

Operating
and
Service

HP 84812A/13A/14A
Peak Power Sensor

Operating and Service Manual
HP 84812A/13A/14A
Peak Power Sensor

SERIAL NUMBERS

Affixed to the instrument is a serial number label. The serial number is in the form: 0000A00000. The first four digits and the letter are the serial number prefix. The last five digits are the suffix. The prefix is the same for identical instruments; it changes only when a configuration change is made to the instrument. The suffix, however, is assigned sequentially and is different for each instrument.

This manual applies to instruments with following serial number prefixes:

HP 84812A: 3113A

HP 84813A: To be assigned.

HP 84814A: To be assigned.



**HEWLETT
PACKARD**

HP Part No. 84812-90003

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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), to the extent allowed by the Institute's calibration facility, and to the calibration facilities of other International Standards Organization members.

WARRANTY

This Hewlett-Packard instrument product is warranted against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Hewlett-Packard Company will, at its option, either repair or replace products which prove to be defective.

For warranty service or repair, this product must be returned to a service facility designated by HP. Buyer shall prepay shipping charges to HP and HP shall pay shipping charges to return the product to Buyer. However, Buyer shall pay all shipping charges, duties, and taxes for products returned to HP from another country.

HP warrants that its software and firmware designated by HP for use with an instrument will execute its programming instructions when properly installed on that instrument. HP does not warrant that the operation of the instrument, or software, or firmware will be uninterrupted or error free.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation or maintenance.

NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. HP SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

EXCLUSIVE REMEDIES

THE REMEDIES PROVIDED HEREIN ARE BUYER'S SOLE AND EXCLUSIVE REMEDIES. HP SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

ASSISTANCE

Product maintenance agreements and other customer assistance agreements are available for Hewlett-Packard products.

For any assistance, contact your nearest Hewlett-Packard Sales and Service Office. Addresses are provided at the back of this manual.

About this Book

The HP 84812A, 84813A, 84814A Operating and Service Manual contains information about the use, maintenance, and repair of the HP 84812A, 84813A and 84814A Peak Power Sensors. In this manual, the words "Sensor", "Peak Sensor", and "Peak Power Sensor" refer to any of the HP 84812A, 84813A, and 84814A Peak Power Sensors.

- Chapter 1, About this Book, contains:
 - How to use this book to find information about the task you are performing
- Chapter 2, About the Sensor, contains:
 - Sensor Description
 - Options
 - Adapters Available
 - Specifications
- Chapter 3, Inspection of the Sensor, contains:
 - Visual Inspection
 - Operation Check
 - Sensor Check
 - Sensor Check with Calibrated Reference
 - Shipping the Sensor
 - Storing the Sensor
- Chapter 4, Operating the Sensor, contains:
 - Operating Instructions
 - Operating Environment
 - Operating Precautions
 - Measuring Power and Pulse Parameters

- Chapter 5, Service, contains:
 - What to do if you suspect your sensor is defective
 - Removing the Covers
 - Anti-Static Work Station
 - Cable Replacement
 - Replaceable Parts List
 - List of Exchange Sensor modules
- Chapter 6, Calibration, containing:
 - List of Calibration Test Equipment
 - Read Peak Power Sensor Calibration Frequencies
 - Measure Reflection Coefficient
 - Measure Power Levels
 - Calculate Transfer Cal Factor Percentage
 - Download Transfer Cal Factors
 - Power Variation Testing

About the Sensor

Sensor Description

The HP 84812A, 84813A, and 84814A Peak Power Sensors are specifically designed to be used with the HP 8990A Peak Power Analyzer. Together, any of the three Sensors and the analyzer comprise the power measurement system which senses and displays envelope power in the range of -32 to +20 dBm.

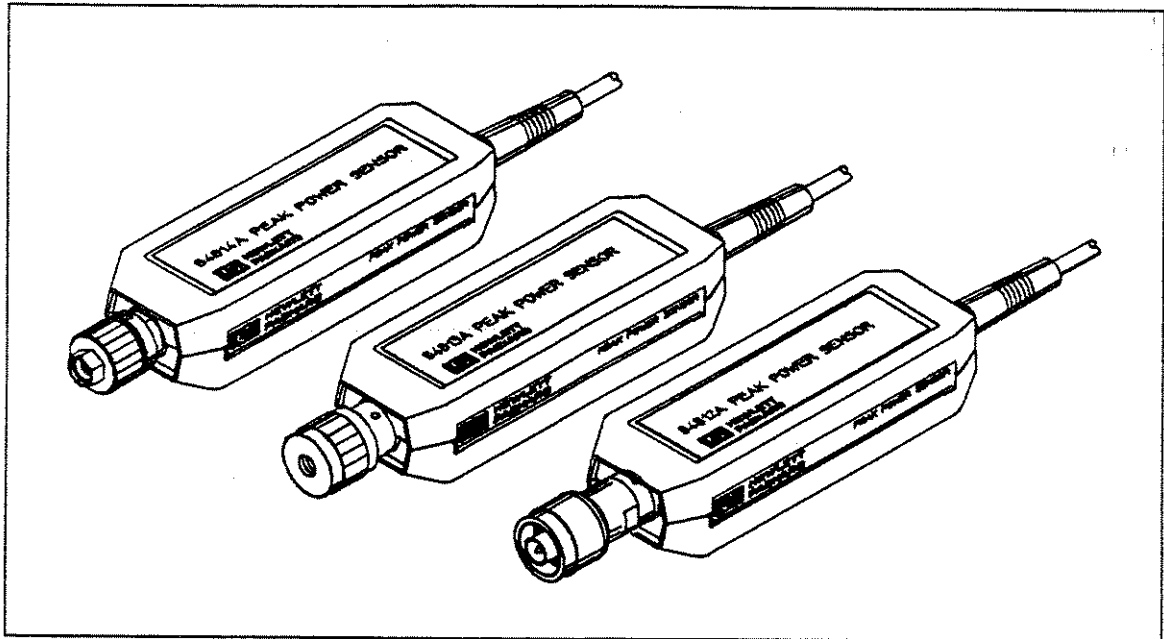


Figure 2-1. The Peak Power Sensors

Figure 2-1 shows the Peak Power Sensors.

Balanced Planar Doped Barrier (PDB) diodes are the sensing elements of the Peak Power Sensors. They

provide a specified dynamic range of -32 to +20 dBm (usable to -40 dBm). The Peak Power Sensors also contain a wideband, high dynamic range sensor amplifier which allows for very fast system risetime. Excellent SWR is provided by the integrated matching network and diodes.

Peak Power Sensor calibration data is automatically loaded from the Sensor EEPROM to the HP 8990A Peak Power Analyzer. Thus, the user is not required to perform a manual Sensor calibration.

Options

The options listed here apply to the HP 84812A, 84813A or 84814A Peak Power Sensors.

Option 001 provides a 6.1 metre (20 ft) sensor cable.

Note



The specified risetime for an HP 8990A using a Sensor with the Option 001 (20 ft Sensor cable) is <10 ns. Risetime is <5 ns using the standard (5 ft) Sensor cable.

Option 1BN provides a MIL STANDARD 45662A calibration certificate with your sensor.

Adapters Available

Type-N (m) to 3.5 mm (f):

HP Part No. 08485-60005 (Recommended to 1 GHz.)
HP Part No. 1250-1744

Type-N (m) to 2.4 mm (f):

HP Part No. 08487-60001 (Recommended to 1 GHz.)
HP Part No. 11903D

Specifications

Specifications are those parameters against which the Peak Power Sensors can be tested. General characteristics are parameters included as useful information. Table 2-1 lists the specifications and general characteristics of the Sensors.

Table 2-1. Peak Power Sensors Specifications

Specifications	
Frequency Range 84812A:	500 MHz to 18 GHz
Frequency Range 84813A:	500 MHz to 26.5 GHz
Frequency Range 84814A:	500 MHz to 40 GHz
Dynamic Range:	-32 to +20 dBm (Usable to -40 dBm.)
Sensor Calibration	< 4 GHz: $\pm 3.6\%$
RSS Uncertainty:	< 12 GHz: $\pm 3.8\%$
	< 18 GHz: $\pm 4.3\%$
	< 26.5 GHz: $\pm 5.5\%$
	< 40 GHz: $\pm 6.5\%$
Input SWR, max (Reflection Coefficient):	500 MHz to 18 GHz: 1.25 (0.11) 18 to 26.5 GHz: 1.35 (0.15) 26.5 GHz to 40 GHz: 1.60 (0.23)
Maximum Power Input:	1 W peak power for 1 μ s, not to exceed 200 mW (CW)
Operating Temperature:	0°C to +55°C
Acoustic Noise Emissions:	No Fan Installed
Geraeuschemission:	Kein Ventilator Eingebaut

Table 2-1. Peak Power Sensors Specifications (continued)

General Characteristics	
Connector HP 84812A:	Type-N Male
Connector HP 84813A:	APC-3.5 mm Male
Connector HP 84814A:	2.4 mm Male
Sensor Cable Length:	1.5 M (5 ft)
Option 001:	6.1 M (20 ft)
Calibration Interval:	18 months
Parameters Corrected for:	Frequency, Temperature, and Power Non-linearity.
Dimensions HP 84812A:	27mm H, 37mm W, 137mm L (1.05" x 1.45" x 5.4")
Dimensions HP 84813A:	27mm H, 37mm W, 127mm L (1.05" x 1.45" x 5.0")
Dimensions HP 84814A:	27mm H, 37mm W, 127mm L (1.05" x 1.45" x 5.0")
Weight:	Net: 0.35 kg (0.8 lb); Shipping: 1 kg (2 lb)
Option 001:	Net: 0.8 kg (1.5 lb); Shipping: 1.5 kg (3 lb)

2-4 About the Sensor

Inspection of the Sensor

This chapter describes how to inspect your Peak Power Sensor prior to use.

1. The procedure Operation Check should be performed at any time you need to verify Sensor operation.
2. Follow the procedure Shipping the Sensor if the Sensor fails Inspection of the Sensor.
3. Follow the procedure Storing the Sensor when you intend to store the Sensor for any length of time.

Inspecting the Sensor

Inspection of the Sensor includes a Visual Inspection and an Operation Check.

Visual Inspection

1. Inspect the shipping container for damage.

If the shipping container or packaging material is damaged, keep it until the contents of the shipment are checked mechanically and electrically.

2. Inspect the Sensor for mechanical damage.

If there is mechanical damage to the Sensor, notify the nearest Hewlett-Packard Sales or Support Office listed inside the back cover of this manual.

Keep the damaged shipping materials (if any) for inspection by the carrier and a Hewlett-Packard representative.

Operation Check

This operation check is intended to determine if the Sensor is in operating condition, **not** to verify specifications.

In order to pass the operation check the Sensor should:

- Be attached to an HP 8990A Peak Power Analyzer.
- Autoscale and measure the power level of the analyzer SENSOR CHECK source.

Sensor Check

1. Connect the Peak Power Sensor cable to Channel 1 input on the Peak Power Analyzer.
2. Connect the Peak Power Sensor connector to the analyzer SENSOR CHECK source.
3. Preset the analyzer; press: **RECALL**; then **CLEAR**.
4. Press **AUTOSCALE**.
5. Press:

BLUE (shift) key.
TOP
1
6. The reading should appear in the lower portion of the analyzer display. To pass this check the Sensor should read between 8.9 mW (+9.5 dBm) and 11.2 mW (+10.5 dBm).
7. If the Sensor passes, **STOP**. End of operation check.

Note



If you do not receive a reading in this range ($10 \text{ dBm} \pm 0.5 \text{ dB}$) the Sensor or the analyzer SENSOR CHECK source is at fault. Perform the Sensor Check with Calibrated Reference procedure below to find out if the Sensor is faulty.

3-2 Inspection of the Sensor

Sensor Check with Calibrated Reference

This check verifies that the HP 8990 Peak Power Analyzer SENSOR CHECK source is providing a signal and that the Peak Power Sensor is sensing the signal correctly. To do this, an average power meter reading of the HP 8990A Peak Power Analyzer SENSOR CHECK source signal is compared to the Peak Power Sensor reading of the same source.

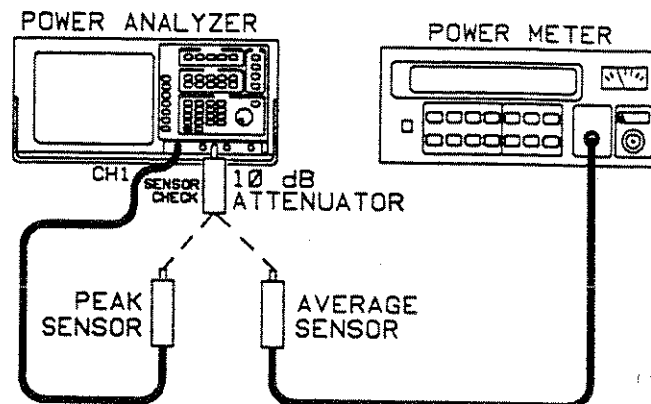


Figure 3-1. SENSOR CHECK Source Check Setup

Equipment	Recommended
Power Meter	HP 437B
Average Power Sensor	HP 8481A
10 dB Attenuator:	HP 8491A Opt 10
Adapters:	As needed.

Note

All equipment must be warmed up for at least one hour.

1. Refer to the equipment table above and Figure 3-1. Attach the 10 dB attenuator to the analyzer SENSOR CHECK source.
2. Change the analyzer SENSOR CHECK source to CW mode:

Preset the analyzer; press: **RECALL**; then **CLEAR**.
Press **UTIL**.

Press the **check source** softkey until **CW** is highlighted.

3. Zero and calibrate the average power sensor.
4. On the average power meter enter the 1.0 GHz cal factor.
5. Connect the average power sensor to the analyzer **SENSOR CHECK** source and take a reading in dBm. The reading should be approximately 0 dBm.

Average Sensor _____ dBm
Reading

6. Disconnect the average sensor from the analyzer **SENSOR CHECK** source.
7. Connect the Peak Power Sensor to the analyzer **SENSOR CHECK** source.
8. Press **AUTOSCALE**.
9. Press:

BLUE KEY

AVG

1

10. Display the analyzer power level reading in dBm:

Press **DISPLAY**

Toggle the **power display** softkey until **log** is highlighted.

11. Take a reading from the lower portion of the analyzer screen.

Peak Sensor _____ dBm
Reading

3-4 Inspection of the Sensor

12. Compare the average sensor reading to the Peak Sensor reading. The Peak Power Sensor is operating if the reading is within ± 0.5 dB of the average sensor reading.
13. If the Peak Sensor does not pass, send it back to Hewlett-Packard. See Shipping the Sensor below.

Note

In order to calibrate the Peak Power Sensor, follow the test procedures located in the Calibration section, Chapter 6, Service. If the Sensor does not pass the calibration, call your nearest Hewlett-Packard Sales or Support Office listed inside the back cover of this manual.

Shipping the Sensor

1. Contact your nearest Hewlett-Packard Sales or Support Office listed inside the back cover of this manual to obtain shipping materials identical to those used in factory packaging if you do not have adequate shipping materials.
2. Attach a tag to the Sensor indicating:
 - a. the type of service required
 - b. your return address
 - c. the Sensor model number
 - d. the Sensor serial number
3. Mark the container FRAGILE to ensure careful handling.

4. Mail the package to your nearest Hewlett-Packard Sales and Support Office listed inside the back cover of this manual.

Note



In any correspondence, refer to the Sensor by model number and serial number.

Storing the Sensor

1. Store the Peak Power Sensor in a clean, dry environment.
2. Store the Sensor within the following environmental conditions:

Temperature	-40 to +75°C
Relative humidity	< 95%
Altitude	< 7,600 m (25,000 ft).

Operating the Sensor

In order to use the Peak Power Sensor:

1. Set up the proper Operating Environment.
2. Be aware of Sensor Operating Precautions.
3. Follow the procedure Measuring Power and Pulse Parameters with your Sensor and the HP 8990A Peak Power Analyzer.

Note



To prolong the life of the Sensor, take care of your connectors. Connecting the Peak Power Sensor to worn or dirty connectors will hasten the degradation of the Peak Power Sensor connector.

Operating Environment

The operating environment for the Power Sensor is as follows:

Temperature..... 0° to 55°C
Relative humidity..... < 95%
Altitude..... < 4,572 m (15,000 ft).

Operating Precautions

Caution



If the following energy and power levels are exceeded, the Peak Power Sensor **WILL** be damaged.

Maximum Average Power: 200 mW

Maximum Peak Power: 1 W for 1 μ s

Never apply torque to the body of the Peak Power Sensor. When making connections, turn only the knurled portion of the connecting nut. Apply no more than 8 in-lbs (90 N·cm) torque to the hex connector nut on the HP 84814A.

Avoid touching the center pin in the Peak Power Sensor connector. Touching the center pin could damage the Sensor through Electro-Static Discharge (ESD).

Clean the Sensor connector only in a Static Safe Workstation like the one described in chapter 5. First use a blast of compressed air. Clean the connector surfaces with a cotton swab saturated with isopropyl alcohol (use no other solvents) then, if needed, a wooden toothpick (use no metal implements).

Measuring Power and Pulse Parameters

To operate the Power Sensor

1. Set up the HP 8990A Peak Power Analyzer for power measurement as described in the HP 8990A Peak Power Analyzer Operating Manual.
2. Connect the Peak Power Sensor cable to Ch 1 or Ch 4 of the HP 8990A Peak Power Analyzer. (Channel 4 is not operable in the HP 8990A Option 001).

4-2 Operating the Sensor

3. Refer to the Operating Precautions before connecting the Peak Power Sensor input to a RF/microwave signal to be measured.

Note

The Peak Power Sensor calibration data is located inside the EEPROM of the sensor and contains information about frequency and temperature over many power levels. Since the calibration data is automatically transferred to the HP 8990A Peak Power Analyzer during a power measurement, the user does not need to perform a manual Sensor calibration.

The Peak Power Sensor:

- a. Automatically adjusts for temperature variations between 0° and 55 °C during power measurement. (This applies only to the Sensor, refer to the analyzer operating manual for analyzer operating environment.)
- b. Automatically interpolates calibration factor data for frequencies between those frequencies at which the Sensor is calibrated. This means that after you enter your frequency of interest into the analyzer, there is no further need to enter calibration factor data.

-
4. Refer to the HP 8990A Peak Power Analyzer Operating Manual for measurement procedures.

Note

Your Peak Power Sensor should be calibrated after 18 months of normal use. See chapter 6, Service, in this manual.

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Service

This chapter details what to do if you suspect your Peak Power Sensor is defective.

Note



Check your warranty. Opening the Power Sensor may void the warranty.

1. First determine if your Sensor is defective.
 - a. Perform the Inspection of the Sensor procedure described in chapter 3.
 - b. If your Sensor fails, it is defective.
2. Determine your Sensor service alternative.
 - a. Call your nearest HP Sales or Support Office listed inside the back cover of this manual.
 - b. Depending on the state of your warranty, the Office will advise you as to the service options available to you.

Exchange Sensor Module

The Service Center may advise you to order an exchange Sensor module. Each exchange Sensor module is fully calibrated and restored to be functionally the same as a new unit except for plastic covers. See Removing the Covers, next page. When your exchange Sensor module arrives, replace your old plastic covers (containing your Sensor serial number) on the new unit. Refer to Table 5-4 to order an exchange Sensor module.

Removing the Covers

Your Sensor serial number is located on a label attached to one of the covers. If you order a restored assembly listed in Table 5-4 you may be advised to save your covers and place them on your new restored assembly. Perform the procedure exactly as described to minimize damage to the connector covers.

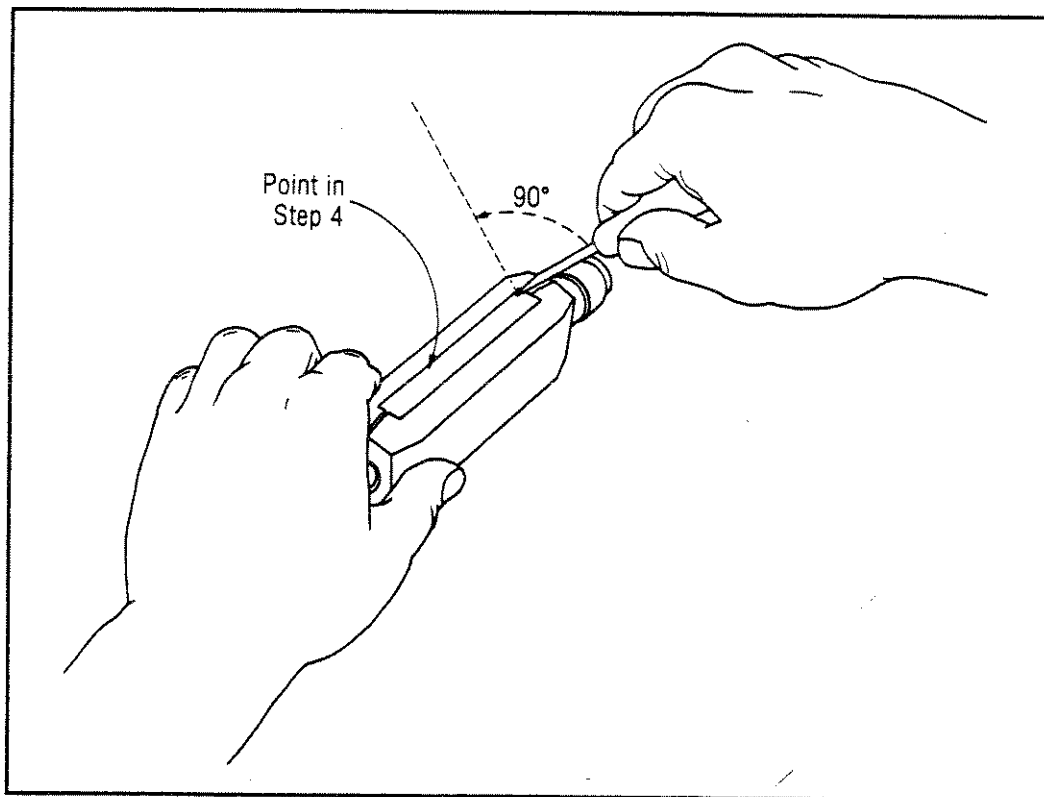


Figure 5-1. Removing the Sensor Covers

Caution



The Sensor plastic half shell covers are easily damaged. Expect to see *at least* some cosmetic damage to the covers from the removal process. If you wish to replace your plastic half shell covers and labels, see Table 5-3.

Equipment:

A small flat blade screwdriver with a blade width no greater than 3.5 mm (1/8 inch).

Procedure.

1. Place the Sensor so its narrow side is on a flat surface. Position it so that the connector is facing away from you. Refer to Figure 5-1.
2. Hold the sides of the Sensor near the cable end. Insert the screwdriver at a 45° angle as shown in Figure 5-1. Make sure the screwdriver is inserted as far forward on the Sensor as possible.
3. Rotate the screw driver about 90° as shown, until the covers snap apart.
4. Repeat steps 2 and 3, inserting the screwdriver approximately 2/3 of the way toward the cable end of the Sensor, at the point shown in Figure 5-1.
5. Separate the plastic shell halves. If the cover does not separate easily, repeat steps 2, 3, and 4 on the other side of the Sensor.
6. Attach the covers to the exchange Sensor module by snapping the two shells together.

Anti-Static Work Station

Electrostatic discharge (ESD) can damage or destroy electronic components. Therefore, all work performed on assemblies consisting of electronic components should be done at a static-safe workstation.

Figure 5-2 shows an example of a static-safe workstation using two types of ESD protection: 1) conductive table mat and wrist strap combination, and 2) conductive floor mat and heel strap combination. These methods may be used together or separately. (A list of static-safe accessories and their part numbers is given on the following pages.)

Reducing Damage Caused by ESD

Below are suggestions that may help reduce ESD damage that occurs during testing and servicing instruments.

PC Board Assemblies and Electronic Components

Handle these items at a static-safe workstation.

Store or transport these items in static-shielding containers.

Test Equipment

Before connecting any coaxial cable to an instrument connector for the first time each day, momentarily ground the center and outer conductors of the cable.

Personnel should be grounded with a resistor-isolated wrist strap before touching the center pin of any connector and before removing any assembly from the instrument.

Be sure that all instruments are properly earth-grounded to prevent build-up of static charge.

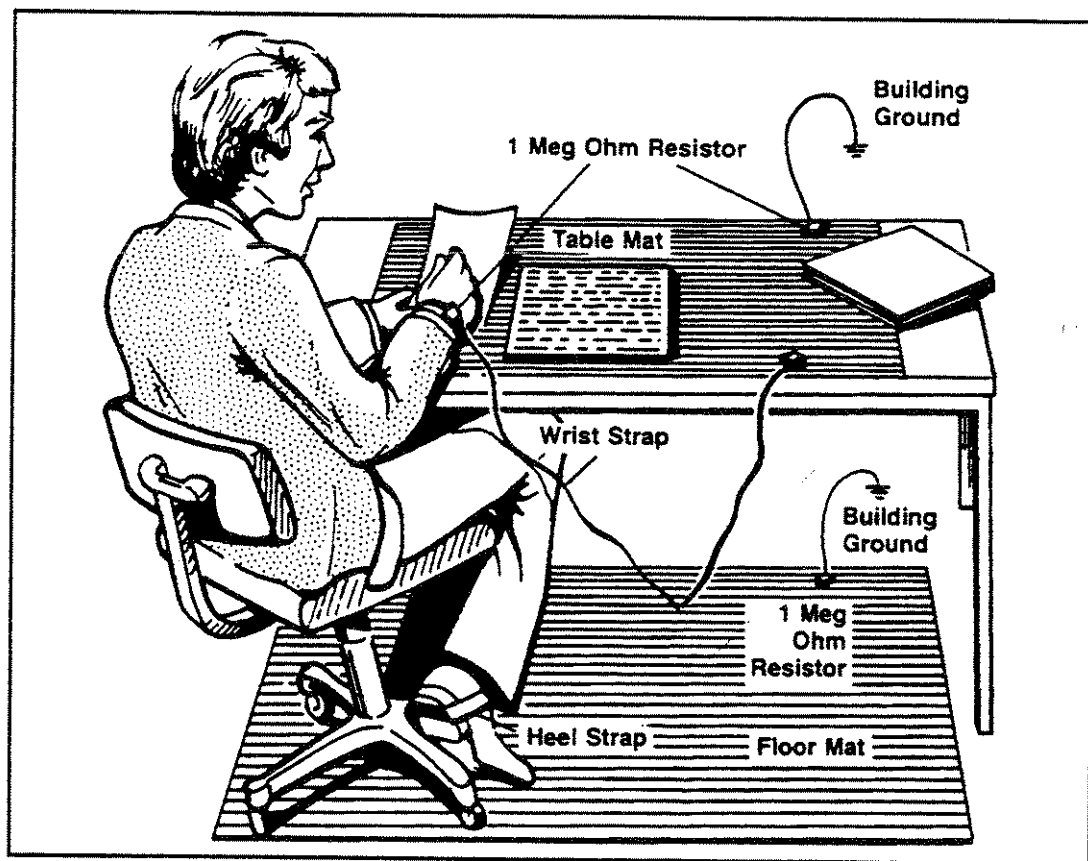


Figure 5-2. Static-Safe Workstation

**Static-Safe
Accessories**

Table 5-1 is a list of static-safe accessories that may be obtained from any Hewlett-Packard office by using the HP part numbers listed.

Table 5-1. Static Safe Accessories

HP Part Number	Description
9300-0797	3M TM static control mat .6m x 1.2m (2 x 4 ft) 4.6m (15 ft.) ground wire wrist strap and attachment cord
9300-0980	Wrist strap cord 1.5m (5 ft.)
9300-0985	Wrist strap (large)
9300-0986	Wrist strap (small)
9300-1169	ESD heel strap (reusable 6 to 12 months)
9300-0793	Shoe ground strap (one-time use only)

**More Static-Safe
Accessories**

The ESD accessories in Table 5-2 can be ordered from:

Hewlett-Packard Company
Computer Supplies Operations
1320 Kifer Road
Sunnyvale, California 94086
Phone: (408) 738-8858

Table 5-2. More Static Safe Accessories

HP Part Number	Description
92175A	Black, hard-surface, static control mat 1.2m x 1.5m (4 ft. x 5 ft.)
92175B	Brown, soft-surface, static control mat 2.4m x 1.2m (8 ft. x 4 ft.)
92175C	Small, black, hard-surface, static control mat 1.2m x 0.9m (4 ft. x 3 ft.)
92175T	Tabletop static control mat 58 cm x 76 cm (23" x 30")
92176A	Anti-static carpet (natural color), 1.8m x 1.2m (6 ft. x 4 ft.)
92176C	Anti-static carpet (russet color), 1.8m x 1.2m (6 ft. x 4 ft.)
92176B	Anti-static carpet (natural color), 2.4m x 1.2m (8 ft. x 4 ft.)
92176D	Anti-static carpet (russet color), 2.4m x 1.2m (8 ft. x 4 ft.)

Cable Replacement

This procedure describes how to replace the Peak Sensor cable.

Caution



Open the Peak Power Sensor **ONLY** in a static free environment or damage **WILL** occur.

Disconnect the Sensor from the HP 8990A before beginning the replacement procedure.

Replacing the cable **WILL** invalidate MIL-STANDARD 45662A calibration. If you wish to retain your MIL-STANDARD 45662A calibration contact your nearest Hewlett-Packard Sales or Support Office.

Replace your cable with one of the same length to maintain Sensor specifications. Do not replace a 5 foot cable with a 20 foot cable. Do not replace a 20 foot cable with a 5 foot cable.

Equipment

Open End 7/16 in. (11.2 mm); 25 in-lbs (282.5 N-cm)
Torque wrench

Open End SMC 15/64 in. (6 mm); 4 in-lbs (45 N-cm)
Torque wrench

Screwdriver Small Posidrive

Procedure

1. Perform this procedure only in an Electro-Static Discharge (ESD) free environment.
2. Disconnect the Peak Power Sensor from the HP 8990A Peak Power Analyzer.
3. Remove the covers. See Figure 5-1 and Removing the Covers in this chapter.
4. Refer to Figure 5-3. Remove two screws **2** from the sensor shield **4**.

5. Slide the sensor shield **4** over the Sensor cable and expose the Sensor interior.
6. With your 15/64 in. wrench unscrew the SMC nut **5A** from the PC board.
7. With your fingers pull the **5B** connector free from the PC board.
8. With your 7/16 in. wrench unscrew the cable nut **5C**.
9. Pull the sensor shield free of the cable.
10. Slide the sensor shield **4** over the new cable.
11. Tighten cable nut **5C** to 25 in·lbs (282.5 N·cm).
12. Place a drop of "Blue Loctite™" (not shown) on the exposed threads of **5C**.
13. Place connector **5B** on the PC board.
14. Tighten nut **5A** to 4 in·lbs (45 N·cm).
15. Slide metal case over the unit and secure with screws **2** and lockwashers **3**.
16. Reinstall the covers.
17. Perform the operation check in Chapter 3, Inspection of the Sensor.

Table 5-3. Replaceable Parts

Reference Designation	HP Part No.	CD	Qty	Description	Mfr Code	Manufacturer Part Number
1	85025-40006	3	1	Plastic Half Body	28480	85025-40006
2	0515-0972	6	1	Screw-Mach M2.5 X 0.45 4MM-LG PAN-HD	83486	
3	2190-0583	9	1	Washer-LK HLCL 2.5 2.6-MM-ID 5.1-MM-OD		
4	84812-20027	7	1	Sensor Shield	28480	84812-20027
5	84812-60008	9	1	Cable AY-Sensor 5	28480	84812-60008
	84812-60009	9	1	Cable AY-Sensor 20	28480	84812-60009
6	84812-80004	6	1	Label-Serial	28480	84812-80004
7	84812-80001	3	1	Label Info	28480	84812-80001
8	84812-80003	5	1	Label-ID 84812A	28480	84812-80003
	84813-80001	4	1	Label-ID 84813A	28480	84813-80001
	84814-80001	5	1	Label-ID 84814A	28480	84814-80001
9	84812-80002	4	1	Label Caution	28480	84812-80002
10	84812-80005	7	1	Label-Overlay	28480	84812-80005
11	0470-0231	6	1	Sealant Loctite 242/PRMBND MM 115	05972	242

Table 5-4. Exchange Sensor modules

Model No.	Sensor with 5 ft cable	Sensor with 20 ft cable
HP 84812A	84812-69013	84812-69002
HP 84813A	84813-69014	84813-69003
HP 84814A	84814-69015	84814-69002

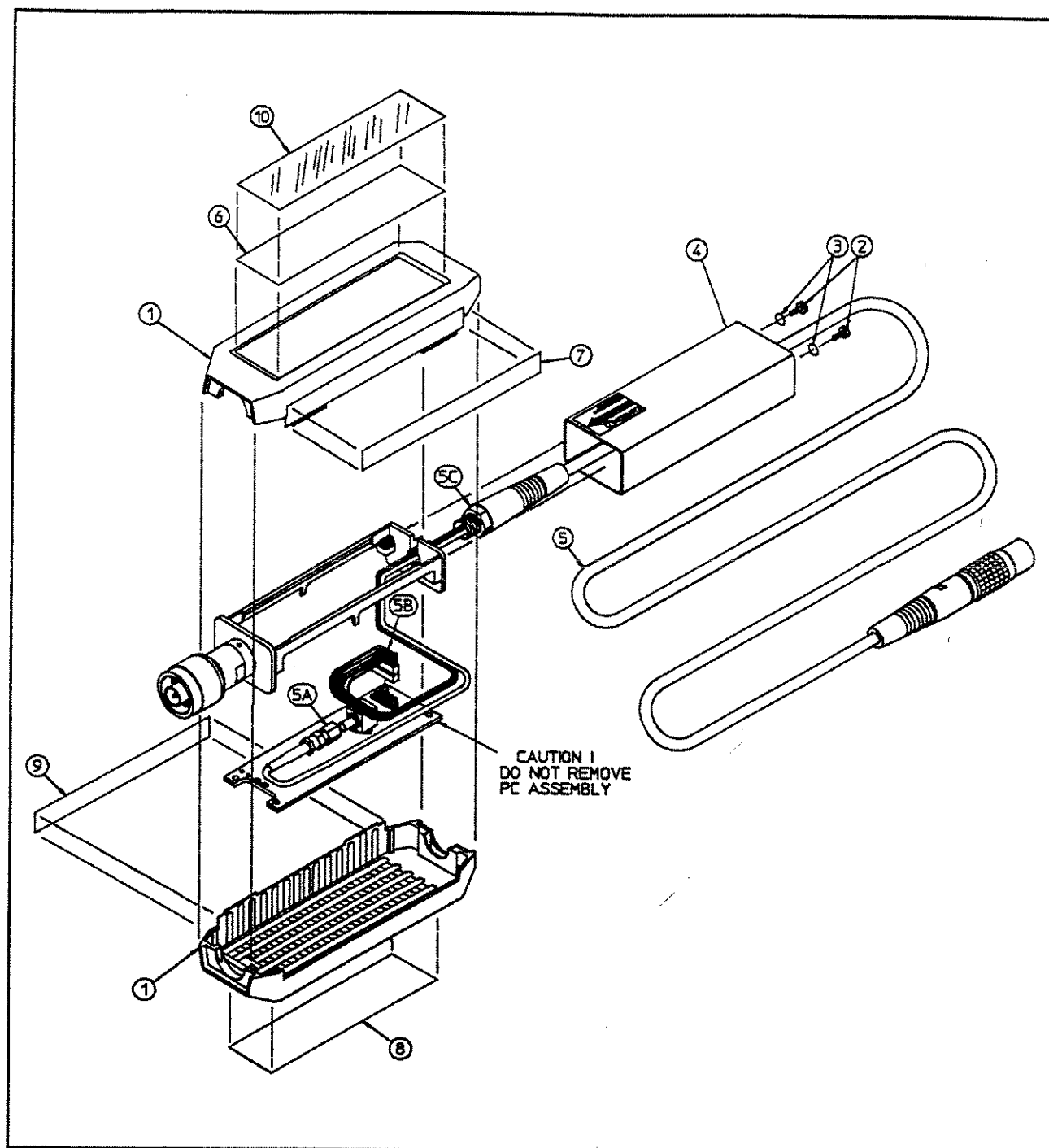


Figure 5-3. Cable Replacement

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Calibration

Introduction

After 18 months of normal use, your HP 84812A, 84813A or 84814A Peak Power Sensor should be calibrated.

Before attempting calibration, make sure your Sensor passes the operating check located in chapter 3, Inspection of the Sensor.

There are three ways you can calibrate your Sensor:

- Perform this calibration procedure.
 - Refer to the list of required equipment in Table 6-1 to determine if you have the resources needed to calibrate your sensor.
- Replace your Sensor with an exchange Sensor module. The exchange Sensor module is restored to original condition with a factory calibration. See Table 5-4 Exchange Sensor modules.
- Send your Sensor back to HP for a factory calibration.

If you choose to return your sensor to HP for calibration or replacement, call your nearest HP Sales or Support office listed inside the back cover of this manual to get cost and time estimates.

If you choose to perform your own calibration, continue reading.

Table 6-1. Recommended Calibration Test Equipment

Instrument Type	Critical Specifications	Suggested Model
Peak Power Analyzer	No substitute	HP 8990A
HP-IB Controller	Interface capabilities as defined by IEEE Compatibility Code (Std 488.2-1988): SH1, AH1, T5, L4, SR1, RL1, PP1, DC1, DT1, C0, and E2.	HP 9000 Series 200/300
Software	HP Basic Operating System	HP Basic 3.0 or greater
Network Analyzer System	500 MHz to 26.5 GHz 500 MHz to 40 GHz	HP 8510B HP 8510C
S Parameter Test Set	Compatible with frequency range of Network Analyzer	HP 8515A HP 8517A
Signal Generator	500 MHz to 26.5 GHz ≤ -50 dBc harmonics and spurious signals 500 MHz to 40 GHz ≤ -50 dBc harmonics and spurious signals	HP 8673D HP 83640A
Power Splitter	Reflection RSS Uncertainty < 0.03 Standards Laboratory Calibration	
2.4 mm	(HP 84814A, only)	HP 11760S K13
3.5 mm	(HP 84813A, only)	HP 11760S K05
Type N	(HP 84812A, only)	HP 11760S K03
Average Power Meter	2 each. No substitute	HP 437B
Average Sensor	Power Range: $1\mu\text{W}$ to 100 mW	
2.4 mm	Compatible with HP 437B. (HP 84814A, only) Freq. Range: 500 MHz to 40 GHz	HP 8487A
3.5 mm	Compatible with HP 437B. (HP 84813A, only) Freq. Range: 500 MHz to 26.5 GHz	HP 8485A
Type-N	Compatible with HP 437B. (HP 84812A, only) Freq. Range: 500 MHz to 18 GHz	HP 8481A

6-2 Calibration

Table 6-1. Recommended Calibration Test Equipment (continued)

Instrument Type	Critical Specifications	Suggested Model
Standardized Sensor	Standards Lab calibrated average sensor. Compatible with average power meter.	
2.4 mm	Max SWR at 50 MHz ≤ 1.15 (HP 84814A)	HP 8487A H84
3.5 mm	Max SWR at 50 MHz ≤ 1.15 (HP 84813A)	HP 8485A H84
Type N	Max SWR at 50 MHz ≤ 1.15 (HP 84812A)	HP 8481A H84
	Cal Factor Calibration Uncertainty (RSS): 2 — 4 GHz: $< \pm 1.57\%$ 4 — 12 GHz: $< \pm 1.89\%$ 12 — 18 GHz: $< \pm 2.22\%$ 18 — 26.5 GHz: $< \pm 2.50\%$ 26.5 — 40 GHz: $< \pm 3.40\%$	
	Reflection Coefficient Uncertainty (RSS): 2 — 4 GHz: < 0.014 4 — 12 GHz: < 0.015 12 — 18 GHz: < 0.02 18 — 26.5 GHz: < 0.029 26.5 — 40 GHz: < 0.025	
Calibration Kit		
2.4 mm	HP 84814A (only)	HP 85056D
3.5 mm	HP 84813A (only)	HP 85052D
Type N	HP 84812A (only)	HP 85032B

- f. Under **MENUS**, press **CHAN/VERT**.
- g. Press **sensor zero**.
- h. Wait a moment. The Analyzer display should respond with:

sensor zero completed

Procedure

1. Set up your system as shown in Figure 6-3. Connect the **STANDARD SENSOR** (standards lab calibrated average power sensor) to the calibrated port of the splitter. The calibrated port is identified on the calibration report from the calibration lab.
2. Set the signal generator to the calibration frequency of interest. See Table 6-2.
3. Enter the calibration frequency into both average power meters.
4. Adjust the signal generator output power level until the reference average power meter reads $1 \text{ mW} \pm 0.005 \text{ mW}$.
5. Record in Table 6-2 data table the average power, P_{std} and P_{ref} , as measured by the standard sensor and the reference sensor, respectively.
6. Repeat steps 2 through 5 for each calibration frequency.
7. Replace the standard power sensor and meter with the Peak Power Sensor to be calibrated and HP 8990A Peak Power Analyzer. Refer to Figure 6-3.
8. Take a CW power measurement with the peak power analyzer, press:
 - a. Press **AUTOSCALE**.
 - b. Press **Blue** shift key.
 - c. Press **avg** on the keypad.

- d. Press **1** on the keypad.
9. On the peak power analyzer, under MENUS, press **CARRIER FREQ**.
10. Set the signal generator to the calibration frequency of interest. See Table 6-2.
11. Enter the calibration frequency on the analyzer keypad.
12. On the reference (average) power meter enter the calibration frequency.
13. Adjust the signal generator output power level until the reference average power meter reads approximately 1 mW.
14. Record in Table 6-2 the reference power meter reading (P'_{ref}) and the peak analyzer reading (P'_{dut}). The reading appears in the lower left area of the peak analyzer display.
15. Repeat steps 10 through 14 for each calibration frequency.
16. Leave the test setup intact while you perform the Calculate Transfer Cal Factors and Download Transfer Cal Factors procedures.

Calculate Transfer Cal Factor Percentage

This is the fourth step in the calibration procedure. This procedure uses the measurements you have just made in the second step (where you measured reflection coefficient) and third step (where you measured power levels) to calculate the transfer calibration factor percentages (Cf) you will download to the Sensor EEPROM in step 5.

Note



Due to the complexity of the calculations, we suggest using the Calculating Cf Program (HP Basic 3.0 or greater have the necessary math functions) the end of this procedure. The Calculating CF Example can be used as a guide to help you to use one of the popular spreadsheet programs available for personal computers.

Calculate Cf

1. Calculate the incident power level to the standard sensor.

$$P_{ist} = P_{std} |(1 - \Gamma_{std} \Gamma_{sp})^2|$$

where:

$\Gamma_{std} \Gamma_{sp}$ is a complex number (see Calculating Cf Example).

$P_{ist} \equiv$ incident power to the standard sensor

$P_{std} \equiv$ power measured by the standard sensor

$\Gamma_{std} \equiv$ reflection coefficient of standard sensor

$\Gamma_{sp} \equiv$ equivalent source match of splitter

Γ , gamma, $\equiv |\Gamma|, \angle \Gamma$

2. Calculate the incident power level on the DUT sensor.

$$P_{idut} = \frac{(P'_{ref})(P_{ist})}{P_{ref}}$$

Calculating CF Program

Copy and save the following program to generate your transfer calibration factor percentages. The program will prompt you to enter the data for each frequency. Copy the resultant transfer cal factor percentages into the Cf (%) column of Table 6-2.

```
10 PRINT "The following program will calculate the cal factor."
20 INPUT "Enter the freq in GHz.",Freq
30 INPUT "Enter GAMMAsp:",Gamsp
40 INPUT "Enter the angle GAMsp:",Agamsp
50 INPUT "Enter GAMstd:",Gamstd
60 INPUT "Enter the angle GAMstd:",Agamstd
70 INPUT "Enter GAMdut:",Gamdut
80 INPUT "Enter the angle GAMdut:",Agamdut
90 INPUT "Enter Pstd:",Pstd
100 INPUT "Enter Pref:",Pref
110 INPUT "Enter Pdut:",Pdut
120 INPUT "Enter P'ref:",Pref2
130 PRINT "Please wait while I calculate the cal factor."
140 A=Gamstd*Gamsp
150 B=Agamstd+Agamsp
160 Pist=Pstd*((1-A*COS(B))^2+(A*SIN(B))^2)
170 Pidut=Pref2*Pist/Pref
180 C=Gamdut*Gamsp
190 D=Agamdut+Agamsp
200 Pd=Pidut/(1-C*COS(D))^2+(C*SIN(D))^2
210 Cf=Pdut/Pd*100
220 Cfpercent=PROUND(Cf,-1)
230 PRINT "The Cal Factor ";Freq;" GHz is: ";Cfpercent;" %."
240 INPUT "Enter 'Y' or 'y' if more calculation are required.",A$
250 If A$="Y" OR A$="y" THEN GOTO 20
260 PRINT "The calculations are complete."
270 END
```

Download Transfer Cal Factors

This procedure uses a program to download transfer calibration factor percentage (Cf) to the Sensor EEPROM.

Note



The Sensor EEPROM will round up the calibration factor percentage to the nearest 0.4%. For example: You enter 96.5 as a cal factor percentage for 16 GHz. Later, if you query the Sensor EEPROM using ":CAL:FIELD:DATA?", the EEPROM will report a cal factor percentage of 96.8.

- Leave the equipment set up as shown in Figure 6-3, but connect the controller to the HP 8990A Peak Power Analyzer via HP-IB as shown in Figure 6-1.
- Download Cf to the Peak Power Sensor EEPROM using the following program.

Caution



DO NOT disconnect the sensor or cycle power while executing any read or write function to the Peak Power Sensor EEPROM. If this happens, the Peak Power Sensor EEPROM will be erased. This condition is not user repairable. The Peak Power Sensor must be sent back to Hewlett-Packard for calibration.

```

10  !   Transfer cal factor downloading program
20  DIM Flist(50), Clist(50)
30  ASSIGN @A to 707
40  !
50  ! Read number of field cal points.
60  !
70  OUTPUT @A;":CAL:FIELD:POINTS? CHAN1"
80  ENTER @A;N
90  PRINT "CHAN1 #of field cal points: ";N
100 !
110 ! Read field cal test frequencies.
120 !

```

```
130 REDIM Flist(1:N)                ! Make space for N freqs.
140 OUTPUT @A;":CAL:FIELD:FREQUENCY? CHAN1"
150 ENTER @A;Flist(*)              ! Get freq array.
160 !
170 ! Get correction factors from user.
180 !
190 REDIM Clist(1:N)                ! Make space for N values.
200 PRINT
210 PRINT "Correction Factors:"
220 FOR I=1 to N
230     IMAGE #,2X,DD.DD," GHz"
240     PRINT USING 230;Flist(I)/1.E+9
250     Clist(I)=100.0              ! Default.
260     INPUT "Enter the correction factor for this frequency:",Clist(I)
270     IMAGE 4X,DDD.DD
280     PRINT USING 270;Clist(I)
290 NEXT I
300 !
310 ! Send new cal factors out.
320 !
330 IMAGE #,":CAL:FIELD:DATA CHAN1,"
340 OUTPUT @A USING 330
350 IMAGE #,DDD.DD,", "            ! No linefeed, trailing comma.
360 FOR I=1 to N-1                ! For each value except last....
370     OUTPUT @A USING 350;Clist(I) ! Each value get trailing comma.
380 NEXT I
390 OUTPUT @A;Clist(N)            ! Send final value, no comma.
400 !
410 PRINT "CF data has been entered."
420 END
```

Power Variation Testing

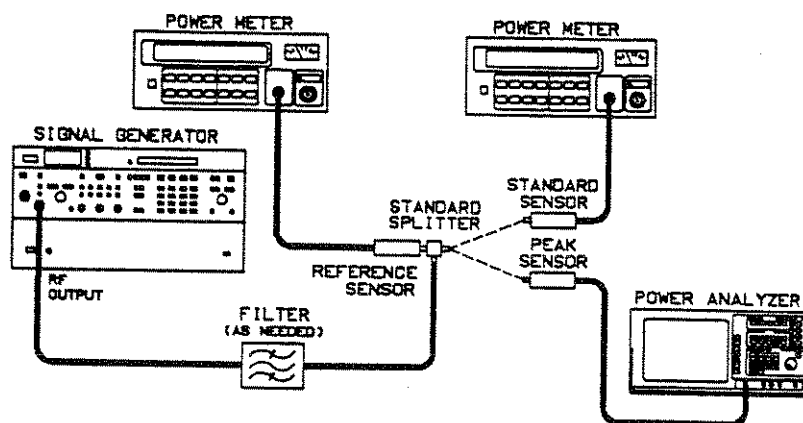


Figure 6-4. Power Level Variation Test

This is the sixth step of the calibration procedure.

In the procedures that follow, you will compare the results of your newly calibrated Peak Power Sensor to your calibrated average sensor and record your test results in a copy of Table 6-4 and Table 6-5.

Note



It is assumed your test equipment settings and setup are the same as what you used in Measure the Power Levels procedure, earlier.

Procedure

1. Set up your system as shown in Figure 6-4. Connect the Standard Sensor (standards lab calibrated average power sensor) to the calibrated port of the splitter.
2. Set the signal generator frequency to the frequency you entered in Table 6-3.
3. In Table 6-4 and Table 6-5, enter the same non-calibration frequency you entered in Table 6-3.
4. Enter the frequency into both average power meters.

5. Adjust the signal generator output power level until the reference average power meter reads approximately $100 \mu\text{W} \pm 5 \mu\text{W}$
6. Record in Table 6-4 the average power, P_{std} and P_{ref} , as measured by the standard sensor and the reference sensor, respectively.

2 mW to 10 mW Test with Standard Sensor

7. Adjust the signal generator power level until the reference power meter read (2 mW to $10 \text{ mW} \pm 0.05 \text{ mW}$).
8. Record in Table 6-5 the average power, P_{std} and P_{ref} , as measured by the standard sensor and the reference sensor, respectively.

With Peak Sensor

9. Replace the standard power sensor and meter with the Peak Sensor (DUT) and HP 8990A Peak Power Analyzer. Refer to Figure 6-4.
10. On the analyzer, press **LOCAL**.
11. Press **CARRIER FREQ**.
12. Enter the non calibration frequency on the Peak Analyzer keypad.
13. Adjust the signal generator power level output until the reference average power meter reads approximately $100 \mu\text{W} \pm 5 \mu\text{W}$
14. Press **AUTOSCALE** on peak power analyzer.
15. Take a CW power measurement with the peak power analyzer, press:
 - a. Press **Blue** shift key.
 - b. Press **avg** on the keypad.
 - c. Press **1** on the keypad.

16. Record in Table 6-4 the reference power meter reading (P'_{ref}) and the analyzer reading (P_{dut}).

2 mW Test with Peak Sensor

17. Adjust the signal generator power level you set in step 7.
18. Press **AUTOSCALE**.
19. Record in Table 6-4 the reference power meter reading (P'_{ref}) and the Peak analyzer CW power reading (P_{dut}).

Calculate %Error

20. Calculate the %Error using some of the same formulas you used in the Calculating Cf Example, earlier.

$$P_{ist} = P_{std} |(1 - \Gamma_{std} \Gamma_{sp})^2|$$

$$P_{idut} = \frac{(P'_{ref})(P_{ist})}{P_{ref}}$$

$$P_d = \frac{P_{idut}}{|(1 - \Gamma_{sp} \Gamma_{dut})^2|}$$

$$\%Error = \left(\frac{P_d - P_{dut}}{P_d} \right) (100)$$

21. Record in Table 6-4 and Table 6-5.

Compare this %Error to the Sensor Calibration RSS uncertainty listed in Table 2-1. Remember the specification is range specific. For example, if you chose 9 GHz as your non-calibration frequency, compare the %Error to the specification for the < 12 GHz range. If the %Error is greater than the uncertainty specifications, the peak sensor fails calibration and must be repaired.

Note

If the %Error fails by less than two percent, repeating the complete calibration might improve the %Error. For example, if 9 GHz is your non-calibration frequency and your %Error is 5.8% or less, the error could be attributed to faulty connections. As noted earlier, follow the procedures in Application Note 326 when making or breaking connections.

Table 6-2. Calibration Factor at Calibration Frequencies Data Table

Freq. (GHz)	Γ_{sp}	$\angle\Gamma_{sp}$	Γ_{std}	$\angle\Gamma_{std}$	Γ_{dut}	$\angle\Gamma_{dut}$	P_{std} (mW)	P_{ref} (mW)	P_{dut} (mW)	P'_{ref} (mW)	Cf (%)

Table 6-3. Non-Calibration Frequency Data Table

Freq. GHz	Γ_{sp}	$\angle\Gamma_{sp}$	Γ_{std}	$\angle\Gamma_{std}$	Γ_{dut}	$\angle\Gamma_{dut}$

Table 6-4. 100 μ W Power Level Data Table

Freq. (GHz)	P _{std} (μ W)	P _{ref} (μ W)	P _{dut} (μ W)	P' _{ref} (μ W)	% Error

Table 6-5. 2 mW to 20 mW Power Level Data Table

Freq. (GHz)	P _{std} (mW)	P _{ref} (mW)	P _{dut} (mW)	P' _{ref} (mW)	% Error

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