Agilent W8486A Power Sensor

Operating Manual

Agilent Technologies

Notices

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Safety Summary

The following general safety precautions must be observed during all phases of operation of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies, Inc. assumes no liability for the customer's failure to comply with these requirements.

Safety Notices

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or loss of life. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

CAUTION

A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a **CAUTION** notice until the indicated conditions are fully understood and met.

General Safety Information

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

WARNING **BEFORE CONNECTING THE POWER SENSOR TO OTHER INSTRUMENTS, ensure that all instruments are connected to the protective (earth) ground. Any interruption of the protective earth grounding will cause a potential shock hazard that could result in personal injury.**

CAUTION

- Use the device with the cables provided.
- Repair or service that is not covered in this manual should only be performed by qualified personnels.

Operating Environment

The operating environment for the power sensors should be within the following limits:

Environmental conditions	Requirements
Temperature	0 to +55 °C
Relative humidity	<95%
Altitude	<4550 meters (15 000 feet)

Operating Precautions

CAUTION

If the following energy and power levels are exceeded, the power meter system may be damaged.

- Maximum Average Power: 200 mW
- Maximum Peak Power: 40 W

Connect the power sensor by turning only the nut on the type-N connector. Damage can occur if torque is applied to the power sensor body.

The waveguide flanges can be damaged if the flange screws are over-tightened. Do not fully tighten one flange screw without tightening the one opposite. First insert screws and tighten until finger tight. If you are using the hex ball driver, hold the driver between thumb and forefinger while incrementally tightening screws opposite each other until reaching a maximum torque of 60 inch-ounces (0.42 N $\times$ m).

Use the plastic flange cover to protect the waveguide connector from dirt and mechanical damage whenever it is not in use. Any burn, dents or dirt on the flange or waveguide surface will increase the SWR and change the Cal Factor.

The type-N connector plastic bead deteriorates when contacted by any chlorinated or aromatic hydrocarbons such as acetone, trichlorethylene, carbon tetrachloride, benzene, etc. Clean the connector face with a cotton swab saturated in isopropyl alcohol.

In This Guide ...

1 **Introduction** Chapter 1 covers the general information, description, accessories and installation procedure of the W8486A Power Sensor.

2 **Making Measurements** Chapter 2 explains power measurements, calibration factor, sensitivity and modulation effect of the W8486A Power Sensor.

3 **Specifications** Chapter 3 shows the specifications of the W8486A Power Sensor.

4 **Service** Chapter 4 covers the servicing of your W8486A Power Sensor.

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Figures

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Tables

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1 Introduction

General Information

This manual contains information about initial inspection and operation of the W8486A power sensor.

Instruments Covered by Manual

These instruments have two-part serial numbers which is in the form 0000A0000. The first four digits and the letter comprise the serial number prefix. The last five digits form a sequential suffix which is unique to each instrument. The contents of this manual apply directly to instruments having the serial number prefix 3139A and above.

Manual Changes Supplement

An instrument manufactured after the printing of a manual may have a serial number prefix not listed above. Unlisted serial number prefixes indicate that the manual for such an instrument has been amended with a distinctive yellow *Manual Changes* supplement containing updated technical information.

Manual Changes supplements may also provide corrections to errors in manuals. To keep the instrument manual as current and accurate as possible, Agilent recommends that you periodically obtain the latest *Manual Changes* supplement. *Manual Changes* supplements are keyed to a manual's print date and part number.

For information concerning a serial number prefix not listed on this manual or in the *Manual Changes* supplement, contact your nearest Agilent office.

Warranty

The power sensor is warranted and certified. Do not open the power sensor. Any attempt to disassemble the power sensor will void warranty.

Description

The W8486A is a diode power sensor. It measures power levels in a range from –30 dBm to +20 dBm. (Specifications for the power sensor are in Table 3-1 on page 12.) The W8486A measures at frequencies from 75 GHz to 110 GHz.

The power is determined from the ac voltage developed across the 50 ohm load from the microwave source. The diodes convert this ac voltage to dc. The dc voltage produced is the square of the ac voltage. The dc voltage thus generated is a very low-level voltage and requires amplification before it can be transferred on standard cables to the power meter.

The amplification is provided by an input amplifier assembly which consists of a chopper (sampling gate) and an input amplifier. The dc voltage is routed to the chopper circuit which converts the low-level dc voltage to an ac voltage. The chopper is driven by a 220 Hz square wave generated by the power meter. The result is an ac output signal proportional to the dc input. The ac signal is then amplified by the input amplifier. The relatively high-level ac signal output can now be routed by standard cables.

NOTE The W8486A power sensor is compatible with the Agilent 435B, 436A, 437B, and 438A power meters.

In application, the power sensor is connected between a microwave source and a compatible power meter. The power sensor provides a matched load for the microwave source for very low SWR. The power meter indicates the power dissipated in the load in µW, mW or in dBm.

CAUTION Do not disassemble the power sensor. The power sensor is extremely static sensitive and can be easily damaged.

Accessories

Included is a hex ball driver plus the waveguide mounting screws. Refer to Figure 1-1 for a visual check of what should be included with your power sensor.

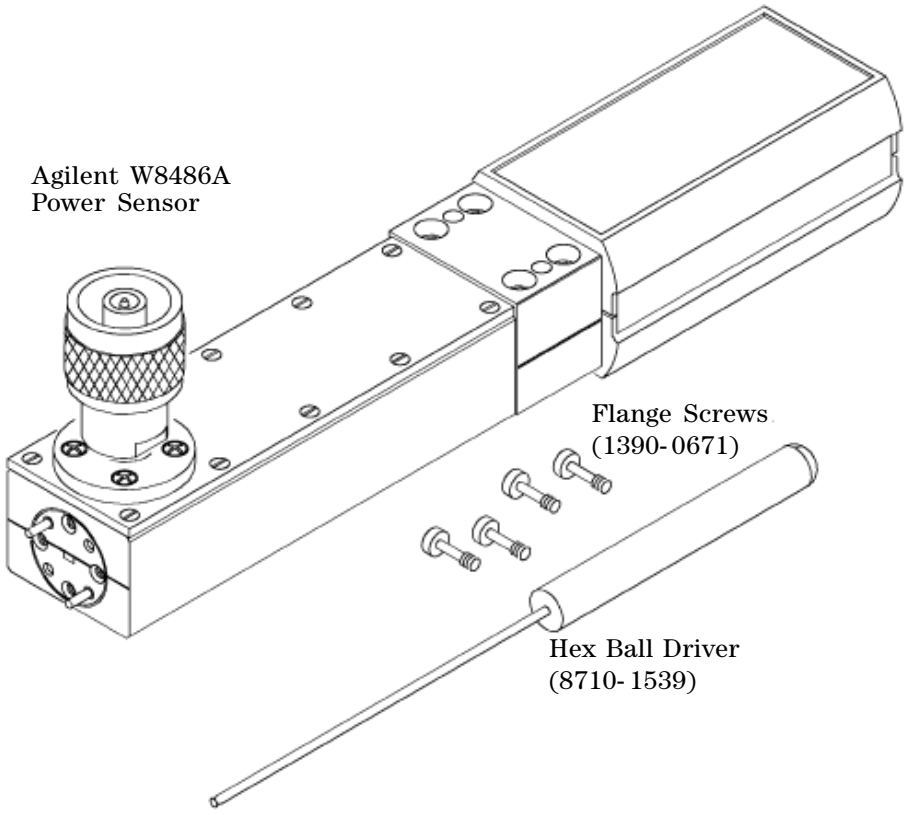

Figure 1-1 W8486A power sensor with accessories and hardware

Installation

Initial Inspection

Inspect the shipping container for damage. If the shipping container or packaging material is damaged, it should be kept until the contents of the shipment have been checked mechanically and electrically. If there is mechanical damage or if the instrument does not pass the performance tests, notify the nearest Agilent office. Keep the damaged shipping materials (if any) for inspection by the carrier and a Agilent representative.

Interconnections

The W8486A power sensor has two inputs: a type-N connector and a WR-10 waveguide flange. During calibration, the type-N connector is connected to the calibration port of the power meter. During measurement, the waveguide flange is connected to the device under test.

CAUTION

Connect the power sensor by turning only the nut on the type-N connector. Damage can occur if torque is applied to the power sensor body.

The waveguide flanges can be damaged if the flange screws are over-tightened. Do not fully tighten one flange screw without tightening the one opposite. First insert screws and tighten until finger tight. If you are using the hex ball driver, hold the driver between thumb and forefinger while incrementally tightening screws opposite each other until reaching a maximum torque of 60 inch-ounces (0.42 N x m).

Use the plastic flange cover to protect the waveguide connector from dirt and mechanical damage whenever it is not in use. Any burn, dents or dirt on the flange or waveguide surface will increase the SWR and change the Cal Factor.

Refer to the power meter operating and service manual for interconnecting instructions.

CAUTION Connect the power sensor by turning only the nut on the type-N connector. Damage can occur if torque is applied to the power sensor body.

Storage and Shipment

Environment

The instruments should be stored in a clean, dry environment. The following limitations apply to both storage and shipment:

Environmental conditions	Requirements
Temperature	–40 to +55 °C
Relative humidity	<95% @ 40 °C
Altitude	<15,300 meters (25 000 feet)

Origonal Packaging

Containers and materials identical to those used in factory packaging are available through Agilent offices. If the instrument is being returned to Agilent for servicing, attach a tag indicating the type of service required, return address, model number, and serial number.

Also, mark the container FRAGILE to assure careful handling. In any correspondence, refer to the instrument by model number and serial number.

2
Making Measurements

Operation

Power Meter Calibrations

The procedure of calibrating one power meter may be different for another power meter. Follow the calibration directions given in your power meter manual.

Power Measurements

To correct for varying responses at different frequencies a cal factor chart is included on the power sensors. To use the cal factor at the frequency of interest, adjust the power meter's CAL FACTOR control according to the instructions in the power meter's operating and service manual.

If you are using a 435B or 436A, the minimum cal factor setting is 85% and the maximum is 100%. If the cal factor setting for your frequency of interest is below the meter's minimum or above the meter's maximum, set the cal factor control to 100%, and divide the reading in watts units by the decimal equivalent of the cal factor. For example, if the cal factor is 75%, divide the reading by 0.75. (This will result in a larger value of power than that displayed by the meter.)

If the cal factor is 104%, divide the reading by 1.04. (This will result in a smaller value of power than that displayed by the meter.)

If reading in dBm, use the chart in Table 2-1 to convert the cal factor to dB and add this value to the reading. Interpolate for values between those shown. As above, the cal factor control should be set to 100%. If the cal factor is 75%, add 1.25 dB to the displayed value. On the other hand, if the cal factor is 104%, subtract 0.170 from the displayed reading

NOTE

The above procedure has eliminated some mathematical steps, the following formula may be of some use:

Correction dB = Reading dBm –10 x Log_{10} Cal Factor (decimal).

Table 2-1 Cal Factor to dB conversion table

Cal Factor	dB	Cal Factor	dB	Cal Factor	dB
70%	1.55	79%	1.02	103%	–0.128
71%	1.49	80%	0.97	104%	–0.170
72%	1.43	81%	0.92	105%	–0.212
73%	1.37	82%	0.86	106%	–0.253
74%	1.31	83%	0.81	107%	–0.294
75%	1.25	84%	0.76	108%	–0.334
76%	1.19	85%	0.71	109%	–0.374
77%	1.14	101%	–0.043	110%	–0.414
78%	1.08	102%	–0.086		

The sensitivity of the power sensor is influenced by ambient temperature. The sensor should be recalibrated after each change in temperature to obtain the most accurate results. Typical temperature sensitivity variations are shown in Figure 2-0.

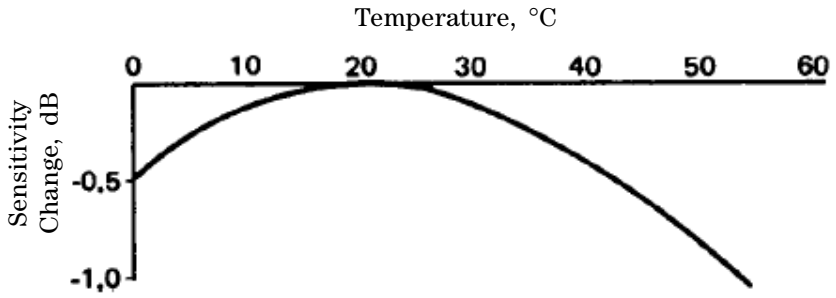

Figure 2-0 Typical influence of temperature on sensitivity

Operating Instructions

To operate the power sensor, refer to the operating instructions in Section III of the power meter operating and service manual.

NOTE

If having an open RF connection on your system is a concern, terminate the sensor type-N calibration port with a 50Ω load.

Correction dB = Reading dBm –10 x Log_{10} Cal Factor (decimal).

Modulation Effects

When measuring microwave sources that are modulated at the chopper frequency (nominally 220 Hz), or at the first or second harmonic or submultiples of the chopper frequency, beat notes will occur. Unless these beat notes are exactly the chopper frequency, they can usually be eliminated by averaging since the amplitudes are plus and minus the actual power. These frequencies may also be avoided by changing the modulation frequency slightly, if possible.

If you are using a 437B power meter, select a manual filter setting of at least 128 (as displayed on power meter) to minimize beat note interference. To minimize beat note interference using a 438A power meter select a filter number of at least 7.

3 Specifications

Specifications

The specifications listed in Table 3-1 are the performance standards or limits against which the power sensor may be tested.

Table 3-1 Specifications

Characteristics and Conditions	Limits	Comments
Frequency Range	75.0 to 110 GHz	
Power Range	1 µW to 100 mW (–30 dBm to +20 dBm)	
Nominal Impedance	50 Ω	
Connectors 50 MHz Calibration Port Waveguide Flange	 Type-N (Male) UG-387/U Flange (Modified)	 50 Ω nominal impedance
Maximum Standing Wave Ratio (SWR) and Reflection Coefficient (Rho) Agilent W8486A	 **SWR** **Rho** 1.08 0.038	
Maximum Power	40 W (peak), 200 mW (average)	Any port
Worst Case Power Linearity	10 mW to 100 mW (+10 dBm to +20 dBm) +1%, –3%	Negligible deviation except for those power ranges noted. Note that the D-Type linearity for the compensating overall system linearity must be selected with this sensor as it is a diode-based sensor.
Operating Temperature Range	0 to 55 °C	

Table 3-1 Specifications

Characteristics and Conditions	Limits	Comments
Net Weight	0.4 kg (0.9 lb)	
Dimensions	Width: 38 mm (1.2 in) Length: 199 mm (7.8 in) Height: 60 mm (2.4 in)	

Recommended Calibration Interval

Agilent Technologies recommends a one-year calibration cycle for the 8486 Series power sensors.

Calibration Factor (CF) and Reflection Coefficient (Rho)

The CAL FACTOR compensates for the frequency response of the sensor. CAL FACTOR and reflection coecient data are provided on a label attached to the sensor cover. Maximum and probable uncertainties of the CAL FACTOR data are listed in Table 3-2. Probable uncertainties are calculated using the root sum of the squares (RSS) method. To use CAL FACTOR data during power measurements, see Chapter 2, “Power Measurements.” in this manual.

Reflection Coefficient (Rho, or ρ) relates to SWR according to the following formula:

$$SWR = \frac{(1+\rho)}{(1-\rho)}$$

Table 3-2 Calibration factor uncertainty at 1 mW (0 dBm)

Frequency (GHz)	Worst Case Uncertainty	(RSS) Probable Uncertainty
75	15.6	5.5
77	15.3	5.4
79	15.1	5.2
81	14.9	5.1
83	14.7	5.1
85	14.4	5.0
87	14.2	4.9
89	14.0	4.8
91	13.8	4.8
93	13.5	4.7

Frequency (GHz)	Worst Case Uncertainty	(RSS) Probable Uncertainty
94	13.4	4.7
95	7.9	3.4
96	13.4	4.7
98	13.7	4.7
100	14.2	4.8
102	14.4	4.9
104	14.6	5.0
106	14.9	5.1
108	15.1	5.1
110	15.3	5.2

4 Service

Performance Test

This section does not establish SWR test procedures since there are several test methods and dierent equipment available for testing the SWR or reflection coecient. Therefore, the actual accuracy of the test equipment, all source match corrections, and all harmonics must be accounted for when measuring against instrument specifications to determine a pass or fail condition.

To measure the SWR across the waveguide band, use a directional coupler and detector selected for the band of interest. The directional coupler should have a directivity greater than 40 dB. The detector should have greater than 0.4 mV/µW sensitivity and should be calibrated with a rotary vane attenuator with an accuracy of 2%. Incident power should be less than –20 dBm. A convenient source is a frequency multiplier driven by an Agilent 8350B and Agilent 83594A.

To check the calibration factor, the power sensor should be compared with another recently calibrated power sensor. The source should be leveled with a reference coupler that has low SWR and high directivity to monitor or level the incident power (which should be less than –30 dBm).

For reflection measurements, we suggest Application Note 183 “High Frequency Swept Measurements." For calibration factor and error analysis, we suggest Application Note 64-1 “Fundamentals of RF and Microwave Power Measurements."

NOTE The true position of the holes relative to each other are held to a diameter tolerance of 0.0254 mm (0.001). The holes are held to 1.664 mm (0.0655) minimum diameter while the pins are held to 1.61 mm (0.0634) maximum diameter.

Replaceable Parts

The hex ball driver, the flange covers, and the hardware are the only replaceable parts. The part numbers are listed in Figure 1-1. A listing of Agilent sales and service offices is located at the end of this manual.

Repair and Adjustments

Do not attempt to repair or adjust the power sensor. Due to the extreme static sensitivity of the power sensor, customer repair is not recommended. If your power sensor should fail or need calibration, return it to Agilent.

CAUTION Do not disassemble the power sensor. The power sensor is extremely static sensitive and can be easily damaged. If the power sensor shows evidence of attempted customer repair, the warranty may be voided.

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China:
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Europe:
(tel) 31 20 547 2111
Japan:
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