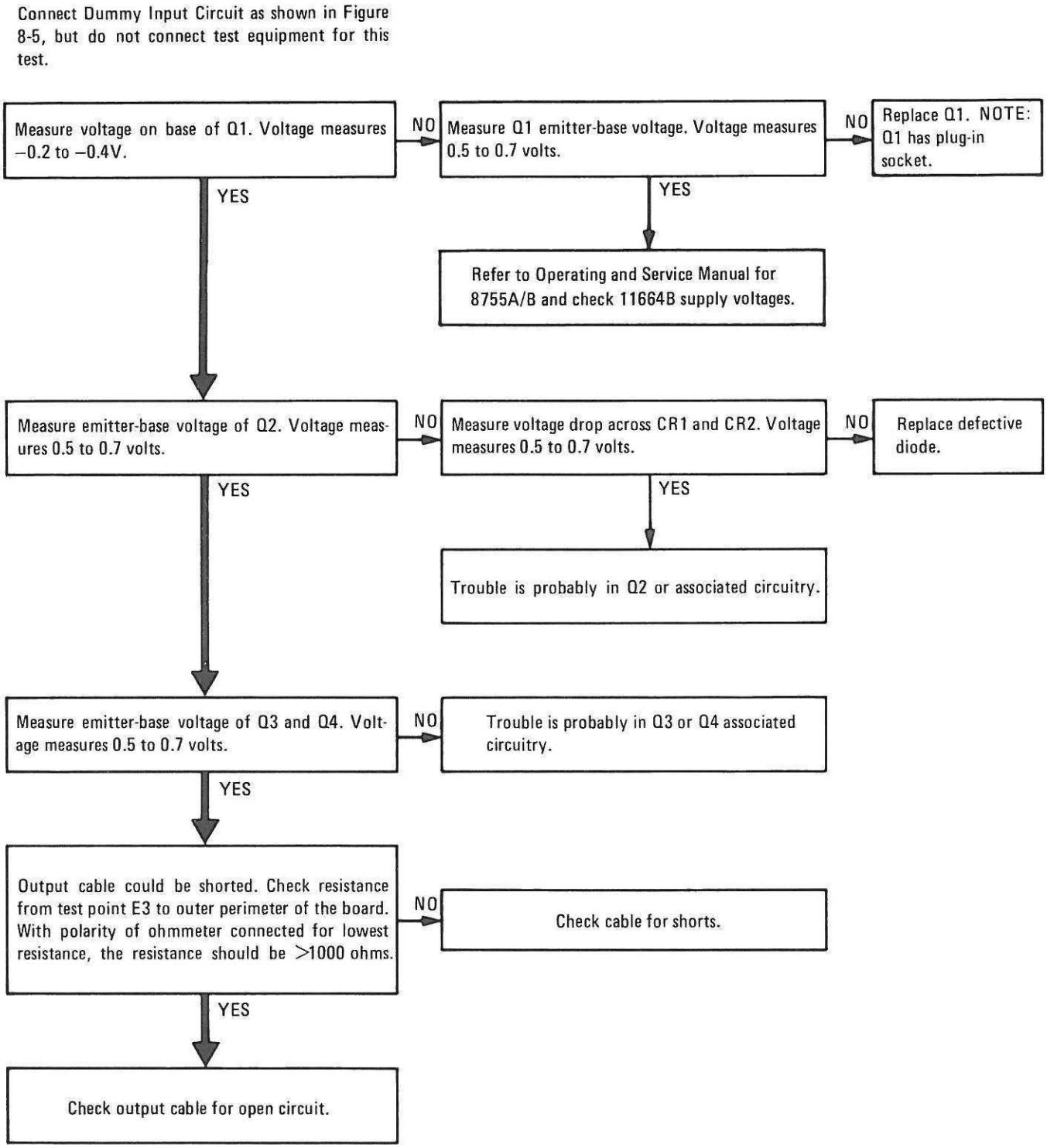


Figure 8-6. Isolating Trouble to an Individual Component in the A1 Preamplifier

PRINCIPLES OF OPERATION

The Model 11664B Detector consists of two basic assemblies, the A2 RF Input Assembly and the A1 Preamplifier Assembly.

A2 RF Input Assembly

The A2 RF Input Assembly consists of the input connector, the Hot Carrier Diode Assembly, and mounting hardware. The Hot Carrier Diode consists of the diode itself and associated components in a hermetically sealed assembly. Capacitor A2C1 conducts the RF signal applied to the input connector to the Hot Carrier Diode A2CR1. Resistor A2R1 matches the impedance of the input to the cable. Diode A2CR1 detects the 27.8 KHz envelope of the modulated RF signal.

A1 Preamplifier Assembly

The 27.8 KHz squarewave signal from the A2 RF Input Assembly is fed into the base of A1Q1. Resistor A1R1 reduces the input RC time-constant to less than 2 microseconds so that the input to the Amplifier will follow the modulation envelope at power levels greater than −5 dBm. A resistor, A1R2, adjusts the bias on the base of A1Q1 and across A1CR1.

Transistors A1Q1 and A1Q2 comprise a feedback pair. They are a high-gain direct-coupled amplifier stage composed of an NPN and a PNP transistor cascaded together. A positive-going pulse on the base of A1Q1 will increase the voltage through A1Q1, giving a negative-going pulse to the base of A1Q2. This pulse will, by a similar action, give a positive-going pulse going to the emitter of A1Q1. This positive-going pulse on the emitter of A1Q1 tends to limit the gain of the amplifier.

Transistors A1Q3 and A1Q4 are output emitter followers connected in parallel. They are complementary symmetry fed from the emitter and collector of A1Q1. The necessary difference in bias is furnished by diodes A1CR1 and A1CR2.

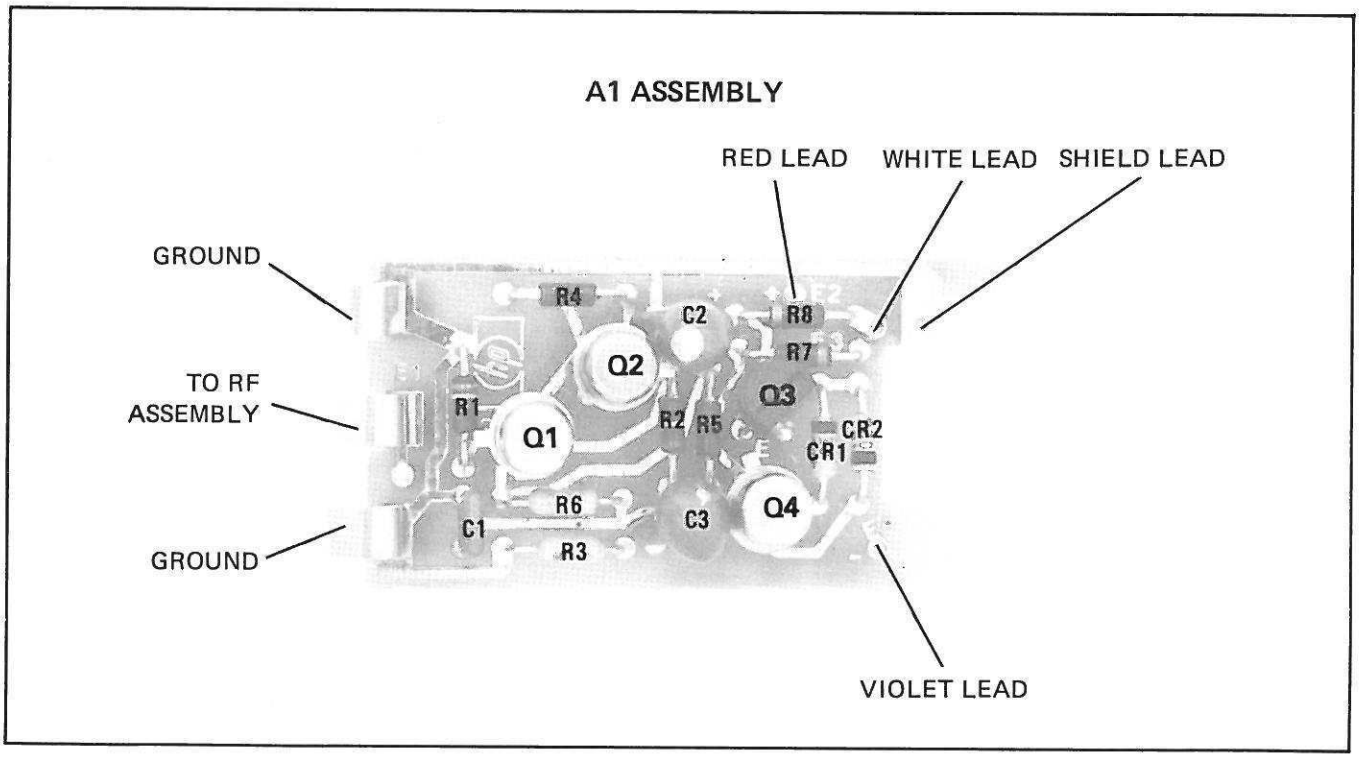
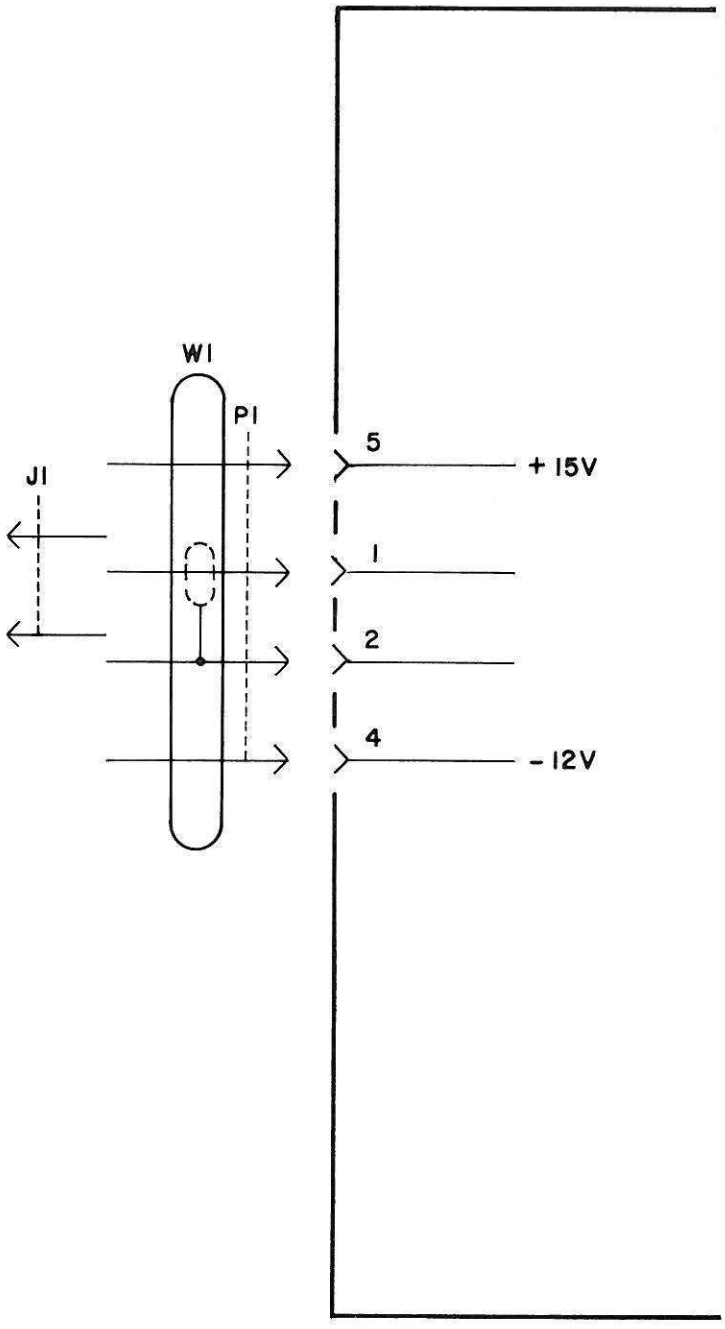


Figure 8-7. A1 Preamplifier Component Identification Illustration



NOTES:

1. Reference designators within the assemblies are abbreviated. Prefix abbreviation with assembly number for complete reference designator.

2. Unless otherwise indicated:
   Resistance in ohms (Ω)
   Capacitance in microfarads (μF)

3. Measurement Conditions:
   Either the RF Input Assembly or the Dummy Input Circuit (Figure 8-5) must be connected to the Preamplifier input.

4. Voltages shown are measured with respect to circuit ground.

Figure 8-8. Model 11664B Schematic

HEWLETT hp PACKARD

SALES & SERVICE OFFICES

AFRICA, ASIA, AUSTRALIA

ANGOLA
Telectra
Empresa Técnica de Equipamentos Eléctricos S A R L
R Barbosa Rodrigues 42-1 DT
Caixa Postal 6487
Luanda
Tel 35515/6
Cable TELECTRA Luanda

AUSTRALIA
Hewlett-Packard Australia Pty Ltd
31-41 Joseph Street
Blackburn Victoria 3130
P O Box 36
Doncaster East, Victoria 3109
Tel 895351
Telex 31-024
Cable HEWPARD Melbourne

Hewlett-Packard Australia Pty Ltd
31 Bridge Street
Pymble
New South Wales 2073
Tel 4496566
Telex 21561
Cable HEWPARD Sydney

Hewlett-Packard Australia Pty Ltd
153 Greenhill Road
Parkside, S A 5063
Tel 2725911
Telex 82536
Cable HEWPARD Adelaide

Hewlett-Packard Australia Pty Ltd
141 Stirling Highway
Nedlands W A 6009
Tel 3865455
Telex 93859
Cable HEWPARD Perth

Hewlett-Packard Australia Pty Ltd
121 Wollongong Street
Fyshwick, A C T 2609
Tel 804244
Telex 62650
Cable HEWPARD Canberra

Hewlett Packard Australia Pty Ltd
5th Floor
Teachers Union Building
495-499 Boundary Street
Spring Hill, Queensland 4000
Tel 2291544
Cable HEWPARD Brisbane

BANGLADESH
The General Electric Co of Bangladesh Ltd
Magnet House 72
Dilkusha Commercial Area
Motijheel Dacca 2
Tel 252415 252419
Telex 734
Cable GECDAC Dacca

ETHIOPIA
Abdella Abdulmalik
P O Box 2635
Addis Ababa
Tel 11 93 40

GUAM
Medical Only
Guam Medical Supply Inc
Suite C Airport Plaza
P O Box 8947
Tamuning 96911
Tel 646-4513
Cable EARMED Guam

HONG KONG
Schmidt & Co (Hong Kong) Ltd
Wing On Centre 28th Floor
Connaught Road C
Hong Kong
Tel 5-455644
Telex 74766 SCHMC HX

INDIA
Blue Star Ltd
Kasturi Buildings
Jamshedji Tata Rd
Bombay 400 020
Tel 29 50 21
Telex 011-2156
Cable BLUEFROST

Blue Star Ltd
Sahas
414/2 Vir Savarkar Marg
Prabhadevi
Bombay 400 025
Tel 45 78 87
Telex 011-4093
Cable FROSTBLUE

Blue Star Ltd
Band Box House
Prabhadevi
Bombay 400 025
Tel 45 73 01
Telex 011-3751
Cable BLUESTAR

Blue Star Ltd
Bhavdeep
Stadium Road
Ahmedabad 380 014
Tel 42880
Telex 234
Cable BLUEFROST

Blue Star Ltd
7 Hare Street
P O Box 506
Calcutta 700 001
Tel 23-0131
Telex 021-7655
Cable BLUESTAR

Blue Star Ltd
Bhandari House
7th & 8th Floor
91 Nehru Place
New Delhi 110 024
Tel 634770 & 635166
Telex 031-2463
Cable BLUESTAR

Blue Star Ltd
Blue Star House
11/11A Magarath Road
Bangalore 560 025
Tel 55668
Telex 043-430
Cable BLUESTAR

Blue Star Ltd
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