# Agilent N1913A and N1914A EPM Series Power Meters

## Consistent Results and Greater Capability

### Data Sheet


As signals become more complex, it becomes more difficult to make fast, accurate power measurements. For years, you've depended on Agilent's EPM Series power meters. Today, the Agilent N1913A and N1914A EPM power meters are versatile, user-friendly replacements for the E4418B/19B EPM Series. Best of all, you get these extras for about the same price as the EPM Series. Get consistent results and greater capability—with the new EPM power meters.

### Essential specifications

- Frequency range: 9 kHz to 110 GHz
- Power range: –70 dBm to +44 dBm (100 pW to 25 W, depending on the attached power sensor)
- Measurement speed: Up to 400 readings/sec with E-Series sensors
- Absolute accuracy: ±0.02 dB logarithmic, ±0.5% linear
- Relative accuracy: ±0.04 dB logarithmic, ±1% linear

## Do more with new-generation EPM power meters

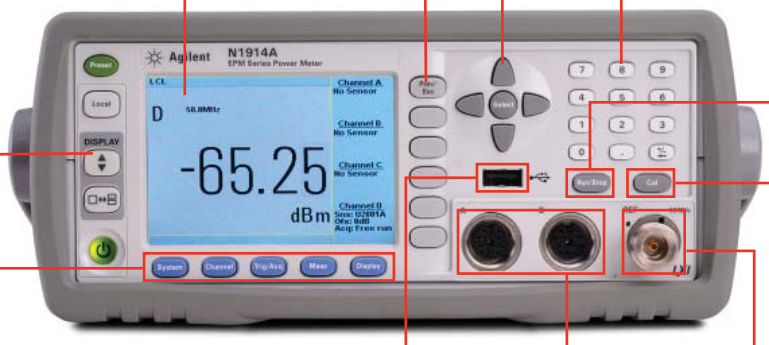
- Get up to four channels[1] to speed and simplify RF average power measurements
- Measure faster with improved measurement speed of 400 readings/sec with the Agilent E-Series sensors
- View test results more easily with the industry's first color LCD readout in an average power meter
- Go beyond GPIB with USB and LAN/LXI-C interfaces
- Automate frequency/power sweep measurements with the optional external trigger in/out feature
- Confirm battery power with a single-button push[2]—and get extra operating time with the optional spare battery
- Easily replace existing 436A. 437B and 438A meters with optional 43x code compatibility[3]
- Enhance manufacturing test by connecting a large external monitor with the unique VGA output option

1. *Additional two optional USB channels available (see Ordering Information, page 10)*
2. *Only applicable for models with battery option (see Ordering Information, page 10)*
3. *N1913A is backward compatible with the 436A and 437B, while N1914A is compatible with 438A*

Agilent Technologies

# Take a Closer Look

## N1914A front panel




Industry's first high-resolution color LCD in an average power meter

Soft keys provide menu selection

Arrow keys and Select allow positioning of the cursor for character selection and editing

Numeric keypad

Display keys select the display format for the active window (single/split screen)

Run/Stop enables single-shot measurements

Cal enables fully automatic digital zeroing (corrected for residual offsets) and fully automatic sensor calibration

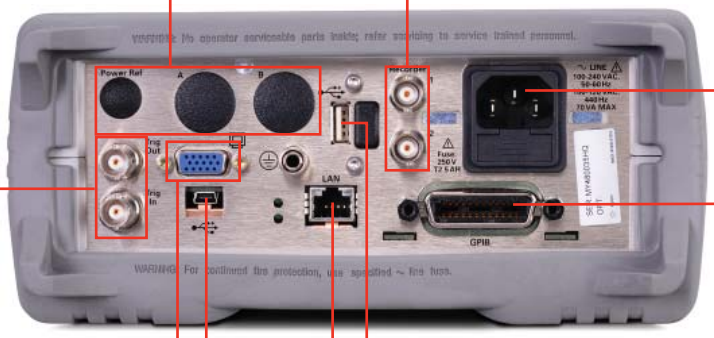
Hard keys provide quick access to the most frequently used functions, such as Trigger and Acquisition

USB port for additional sensor connection

Channel A&B sensor connectors

Power reference (0 dBm, 50 MHz)

## N1914A back panel




Rear-panel sensor and Power Ref connectors provide an option to replace front-panel connectors

DC recorder outputs (0-1 V)

Line power accepts universal input voltage with automatic range selection

Optional trigger in and out connectors

GPIB connector

Optional VGA output

USB port for additional sensor connection

USB port

LAN port

# N1913A/14A Series Power Meter: Applications and Compatible Sensors for Average Power Measurements

| Signal characteristics > | CW | Modulated | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Wireless standards | | | | | |
| | CW | Pulse/ averaged | AM/FM profiled | Mobile phone | | | WLAN | WPAN | WMAN |
| Typical application examples > | Metrology lab | Radar/ navigation | Mobile radio | GSM EDGE GPRS | CDMA2000 cdmaONE IDEN | 3G HSPA LTE | 802.11a 802.11b 802.11g 802.11n | *Bluetooth*® RFID ZigBee | Wimax Wibro |
| Themocouple sensors: 8480A/B/H, N8480A/B/H, R/Q8486A, N8486AR/AQ | ● | ● | ● | ● Average only | ● Average only | ● Average only | ● Average only | ● Average only | ● Average only |
| Diode sensors: 8480D, V8486A, W8486A | ● | ● | ● | ● Average only | ● Average only | ● Average only | ● Average only | ● Average only | ● Average only |
| Diode sensors compensated for extended range: E4412A/3A | ● | | FM only | | | | | | |
| Two-path diode-stack sensors: E9300 Series | ● | ● | ● | ● Average only | ● Average only | ● Average only | ● Average only | ● Average only | ● Average only |
| USB sensors: U2000 Series | ● | ● | ● | ● Average only | ● Average only | ● Average only | ● Average only | ● Average only | ● Average only |

* *The N1913A/4A power meters are compatible with all 8480 Series power sensors, including discontinued models.*

# N1913A/14A EPM Series Power Meters 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".

| | |
|---|---|
| Compatible power sensors | Agilent 8480 Series<br>Agilent E9300 E-Series<br>Agilent E4410 E-Series<br>Agilent N8480 Series<br>Agilent U2000 Series |
| 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 (Agilent E-Series power sensors)<br>50 dB maximum (Agilent 8480 Series power sensors)<br>55 dBm maximum (Agilent N8480 Series power sensors)<br>80 dBm maximum (Agilent U2000 Series USB power sensors) |
| Display units | Absolute: Watts or dBm<br>Relative: Percent or dB |
| Display resolution | Selectable resolution of: 1.0, 0.1, 0.01 and 0.001 dB in logarithmic mode, or 1, 2, 3 and 4 significant digits in linear mode |
| Default resolution | 0.01dB in logarithmic mode or three digits in linear mode |

## Accuracy

| | |
|---|---|
| Absolute accuracy | ±0.02 dB (Logarithmic) or ±0.5% (Linear). Please add the corresponding power sensor linearity percentage from Tables 6, 9 and 10 (for the E-Series sensors), Table 14 (for the 8480 series sensors) and Table 16 (for N8480 sensors) to assess the overall system accuracy. |
| Relative accuracy | ±0.04 dB (Logarithmic) or ±1.0% (Linear). Please add the corresponding power sensor linearity percentage from the mentioned tables above to assess the overall system accuracy. |
| Zero set<br>(digital settability of zero) | Power sensor dependent (refer Table 1), this specification applies when zeroing is performed with the sensor input disconnected from the POWER REF. |
| Zero drift of sensors | This parameter is also called long term stability and is the change in the power meter indication over a long time (within one hour) at a constant temperature after a 24-hour warm-up of the power meter. Sensor dependent, refer to Table 1. For E9300 sensors, refer to Table 11 for complete data. |

## Measurement noise

Sensor dependent, refer to Tables 1 and 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 power sensor with the number of averages set to 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.<br><br>For example: For an Agilent 8481D power sensor in normal mode with the number of averages set to 4, the measurement noise is equal to: (<45 pW x 2.75) = <124 pW |

# N1913A/14A EPM Series Power Meters Performance Characteristics *(continued)*

| 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 |
| Accuracy (for two years) | ±0.4% (25 ±10 °C)<br>±1.2% (0 to 55 °C) |
| Frequency | 50 MHz nominal |
| SWR | 1.05 (typical), 1.08 (0 to 55°C) |
| Connector type | Type-N (f), 50 Ω |

## Measurement speed

Using remote interface (over the GPIB, USB or LAN), three measurement speed modes are available as shown, along with the typical maximum measurement speed for each mode.

| | |
|---|---|
| With N1913A power meter | • Normal: 20 readings/second<br>• x2: 40 readings/second<br>• Fast: 400 readings/second |
| With N1914A power meter | The measurement speed is reduced, for example, with both channels in FAST mode, the typical maximum measurement speed is 200 readings/second. |
| Fast mode is for Agilent E-Series power sensors only. | |
| Maximum measurement speed is obtained using binary output in free run trigger mode. | |

*Table 1. Power sensors zero set, zero drift and measurement noise*

| 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, N8486AR, N8486AQ | ±25 nW | *<±3 nW* | *<80 nW* |
| 8483A | ±50 nW | *<±10 nW* | *<110 nW* |
| N8481B, N8482B | ±50 µW | *<±10 µW* | *<110 µW* |
| 8481D, 8485D, 8487D | ±20 pW | *<±4 pW* | *<45 pW* |
| N8481H, N8482H | ±5 µW | *<±1 µW* | *<10 µW* |
| R8486D, Q8486D | ±30 pW | *<±6 pW* | *<65 pW* |
| V8486A, W8486A | ±200 nW | *<±40 nW* | *<450 nW* |

1. *Within 1 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.*

The 8480 Series sensors in the table do not include discontinued models.

*Table 2. Noise multiplier*

| Number 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* |

# N1913A/14A EPM Series Power Meters Performance Characteristics *(continued)*

## 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. Settling time*

| Number of averages | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Settling time with E-Series sensors (s) | | | | | | | | | | | |
| Normal mode | *0.08* | *0.13* | *0.24* | *0.45* | *1.1* | *1.9* | *3.5* | *6.7* | *14* | *27* | *57* |
| x2 mode | *0.07* | *0.09* | *0.15* | *0.24* | *0.45* | *1.1* | *1.9* | *3.6* | *6.7* | *14* | *27* |
| 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* | *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* |

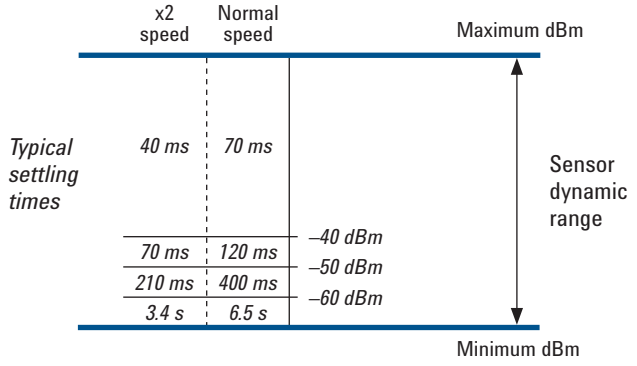
E-Series sensors In FAST mode (using free run trigger), within the range –50 dBm to +17 dBm, for a 10 dB decreasing power step, the settling time is:
N1913A: 10 ms[2]
N1914A: 20 ms[2]

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.*

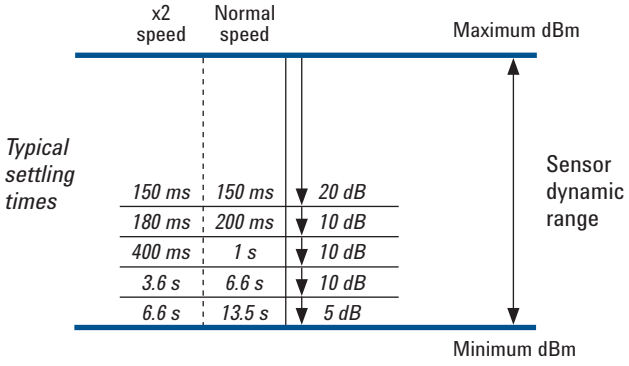
# N1913A/14A EPM Series Power Meters Performance Characteristics *(continued)*

## Settling time (continued)

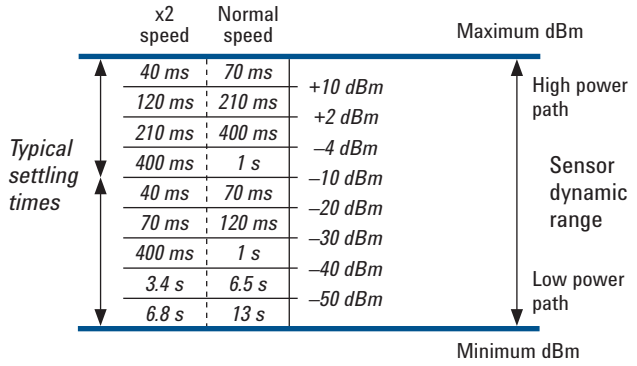
Auto filter, 10 dB decreasing power step for normal and X2 modes (not across the range switch points for E-Series and N8480 Series sensors).



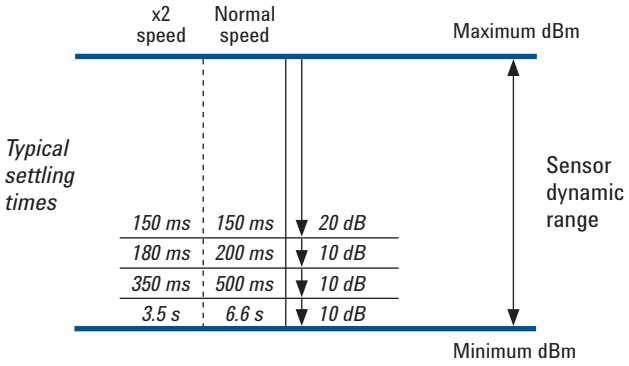

*With E-Series E4412/13A sensors*



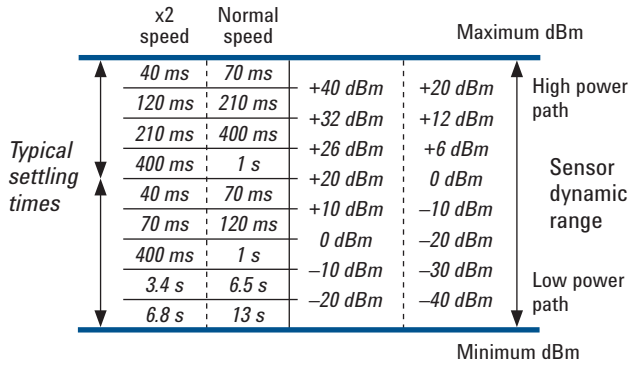

*With N8480 Series sensors*




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




*With 8480 Series sensors*




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

# N1913A/14A EPM Series Power Meters Performance Characteristics *(continued)*

## Power meter functions

| | |
|---|---|
| Accessed by key entry | Either hard keys, or soft key 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. Frequency range from 1 kHz to 999.9 GHz. Also settable in 1 kHz steps. |
| Cal factor | Sets the calibration factor for the meter. Range: 1% to 150%, in 0.1% increments. |
| 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 0.001% increments, 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 |
| Limits | High and low limits can be set in the range –150.000 dBm to +230.000 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 sensors and N8480 Series) |
| Display | Color display with selectable single and split screen formats are available. A quasi-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. With the optional USB ports, additional dual channel (C & D), adds up to total 4-channels measurement display. |

## Power meter general specifications

| | | | |
|---|---|---|---|
| Dimensions | The following dimensions exclude front and rear protrusions:<br>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 | Model | Net | Shipping |
| | N1913A | *3.6 kg (8.0 lb)* | *8.2 kg (18.1 lb)* |
| | N1914A | *3.7 kg (8.2 lb)* | *8.2 kg (18.3 lb)* |

## Rear panel connectors

| | |
|---|---|
| Recorder outputs | Analog 0 to 1 Volt, 1 kΩ output impedance, BNC connector. N1914A recorder outputs are dedicated to channel A and channel B. |
| GPIB, USB 2.0 and 10/100BaseT LAN | Interfaces to allow communication with an external controller |
| Trigger Input (optional) | Input has TTL compatible logic levels and uses a BNC connector.<br>High: >2.4 V Low: <0.7 V |
| Trigger Output (optional) | Output provides TTL compatible logic levels and uses a BNC connector.<br>High: >2.4 V Low: <0.7 V |
| Ground | Binding post, accepts 4 mm plug or bare wire connection |
| USB Host (options) | USB ports which connects to U2000 series USB power sensors |
| VGA Out (options) | Standard 15-pin VGA connector, allows connection of external VGA monitor |

# N1913A/14A EPM Series Power Meters Performance Characteristics *(continued)*

## Line power

| | |
|---|---|
| Input voltage range | 90 to 264 VAC, automatic selection |
| Input frequency range | 47 to 63 Hz and 400 Hz @ 110 Vac |
| Power requirement | 75 VA (50 Watts) |

## Battery option operational characteristics[1]

| | |
|---|---|
| The following information describes characteristic performance based at a temperature of 25 °C unless otherwise noted. | |
| Typical operating time | Up to 6 hours with LCD backlight on; up to 7.5 hours with LCD backlight off (N1913A power meter). |
| Charge time | Approximately, 2.5 hours to charge fully from an empty state. Power meter is operational whilst charging. |
| Battery type | Lithium-ion (Li-ion) |
| Battery storage temperature | –20 °C to 60 °C, ≤80 % RH |

## Environmental characteristics

| | |
|---|---|
| Electromagnetic compatibility | Complies with the essential requirements of EMC Directive (2004/108/EC) as follows:<br>• IEC61326- 1:2005 / EN61326- 1:2006<br>• CISPR11:2003 / EN55011:2007 (Group 1, Class A)<br><br>The product also meets the following EMC standards:<br>• Canada: ICES/NMB- 001:2004<br>• Australia/New Zealand: AS/NZS CISPR 11:2004 |
| Product safety | This product conforms to the requirements of the following safety standards:<br>• IEC 61010- 1:2001 / EN 61010- 1:2001<br>• CAN/CSA- C22.2 No.61010- 1- 04<br>• ANSI/UL61010- 1:2004 |
| Low Voltage Directive | This product conforms to the requirements of European Council Directive "2006/95/EC" |

## 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 | 4,600 meters (15,000 feet) |

## Storage conditions

| | |
|---|---|
| Non-operating storage temperature | –40 °C to +70 °C |
| Non-operating maximum humidity | 90% at 65 °C (non-condensing) |
| Non-operating maximum altitude | 4,600 meters (15,000 feet) |

## Remote programming

| | |
|---|---|
| Interface | GPIB, USB and LAN interfaces operates to IEEE 488.2 standard |
| Command language | SCPI standard interface commands. Code-compatible with legacy E4418B/9B EPM Series, 436A, 437B and 438A power meters (43X compatibility only with option N191xA-200). |
| GPIB compatibility | SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP1, DC1, DT1, C0 |

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

# N1913A/14A EPM Series Power Meters Ordering Information

## Power meters

| N1913A |
|---|
| Single-channel average power meter |

| N1914A |
|---|
| Dual-channel average power meter |

| Standard-shipped accessories |
|---|
| Power cord |
| Power sensor cable, 1.5 m (5 ft) (One per N1913A, two per N1914A) |
| USB cable Type A to Mini-B, 6 ft |
| Hard copy English language User's Guide and Installation Guide |
| Product CD-ROM (contains English and localized User's Guide and Programming Guide) |
| Agilent IO Libraries Suite CD-ROM |
| Calibration certificate |

| Warranty |
|---|
| Standard 1-year, return-to-Agilent warranty and service plan for N1913A/N1914A |
| 3 months for standard-shipped accessories |

## Options

| Power meter configurations | |
|---|---|
| N191xA-102 | Single/dual-channel average power meter, battery |
| N191xA-103 | Single/dual-channel average power meter, battery, two rear USB ports |
| N191xA-104 | Single/dual-channel average power meter, VGA |
| N191xA-105 | Single/dual-channel average power meter, battery, one front and one rear USB port, VGA |
| N191xA-106 | Single/dual-channel average power meter, one front and one rear USB port |
| N191xA-107 | Single/dual-channel average power meter, external trigger IN/OUT |
| N191xA-108 | Parallel rear panel sensor input connectors and front panel reference calibrator connector, two rear USB ports |
| N191xA-109 | Parallel rear panel sensor input connectors and rear panel reference calibrator connector, two rear USB ports |
| N1913A-200 | 436A and 437B code compatibility |
| N1914A-200 | 438A code compatibility |

| Power sensor cables | |
|---|---|
| 11730A | Power sensor cable: 1.5 m/5 ft |
| 11730B | Power sensor cable: 3.0 m/10 ft |
| 11730C | Power sensor cable: 6.1 m/20 ft |
| 11730D | Power sensor cable: 15.2 m/50 ft |
| 11730E | Power sensor cable: 30.5 m/100 ft |

| Other accessories | |
|---|---|
| 34131A | Transit case |
| 34141A | Soft carrying case |
| 34161A | Accessory pouch |
| N191xA-300 | Spare battery pack |
| N191xA-908 | Rackmount kit for one instrument |
| N191xA-909 | Rackmount kit for two instruments |

| Warranty | |
|---|---|
| R-50C-011-3 | Agilent Calibration Upfront Plan 3-year coverage |
| R-50C-011-5 | Agilent Calibration Upfront Plan 5-year coverage |
| R-51B-001-3C | 1 year Return-to-Agilent warranty extended to 3 years |
| R-51B-001-5C | 1 year Return-to-Agilent warranty extended to 5 years |

| GPIB connectivity products | |
|---|---|
| 82357B | USB/GPIB converter |
| 10833x | GPIB cables: 10833D (0.5 m), 10833A (1 m), 10833B (2 m), 10833C (4 m), 10833F (6 m), 10833G (8 m) |

| Documentation | |
|---|---|
| N191xA-0B0 | Delete hard copy English language User's Guide |
| N191xA-0BF | Hard copy English language Programming Guide |
| N191xA-ABA | Additional hard copy English language User's Guide and Programming Guide |
| N191xA-ABJ | Hard copy Japanese localization User's Guide and Programming Guide |

# E-Series Power Sensor Specifications

The E-Series of power sensors have their calibration factors stored in EEPROM and operate over a wide dynamic range. They are designed for use with the EPM Series of power meters and two classes of sensors are available:

- CW power sensors (E4412A and E4413A)
- Average power sensors (E9300 sensors)

# E-Series CW Power Sensor Specifications

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

*Table 4. E4410 Series max SWR specification*

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

* *Applies to sensors with serial prefix US 3848 or greater*

# E-Series CW Power Sensor Specifications *(continued)*

## 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 data sheet 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 1 mW (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 1 mW (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 |

# E-Series CW Power Sensor Specifications *(continued)*

## Power linearity

*Table 6. E4410 Series power linearity specification*

| 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% |

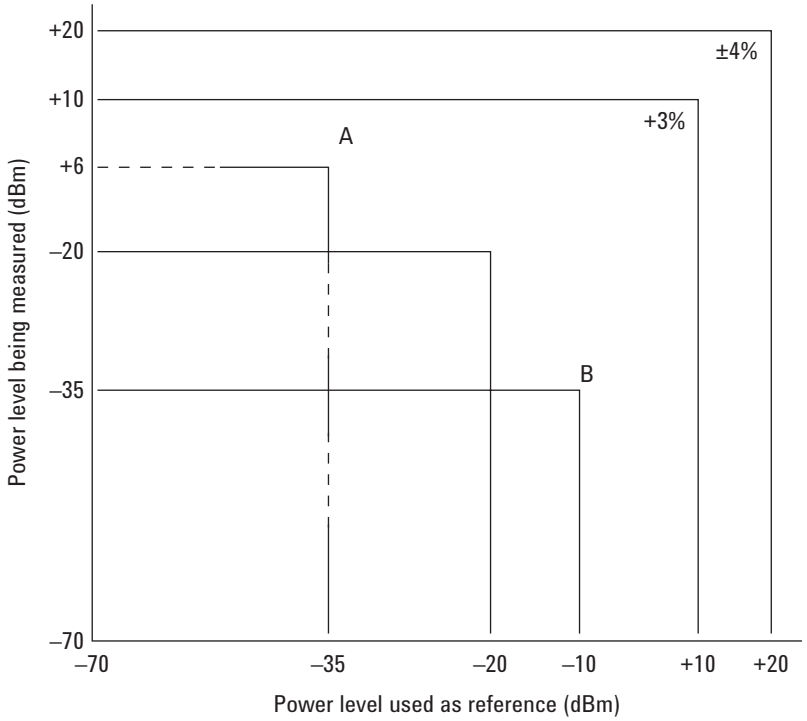



*Figure 1. Relative mode power measurement linearity with EPM Series power meter/E-Series CW power sensor at 25 °C ± 5 °C (typical)*

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

# E-Series E9300 Average Power Sensor Specifications

The E-Series E9300 wide dynamic range, average power sensors are designed for use with the EPM family of power meters. These 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.

The E-Series E9300 power sensors have two independent measurement paths (high and low power paths) as shown in Table 7.

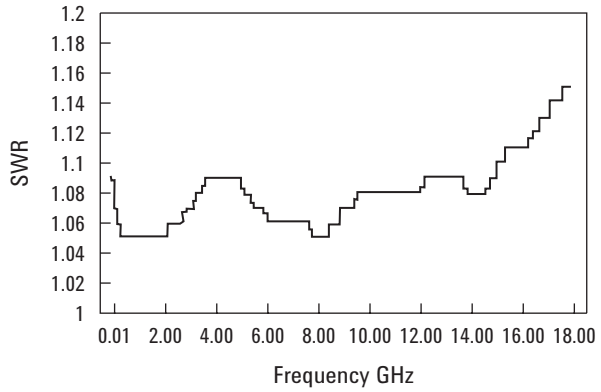
*Table 7. E9300 Series two-path specification*

| | "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 |

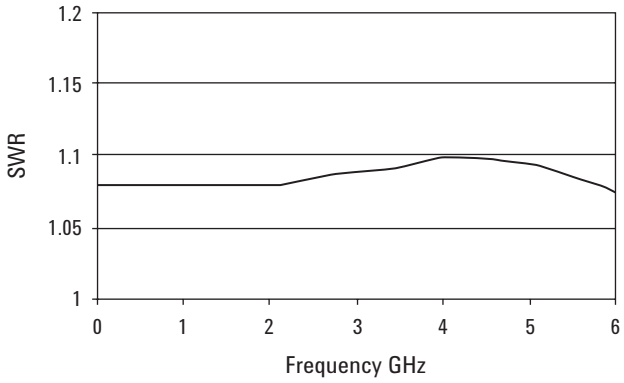
*Table 8. E9300 Series sensors specification*

| 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<br>30 MHz to 2 GHz: 1.13<br>2 GHz to 14 GHz: 1.19<br>14 GHz to 16 GHz: 1.22<br>16 GHz to 18 GHz: 1.26 | 10 MHz to 30 MHz: 1.21<br>30 MHz to 2 GHz: 1.15<br>2 GHz to 14 GHz: 1.20<br>14 GHz to 16 GHz: 1.23<br>16 GHz to 18 GHz: 1.27 | +25 dBm (320 mW) average;<br>+33 dBm peak (2 W)<br>(< 10 µsec) | Type-N (m) |
| E9301A | 10 MHz to 6 GHz | 10 MHz to 30 GHz: 1.15<br>30 MHz to 2 GHz: 1.13<br>2 GHz to 6 GHz: 1.19 | 10 MHz to 30 MHz: 1.21<br>30 MHz to 2 GHz: 1.15<br>2 GHz to 6 GHz: 1.20 | +25 dBm (320 mW) average;<br>+33 dBm peak (2 W)<br>(< 10 µsec) | Type-N (m) |
| E9304A | 9 kHz to 6 GHz | 9 kHz to 2 GHz: 1.13<br>2 GHz to 6 GHz: 1.19 | 9 kHz to 2 GHz: 1.15<br>2 GHz to 6 GHz: 1.20 | +25 dBm (320 mW) average;<br>+33 dBm peak (2 W)<br>(< 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<br>8 GHz to 12.4 GHz: 1.17<br>12.4 GHz to 18 GHz: 1.24 | 10 MHz to 8 GHz: 1.14<br>8 GHz to 12.4 GHz: 1.18<br>12.4 GHz to 18 GHz: 1.25 | 0 to 35 °C: 30 W avg<br>35 to 55 °C: 25 W avg<br>< 6 GHz: 500 W pk<br>> 6 GHz: 125 W pk<br>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<br>35 to 55 °C: 25 W avg<br>< 6 GHz: 500 W pk<br>> 6 GHz: 125 W pk<br>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<br>8 GHz to 12.4 GHz: 1.25<br>12.4 GHz to 18 GHz: 1.28 | 10 MHz to 8 GHz: 1.17<br>8 GHz to 12.4 GHz: 1.26<br>12.4 GHz to 18 GHz: 1.29 | 3.16 W avg<br>100 W pk<br>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<br>100 W pk<br>100 W.µS per pulse | Type-N (m) |

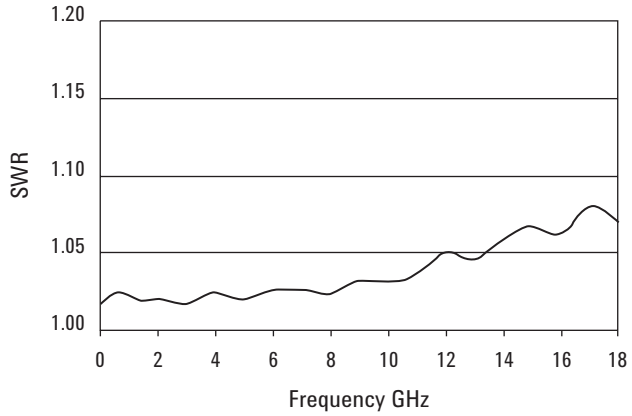
# E-Series E9300 Average Power Sensor Specifications *(continued)*



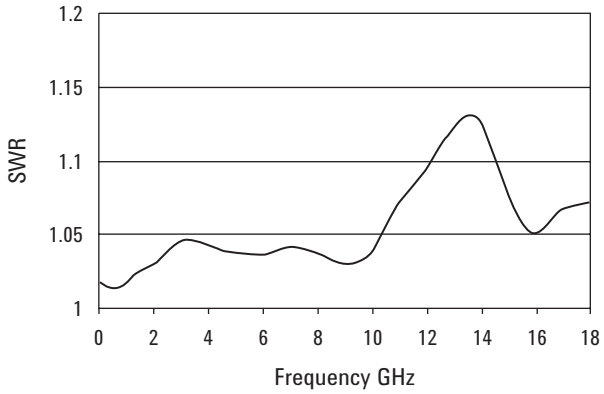

*Typical SWR, 10 MHz to 18 GHz (25 °C ±10 °C) for E9300A and E9301A sensor*




*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*

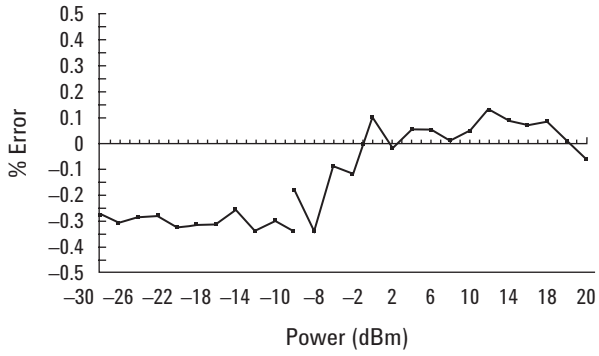
# E-Series E9300 Average Power Sensor Specifications *(continued)*

## Power linearity*

*Table 9. E9300 Series power linearity (after zero and cal at ambient environmental conditions) sensor*

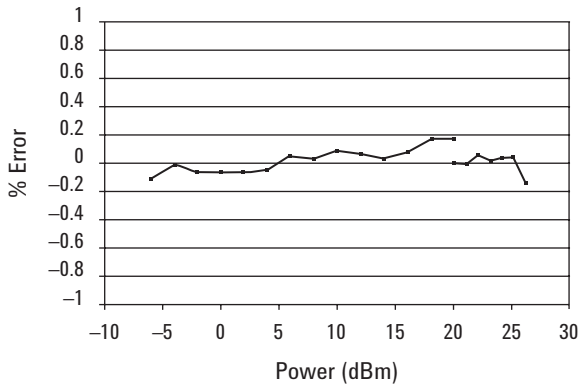
| Sensor | Power | Linearity (25 °C ±10 °C) | Linearity (0 °C to 55 °C) |
|---|---|---|---|
| E9300A, E9301A, E9304A | –60 to –10 dBm | ±3.0% | ±3.5% |
| | –10 to 0 dBm | ±2.5% | ±3.0% |
| | 0 to +20 dBm | ±2.0% | ±2.5% |
| E9300B, E9301B | –30 to +20 dBm | ±3.5% | ±4.0% |
| | +20 to +30 dBm | ±3.0% | ±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*



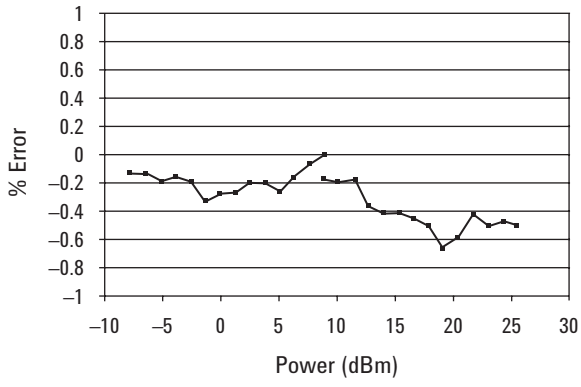

*Typical E9300A/01A/04A power linearity at 25 °C, after zero and calibration, with associated measurement uncertainty*

| 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% |

# E-Series E9300 Average Power Sensor Specifications *(continued)*

## Effects of change in temperature on linearity

Note: If the temperature changes after calibration and you choose not to re-calibrate the sensor, the following additional power linearity error should be added to the linearity specs in Table 9.

### For small changes in temperature:

The typical maximum additional power linearity error due to small temperature change after calibration is ±0.15%/°C (valid after zeroing the sensor).

### For large changes in temperature:

Refer to Table 10.

*Table 10. Typical maximum additional power linearity error due to temperature change (valid after zeroing the sensor)*

| Sensor | Power | Additional power linearity error (25 °C ± 10 °C) | Additional power linearity error (0 °C 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% |

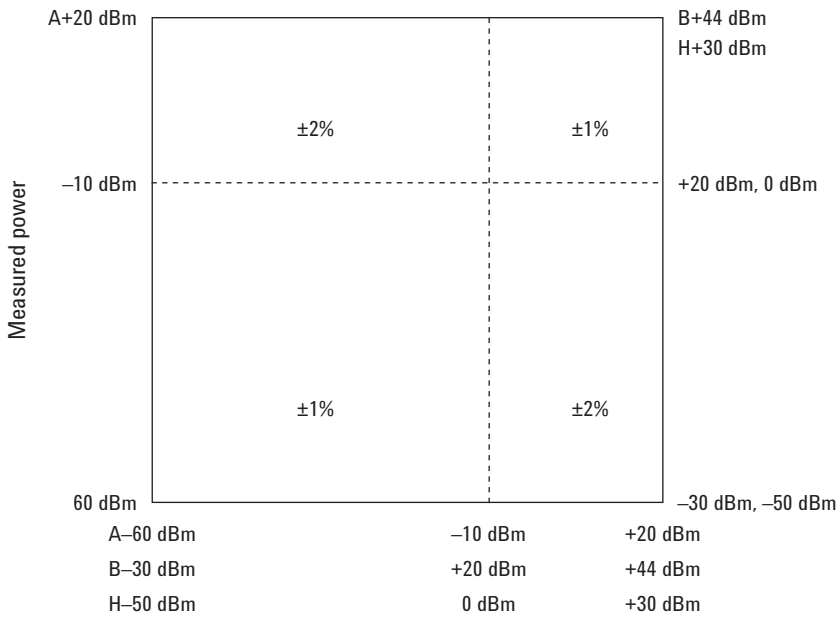



*Figure 2. Relative mode power measurement linearity with an EPM Series power meter, at 25 °C ±10 °C (typical)*

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.

# E-Series E9300 Average Power Sensor Specifications *(continued)*

## 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.

### E9300 "A" suffix sensors example:

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 Series sensor switch point specification*

| 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.*

# E-Series E9300 Average Power Sensor Specifications *(continued)*

## 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. As the E-Series E9300 power sensors have two independent measurement paths (high and low power paths), there are two calibration factor uncertainty tables. 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 12a. Calibration factor uncertainties (low power path)*

| Frequency | Uncertainty (%) (25 °C ±10 °C) | Uncertainty (%) (0 °C 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 °C 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% |

# 848xD Series Diode and 8483A Thermocouple Power Sensor Specifications

## Calibration factor uncertainties

These thermocouple and diode power sensors provide extraordinary accuracy, stability, and SWR over a wide range of frequencies (100 kHz to 110 GHz) and power levels (–70 dBm to +20 dBm).

*Table 13. Typical root sum of squares (rss) uncertainty on the calibration factor data printed on the power sensor*

| Frequency (GHz) | 8483A | 8481D | 8485D | 8487D | R8486D | Q8486D |
|---|---|---|---|---|---|---|
| 0.0001 | 1.3 | – | – | – | – | – |
| 0.0003 | 1.2 | – | – | – | – | – |
| 0.001 | 1.1 | – | – | – | – | – |
| 0.003 | 1.2 | – | – | – | – | – |
| 0.01 | 1.2 | – | – | – | – | – |
| 0.03 | 1.2 | – | – | – | – | – |
| 0.05 | 1.2 | – | – | – | – | – |
| 0.1 | 1.2 | – | – | – | – | – |
| 0.3 | 1.2 | – | – | – | – | – |
| 1 | 1.2 | 0.8 | 1.4 | 1.3 | – | – |
| 2 | 1.2 | 0.8 | 1.4 | 1.3 | – | – |
| 4 | – | 0.8 | 1.7 | 1.4 | – | – |
| 6 | – | 0.9 | 1.7 | 1.4 | – | – |
| 8 | – | 1.0 | 1.7 | 1.4 | – | – |
| 10 | – | 1.1 | 1.9 | 1.5 | – | – |
| 12 | – | 1.2 | 1.9 | 1.5 | – | – |
| 14 | – | 1.1 | 2.0 | 1.6 | – | – |
| 16 | – | 1.5 | 2.1 | 1.7 | – | – |
| 18 | – | 1.7 | 2.2 | 1.7 | – | – |
| 22 | – | – | 2.7 | 1.9 | – | – |
| 26.5 | – | – | 2.8 | 2.2 | 3.0 | – |
| 28 | – | – | 2.9* | 2.3 | 3.2 | – |
| 30 | – | – | 3.2* | 2.4 | 3.0 | – |
| 33 | – | – | 3.3* | 2.6 | 3.0 | 4.2 |
| 34.5 | – | – | – | 2.6 | 3.0 | 4.2 |
| 37 | – | – | – | 2.7 | 3.0 | 4.2 |
| 40 | – | – | – | 3.0 | – | 4.2 |
| 42 | – | – | – | 3.2 | – | 4.9 |
| 44 | – | – | – | 2.5 | – | 5.1 |
| 46 | – | – | – | 3.8 | – | 5.5 |
| 48 | – | – | – | 3.8 | – | 5.8 |
| 50 | – | – | – | 5.0 | – | 6.2 |

* *These uncertainties only apply to Option 033.*

** *The 8480 Series sensors in the table do not include discontinued models.*

# 848xD Series Diode and 8483A Thermocouple Power Sensor Specifications *(continued)*

## Maximum SWR and power linearity

*Table 14. 8480 Series maximum SWR and power linearity*

| Model | Frequency range | Maximum SWR | Power linearity[1] | Maximum power | Connector type | Weight |
|---|---|---|---|---|---|---|
| 100 mW sensors, 1 µW to 100 mW (–30 dBm to +20 dBm) | | | | | | |
| 8483A (75-Ohm) | 100 kHz to 2 GHz | 100 kHz to 600 kHz: 1.80<br>600 kHz to 2 GHz: 1.18 | +10 dBm to +20 dBm: (±3%) | 300 mW avg, 10 W pk | Type-N (m) 75 Ohm | Net: 0.2 kg (0.38 lb)<br>Shipping: 0.5 kg (1.0 lb) |
| V8486A | 50 GHz to 75 GHz | 50 GHz to 75 GHz: 1.06 | –30 dBm to +10 dBm: (±1%)<br>+10 dBm to +20 dBm: (±2%) | 200 mW avg, 40 W pk (10.µs per pulse, 0.5% duty cycle) | Waveguide flange UG-385/U | Net: 0.4 kg (0.9 lb)<br>Shipping: 1 kg (2.1 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 | Net: 0.4 kg (0.9 lb)<br>Shipping: 1 kg (2.1 lb) |
| High sensitivity sensors, 100 pW to 10 µW (–70 dBm to –20 dBm) | | | | | | |
| 8481D[2] | 10 MHz to 18 GHz | 10 MHz to 30 MHz: 1.40<br>30 MHz to 3 GHz: 1.15<br>4 GHz to 10 GHz: 1.20<br>10 GHz to 15 GHz: 1.30<br>15 GHz to 18 GHz: 1.35 | –30 dBm to –20 dBm: (±1%) | 100 mW avg, 100 mW pk | Type-N (m) | Net: 0.16 kg (0.37 lb)<br>Shipping: 0.9 kg (2.0 lb) |
| 8485D[2] | 50 MHz to 26.5 GHz | 0.05 GHz to 0.1 GHz: 1.19<br>0.1 GHz to 4 GHz: 1.15<br>4 GHz to 12 GHz: 1.19<br>12 GHz to 18 GHz: 1.25<br>18 GHz to 26.5 GHz: 1.29 | –30 dBm to –20 dBm: (±2%) | 100 mW avg, 100 mW pk | APC-3.5 mm (m) | Net: 0.2 kg (.38 lb)<br>Shipping: 0.5 kg (1.0 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-3.5 mm (m) | Net: 0.2 kg (0.38 lb)<br>Shipping: 0.5 kg (1.0 lb) |
| 8487D[2] | 50 kHz to 50 GHz | 0.05 GHz to 0.1 GHz: 1.19<br>0.1 GHz to 4 GHz: 1.15<br>2 GHz to 12.4 GHz: 1.20<br>12.4 GHz to 18 GHz: 1.29<br>18 GHz to 34 GHz: 1.37<br>34 GHz to 40 GHz: 1.61<br>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) | Net: 0.2 kg (0.38 lb)<br>Shipping: 0.5 kg (1.0 lb) |
| R8486D[2] | 26.5 GHz to 40 GHz | 26.5 GHz to 40 GHz: 1.40 | –30 dBm to –25 dBm: (±3%)<br>–25 dBm to –20 dBm: (±5%) | 100 mW avg, or pk 40 V dc max | Waveguide flange UG-599/U | Net: 0.26 kg (0.53 lb)<br>Shipping: 0.66 kg (1.3 lb) |
| Q8486D[2] | 33 GHz to 50 GHz | 33 GHz to 50 GHz: 1.40 | –30 dBm to –25 dBm: (±3%)<br>–25 dBm to –20 dBm: (±5%) | 100 mW avg, or pk 40 V dc max | Waveguide flange UG-383/U | Net: 0.26 kg (0.53 lb)<br>Shipping: 0.66 kg (1.3 lb) |

1. *Negligible deviation except for those power ranges noted.*
2. *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.*

* The 8480 Series sensors in the table do not include discontinued models.

# N8480 Series Thermocouple Power Sensor Specifications

The N8480 Series power sensors (excluding Option CFT) measure power levels from –35 dBm to +44 dBm (316 nW to 25.1 W), at frequencies from 100 kHz to 50 GHz and have two independent power measurement range (upper and lower range).

Meanwhile, the N8480 sensors with Option CFT only measure power levels from –30 dBm to +44 dBm (1 µW to 25.1 W) in single range. Similiar to the E-Series power sensors, the N8480 Series power sensors are also equipped with EEPROM to store sensor's characteristics such as model number, serial number, linearity, temperature compensation, calibration factor, and so forth.

This feature ensures the correct calibration data is applied by any compatible power meter connected with N8480 Series power sensor, and to ensure the accuracy of the measurements.

## Calibration factor uncertainties

*Table 15. N8480 Series calibration factor uncertainty at 25 °C ± 3 °C*

| Frequency | N8481A | N8481B | N8481H | N8482A | N8482B | N8482H | N8485A | N8487A | N8486AR | N8486AQ |
|---|---|---|---|---|---|---|---|---|---|---|
| 100 kHz to 10 MHz | – | – | – | 0.91 | 1.48 | 0.89 | – | – | – | – |
| 10 MHz to 30 MHz | 0.82 | 1.42 | 0.77 | 0.78 | 1.43 | 0.79 | 0.82 | – | – | – |
| 30 MHz to 500 MHz | 0.77 | 1.48 | 0.89 | 0.77 | 1.49 | 0.89 | 1.24 | 1.33 | – | – |
| 500 MHz to 1.2 GHz | 0.78 | 1.48 | 0.89 | 0.78 | 1.49 | 0.89 | 1.26 | 1.35 | – | – |
| 1.2 GHz to 6 GHz | 0.91 | 1.58 | 1.06 | 0.89 | 1.56 | 1.02 | 1.35 | 1.41 | – | – |
| 6 GHz to 14 GHz | 1.26 | 1.77 | 1.46 | – | – | – | 1.66 | 1.61 | – | – |
| 14 GHz to 18 GHz | 1.59 | 1.92 | 1.73 | – | – | – | 1.83 | 1.73 | – | – |
| 18 GHz to 26.5 GHz | – | – | – | – | – | – | 2.67 | 2.26 | – | – |
| 26.5 GHz to 33 GHz | – | – | – | – | – | – | 3.32 | 2.58 | 2.68 | – |
| 33 GHz to 34 GHz | – | – | – | – | – | – | – | 2.80 | 3.19 | 3.14 |
| 34 GHz to 35 GHz | – | – | – | – | – | – | – | 2.80 | 3.19 | 3.40 |
| 35 GHz to 40 GHz | – | – | – | – | – | – | – | 2.80 | 3.19 | 3.14 |
| 40 GHz to 45 GHz | – | – | – | – | – | – | – | 3.66 | – | 3.19 |
| 45 GHz to 50 GHz | – | – | – | – | – | – | – | 4.23 | – | 3.26 |

# N8480 Series Thermocouple Power Sensor Specifications *(continued)*

## Maximum SWR and power linearity for standard N8480 Series power sensors

*Table 16. N8480 Series maximum SWR and power linearity*

| Model | Frequency range | Maximum SWR[1] | Power linearity[1, 2] | Maximum power | Connector type | Weight |
|---|---|---|---|---|---|---|
| 100 mW sensors. Power range[3]: 316 nW to 100 mW (–35 dBm to +20 dBm) | | | | | | |
| N8481A | 10 MHz to 18 GHz | 10 MHz to 30 MHz: 1.37<br>30 MHz to 50 MHz: 1.14<br>50 MHz to 2 GHz: 1.08<br>2 GHz to 12.4 GHz: 1.16<br>12.4 GHz to 18 GHz: 1.23 | –1 dBm to +15 dBm (±0.52%)<br>+15 dBm to +20 dBm (±0.80%) | +25 dBm<br>15 W/2 µs | Type-N (m) | Net: 0.181 kg (0.40 lb)<br>Shipping: 0.90 kg (1.98 lb) |
| N8482A | 100 kHz to 6 GHz | 100 kHz to 300 kHz: 1.54<br>300 kHz to 1 MHz: 1.17<br>1 MHz to 2 GHz: 1.06<br>2 GHz to 6 GHz: 1.07 | –1 dBm to +15 dBm (±0.52%)<br>+15 dBm to +20 dBm (±0.80%) | +25 dBm<br>15 W/2 µs | Type-N (m) | Net: 0.181 kg (0.40 lb)<br>Shipping: 0.90 kg (1.98 lb) |
| N8485A | 10 MHz to 26.5 GHz | 10 MHz to 50 MHz: 1.33<br>50 MHz to 100 MHz: 1.08<br>100 MHz to 2 GHz: 1.05<br>2 GHz to 12.4 GHz: 1.14<br>12.4 GHz to 18 GHz: 1.19<br>18 GHz to 26.5 GHz: 1.26 | –1 dBm to +15 dBm (±0.52%)<br>+15 dBm to +20 dBm (±0.80%) | +25 dBm<br>15 W/2 µs | APC-3.5 mm (m) | Net: 0.183 kg (0.40 lb)<br>Shipping: 0.90 kg (1.98 lb) |
| N8485A Option 033 | 10 MHz to 33 GHz | 26.5 GHz to 33 GHz: 1.32 | –1 dBm to +15 dBm (±0.52%)<br>+15 dBm to +20 dBm (±0.80%) | +25 dBm<br>15 W/2 µs | APC-3.5 mm (m) | Net: 0.183 kg (0.40 lb)<br>Shipping: 0.90 kg (1.98 lb) |
| N8487A | 50 MHz to 50 GHz | 50 MHz to 100 MHz: 1.08<br>100 MHz to 2 GHz: 1.05<br>2 GHz to 12.4 GHz: 1.10<br>12.4 GHz to 18 GHz: 1.16<br>18 GHz to 26.5 GHz: 1.22<br>26.5 GHz to 40 GHz: 1.30<br>40 GHz to 50 GHz: 1.34 | –1 dBm to +15 dBm (±0.52%)<br>+15 dBm to +20 dBm (±0.80%) | +25 dBm<br>15 W/2 µs | 2.4 mm (m) | Net: 0.154 kg (0.34 lb)<br>Shipping: 0.874 kg (1.92 lb) |
| N8486AR | 26.5 GHz to 40 GHz | 26.5 GHz to 40 GHz: 1.40 | –1 dBm to +15 dBm (±0.52%)<br>+15 dBm to +20 dBm (±0.80%) | +25 dBm<br>15 W/2 µs | Waveguide flange UG-599/U | Net: 0.202 kg (0.45 lb)<br>Shipping: 0.922 kg (2.03 lb) |
| N8486AQ | 33 GHz to 50 GHz | 33 GHz to 50 GHz: 1.50 | –1 dBm to +15 dBm (±0.52%)<br>+15 dBm to +20 dBm (±0.80%) | +25 dBm<br>15 W/2 µs | Waveguide flange UG-383/U | Net: 0.204 kg (0.45 lb)<br>Shipping: 0.924 kg (2.03 lb) |
| High power sensors. Power range[3]: 316 µW to 21.1 W (–5 dBm to +44 dBm) | | | | | | |
| N8481B | 10 MHz to 18 GHz | 10 MHz to 2 GHz:1.09<br>2 GHz to 12.4 GHz: 1.14<br>12.4 GHz to 18 GHz: 1.23 | +29 dBm to +39 dBm (±0.52%) | +49 dBm<br>500 W/1 µs | Type-N (m) | Net: 0.684 kg (1.51 lb)<br>Shipping: 1.404 kg (3.09 lb) |
| N8482B | 100 kHz to 6 GHz | 100 kHz to 2 GHz: 1.08<br>2 GHz to 6 GHz: 1.16 | +39 dBm to +44 dBm (±0.80%) | +49 dBm<br>500 W/1 µs | Type-N (m) | Net: 0.684 kg (1.51 lb)<br>Shipping: 1.404 kg (3.09 lb) |
| High power sensors. Power range[3]: 31.6 µW to 3.2 W (–15 dBm to +35 dBm) | | | | | | |
| N8481H | 10 MHz to 18 GHz | 10 MHz to 8 GHz: 1.20<br>8 GHz to 12.4 GHz: 1.25<br>12.4 GHz to 18 GHz: 1.30 | +17 dBm to +30 dBm (±0.52%) | +40 dBm<br>100 W/1 µs | Type-N (m) | Net: 0.234 kg (0.52 lb)<br>Shipping: 0.954 kg (2.10 lb) |
| N8482H | 100 kHz to 6 GHz | 100 kHz to 6 GHz: 1.13 | +30 dBm to +35 dBm (±0.80%) | +40 dBm<br>100 W/1 µs | Type-N (m) | Net: 0.234 kg (0.52 lb)<br>Shipping: 0.954 kg (2.10 lb) |

1. *At 25 °C ± 10 °C*
2. *The N8480 Series power sensors' linearity is negligible except for the power range specified in the table*
3. *For N8480 Standard (excluding the CFT option)*

# N8480 Series Thermocouple Power Sensor Specifications *(continued)*

## Switch point data

Switching point is applicable for standard N8480 Series power sensors only.

The N8480 Series power sensors have two power measurement ranges; a lower range and upper range. The power meter automatically selects the proper power range. To avoid unnecessary switching when the power level is near switching point, a **Switching Point Hysteresis** has been added.

Switching point hysteresis:

*0.5 dB typical*

Example of switching point hysteresis on N8481/2H power sensors, this hysteresis causes the lower range to remain selected until approximately 17.5 dBm as the power level is increased, above this power the upper range is selected.

The upper range remains selected until approximately 16.5 dBm as the signal level decreases, below this power the lower range is selected.

For more detailed specifications, refer to *Agilent N8480 Series Thermocouple Power Sensors,* data sheet (5989-9333EN).

# U2000 Series USB Power Sensor Specifications

The U2000 Series USB power sensors are true average, wide-dynamic-range RF/microwave power sensors, based on a dual-sensor diode pair/attenuator/diode pair topology.

The U2000 Series USB power sensors can be operated on N1913A/14A via the USB host port (options).

## Frequency and power ranges

*Table 17. U2000 Series USB sensors frequency and power ranges*

| Model | Frequency range | Power range | Maximum power |
|---|---|---|---|
| U2000A | 10 MHz to 18 GHz | –60 dBm to +20 dBm | +25 dBm avg, 20 VDC<br>+33 dBm pk, <10 µs |
| U2001A | 10 MHz to 6 GHz | | |
| U2002A | 50 MHz to 24 GHz | | |
| U2004A | 9 kHz to 6 GHz | –60 dBm to +20 dBm | +25 dBm avg, 5 VDC<br>+33 dBm pk, <10 µs |
| U2000B | 10 MHz to 18 GHz | –30 dBm to +44 dBm | +45 dBm avg, 20 VDC<br>+47 dBm pk, 1 µs |
| U2001B | 10 MHz to 6 GHz | | |
| U2000H | 10 MHz to 18 GHz | –50 dBm to +30 dBm | +33 dBm avg, 20 VDC<br>+50 dBm pk, 1 µs |
| U2001H | 10 MHz to 6 GHz | | |
| U2002H | 50 MHz to 24 GHz | –50 dBm to +30 dBm | +33 dBm avg, 10 VDC<br>+50 dBm pk, 1 µs |

## Power accuracy

*Table 18. U2000 Series USB sensors power accuracy*

| Model | Power range | Accuracy[1] (25 °C ± 10 °C) | Accuracy[1] (0 °C to 55 °C) |
|---|---|---|---|
| U2000/1/2/4A | –60 dBm to +20 dBm | ±3.0% | ±3.5% |
| U2000/1/2H | –50 dBm to +30 dBm | ±4.0% | ±5.0% |
| U2000/1B | –30 dBm to +44 dBm | ±3.5% | ±4.0% |

Specifications valid with the following conditions:

- After zeroing
- Number of averages = 1024
- After 30 minutes of power-on warm-up

1. *This accuracy is essentially a combination of linearity, instrumentation accuracy, and traceability to absolute accuracy at 50 MHz, 0 dBm.*
   *Note: Mismatch uncertainty, calibration factor uncertainty, and power level dependent terms (zero set, drift, and noise) are excluded in this specification.*

# U2000 Series USB Power Sensor Specifications *(continued)*

## Maximum SWR

*Table 19. U2000 Series USB sensors maximum SWR*

| Model | Frequency range | Maximum SWR (25 °C ± 10 °C) | Maximum SWR (0 °C to 55 °C) |
|---|---|---|---|
| U2000A | 10 MHz to 30 MHz | 1.15 | 1.21 |
| | 30 MHz to 2 GHz | 1.13 | 1.15 |
| | 2 GHz to 14 GHz | 1.19 | 1.20 |
| | 14 GHz to 16 GHz | 1.22 | 1.23 |
| | 16 GHz to 18 GHz | 1.26 | 1.27 |
| U2001A | 10 MHz to 30 MHz | 1.15 | 1.21 |
| | 30 MHz to 2 GHz | 1.13 | 1.15 |
| | 2 GHz to 6 GHz | 1.19 | 1.20 |
| U2002A | 50 MHz to 2 GHz | 1.13 | 1.15 |
| | 2 GHz to 14 GHz | 1.19 | 1.20 |
| | 14 GHz to 16 GHz | 1.22 | 1.23 |
| | 16 GHz to 18 GHz | 1.26 | 1.27 |
| | 18 GHz to 24 GHz | 1.30 | 1.30 |
| U2004A | 9 kHz to 2 GHz | 1.13 | 1.15 |
| | 2 GHz to 6 GHz | 1.19 | 1.20 |
| U2000B | 10 MHz to 2 GHz | 1.12 | 1.14 |
| | 2 GHz to 12.4 GHz | 1.17 | 1.18 |
| | 12.4 GHz to 18 GHz | 1.24 | 1.25 |
| U2001B | 10 MHz to 2 GHz | 1.12 | 1.14 |
| | 2 GHz to 6 GHz | 1.17 | 1.18 |
| U2000H | 10 MHz to 8 GHz | 1.15 | 1.17 |
| | 8 GHz to 12.4 GHz | 1.25 | 1.26 |
| | 12.4 GHz to 18 GHz | 1.28 | 1.29 |
| U2001H | 10 MHz to 6 GHz | 1.15 | 1.17 |
| U2002H | 50 MHz to 8 GHz | 1.15 | 1.17 |
| | 8 GHz to 12.4 GHz | 1.25 | 1.26 |
| | 12.4 GHz to 18 GHz | 1.28 | 1.29 |
| | 18 GHz to 24 GHz | 1.30 | 1.31 |

For more detailed specifications, refer to *Agilent U2000 Series USB Power Sensors,* data sheet (5989-6278EN).

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