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## E4416A EPM-P Series Single Channel Power Meter

**Product Status:** Currently Orderable | Currently Supported

### Key Specifications

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- 20 Msample/s per second sampling rate for reliable continuous and single shot measurements on wide bandwidth signals
- Time-gated and free run power measurements
- Free 'Analyzer Software' software for complete pulse and statistical analysis, software is located 'In the Library'
- 8 pre-defined wireless configurations (GSM, EDGE, NADC, iDEN, Bluetooth™, IS-95 CDMA, W-CDMA and cdma2000)

### Description

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The E4416A single channel EPM-P series power meter, for peak, average, peak-to-average ratio and time-gated measurements, using the E9320 peak and average power sensors.

- 20 Msample/s per second sampling rate for reliable continuous and single shot measurements on wide bandwidth signals
- Time-gated and free run power measurements
- Free 'Analyzer Software' software for complete pulse and statistical analysis, software is located 'In the Library'
- 8 pre-defined wireless configurations (GSM, EDGE, NADC, iDEN, Bluetooth™, IS-95 CDMA, W-CDMA and cdma2000)

**Read** the E4416A

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## 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	300 kHz/	300 kHz/	100 kHz/	30 kHz/
E9325A	-40 dBm to +20 dBm	-42 dBm to +20 dBm	-43 dBm to +20 dBm	-45 dBm to +20 dBm
E9322A	1.5 MHz/	1.5 MHz/	300 kHz/	100 kHz/
E9326A	-36 dBm to +20 dBm	-37 dBm to +20 dBm	-38 dBm to +20 dBm	-39 dBm to +20 dBm
E9323A	5 MHz/	5 MHz/	1.5 MHz/	300 kHz/
E9327A	-32 dBm to +20 dBm	-32 dBm to +20 dBm	-34 dBm to +20 dBm	-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:  $\pm 0.02$  dB  
Linear:  $\pm 0.5\%$

**Relative** Logarithmic:  $\pm 0.04$  dB  
Linear:  $\pm 1.0\%$

#### Normal mode:

	Calibration temperature <sup>1</sup> $\pm 5$ °C	Temperature 0 to 55 °C
<b>Absolute accuracy (log)</b>	$\pm 0.04$ dB	$\pm 0.08$ dB
<b>Absolute accuracy (linear)</b>	$\pm 0.8\%$	$\pm 1.7\%$
<b>Relative accuracy (log)</b>	$\pm 0.08$ dB	$\pm 0.16$ dB
<b>Relative accuracy (linear)</b>	$\pm 1.6\%$	$\pm 3.4\%$

**Time Base Accuracy** 0.01%

## 1 mW power reference

**Power output:** 1.00 mW (0.0 dBm). Factory set to  $\pm 0.4\%$  traceable to the National Physical Laboratories (NPL), UK<sup>2</sup>

**Accuracy:** For two years  
 $\pm 0.5\%$  ( $23 \pm 3$  °C)  
 $\pm 0.6\%$  ( $25 \pm 10$  °C)  
 $\pm 0.9\%$  (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 <sup>3,4</sup>
<b>E-Series E9320 peak and average sensors</b>	Average only mode	20	40	400
	Normal mode <sup>5</sup>	20	40	1000
<b>E-Series CW and E9300 average power sensors</b>		20	40	400
<b>8480 and N8480 Series sensor</b>		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  $\pm 5$  °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 Comité International des Poids et Mesures Mutual Recognition Arrangement. Further information is available from the Bureau International des Poids et Mesures.
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

<b>Sources:</b>	Internal, External TTL, GPIB, RS232/422,
<b>Time resolution:</b>	50 ns
<b>Delay range:</b>	$\pm 1.0$ s
<b>Delay resolution:</b>	50 ns for delays < $\pm 50$ ms; otherwise 200 ns
<b>Hold-off:</b>	
<b>Range:</b>	1 $\mu$ s to 400 ms
<b>Resolution:</b>	1% of selected value (minimum of 100 ns)
<b>Internal trigger:</b>	
<b>Range:</b>	-20 to +20 dBm
<b>Level accuracy:</b>	$\pm 0.5$ dB
<b>Resolution:</b>	0.1 dB
<b>Latency:</b>	500 ns $\pm$ 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 k $\Omega$ .

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

## Sampling characteristics

<b>Sampling rate:</b>	20 Msamples/second
<b>Sampling technique:</b>	Continuous sampling

## Rear panel inputs/outputs

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

### Remote input/output:

<b>TTL output:</b>	used to signal when measurement has exceeded a defined limit.
<b>TTL input:</b>	initiates zero and calibration cycle.
<b>Connector type:</b>	RJ-45 series shielded modular jack assembly.
<b>TTL output:</b>	high = 4.8 V max; low = 0.2 V max.
<b>TTL input:</b>	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

<b>Input voltage range</b>	85 to 264 Vac, automatic selection
<b>Input frequency range</b>	47 to 440 Hz
<b>Power requirement</b>	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

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

### Storage conditions:

<b>Storage temperature</b>	-20 to +70 °C
<b>Non-operating maximum humidity:</b>	90% at 65 °C (non-condensing)
<b>Non-operating maximum altitude:</b>	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 uncertainties

### Documentation

A hard copy of the *Installation Guide* and CD<sup>1</sup> 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<sup>1</sup>**

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 <sup>2</sup>		
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.

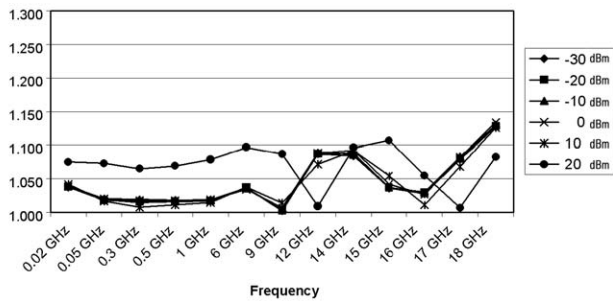
The E9320 power sensors have two measurement ranges (lower and upper) as detailed in Table 4.

**Table 4. Lower and upper measurement ranges**

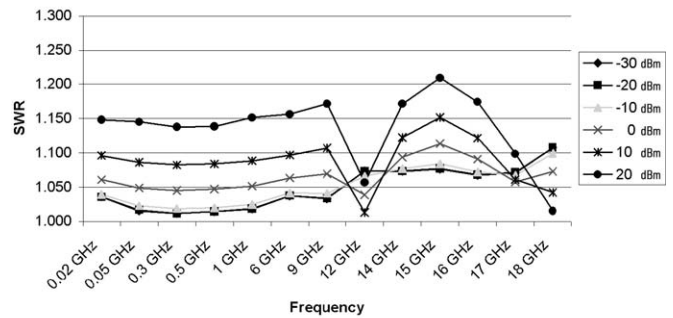
	E9321A/E9325A		E9322A/E9326A		E9323A/E9327A	
	Normal	Average only	Normal	Average only	Normal	Average only
Lower range (min. power)	-50 dBm	-65 dBm	-45 dBm	-60 dBm	-40 dBm	-60 dBm
Lower range (max. power) Lower to upper auto range point	+0.5 dBm	-17.5 dBm <sup>1</sup>	-5 dBm	-13.5 dBm <sup>1</sup>	-5 dBm	-10.5 dBm <sup>1</sup>
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 <sup>1</sup>	+20 dBm	+20 dBm <sup>1</sup>	+20 dBm	+20 dBm <sup>1</sup>

**Table 5. Power sensor maximum SWR**

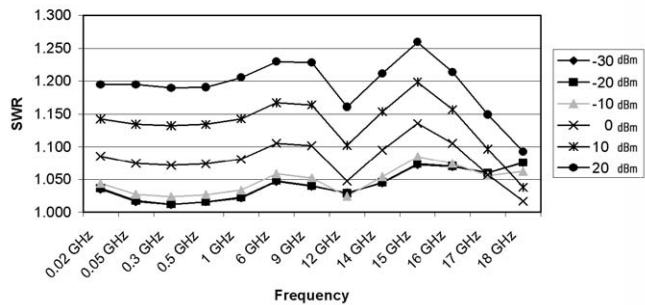
Sensor model	Maximum SWR (<= 0 dBm)
E9321A, E9325A	50 MHz to 2 GHz: 1.12 2 GHz to 10 GHz: 1.16 10 GHz to 16 GHz: 1.23 16 GHz to 18 GHz: 1.28
E9322A, E9326A	50 MHz to 2 GHz: 1.12 2 GHz to 12 GHz: 1.18 12 GHz to 16 GHz: 1.21 16 GHz to 18 GHz: 1.27
E9323A, E9327A	50 MHz to 2 GHz: 1.14 2 GHz to 16 GHz: 1.22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

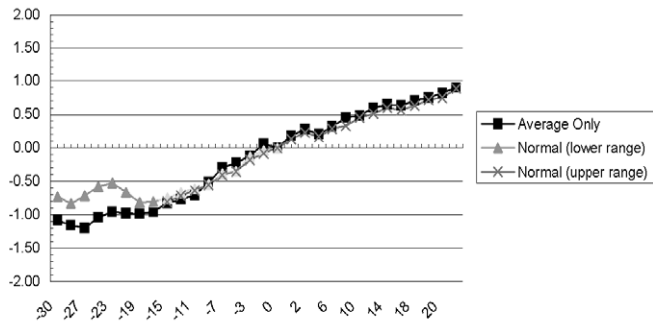
Sensor model	Temperature ( 25 ± 10 °C)	Temperature (0 to 55 °C)
E9321A and E9325A	±3.7%	±4.5%
E9322A and E9326A	±3.7%	±4.5%
E9323A and E9327A	±3.7%	±5.0 %

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).**

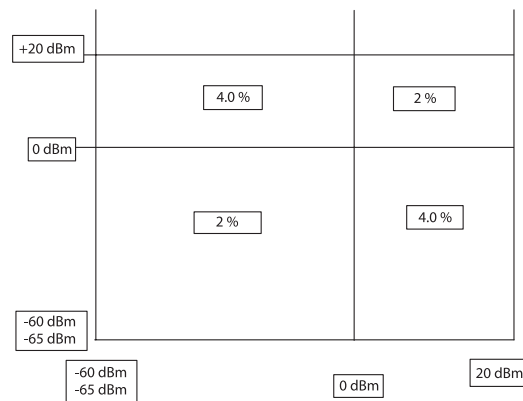


Figure 5 shows the typical uncertainty in making a relative power measurement, using the same power meter channel and the same power sensor to obtain the reference and the measured values. It also assumes that negligible change in frequency and mismatch error occurs when transitioning from the power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



## 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

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

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