Agilent
E4416A/E4417A EPM-P Series Power Meters and E-Series E9320 Peak and Average Power Sensors

Data Sheet

Agilent Technologies

EPM-P power meter specifications

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

Supplemental characteristics 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'.

Measurement uncertainties information can be found in, *Fundamentals of RF and Microwave Power Measurements - Application Note 64-1*, literature number 5965-6630E.

Compatibility, the EPM-P series power meters operate with the E-series E9320 family of power sensors for peak, average and time-gated power measurements. The EPM-P series also operates with the existing 8480 and N8480 series, E-series CW and the E9300 range of power sensors for average power measurements. For specifications pertaining to the 8480 and E-series CW and E9300 power sensors, please refer to the *EPM Series Power Meters, E-Series and 8480 Series Power Sensors*, Technical Specifications, literature number 5965-6382E. For specifications pertaining to the N8480 series power sensors, please refer to the *N8480 Series Thermocouple Power Sensors*, Technical Specifications, literature number 5989-9333EN.

Measurement modes, the EPM-P series power meters have two measurement modes:

1. Normal mode (default mode using E9320 sensors) for peak, average and time-related measurements, and
2. Average only mode. This mode is primarily for average power measurements on low-level signals, when using E9320 sensors, and is the mode used with 8480 and N8480 series sensors, E-series CW sensors and E-series E9300 sensors.

Frequency range: 9 kHz to 110 GHz, sensor dependent

Power range: -70 to +44 dBm, sensor dependent

Single sensor dynamic range

E-series E9320 peak and average power sensors:
70 dB maximum (normal mode);
85 dB maximum (average only mode)
E-series CW power sensors: 90 dB
E-series E9300 average power sensors:
80 dB maximum
8480 series sensors: 50 dB maximum
N8480 series sensors: 55 dB maximum

Display units

Absolute: Watts or dBm
Relative: Percent or dB

Display resolution: Selectable resolution of 1.0, 0.1, 0.01, 0.001 dB in logarithmic mode, or 1 to 4 significant digits in linear mode.

Offset range: ±100 dB in 0.001 dB increments, to compensate for external loss or gain

Video bandwidth: 5 MHz (set by meter and is sensor dependent)

Note that the video bandwidth represents the ability of the power sensor and meter to follow the power envelope of the input signal. The power envelope of the input signal is, in some cases, determined by the signal's modulation bandwidth, and hence video bandwidth is sometimes referred to as modulation bandwidth.

Video bandwidth/ dynamic range optimization

The power measurement system, comprising the sensor and meter, has its maximum video bandwidth defined by the E9320 sensor. To optimize the system's dynamic range for **peak power measurements**, the video bandwidth in the meter can be set to **High**, **Medium** and **Low**, as detailed in the following table. The filter video bandwidths stated in the table are not the 3 dB bandwidths as the video bandwidths are corrected for optimal flatness. Refer to figures 6 to 8 for information on the sensor's peak flatness response. A filter **OFF** mode is also provided.

Table 1. Video bandwidth versus peak power dynamic range

Sensor model	Video bandwidth/maximum peak power dynamic range			
	OFF	**High**	**Medium**	**Low**
E9321A E9325A	300 kHz/ -40 dBm to +20 dBm	300 kHz/ -42 dBm to +20 dBm	100 kHz/ -43 dBm to +20 dBm	30 kHz/ -45 dBm to +20 dBm
E9322A E9326A	1.5 MHz/ -36 dBm to +20 dBm	1.5 MHz/ -37 dBm to +20 dBm	300 kHz/ -38 dBm to +20 dBm	100 kHz/ -39 dBm to +20 dBm
E9323A E9327A	5 MHz/ -32 dBm to +20 dBm	5 MHz/ -32 dBm to +20 dBm	1.5 MHz/ -34 dBm to +20 dBm	300 kHz/ -36 dBm to +20 dBm

Accuracy

Instrumentation

Please add the corresponding power sensor linearity percentage; see Tables 6a and 6b for the E9320 sensors.

Average only mode:

Absolute Logarithmic: ±0.02 dB
Linear: ±0.5%

Relative Logarithmic: ±0.04 dB
Linear: ±1.0%

Normal mode:

	Calibration temperature[1] ±5 °C	Temperature 0 to 55 °C
Absolute accuracy (log)	±0.04 dB	±0.08 dB
Absolute accuracy (linear)	±0.8%	±1.7%
Relative accuracy (log)	±0.08 dB	±0.16 dB
Relative accuracy (linear)	±1.6%	±3.4%

Time Base Accuracy 0.01%

1 mW power reference

Power output: 1.00 mW (0.0 dBm). Factory set to ±0.4% traceable to the National Physical Laboratories (NPL), UK[2]

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 E41xA-003)

Connector type: Type N (f), 50 ohms

Measurement characteristics:

Measurements: Average power
Peak power
Peak-to-average ratio
Measurements between two time offsets (time-gating)

Averaging: Averaging over 1 to 1024 readings is available for reducing noise

Measurement speed (GPIB)

Over the GPIB, three measurement speeds are available (normal, x 2 and fast). The typical maximum speed is shown in the table below.

Table 2. Measurement speed for different sensor types

Sensor type		Measurement speed (readings/second)		
		Normal	x 2	Fast[3,4]
E-Series E9320 peak and average sensors	Average only mode	*20*	*40*	*400*
	Normal mode[5]	*20*	*40*	*1000*
E-Series CW and E9300 average power sensors		*20*	*40*	*400*
8480 and N8480 Series sensor		*20*	*40*	*N.A.*

Channel functions A, B, A/B, B/A, A-B, B-A and Relative

Storage registers 10 instrument states can be saved via the Save/Recall menu.

Predefined setups

For common wireless standards (GSM900, EDGE, NADC, iDEN, Bluetooth, IS-95 CDMA, W-CDMA and cdma2000), predefined setups are provided.

1. Power meter is within ±5 °C of its calibration temperature.
2. 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/**
3. Fast speed is not available for 8480 and N8480 series sensors.
4. Maximum measurement speed is obtained by using binary output in free run trigger.
5. For E9320 sensors, maximum speed is achieved using binary output in free run acquisition.

Trigger

Sources: Internal, External TTL, GPIB, RS232/422,

Time resolution: *50 ns*

Delay range: *±1.0 s*

Delay resolution: *50 ns for delays < ±50 ms; otherwise 200 ns*

Hold-off:
- **Range:** *1 us to 400 ms*
- **Resolution:** *1% of selected value (minmum of 100 ns)*

Internal trigger:
- **Range:** *-20 to +20 dBm*
- **Level accuracy:** *±0.5 dB*
- **Resolution:** *0.1 dB*
- **Latency:** *500 ns ± 100 ns*

Latency is defined as the delay between the applied RF crossing the trigger level and the meter switching into the triggered state.

External trigger range: *High > 2.0 V, Low < 0.8 V*; BNC connector; rising or falling edge triggered; input impedance > 1 kΩ.

Trigger out: Output provides TTL compatible levels (*high > 2.4 V, low < 0.4 V*) and uses a BNC connector

Sampling characteristics

Sampling rate: *20 Msamples/second*

Sampling technique: *Continuous sampling*

Rear panel inputs/outputs

Recorder output(s): Analog 0 to 1 V, 1 kΩ output impedance, BNC connector. Two outputs are available on E4417A (channels A and B).

Remote input/output:
- **TTL output:** used to signal when measurement has exceeded a defined limit.
- **TTL input:** initiates zero and calibration cycle.
- **Connector type:** RJ-45 series shielded modular jack assembly.
- **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.*

RS-232/422 interface: Serial interface for communication with an external controller. Male plug 9-pin D-subminiature connector.

Trigger in: Accepts a TTL signal for initiating measurements, BNC connector.

Trigger out: Outputs a TTL signal for synchronizing with external equipment, BNC 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	47 to 440 Hz
Power requirement	approximately 50 VA (14 Watts)

Remote programming

Interface: GPIB interface operates to IEEE 488.2 and IEC-625. RS-232 and RS-422 serial interfaces supplied as standard

Command language: SCPI standard interface commands

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

Environmental specifications

Operating environment

Temperature	0° to 55 °C
Maximum humidity	95% at 40 °C, (non-condensing)
Minimum humidity	15% at 40 °C
Maximum altitude	3,000 meters (9,840 feet)

Storage conditions:

Storage temperature	-20 to +70°C
Non-operating maximum humidity:	90% at 65 °C (non-condensing)
Non-operating maximum altitude:	15,420 meters (50,000 feet)

Regulatory information

Electromagnetic compatibility: This product conforms with the protection requirements of European Council Directive 89/336/EEC for Electromagnetic Compatibility (EMC). The conformity assessment requirements have been met using the technical Construction file route to compliance, using EMC test specifications EN 55011:1991 (Group 1, Class A) and EN 50082-1:1992. In order to preserve the EMC performance of the product, any cable which becomes worn or damaged must be replaced with the same type and specification.

Product safety: This product conforms to the requirements of European Council Directive 73/23/EEC, and meets the following safety standards:

IEC 61010-1(1990) + A1 (1992) + A2 (1995) /
EN 61010-1 (1993)
IEC 825-1 (1993) / EN 60825-1 (1994)
Canada / CSA C22.2 No. 1010.1-93

Physical specifications

Dimensions: The following dimensions exclude front and rear panel 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

Net:

E4416A: *4.0 kg (8.8 lbs) approximate*
E4417A: *4.1 kg (9.0 lbs) approximate*

Shipping:

E4416A: *7.9 kg (17.4 lbs) approximate*
E4417A: *8.0 kg (17.6 lbs) approximate*

Ordering information

Accessories supplied

Power sensor cable

E9288A 1.5 meter (5 ft). One per E4416A, two per E4417A

Power cord

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

ANSI/NCSL Z540-1-1994 certificate of calibration supplied as standard.

Installation guide

Users Guide and Programming Guide (CD-ROM format)

Power meter options

Connectors

E441xA-002 Parallel rear panel sensor input connector(s) and front panel reference calibrator connector

E441xA-003 Parallel rear panel sensor input connector(s) and rear panel reference calibrator connector

Calibration documentation

E441xA-A6J ANSI Z540 compliant calibration test data including measurement uncertain ties

Documentation

A hard copy of the *Installation Guide* and CD[1] of the *English language User's Guide and Programming Guide* is provided with the EPM-P power meter as standard. A selection can be made to delete the hard copy.

E441xA-0B0 Delete manual set

Additional documentation

Selections can be made for the localization of the User's Guide, an English language Programming Guide and Service Manual.

E441xA-0B3 English language Service Manual
E441xA-0BK English language manual set (hardcopy User's Guide and English Programming Guide)
E441xA-ABD German localization (hard copy User's Guide and English Programming Guide)
E441xA-ABE Spanish localization (hard copy User's Guide and English Programming Guide)
E441xA-ABF French localization (hard copy User's Guide and English Programming Guide)
E441xA-ABJ Japanese localization (hard copy User's Guide and English Programming Guide)
E441xA-ABZ Italian localization (hard copy User's Guide and English Programming Guide)

Power sensor cables

E441xA-004 Delete power sensor cable

For operation with the E9320 power sensors:

E9288A Power sensor cable, length 5 ft (1.5 m)
E9288B Power sensor cable, length 10 ft (3 m)
E9288C Power sensor cable, length 31 ft (10 m)

Note: The E9288A, B, and C sensor cables will also operate with 8480, N8480 and E-series power sensors.

For operation with 8480, N8480, E-series CW and E9300 power sensors:

11730A Power sensor and SNS noise source cable, length 5 ft (1.5 m)
11730B Power sensor and SNS noise source cable, length 10 ft (3 m)
11730C Power sensor and SNS noise source cable, length 20 ft (6.1 m)
11730D Power sensor cable, length 50 ft (15.2 m)
11730E Power sensor cable, length 100 ft (30.5 m)
11730F Power sensor cable, length 200 ft (61.0 m)

Other sensor cable lengths can be supplied on request.

Accessories

E441xA-908 Rack mount kit (one instrument)
E441xA-909 Rack mount kit (two instruments)
34131A Transit case for half-rack 2U high instruments
34141A Yellow soft carry / operating case
34161A Accessory pouch

Service options

Warranty

Included with each EPM-P series power meter is a standard 36-month, return-to-Agilent warranty and service plan. For warranty and service of 5 years, please order 60 months of R-51B.

1. CD includes EPM-P analyzer software.

R-51B Return-to-Agilent warranty and service plan

Calibration[1]

For 3 years, order 36 months of the appropriate calibration plan shown below. For 5 years, specify 60 months.

R-50C-001 Standard calibration plan

R-50C-002 Standard compliant calibration plan

E-series E9320 power sensor specifications

The E9320 peak and average power sensors are designed for use with the EPM-P series power meters. The E9320 sensors have two measurement modes:

Normal mode (default mode for E9320 sensors) for peak, average and time-related measurements

Average only mode is designed primarily for average power measurements on low-level signals. This mode is the only mode used with 8480 and N8480 series sensors, E-series CW sensors and E-series E9300 sensors.

The following specifications are valid after zero and calibration of the power meter.

Note: E9320 power sensors MUST be used with an E9288A, B or C cable.

Table 3. Sensor specifications

Sensor model	Video bandwidth	Frequency range	Power range		Maximum power	Connector type
			Average only mode	Normal mode[2]		
E9321A	300 kHz	50 MHz to 6 GHz	-65 dBm to +20 dBm	-50 dBm to +20 dBm	+23 dBm average; +30 dBm peak (< 10 μsec duration)	Type N (m)
E9325A		50 MHz to 18 GHz				
E9322A	1.5 MHz	50 MHz to 6 GHz	-60 dBm to +20 dBm	-45 dBm to +20 dBm		
E9326A		50 MHz to 18 GHz				
E9323A	5 MHz	50 MHz to 6 GHz	-60 dBm to +20 dBm	-40 dBm to +20 dBm		
E9327A		50 MHz to 18 GHz				

1. Options not available in all countries.
2. For average power measurements, free run acquisition.

The E9320 power sensors have two measurement ranges (lower and upper) as detailed in Table 4.

Table 4. Lower and upper measurement ranges

	E9321A/E9325A		E9322A/E9326A		E9323A/E9327A	
	Normal	**Average only**	**Normal**	**Average only**	**Normal**	**Average only**
Lower range (min. power)	*-50 dBm*	*-65 dBm*	*-45 dBm*	*-60 dBm*	*-40 dBm*	*-60 dBm*
Lower range (max. power) Lower to upper auto range point	*+0.5 dBm*	*-17.5 dBm[1]*	*-5 dBm*	*-13.5 dBm[1]*	*-5 dBm*	*-10.5 dBm[1]*
Upper to lower auto range point	*-9.5 dBm*	*-18.5 dBm*	*-15 dBm*	*-14.5 dBm*	*-15 dBm*	*-11.5 dBm*
Upper range (min. power)	*-35 dBm*	*-50 dBm*	*-35 dBm*	*-45 dBm*	*-30 dBm*	*-35 dBm*
Upper range (max. power)	*+20 dBm*	*+20 dBm[1]*	*+20 dBm*	*+20 dBm[1]*	*+20 dBm*	*+20 dBm[1]*

Table 5. Power sensor maximum SWR

Sensor model	Maximum SWR (< = 0 dBm)
E9321A, E9325A	50 MHz to 2 GHz: 1.12 2 GHz to 10 GHz: 1.16 10 GHz to 16 GHz: 1.23 16 GHz to 18 GHz: 1.28
E9322A, E9326A	50 MHz to 2 GHz: 1.12 2 GHz to 12 GHz: 1.18 12 GHz to 16 GHz: 1.21 16 GHz to 18 GHz: 1.27
E9323A, E9327A	50 MHz to 2 GHz: 1.14 2 GHz to 16 GHz: 1.22 16 GHz to 18 GHz: 1.26

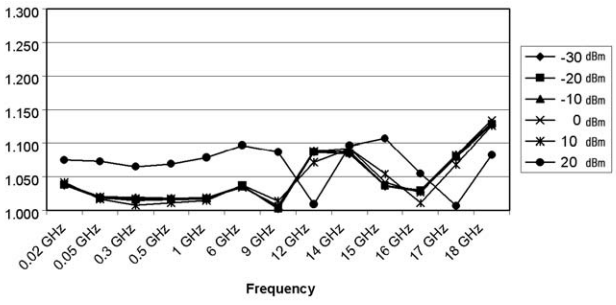


Figure 1. Typical SWR for the E9321A and E9325A sensors at various power levels

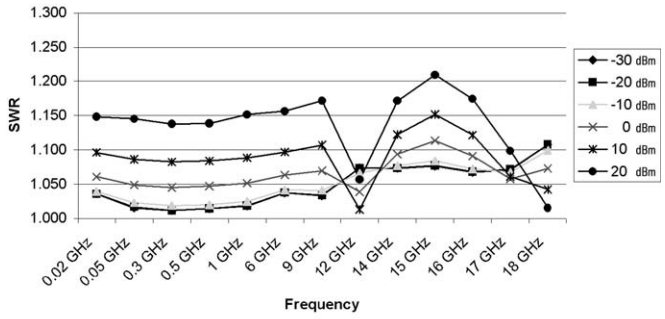


Figure 2. Typical SWR for the E9322A and E9326A sensors at various power levels

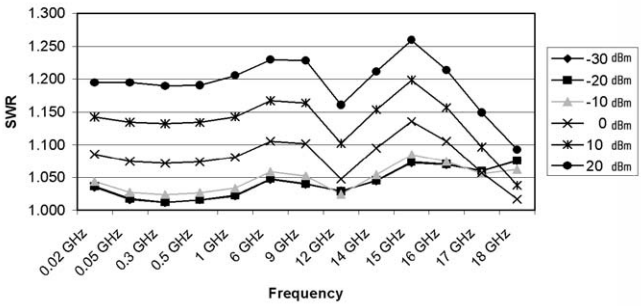


Figure 3. Typical SWR for the E9323A and E9327A sensors at various power levels

1. Applies to CW and constant amplitude signals only above –20 dBm.

Sensor linearity

Table 6a. Power sensor linearity, normal mode (upper and lower range).

Sensor model	Temperature (25 ± 10 °C)	Temperature (0 to 55 °C)
E9321A and E9325A	±4.2%	±5.0%
E9322A and E9326A	±4.2%	±5.0%
E9323A and E9327A	±4.2%	±5.5 %

Table 6b. Power sensor linearity, average only mode (upper and lower range).

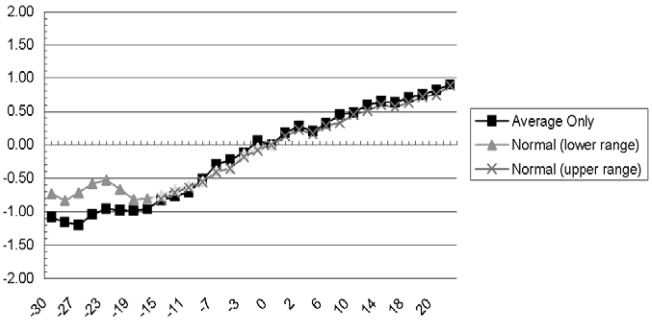
Sensor model	Temperature (25 ± 10 °C)	Temperature (0 to 55 °C)
E9321A and E9325A	±3.7%	±4.5%
E9322A and E9326A	±3.7%	±4.5%
E9323A and E9327A	±3.7%	±5.0 %

If the sensor temperature changes after calibration, and the meter and sensor is not re-calibrated, then the following additional linearity errors should be added to the linearity figures in Tables 6a and 6b.

Table 6c. Additional linearity error (normal and average only modes).

Sensor model	Temperature (25 ± 10 °C)	Temperature (0 to 55 °C)
E9321A and E9325A	±1.0%	±1.0%
E9322A and E9326A	±1.0%	±1.5%
E9323A and E9327A	±1.0%	±2.0 %

Figure 4. Typical power linearity at 25 °C for the E9323A and E9327A 5 MHz bandwidth sensors, after zero and calibration, with associated measurement uncertainty.



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

Figure 5. Relative mode power measurement linearity with an EPM-P series power meter, at 25 °C (typical).

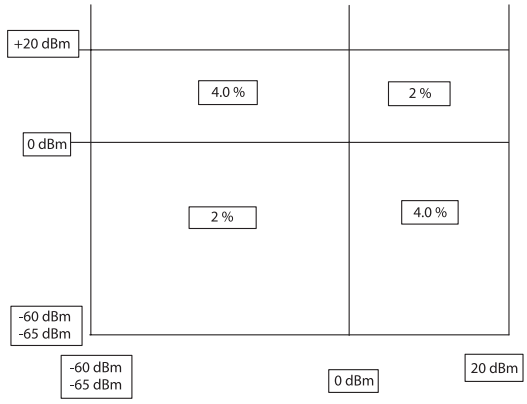


Figure 5 shows the typical uncertainty in making a relative power measurement, using the same power meter channel and the same power sensor to obtain the reference and the measured values. It also assumes that negligible change in frequency and mismatch error occurs when transitioning from the power level used as the reference to the power level measured.

Peak flatness

The peak flatness is the flatness of a peak-to-average ratio measurement for various tone-separations for an equal magnitude two-tone RF input. Figures 6, 7 and 8 refer to the relative error in peak-to-average measurement as the tone separation is varied. The measurements were performed at –10 dBm average power using an E9288A sensor cable (1.5 m).

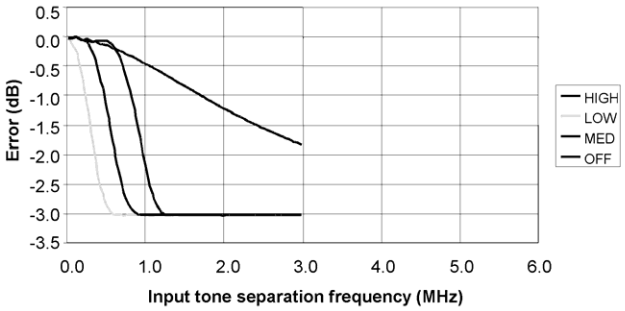


Figure 6. E9321A and E9325A Error in peak-to-average measurements for a two-tone input (high, medium, low and off filters).

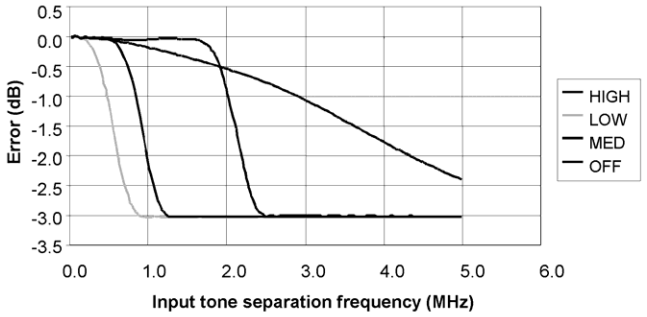


Figure 7. E9322A and E9326A error in peak-to-average measurements for a two-tone input (high, medium, low and off filters).

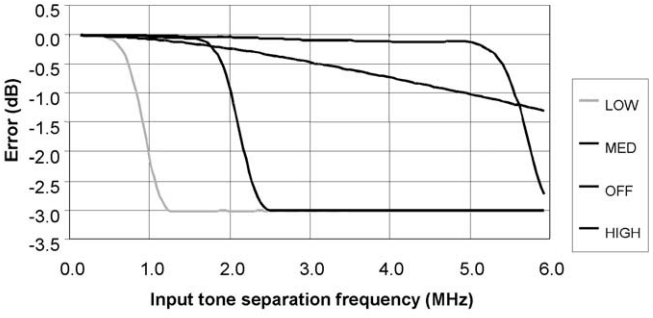


Figure 8. E9323A and E9327A error in peak-to-average measurements for a two-tone input (high, medium, low and off filters).

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 data sheet with the serial number of the power sensor you are using. The CF corrects for the frequency response of the sensor. The EPM-P series power meter automatically reads the CF data stored in the sensor and uses it to make corrections.

For power levels greater than 0 dBm, add to the calibration factor uncertainty specification:
±0.1%/dB (for E9321A and E9325A sensors),
±0.15%/dB (for E9322A and E9326A sensors) and
±0.2%/dB (for E9323A and E9327A sensors).

Reflection Coefficient (Rho) relates to the SWR according to the formula:
SWR = (1 + Rho) / (1 – Rho)

Maximum uncertainties of the CF data are listed 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.

Table 7. Calibration factor uncertainty at 0.1 mW (-10 dBm).

Frequency	Uncertainty (%) (25 ±10°C)	Uncertainty (%) (0 to 55°C)
50 MHz	Reference	Reference
100 MHz	±1.8	±2.0
300 MHz	±1.8	±2.0
500 MHz	±1.8	±2.0
800 MHz	±1.8	±2.0
1.0 GHz	±2.1	±2.3
1.2 GHz	±2.1	±2.3
1.5 GHz	±2.1	±2.3
2.0 GHz	±2.1	±2.3
3.0 GHz	±2.1	±2.3
4.0 GHz	±2.1	±2.3
5.0 GHz	±2.1	±2.3
6.0 GHz	±2.1	±2.3
7.0 GHz	±2.3	±2.5
8.0 GHz	±2.3	±2.5
9.0 GHz	±2.3	±2.5
10.0 GHz	±2.3	±2.5
11.0 GHz	±2.3	±2.5
12.0 GHz	±2.3	±2.5
12.4 GHz	±2.3	±2.5
13.0 GHz	±2.3	±2.5
14.0 GHz	±2.5	±2.8
15.0 GHz	±2.5	±2.8
16.0 GHz	±2.5	±2.8
17.0 GHz	±2.5	±2.8
18.0 GHz	±2.5	±2.8

Zero set

This specification applies to a ZERO performed when the sensor input is not connected to the POWER REF.

Table 8. Zero set

Sensor model	Zero set (normal mode)	Zero set (average only mode)
E9321A, E9325A	5 nW	0.17 nW
E9322A, E9326A	19 nW	0.5 nW
E9323A, E9327A	60 nW	0.6 nW

Zero drift and measurement noise

Table 9. Zero drift and measurement noise.

Sensor model	Zero drift[1]		Measurement noise[2]		
	Normal mode	Average only mode	Normal mode[3]	Normal mode [4]	Average only mode
E9321A E9325A	*< ±5 nW*	*< ±60 pW*	*< 6 nW*	*< 75 nW*	*< 165 pW*
E9322A E9326A	*< ±5 nW*	*< ±100 pW*	*< 12 nW*	*< 180 nW*	*< 330 pW*
E9323A E9327A	*< ±40 nW*	*< ±100 pW*	*< 25 nW*	*< 550 nW*	*< 400 pW*

Effect of averaging on noise: Averaging over 1 to 1024 readings is available for reducing noise. Table 9 provides the measurement noise for a particular sensor. Use the noise multipliers in Table 10, for the appropriate speed (normal or x 2) or measurement mode (normal or average only) and the number of averages, to determine the total measurement noise value.

In addition, for x 2 speed (in normal mode) the total measurement noise should be multiplied by **1.2**, and for fast speed (in normal mode), the multiplier is **3.4**.
Note that in fast speed, no additional averaging is implemented.

Table 10. Noise multipliers

Mode	Number of averages	1	2	4	8	16	32	64	128	256	512	1024
Average -only	**Noise multiplier** (normal speed)	*5.5*	*3.89*	*2.75*	*1.94*	*1.0*	*0.85*	*0.61*	*0.49*	*0.34*	*0.24*	*0.17*
	Noise multiplier (x 2 speed)	*6.5*	*4.6*	*3.25*	*2.3*	*1.63*	*1.0*	*0.72*	*0.57*	*0.41*	*0.29*	*0.2*
Normal	**Noise multiplier** (normal speed; free run acquisition)	*1.0*	*0.94*	*0.88*	*0.82*	*0.76*	*0.70*	*0.64*	*0.58*	*0.52*	*0.46*	*0.40*

Example:
E9321A power sensor, number of averages = 4, free run acquisition, normal mode, x 2 speed.
Measurement noise calculation:
(< 6 nW x 0.88 x 1.2) = < 6.34 nW

Effect of video bandwidth setting: The noise per sample is reduced by applying the meter video bandwidth reduction filter setting (High, Medium or Low). If averaging is implemented, this will dominate any effect of changing the video bandwidth.

Table 11. Effect of video bandwidth on noise per sample.

Sensor	Noise multipliers		
	Low	Medium	High
E9321A E9325A	*0.32*	*0.50*	*0.63*
E9322A E9326A	*0.50*	*0.63*	*0.80*
E9323A E9327A	*0.40*	*0.63*	*1.0*

Example:
E9322A power sensor, triggered acquisition, video bandwidth = High.
Noise per sample calculation:
(< 180 nW x 0.80) = < 144 nW

Effect of time-gating on measurement noise

The measurement noise will depend on the time gate length, over which measurements are made. Effectively 20 averages are carried out every 1 us of gate length.

1. Within 1 hour after zero set, at a constant temperature, after a 24 hour warm-up of the power meter.
2. Measured over a one-minute interval, at a constant temperature, two standard deviations, with averaging set to 1 (for normal mode), 16 (for average only mode, normal speed) and 32 (for average only mode, x 2 speed).
3. In free run acquisition mode.
4. Noise per sample, video bandwidth set to OFF with no averaging (i.e. averaging set to 1) - see the note "Effect of Video Bandwidth Setting" and Table 11.

Settling times

Average-only mode:

In normal and x 2 speed, manual filter, 10 dB decreasing power step refer to Table 12.

Table 12. Settling time (average only mode)

Number of average	1	2	4	8	16	32	64	128	256	512	1024
Settling time(s) normal	*0.08*	*0.13*	*0.24*	*0.45*	*1.1*	*1.9*	*3.5*	*6.7*	*14*	*27*	*57*
Settling time(s) x 2	*0.07*	*0.09*	*0.15*	*0.24*	*0.45*	*1.1*	*1.9*	*3.5*	*6.7*	*14*	*27*

In fast speed, within the range –50 to +20 dBm, for a 10 dB decreasing power step, the settling time is *10 ms* (for the E4416A) and *20 ms* (for the E4417A).

When a power step crosses the power sensor's auto-range switch point, add *25 ms*.

Normal mode:

In normal, free run acquisition mode, within the range –20 to +20 dBm, for a 10 dB decreasing power step, the settling time is dominated by the measurement update rate and is listed in Table 13 for various filter settings.

Table 13. Settling time (normal mode)

Number of averages	1	2	4	8	16	32	64	128	256	512	1024
Settling time free run acquisition, normal speed (s)	*0.1*	*0.15*	*0.25*	*0.45*	*0.9*	*1.7*	*3.3*	*6.5*	*13.0*	*25.8*	*51.5*
Settling time free run acquisition, X2 speed (s)	*0.08*	*0.1*	*0.15*	*0.25*	*0.45*	*0.9*	*1.7*	*3.3*	*6.5*	*13.0*	*25.8*

Table 14. Rise and fall times versus sensor bandwidth[1]

In normal mode, measuring in continuous or single acquisition mode, the performance of rise times, fall times and 99% settled results are shown in Table 14. Rise time and fall time specifications are for a 0.0 dBm pulse, with the rise time and fall time measured between 10% to 90% points and upper range selected.

Sensor model	Parameter	Video bandwidth setting			
		Low	Medium	High	Off
E9321A, E9325A	Rise time (< µs)	*2.6*	*1.5*	*0.9*	*0.3*
	Fall time (< µs)	*2.7*	*1.5*	*0.9*	*0.5*
	Settling Time (rising) (< µs)	*5.1*	*5.1*	*4.5*	*0.6*
	Settling Time (falling) (< µs)	*5.1*	*5.1*	*4.5*	*0.9*
E9322A, E9326A	Rise time (< µs)	*1.5*	*0.9*	*0.4*	*0.2*
	Fall time (< µs)	*1.5*	*0.9*	*0.4*	*0.3*
	Settling Time (rising) (< µs)	*5.3*	*4.5*	*3.5*	*0.5*
	Settling Time (falling) (< µs)	*5.3*	*4.5*	*3.5*	*0.9*
E9323A, E9327A	Rise time (< µs)	*0.9*	*0.4*	*0.2*	*0.2*
	Fall time (< µs)	*0.9*	*0.4*	*0.2*	*0.2*
	Settling Time (rising) (< µs)	*4.5*	*3.5*	*1.5*	*0.4*
	Settling Time (falling) (< µs)	*4.5*	*3.5*	*2*	*0.4*

Overshoot in response to power steps with fast rise times, i.e. less than the sensor rise time, is < *10%*. When a power step crosses the power sensor's auto-range switch point, add *10 µs*.

1. Rise and fall time specifications are only valid when used with the E9288A sensor cable (1.5 meters).

Physical specifications

Dimensions: 150 mm L x 38 mm W x 30 mm H
(5.9 in x 1.5 in x 1.2 in)
Weight: Net: 0.2 kg (0.45 lbs)
Shipping: 0.55 kg (1.2 lbs)

Ordering information

E9321A	50 MHz to 6 GHz; 300 kHz BW
E9322A	50 MHz to 6 GHz; 1.5 MHz BW
E9323A	50 MHz to 6 GHz; 5 MHz BW
E9325A	50 MHz to 18 GHz; 300 kHz BW
E9326A	50 MHz to 18 GHz; 1.5 MHz BW
E9327A	50 MHz to 18 GHz; 5 MHz BW

Accessories supplied

Operating and Service Guide (multi-language)
ANSI/NCSL Z540-1-1994 Certificate of Calibration
supplied as standard

Power sensor options

E932xA-A6J	Supplies ANSI/NCSL Z540-1-1994 test data including measurement uncertainties
E932xA-0B1	Add manual set

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