



Agilent E8486A Power Sensor

User's and Service Guide



Agilent Technologies

Notices

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A **CAUTION** notice denotes a hazard. It calls attention to an operating procedure, practice, or the likes of 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.

WARNING

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

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Agilent Technologies certifies that this product met its published specifications at the time of shipment. Agilent further certifies that its calibration measurements are traceable to the United States National Institute of Standard and Technology (formerly National Bureau of Standards), to the extent allowed by that organization's calibration facility, and to the calibration facilities of other International Standards Organization members.

Warranty

This Agilent Technologies instrument product is warranted against defects in material and workmanship for a period of 3 years from date of shipment. During the warranty period, Agilent Technologies 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 Agilent Technologies. Buyer shall prepay shipping charges to Agilent Technologies and Agilent Technologies shall pay shipping charges, duties, and taxes for products returned to Agilent Technologies from another country. Agilent Technologies warrants that its software and firmware designated by Agilent Technologies for use with an instrument will execute its programming instructions when properly installed on that instrument. Agilent Technologies does not warrant that the operation of the instrument or firmware will be uninterrupted or error free.

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Safety Considerations

Read the information below before using this instrument.

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 for design, manufacture, and intended use of the instrument. Agilent Technologies assumes no liability for the customer's failure to comply with these requirements.

WARNING

- **Do not use the device if it is damaged. Before you use the device, inspect the casing. Look for cracks or missing plastic. Do not operate the device around explosive gas, vapor, or dust.**
 - **Observe all markings on the device before establishing any connection.**
-

CAUTION

- If the device is used in a manner not specified by the manufacturer, the device protection may be impaired.
 - Always use dry cloth to clean the device. Do not use ethyl alcohol or any other volatile liquid to clean the device.
-

Environmental Conditions

This instrument is designed for indoor use and in an area with low condensation. The table below shows the general environmental requirements for this instrument.

Environmental condition	Requirement
Temperature	Operating condition <ul style="list-style-type: none">• 0 °C to 55 °C Storage condition <ul style="list-style-type: none">• –40 °C to 70 °C
Humidity	Operating conditions <ul style="list-style-type: none">• Maximum humidity<ul style="list-style-type: none">• 95% RH at 40 °C (non-condensing)• Minimum humidity<ul style="list-style-type: none">• 50% RH at 40 °C (non-condensing) Storage conditions <ul style="list-style-type: none">• Maximum humidity<ul style="list-style-type: none">• 90% RH at 65 °C (non-condensing)
Altitude	Operating/storage altitude <ul style="list-style-type: none">• Up to 4572 meters (15000 feet)
Pollution degree	2





Regulatory Information

The E8486A complies with the following safety and Electromagnetic Compatibility (EMC) compliances:

EMC compliance

- IEC 61326-1:2005/EN61326-1:2006
- CISPR11:2003/EN55011:2007, Group 1 Class A
- Canada: ICES/NMB-001:Issue 4, June 2006
- Australia/New Zealand: AS/NZS CISPR 11:2004

Regulatory Markings

	<p>The CE marking is a legal compliance marking of the European Community. This CE marking shows that the product complies with all the relevant European Legal Directives.</p>		<p>The C-tick mark is a registered trademark of the Spectrum Management Agency of Australia. This signifies compliance with the Australia EMC Framework regulations under the terms of the Radio Communication Act of 1992.</p>
<p>ICES/NMB-001</p>	<p>ICES/NMB-001 indicates that this ISM device complies with the Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB-001 du Canada.</p>		<p>This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.</p>
	<p>This symbol indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.</p>		

Waste Electrical and Electronic Equipment (WEEE) Directive 2002/96/EC

This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.

Product Category:

With reference to the equipment types in the WEEE directive Annex 1, this instrument is classified as a “Monitoring and Control Instrument” product.

The affixed product label is as shown below.



Do not dispose in domestic household waste.

To return this unwanted instrument, contact your nearest Agilent Service Center, or visit

www.agilent.com/environment/product

for more information.

Declaration of Conformity (DoC)

The Declaration of Conformity (DoC) for this instrument is available on the Agilent Web site. You can search the DoC by its product model or description at the Web address below.

<http://regulations.corporate.agilent.com/DoC/search.htm>

NOTE

If you are unable to search for the respective DoC, contact your local Agilent representative.

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1 Introduction

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This chapter assists you in how to set up the E8486A for the first time. A summary of all the features of the E8486A is also given.





Figure 1-1 Agilent E8486A Power Sensor

General Information

This User's and Service Guide contains information about the initial inspection and operation of the Agilent E8486A Power Sensor.

Description

The Agilent E8486A is a diode-based power sensor that measures at frequencies from 60 GHz to 90 GHz. It comes in two options: the Option 100 and the Option 200:

Option	Description
100	<ul style="list-style-type: none">measures power levels in a range from -30 dBm to $+20$ dBmdoes not come with EEPROM (Electrically Erasable Programmable Read-Only Memory)
200	<ul style="list-style-type: none">measures power levels in a range from -60 dBm to $+20$ dBmcomes with EEPROM (Electrically Erasable Programmable Read-Only Memory)

Further specifications for the power sensor can be found in [Table 3-1](#) on page 18.

The power is determined from the AC voltage developed across the waveguide termination from the microwave source. The diodes convert this AC voltage to DC. The DC voltage produced is proportional to 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 via the sensor cable 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 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.

1 Introduction

General Information

The Agilent E8486A power sensor is compatible with all Agilent power meters:

- EPM (E.g. Agilent N1913/14A, Agilent E4418/19B)
- EPM-P (E.g. Agilent E4416/17A)
- P-Series (E.g. Agilent N1911/12A)

Agilent recommends the use of the following cables with the Agilent E8486A power sensor, if you use the following power meters:

Power meter model	Recommended cables ^[1]
N1911/12A	<ul style="list-style-type: none">• 11730A (1.5 m)• 11730E (30.5 m)• 11730F (61 m)• E9288A (1.5 m)• N1917A (1.5 m)
N1913/14A	<ul style="list-style-type: none">• 11730A (1.5 m)• 11730E (30.5 m)• 11730F (61 m)• E9288A (1.5 m)

[1] These recommendations are only valid for the Option 100.

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.

Standard Shipped Items

The list of items shipped together with your power sensor is as follows:

- Hex ball driver (8710-0523)
- Flange screws (1390-0671)
- E8486A User's and Service Guide, English (E8486-90001)

Refer to [Figure 1-2](#) for a visual check of the accessories that should be included with your power sensor.

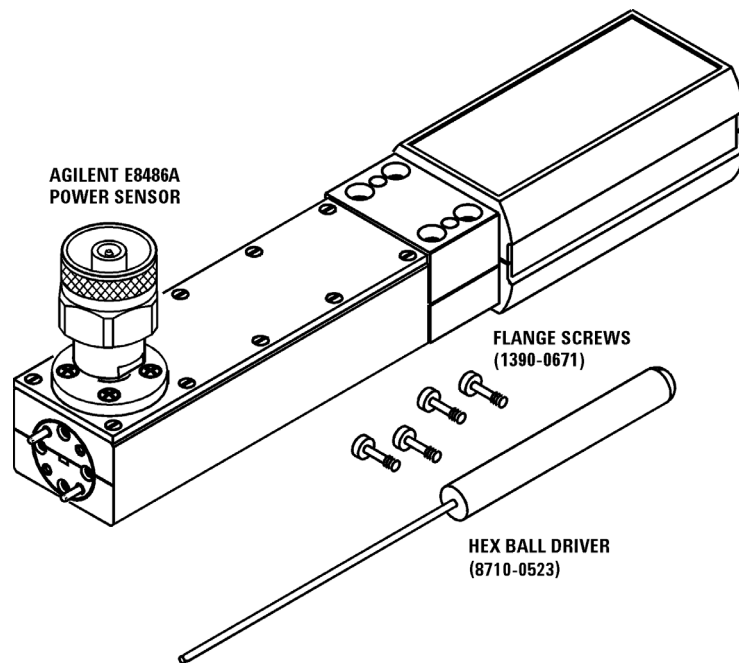


Figure 1-2 Agilent E8486A Power Sensor with Accessories and Hardware

Warranty

The power sensor is warranted and certified as indicated on the last page of this manual. Do not open the power sensor. Any attempt to disassemble the power sensor will void the warranty.

Recommended Calibration Interval

Agilent Technologies recommends a one-year calibration cycle for the E8486A power sensor.

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 Technologies office. Keep the damaged shipping materials (if any) for inspection by the carrier and a Agilent Technologies representative.

Interconnections and Calibration

The Agilent E8486A power sensor has two inputs: a Type-N connector and a 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 $0.42 \text{ N} \times \text{m}$.

Use the protective packaging provided with the power sensor to protect it from dirt and mechanical damage whenever it is not in use. Any burrs, dents, or dirt on the flange or waveguide surface will increase the SWR and change the Cal Factor.

Refer to the power meter user's guide for interconnecting instructions.

Storage and Shipment

Original Packaging

Containers and materials identical to those used in factory packaging are available through Agilent Technologies offices. If the instrument is being returned to Agilent Technologies 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 General Operation

Operation 10

This chapter explains the various functions available in the E8486A.



Operation

Operating Precautions

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 and cause damage to the power sensor.

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:
 - Option 100: 40 W^[1]
 - Option 200: 1 W^[1]

[1] 10 μ s pulse, 0.5% duty cycle or equivalent such that 200 mW maximum average power and 40 W/1 W peak power are not exceeded.

The power sensor has a precision machined E-band waveguide interface. The size and position of the aperture, the alignment holes and pins, and the flatness of the mating faces are all very tightly controlled. Refer to Figure 2-1.

In order to get the best possible measurement results the mating part must be of similar quality. Connection to an E-band waveguide component in which the interface dimensions are not accurately controlled can lead to increased SWR, inaccurate Cal Factor correction, and/or repeatability problems. In addition, connections to a well-manufactured but dirty part can lead to any of the above measurement problems. Conversely, always ensuring connections to parts with clean, high-quality waveguide interfaces will lead to accurate power measurements over the life of the product.

CAUTION

Connection to an E-band waveguide component with a dirty or damaged flange (for example loose particulates, raised metal burrs, or bent alignment pins) can damage the precision interface of the power sensor. Always inspect and clean the mating part prior to connection.

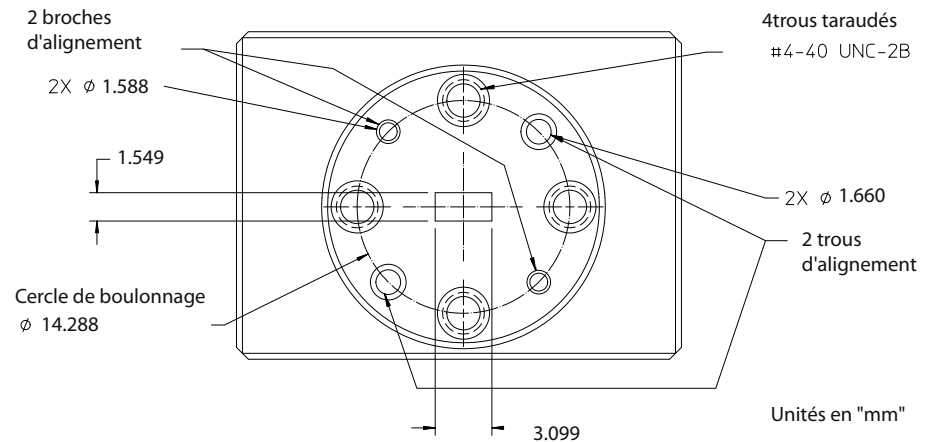


Figure 2-1 Precision E-band Interface on Front of Power Sensor

Use the protective packaging provided with the sensor 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.

Power Meter Calibrations

The procedure for calibration may be different for each compatible power meter. Follow the calibration directions given in your power meter user's guide.

Power Measurements

The Option 100 does not come with EEPROM, so the calibration factors need to be manually pre-entered into the power meter to correct for varying responses at different frequencies. The Option 200 comes with EEPROM and with the calibration factors pre-entered as well. You can input the frequency and the corresponding calibration factor will be applied. This will automatically correct the power readings. The typical calibration factor uncertainty table is shown below:

Table 2-1 Calibration uncertainty

Frequency (GHz)	Expanded uncertainty (%)
60	6.4
61	6.1
62	5.8
63	5.6
64	5.6
65	5.6

Table 2-1 Calibration uncertainty (continued)

Frequency (GHz)	Expanded uncertainty (%)
66	5.6
67	5.8
68	5.9
69	5.9
70	5.7
71	5.6
72	5.5
73	5.6
74	5.8
75	6.6
76	6.1
77	5.6
78	5.3
79	5.3
80	5.5
81	5.7
82	5.9
83	5.8
84	5.6
85	5.4
86	5.3
87	5.5
88	5.7
89	6.0
90	6.1

2 General Operation

Operation

NOTE

The uncertainty data is the expanded uncertainty with a 95% confidence level and a coverage factor (k) of 2.

Operating Instructions

To operate the power sensor, refer to the operating instructions in the power meter user's guide.

NOTE

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

Modulation Effects

When measuring microwave sources that are modulated at the chopper frequency (nominally 217 Hz for the Option 100 and 436 Hz for the Option 200 for both the Agilent E4418A/B and Agilent E4419A/B), or at the first or second harmonic or submultiples of the chopper frequency, beat notes will occur. Unless the modulation rate is exactly the chopper frequency, these beat notes can usually be eliminated by averaging since the amplitudes are centered on the actual power. These frequencies may also be avoided by changing the modulation frequency slightly, if possible.

If you are using an Agilent E4418A/B or Agilent E4419A/B Power Meter, a filter setting of 128 will minimize most beat note interference.

Linearity Correction

For most Agilent 8480 series power sensors the correct (A type or D type) linearity correction table is automatically selected. However, when you use the Agilent E8486A Power Sensor with Agilent EPM power meters, you must override the automatic selection and select the D-type correction. This procedure provides optimum accuracy when making power measurements of more than +10 dBm. Subsequent connection of another A-type sensor will result in a warning message stating “Linearity Override May be Required”.

To select the linearity type to be applied, press the following buttons in sequence:

Agilent E4418B

System Inputs > Tables > Linearity > ATyp

System Inputs > Tables > Linearity > DTyp

Agilent E4419B

System Inputs > Tables > A Linearity > ATyp

System Inputs > Tables > A Linearity > DTyp

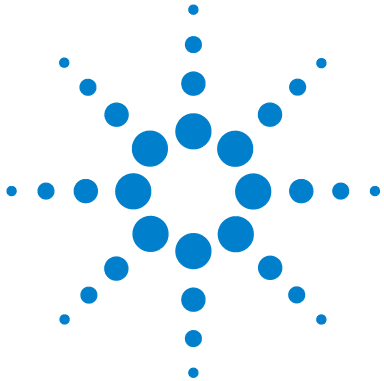
System Inputs > Tables > B Linearity > ATyp

System Inputs > Tables > B Linearity > DTyp

2 General Operation

Operation

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3 Characteristics and Specifications

Specifications 18

This chapter specifies the characteristics and specifications of the E8486A.



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

FREQUENCY RANGE

60 GHz to 90 GHz

POWER RANGE

- Option 100 (42 dB)
 - 1 μ W to 100 mW (–30 dBm to +20 dBm)
 - Option 200 (10 dB)
 - 1 nW to 100 mW (–60 dBm to +20 dBm)
-

MAXIMUM SWR

- Option 100
 - < 1.06
 - Option 200
 - < 1.28
-

POWER LINEARITY

- Option 100
 - –30 dBm to +10 dBm (< $\pm 1\%$)
 - +10 dBm to +20 dBm (< $\pm 2\%$)^[1]
 - +10 dBm to +20 dBm (+1%, –3%)^[2]
 - Option 200
 - –60 dBm to –30 dBm (< $\pm 1.5\%$)
 - –30 dBm to +10 dBm (< $\pm 1\%$)
 - +10 dBm to +20 dBm (< $\pm 1.5\%$)
-

MAXIMUM POWER (DAMAGE LEVEL)

- Option 100
 - 200 mW average, 40 W peak^[3]
 - Option 200
 - 200 mW average, 1 W peak^[3]
-

CONNECTORS

- 50 MHz Calibration Port
 - Type-N (Male)^[4]
 - Waveguide Flange
 - UG-387/U Flange^[5]
-

Table 3-1 Specifications (continued)

ZERO SET

- Option 100
 - $< \pm 200$ nW
- Option 200
 - $< \pm 200$ pW

ZERO DRIFT

- Option 100
 - $< \pm 40$ nW
- Option 200
 - $< \pm 40$ pW

MEASUREMENT NOISE

- Option 100
 - $< \pm 450$ nW
 - Option 200
 - $< \pm 450$ pW
-

[1] For EPM series power meters

[2] For all other Agilent power meters

[3] 10 μ s per pulse, 0.5% duty cycle

[4] 50 Ω nominal impedance

[5] EIA WR-12

General Characteristics

Table 3-2 General Characteristics

OPERATING ENVIRONMENT

Refer to “[Environmental Conditions](#)” on page VI

STORAGE COMPLIANCE

Refer to “[Environmental Conditions](#)” on page VI

EMC COMPLIANCE

Refer to “[Environmental Conditions](#)” on page VI

NET WEIGHT

0.4 kg

DIMENSIONS (W × H × D)

38 × 60 × 199 mm

WARRANTY

- Please refer to http://www.agilent.com/go/warranty_terms
 - 3 years for the product
 - Please note that for the product, the warranty does not cover:
 - Damage from contamination
 - Normal wear and tear of mechanical components
 - Manuals or fuses
-

CALIBRATION CYCLE

1 year



4 Service

Performance Tests [22](#)

This chapter outlines the performance tests and service information related to the E8486A.



Performance Tests

This section does not establish SWR test procedures since there are several test methods and different equipment available for testing the SWR or the reflection coefficient. 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.

Below is a list of equipment used for performance verification:

- Millimeter-wave network analyzer (Agilent N5251A)
- WR-12 calibration kit (OML V12CAL Series)
- Waveguide adapter (Flann Microwave Series 373-W)

The performance test procedure is as shown below:

- 1 Turn on the network analyzer and allow it to warm up for approximately an hour.
- 2 Set the start and stop frequency of the network analyzer to 60 GHz and 90 GHz respectively.
- 3 Perform a one-port calibration on the network analyzer using the calibration kit.
- 4 Connect the Agilent E8486A Power Sensor to the test port of the network analyzer upon the completion of the calibration.
- 5 Compare the measured results to the SWR specifications in [Table 3-1](#) on page 18.

NOTE

If the verification fails, refer to “[Repair and Adjustments](#)” on page 24

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 a low SWR and a high directivity to monitor or level the incident power (which should be less than -30 dBm).

For reflection measurements, refer to Application Note 183 “High Frequency Swept Measurements.” For calibration factor and error analysis, referring to Application Note 64-1 “Fundamentals of RF and Microwave Power Measurements.” is recommended.

Replaceable Parts

The hex ball driver, the flange covers, and the hardware are the only replaceable parts. The part numbers are listed in [Figure 1-2](#) on page 5. 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 Technologies.

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.

www.agilent.com

Contact us

To obtain service, warranty, or technical assistance, contact us at the following phone or fax numbers:

United States:

(tel) 800 829 4444 (fax) 800 829 4433

Canada:

(tel) 877 894 4414 (fax) 800 746 4866

China:

(tel) 800 810 0189 (fax) 800 820 2816

Europe:

(tel) 31 20 547 2111

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