

HP 85047A S-PARAMETER TEST SET

SERIAL NUMBERS

This manual applies directly to the HP 85047A S-parameter test set with serial number prefix 3033A and above.

For additional information about serial numbers, refer to INSTRUMENTS COVERED BY MANUAL in General Information.

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CERTIFICATION

Hewlett-Packard Company certifies that this product met its published specifications at the time of shipment from the factory. Hewlett-Packard further certifies that its calibration measurements are traceable to the United States National Institute of Standards and Technology (NIST, formerly NBS), to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

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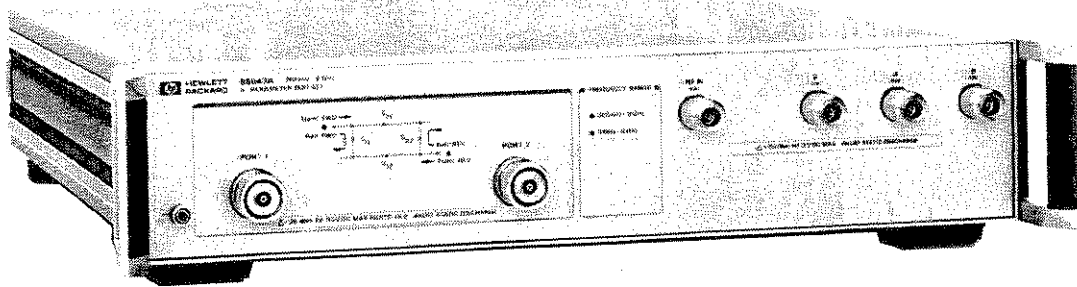
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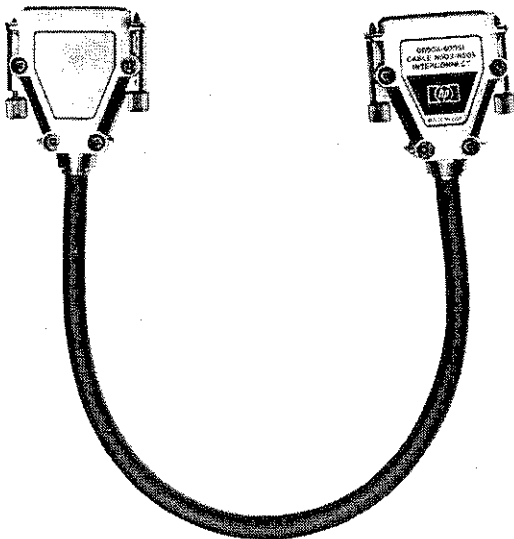
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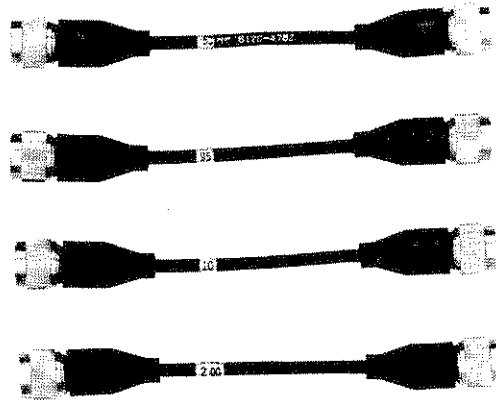
BP24.2



HP 85047A



INTERCONNECT CABLE
HP Part Number 08503-60051



RF CONNECTING CABLES
HP Part Number 8120-4782

Figure 1. HP 85047A S-Parameter Test Set with Accessories Supplied

SECTION CONTENTS

- 1 Using the HP 85047A
- 1 Instruments Covered by Manual
- 2 Description and Operating Characteristics of the Instrument
- 2 Options
- 2 Accessories
- 3 Operating and Safety Precautions
- 4 Specifications
- 6 Additional Equipment Required

The purpose of this manual is to enable you to use your HP 85047A S-parameter test set efficiently and confidently. This manual contains both general and specific information. To use the HP 85047A to perform a specific function (without reading the entire manual), follow the directions in *Using the HP 85047A*.

USING THE HP 85047A

The HP 85047A has been designed to operate specifically with the HP 8753B/C Option 006 network analyzer and the HP 8702A/B Option 006 lightwave component analyzer.

- To install the instrument, turn to the *Installation* section.
- To check the proper operation of the HP 85047A, see the *Operator's Check* in the *Operation* section.
- To verify that the instrument meets its published specifications, turn to the *Performance Tests* section.
- To troubleshoot the HP 85047A, turn to the *Service* section.

INSTRUMENTS COVERED BY MANUAL

The instrument serial number is printed on the serial number label affixed to the rear panel of the instrument (see Figure 4). The serial number consists of two parts:

- Prefix: the first four digits and the letter,
- Suffix: the last five digits, unique to each test set.

The contents of this manual apply directly to test sets with the same serial number prefix as the one on the title page under the heading SERIAL NUMBERS.

If the serial prefix of your test set is lower than the one on the title page, your instrument differs from those documented in this manual. Most differences are slight, so you may use the information as presented. However for utmost accuracy, refer to the "Manual Backdating" chapter of this manual. Significant differences, if any, are documented there.

You can order this manual in microfiche form (in 4 x 6 inch microfilm transparency format). The part number appears on the title page.

DESCRIPTION AND OPERATING CHARACTERISTICS OF THE INSTRUMENT

When used with the HP 8753B/C network analyzer or HP 8702A/B lightwave component analyzer, the HP 85047A provides a convenient means of measuring reflection and transmission coefficients (scattering parameters) of one-port or two-port devices. The test set can be operated in either of two frequency ranges: 300 kHz to 3 GHz or 3 MHz to 6 GHz. Both analyzers require option 006 for 6 GHz operation.

Table 1 lists the operating specifications and characteristics of the HP 85047A. The test set is illustrated on the cover of this manual and shown in a typical measurement setup in Figure 6.

OPTIONS

Option 001

Standard test sets with serial prefix 2936A and below had a mechanical transfer switch.

This former option substituted a solid-state switch for the mechanical switch. The solid-state switch allows fast, continuous switching, improved accuracy and increased reliability.

The HP 86389B solid-state switch upgrade kit is available for post-sale installation of the option. Upgrades are performed on a return-to-HP basis. Labor is included. Note that this option is compatible only with these (or higher) firmware revisions: HP 8753B rev 3.00, HP 8753C rev 4.01, or HP 8702B rev 1.00.

For additional information, refer to "Solid-State Switch Operation Considerations" at the end of the "Operation" chapter.

Option 009

This option substitutes a mechanical switch for the solid-state transfer switch.

Option 908

This option supplies the test set with the parts required to rack mount it with handles removed. Refer to the *Installation* section for additional information.

Option 910

This option provides a duplicate test set manual.

Option 913

This option supplies the test set with the parts required to rack mount it with handles. Refer to the *Installation* section for additional information.

ACCESSORIES

Accessories Supplied

Figure 1 shows the HP 85047A with the accessories supplied (see *Replaceable Parts* for part numbers):

- Four RF connecting cables
- Interconnect cable
- Performance test disc

Accessories Available

Calibration and Accessory Kits. The calibration kits listed below contain the components required to characterize the systematic errors of various measurement systems. The components also allow adaptation of devices to various measurement systems.

The accessory kits listed contain the components generally required to measure devices with the types of connectors indicated. Additional information is included in the analyzer manual and the data sheet.

Connector Type	Calibration Kit	Accessory Kit
7 mm Type-N 50 Ω 3.5 mm (SMA) BNC 50 Ω	HP 85031B HP 85032B HP 85033C	HP 11853A* HP 85033A HP 11854A*
*use with HP 85032B type-N 50 Ω calibration kit		

Cable Sets. Use the HP 11857D 7 mm test port return cable set to extend the test ports of the HP 85047A. Additional information is included in the analyzer manual.

Transistor Fixtures. Three transistor fixtures are available to measure the S-parameters of transistors with the HP 85047A:

- HP 11600B* tests TO-18/TO-72 type transistors.
- HP 11602B* tests TO-5/TO-12 type transistors.
- HP 11608A tests 50 Ω stripline transistors.

*use with HP 11858A transistor fixture adapter

OPERATING AND SAFETY PRECAUTIONS

Operating

You need observe only normal precautions in handling and operating the HP 85047A. Do not exceed its operating level input of +26 dBm or 30 Vdc.

Service

The voltages in this test set do not warrant more than normal caution for operator safety. Nevertheless, service should be performed only by qualified personnel.

SPECIFICATIONS

Definitions

The specifications listed in Table 1 range from those guaranteed by Hewlett-Packard to those typical of most HP 85047A instruments but not guaranteed. Codes in the far right column of Table 1 reference a specification definition listed below. These definitions are intended to clarify the extent to which Hewlett-Packard supports the specified performance of the HP 85047A.

S-1: This performance parameter is field verifiable using performance tests documented in the service manual.

S-2: Due to limitations on available industry standards, the guaranteed performance of the instrument cannot be verified outside the factory. Field procedures can verify performance with a confidence prescribed by available standards.

T: Typical but non-warranted performance characteristics intended to provide information useful in applying the instrument. Typical characteristics are representative of most instruments, though not necessarily tested in each unit and not field tested.

Table 1. Specifications (1 of 2)

Parameter	Specification	Code
Directivity ¹ (Port 1, 2)	300 kHz to 1.3 GHz: ≥ 35 dB ² 1.3 GHz to 3 GHz: ≥ 30 dB 3 GHz to 6 GHz: ≥ 25 dB	S-1
DC bias input range:	+30 VDC, ± 200 mA with no degradation in RF specifications (± 1 A maximum)	S-2
Source Match ¹	300 kHz to 1.3 GHz: ≥ 20 dB 1.3 GHz to 3 GHz: ≥ 16 dB 3 GHz to 6 GHz: ≥ 14 dB	S-1
Switch Repeatability	± 0.03 dB	S-1

Table 1. Specifications (2 of 2)

Parameter	Specification		Code	
	Range	Solid-State Switch		Mechanical Switch
Frequency Range	300 kHz to 3 GHz 3 MHz to 6 GHz		T	
Frequency Response ¹ : Typical Transmission Tracking Magnitude	300 Hz to 3 GHz 3 to 6 GHz	± 2.0 dB ³ ± 2.0 dB ³	± 1.5 dB ³ ± 1.5 dB ³	T
Phase ⁴	300 kHz to 3 GHz 3 GHz to 6 GHz	± 10 deg ± 20 deg		
Typical Reflection Tracking Magnitude	300 kHz to 3 GHz 3 GHz to 6 GHz	± 2.0 dB ³ ± 2.0 dB ³	± 1.5 dB ³ ± 1.5 dB ³	
Phase ⁴	300 kHz to 3 GHz 3 to 6 GHz	± 10 deg ± 20 deg		
Nominal Insertion Loss RF IN to Port 1, 2	3 GHz range 6 GHz range	4.0 dB + 0.8 dB/GHz 17.5 dB + 0.8 dB/GHz	2.5 dB + 0.5 dB/GHz 16 dB + 0.5 dB/ GHz	T
RF IN to R	3 GHz range 6 GHz range	19 dB + 0.5 dB/GHz 34 dB + 0.5 dB/GHz		
Port 1, 2 to A, B	16 dB			
Typical Isolation between Port 1 and 2	3 GHz range 6 GHz range	100 dB 90 dB		T
Impedance Port 1, 2 RF IN, R, A, B	50 Ω Nominal 50 Ω Nominal			T
Connectors Port 1, 2 RF IN, R, A, B DC bias input Limit Test Test Sequence	7 mm Center conductor depth: 0.000 to 0.002 inch 50 Ω type-N (f) Pin depth: 0.201 to 0.207 inch ⁵ BNC (f) BNC (f) BNC (f)			
Damage level	+26 dBm RF input			T
Power	+22 Vdc from the analyzer via interface cable.			
Dimensions	432 mm x 90 mm x 495 mm (17 x 3.5 x 19.5 inches)			
Weight	10 kg (22 lb) net; 15 kg (33 lb) shipping			
<ol style="list-style-type: none"> Can be greatly improved with accuracy enhancement techniques. 300 kHz to 1 MHz environmental range: 25 \pm 5°C. Directivity is typically better than 25 dB in 0° to 55°C range. Deviation from mean value. Deviation from linear phase. Center conductor protrusion from reference plane. 				

ADDITIONAL EQUIPMENT REQUIRED

Table 2 lists additional equipment and accessories required for use with the HP 85047A. The table notes which items are required to verify the performance of the test set and which are required to operate it. Other equipment may be substituted if its specifications meet or exceed the specifications listed in the critical specifications column.

Table 2. Additional Equipment Required

Instrument	Critical Specifications	Recommended Model	Use*
Analyzer		HP 8753B/C Option 006 HP 8702A/B Option 006	O, P, T
HP-IB Cables (2)		HP 10833A/B/D	P
Power supply	range: 0 to +5V, 0 to 100 mA	HP 6218C	P
7mm calibration kit	load RL: ≥ 52 dB, DC to 5 GHz ≥ 46 dB, 5 to 6 GHz	HP 85031B	P
BNC cable		HP P/N 8120-1839	P
Adapter, BNC to banana plug		HP P/N 1251-2277	P
Multimeter	range: DC to 50V	HP 3456A	T
Oscilloscope	100 MHz bandwidth	HP 1740A	T
RF cable set	50 Ω type-N, three 24 inch phase-matched, one 34 inch	HP 11851B	T
Disk Drive	CS80 protocol	HP 9122C/D	P
7 mm connector gage	measurement uncertainty: <0.0002 inch	part of HP 85050B calibration kit	T
Power meter	300 kHz to 6 GHz power: -30 to +20 dBm accuracy: ± 0.05 dB	HP 436A, HP 438A	T
Power sensor	300 kHz to 3 GHz power: -30 to +20 dBm	HP 8482A	T
	3 GHz to 6 GHz power: -30 to +20 dBm	HP 8481A, HP 8485A	T
* O = operation; P = performance test; T = troubleshooting			

SECTION CONTENTS

- 1 Initial Inspection
- 1 Environmental Considerations
- 3 Preparation for Use
- 3 Packaging

INITIAL INSPECTION

Inspect the shipping container (including cushioning material) for damage. If no damage is evident, performing the *Operator's Check* in the *Operation* section should suffice for incoming inspection. If the test set does not pass the *Operator's Check*, refer to the troubleshooting procedures in the *Service* section.

If the shipping container is damaged, keep it until you have checked the contents for completeness. The contents are listed in Table 3. Then check the test set mechanically and electrically. Perform all of the electrical performance tests in the *Performance Tests* section.

If the test set fails the electrical tests, or is damaged, defective, or incomplete, keep the shipping materials and notify both the carrier and the nearest Hewlett-Packard office. The HP office will arrange for repair or replacement of the test set without waiting for settlement of the claim.

Table 3. Components of HP 85047A Test Set

Item	Part Number
Operating and Service Manual	85047-90001
Interconnect Cable	08503-60051*
RF Test Set Cables (4)	8120-4782*
Performance Test Disc	85047-10001

*Shown in Figure 1.

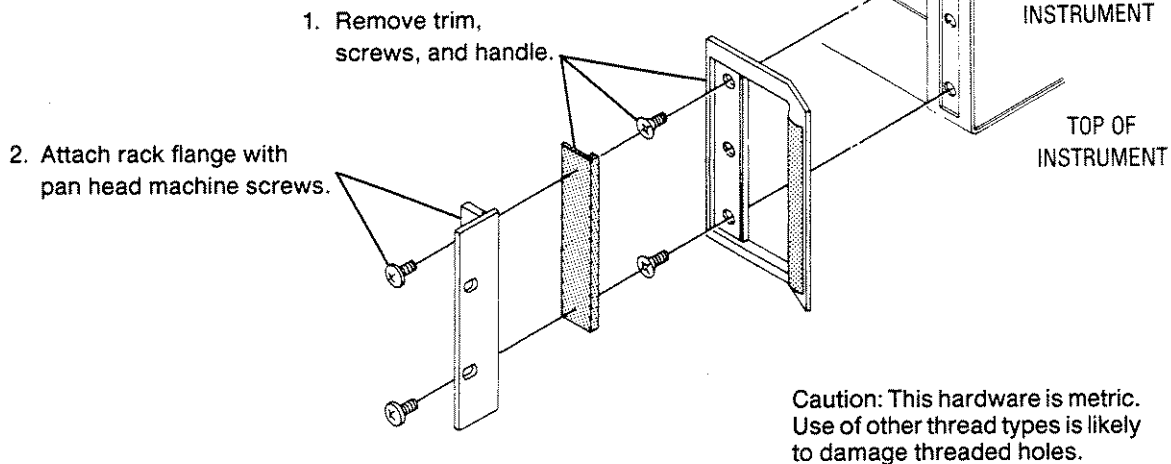
ENVIRONMENTAL CONSIDERATIONS

Operation and Storage

For best performance, the HP 85047A should be operated in temperatures between 0°C and +55°C with relative humidity between 5% and 95% at 40°C (noncondensing). It may be operated at altitudes up to 4,500 metres (15,000 feet).

The HP 85047A may be stored in temperatures from -40°C to +75°C, with relative humidity up to 90% at +65°C (non-condensing) and at altitudes up to 15,240 metres (50,000 feet).

OPTION 908
RACK MOUNT KIT
WITH HANDLES REMOVED
HP Part Number 5062-3976



OPTION 913
RACK MOUNT KIT FOR
INSTRUMENTS WITH PREVIOUSLY
ATTACHED FRONT HANDLES
HP Part Number 5062-4069

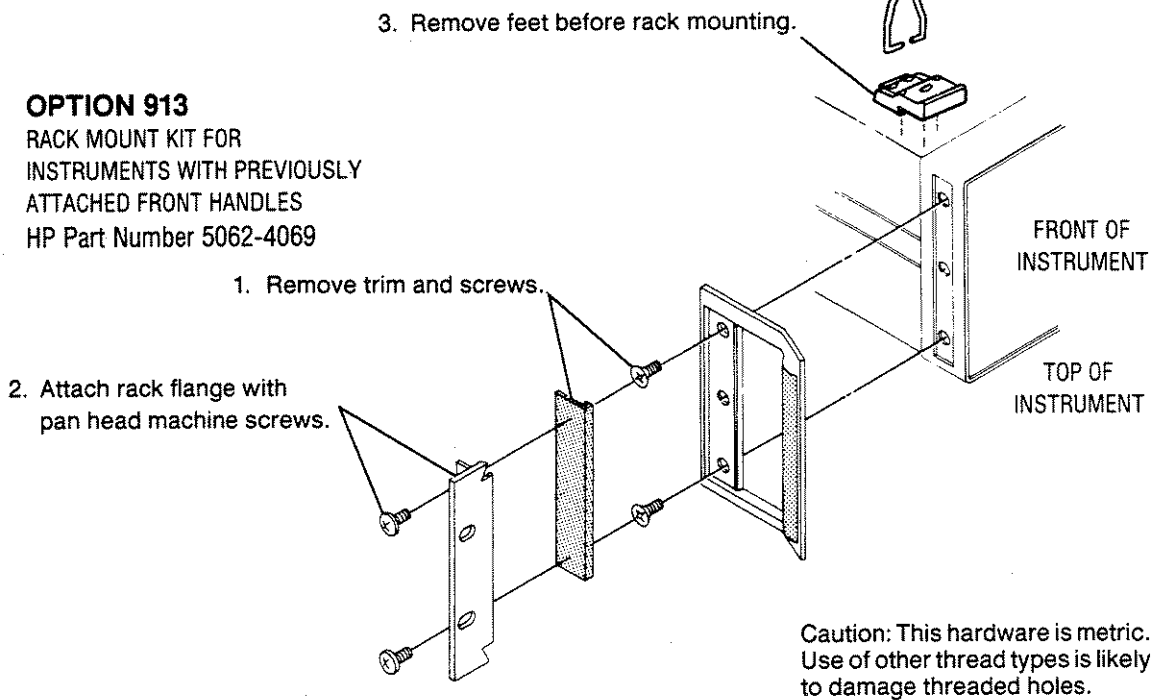


Figure 2. Attaching Rack Mounting Hardware

PREPARATION FOR USE

Positioning the Test Set

Typically the HP 85047A is placed under the network (or lightwave component) analyzer whether it is rack-mounted or used on a bench. To install the flanges to rack mount the instrument (with or without handles) in a standard 19 inch rack, refer to Figure 2. The recommended rack is the HP 85043B. Instructions for rack mounting the HP 85047A in a system configuration with the analyzer are provided in the analyzer manual and in the HP 85043B system rack manual.

To install the HP 85047A for use on a bench, place it under the analyzer. Use an anti-static work surface to lessen the chance of ESD damage.

Connecting the Test Set

Mating Connectors. Ports 1 and 2 of the HP 85047A are precision 7 mm connectors and mate with precision 7 mm connectors.

The RF IN, R, A and B ports of the HP 85047A are 50 Ω utility type-N female connectors which mate with the corresponding type-N male connectors. These connectors' dimensions conform to US specification MIL-C-39012, except for the center pin protrusion specification which is .201 to .207 inch.

The NETWORK ANALYZER INTERCONNECT connector is a series D 25-contact female connector and mates with the corresponding male connector on the interconnect cable.

The BIAS CONNECT, LIMIT TEST and TEST SEQUENCE connectors are 50 Ω BNC female connectors and mate with the corresponding male connectors (UG-88/U).

Power and Control Connections. Power for the HP 85047A is supplied by the network analyzer through the interconnect cable. The interconnect cable also transmits control signals between the test set and the network analyzer. Connect the interconnect cable from the NETWORK ANALYZER INTERCONNECT connector on the rear panel of the HP 85047A to the TEST SET INTERCONNECT connector on the rear panel of the analyzer.

Signal Path Connections. Place the test set under the analyzer and connect its RF IN port to the analyzer's RF OUT port, R to R, A to A and B to B. Use the four cables supplied with the test set.

Bias Connections. These BNC connectors supply bias voltages to transistors under test in a transistor fixture. Refer to the transistor fixture manual for additional information.

Limit Test Connection. This BNC connector outputs a TTL signal to indicate limit test results.

Test Sequence Connection. This BNC connector outputs a user-set TTL signal in a test sequence.

PACKAGING

If reshipping is required, the test set should be repackaged in the original factory package. Containers and materials identical to those used by the factory are available through Hewlett-Packard offices. To prevent damage to the test port connectors, cover them with plastic caps (HP part number 1401-0123).

Alternatively, comparable packaging materials may be used. Wrap the test set in heavy paper or anti-static plastic. If shipping to an HP Office or Service Center, complete and attach a service tag (in this manual). Use sufficient shock absorbing material on all sides of the HP 85047A to provide a thick, firm cushion and prevent movement. Seal the shipping container securely and mark it **FRAGILE**.

In any correspondence with HP, refer to the HP 85047A by full model and serial number.

SECTION CONTENTS

- 1 Connector Considerations
- 2 Front Panel Features
- 3 Rear Panel Features
- 6 Operator's Check
- 8 Solid-State Switch Operation Considerations

This section illustrates the features and functions of the front and rear panels of the HP 85047A (Figures 3 and 4). Figure 5 depicts the RF signal path through the test set for each of the four S-parameter measurements. Figure 6 shows a typical test set measurement setup.

CONNECTOR CONSIDERATIONS

Inspect the 7 mm connectors of port 1 and 2 on a regular basis (frequency should vary with use). The connectors should be clean and the center pin centered.

Gage the 7 mm connectors of port 1 and 2 on a regular basis if DUTs are normally connected directly to them (rather than to cables). Connector dimensions are specified in Table 1. Gages are listed in Table 2. Note that when gaging the connectors, the collet must be removed. Refer to the *Microwave Connector Care* manual for instructions. If the connectors are dirty, damaged, or out of specification, refer to the *Service* section of this manual and the *Microwave Connector Care* manual (part of the analyzer manual set).



SUSCEPTIBLE TO DAMAGE FROM ESD

ESD (electrostatic discharge) can damage the sensitive devices in this instrument. Use this instrument at a static-safe workstation and wear a grounding strap.

FRONT PANEL FEATURES

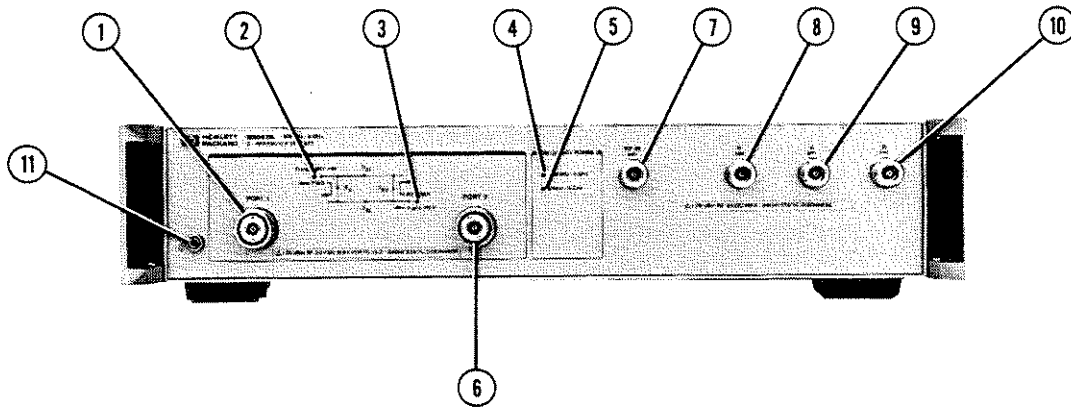


Figure 3. Front Panel Features

1. **PORT 1.** The device under test is connected here, to port 2, or to both.



Do not input more than +26 dBm (about 0.4W) or 30 VDC to PORT 1 or PORT 2.

Maximum input to RF, R, A, or B ports is +26 dBm or 3 VDC.

2. **S11 S21 Indicator LED.** This indicator, when lit, means that the test set is in the S11 or S21 measurement mode and power is incident from port 1.
3. **S22 S12 Indicator LED.** This indicator, when lit, means that the test set is in the S22 or S12 measurement mode and power is incident from port 2.
4. **300 kHz–3 GHz LED.** This indicator, when lit, means that the test set and the analyzer are set to operate in the lower frequency range. The test set doubler is off and bypassed.
5. **3 MHz–6 GHz LED.** This indicator, when lit, means that the test set and the analyzer are set to operate in the upper frequency range, nominally above 3 MHz. The test set doubler is turned on.
6. **PORT 2.** The device under test is connected here, to port 1, or to both.
7. **RF IN.** This RF input connector receives the RF signal from the analyzer RF OUT connector.
8. **R.** This RF connector provides the reference signal to input R of the analyzer.
9. **A.** This RF connector provides an RF input signal to input A of the analyzer from a device under test.
10. **B.** This RF connector provides an RF input signal to input B of the analyzer from a device under test.
11. **Ground Input.** This connector provides a front panel ground connection.

REAR PANEL FEATURES

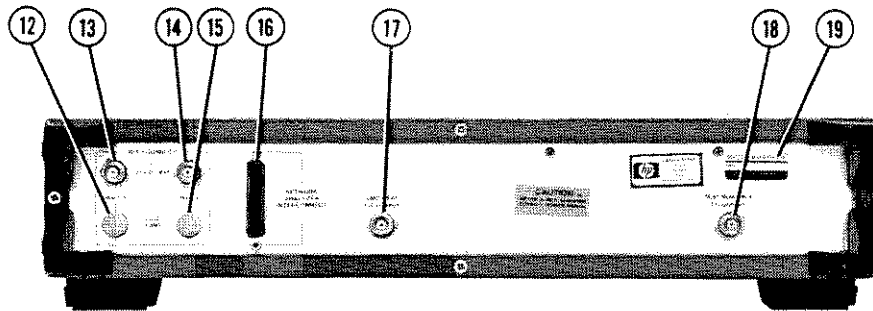


Figure 4. Rear Panel Features

12. **PORT 2 FUSE.** This fuse protects the port 2 bias line. See *Replaceable Parts* for rating and part number.
13. **PORT 2 BIAS CONNECTOR.** This connector (when connected to an appropriate source) biases devices connected to port 2.
14. **PORT 1 BIAS CONNECTOR.** This connector (when connected to an appropriate source) biases devices connected to port 1.
15. **PORT 1 FUSE.** This fuse protects the port 1 bias line. See *Replaceable Parts* for rating and part number.
16. **NETWORK ANALYZER INTERCONNECT.** This connector supplies the test set with power from the analyzer and also serves as a bidirectional control path.
17. **LIMIT TEST.** This connector outputs a TTL signal of the limit test result as follows:
 - Pass: TTL high
 - Fail: TTL low
18. **TEST SEQUENCE.** This connector outputs a TTL signal which can be programmed by the user in a test sequence to be high or low.
19. **SERIAL NUMBER LABEL.** The instrument's serial number and options, if any, are printed here. For information about serial numbers, see *Instruments Covered by Manual* in the *General Information* section.

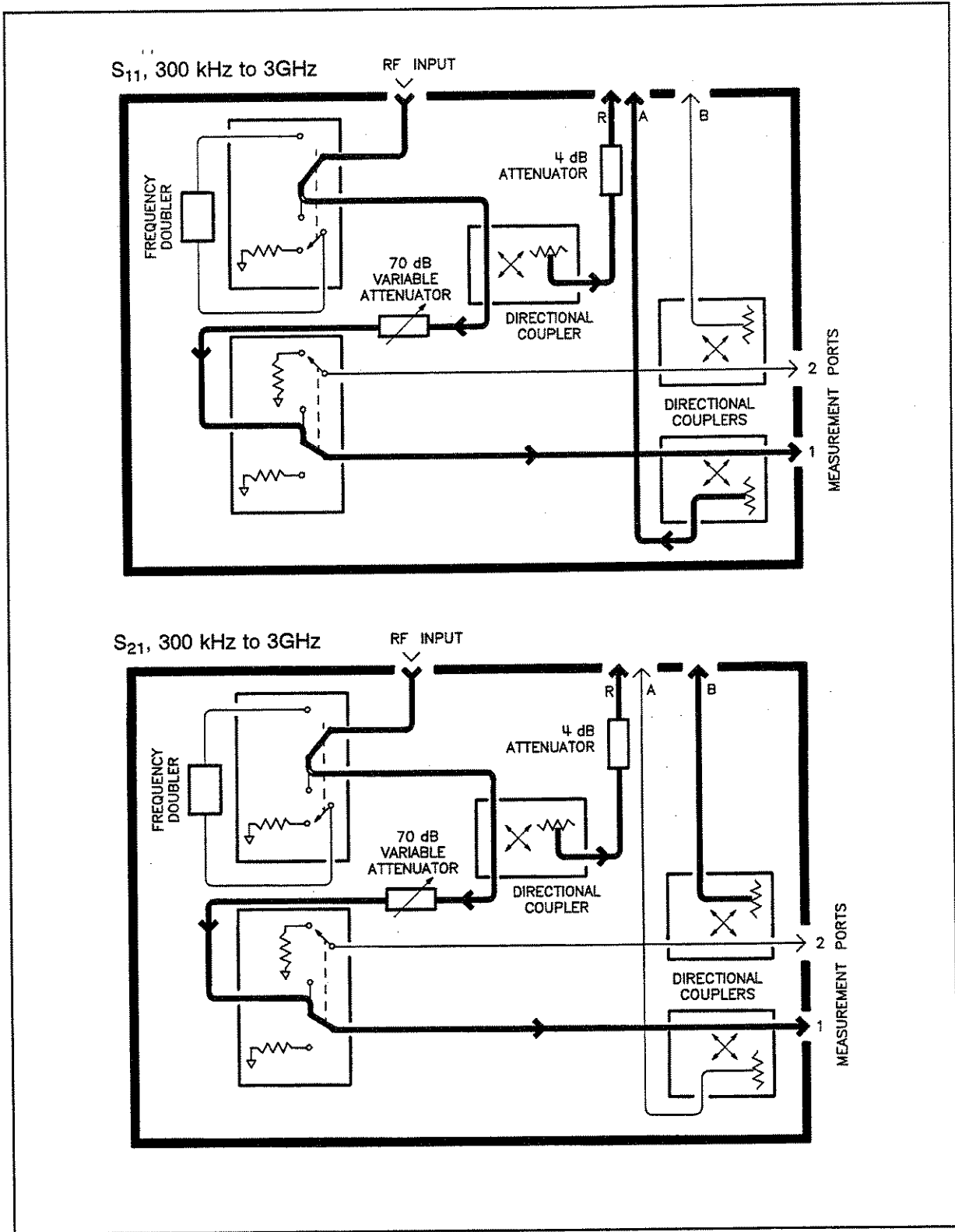


Figure 5. RF Signal Path (1 of 2)

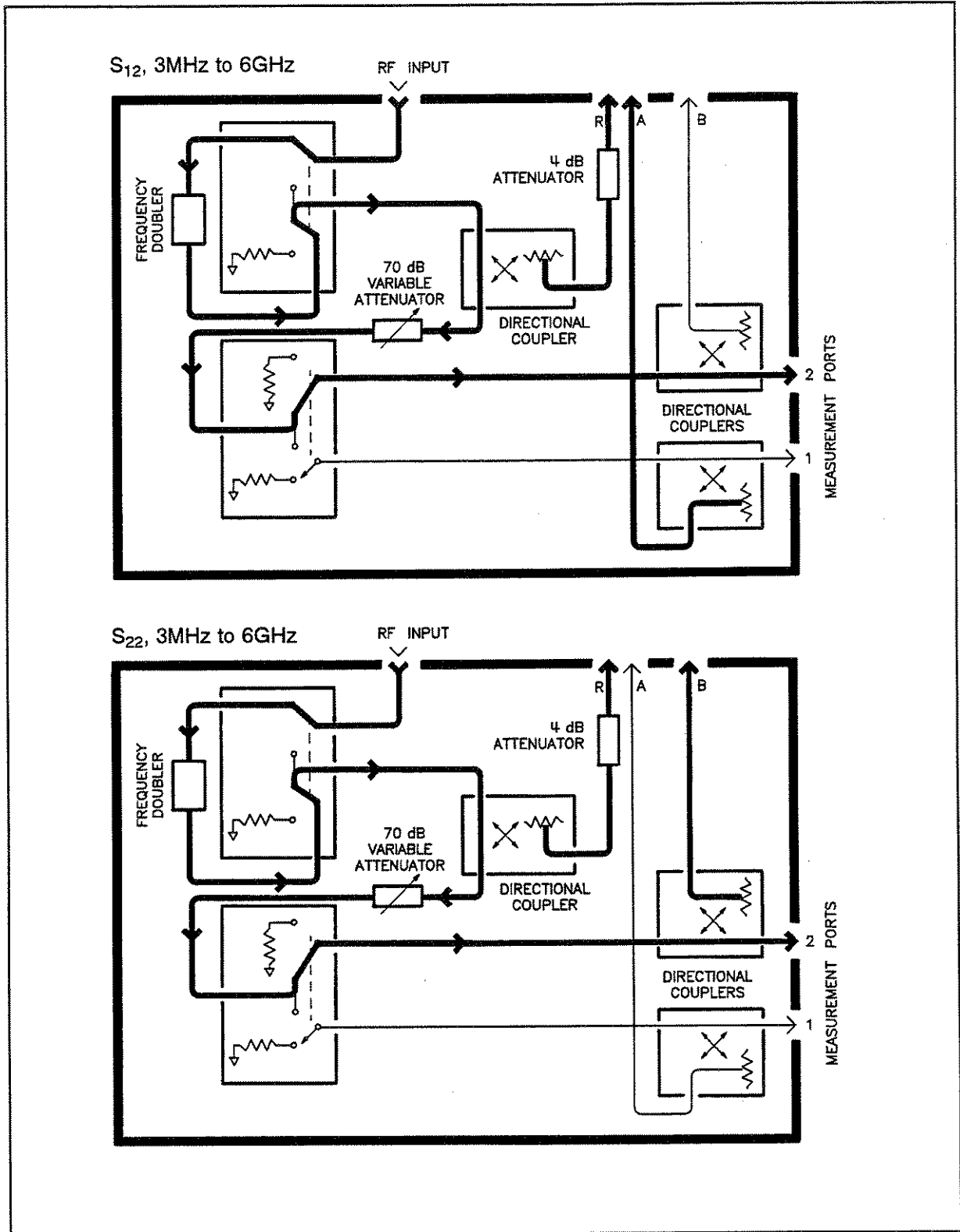


Figure 5. RF Signal Path (2 of 2)

OPERATOR'S CHECK

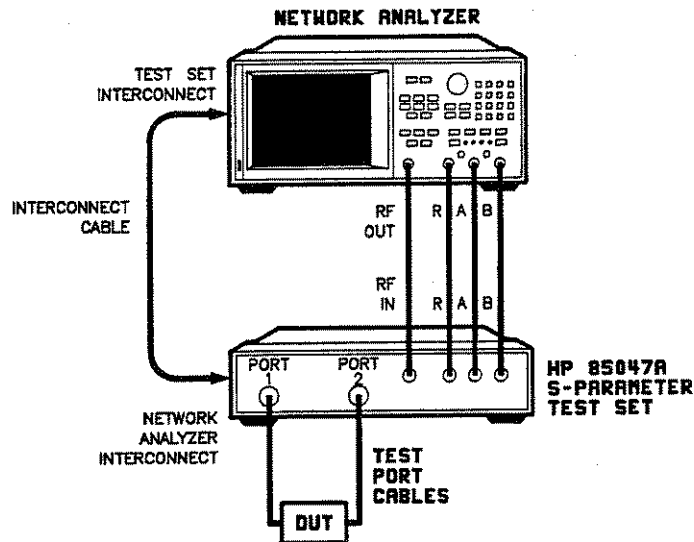


Figure 6. Typical Measurement Setup

EQUIPMENT

Network analyzer	HP 8753B/C Option 006 ¹
Interconnect cable	(HP p/n 08503-60051, supplied with test set)
RF cable set (4)	(HP p/n 8120-4782, supplied with test set)
50 ohm 7 mm termination	909F or 85031-60002 ²
Test port cable set	HP 11857D

1. The HP 8702A/B Option 006 lightwave component analyzer can be substituted for the network analyzer in this test.
2. Part of HP 85031B calibration kit.

DESCRIPTION AND PROCEDURE

Follow this procedure for incoming inspection or instrument operation verification. Passing this check verifies the operation of the test set to 90% certainty. Refer to the *Performance Tests* section for a more rigorous test.

1. Connect the equipment as shown in Figure 6 and turn on the network analyzer but do not connect the DUT. Instead, connect the load to port 1 of the test set.
2. On the network analyzer press **[PRESET] [SCALE REF] [[REFERENCE POSITION] [7] [x1] [MKR FCTN] [MARKER SEARCH] [TRACKING ON] [MAX]** to observe the directivity of port 1. The marker should read less than -30 dB and the trace should look like Figure 7a.

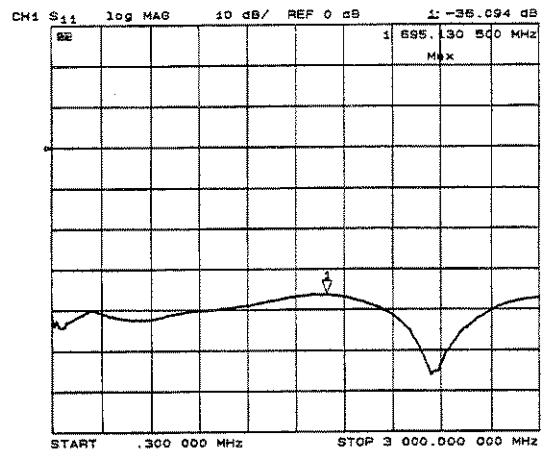
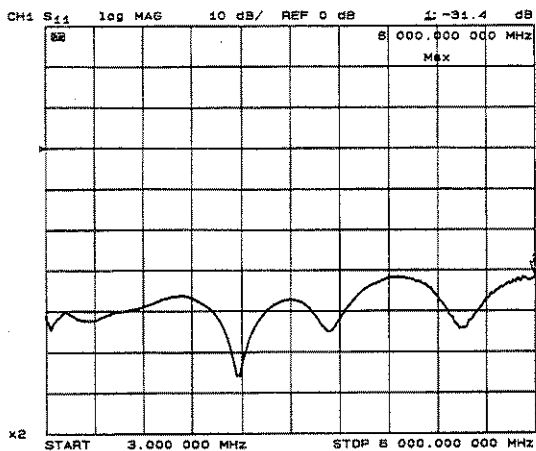


Figure 7. Typical Directivity Trace

3. Press **[SYSTEM] [FREQ RANGE 6 GHz]**. The 3 MHz–6 GHz LED should light.
4. The marker should now read less than -25 dB and look like Figure 7b.
5. Remove the load from port 1. Press **[MENU] [POWER] [ATTENUATOR PORT 1]** and then press **[▲]** seven times. Each time **[▲]** is pressed, there should be an audible click and the trace should drop about 10 dB. Press **[0] [x1]**.
6. Press **[MEAS] [S22]**. The LED near port 2 should light.
7. Press **[MENU] [POWER] [ATTENUATOR PORT 2]** and vary the attenuation as in step 5. The results should be the same as above.
8. Connect the load to port 2. The marker should now read less than -25 dB and look like Figure 7b.
9. Press **[SYSTEM] [FREQUENCY RANGE 3 GHz]**. The 300 kHz–3GHz LED should light.
10. The marker should read less than -30 dB and the trace should resemble Figure 7a.
11. If the test set does not perform as expected, follow these suggestions:

Check that all connections, including the interconnect cable, are clean and properly connected.

If the test set operation is normal, except that the directivity fails, repeat the %IFOperator's Check with a different known good load. If the problem persists, perform the directivity performance test to confirm the problem. Refer to *Service* for troubleshooting.

For troubleshooting of the switch control assembly and attenuator assembly, refer to the %IFService section.

SOLID-STATE SWITCH OPERATION CONSIDERATIONS

Output power is directed to test port 1 or 2 by a transfer switch which may be mechanical or solid-state.

The solid-state switch affects the operation of the network analyzer system in these ways:

- Full 2-port calibration: all four forward (S11, S21) and reverse (S12, S22) parameters are now updated continuously, as required for full 2-port error correction. This is possible because the solid-state switch can transfer power from port 1 to port 2 continuously. The "Cor" notation on the CRT indicates that all four parameters are being updated.

The mechanical transfer switch does not operate continuously (to prevent its wearing out). After the initial measurement, the analyzer applies power to one port only, as indicated by the "C2" notation. "C2" means only two of the four S-parameters are being updated.

Full 2-port error correction is important in tuning applications, or when a series of devices are connected.

- Nominal insertion loss: increases by 2 to 3 dB. See Table 1 for details.
- Operating noise: lessens as the solid-state switch is not mechanical in operation.
- Reliability: improves because the switch has no moving parts.
- Error messages: "Continuous switching not allowed" is not displayed in dual channel mode unless the channels are set to different attenuator settings.

Upgrade kits are available to enable HP 8753 network analyzers to support solid-state switching.

Model	Kit	Description
HP 8753A	HP 11882A	HP 8753A to B rev 3.0 firmware
HP 8753B ¹	HP 86388A	HP 8753B to rev 3.0 firmware
HP 8753C	no upgrade required	

1. Upgrade not required for use with mechanical transfer switch test sets.

