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Agilent E4418B/E4419B

EPM Series Power Meters, E-Series and 8480 Series Power Sensors

Data Sheet





Agilent Technologies

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Why Agilent's power meters and sensors?



Reliable, high-performing solutions

Every power meter and sensor from Agilent consistently delivers great results.



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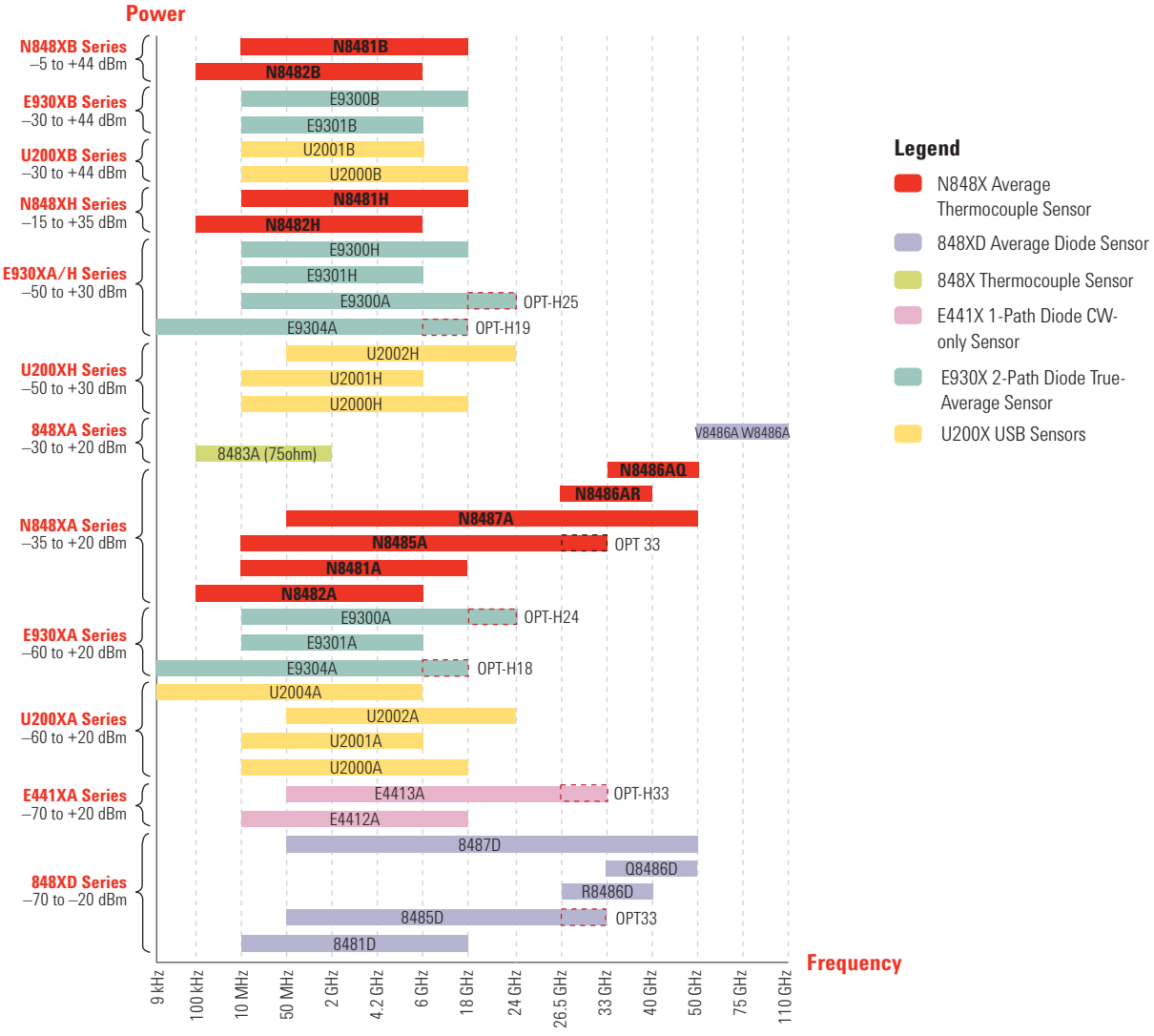
"Agilent's power meters have long been recognized as the industry standard for RF and microwave power measurements."

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E4418B/9B EPM Series power meter: applications and compatible sensors for average power measurements

Sensor technology

Signal characteristics >	CW	Modulated					
	CW	Pulse/ averaged	AM/FM profiled	Wireless standards			
Typical application examples >	Metrology lab	Radar/ navigation	Mobile radio	TDMA GSM EDGE NADC IDEN	cdmaOne Bluetooth®	W-CDMA cdma2000®	802.11a/b/g MCPA HiperLan2 WiMAX
Themocouple sensors 8480A/B/H, N8480A/B/H, R/Q8486A, N8486AR/AQ	•	•	•	• Avg.only	• Avg.only	• Avg.only	• Avg.only
Diode sensors 8480D, V8486A, W8486A	•	•	•	• Avg.only	• Avg.only	• Avg.only	• Avg.only
Diode sensors compensated for extended range E4412A/3A	•		FM only				
Two-path diode-stack sensors E9300 Series	•	•	•	• Avg.only	• Avg.only	• Avg.only	• Avg.only



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E4418B/9B EPM Series power meter performance characteristics

Specifications describe the instrument's warranted performance and apply after a 30-minute warm-up. These specifications are valid over its operating/environmental range unless otherwise stated and after performing a zero and calibration procedure.

Supplemental characteristics (shown in italics) are intended to provide additional information, useful in applying the instrument by giving typical (expected), but not warranted performance parameters. These characteristics are shown in italics or labeled as *"typical", "nominal"* or *"approximate".*

For information on measurement uncertainty calculations, refer to Application Note 64-1C, "Fundamentals of RF and Microwave Power Measurements", literature number 5965-6380E.

Compatible power sensors: E4410 and E9300 E-Series, 8480 Series and N8480 Series average power sensors

Frequency range: 9 kHz to 110 GHz, sensor dependent

Power range: –70 dBm to +44 dBm (100 pW to 25 W), sensor dependent

Single sensor dynamic range:
90 dB maximum (E-Series sensors)
50 dB maximum (8480 Series sensors)
55 dB maximum (N8480 Series sensors)

Display units:
Absolute: Watts or dBm
Relative: Percent or dB

Display resolution: Selectable resolution of 1.0, 0.1, 0.01, and 0.001dB in Log mode, or 1 to 4 digits in linear mode

Default resolution: 0.01 dB in log mode, 3 digits in linear mode

Accuracy

Absolute: ±0.02 dB (log) or ±0.5% (linear). Please add the corresponding power sensor linearity percentage from Tables 6, 9 and 10 (for the E-series sensors), and Table 14 (for the 8480 series sensors) to asses the overall system accuracy.

Relative accuracy: ±0.04 dB (log) or ±1.0% (linear). Please add the corresponding power sensor linearity percentage from Tables 6, 9 and 10 (for the E-Series sensors), and Table 14 (for the 8480 series sensors) to asses the overall system accuracy.

Zero set (digital settability of zero): Sensor dependent (refer to Table 1). For E-Series sensors, this specification applies to a zero performed when the sensor input is not connected to the POWER REF.

Zero drift of sensors: Sensor dependent, refer to Table 1. For E9300 sensors, refer to Table 11 for complete data.

Measurement noise: Sensor dependent, refer to Table 1 and Table 2. For E9300 sensors, refer to Table 11 for complete data.

Effects of averaging on noise: Averaging over 1 to 1024 readings is available for reducing noise. Table 1 provides the measurement noise for a particular sensor with the number of averages set at 16 (for normal mode) and 32 (for x2 mode). Use the noise multiplier, for the appropriate mode (normal or x2) and number of averages, to determine the total measurement noise value.

Example:
8481D power sensor, normal mode, number of averages = 4

Measurement noise calculation:
(<45 pW x 2.75) = <121 pW

*For specifications pertaining to the N8480 Series power sensors, please refer to the *"Agilent N8480 Series Power Sensors Data Sheet"*, literature number 5989-9333EN.

Power reference

Power output: 1.00 mW (0.0 dBm). Factory set to ±0.4% traceable to the National Physical Laboratory (NPL), UK[1].

Accuracy: For two years:
±0.5% (23 ± 3 °C)
±0.6% (25 ± 10 °C)
±0.9% (0 to 55 °C)

Frequency: 50 MHz nominal

SWR: 1.06 maximum
(1.08 maximum for Option 003)

Connector type: Type-N (f), 50 Ω

Measurement speed

Three measurement speed modes, over the GPIB, are available as shown, along with the typical maximum measurement speed for each mode.

With E4418B power meter
Normal: 20 readings/second
x2: 40 readings/second
Fast: 200 readings/second

With E4419B power meter
Measurement speed is reduced, for example, with both channels in FAST mode, the typical maximum measurement speed is 100 readings /second.

Fast mode is for E-Series sensors only.

Maximum measurement speed is obtained using binary output and in free run trigger mode.

1. National metrology institutes of member states of the Metre Convention, such as the National Institute of Standards and Technology in the USA, are signatories to the ComitÈ International des Poids et Mesures Mutual Recognition Arrangement. Further information is available from the Bureau International des Poids et Mesures, at http://www.bipm.fr/

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E4418B/9B EPM Series power meter performance characteristics (continued)

Table 1

Model	Zero set	Zero drift [1]	Measurement noise [2]
E9300A, E9301A, E9304A [3]	±500 pW	*<±150 pW*	*<700 pW*
E9300B, E9301B [3]	±500 nW	*<±150 nW*	*<700 nW*
E9300H, E9301H [3]	±5 nW	*<±1.5 nW*	*<7 nW*
E4412A, E4413A	±50 pW	*<±15 pW*	*<70 pW*
N8481A, N8482A, N8485A,N8487A, N8486AQ, N8486AR	±25 nW	*<±3 nW*	*<80 nW*
N8481B, N8482B	±25 µW	*<±3 µW*	*<80 µW*
N8481H, N8482H	±2.5 µW	*<±0.3 µW*	*<8 µW*
8481A, 8482A, 8483A, 8485A, 8487A, R8486A, Q8486A	±50 nW	*<±10 nW*	*<110 nW*
8481B, 8482B	±50 µW	*<±10 µW*	*<110 µW*
8481D, 8485D, 8487D	±20 pW	*<±4 pW*	*<45 pW*
8481H, 8482H	±5 µW	*<±1 µW*	*<10 µW*
R8486D, Q8486D	±30 pW	*<±6 pW*	*<65 pW*
V8486A, W8486A	±200 nW	*<±40 nW*	*<450 nW*

1. Within one hour after zero set, at a constant temperature, after a 24-hour warm-up of the power meter.
2. The number of averages at 16 for normal mode and 32 for x2 mode, at a constant temperature, measured over a one-minute interval and two standard deviations. For E-Series sensors, the measurement noise is measured within the low range. Refer to the relevant sensor manual for further information.
3. Specification applies to the low power path, 15% to 75% relative humidity.

Table 2

No. of averages	1	2	4	8	16	32	64	128	256	512	1024
Noise multiplier											
Normal mode	*5.5*	*3.89*	*2.75*	*1.94*	*1*	*0.85*	*0.61*	*0.49*	*0.34*	*0.24*	*0.17*
x2 mode	*6.5*	*4.6*	*3.25*	*2.3*	*1.63*	*1*	*0.72*	*0.57*	*0.41*	*0.29*	*0.2*

Settling time [1]

Manual filter, 10-dB decreasing power step for normal and x2 modes (not across range switch points for E-Series and N8480 Series sensors)

Table 3

No. of averages	1	2	4	8	16	32	64	128	256	512	1024
Settling time with E-Series sensors (s)											
Normal mode	*0.07*	*0.12*	*0.21*	*0.4*	*1*	*1.8*	*3.3*	*6.5*	*13*	*27*	*57*
x2 mode	*0.04*	*0.07*	*0.12*	*0.21*	*0.4*	*1*	*1.8*	*3.4*	*6.8*	*14.2*	*32*
Settling time with N8480 Series sensors (s)											
Normal mode	*0.15*	*0.2*	*0.3*	*0.5*	*1.1*	*1.9*	*3.4*	*6.6*	*13*	*27*	*57*
x2 mode	*0.15*	*0.18*	*0.22*	*0.35*	*0.55*	*1.1*	*1.9*	*3.5*	*6.9*	*14.5*	*33*
Settling time with 8480 Series sensors (s)											
Normal mode	*0.15*	*0.2*	*0.3*	*0.5*	*1.1*	*0.9*	*3.4*	*6.6*	*13*	*27*	*57*
x2 mode	*0.15*	*0.18*	*0.22*	*0.35*	*0.55*	*1.1*	*1.9*	*3.5*	*6.9*	*14.5*	*33*

*E-Series sensors in Fast mode (using free run trigger), within the range –50 dBm to +17 dBm, the settling time is:

E4418B: *10 ms* [2]

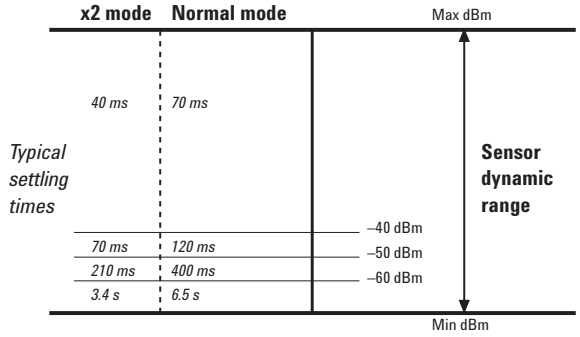
E4419B: *20 ms* [2]

1. Settling time: 0 to 99% settled readings over the GPIB
2. When a power step crosses through the sensor's auto-range switch point, add 25 ms. Refer to the relevant sensor manual for switch point information.

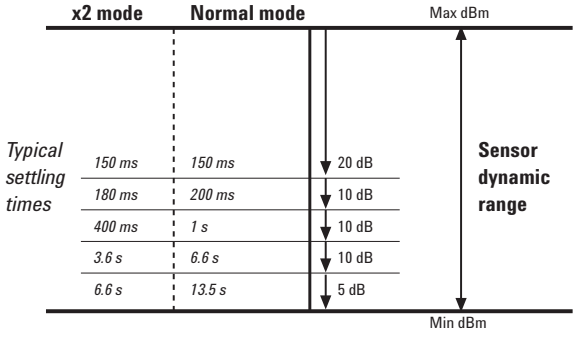
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E4418B/9B EPM Series power meter performance characteristics (continued)

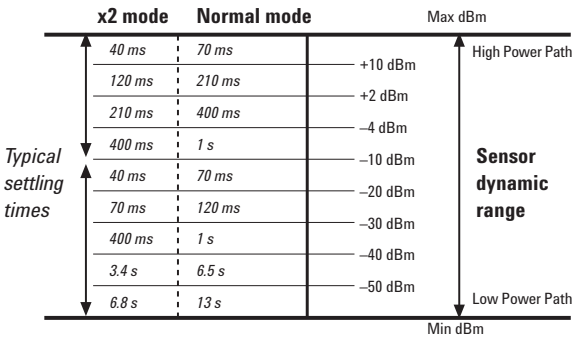
Auto filter, default resolution for normal and x2 modes



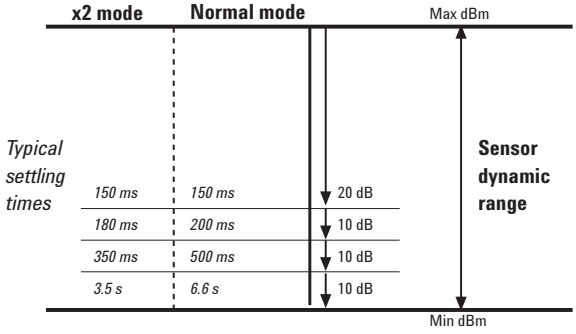
With E-Series E4412A/13A sensors, at 10-dB decreasing power step (not across range switch point)



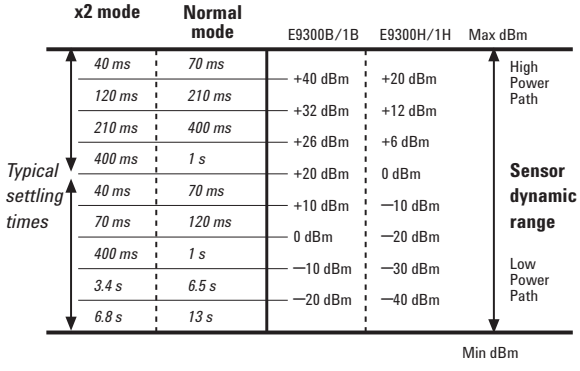
With N8480 Series sensors, at 10-dB decreasing power step (not across range switch point)



With E-Series E9300A/01A/04A sensors



With 8480 Series sensors, at 10-dB decreasing power step



With E-Series E9300B/01B/00H/01H sensor

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E4418B/9B EPM Series power meter performance characteristics (continued)

Power meter functions

Accessed by key entry: either hardkeys, or softkey menu, and programmable.

Zero: Zeros the meter. (Power reference calibrator is switched off during zeroing).

Cal: Calibrates the meter using internal (power reference calibrator) or external source. Reference cal factor settable from 1% to 150%, in 0.1% increments.

Frequency: Entered frequency range is used to interpolate the calibration factors table.

Range: 1 kHz to 999.9 GHz, settable in 1-kHz steps.

Cal factor: Sets the calibration factor for the meter. Range: 1% to 150%, in increments of 0.1%.

Relative: Displays all successive measurements relative to the last displayed value.

Offset: Allows power measurements to be offset by –100 dB to +100 dB, settable in 0.001-dB increments, to compensate for external loss or gain.

Save/recall: Store up to 10 instrument states via the save/recall menu.

dBm/W: Selectable units of either Watts or dBm in absolute power; or percent or dB for relative measurements.

Filter (averaging): Selectable from 1 to 1024. Auto-averaging provides automatic noise compensation.

Duty cycle: Duty cycle values between 0.001% to 99.999%, in increments of 0.001%, can be entered to display a peak power representation of measured power. The following equation is used to calculate the displayed peak power value: peak power = measured power/duty cycle.

Sensor cal tables: Selects cal factor versus frequency tables corresponding to specified sensors (8480 Series only).

Limits: High and low limits can be set in the range –150 dBm to +230 dBm, in 0.001-dBm increments.

Preset default values: dBm mode, rel off, power reference off, duty cycle off, offset off, frequency 50 MHz, AUTO average, free run, AUTO range (for E-Series and N8480 Series sensors).

Display: Selectable single and split screen formats are available. Aquasi-analog display is available for peaking measurements. The dual-channel power meter can simultaneously display any two configurations of A, B, A/B, B/A, A-B, B-A and relative.

General specifications

Dimensions

The following dimensions exclude front and rear protrusions:

212.6 mm W x 88.5 mm H x 348.3 mm D (8.5 in x 3.5 in x 13.7 in)

Weight

E4418B: 4.0 kg (8.8 lb) net, 7.9 kg (17.4 lb) shipping

E4419B: 4.1 kg (9.0 lb) net, 8.0 kg (17.6 lb) shipping

Rear panel connectors

Recorder outputs: Analog 0 to 1-Volt, 1-kΩ output impedance, BNC connector. E4419B recorder outputs are dedicated to channel A and channel B.

Remote input/output: A TTL logic level is output when the measurement exceeds a predetermined limit. TTL inputs are provided to initiate zero and calibration cycles. RJ-45 series shielded modular jack assembly connector. TTL Output: high = 4.8 V max; low = 0.2 V max TTL

Input: high = 3.5 V min, 5 V max; low = 1 V max, –0.3 V min.

GPIB: Allows communication with an external controller.

RS-232/422: Allows communication with an external RS-232/422 controller. Male/plug 9 position D-subminiature connector.

Ground: Binding post, accepts 4-mm plug or bare-wire connection.

Line power

Input voltage range: 85 to 264 VAC, automatic selection.

Input frequency range: 50 to 440 Hz.

Power requirement: Approximately 50 VA (14 W)

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E4418B/9B EPM Series power meter performance characteristics (continued)

Battery Option 001 operational characteristics[1]

The following information describes characteristic performance based at a temperature of 25 °C unless otherwise noted.

Typical operating time: up to 3.5 hours with LED backlight on; up to 5.5 hours with LED backlight off (E4418B power meter).

Charge time: 2 hours to charge fully from an empty state; 50 minutes charging enables 1 hour of operation with LED backlight on; 35 minutes charging enables 1-hr operation with LED backlight off. Power meter is operational whilst charging.

Service life (to 70% of initial capacity at 25 °C)**:** 450 charge/discharge cycles

Chemistry: Nickel metal hydride

Weight: 1 kg

Environmental characteristics

General conditions: Complies with the requirements of the EMC Directive 89/336/EEC. This includes Generic Immunity Standard EN 50082-1: 1992 and Radiated Interference Standard EN 55011: 1991/CISPR11:1990, Group 1 - Class A.

Operating environment

Temperature: 0°C to 55 °C

Maximum humidity: 95% at 40 °C (non-condensing).

Minimum humidity: 15% at 40 °C (non-condensing).

Maximum altitude: 3000 meters (9840 feet).

Storage conditions

Storage temperature: –20 °C to +70 °C.

Non-operating maximum humidity: 90% at 65 °C (non-condensing).

Non-operating maximum altitude: 15240 meters (50,000 feet).

Safety

Conforms to the following product specifications:

EN61010-1: 1993/IEC 1010-1: 1990 +A1/CSA C22.2 No. 1010-1: 1993

EN60825-1: 1994/IEC 825-1: 1993 Class 1 Low Voltage Directive 72/23/EEC

Remote programming

Interface: GBIB interface operates to IEEE 488.2. RS-232 and RS-422 serial interface supplied as standard.

Command language: SCPI standard interface commands. 436A and 437B code compatible (E4418B only); 438A code compatible (E4419B only).

GPIB compatibility: SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP1, DC1, DT1, C0.

Battery: Lithium polycarbon monoflouride, approximate lifetime 5 years at 25 °C

1. Characteristics describe product performance that is useful in the application of the product, but is not covered by the product warranty.

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E4418B/9B EPM Series power meter ordering information

Power meters

E4418B: Single-channel EPM Series power meter

E4419B: Dual-channel EPM Series power meter

Standard inclusion with each power meter

Power sensor cable: E4418B has one 1.5-meter (5-ft) sensor cable. E4419B has two 1.5-meter (5-ft) sensor cables.

Power cord: One 2.4-meter (7.5-ft) cable. Power plug matches destination requirements.

Documentation: A hard copy and CD version of the English language User's Guide and Programming Guide is provided with the EPM power meter as standard. A selection can be made to delete the hard copy.

Warranty: Included with each EPM Series power meter[1] is a standard 12-month return-to-Agilent warranty and service plan. A selection can be made to extend the initial warranty and service plan to 3 years.

Power

Option E441xB-001: Mains power and internal rechargeable battery

Connectors

Option E441xB-002: Parallel rear panel sensor input connector(s) and front panel reference calibrator connector

Option E441xB-003: Parallel rear panel sensor input connectors and rear panel reference calibrator connector

Calibration test data

Option E441xB-A6J: ANSI Z540 compliant calibration test data including measurement uncertainties

Option E441xB-1A7: ISO17025 compliant calibration test data including measurement uncertainties

Documentation

Option E441xB-OBO: Delete hard copy manual set from standard inclusion with power meter

Option E441xB-915: English language Service Manual

Option E441xB-916: English language manual set (hard copy Users Guide and Programming Guide)

Option E441xB-ABD: German localization (hard copy Users Guide and English Programming Guide)

Option E441xB-ABE: Spanish localization (hard copy Users Guide and English Programming Guide)

Option E441xB-ABF: French localization (hard copy Users Guide and English Programming Guide)

Option E441xB-ABJ: Japanese localization (hard copy Users Guide and English Programming Guide)

Cables

Option E441xB-004: Delete power sensor cable from standard inclusion with power meter

11730A: Power sensor and SNS noise source cable, length 1.5 meters (5 ft)

11730B: Power sensor and SNS noise source cable, length 3 meters (10 ft)

11730C: Power sensor and SNS noise source cable, length 6.1 meters (20 ft)

11730D: Power sensor cable, length 15.2 meters (50 ft)

11730E: Power sensor cable, length 30.5 meters (100 ft)

11730F: Power sensor cable, length 61 meters (200 ft)

Accessories

Option E441xB-908: Rackmount kit (one instrument)

Option E441xB-909: Rackmount kit (two instruments)

34131A: Transit case for half-rack 2U high instruments

34141A: Yellow soft carry/operating case

34161A: Accessory pouch

E9287A[2]: Spare battery pack for the EPM power meter

Complementary equipment

11683A: Range calibrator

Verifies the accuracy and linearity of the EPM Series power meters. Outputs corresponding to meter readings of 3, 10, 30, 100 and 300 µW and 1, 3, 10, 30 and 100 mW are provided. Calibration uncertainty is ±0.25% on all ranges.

Service options

Warranty
Return-to-Agilent warranty and service plan that extends initial plan to 3 years

Calibration[3]
For 3 years, order 36 months of the appropriate calibration plan shown below.

R-50C-001-3: Standard calibration plan

R-50C-021-3 Z540 calibration plan:

The E-Series and 8480 Series power sensors have a 12-month return-to-Agilent warranty and service plan. For more information, contact your local sales and service office.

1. Only for EPM series power meter with Option E441XB-001 installed.
2. For Option E441XB-001, the 36-month warranty does not apply to the E9287A battery pack.
3. Options not available in all countries.

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E-Series CW power sensor specifications

Widest dynamic range: 100 pW to 100 mW (–70 dBm to +20 dBm)

Table 4

Model	Maximum SWR	Maximum SWR	Maximum power	Connector type
E 4412A	10 MHz – 18 GHz	*10 MHz to <30 MHz: 1.22 30 MHz to <2 GHz: 1.15 2 GHz to <6 GHz: 1.17 6 GHz to <11 GHz:1.2 11 GHz to <18 GHz: 1.27	200 mW (+23 dBm)	Type-N (m)
E4413A	50 MHz – 26.5 GHz	50 MHz to <100 MHz: 1.21 100 MHz to <8 GHz: 1.19 8 GHz to <18 GHz: 1.21 18 GHz to 26.5 GHz: 1.26	200 mW (+23 dBm)	APC-3.5 mm (m)

Calibration factor (CF) and reflection coefficient (Rho)

Calibration factor and reflection coefficient data are provided at 1 GHz increments on a data sheet included with the power sensor. This data is unique to each sensor. If you have more than one sensor,match the serial number on the Certificate of Calibration (COC) with the serial number on the power sensor you are using. The CF corrects for the frequency response of the sensor. The EPM power meter automatically reads the CF data stored in the sensor and uses it to make the corrections. For power levels greater than 0 dBm, add 0.5%/dB to the calibration factor uncertainty specification.

Reflection coefficient (Rho) relates to the SWR according to the following formula: SWR = 1 + Rho/1 - Rho

Maximum uncertainties of the CF data are listed in Table 5a, for the E4412A power sensor, and Table 5b for the E4413A power sensor. The uncertainty analysis for the calibration of the sensors was done in accordance with the ISO/TAG4 Guide. The uncertainty data reported on the calibration certificate is the expanded uncertainty with a 95% confidence level and a coverage factor of 2.

Table 5a. E4412A calibration factor uncertainty at 1mW (0 dBm)

Frequency	Uncertainty*(%)
10 MHz	1.8
30 MHz	1.8
50 MHz	Reference
100 MHz	1.8
1.0 GHz	1.8
2.0 GHz	2.4
4.0 GHz	2.4
6.0 GHz	2.4
8.0 GHz	2.4
10.0 GHz	2.4
11.0 GHz	2.4
12.0 GHz	2.4
14.0 GHz	2.4
16.0 GHz	2.6
18.0 GHz	2.6

Table 5b. E4413A calibration factor uncertainty at 1mW (0 dBm)

Frequency	Uncertainty*(%)
50 MHz	Reference
100 MHz	1.8
1.0 GHz	1.8
2.0 GHz	2.4
4.0 GHz	2.4
6.0 GHz	2.4
8.0 GHz	2.4
10.0 GHz	2.6
11.0 GHz	2.6
12.0 GHz	2.8
14.0 GHz	2.8
16.0 GHz	2.8
17.0 GHz	2.8
18.0 GHz	2.8
20.0 GHz	3.0
24.0 GHz	3.0
26.0 GHz	3.0
28.0 GHz	3.0

* Applies to sensors with serial prefix US 3848 or greater

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E-Series CW power sensor specifications (continued)

Power linearity

Table 6

Power	Temperature (25 °C ±5 °C)	Temperature (0 °C to 55 °C)
100 pW to 10 mW (–70 dBm to +10 dBm)	±3%	±7%
10 mW to 100 mW (+10 dBm to +20 dBm)	±4.5%	±10%

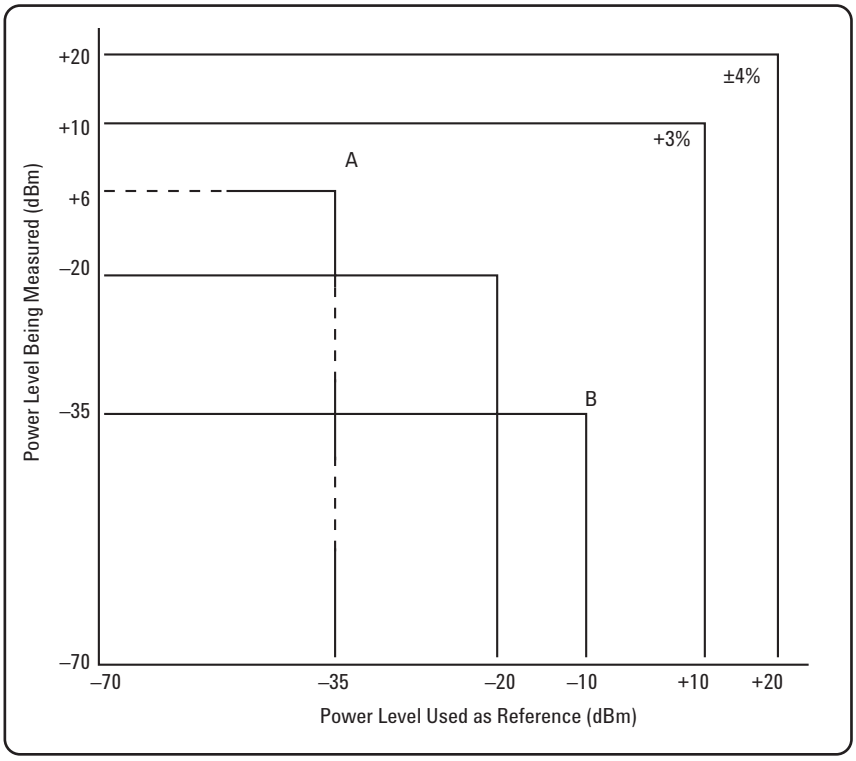


Figure 1. Relative mode power measurement linearity with EPM Series power meter/E-Series CW power sensor at 25 °C ± 5 °C (typical)

The chart in **Figure 1** shows the typical uncertainty in making a relative power measurement, using the same power meter channel and the same power sensor to obtain the reference and the measured values. Example A illustrates a relative gain (amplifier measurement). Example B illustrates a relative loss (insertion loss measurement). This chart assumes negligible change in frequency and mismatch occur when transitioning from the power level used as the reference to the power level being measured.

Example A:
P = 10(P)/10 x 1 mW
P = 10 6/10 x 1 mW
P = 3.98 mW
3% x 3.98 mW = 119.4 µW

Example B:
P = 10 (P)/10 x1 mW
P = 10 -35/10 x 1 mW
P = 316 nW
3% x 316 nW = 9.48 nW

where P = power in Watts,
and (P) = power in dBm

General

Dimensions:

E4412A:
130 mm L x 38 mm W x 30 mm H

E4413A:
102 mm L x 38 mm W x 30 mm H

Weight: 0.18 kg (0.4 lb).



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E-Series average power sensor specifications

Specifications are valid ONLY after proper calibration of the power meter and apply for CW signals unless otherwise stated. Specifications apply over the temperature range 0 °C to 55 °C unless otherwise stated, and specifications quoted over the temperature range 25 °C ±10 °C, conform to the standard environmental test conditions as defined in TIA/EIA/IS-97-A and TIA/EIA/IS-98-A [1].

The E-Series E9300 power sensors have two independent measurement path as shown:

Table 7

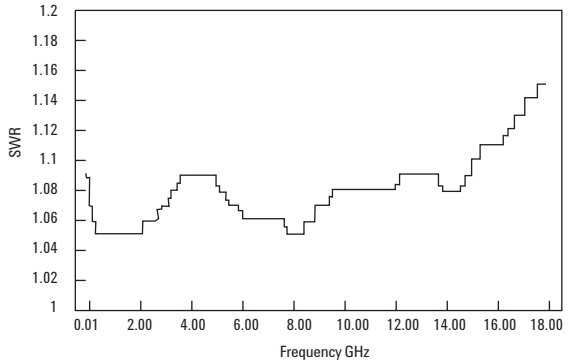
	"A" suffix sensors	"B" suffix sensors	"H" suffix sensors
High power path	–10 to +20 dBm	+20 to +44 dBm	0 to +30 dBm
Low power path	–60 to –10 dBm	–30 to +20 dBm	–50 to 0 dBm

Table 8

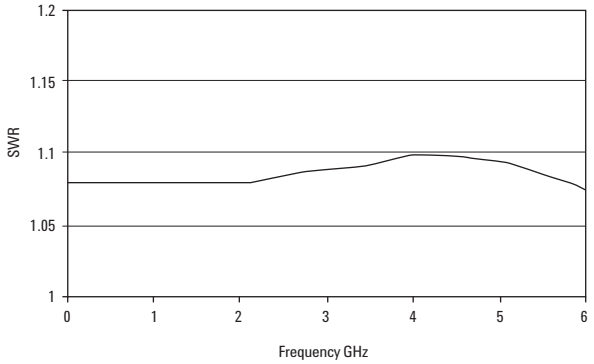
Model	Frequency range	Maximum SWR (25 °C ± 10 °C)	Maximum SWR (0 to 55 °C)	Maximum power	Connector type
–60 dBm to +20 dBm wide dynamic range sensors					
E9300A	10 MHz to 18 GHz	10 MHz to 30 MHz: 1.15 30 MHz to 2 GHz: 1.13 2 GHz to 14 GHz: 1.19 14 GHz to 16 GHz: 1.22 16 GHz to 18 GHz: 1.26	10 MHz to 30 MHz: 1.21 30 MHz to 2 GHz: 1.15 2 GHz to 14 GHz: 1.20 14 GHz to 16 GHz: 1.23 16 GHz to 18 GHz: 1.27	+25 dBm (320 mW) average; +33 dBm peak (2 W) (< 10 µsec)	Type-N (m)
E9301A	10 MHz to 6 GHz	10 MHz to 30 GHz: 1.15 30 MHz to 2 GHz: 1.13 2 GHz to 6 GHz: 1.19	10 MHz to 30 MHz: 1.21 30 MHz to 2 GHz: 1.15 2 GHz to 6 GHz: 1.20	+25 dBm (320 mW) average; +33 dBm peak (2 W) (< 10 µsec)	Type-N (m)
E9304A	9 kHz to 6 GHz	9 kHz to 2 GHz: 1.13 2 GHz to 6 GHz: 1.19	9 kHz to 2 GHz: 1.15 2 GHz to 6 GHz: 1.20	+25 dBm (320 mW) average; +33 dBm peak (2 W)(< 10 µsec)	Type-N (m)
–30 dBm to +44 dBm wide dynamic range sensors					
E9300B	10 MHz to 18 GHz	10 MHz to 8 GHz: 1.12 8 to 12.4 GHz: 1.17 12.4 to 18 GHz: 1.24	10 MHz to 8 GHz: 1.14 8 to 12.4 GHz: 1.18 12.4 to 18 GHz: 1.25	0 to 35 °C: 30 W avg 35 to 55 °C: 25 W avg < 6 GHz: 500 W pk > 6 GHz: 125 W pk 500 W.µS per pulse	Type-N (m)
E9301B	10 MHz to 6 GHz	10 MHz to 6 GHz: 1.12	10 MHz to 6 GHz: 1.14	0 to 35 °C: 30 W avg 35 to 55 °C: 25 W avg < 6 GHz: 500 W pk > 6 GHz: 125 W pk 500 W.µS per pulse	Type-N (m)
–50 dBm to +30 dBm wide dynamic range sensors					
E9300H	10 MHz to 18 GHz	10 MHz to 8 GHz: 1.15 8 to 12.4 GHz: 1.25 12.4 to 18 GHz: 1.28	10 MHz to 8 GHz: 1.17 8 to 12.4 GHz: 1.26 12.4 to 18 GHz: 1.29	3.16 W avg 100 W pk 100 W.µS per pulse	Type-N (m)
E9301H	10 MHz to 6 GHz	10 MHz to 6 GHz: 1.15	10 MHz to 6 GHz: 1.17	3.16 W avg 100 W pk 100 W.µS per pulse	Type-N (m)

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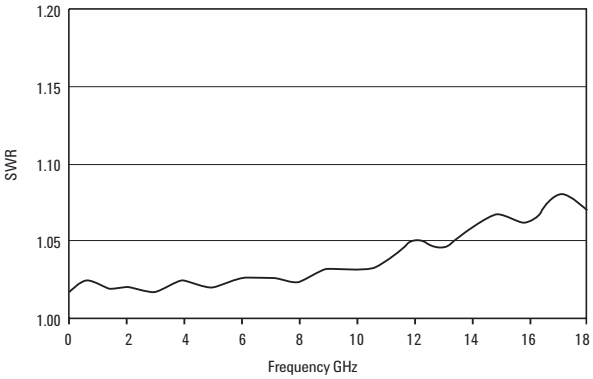
E-Series average power sensor specifications (continued)



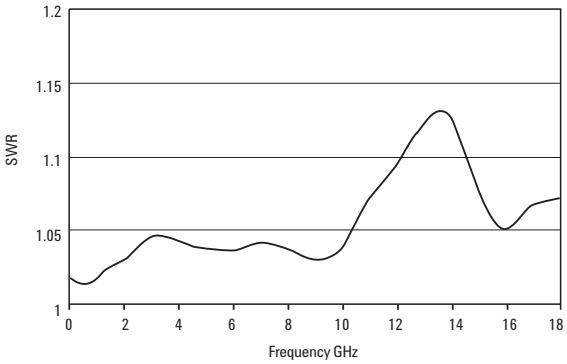
Typical SWR, 10 MHz to 18 GHz (25 °C ±10 °C) for E9300A and E9301A sensor



Typical SWR, 9 kHz to 6 GHz (25 °C ±10 °C) for E9304A sensors



Typical SWR, 10 MHz to 18 GHz (25 °C ±10 °C) for E9300B and E9301B sensors



Typical SWR, 10 MHz to 18 GHz (25 °C ±10 °C) for E9300H and E9301H sensors

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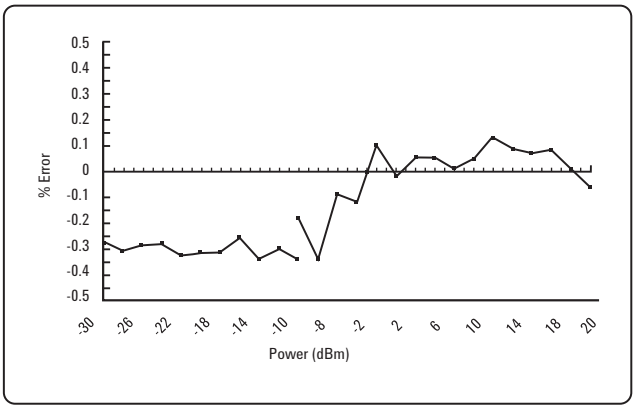
E-Series average power sensor specifications (continued)

Power linearity *

Table 9

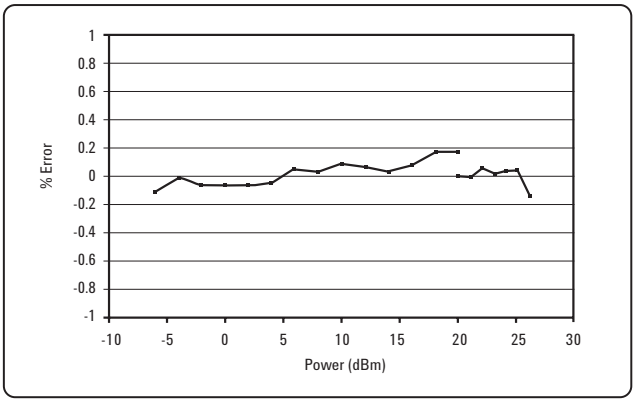
Sensor	Power	Linearity (25 °C ±10 °C)	Linearity (0 °C to 55 °C)
E9300A, E9301A, E9304A	–60 to –10 dBm	±3.0%	±3.5%
	–10 to 0 dBm	±2.5%	±3.0%
	0 to +20 dBm	±2.0%	±2.5%
E9300B, E9301B	–30 to +20 dBm	±3.5%	±4.0%
	+20 to +30 dBm	±3.0%	±3.5%
	+30 to +44 dBm	±2.5%	±3.0%
E9300H, E9301H	–50 to 0 dBm	±4.0%	±5.0%
	0 to +10 dBm	±3.5%	±4.0%
	+10 to +30 dBm	±3.0%	±3.5%

*after zero and calibration at ambient environmental conditions



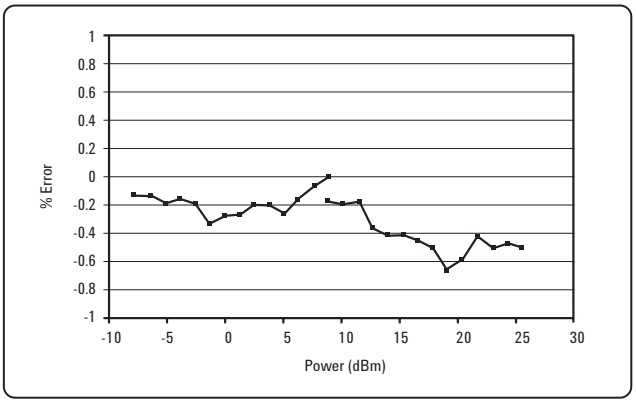
Typical E9300A/01A/04A power linearity at 25 °C, after zero and calibration, with associated measurement uncertainty

Power range	Measurement uncertainty
–30 to –20 dBm	±0.9%
–20 to –10 dBm	±0.8%
–10 to 0 dBm	±0.65%
0 to +10 dBm	±0.55%
+10 to +20 dBm	±0.45%



Typical E9300B/01B power linearity at 25 °C, after zero and calibration, with associated measurement uncertainty

Power range	Measurement uncertainty
–6 to 0 dBm	± 0.65%
0 to +10 dBm	± 0.55%
+10 to +20 dBm	± 0.45%
+20 to +26 dBm	± 0.31%



Typical E9300H/01H power linearity at 25 °C, after zero and calibration, with associated measurement uncertainty

Power range	Measurement uncertainty
–26 to –20 dBm	± 0.9%
–20 to –10 dBm	± 0.8%
–10 to 0 dBm	± 0.65%
0 to +10 dBm	± 0.55%
+10 to +20 dBm	± 0.45%
+20 to +26 dBm	± 0.31%

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Effects of change in temperature on linearity

If temperature changes and you choose not to re-calibrate the sensor, add the following power linearity error to the linearity specs in Table 9:

For small changes in temperature

Typical maximum additional power linearity error = *±0.15%/°C*
(valid after zeroing the sensor)

For large changes in temperature

Table 10

Sensor	Power	Additional power linearity error (25 °C ± 10 °C)	Additional power linearity error (0 to 55 °C)
E9300A, E9301A, E9304A	–60 to –10 dBm	±1.5%	±2.0%
	–10 to 0 dBm	±1.5%	±2.5%
	0 to +20 dBm	±1.5%	±2.0%
E9300B, E9301B	–30 to +20 dBm	±1.5%	±2.0%
	+20 to +30 dBm	±1.5%	±2.5%
	+30 to +44 dBm	±1.5%	±2.0%
E9300H, E9301H	–50 to 0 dBm	±1.5%	±2.0%
	0 to +10 dBm	±1.5%	±2.5%
	+10 to 30 dBm	±1.5%	±2.0%

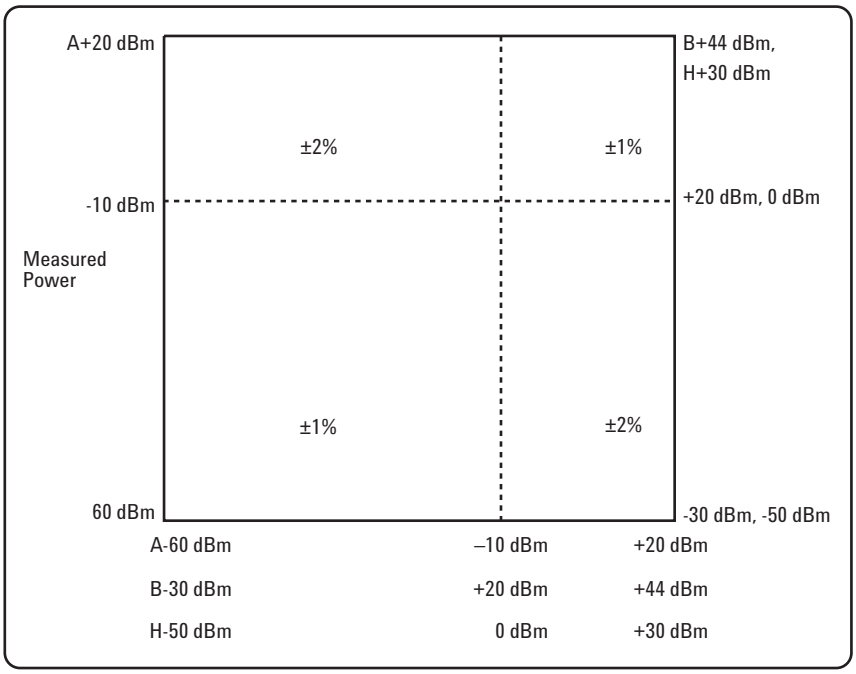


Figure 2. Relative mode power measurement linearity with an EPM Series power meter, at 25 °C ±10 °C (typical)

Figure 2 shows the typical uncertainty in making a relative power measurement, using the same power meter channel and same power sensor to obtain the reference and the measured values, and assumes that negligible change in frequency and mismatch error occur when transitioning from the power level used as the reference to the power level being measured.

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Switch point data

The E9300 power sensors have two paths as shown in Table 7. The power meter automatically selects the proper power level path. To avoid unnecessary switching when the power level is near the switch point, switching point hysteresis has been added.

Example with E9300 "A" suffix sensors:

Hysteresis causes the low power path to remain selected until approximately –9.5 dBm as the power level is increased. Above this power, the high power path will be selected. The high power path will remain selected until approximately –10.5 dBm is reached as the signal level decreases. Below this power, the low power path will be selected.

Switching point linearity: *Typically ±0.5% (±0.02 dB)*
Switching point hysteresis: *0.5 dB typical*

Table 11

E9300 sensor suffix	Conditions[1]	Zero set	Zero drift[2]	Measurement noise[3]
A	Lower power path (15% to 75% RH)	500 pW	150 pW	700 pW
	Lower power path (75% to 95% RH)	500 pW	4,000 pW	700 pW
	High power path (15% to 75% RH)	500 nW	150 nW	500 nW
	High power path (75% to 95% RH)	500 nW	3000 nW	500 nW
B	Lower power path (15% to 75% RH)	500 nW	150 nW	700 nW
	Lower power path (75% to 95% RH)	500 nW	4 µW	700 nW
	High power path (15% to 75% RH)	500 µW	150 µW	500 µW
	High power path (75% to 95% RH)	500 µW	3000 mW	500 µW
H	Lower power path (15% to 75% RH)	5 nW	1.5 nW	7 nW
	Lower power path (75% to 95% RH)	5 nW	40 µW	7 nW
	High power path (15% to 75% RH)	5 µW	1.5 µW	5 µW
	High power path (75% to 95% RH)	5 µW	30 mW	5 µW

1. RH is the abbreviation for relative humidity.
2. Within 1 hour after zero set, at a constant temperature, after a 24-hour warm-up of the power meter with power sensor connected.
3. The number of averages at 16 for normal mode and 32 for x2 mode, at a constant temperature, measured over a one minute interval and two standard deviations.

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Calibration factor (CF) and reflection coefficient (Rho)

Calibration factor and reflection coefficient data are provided at frequency intervals on a data sheet included with the power sensor. This data is unique to each sensor. If you have more than one sensor, match the serial number on the Certificate of Calibration (COC) with the serial number on the power sensor you are using. The CF corrects for the frequency response of the sensor. The EPM series power meter automatically reads the CF data stored in the sensor and uses it to make the corrections.

Reflection coefficient (Rho) relates to the SWR according to the following formula:
SWR = (1 + Rho)/(1 - Rho)

Maximum uncertainties of the CF data are listed in tables 12a and 12b, for each individual measurement path (high power and low power, as shown in Table 7). The uncertainty analysis for the calibration of the sensors was done in accordance with the ISO Guide. The uncertainty data reported on the calibration certificate is the expanded uncertainty with a 95% confidence level and a coverage factor of 2.

General

Dimensions: 130 mm L x 38 mm W x 30 mm H

Weight: 0.18 kg (0.4 lbs)

Table 12a. Calibration factor uncertainties (low power path)

Frequency	Uncertainty (%) (25 °C ±10 °C)	Uncertainty (%) (0° to 55 °C)
10 MHz to 30 MHz	± 1.8%	±2.2%
30 MHz to 500 MHz (E9304A: 9 kHz to 500 MHz)	±1.6%	±2.0%
500 MHz to 1.2 GHz	±1.8%	±2.5%
1.2 GHz to 6 GHz	±1.7%	±2.0%
6 GHz to 14 GHz	±1.8%	±2.0%
14 GHz to 18 GHz	± 2.0 %	±2.2%

Table 12b. Calibration factor uncertainties (high power path)

Frequency	Uncertainty (%) (25 °C ±10 °C)	Uncertainty (%) (0° to 55 °C)
10 MHz to 30 MHz	± 2.1%	±4.0%
30 MHz to 500 MHz (E9304A: 9 kHz to 500 MHz)	±1.8%	±3.0%
500 MHz to 1.2 GHz	±2.3%	±4.0%
1.2 GHz to 6 GHz	±1.8%	±2.1%
6 GHz to 14 GHz	±1.9%	±2.3%
14 GHz to 18 GHz	± 2.2 %	±3.3%



References:
[1] TIA is the Telecommunications Industry Association; EIA is the Electronic Industries Association. TIA/EIA/IS-97-A is the recommended minimum performance standards for base stations supporting dualmode wideband spread spectrum cellular mobile stations. TIA/EIA/IS-98-A is the recommended minimum performance standards for dual-mode wideband spread spectrum cellular mobile stations.

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8480 Series diode and thermocouple power sensor specifications

The 8480 Series sensors provide extraordinary accuracy, stability and SWR over a wide range of frequencies (100 kHz to 110 GHz) and power levels –70 dBm to +44 dBm.

Calibration factor uncertainties

Table 13. Typical measurement uncertainties of Calibration Factor (CF) data printed on the power sensor

Frequency	25°C ± 3°C		
	8481A	8482A	8485A
100KHz to 10MHz		0.87	
10MHz to 30MHz	0.81	0.8	
30MHz to 500MHz	0.78	0.8	1.29
500MHz to 1.2GHz	0.78	0.8	1.26
1.2GHz to 6GHz	0.92	0.9	1.35
6GHz to 14GHz	1.16		1.61
14GHz to 18GHz	1.59		1.77
18GHz to 26.5GHz			2.47
26.5GHz to 33GHz			3.35*
33GHz to 34GHz			
34GHz to 35GHz			
35GHz to 40GHz			
40GHz to 45GHz			
45GHz to 50GHz			

Frequency	25°C ± 3°C						
	8487A	8481H	8481B	8482H	8482B	R8486A	Q8486A
100KHz to 10MHz				0.91	1.50		
10MHz to 30MHz		0.86	1.48	0.81	1.44		
30MHz to 500MHz	1.38	0.88	1.48	0.92	1.51		
500MHz to 1.2GHz	1.34	0.87	1.48	0.88	1.48		
1.2GHz to 6GHz	1.41	0.98	1.54	0.95	1.53		
6GHz to 14GHz	1.59	1.36	1.71				
14GHz to 18GHz	1.69	1.71	1.99				
18GHz to 26.5GHz	2.23						
26.5GHz to 33GHz	2.58					2.79	
33GHz to 34GHz	2.73					2.93	3.12
34GHz to 35GHz	2.73					2.93	3.40
35GHz to 40GHz	2.73					2.93	3.12
40GHz to 45GHz	3.67						3.15
45GHz to 50GHz	4.33						3.34

Frequency	25°C ± 3°C					
	8483A	8481D	8485D	8487D	R8486D	Q8486D
100KHz to 10MHz	1.59					
10MHz to 30MHz	1.39	0.77				
30MHz to 500MHz	1.41	0.81	1.24	1.33		
500MHz to 1.2GHz	1.41	0.81	1.26	1.35		
1.2GHz to 6GHz	1.46	0.97	1.35	1.41		
6GHz to 14GHz		1.20	1.63	1.62		
14GHz to 18GHz		1.72	1.83	1.73		
18GHz to 26.5GHz			2.45	2.25		
26.5GHz to 33GHz			2.94*	2.55	2.47	
33GHz to 34GHz				3.08	2.42	2.85
34GHz to 35GHz				3.08	2.42	2.85
35GHz to 40GHz				3.08	2.42	2.85
40GHz to 45GHz				4.28		2.84
45GHz to 50GHz				4.72		2.84

* These uncertainties only apply to Option 033

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8480 Series diode and thermocouple power sensor specifications (continued)

Maximum SWR and power linearity

Table 14

Model	Frequency range	Maximum SWR	Power linearity [1]	Maximum power	Connector type	Weight
25-Watt sensors, 1 mW to 25 W (0 dBm to +44 dBm)						
8481B	10 MHz to 18 GHz	10 MHz to 2 GHz: 1.10 2 GHz to 12.4 GHz: 1.18 12.4 GHz to 18 GHz: 1.28	+35 dBm to + 44 dBm: (±4%)	0 °C to 35 °C: 30 W avg[2] 35 °C to 55 °C: 25 W avg 0.01 to 5.8 GHz: 500 W pk 5.8 to 18 GHz: 125 W pk 500 W.µs per pulse	Type-N(m)	0.8 kg (1.75 lb)
8482B	100 kHz to 4.2 GHz	100 kHz to 2 GHz: 1.10 2 GHz to 4.2 GHz: 1.18	+35 dBm to + 44 dBm: (±4%)	0 °C to 35 °C: 30 W avg[2] 35 °C to 55 °C: 25 W avg 0.01 to 5.8 GHz: 500 W pk 5.8 to 18 GHz: 125 W pk 500 W.µs per pulse	Type-N(m)	0.8 kg (1.75 lb)
3-Watt sensors, 100 µW to 3 W (–10 dBm to +35 dBm)						
8481H	10 MHz to 18 GHz	10 MHz to 8 GHz: 1.20 8 GHz to 12.4 GHz: 1.25 12.4 GHz to 18 GHz: 1.30	+25 dBm to + 35 dBm: (±5%)	3.5 W avg, 100 W pk 100 W.µs per pulse	Type-N(m)	0.2 kg (0.38 lb)
8482H	100 kHz to 4.2 GHz	100 kHz to 4.2 GHz: 1.20	+25 dBm to + 35 dBm: (±5%)	3.5 W avg, 100 W pk 100 W.µs per pulse	Type-N(m)	0.2 kg (0.38 lb)
100-mW sensors, 1 µW to 100 mW (–30 dBm to +20 dBm)						
8485A	50 MHz to 26.5 GHz	50 MHz to 100 MHz: 1.15 100 MHz to 2 GHz: 1.10 2 GHz to 12.4 GHz: 1.15 12.4 GHz to 18 GHz: 1.20 18 GHz to 26.5 GHz: 1.25	+10 dBm to + 20 dBm: (±3%)	300 mW avg, 15 W pk 30 W.µs per pulse	APC-3.5mm(m)	0.2 kg (.38 lb)
Option 8485A-033	26.5 MHz to 33 GHz	26.5 GHz to 33 GHz: 1.40	+10 dBm to + 20 dBm: (±3%)	300 mW avg, 15 W pk 30 W.µs per pulse	APC-3.5mm(m)	0.2 kg (.38 lb)
8481A	10 MHz to 18 GHz	10 MHz to 30 MHz: 1.40 30 MHz to 50 MHz: 1.18 50 MHz to 2 GHz: 1.10 2 GHz to 12.4 GHz: 1.18 12.4 GHz to 18 GHz: 1.28	+10 dBm to + 20 dBm: (±3%)	300 mW avg, 15 W pk 30 W.µs per pulse	Type-N (m)	0.2 kg (0.38 lb)
8482A	100 kHz to 4.2 GHz	100 kHz to 300 kHz: 1.60 300 kHz to 1 MHz: 1.20 1 MHz to 2 GHz: 1.10 2 GHz to 4.2 GHz: 1.30	+10 dBm to + 20 dBm: (±3%)	300 mW avg, 15 W pk 30 W.µs per pulse	Type-N (m)	0.2 kg (0.38 lb)
8483A (75-ohm)	100 kHz to 2 GHz	100 kHz to 600 kHz: 1.80 600 kHz to 2 GHz: 1.18	+10 dBm to + 20 dBm: (±3%)	300 mW avg, 10 W pk	Type-N (m) (75-ohm)	0.2 kg (0.38 lb)
R8486A	26.5 GHz to 40 GHz	26.5 GHz to 40 GHz: 1.40	+10 dBm to + 20 dBm: (±3%)	300 mW avg, 15 W pk 30 W.µs per pulse	Waveguide flange UG-599/U	0.26 kg (0.53 lb)
Q8486A	33 GHz to 50 GHz	33 GHz to 50 GHz: 1.50	+10 dBm to + 20 dBm: (±3%)	300 mW avg, 15 W pk 30 W.µs per pulse	Waveguide flange UG-383/U	0.26 kg (0.53 lb)
V8486A	50 GHz to 75 GHz	50 GHz to 75 GHz: 1.06	+10 dBm to + 20 dBm: (±2%) –30 dBm to + 10 dBm: (±1%)	200 mW avg, 40 W pk (10.µs per pulse, 0.5% duty cycle)	Waveguide flange UG-385/U	0.4 kg (0.9 lb)
W8486A	75 GHz to 110 GHz	75 GHz to 110 GHz: 1.08	(±2%)	200 mW avg, 40 W pk (10.µs per pulse, 0.5% duty cycle)	Waveguide flange UG-387/U-M	0.4 kg (0.9 lb)
8487A	50 MHz to 50 GHz	50 MHz to 100 MHz: 1.15 100 MHz to 2 GHz: 1.10 2 GHz to 12.4 GHz: 1.15 12.4 GHz to 18 GHz: 1.20 18 GHz to 26.5 GHz: 1.25 26.5 GHz to 40 GHz: 1.30 40 GHz to 50 GHz: 1.50	+10 dBm to + 20 dBm: (±3%)	300 mW avg, 15 W pk 30 W.µs per pulse	2.4 mm (m)	0.14 kg (.28 lb)

1. Negligible deviation except for those power ranges noted.
2. For pulses greater than 30 W, the maximum average power (Pa) is limited by the energy per pulse (E) in W.µs according to Pa = 30-0.02 E.

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8480 Series diode and thermocouple power sensor specifications (continued)

Model	Frequency range	Maximum SWR	Power linearity [1]	Maximum power	Connector type	Weight
High-sensitivity sensors, 100 pW to 10 µW (–70 dBm to –20 dBm)						
8481D [3]	10 MHz to 18 GHz	10 MHz to 30 MHz: 1.40 30 MHz to 4 GHz: 1.15 4 GHz to 10 GHz: 1.20 10 GHz to 15 GHz: 1.30 15 GHz to 18 GHz: 1.35	–30 dBm to –20 dBm: (±1%)	100 mW avg, 100 mW pk	Type-N (m)	0.16 kg (0.37 lb)
8485D [3]	50 MHz to 26.5 GHz	0.05 GHz to 0.1 GHz: 1.19 0.1 GHz to 4 GHz: 1.15 4 GHz to 12 GHz: 1.19 12 GHz to 18 GHz: 1.25 18 GHz to 26.5 GHz: 1.29	–30 dBm to –20 dBm: (±2%)	100 mW avg, 100 mW pk	APC-3.5mm (m)	0.2 kg (.38 lb)
Option 8485D-033	50 MHz to 33 GHz	26.5 GHz to 33 GHz: 1.35	–30 dBm to –20 dBm: (±2%)	100 mW avg, 100 mW pk	APC-3.5mm (m)	0.2 kg (.38 lb)
8487D [3]	50 MHz to 50 GHz	0.05 GHz to 0.1 GHz: 1.19 0.1 GHz to 2 GHz: 1.15 2 GHz to 12.4 GHz: 1.20 12.4 GHz to 18 GHz: 1.29 18 GHz to 34 GHz: 1.37 34 GHz to 40 GHz: 1.61 40 GHz to 50 GHz: 1.89	–30 dBm to –20 dBm: (±2%)	100 mW avg, 100 mW pk 10 W.µs per pulse	2.4 mm (m)	0.2 kg (0.38 lb)
R8486D [3]	26.5 GHz to 40 GHz	26.5 GHz to 40 GHz: 1.40	–30 dBm to –25 dBm: (±3%) –25 dBm to –20 dBm: (±5%)	100 mW avg, or pk 40 V dc max	Waveguide flange UG-599/U	0.26 kg (0.53 lb)
Q8486D [3]	33 GHz to 50 GHz	33 GHz to 50 GHz: 1.40	–30 dBm to 25 dBm: (±3%) –25 dBm to –20 dBm: (±5%)	100 mW avg, or pk 40 V dc max	Waveguide flange UG-383/U	0.26 kg (0.53 lb)

1. Negligible deviation except for those power ranges noted.
2. For pulses greater than 30 W, the maximum average power (Pa) is limited by the energy per pulse (E) in W.µs according to Pa = 30-0.02 E.
3. Includes 11708A 30 dB attenuator for calibrating against 0 dBm, 50 MHz power reference. The 11708A is factory set to 30 dB ±0.05 dB at 50 MHz, traceable to NIST. SWR < 1.05 at 50 MHz.





N8480 Series thermocouple power sensor specifications

The N8480 Series power sensors are replacing the 8480 Series thermocouple range. Detailed specifications on the N8480 Series can be found in the *"Agilent N8480 Series Power Sensors Data Sheet"*, literature number 5989-9333EN.

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Revised: October 6, 2008

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Printed in USA, May 22, 2009
5965-6382E

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