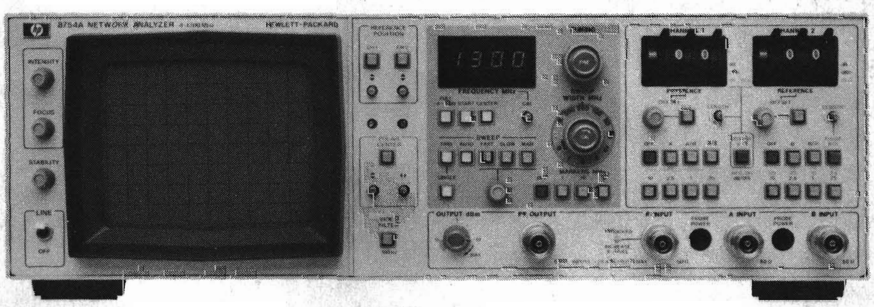
OPERATING INFORMATION

8754A
NETWORK ANALYZER
4 MHz — 1300 MHz



HEWLETT PACKARD

HEWLETT hp PACKARD

OPERATING INFORMATION

8754A
NETWORK ANALYZER
4 MHz — 1300 MHz

MANUAL PART NO. 08754-90016

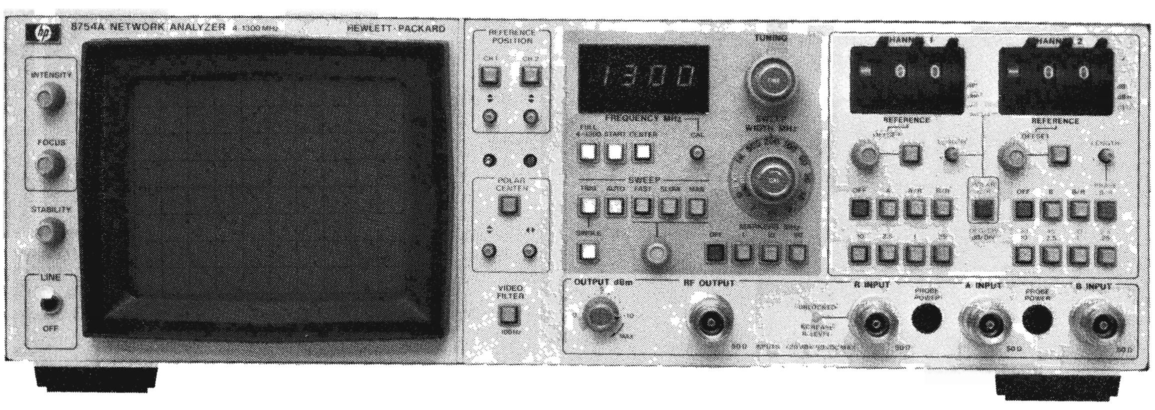
Printed: May 1979

CONTENTS

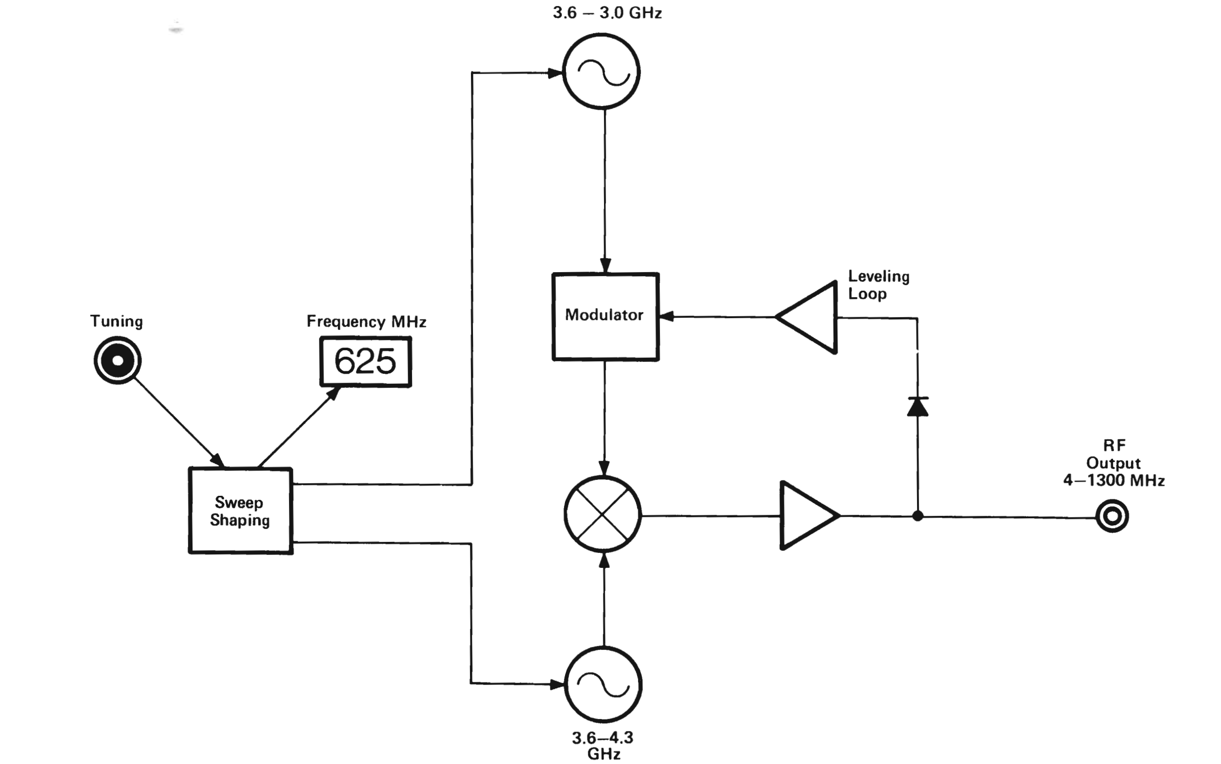
PREFACE

This operating information booklet will help you make transmission and reflection measurements with the HP 8754A Network Analyzer and its associated test sets and accessories. This information is placed in Section 3 of the 8754A Operating and Service Manual as well as being supplied as a separate booklet to be kept with the instrument for use by the operator.

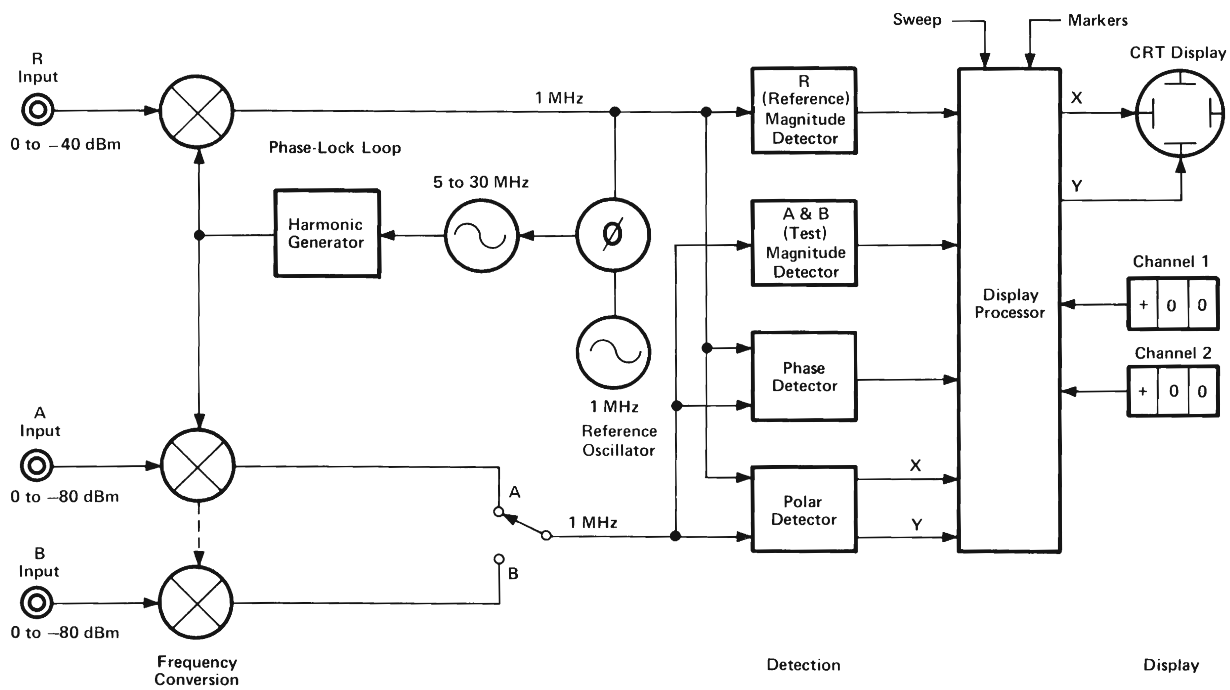
This booklet introduces the 8754A and its standard measurement accessories, as well as its specifications and its operating characteristics. Then it describes basic measurement setup operations, such as setting frequency sweep and measurement calibration, performed for all measurements. Specific step-by-step sequences used to measure and interpret response of the test device are found in the Transmission Measurements, Reflection Measurements, Power Level Measurements, and S-Parameter Measurements topics. Using the Storage-Normalizer describes setup and use of the HP 8750A Storage-Normalizer. A discussion of Using an External Source describes use of a stabilized source such as the HP 8640B to improve resolution for narrowband measurements. Summaries at the end of this section describe the functions of the 8754A controls and indicators and the input/output connections.



8754A Network Analyzer



8754A Source



8754A Receiver

INSTRUMENT DESCRIPTION

The 8754A Network Analyzer consists of an internally leveled 4 to 1300 MHz swept source with crystal markers, a three input tuned receiver with two independent measurement channels, and a CRT display with rectangular and polar graticules. Together with appropriate signal separation accessories, the 8754A is a complete stimulus/response test system that measures magnitude and phase characteristics of linear networks by comparing the incident signal with the signal transmitted by the device or reflected from its input.

The basic transmission measurements described here are: insertion loss or gain, insertion phase, and transmission coefficient, S_{21} or S_{12}. Basic reflection measurements are: return loss, from which SWR can be calculated, and reflection coefficient, S_{11} or S_{22}, from which impedance can be calculated or read from a Smith Chart overlay.

Block Diagram Description

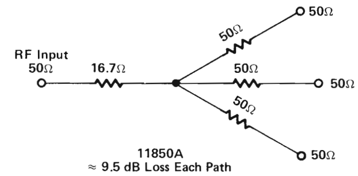
The source provides RF to the test device. It uses two varactor tuned microwave oscillators, one swept up in frequency from 3.6 to 4.3 GHz and one swept down in frequency from 3.6 to 3.0 GHz, in a "see-saw" configuration. The oscillator outputs are mixed and the difference frequency is amplified to provide the 4 to 1300 MHz RF output. An internal leveling loop maintains constant RF output power level over the sweep.

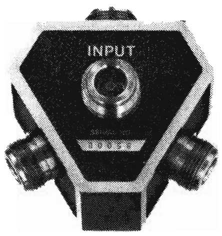
The receiver provides signal processing to convert incident (R) and test (A and B) inputs to dc levels for display. Signal separation accessories route the signal incident at the test device to the R input and the reflected and transmitted signals to the A or B inputs. The receiver uses the sampling technique to convert the three input signals to 1 MHz IF for detection while maintaining their magnitude and phase relationships. An automatic phase lock loop tunes the receiver to the frequency of the R input signal; the A and B inputs are used as full range test inputs. Two measurement channels allow measurement of any two parameters using a single test setup. For simultaneous transmission and reflection measurements the A or B IF is switched to the detectors on alternate sweeps. Absolute magnitude of the three inputs as well as the magnitude ratio and phase angle difference between the R input and either of the test inputs are processed for display on the built-in CRT.

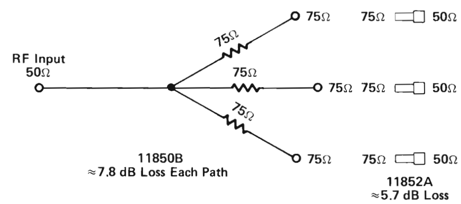
Measurement Accessories

Several test sets, signal cable sets, and other measurement accessories are designed especially for use with the 8754A.

Power Splitter. For precision transmission measurements, use the 11850A (50Ω) or 11850B (75Ω) Three Way Power Splitter and the 11851A RF Cable Kit. One output port provides the reference signal and the other two ports can be used for independent transmission measurements. The 11850B includes three 11852A 50Ω to 75Ω Minimum Loss Pads for matching the 75Ω 11850B outputs to the 8754A 50Ω, R, A, and B inputs.

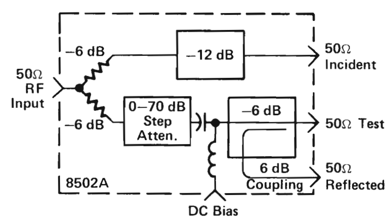


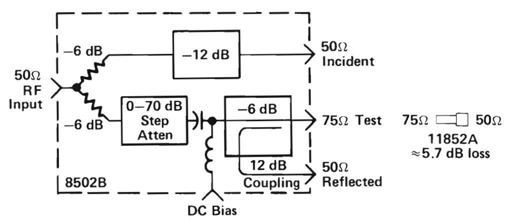


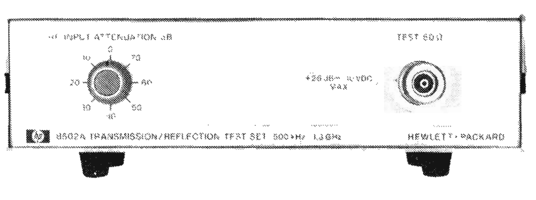


11850A/B Three-Way Power Splitter

Transmission/Reflection Test Set. The 8502A (50Ω) or 8502B (75Ω) Transmission/Reflection Test Set contains a power splitter and directional bridge allowing transmission and reflection measurements using the same test setup. It also incorporates a 0 to 70 dB, 10 dB step attenuator to reduce the incident signal level without affecting the signal level at the R input. The 8502B includes one 11852A 50Ω to 75Ω Minimum Loss Pad for matching the 75Ω Test output to the 8754A 50Ω, B input. The 11851A RF Cable Set consisting of three 610 mm (24") cables phase matched to ±4 degrees and one 860 mm (34") cable is recommended for use with the 8502. This cable set or its equivalent is required to perform phase calibration. The equal length cables connect the 8754A RF, R, and A inputs to the test set and the longer cable serves as the transmission return to the B input.



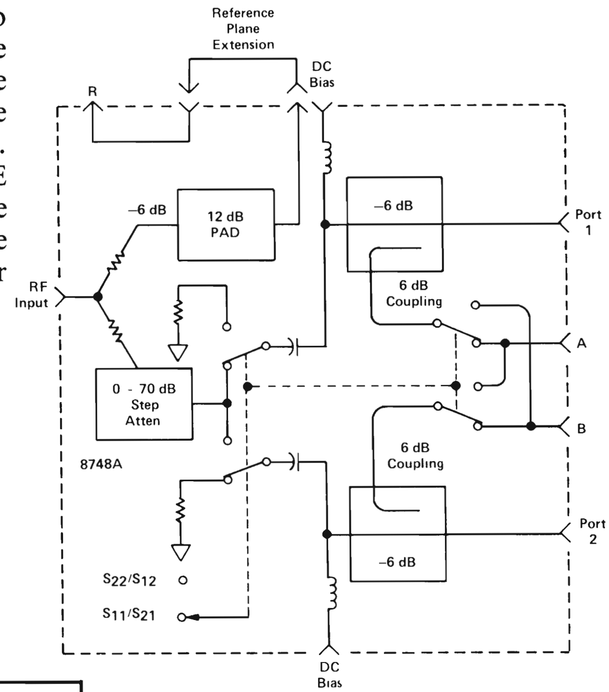


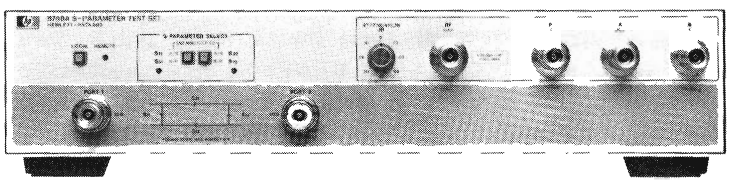


8502A Transmission/Reflection Test Set

S-Parameter Test Set. Transmission and reflection measurements on two port devices which require measurement of both forward and reverse characteristics can be accomplished using the 8748A S-Parameter Test Set. This test set contains the necessary splitter, couplers, and switches to measure forward and reverse characteristics without disconnecting the reversing the test device, a 0 to 70 dB, 10 dB step attenuator to control the incident signal level, and includes the necessary equal length signal cables and interface cable to connect the test set to the 8754A. Connect the test device using the 11857A Test Port Extension Cables or the 11608A, 11600B, or 11602B Transistor Fixtures.

Measurement setup instructions for the 8748A will refer to the rear panel Reference Plane Extension cables. These are the rigid loops provided with the 8748A to equalize the lengths of the reference and test signal paths to achieve correct phase calibration. Six of these loops are provided. Connect one between the 8748A rear panel REFERENCE PLANE EXTENSION connectors depending upon the method used to connect the test device to the test ports. The table below lists their part numbers and application in order of increasing length.



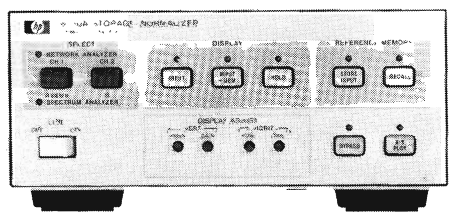


8748A S-Parameter Test Set

8748A Reference Plane Extension Cables

HP Part No.	Application
08748-20020	Test device connected directly to Port 1 or Port 2 (reflection only).
08748-20021	60 to 120 mm adapter length at Port 1 or Port 2 (reflection only).
08478-20022	11608A Transistor Fixture (transmission/reflection) or, 120 to 190 mm adapter length at Port 1 or Port 2 (reflection only).
08478-20023	190 to 250 mm adapter length at Port 1 or Port 2 (reflection only).
08478-20024	11600B or 11602B Transistor Fixture with 11858A Transistor Fixture Adapter (transmission/reflection)
08748-20025	Test device connected between two 11857A (610 mm, 24") Test Port Extension Cables (transmission/reflection)

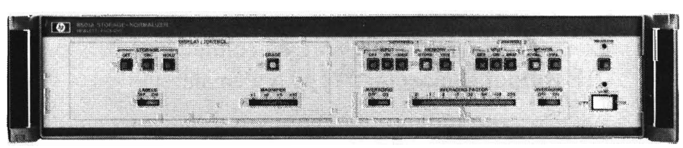
Storage-Normalizer. Two storage-normalizer units are offered for use with the 8754A. Both use digital storage to provide crisp, flicker-free CRT displays regardless of sweep rate, and normalization to remove the frequency response characteristics of a standard from the measurement.



8750A Storage Normalizer

The 8750 is an economical way to provide digital storage and normalization for rectangular magnitude and phase traces. All standard features of the 8750 apply to operation with the 8754A. The rectangular measurement trace is digitized at 250 points/sweep with 500-point y-axis resolution. The 8750A does not process the polar trace.

The 8501A processing includes averaging and magnification. In addition, the 8501A will process a polar trace. A single internal adjustment (DAC gain) is required to match the 8501A to the 8754A. All standard features of the 8501A apply to operation with the 8754A except display of operating mode labels. Data can be read from the 8501A memory via the HP-IB. Graphics written into the 8501A via the HP-IB can be displayed by the 8754A CRT but reduced writing speed of the 8754A CRT causes dropouts and distortion of figures.



8501A Storage Normalizer

SPECIFICATIONS

HP 8754A Network Analyzer Specifications (1 of 2)

SOURCE

FREQUENCY

Range: 4 MHz to 1300 MHz
Sweep Modes: Linear full sweep (4 MHz to 1300 MHz) and calibrated sweep widths with variable start or center frequency.
Markers: Internal, crystal-generated harmonic markers; amplitude markers for rectangular displays, intensity markers for polar displays.
- **Spacing:** 1, 10, and 50 MHz
- **Accuracy:** ±0.01%

Digital Frequency Readout: Indicates frequency of variable marker in linear full sweep mode and start or center frequency in calibrated sweep width mode.
- **Resolution:** 1 MHz
- **Accuracy:** ±10 MHz (20°C to 30°C). Readout is adjustable for calibration to internal crystal markers.

OUTPUT

Power:
- **Range:** Calibrated 0 to +10 dBm
- **Accuracy:** ±0.8 dB at 50 MHz
- **Flatness:** ±0.5 dB

Spectral Purity (at +10 dBm RF output level):
- **Residual FM**[1]: ≤7 kHz RMS (10 kHz bandwidth) bandwidth)
- **Harmonics:** −28 dBc
- **Spurious Signals:** 4 MHz to 500 MHz, −65 dBc
  500 MHz to 1300 MHz, −50 dBc

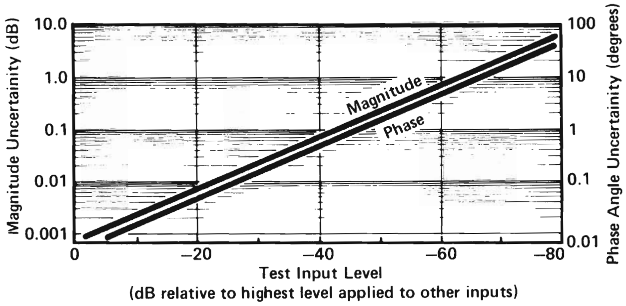
GENERAL

Trigger Modes: AUTO (repetitive) and TRIG (single sweep triggered by front-panel pushbutton or rear-panel PROGRAMMING connector)
RF Output Connector: Type N Female

RECEIVER

INPUT

Frequency Range: 4 MHz to 1300 MHz
Input Channels: Three Inputs, R, A, and B. Two test inputs (A and B) with 80 dB dynamic range and a reference input (R) with 40 dB dynamic range.
Impedance: 50Ω. Input port match ≥20 dB return loss (≤1.22 SWR).
Maximum Input Level: 0 dBm
Damage Level: +20 dBm (50 Vdc)
Noise Level: <−80 dBm, A and B inputs
Minimum R Input Level: −40 dBm (≥−40 dBm required to operate R input phase lock)
Crosstalk Between Channels: >83 dB
Error Limits:



MAGNITUDE

Frequency Response (flatness):
- **Absolute (A, B, R):** ±1 dB
- **Ratio (A/R, B/R):** ±0.3 dB

Dynamic Accuracy (+20°C to +30°C):
- ±0.3 dB from 0 to −50 dBm
- ±0.5 dB from −50 to −60 dBm
- ±1 dB from −60 to −70 dBm
- ±2.5 dB from −70 to −80 dBm

[1] Applies in swept and CW modes.

HP 8754A Network Analyzer Specifications (2 of 2)

RECEIVER (Cont'd)

Reference Offset:
Range: ±199 dB in 1 dB steps
Accuracy: Included in Dynamic Accuracy above.
Display Resolution: 10, 2.5, 1, 0.25 dB/div
Display Accuracy: ±2% ±0.05 division

PHASE

Frequency Response: ≤±2.5°

Range: ±180°
Dynamic Accuracy:
±2° from 0 to −50 dBm
±4° from 0 to −70 dBm
Reference Offset:
Range: ±199° in 1° steps
Accuracy: ±1%
Display Resolution: 90°, 45°, 10°, 2.5°/major division
Display Accuracy: ±2% ±0.05 division

POLAR

See Magnitude and Phase specifications for Frequency Response, Dynamic Accuracy, and Reference Offset.
Display Accuracy: Actual value is within 2.5 mm of displayed value.

DISPLAY

Measurement Functions: CRT displays either polar trace or two independent rectangular traces.

Channel 1:	A Magnitude Absolute (dBm)
	R Magnitude Absolute (dBm)
	A/R Magnitude Ratio (dB)
	B/R Magnitude Ratio (dB)
Channel 2:	B Magnitude Absolute (dBm)
	B/R Magnitude Ratio (dB)
	B/R Phase (degrees)
Polar:	A/R Magnitude Ratio (dB) and Phase (degrees)

DISPLAY (Cont'd)

Reference Position: Reference lines for Channel 1, Channel 2, and Polar Center can be independently set to any position on the CRT for calibration. Display resolution expands about the Reference Position line.

Graticule size:
Rectangular (cartesian): 100 mm (3.94 in.) horizontal by 80 mm (3.15 in.) vertical.
Polar: 80 mm (3.15 in.) in diameter
Both graticules internal to CRT
Smith Chart Overlays:
Viewing: 0.2 expanded, 0.1 expanded, compressed 2.0, regular
Photographic: 0.2 expanded, 0.1 expanded, compressed, 2.0, regular
Phosphor: P39

GENERAL

Magnitude/Phase Output: −10 mV/degree and −100 mV/dB at BNC female connector multiplexed by TTL level or contact closure at pin of PROGRAMMING connector for use with external digital voltmeter.

Accuracy:
Magnitude: See Magnitude Dynamic Accuracy specification.
Phase: ±1.5% (0 to ±170°), ±2% (±170° to ±180°).

Environmental:
Temperature:
Operating: 0°C to +55°C except where noted
Storage: −40°C to +75°C
Power: Selection of 100, 120, 220, and 240 Vac +5%, −10%; 48 to 66 Hz; 200 VA maximum
Dimensions: 133 mm x 425 mm x 505 mm (5.25 in. x 16.75 in. x 19.875 in.)
Weight: Net, 17.7 kg (39 lb);
Shipping: 20 kg (44 lb)

HP 8754A Performance Characteristics (1 of 2)

SOURCE

FREQUENCY CHARACTERISTICS

Sweep Width Accuracy:
500 to 1000 MHz: Typically ±2%
50 to 200 MHz: Typically ±5%
1 to 20 MHz: Typically ±8%
Stability:
Temperature: Typically ±400 kHz/°C
Time: Typically ±100 kHz/hour

OUTPUT CHARACTERISTICS

Impedance: 50Ω. Source match typically less than 1.4 SWR (>16 dB return loss).
Power Range: Uncalibrated to typically +13 dBm
Spectral Purity (at +10 dBm):
Harmonics: Typically −35 dBc
Spurious Signals:
4 to 500 MHz: Typically −75 dBc
500 to 1300 MHz: Typically −60 dBc

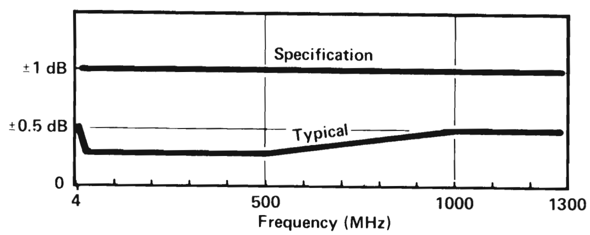
GENERAL CHARACTERISTICS

Sweep Time:
Approximately 10 ms to 500 ms in FAST mode
Approximately 1 sec to 50 sec in SLOW mode

RECEIVER

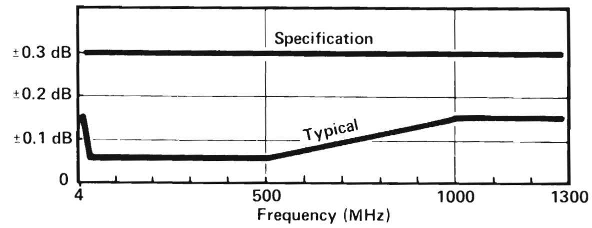
MAGNITUDE CHARACTERISTICS

Frequency Response (flatness): Absolute (A, B):

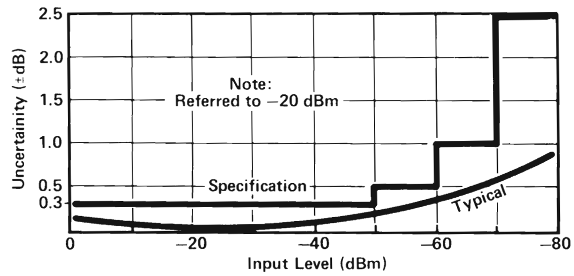


RECEIVER (Cont'd)

Frequency Response (Flatness): Ratio (A/R, B/R):



Dynamic Accuracy (+20° to +30°C): Typically less than 0.01 dB/dB from −10 dBm to −40 dBm



Reference Offset:
Accuracy: Typically less than ±0.1% of value.
Vernier Range: Typically ±80 dB of variable offset used for calibration of ratio measurements.

Error Resulting from Change in Harmonic Number:
Ratio (A/R and B/R): Typically ⩽0.05 dB
Absolute (A, B, and R): Typically ⩽0.2 dB

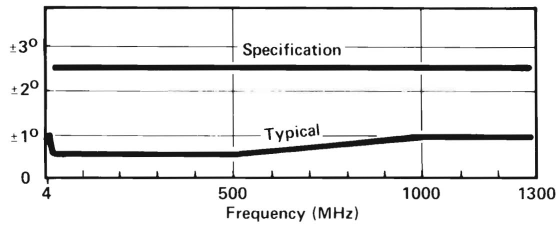
Absolute Power Measurements (A, B, and R):
Calibrated in dBm; typically <±0.5 dBm with 0 dBm, 50 MHz input

HP 8754A Performance Characteristics (2 of 2)

RECEIVER (Cont'd)

PHASE CHARACTERISTICS

Frequency Response:



Reference Offset Range: Vernier provides typically ±20° of variable offset used for phase calibration.
Electrical Length Adjustment Range: Typically 160 mm.
Phase Error Resulting from Change in Harmonic Number: Typically ≤0.5°.

DISPLAY:

Video Filter: Typically 100 Hz (10 kHz without filter)

GENERAL CHARACTERISTICS

External Sweep Input: 0 to +10V nominal. BNC female connector used to sweep CRT display when receiver is used with an externally swept source or to remotely program the frequency of an internal RF source from an external digital-to-analog converter.
Sweep Output: –5V to +5V nominal, BNC female connector, used to frequency modulate (sweep) external generator.

GENERAL CHARACTERISTICS (Cont'd)

X-Y Recorder/External CRT Output:
Horizontal: 0.1V/Div. (0 to 1V).
Vertical: 0.1V/Div. (±0.4 full scale).
Penlift/Blanking: +5V Blanking and Penlift; –5V intensifies crystal markers.
Connectors: BNC female.
External Marker Input: typically –13 dBm RF signal into the External Marker Input will produce an amplitude (rectilinear) or intensity (polar) marker on the trace at the frequency of the RF signal. BNC female connector, 50Ω.
Probe Power: +15 Vdc and –12.6 Vdc, for use with 10855A Preamp or 1121A AC Probe. Two probe power jacks are available.
Storage-Normalizer Interfaces: directly compatible with both the HP 8750A Storage-Normalizer and the HP 8501A Storage-Normalizer. All 8501A features except CRT labels and graphics are available when the 8501A is used in conjunction with the 8754A.
Programming Connector:
Function: 25 pin Amphenol connector (with mating connector). Outputs include magnitude/phase and sweep outputs and inputs described above as well as measurement mode selection by TTL levels or contact closures.

Warm Up: One-half hour is required for temperature to stabilize.

POLAR CHARACTERISTICS

Electrical Length Adjustment Range:
Typically 160 mm, resulting in an 80-mm adjustment to the reference plane in a reflection measurement.

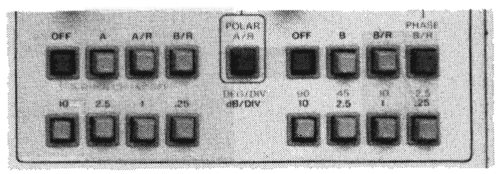
FRONT PANEL INTRODUCTION

For those operators who are familiar with the 8754A, the Quick Reference Guide on 44 and 45 may be sufficient.

For more detailed operating instructions, the following paragraphs are supplied. They provide instructions for the following operations which are common to all measurements.

Select Measurement
Set CRT Display
Set Frequency Sweep
Set Signal Levels
Measurement Calibration
Electrical Length Compensation
Read Measurement Value

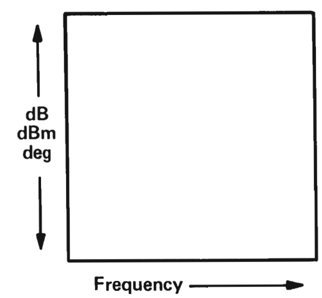
Select Measurement



These buttons select the measurement displayed on the CRT. Two independent channels are provided for rectangular measurements (vs. frequency). POLAR A/R mode overrides the other selections and provides an X-Y display of magnitude and phase.

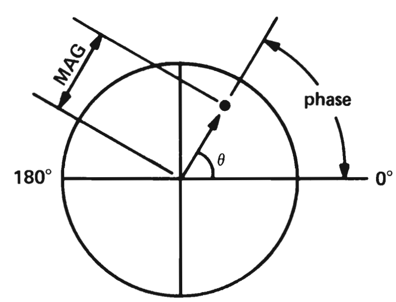
Rectangular Measurements:

A = power level at A input (dBm)
B = power level at B input (dBm)
R = power level at R input (dBm)
(R is selected when Channels 1 and 2 are both off.)
A/R = power ratio between A and R inputs (dB)
B/R = power ratio between B and R inputs (dB)
PHASE B/R = phase difference between B and R inputs (degrees)



Rectangular scale/division is set independently for each measurement channel.

Polar A/R displays the complex coefficient consisting of the magnitude ratio and the phase angle between the A and R inputs. Polar Full scale is selected by changing the Channel 1 Reference value; polar phase rotation is selected by changing the Channel 2 Reference value.



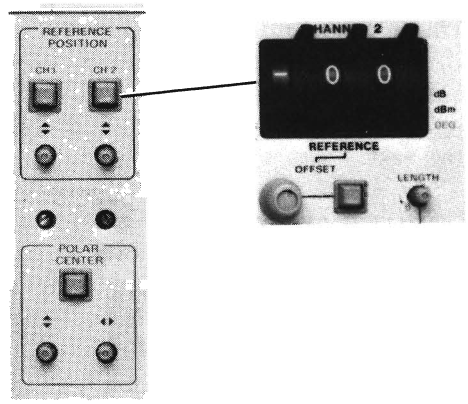
For example, when the 8754A is used with the 8502A or 8748A test sets, the R input is the incident signal, the A input is the reflected signal, and the B input is the transmitted signal.

A/R = reflected/incident = return loss (dB) or reflection coefficient = S_{11}
B/R = transmitted/incident = gain/loss = S_{21}

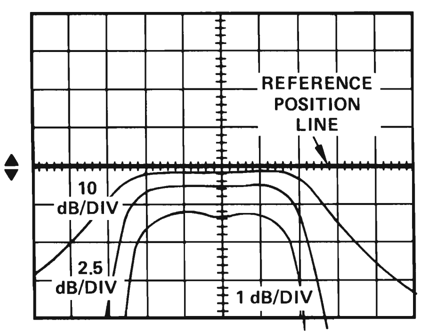
Set CRT Display

The CH 1 and CH 2 buttons are pressed to select display of the rectangular reference position line for each channel instead of the measurement trace. They provide a means to identify the trace for each channel, and to establish the vertical position which corresponds to the REFERENCE value readout on the corresponding lever switches.

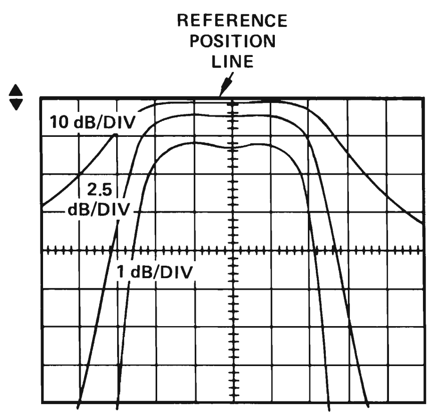
Screwdriver adjustments are provided to adjust the position (POSN) and the length (GAIN) of the horizontal sweep when making rectangular measurements.



As shown in the diagrams below, for rectangular displays of magnitude and phase the reference position line is the position from which scale/division expands or contracts the trace. The reference position line for each measurement channel can be independently set to any vertical location using the CH1 ▲▼ or CH2 ▲▼ verniers and can be changed at any time without affecting display calibration. This allows you to set the reference position line to the most convenient location for viewing the trace, usually the center CRT graticule.



SCALE/DIVISION		
10	2.5	1
+40	+10	+4
+30	+7.5	+3
+20	+5	+2
+10	+2.5	+1
0	0	0
−10	−2.5	−1
−20	−5	−2
−30	−7.5	−3
−40	−10	−4



SCALE/DIVISION		
10	2.5	1
0	0	0
−10	−2.5	−1
−20	−5	−2
−30	−7.5	−3
−40	−10	−4
−50	−12.5	−5
−60	−15	−6
−70	−17.5	−7
−80	−20	−8

POLAR CENTER is pressed to display the polar beam center position instead of the polar trace. Use the ▲▼ and ◀▶ verniers to position the polar center dot at the center of the polar graticule.

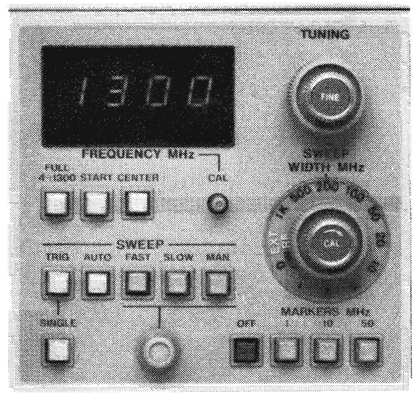
Set Frequency Sweep

The 8754A source can sweep the full 4–1300 MHz range or any intermediate sweep width from 1000 MHz to less than 1 MHz. The FREQUENCY MHz display combined with the crystal markers make setting and reading frequency simple and fast.

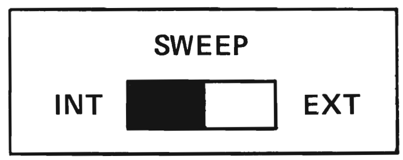
Usual settings for the SWEEP controls are: AUTO to select the internally-generated sweep trigger, and either FAST or SLOW to select the sweep time range. (Also, set the rear panel SWEEP control to INT.) The vernier controls the sweep time within the fast and slow ranges.

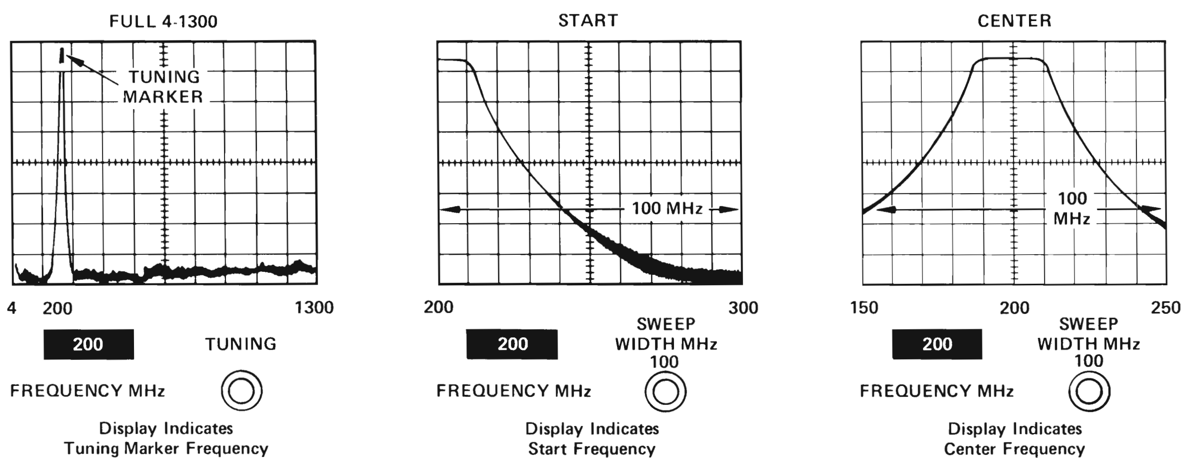
As shown below, the major sweep modes are FULL, START, and CENTER. Press FULL 4–1300 and use TUNING to set the start or center frequency of the sweep as indicated by the digital frequency display and the movable tuning marker. Then select START or CENTER and zoom in on the response of the area of interest, using the switch selected sweep widths.

FRONT PANEL



REAR PANEL





Markers are displayed on a rectangular trace as a positive amplitude mark (⎍) or an intensified short dash on the polar trace. The MARKERS buttons select display of internal crystal-generated harmonic markers at 50, 10, or 1 MHz intervals. (1 MHz markers are active only at 20 MHz and below sweep widths.)

The frequency readout is accurate to ± 10 MHz over the full range and can be calibrated to 1 MHz crystal marker accuracy at the frequency of interest using any trace on the rectangular display and the CAL vernier adjacent to the readout. (If the trace is difficult to read, use the REFERENCE POSITION line of the unused measurement channel to display the markers.) Calibrate the readout as follows: Select CENTER sweep mode, 200 MHz sweep width, and 50 MHz markers. Use the TUNING control to center a marker (⎍) nearest the frequency of interest exactly over the center vertical graticule. With the marker centered, adjust the CAL vernier for a readout of XX00 or XX50 (some multiple of 50 or 100 MHz).

You may continue this sequence at sweep width positions below 20 MHz and use the 1 MHz markers to set the readout with greater precision. The center of the marker, not the leading or trailing edge, indicates the 50, 10, or 1 MHz harmonic frequency.

Another use for the crystal markers is to set an intermediate sweep width. Select a sweep width one step higher than the width you require and select appropriate markers, then adjust the inner sweep width vernier counterclockwise from the CAL position to achieve the desired width.

Set Signal Levels

Source Output Power. The output dBm control sets the source output level at the RF OUTPUT connector. This output is internally leveled between 0 dBm and +10 dBm. External precision attenuation, such as incorporated in the 8502A/B and 8748A test sets, may be used to control the incident signal level at the test device.

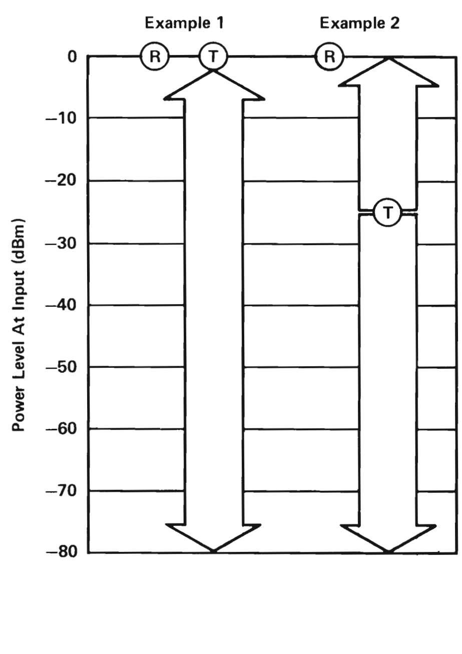
Input Power. Maximum power which should be applied to the R, A, and B inputs is 0 dBm. Above 0 dBm, measurement errors may result from input sampler compression. To maintain receiver phase-lock, the R input level must be between 0 dBm and –40 dBm. The red UNLOCKED indicator will light when the R input falls below –40 dBm.

The A and B inputs are identical, each with a 0 dBm to –80 dBm range. Best measurement accuracy is achieved when the R input is between 0 and –30 dBm and the A or B test inputs are near maximum. For example, dynamic accuracy is ±2.5 dB with the test input level at –75 dBm but improves to ±0.3 dB above –50 dBm.

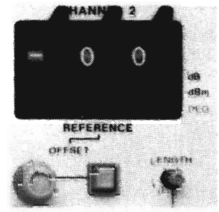
Measurement uncertainty caused by crosstalk between inputs can become important when the signal levels differ significantly. For example, with the R input at 0 dBm and the B input at –75 dBm, the measurement uncertainty contributed by crosstalk is about 1 dB. This uncertainty can be reduced to about 0.1 dB by reducing the R input level to –30 dBm.

The input level at calibration determines the available measurement range without overload or excessive measurement uncertainty. For reflection measurements and transmission loss measurements, the incident signal level should be as high as the test device characteristics will permit. For gain measurements, set the incident signal level to a value at which the expected device output will not exceed 0 dBm at the A or B input. When using the 8502A/B or 8748A test sets, the incident signal can be attenuated without reducing the signal level at the R input.

Two examples are shown in this chart. Example (1) represents calibration levels for a passive device with both R and test inputs at 0 dBm. When calibrated at these levels, loss and phase may be measured to –80 dBm. Example (2) shows calibration levels for a test device with expected 20 dB of gain. The R input level is set to 0 dBm and the test channel input level is set to –25 dBm. At these levels, the 8754A can measure up to 25 dB of gain and about 55 dB loss. Refer to the Power Level Measurements sequence to measure the signal level at each input port.



Measurement Calibration



Since the network analyzer displays the difference between its inputs in dB or degrees, any unequal losses between between the A, B, and R signal paths will cause a value to be displayed which is different from the characteristics of the network being measured. Hence, the system must first be calibrated to a standard with known response characteristics. Measurements on a test device are then made relative to the calibration standard.

Any device with known characteristics may be used as a calibration standard. The usual calibration standard for transmission measurements is a "through" connection (connect the points at which the test device will be connected to achieve a zero length, zero loss transmission line). The usual standard for reflection measurements is a short circuit at the measurement plane (connect the short circuit at the point at which the test device will be connected). Thus, calibration establishes the magnitude and phase response of the test setup to a known value. All cables, adapters etc. used in calibration must also be used in measurement or the calibration will not be exact.

Magnitude ratio calibration eliminates any offset caused by unequal losses between the reference and test signal paths to establish a 0 dB reference from which test device response can be measured. Magnitude ratio calibration is accomplished by connecting the standard, setting the REFERENCE display to 00, then using the OFFSET vernier to move the trace to the reference position line. When the OFFSET button is depressed the offset determined by the vernier is applied to the measurement; when the button is released, the offset is not applied to the measurement.

The general sequence for magnitude and phase calibration is as follows:

Connect calibration standard Set REFERENCE switch to –00 Depress OFFSET button Adjust OFFSET vernier to position trace at reference position

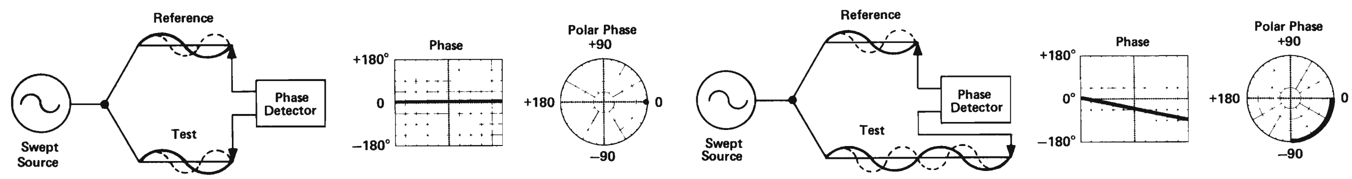
After calibration, the OFFSET vernier should not be moved or calibration will no longer be valid.

If the calibration trace has frequency response errors, they must be accounted for. Using the OFFSET vernier, move a point on the trace to the reference position line. Then, using a grease pencil, write the trace onto the CRT. (Remove the blue filter to reduce parallax.) An alternate method is to use the 8750A Storage Normalizer to store the calibration trace in memory and automatically subtract it from the measurement, as described later.

When measuring A, B, or R absolute power in dBm, simply release the OFFSET button to disengage the vernier.

Electrical Length Compensation

Phase calibration requires equal electrical lengths in the reference and test signal paths. The electrical length is equal when the phase angle is constant over the frequency sweep with the standard connected. For fine adjustment of electrical length two independent controls, PHASE B/R LENGTH for the transmitted signal path and POLAR A/R LENGTH for the reflected signal path, provide up to 16 centimeters of internal line length equalization adjustment. Beyond this limit the reference and test signal path cables must be selected to obtain equal electrical lengths.



Constant phase response is identified by a flat trace for a rectangular display or a small cluster for a polar display. If the phase angle becomes more negative with increasing frequency, then the test signal path is longer than the reference signal path. Therefore, length must be added to the R-input signal path if the range of the front-panel LENGTH controls is insufficient. If the phase angle becomes more positive with increased frequency then length must be added to the A or B input signal path.

When making reflection or transmission measurements using the 8502 or 8748 test set, the usual test setup uses R input as the incident signal, A input as the reflected signal, and B input as the transmitted signal. With this setup, first adjust the A and R lengths to equalize the POLAR A/R display when calibrating reflection coefficient (open or short). Then adjust the B length to equalize the PHASE B/R display when calibrating transmission (through).

Read Measured Value

After calibration, the REFERENCE switch displays the value of the reference position in dBm, dB, or degrees. Also, the measurement trace on the CRT is positioned relative to the reference position, depending upon whether the response characteristic is positive or negative with respect to the reference value. Thus, the measured value is the sum of the REFERENCE value displayed on the switch plus the CRT trace displacement from the reference position. For best measurement accuracy, always use the REFERENCE switch to move the trace as close as possible to the reference position, then interpolate between the graticule lines for additional resolution.

The reference position for rectangular displays is the horizontal reference position line, and for polar displays the outer circle, zero degrees point. Using this sequence, you can read magnitude and phase values from the digital reference displays directly with 1 dB and 1 degree resolution.

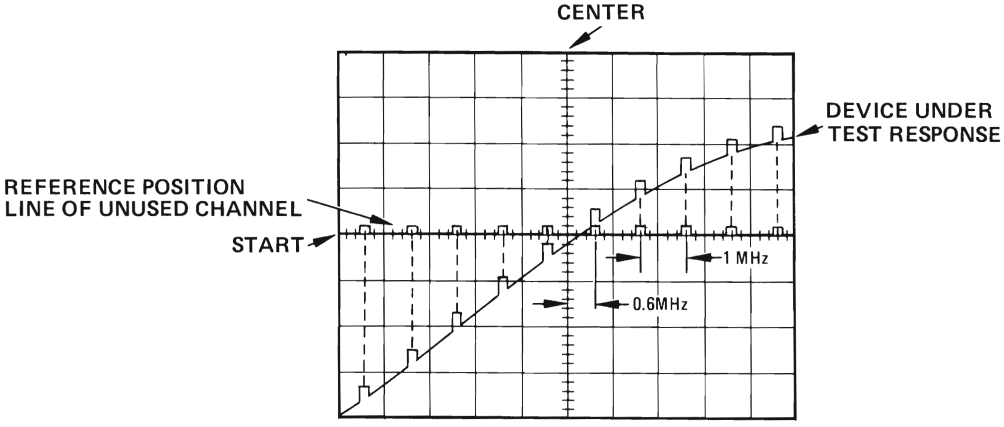
The general sequence to read the measured magnitude or phase value at any point on the trace is as follows:

Connect device to be measured
Set REFERENCE switch to move point on trace as close to reference position as possible
MEASURED VALUE = Value displayed on REFERENCE switch + trace displacement from reference position.

To familiarize yourself with operation of the reference controls, note that when the + sign is displayed, increasing the reference value (levers down) moves the trace down with respect to the reference position line; with the – sign displayed, changing the reference value to a more negative value (levers down) moves the trace up with respect to the reference position line.

Proper selection of sweep time is essential for accurate measurements. This is accomplished by selecting FAST, with the sweep time vernier fully clockwise, then decreasing the sweep time by rotating the vernier counterclockwise and if necessary, selecting the slow sweep range until there is no change in the test device response. The VIDEO FILTER reduces the post detection bandwidth and thus usually requires a much slower sweep. As you increase the sweep width, the effective sweep rate increases, sometimes requiring a slower sweep.

The general sequence to read the frequency value at any point on the trace is to select the START or CENTER sweep mode, then use TUNING to move the point on the trace to the start or center graticule line. The frequency value can then be read from the FREQUENCY MHz display with 1 MHz resolution. Obtain greater resolution by selecting 20 MHz or less sweep width, 1 MHz crystal markers, and interpolating the frequency value, using the markers and graticule. If the trace is difficult to read, use the REFERENCE POSITION line of the unused measurement channel to display the markers as shown below.



CONVENIENT METHOD OF READING FREQUENCY USING THE REFERENCE POSITION LINE OF UNUSED CHANNEL

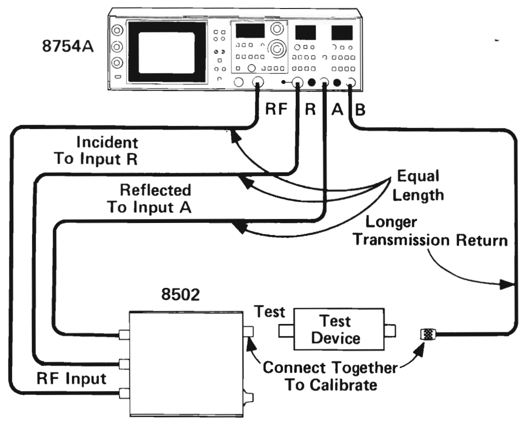
TRANSMISSION MEASUREMENTS

The 8754A measures transmission insertion loss or gain (B/R) using either Channel 1 or Channel 2, and measures insertion phase (PHASE B/R) using Channel 2. The calibration standard for transmission measurements is a "through" connection (connect together the points at which the test device will be connected). Complete transmission calibration sets the magnitude ratio between the R and B inputs to 0 dB and the phase angle to 0° over the frequency range of interest. The following paragraphs describe transmission magnitude ratio and insertion phase calibration and measurement in separate sequences, but the sequences can be combined by using Channel 1 for magnitude and Channel 2 for phase.

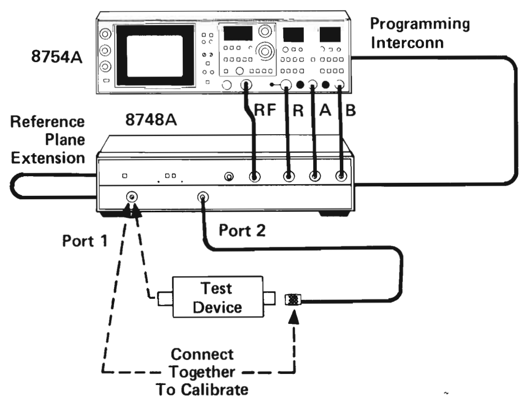
Test Setup

These figures show three transmission test setups using available accessories. Whatever the test setup, calibrate using the same adapters and interconnect cables that will be used for the measurement. If it is necessary to change adapters between calibration and measurement (such as testing a device having the same sex connectors at both ports), best accuracy is achieved by switching between adapters having equal loss and electrical length.

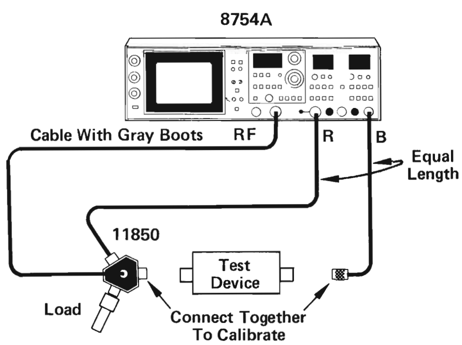
This diagram shows transmission connections using the 8502A Transmission/Reflection Test Set and the 11851A Cable Kit. Use the longer cable as the transmission return between the TEST port and the B INPUT port to provide equal electrical length between the reference and test signal paths. The test device input port is connected to the 8502A TEST port. The 8502 0—70 dB, 10 dB step attenuator is useful for controlling incident power level when testing active devices.



This diagram shows connections using the 8748A S-Parameter Test Set with the test device connected between 11857A cables connected to Ports 1 and 2. Use the four short cables supplied to connect the RF, R, A, B ports. The rear panel test set interconnection cable must be installed for the 8748A S-Parameter select switch to operate correctly. Refer to the table on Page 5 to select the correct reference line extension for your measurement setup.



This diagram shows connections using the 11850A power splitter and the 11851A Cable Kit. Use the longer cable to connect the 8754 RF output and the power splitter input to maintain equal electrical length between the reference and test signal paths. The unused output can be terminated by an HP 908A 50Ω coaxial load or connect the output to the A input. One advantage in using this setup for magnitude only measurements is that two devices can be tested simultaneously. This is done by connecting a second test device from the unused output port of the power splitter to 8754A input A and using the same insertion loss and gain calibration and measurement sequence for Channel 1 A/R and Channel 2 B/R.



Insertion Loss or Gain

Measure transmission magnitude ratio to determine insertion loss or gain as follows:

CALIBRATION

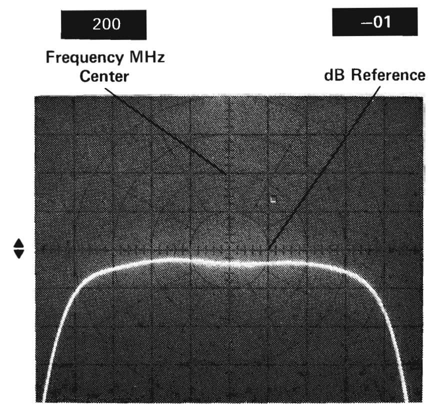
Connect a "through."
Set CRT display, frequency sweep, and signal levels.

Channel 1 or Channel 2, select:

B/R.
Set REFERENCE switch to ± 00.
Adjust OFFSET vernier to move trace to reference position line (OFFSET switch in).

MEASUREMENT

Connect test device.
Set REFERENCE switch to move point of interest on trace to reference position line.
Magnitude ratio = REFERENCE switch setting + trace displacement from reference position line.

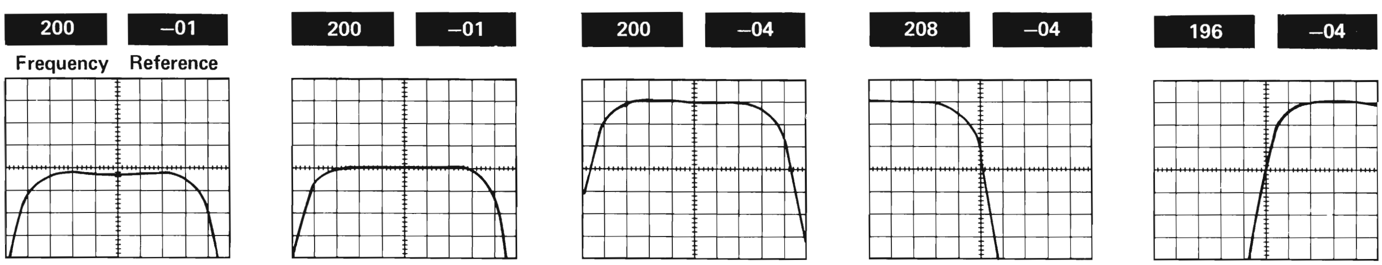


After calibration, a positive value indicates gain; a negative value indicates insertion loss. This example shows measurement of insertion loss of a bandpass filter. The reference position line is set to the middle graticule, REFERENCE switch is set to −01 to position the trace, 1 dB/division is selected, CENTER sweep mode is selected, and the frequency at the center graticule is 200 MHz. The insertion loss at 200 MHz is 1.4 dB. (Add −1 dB REFERENCE switch setting to −0.4 dB position of trace = 1.4 dB insertion loss.)

Relative Measurements

To measure the difference between two points on the trace, use the channel REFERENCE POSITION ⬍ control to move the first point to a horizontal graticule, then use REFERENCE switch to move the second point to the same line. The change from the initial value to the second value for REFERENCE is the difference between the two points. Note that scale division must not be changed during this sequence.

This technique can be used to read relative values between any two points on the trace. For example, the frequency at the −3 dB points of a filter response can be measured as shown in this figure.



Initial Setting | Adjust ⬍ to move point to center graticule | Increase REFERENCE value −03 to move trace up | Adjust TUNING to move upper −3 dB point to center | Adjust TUNING to move lower −3dB point to center

After measurement, press channel REFERENCE POSITION and use ⬍ to move the reference line back to the original position.

Insertion Phase

For a valid insertion phase calibration the electrical length of the reference and transmitted signal paths must be equal with a "through" connection. Refer to the phase calibration discussion, page 15. Measure insertion phase as follows:

CALIBRATION

Connect a "through."
Set CRT display (reference position line to center), frequency sweep, and signal levels.

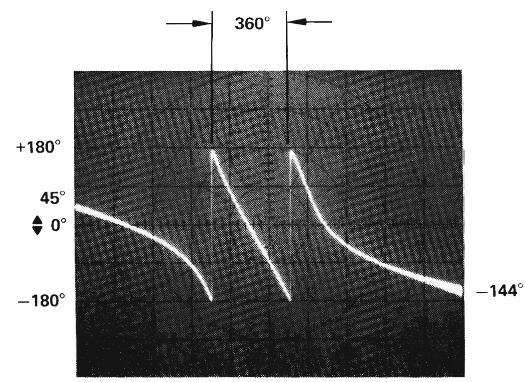
Channel 2, Select:

PHASE B/R.
Set REFERENCE switch to ± 00.
Adjust B/R LENGTH and OFFSET for constant 0° over sweep.

MEASUREMENT

Connect test device.
Set REFERENCE switch to move point of interest on trace to reference position line.
Read phase angle from REFERENCE switch setting.

This figure shows insertion phase of a bandpass filter at 90°/division. The 8754A measurement range is +180 to −180° and the vertical line is the phase detector transition between these values. Thus, the measurement trace between any two of these transitions represents 360° of phase shift.



To illustrate the display format, calculate the total phase shift introduced by the test device over the sweep as follows: Measure the phase angle at the left end of the trace and determine the number of degrees before the first transition trace (45° +180° in this example). Next, count the second and following transition traces and multiply by 360 (1 × 360 in this example). Now determine the number of degrees from the last transition to the right end of the trace (180° + 144° in this example). The sum of these values represents the total phase shift introduced by the test device over this frequency sweep.

$$45° + 180° + (1 \times 360°) + 180° + 144° = 909°$$

When the transmitted signal approaches the noise floor for the phase measurement, about −80 dBm, the phase trace usually approaches zero degrees.

Simultaneous Measurements

Because both Channel 1 and Channel 2 can measure B/R magnitude ratio, you may measure B/R simultaneously on both channels at different scale/division settings. Calibrate both channels as described above for insertion loss or gain. To measure magnitude and phase simultaneously, use Channel 1 for magnitude and Channel 2 for phase. If you decide to use Channel 2 for both magnitude and phase measurements, switching between B/R and PHASE B/R, calibrate magnitude first as described above then do not change Channel 2 OFFSET during phase calibration.

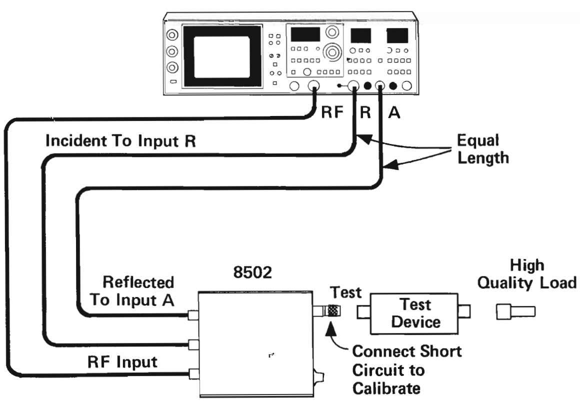
REFLECTION MEASUREMENTS

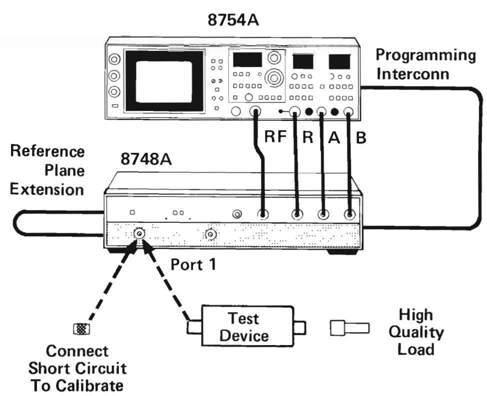
The 8754A displays Return Loss (A/R) using Channel 1 or displays reflection coefficient (POLAR A/R) using Channel 1 for magnitude ratio and Channel 2 for phase angle. The calibration standard for reflection measurements is a short circuit at the point at which the test device will be connected. Complete reflection calibration sets the magnitude ratio between the incident and reflected signal to 0 dB and the phase angle to ±180°, the value for a short circuit. The following paragraphs describe calibration and measurement in separate sequences, but calibration for Return Loss also calibrates POLAR A/R magnitude ratio.

Test Setup

Test setups using the 8502 Transmission/Reflection Test Set and the 8748A S-Parameter Test Set shown on Page 17 for transmission measurements are also used for reflection measurements. Whatever the test setup, calibrate reflection magnitude and phase using the same adapters and interconnect cables that will be used for the measurement.

Best reflection measurement accuracy is usually achieved when the test device is connected directly to the test set RF port because unwanted reflections from adapters, cables, etc. are eliminated. However, for the 8748A, this configuration can only be calibrated for reflection magnitude and phase and transmission magnitude (use the two cable configuration if transmission phase is required). If an adapter is required to connect the test device, refer to the table on Page 5 to select the correct length reference plane extension cable to allow phase calibration using the internal line length equalization controls.





Also, for multiport devices, terminate each unused port to minimize unwanted reflections using a good quality (low return loss, SWR) load, or a transmission return cable to the 8754 receiver input.

Return Loss

Measure Return Loss as follows:

CALIBRATION

Connect a short circuit.
Set CRT display, frequency sweep, and signal levels.
CHANNEL 1, select:
A/R.
Set REFERENCE switch to –00.
Adjust OFFSET vernier to move trace to reference position line (OFFSET switch in).

MEASUREMENT

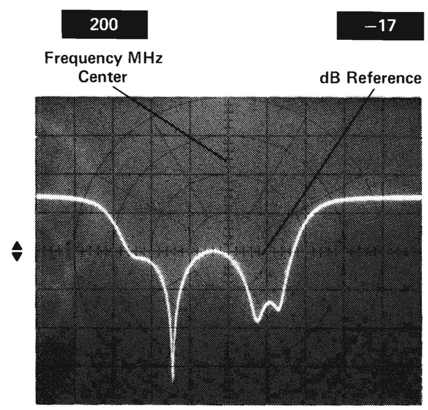
Connect test device
Set REFERENCE switch to move trace to reference position line.
Return Loss = REFERENCE switch setting + trace displacement from reference position line.

After calibration, a negative value indicates that the magnitude of the reflected signal is less than the incident signal. This figure shows return loss of a bandpass filter at 10 dB/division. The reference position line is set ot the center graticule, REFERENCE switch is set to –17 so the Return Loss at the center horizontal graticule is 17 dB.

SWR, standing wave ratio, can be calculated from Return Loss using the HP Reflectometer Calculator (HP P/N 5952-0948) or these equations:

$$\rho = 10^D \text{ where } D = \frac{\text{Return Loss (dB)}}{-20}$$

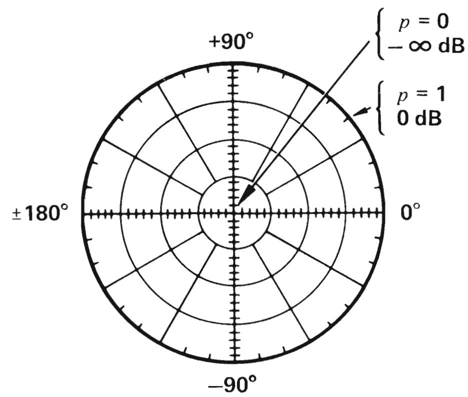
$$\text{SWR} = \frac{1+\rho}{1-\rho}$$



For example, if the measured magnitude ratio is –30 dB, Return Loss = 30 dB, ρ = 0.032, and the SWR is 1.07.

Reflection Coefficient

Reflection coefficient is a complex value consisting of a linear magnitude ratio and a phase angle. The notation used is $\rho \angle \emptyset$ where ρ equals the linear magnitude ratio between the incident and the reflected signal and $\angle \emptyset$ represents the phase angle between the incident and reflected signal.



Reflection coefficient can be read directly from the polar display. The linear magnitude ratio is read from the concentric circles and the phase angle is read from the radial lines. The polar beam center point has the value $\rho = 0$ (infinite dB Return Loss). The outer circle is the magnitude ratio reference line. After calibration the outer circle has the value $\rho = 1$ (0 dB Return Loss). The radial lines are scaled from 0 to ±180° with zero degrees the right hand intersection of the horizontal center line and the concentric circles.

Measure reflection coefficient as follows:

CALIBRATION

Connect short circuit.
Set CRT display (POLAR CENTER), frequency sweep, and signal levels.
Press POLAR A/R.
CHANNEL 1 (Magnitude):
  Set REFERENCE switch to ± 00.
  Adjust OFFSET vernier to move trace to outer circle (OFFSET switch in).
CHANNEL 2 (Phase angle):
  Set REFERENCE switch to ± 00.
  Adjust POLAR A/R LENGTH and OFFSET for smallest cluster at ± 180°.

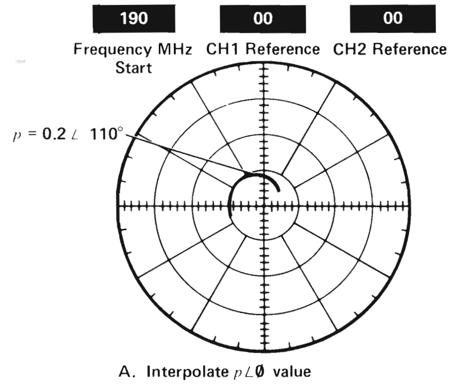
MEASUREMENT

Connect test device.
Read $\rho \angle \phi$ from polar graticule or:
  Set CHANNEL 1 REFERENCE switch to move point on trace to outer circle.
  Set CHANNEL 2 REFERENCE switch to move point on trace to zero degrees.

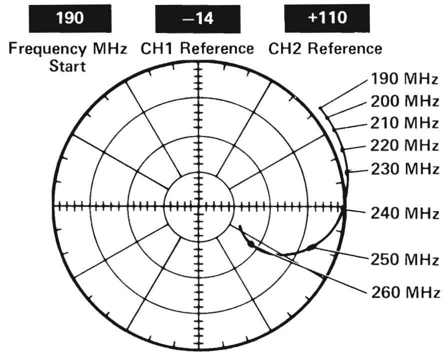
$$\rho = 10^{D} \text{ where } D = \frac{\text{CHANNEL 1 REFERENCE (dB)}}{20}$$

Note: After calibration, Channel 1 REFERENCE values of −6, −14, and −20 correspond to polar outer circle values of 0.5, 0.2, and 0.1, and are therefore convenient settings for interpolating reflection coefficient values from the CRT.

For best accuracy in reading the measured value, use Channel 1 and Channel 2 REFERENCE switches to move the point on the trace to 0° at the outer circle. These following figures show the initial measurement trace position (A), then the resultant trace when the REFERENCE controls are used to move the point of interest to 0° at the outer circle (B).



A. Interpolate ρ∠Ø value from polar graticule



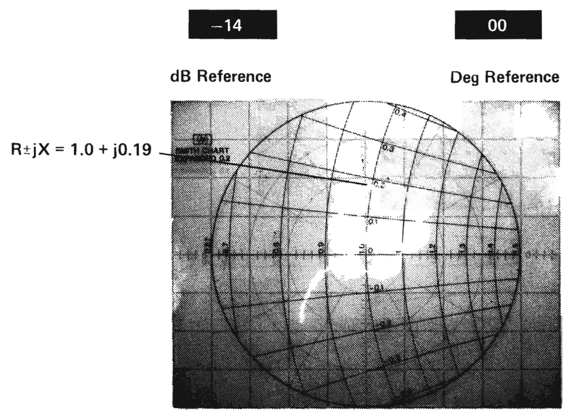
B. Adjust reference values to position point and calculate ρ∠Ø

Frequency information is present on the polar trace using the crystal markers. To measure frequency at a point on the trace: Select A/R, press to release POLAR A/R, and calibrate the FREQUENCY MHz display (see page 12). Select START sweep mode and POLAR A/R. Either interpolate the frequency at the point of interest using the crystal markers as shown in B, or select CW sweep width, adjust TUNING, and read the frequency value directly from the FREQUENCY MHz display.

Impedance - Using the Smith Chart

Impedance can be read directly from the polar reflection coefficient display by installing a Smith Chart overlay. (To install the overlay, grasp the top and bottom of the plastic bezel, squeeze to release the catch, then pull out. Slide the overlay down through the top slot, then reinstall the bezel.) Four versions of the Smith Chart overlay are supplied with the 8754A: 2.0, 1.0, 0.2, and 0.1 full scale reflection coefficient value at the outer circle. To read impedance directly in R ± jX format, install the appropriate overlay, calibrate for reflection coefficient as above, leave Channel 2 REFERENCE switch at ±00, and set Channel 1 REFERENCE switch as follows:

Smith Chart Overlay (ρ full scale)	Channel 1 Reference Switch
2.0	+6
1.0	±00
0.2	−14
0.1	−20



Simultaneous Measurements

For simultaneous measurement of return loss and transmission insertion loss or gain, use Channel 1 A/R and Channel 2 B/R.

To measure transmission magnitude and phase and reflection coefficient using the same test setup, calibrate Channel 2 B/R for insertion loss or gain, Channel 2 PHASE B/R for insertion phase (but do not change Channel 2 OFFSET after magnitude calibration), then calibrate POLAR A/R reflection coefficient as described above (but do not change Channel 2 OFFSET).

POWER LEVEL MEASUREMENTS

The 8754A can measure the absolute power in dBm at the R, A, and B input ports. Some applications of this capability are measuring and setting actual signal levels into the R, A, and B inputs prior to calibration; verifying signal levels at various points in the test setup including actual incident and transmitted power; and direct measurement of losses in the test set, cables, and fixtures.

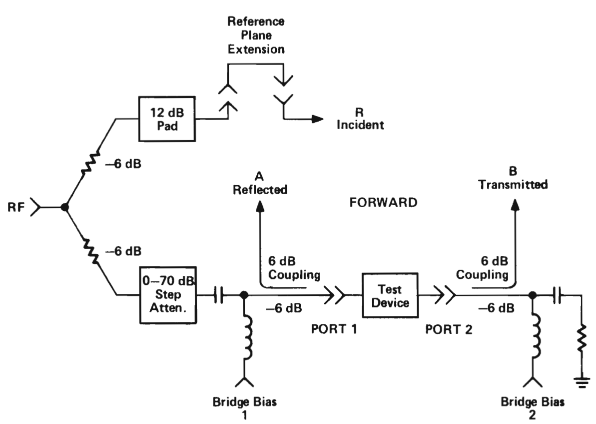
MEASUREMENT

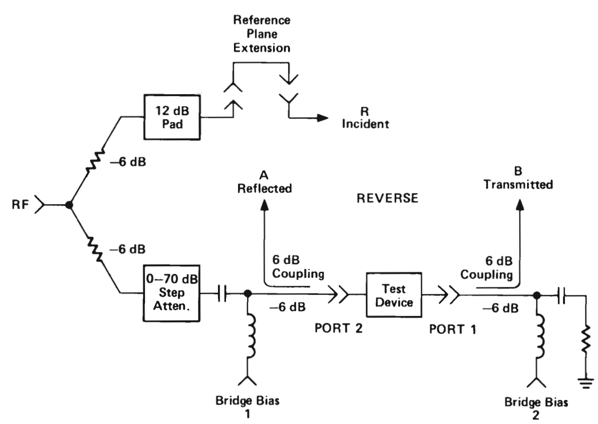
Press to release OFFSET buttons.
Set CRT and frequency sweep.
Select measurement:
R (Channel 1 with both CH1 and CH2 OFF),
A (Channel 1), or
B (Channel 2).
Set REFERENCE to move trace to reference position line.
Power (dBm) = REFERENCE switch setting + trace displacement from reference line.

S-PARAMETER MEASUREMENTS

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 reflection S-parameters (S_{11}, input reflection coefficient, and S_{22}, output reflection coefficient) are measured using a sequence similar to that described for Reflection Coefficient, Page 23. Transmission S-Parameters (S_{12}, forward transmission coefficient and S_{21}, reverse transmission coefficient) are measured using the rectangular magnitude and phase displays.

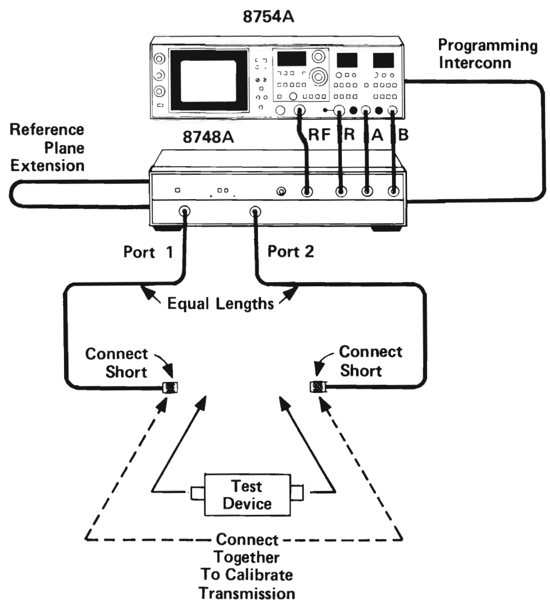
The 8748A front panel S_{11}/S_{21} (forward) and S_{22}/S_{12}(reverse) buttons switch the incident RF to Port 1 in forward or Port 2 in reverse. These illustrations show the signal paths for forward and reverse selections.





Test Setup

This diagram shows connections using the 8748A S-Parameter Test Set. Use the four 19 cm Type N cables supplied to connect the RF, R, A, and B ports on the 8748A and 8754A front panels. The cable between the 8754A and the upper 8748A PROGRAMMING connector is required for proper operation of the network analyzer and test set combination.



Connections to the test device can be made using the 11857A Test Port Extension Cables, or the 11608A, 11600B, or 11602B Transistor Fixtures. The rear panel Reference Plane Extension cable must be matched to the test fixture in order to equalize the signal paths. The table on Page 5 lists the reference plane extension cable which should be used with each fixture. Note that the signal path lengths from ports 1 and 2 must be equal.

With the correct matched test port extension cables or fixture and reference plane extension installed, the test setup has nearly equal losses and electrical lengths for both forward and reverse measurements. This allows forward transmission and reflection calibrations to be used for both forward and reverse measurements. If other than the listed fixtures are used, then the reference and test signal paths must be matched to achieve a symetrical test setup.

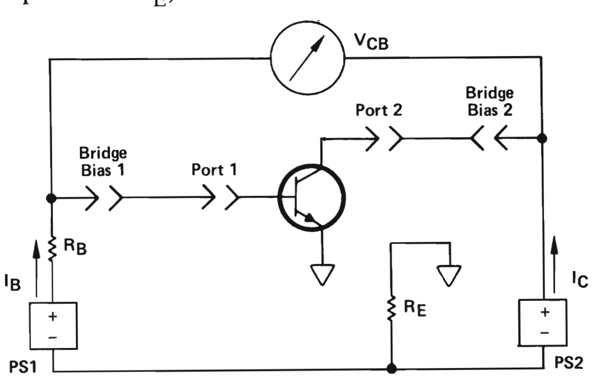
Transistor Bias

BRIDGE BIAS 1 and 2 on the 8748A rear panel provide connections for ±30 Vdc, ±200 mA bias when measuring transistors.

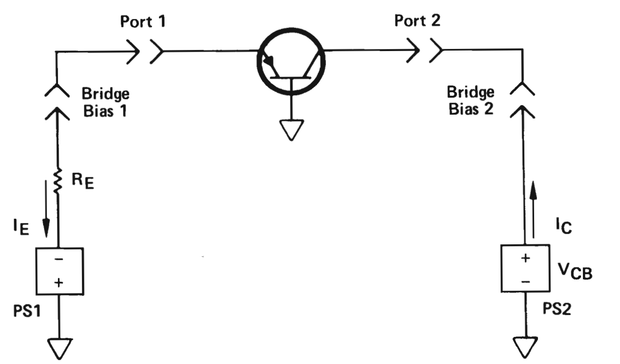
Use a dual dc power supply such as the HP Model 6205B that is designed for use with bias tees optimized for RF applications. (The HP Model 8717B Transistor Bias Supply is not compatible with the 8748A; it is designed for bias tees optimized for microwave frequencies and may cause the test device to oscillate). These diagrams show biasing connections for NPN common emitter and common base configurations. Reverse power supply polarities for PNP devices.

For the common emitter, choose R_E for desired collector current with maximum voltage drop across R_E while maintaining forward bias voltage. (For example, with $I_E = 20$ mA, $R_E = (10V/0.02) = 500\Omega$.) Choose R_B to control oscillations (typically from 100 to 400Ω). Turn on PS2 first and set voltage to V_{CE} + I_R drop across R_E, then turn on PS1 and set for desired I_E.

For the common base, choose R_E as above and R_B is not required. Turn on PS2 first and set to V_{CE} + I_R drop across R_E, then turn on PS1 and set for desired I_E. Finally reset PS2 for desired V_{CB}.



Common Emitter



Common Base

Calibration

Calibrate the 8754A/8748A combination as follows:

S_{21} - Forward Transmission

Connect "through."
Set Test Set: S_{11}/S_{21}.
Perform Insertion Loss or Gain Calibration, B/R, using Channel 2, see Page 18.
Perform Insertion Phase Calibration, PHASE B/R, using Channel 2, see Page 19, but do not adjust Channel 2 OFFSET vernier.

S_{12} - Reverse Transmission

Set Test Set: S_{22}/S_{12}.
Verify that both B/R and PHASE B/R measurements remain near 0 dB, 0° for both forward and reverse. Any offsets between forward and reverse must be noted and manually subtracted from the measured value. A phase-length difference between forward and reverse will occur if the connections from ports 1 and 2 to the test device are not the same length.

S_{11} - Input Reflection

Connect short circuit to Port 1 measurement plane.
Set Test Set: S_{11}/S_{21}.
Perform Reflection Coefficient Calibration, POLAR A/R, see Page 23, but do not adjust CHANNEL 2 OFFSET vernier.

S_{22} - Output Reflection

Connect short circuit to Port 2 measurement plane.
Set Test Set: S_{22}/S_{12}.
Verify that trace remains near outer circle, ± 180° for both forward and reverse. Any offsets between forward and reverse must be noted and manually subtracted from the measured value. A phase-length difference between forward and reverse will occur if the connections from ports 1 and 2 to the test device are not the same length.

Measurement

Measure forward and reverse S-parameters as follows:

Set Test Set: S_{11}/S_{21}.

Set 8754A:

POLAR A/R = $S_{11} = \rho \angle \phi$

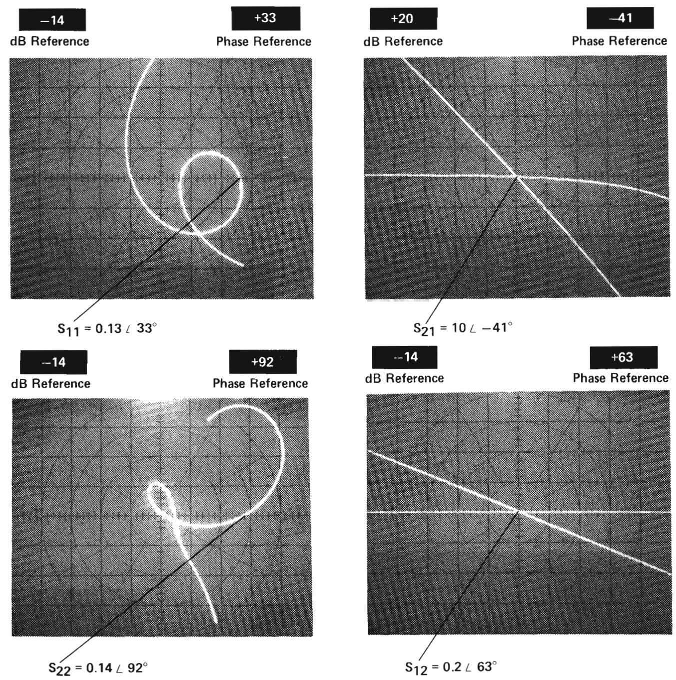
$\left.\begin{array}{l}\text{B/R, CH 2}\\ \text{PHASE B/R, CH 2}\end{array}\right\} = S_{21} = \tau \angle \phi$

Set Test Set: S_{22}/S_{12}.

Set 8754A:

POLAR A/R = $S_{22} = \rho \angle \phi$

$\left.\begin{array}{l}\text{B/R, CH 2}\\ \text{PHASE B/R, CH 2}\end{array}\right\} = S_{12} = \tau \angle \phi$

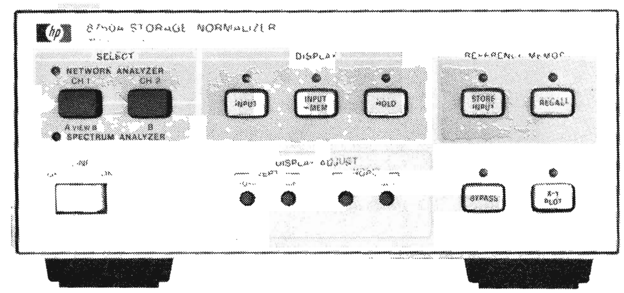


Select S_{11}/S_{21}, press POLAR A/R and use the Reflection Coefficient Measurement sequence, Page 23, to measure S_{11}. Press-to-release POLAR A/R and alternate between CHANNEL 2 B/R and PHASE B/R to obtain magnitude and phase values for S_{21}. The transmission coefficient linear magnitude value, τ, is calculated from the dB magnitude ratio using the same equation used for ρ. Select S_{22}/S_{12} and repeat this sequence for the reverse parameters.

Impedance - Using the Smith Chart

Impedance can be read directly from the polar display for S_{11} or S_{22} by installing the Smith Chart overlay. See Page 24.

USING THE 8750A STORAGE-NORMALIZER

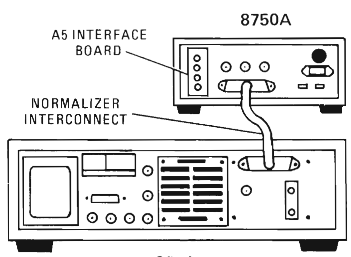


The 8750A provides independent storage and normalization for each of the two 8754A measurement channels. In general, 8750A operating modes are selected by pressing CH1 or CH2 to choose the active display channel, then pressing one of the Display or Reference buttons to choose the active channel operating mode. The active display channel is identified by the lighted indicator in the center of the CH1 or CH2 button, and the mode is identified by a lighted indicator above one of the Display or Reference buttons.

All 8754A setup, calibration, and measurement sequences described in this manual can be accomplished using the 8750A except POLAR A/R measurements. Pressing BYPASS removes the 8750A from the display circuits and returns the CRT to standard analog operation. (The 8750A automatically switches to bypass when POLAR A/R is selected.) Pressing any Display button activates the 8750A and both measurement channels are displayed according to the last Display Mode selection.

Installation

Connect the 8750A and 8754A using the supplied cable between the rear panel NORMALIZER INTERCONNECT connectors. Install the A5 Interface Board labeled NETWORK ANALYZER (with both switches on the board set to EXT) or 8754A NETWORK ANALYZER Board in the 8750A rear panel interfase board slot.



Alignment Test

With any trace on the display, press CH1, INPUT, CH2, INPUT then alternate between INPUT and BYPASS. The trace and any markers should match within ±1/2 minor division. Now press CH1, STORE INPUT, INPUT-MEM. The trace should move to the center graticule, ±1/2 minor division. Next, select INPUT and use scale/division or reference offset to move the trace to above or below the CRT graticule. The trace should be clipped to a solid line about 1 minor division (middle of 90° label) above the top or below the bottom graticule. Note that although the 8750A can be adjusted so that the bypass and input mode traces match very closely, most applications will be served with excellent results if the traces match within ±1/2 minor division. If the traces are correct in these tests then continue with the following paragraphs to familiarize yourself with operation of the 8750A. If the traces differ significantly between INPUT and BYPASS, or if STORE INPUT and INPUT-MEM does not move the trace to the center graticule, perform the Matching the 8750A to the 8754A sequence on page 31 then continue with the following paragraphs.

Digital Storage

When the device response characteristic requires a slow sweep to avoid distortion of the measurement, use digital storage to provide a flicker-free display.

> Select CH1 or CH2
> Press INPUT

Each measurement trace is digitized and stored at the 8754A sweep rate then output to the CRT at a fixed display rate. This provides display of the complete measurement trace regardless of the network analyzer sweep time. Rectangular traces are digitized at 256 points on the x-axis and 512 points on the y-axis (32 points per major vertical division; 256 points to achieve ±50% overrange).

Normalization

The typical use for normalization is to remove the frequency response characteristic of the measurement setup from the measurement. A normalized display shows the difference between the frequency response of the measurement standard and the response of the test device directly as deviation from a straight line. Thus, normalization replaces conventional methods, such as using a grease pencil on the face of the CRT, as the preferred method of measuring and adjusting devices to match a standard response.

> 8754A:
> - Set CRT (reference position line to center graticule).
> - Select measurement (A/R, B/R, PHASE B/R).
> - Connect standard (short, through, or standard device).
> - Set Scale/division same as for measurement.
> - Adjust OFFSET vernier so that trace is fully on the CRT.
>
> 8750A:
> - Select CH1 or CH2 then press STORE INPUT or INPUT-MEM (trace moves to center graticule).
> - Connect test device.

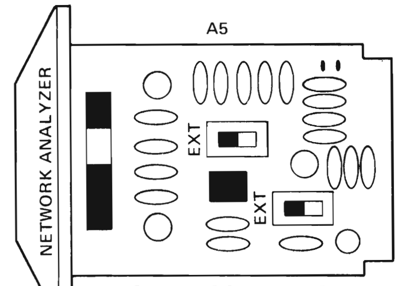
When STORE INPUT is pressed, the current displayed trace, except for frequency markers, is transferred to reference memory. Pressing INPUT-MEM displays the difference between the reference trace and the current measurement as deviation from a straight line at the center graticule. If the current trace is identical to the reference trace, then the normalized trace is a flat line at the center horizontal graticule. RECALL can be pressed to display the stored reference trace instead of the measurement trace, if desired.

It is important that scale/division not be changed after the reference response is stored. Also, the 8750A incorporates ±50% vertical digitizer overrange. This means that traces which exceed the vertical display range by up to four major divisions can be stored for use as the reference even though the trace appears to be truncated at the upper or lower graticule line. If the reference trace exceeds ±50% overrange the normalized display will not be correct.

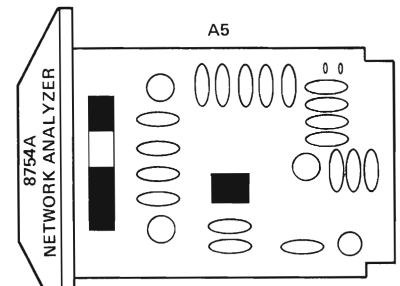
Matching the 8750A to the 8754A

Alignment may be required when the 8750A is first connected to the 8754A. Perform the following alignment sequence when the trace differs significantly (greater than ± 1/2 minor division) between the bypass and input modes and the difference cannot be corrected using the 8750A front panel horizontal and vertical adjustments.

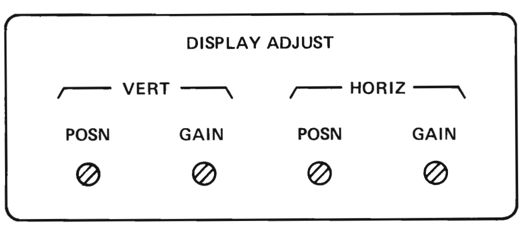
The correct A5 interface board must be installed. Two standard interface boards are supplied with the 8750A, one labled SPECTRUM ANALYZER and one labeled NETWORK ANALYZER. In addition, an optional interface board labeled 8754A NETWORK ANALYZER is available. Set the two switches on the component side of the board to EXT as shown, install it and use the following adjustment sequence. Both the standard and 8754A Network Analyzer Interface boards use the identical alignment procedure. The optional board uses some different components to eliminate the switches and reduce the range of adjustment while increasing the adjustment resolution. If you encounter problems in this procedure, refer to the 8750A Operating and Service Manual.



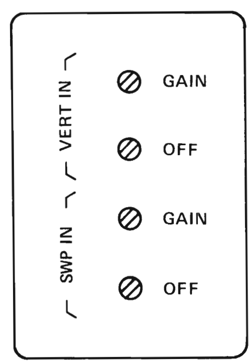
SWITCHES SET AT EXT.
08750-60005 NETWORK ANALYZER INTERFACE BOARD



08750-60036 8754A INTERFACE BOARD



FRONT PANEL



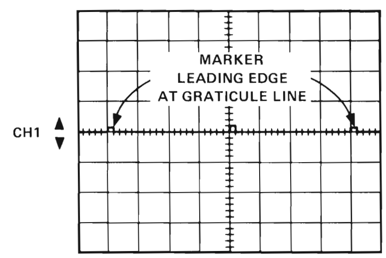
REAR PANEL (A5 INTERFACE BOARD)

8750A ADJUSTMENT

Perform the following sequence to match the 8750A to the 8754A.

a. 8750A: (Initial alignment only).
   Press BYPASS.
   Set front panel VERT POSN, VERT GAIN, HORIZ POSN, HORIZ GAIN to mid-range.
   Set rear panel SWP IN OFF, SWP IN GAIN and VERT IN OFF to midrange, and VERT IN GAIN to fully CW.

b. 8754A:
   Press CENTER.
   Adjust TUNING to $\approx$ 400 MHz.
   Channel 1: Press B/R. Channel 2: Press OFF.
   Press CH1 REFERENCE POSITION.
   Adjust CH 1 ▲▼ to move trace to center graticule.
   Adjust front panel HORIZ POSN and HORIZ GAIN and rear panel TRACE ALIGN for correct trace.
   Set SWEEP WIDTH MHz to 200 MHz.
   Set MARKERS MHz to 50 MHz.
   Set SWEEP WIDTH MHz vernier and TUNING to adjust marker position to

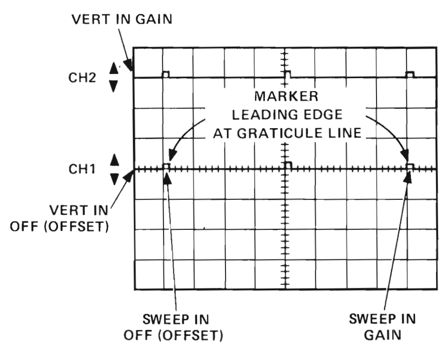


c. 8750A:
   Press CH 1, then INPUT.
   Adjust HORIZ POSN and HORIZ GAIN for full width trace.
   Press STORE INPUT, then INPUT-MEM.
   Adjust VERT POSN to move trace to center graticule.
   Press BYPASS.

d. 8754A:
   Set CH 1 ▲▼ fully clockwise to move trace to just above top graticule.

e. 8750A:
   Press CH 1, then INPUT.
   Adjust VERT GAIN to move trace to one minor division above top graticule.
   Press BYPASS.

f. 8754A:
   Channel 2: press B/R
   Press CH2 REFERENCE POSITION.
   Adjust CH1 ▲▼ and CH2 ▲▼ to move traces to



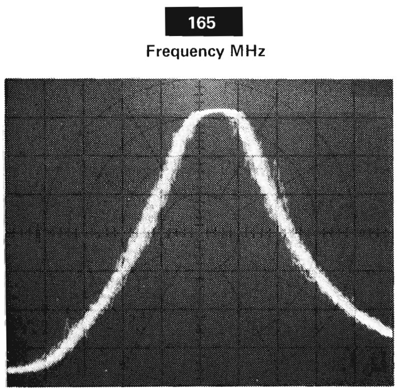
g. 8750A:
   Press CH1, INPUT, CH2, INPUT
   Adjust SWP IN OFF and SWP IN GAIN to match marker position.
   Adjust VERT IN OFF and VERT IN GAIN to position traces.
   Press BYPASS.

h. 8754A:
   Connect test device, release CH1 and CH2 REFERENCE POSITION buttons, and position trace for measurement.

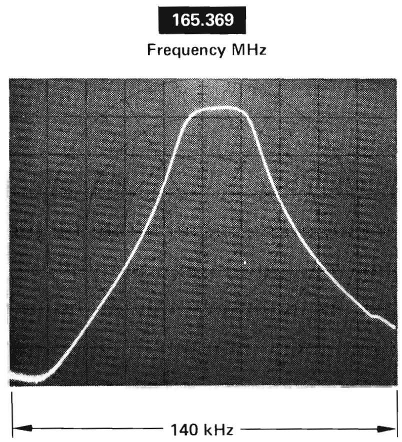
i. 8750A:
   Press CH1, INPUT, CH2, INPUT.
   With trace displayed, switch between INPUT and BYPASS, using the front panel controls to make fine adjustments, if necessary.

USING AN EXTERNAL SOURCE

When the test device magnitude or phase response changes rapidly with frequency, measurement uncertainty (predominantly seen as noise on the trace) may be caused by residual FM characteristics of the source. Using a stabilized source in place of the 8754A built-in source can improve accuracy and resolution when testing narrowband devices. These figures show transmission magnitude measurements for a 20 MHz crystal bandpass filter using the standard 8754A source (A) and the HP Model 8640B Signal Generator (B). All performance characteristics of the 8754A receiver remain the same but a crisp, easy to read trace and improved frequency resolution result from the reduced residual FM characteristics of the 8640B.



(A) 8754A Source



(B) 8640B Source

In order to achieve proper receiver phase-lock and absolute power calibration when using an external source, the 8754A FREQUENCY MHz display should be adjusted to agree with the Source's START, or lower, frequency. Also, the SWEEP WIDTH MHz control should be adjusted to agree with the Source's sweep width, or set to EXT RF for sweeps less than one and one-half octaves.

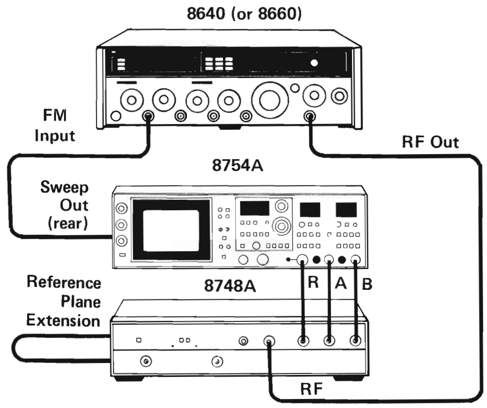
There are two types of external sources which can be used with the 8754A. First, there are stabilized signal generators with FM capabilities such as the HP 8660 or HP 8640 which achieve a swept display using the 8754A −5V to +5V sweep output as their FM input. Second, there are sources such as the HP 8662, 3325, and 8601 which contain their own sweep capabilities and achieve a swept display on the 8754A by using their sweep output as the 8754A external sweep input (0V to +10V, adjustable from +6V to +12V maximum using the 8754A front panel Horizontal Gain control).

Using a source with FM capability (swept by the 8754A SWEEP OUT) is preferred, since retrace blanking and phase lock control are internal and automatic. When using an externally swept source (8754A horizontal axis driven externally), then only one channel can be displayed (no alternate, 2 channel display is allowed), and receiver relock points are not blanked.

Narrowband Sweep Using Source With FM Capabilities

For sweeps less than one and one-half octaves, any any source with dc-coupled FM input, such as the 8640 or 8660 may be used.

For the 8660 and 8640 sources the frequency sweep is obtained by connecting the 8754A rear panel SWEEP OUTPUT to the signal generator FM INPUT. The 8754A Sweep output is a –5V to +5V ramp used to frequency modulate the signal generator RF output at a rate selected by the 8754A SWEEP control. Center frequency peak deviation (1/2 sweep width), and RF output level are set using the stabilized source controls.



Make a measurement using the 8640A or 8640B as follows:

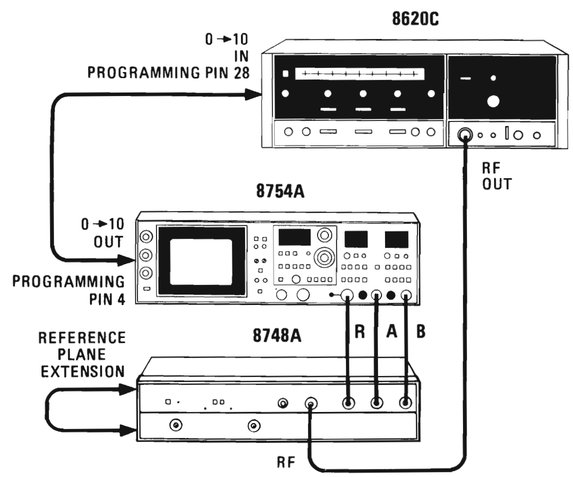
Set 8754A SWEEP WIDTH MHz to EXT RF
Set 8754A FREQUENCY MHz display to the start frequency of the sweep.
Set 8640 FM switch to OFF and set center frequency using 8640 FREQUENCY TUNE and FINE TUNE controls.
Set 8640 FM switch to DC, set 8754A SWEEP to MAN, adjust the 8754A sweep vernier fully counterclockwise, use the 8640 PEAK DEVIATION control to set the start frequency (as read on a counter). Then select 8754A AUTO and FAST or SLOW sweep.

Calibrate and make measurements as discussed previously.

Wideband Sweep Using Source With FM Capability

For sweeps greater than one and one-half octaves, a sweeper such as the HP 8620C may be used.

For the 8620C, the frequency sweep is obtained by connecting the 8754A 0 to 10V sweep output (on J7 PROGRAMMING connector pin 4) to the 8620C external sweep input (PROGRAMMING connector pin 28). The ground connection should also be made between 8754A J7 pin 18 and 8620C pin 43.



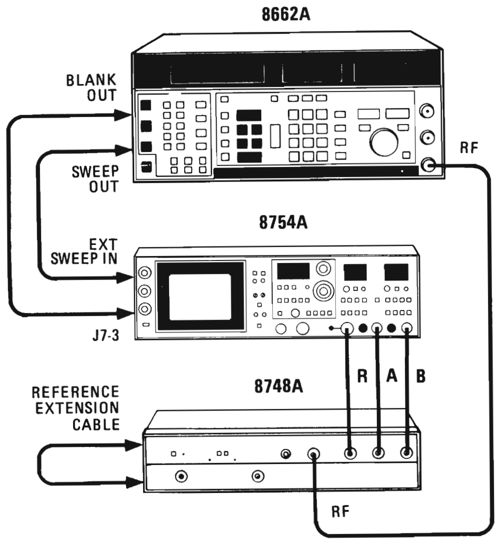
To use this system:

Set 8620C to EXT SWEEP mode Set 8620C START and STOP frequencies as desired Press 8754A FREQUENCY mode START pushbutton Adjust 8754A FREQUENCY MHz display to 8620C START frequency Set 8754A SWEEP WIDTH MHz to 8620C sweep width Adjust 8754A SWEEP controls for desired sweep rate Calibrate and make measurements as discussed previously

Narrowband Sweep Using External Swept Source

For sweeps less than one octave, a source containing its own sweep capability, such as the 8662A Synthesizer, may be used.

For the 8662A, the horizontal axis of the 8754A is driven by connecting the 8662A SWEEP OUTPUT, which is a 0 to 10V ramp, to the 8754A EXT SWEEP IN connector. Proper retrace blanking is achieved by connecting the 8662A Z-axis blanking output to the 8754A PROGRAMMING connector, J7 pin 3 (serial prefix 1908A and higher).



To use this system:

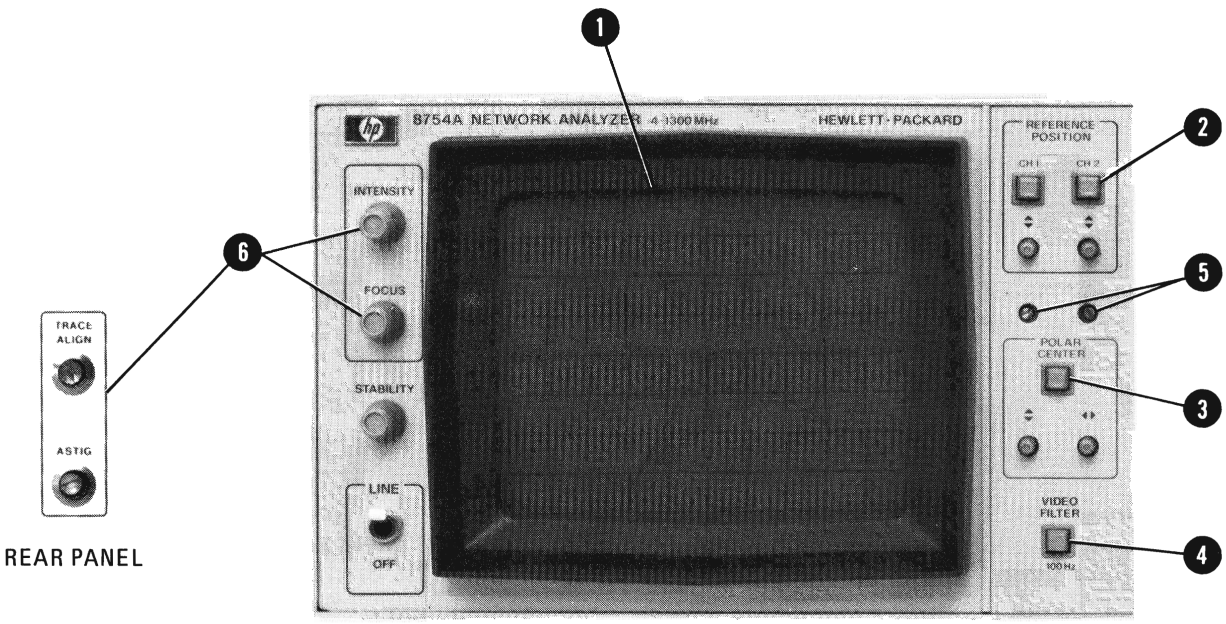
Set 8754A rear-panel switch to EXT SWEEP Set 8662A controls for desired frequency range, power level, and sweep speed (2 ms/step or longer). Set 8754A SWEEP WIDTH MHz to EXT RF Set 8754A FREQUENCY MHz display to the START frequency of the sweep Calibrate and make measurements as discussed previously

No alternate sweep capability exists, so only one rectangular channel will be displayed.

For the 8662A, devices with group delay greater than 1 ms may require slow sweep speed.

CONTROLS, INDICATORS AND DISPLAYS SUMMARY

The 8754A front panel uses press-to-engage-press-to-release pushbuttons, interlocked sets of pushbuttons, and verniers. The following figures describe the three control groups – CRT Display, Source, and Receiver.



CRT DISPLAY

1 **CRT Display.** Both rectangular (for magnitude and phase) and polar (for reflection coefficient) graticules. Smith chart overlays with normalized full scale impedance values of 2, 1, 0.2, and 0.1 are supplied.

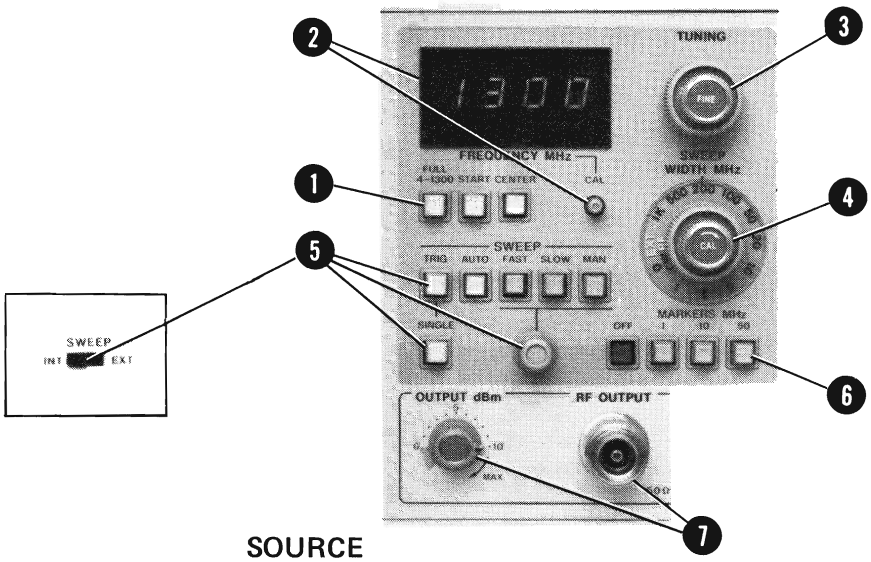
2 **REFERENCE POSITION.** Controls to display and position the independent Channel 1 and Channel 2 rectangular reference position lines. Press CH 1 or CH 2 to display the reference position line then use ▲▼ to set position. Press-to-release CH 1 or CH 2 to display the measurement trace. The display remains calibrated regardless of placement of the reference position line. These operate only when a rectangular measurement mode is selected.

3 **POLAR CENTER.** Controls to display and position the polar beam center. Press POLAR CENTER to display the beam center dot then use ▲▼ and ◀▶ to move the beam center to the center of the polar graticule. Press-to-release POLAR CENTER to display the measurement trace. Operates only when POLAR A/R measurement mode is selected.

4 **VIDEO FILTER.** Selects post-detection bandwidth. Press-to-engage to select 100 Hz, press-to-release to select 10 kHz.

5 **HORIZONTAL POSN and GAIN.** Screwdriver adjustments for rectangular display to set position (POSN) and length of trace (GAIN).

6 **Beam Controls.** Standard CRT controls for INTENSITY (beam brightness), FOCUS (sharpness), TRACE ALIGN (parallelism), and ASTIG (astigmatism, concentricity of dot).



SOURCE

1 Sweep Mode. In FULL 4—1300, the full frequency range of the instrument is swept and the FREQUENCY MHz display shows the frequency of the Tuning Marker. START and CENTER select the Tuning Marker frequency as the start or center frequency of the sweep selected by SWEEP WIDTH MHz.

2 FREQUENCY MHz. Display frequency in MHz according to Sweep Mode selection. In FULL 4–1300 it displays the frequency of the Tuning Marker. In START or CENTER, it displays the start or center frequency of the selected sweep. This display is calibrated using the CAL control and crystal markers selected by MARKERS MHz.

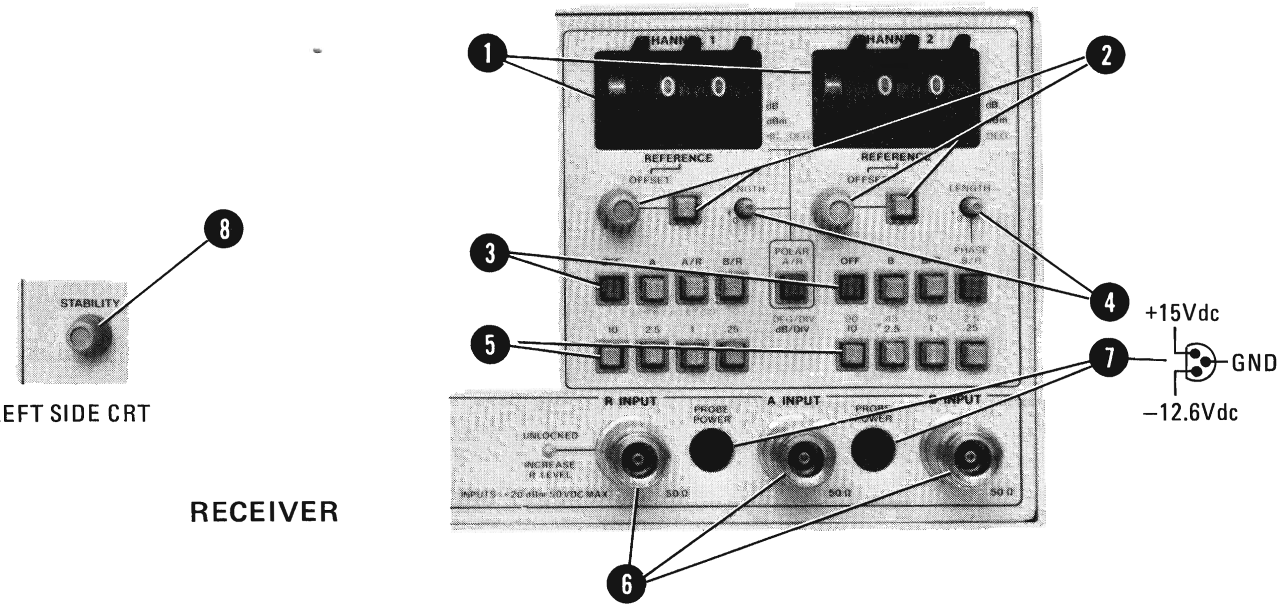
3 TUNING. Provides coarse and fine control of the full sweep Tuning Marker or the START or CENTER frequency.

4 SWEEP WIDTH MHz. Selects sweep width in MHz for START and CENTER sweep modes, a CW mode in which the constant tuned frequency is output, or an EXT RF mode switch selects RF input from an external source. Except for the EXT RF position, this control is active only when START or CENTER is selected. Sweep width is calibrated when the small internal CAL vernier is set to fully CW detent. Uncalibrated vernier settings allow intermediate sweep width selections.

5 SWEEP. Selects sweep trigger and sweep time. With the rear panel sweep switch set to INT, the AUTO button selects the internal sweep generator with sweep times between 0.01 and 0.5 seconds for FAST or 1 to 50 seconds for SLOW. The vernier controls sweep time within these ranges. With MAN selected, the vernier controls the CW frequency output within the selected sweep width. With TRIG selected, the SINGLE button is pressed to cause a single sweep at the selected sweep time. With the rear panel SWEEP switch set to EXT, the sweep is controlled by the signal at the rear panel EXT SWEEP INPUT connector.

6 MARKERS MHz. Selects crystal markers displayed on the trace at 50 MHz, 10 MHz, or 1 MHz intervals used for FREQUENCY MHz display calibration and frequency measurement. The 50 MHz and 10 MHz markers are active in all SWEEP WIDTH positions and the 1 MHz markers are active for sweep widths of 20 MHz or less.

7 OUTPUT dBm, RF OUTPUT. OUTPUT dBm controls internally leveled output power at RF OUTPUT connector. Output level is calibrated from 0 to +10 dBm and maximum uncalibrated power output is approximately +13 dBm.



❶ **CHANNEL 1 and CHANNEL 2 REFERENCE.** Calibrated lever-activated offset controls, independent for each channel, which display the value of the reference position in dB, dBm, or degrees. The range of these controls is ±199.

❷ **OFFSET.** The vernier is used in calibration to move the reference trace to the reference position. With the associated button in the detent position this offset is applied to the measurement; with the button released the offset is not applied. The OFFSET verniers are independent for CHANNEL 1 and CHANNEL 2 and provides about ±80 dB range for magnitude calibration and about ±20 degrees range for phase calibration.

❸ **Measurement Select.** Press to select the measurement. POLAR A/R uses CHANNEL 1 for polar magnitude and CHANNEL 2 for polar phase angle. R, A, and B select power in dBm at the R, A, or B input (OFFSET not engaged). NOTE: To select R, press Channel 1 and 2 OFF. A/R and B/R select magnitude ratio in dB between the A or B and R input. PHASE B/R displays the phase relationship in degrees between B and R inputs. Pressing POLAR A/R overrides any other measurement selection.

❹ **LENGTH.** Used to add equivalent electrical length of approximately 0 to 160 mm to the reference channel in POLAR A/R phase measurements and PHASE B/R phase measurements. These controls are independent.

❺ **Scale/Division.** Select scale/division for rectangular display.

❻ **Receiver Inputs.** The receiver requires a signal at the R input between 0 and −40 dBm to maintain phase lock. The UNLOCKED indicator lights to indicate low R channel input level. A and B inputs are full range test inputs, specified from 0 dBm to −80 dBm.

❼ **PROBE POWER.** Each provides regulated power for operating active probes such as the Model 1121A AC Probe. Voltages supplied are +15 Vdc and −12.6 Vdc.

❽ **STABILITY.** Adjust to eliminate jitter in horizontal position of receiver relock points. Relock points may occur in sweeps >2 octaves wide.

INPUTS/OUTPUTS SUMMARY

This figure shows the 8754A rear panel inputs and outputs.

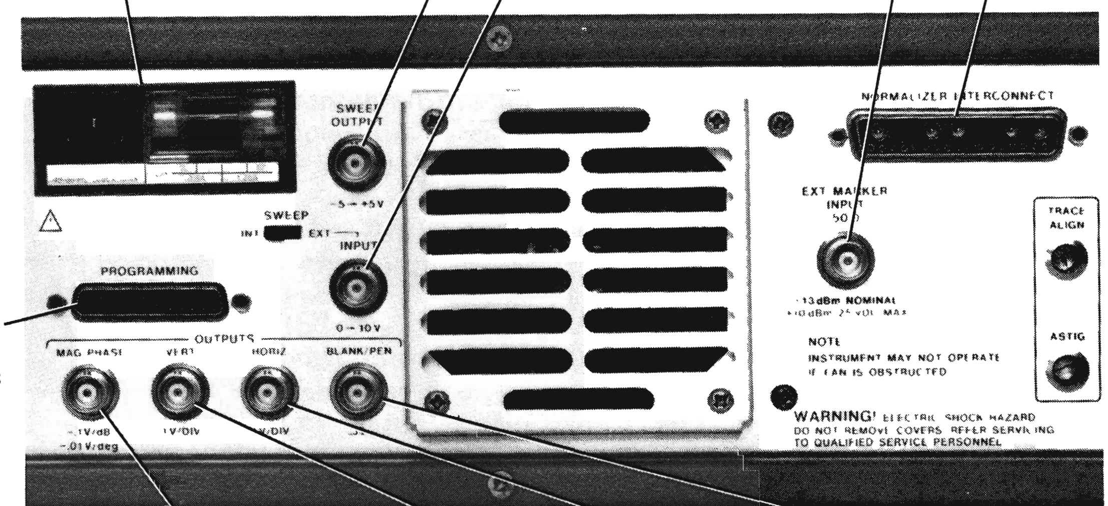
LINE VOLTAGE +5%, −10%	POWER MODULE SELECTION	FUSE
90 to 105 VAC	100V	2.5 AT
108 to 126 VAC	120V	2.5 AT
198 to 231 VAC	220V	1.25 AT
216 to 252 VAC	240V	1.25 AT

825Ω
Sweep Output, ±5V,
Present in all sweep
modes, INT. and EXT.

50KΩ
External Sweep In
1V/Display Division.
Sweeps CRT display
and RF source.

50Ω
CW RF INPUT
Generates Marker
at input frequency.

To 8750A or 8501A
Storage-Normalizer



J7
See Table
for Pin
Functions

A/R or B/R Magnitude Ratio or Phase Angle. Mag ratio or phase selected by J7 pin 19

MAG RATIO = −0.1V/dB	Ø = −0.01V/°
+40 dB = −4V	+180° = −1.8V
0 dB = 0V	0° = 0V
−80 dB = +8V	−180° = +1.8V

For mag ratio, REFERENCE and OFFSET do not affect output. For phase, REFERENCE, OFFSET, and LENGTH are included in output unless 8754A Remote Enable, J7 pin 21 is selected.

1KΩ
Vertical Deflection
Center Graticule = 0V,
±0.4V range,
+0.04V Marker.

1KΩ
Horizontal Deflection,
Left Graticule = 0V,
Right Graticule = 1V.

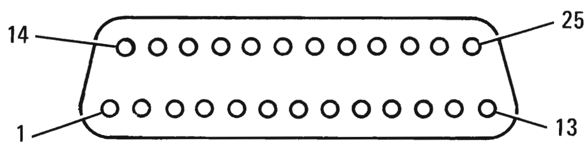
0V During Sweep
+5V Blank when
8754A display
blank.
−5V Polar
Intensity
Markers.

Image of displayed trace.
Includes all processing.

J7, PROGRAMMING CONNECTOR

PROGRAMMING provides TTL or contact closure connections to control 8754A measurements, interface with the 8748A S-Parameter Test Set, and analog outputs to obtain measurement data.

J7 PROGRAMMING PIN FUNCTIONS



Interfece
Connector:
HP P/N 1251-0063

Pin No.	Function
	J7 INPUTS
	TTL Levels or Contact Closure 1 = 5V (open) 0 = 0V (ground)
19	Magnitude or Phase Output Select 1 = Magnitude Ration Output 0 = Phase Angle Output Selects output at rear panel MAG/PHASE output and J7 pins 11 and 22.
10	Reverse 8754A A and B INPUT Functions: 1 = Normal Operation 0 = Reverse A and B nomenclature on front panel Remains active in remote operation.

FRONT PANEL SELECTION	TEST INPUT	ELECTRICAL LENGTH ADJUSTMENT
A, A/R, POLAR A/R	B	PHASE (green control)
B, B/R, PHASE B/R	A	POLAR (blue control)

This control line is useful to display all four S-Parameters in Polar format, using the 8748A.

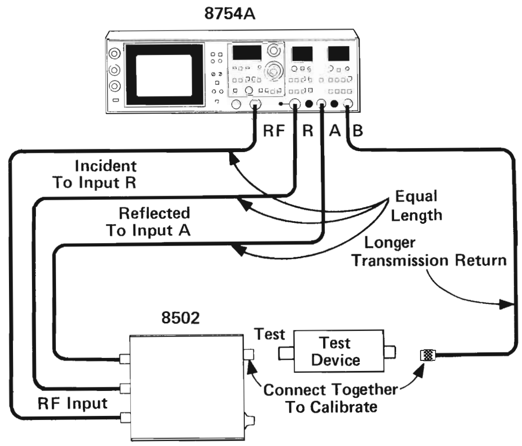
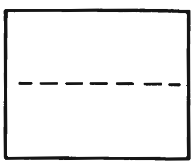
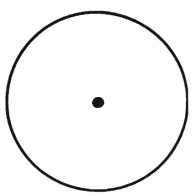
|S|	8754A	8748A	J7 Pin 10	8754A LENGTH Adjustment
S_{11}	POLAR A/R	S_{11}/S_{21}	1	POLAR (blue control)
S_{22}	POLAR A/R	S_{22}/S_{12}	1	POLAR (blue control)
S_{21}	POLAR A/R	S_{11}/S_{21}	0	PHASE (green control)
S_{12}	POLAR A/R	S_{22}/S_{12}	0	PHASE (green control)

J7 PROGRAMMING PIN FUNCTIONS (Cont'd)	
Pin No.	**Function**
J7 INPUTS (Cont'd)	
13	Electrical Length or Degrees/Sweep Select 1 = Electrical Length, 0-16 cm (Disabled when EXT RF is selected.) 0 = Degrees/Sweep, 0-190 degrees/Sweep (Not disabled when EXT RF is selected.) Selects function of A/R LENGTH and B/R LENGTH controls. "Electrical Length" introduces a phase shift proportional to RF frequency which compensates length differences between A, B, and R inputs. "Degrees/Sweep" introduces a phase shift proportional to CRT X-axis (sweep). The phase introduced is zero at the beginning of the sweep, and increases linearly to the selected value at the end of the sweep. The equivalent length added to the R input depends on the SWEEP WIDTH and is calculated as follows: $\text{Electrical Length (m)} = \frac{\text{Phase added/sweep (degrees)}}{\text{Sweep Width (MHz)} \times 1.2}$ Degrees/Sweep may be useful to equalize large differences in electrical length over narrow sweep widths, or when EXT. RF is selected.
15	Stop Sweep 1 = Continue Sweep 0 = Stop Sweep Allows external control of sweep.
16	Sweep Trigger (negative going edge trigger) When this pin is grounded, a sweep will be triggered if the front-panel SWEEP TRIG is depressed, and the retrace cycle is completed.
23	Tuning Marker (Output and Input) When ground is applied, the trace moves up 1/4 major division on rectangular trace or has increased intensity on polar trace. In full sweep mode, this line is momentarily internally grounded when the full sweep TUNING marker is displayed.
24	Relock and Trace Blanking 1 = Unblanked When 0, the CRT trace is blanked. A transition to 1 initiates a 1.5 ms sequence during which the CRT is blanked and the receiver relocks. Minimum pulse width is 20 μsec.
3	Relock and Trace Blanking (Inverted Polarity from pin 24) 0 = Unblanked (Normally 0) When 1, the CRT trace is blanked. Transition to 0 initiates a 1.5 ms sequence during which the CRT is blanked and the receiver relocks. Minimum pulse width is 20 μsec.

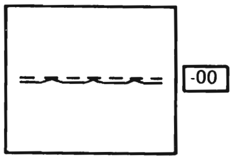
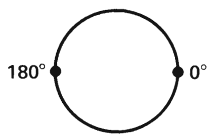
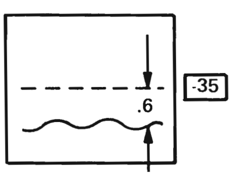
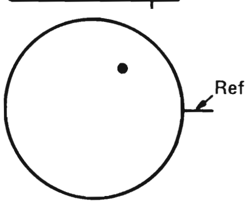
J7 PROGRAMMING PIN FUNCTIONS (Cont'd)	
Pin No.	**Function**
J7 INPUTS (Cont'd)	
8	8748A S-Parameter Select. 0 = Test Set in reverse (S_{22} and S_{12}) 1 = Test Set in forward (S_{11} and S_{21}) Not used in 8754A.
21	8754A Remote Select. 1 = 8754A Local 0 = 8754A Remote Selecting Remote switches the internal sweep generator to the EXT SWEEP mode, disables the Front Panel receiver controls, and enables remote A/R or B/R select (J7 pin 20).
20	Remote A/R or B/R select. 1 = Selects A/R 0 = Selects B/R Controls selection of detector outputs applied to J7 pins 11 and 22, and MAG/PHASE output. Enabled by J7 pin 21, 8754A Remote Select. (See also J7 pin 19). If not enabled, outputs are selected by front panel controls.
J7 OUTPUTS	
11 and 22	Two identical Magnitude or Phase Outputs. They are the same as rear-panel MAG/PHASE output. Magnitude = –0.1V/dB Phase = –0.01V/degree Output is determined by J7 pins 20 and 19 as follows: Magnitude/Phase: Selected by J7 pin 19. A/R or B/R: Selected by front-panel (local operation) or by J7 pin 20 (remote operation). For magnitude ratio, Front-panel REFERENCE and OFFSET do not affect output. For phase, REFERENCE, OFFSET, and LENGTH are included in output unless 8754A Remote Enable, J7 pin 21, is selected.

J7 PROGRAMMING PIN FUNCTIONS (Cont'd)	
Pin No.	**Function**
J7 INPUTS (Cont'd)	
17	−5 to +5V Sweep Output. Internal Sweep output. Same as rear panel SWEEP OUTPUT (see rear panel input/output summary on page 39).
4	0 to 10V Sweep Output Same as J7 pin 17 except levels changed.
J7 ACCESSORY	
14	+20 Vdc. Used for 8748A test set. Not recommended for other external uses (Test (Test Set +50 MA max.).
12 and 18	Ground

QUICK REFERENCE GUIDE

OPERATION	INSTRUCTIONS	PAGE
SET UP	Connect accessories for measurement  	17, 21
SELECT MEASUREMENT (2 Channels)	A = dBm at A input B = dBm at B input R = dBm at R input A/R = Return loss (dB) POLAR A/R = Reflection Coefficient B/R = Insertion loss or gain (dB) PHASE B/R = Insertion phase (deg)	10
SWEEP & CRT DISPLAY  	Set Sweep Functions: INT/EXT (Rear panel) AUTO/TRIG FAST/SLOW/MANUAL Set Reference Positions on CRT: Rectangular: (each channel) 1. Depress REFERENCE POSITION button. 2. Use ▲▼ , position as desired (center). 3. Release REFERENCE POSITION button. POLAR: 1. Press POLAR CENTER button. 2. Use ▲▼ and ◀▶ to move dot to center. 3. Release POLAR CENTER button.	 11
FREQUENCY	Set Frequency Range: 1. Select FULL, START, or CENTER mode. 2. Using TUNING, adjust FREQUENCY MHz to desired START/ CENTER Frequency 3. Adjust SWEEP WIDTH vernier to CAL detent. 4. Select desired SWEEP WIDTH MHz. Calibrate Using Markers: 1. Select 50 MHz markers. Center marker on START or CENTER graticule with TUNING. 2. Adjust FREQUENCY CAL vernier for correct LED readout at nearest 50 MHz marker. 3. Repeat at nearest 10 MHz marker. 4. Adjust SWEEP WIDTH vernier for correct width.	12 12

QUICK REFERENCE GUIDE (Cont'd)

OPERATION	INSTRUCTIONS	PAGE
CHECK SIGNAL LEVELS	Set OUTPUT dBm, Test Set attenuator R input: 0 to –40 dBm; A,B inputs: 0 to –80 dBm	13
CALIBRATE	Absolute Power (A, B, R) dBm: Release OFFSET button to disengage vernier.	25
	Magnitude (A/R, B/R) dB: Connect standard (See below) Move trace to reference position line (each channel) 1. Set REFERENCE levers to –00 dB. 2. Select 0.25 dB/division. 3. Depress OFFSET button to engage vernier. 4. Adjust OFFSET vernier until trace is at reference position line.	18
	Phase B/R degrees: Connect standard (see below). Move trace to reference position line. 1. Set REFERENCE levers to –00 or +180. 2. Select 2.5 deg./division. 3. Adjust LENGTH controls for horizontal trace. If range is insufficient, select cable lengths (R or B Cables, or 8748 ref. ext. cable) 4. If necessary, engage OFFSET vernier and adjust until trace is at reference position line.	19
	POLAR A/R Connect standard (see below). Move dot to reference position. 1. Set CH 1 and CH 2 REFERENCE levers to –00. 2. Depress CH 1 OFFSET button to engage vernier. 3. Adjust CH 1 OFFSET vernier until trace is at outside circle. 4. Adjust POLAR LENGTH control for smallest dot. If range is insufficient, select cable lengths (R or B cables, or 8748 ref. ext. cable). 5. If necessary, engage CH 2 OFFSET vernier and adjust until dot is at 0 or ±180°. Standards: 0 dB 0° transmission = through-line 0 dB 0° reflection = open 0 dB ±180° reflection = short	23
MEASURE 	Absolute Power, Magnitude, Phase: 1. Connect device. 2. Don't touch OFFSET verniers, LENGTH controls. 3. Adjust REFERENCE lever to move trace to reference position. 4. Value = REFERENCE lever + CRT deflection.	25
	Polar: 1. Connect Device. 2. Don't touch OFFSET verniers, LENGTH controls. 3. Read display; slide-in overlays for impedance. 4. Or, adjust CH 1 and CH 2 REFERENCE levers to move desired point to outer circle, 0°, then read magnitude and phase from REFERENCE displays.	23, 24

HEWLETT hp PACKARD

HP Part No. 08754-90016

PRINTED IN U.S.A.