

**User's Guide**  
**V8486A Power Sensor**

**Serial Number Prefix:**  
US3901



Part Number: 08486-90131

**Printed in USA**  
**Print Date: June 2001**  
**Supersedes: January 1999**

© Copyright 1999, 2001 Agilent Technologies, Inc.

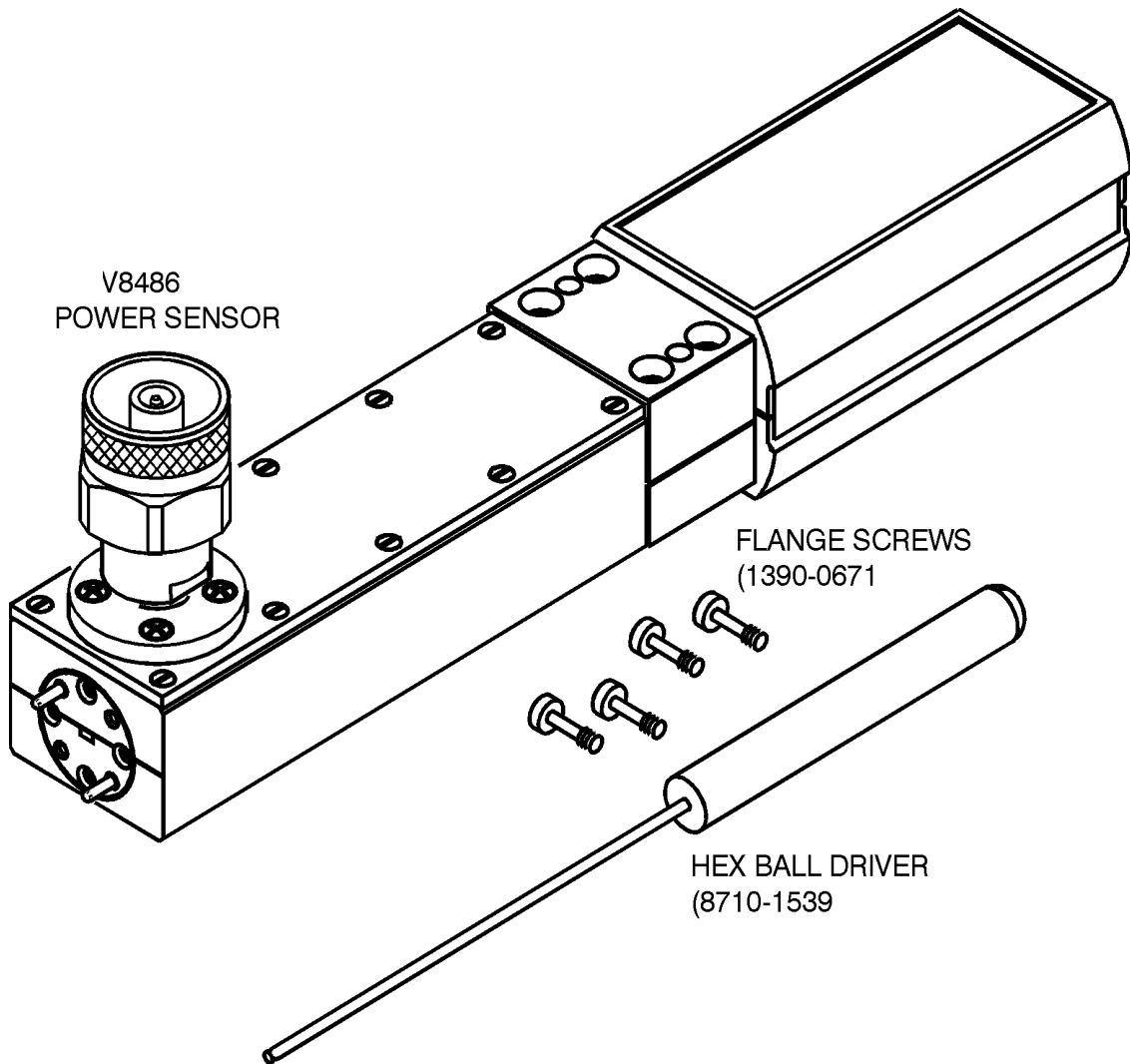
**1. V8486A Power Sensor**

- General Information ..... 3
  - Warranty ..... 3
  - Description ..... 3
  - Accessories ..... 4
  - Specifications ..... 5
  - Calibration Factor (CF) ..... 6
- Installation ..... 8
  - Initial Inspection ..... 8
  - Storage and Shipment ..... 9
- Operation ..... 10
  - Operating Environment ..... 10
  - Operating Precautions ..... 10
  - Power Meter Calibrations ..... 12
  - Power Measurements ..... 12
  - Operating Instructions ..... 14
  - Modulation Effects ..... 14
  - Linearity Correction ..... 15
- Performance Tests ..... 16
- Replaceable Parts ..... 17
  - Repair and Adjustments ..... 17
- Warranty..... 19

---

**1** **V8486A Power Sensor**

**Figure 1-1 V8486A Power Sensor with Accessories and Hardware**



## General Information

This Operating Manual contains information about initial inspection and operation of the V8486A Power Sensor.

## 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 warranty.

## Description

The V8486A is a diode-based power sensor. It measures power levels in a range from  $-30$  dBm to  $+20$  dBm. (Specifications for the Power Sensor are in [Table 1-1](#).) The V8486A measures at frequencies from 50 GHz to 75 GHz.

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.

---

**NOTE**

The V8486A Power Sensor is compatible with the following power meters:

435B	E1416A
436A	E4418A/B
437B	E4419A/B
438A	70100A

To obtain optimum accuracy for power measurements above +10 dBm, when used with the E4418A and E4419A power meters, a firmware upgrade will be required. Refer to your E4418A and E4419A power meter's user's guide for instructions on how to obtain the revision of the firmware currently installed in the unit. The firmware revision required is A1.03.00 (or above) for the E4418A and A2.03.00 (or above) for the E4419A. Contact your local Agilent Technologies Sales and Service Office for more information.

---

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  $\mu\text{W}$ , 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.

## Specifications

The specifications listed in [Table 1-1](#) are the performance standards or limits against which the Power Sensor may be tested.

**Table 1-1 Specifications**

Characteristics and Conditions	Limits	Comments
<b>Frequency Range</b>	50 to 75 GHz	
<b>Power Range</b>	1 $\mu$ W to 100 mW (-30 dBm to +20 dBm)	
<b>Nominal Impedance</b>	N/A	Waveguide impedance varies with frequency.
<b>Connectors</b>		
50 MHz Calibration Port	Type N (Male)	50 $\Omega$ nominal impedance
Waveguide Flange	UG-385/U Flange (Modified)	EIA WR-15
<b>Maximum Standing Wave Ratio (SWR) and Reflection Coefficient (Rho)</b>	<b>SWR Rho<sup>1</sup></b>	
V8486A	1.06 0.029	When mated to UG-385/U flange.
<b>Maximum Power</b>	200 mW (average), 40 W (peak) <sup>2</sup>	Any port
<b>Worst Case Power Linearity</b>	10 mW to 100 mW (+10 dBm to +20 dBm) $\pm$ 2% for EPM power meters; +1%, -3% for all other power meters.	< $\pm$ 1% deviation except for those power ranges noted.
<b>Operating Temperature Range</b>	0 to 55°C	
<b>Net Weight</b>	0.4 kg	
<b>Dimensions</b>	Width: 38 mm Length: 199 mm Height: 60 mm	

1. Reflection coefficient (Rho or  $\rho$ ) relates to SWR according to the following formula:

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

2. 10 micro-second pulse, 0.5% duty cycle or equivalent such that 200 mW maximum average power and 40W peak power are not exceeded.

## Calibration Factor (CF)

The CAL FACTOR compensates for the frequency response of the sensor. CAL FACTOR data is provided on a label attached to the sensor cover. Uncertainties of the CAL FACTOR data are listed in [Table 1-2](#). ISO expanded uncertainties are calculated based on an NIST-traceable transfer standard and an analysis of factory test system uncertainties. To use CAL FACTOR data during power measurements, see "Power Measurements" in this manual.

**Table 1-2 Calibration Factor Uncertainty at 1 mW (0 dBm)**

Frequency (GHz)	ISO Expanded Uncertainty % <sup>1</sup> (coverage factor k=2)
50	4.8
51	6.1
52	5.9
53	5.9
54	5.9
55	4.6
56	6.1
57	6.1
58	6.2
59	6.2
60	4.7
61	6.2
62	6.1
63	6
64	6
65	4.5
66	6.6
67	6.7
68	6.7
69	6.6
70	4.4



<b>Frequency (GHz)</b>	<b>ISO Expanded Uncertainty %<sup>1</sup> (coverage factor k=2)</b>
71	6.7
72	6.8
73	7.0
74	7.3
75	5.1

1. Refer to Application Note 64-1A: literature number 5965-6630E, “Fundamentals of RF and Microwave Power Measurements” for more information regarding ISO expanded uncertainty.

## 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

The V8486A 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 N x 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 operating and service manual for interconnecting instructions.

## Storage and Shipment

### Environment

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

Temperature . . . . .	-40 to +75°C
Relative Humidity . . . . .	<95% @ 40°C
Altitude . . . . .	< 7,600 meters

### 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.

---

## Operation

---

### 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.**

---

## Operating Environment

The operating environment for the Power Sensors should be within the following limits:

Temperature .....	0 to +55°C
Relative Humidity .....	< 95%
Altitude .....	< 4550 meters

## 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<sup>1</sup>

---

The power sensor has a precision machined V-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 1-2](#).

In order to get the best possible measurement results the mating part must be of similar quality. Connection to a V-band waveguide component in which the interface dimensions are not accurately controlled can lead to increased SWR, inaccurate Cal Factor correction, and/or repeatability

---

1. 10 micro-second pulse, 0.5% duty cycle or equivalent such that 200 mW maximum average power and 40W peak power are not exceeded.

problems. In addition, connections to a well-manufactured but dirty part can lead to any of the above measurement problems. Conversely, always insuring connections to parts with clean, high-quality waveguide interfaces will lead to accurate power measurements over the life of the product.

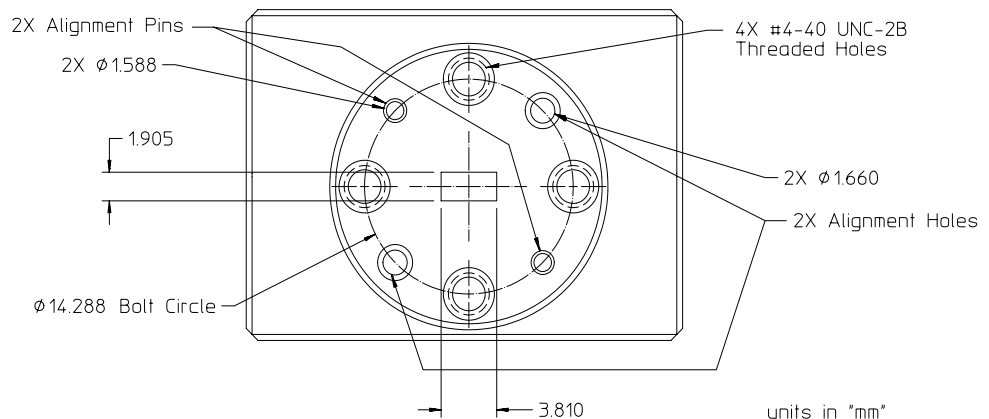
---

**CAUTION**

---

Connection to a V-band waveguide component with a dirty, or damaged flange (e.g. 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 1-2 Precision V-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, trichloroethylene, 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 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. This will automatically correct the power readings.

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 1-3](#) 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* 0.17 dB from the displayed reading.

**NOTE**

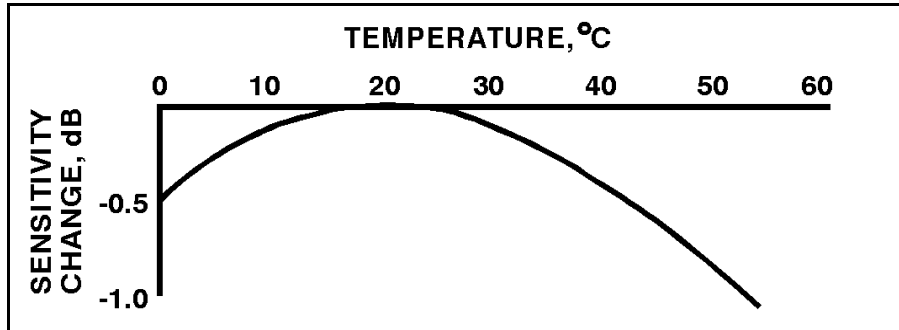
The above procedure has eliminated some mathematical steps; the following formula may be of some use:

$$\text{Correct dBm} = \text{Reading dBm} - 10 \times \text{Log}_{10} \{\text{Cal Factor (decimal)}\}.$$

**Table 1-3 Cal Factor**

<b>Cal Factor</b>	<b>dB</b>	<b>Cal Factor</b>	<b>dB</b>	<b>Cal Factor</b>	<b>dB</b>
70%	1.549	85%	0.706	115%	-0.607
71%	1.487	101%	-0.043	116%	-0.645
72%	1.427	102%	-0.086	117%	-0.682
73%	1.367	103%	-0.128	118%	-0.719
74%	1.308	104%	-0.170	119%	-0.755
75%	1.249	105%	-0.212	120%	-0.792
76%	1.192	106%	-0.253	121%	-0.828
77%	1.134	107%	-0.294	122%	-0.864
78%	1.079	108%	-0.334	123%	-0.899
79%	1.024	109%	-0.374	124%	-0.934
80%	0.969	110%	-0.414	125%	-0.969
81%	0.915	111%	-0.453	126%	-1.004
82%	0.862	112%	-0.492	127%	-1.038
83%	0.809	113%	-0.531	128%	-1.072
84%	0.757	114%	-0.569	129%	-1.106
				130%	-1.139

**Figure 1-3** Typical Influence of Temperature on Sensitivity



The sensitivity of the power sensor is influenced by ambient temperature. The sensor should be calibrated at the temperature of operation to obtain the most accurate results. Typical temperature sensitivity variations are shown in [Figure 1-3](#).

## Operating Instructions

To operate the Power Sensor, refer to the operating instructions in 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 50 $\Omega$  load.

---

## Modulation Effects

When measuring microwave sources that are modulated at the chopper frequency (nominally 220 Hz for the 43X family and 217 Hz for the E4418A/B and 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, they 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 437B, E4418A/B or E4419A/B Power Meter, a filter setting of 128 will minimize most beat note interference. To minimize beat note interference using a 438A Power Meter select a filter number of at least 7.



## Linearity Correction

For most 8480 series power sensors the correct (A type or D type) linearity correction table is automatically selected. However, when you use the V8486A power sensor with EPM power meters, you must override the automatic selection and select the D-type correction. This procedure provides optimum accuracy when making power measurements  $>+10\text{dBm}$ . Subsequent connection of another A-type sensor will result in a warning message stating the “Linearity Override May be Required”.

To select the linearity type to be applied:

E4418B

Press [System Inputs], Tables, Linearity ATyp DTyp.

E4419B

Press [System Inputs], Tables, A Linearity ATyp DTyp or B Linearity ATyp DTyp.

---

**NOTE**

For use with the E4418A and E4419A power meters, a firmware upgrade will be required. Refer to your E4418A and E4419A power meter's user's guide for instructions on how to obtain the revision of the firmware currently installed in the unit. The firmware revision required is A1.03.00 (or above) for the E4418A and A2.03.00 (or above) for the E4419A. Contact your local Agilent Technologies Sales and Service Office for further information.

---

## 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 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.

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 36 dB, such as the V752C/D. The detector should have greater than 0.4 mV/ $\mu$ W 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 8360 B-Series swept signal generator.

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.

For calibration factor and error analysis we suggest Application Note 64-1A: literature number 5965-6630E, "Fundamentals of RF and Microwave Power Measurements".

---

## Replaceable Parts

The part numbers of the hex ball driver and the hardware are listed in Figure 1. In addition, the following protective parts are replaceable:

**Table 1-4**

### Replaceable Parts

Part Number	Description	Usage
1401-0214	protective cap	Type-N connector
08486-40103	protective cover	V-band waveguide flange

There are no other replaceable parts for this product.

A listing of Agilent Technologies 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.

---

By internet, phone, or fax, get assistance with all your test and measurement needs.

**Table 1-5 Contacting Agilent**

<b>Online assistance:</b> <a href="http://www.agilent.com/find/assist">www.agilent.com/find/assist</a>			
<b>United States</b> (tel) 1 800 452 4844	<b>Latin America</b> (tel) (305) 269 7500 (fax) (305) 269 7599	<b>Canada</b> (tel) 1 877 894 4414 (fax) (905) 282-6495	<b>Europe</b> (tel) (+31) 20 547 2323 (fax) (+31) 20 547 2390
<b>New Zealand</b> (tel) 0 800 738 378 (fax) (+64) 4 495 8950	<b>Japan</b> (tel) (+81) 426 56 7832 (fax) (+81) 426 56 7840	<b>Australia</b> (tel) 1 800 629 485 (fax) (+61) 3 9210 5947	

<b>Asia Call Center Numbers</b>		
<b>Country</b>	<b>Phone Number</b>	<b>Fax Number</b>
Singapore	1-800-375-8100	(65) 836-0252
Malaysia	1-800-828-848	1-800-801664
Philippines	(632) 8426802 1-800-16510170 (PLDT Subscriber Only)	(632) 8426809 1-800-16510288 (PLDT Subscriber Only)
Thailand	(088) 226-008 (outside Bangkok) (662) 661-3999 (within Bangkok)	(66) 1-661-3714
Hong Kong	800-930-871	(852) 2506 9233
Taiwan	0800-047-866	(886) 2 25456723
People's Republic of China	800-810-0189 (preferred) 10800-650-0021	10800-650-0121
India	1-600-11-2929	000-800-650-1101

## Warranty

This Agilent Technologies instrument product is warranted against defects in material and workmanship for a period of 1 year 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 to return the product to Buyer. However, Buyer shall pay all 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 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. HEWLETT-PACKARD 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. AGILENT TECHNOLOGIES SHALL NOT BE LIABLE FOR ANY DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

---

# Index

---

## A

adjustments, 17

## C

cal factor, 13

calibration factor, 6

calibration factor uncertainty, 6

calibrations

power meter, 12

CF, 6

connections, 8

connectors, 5

## D

dimensions, 5

## F

frequency range, 5

## I

interface

V-band, 11

## L

linearity correction, 15

## M

marker, 4

maximum power, 5

measurements

power, 12

modulation effects, 14

## N

net weight, 5

nominal impedance, 5

## O

operating

environment, 10

precautions, 10

temperature range, 5

operating environment, 10

operating precautions, 10

operating temperature range, 5

## P

packaging, 9

performance tests, 16

power

maximum, 5

worst case linearity, 5

power measurements, 12

power meter calibrations, 12

power range, 5

## R

repair, 17

replaceable parts, 17

Rho, 5

## S

specifications, 5

standing wave ratio, 5

storage, 9

## T

temperature

operating range, 5

tests

performance, 16

## U

uncertainty

calibration factor, 6

## V

V-band interface, 11

## W

warranty, 3, 19

worst case power linearity, 5