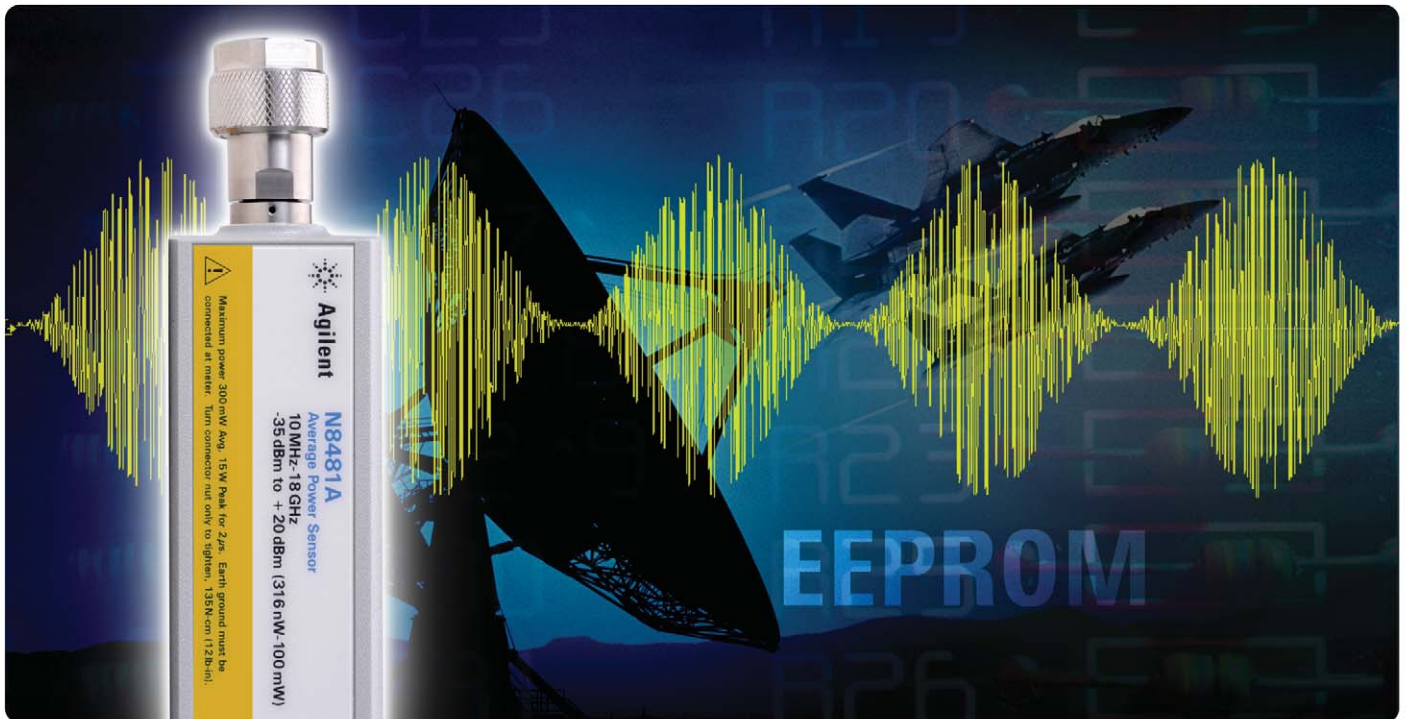
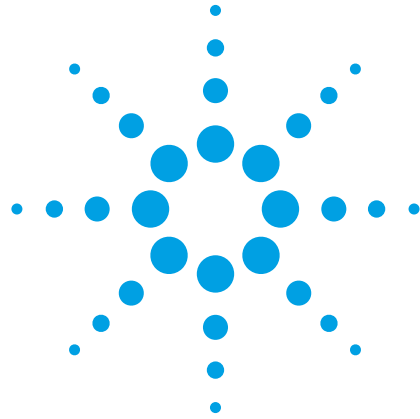


Agilent N8480 Series Thermocouple Power Sensors

Data Sheet



Why Agilent's power meters and sensors?



Reliable, high-performing solutions

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



A sure investment for many years to come

Code-compatibility between power meters reduces the need for re-coding. Not only that, all Agilent power meters are backward-compatible with most legacy power sensors.



One specific application: One right solution

Agilent offers a wide selection of power meters and sensors for practically all application needs—wireless communications, radar pulse measurements, component test and more.



Global network support

No matter where you are, Agilent is committed to giving you the 24-hour support you need regarding our products, applications or services.

“Agilent’s power meters have long been recognized as the industry standard for RF and microwave power measurements.”

Introducing the N8480 Series power sensors



The N8480 Series thermocouple power sensors are amongst Agilent's most accurate and reliable sensors. These will eventually replace the 8480 Series thermocouple range — only better with EEPROM *and* extended frequency and power ranges.

Features

- High accuracy with excellent linearity and noise specifications
- Wide dynamic range in a single sensor
- Auto-download of calibration factor and corrections from EEPROM
- Option CFT of the sensors are available for full code-compatibility with the 8480 Series
- Broad compatibility with existing power meters: N1911A/12A P-Series, EPM-P Series and EPM Series

Accurate, repeatable measurements

Here's how: Excellent linearity (1% approx.) and noise specifications. The sensors' low SWR further enhances accuracy by minimizing mismatch uncertainty. As if this weren't enough, these sensors also come with dual-range power for greater sensitivity to fluctuating signals, in particular. With high accuracy and stability, the N8480 helps you test confidently, faster.

Calibration-easy testing

During test, calibrating your sensor is an essential step, yet it shouldn't be taking too much of your time and effort. With the N8480 sensors, there's no need for cumbersome keying-in of calibration factor (CF), nor concern for manual input errors. That's because CF, linearity and temperature corrections are all stored in the sensors' EEPROM—auto-downloaded on calibration. Efficient calibration procedure makes for efficient testing overall, with N8480.

One sensor, WIDEST range

Pick an N8480 sensor—any one—and you'll see how its wide dynamic range equip you for various applications: metrology labs, radar, mobile radio, TDMA, GSM, W-CDMA and WiMAX™, among others. With up to 55 dBm wide dynamic range, the N8480 Series offers you the widest thermocouple sensor power range in the industry.

System integration can be a pain, but not with the N8480

The N8480 Series sensors are backward compatible with Agilent's leading range of power meters, including the P-Series, EPM-P Series and EPM Series. All that's needed is a simple firmware upgrade that's downloadable from the website, for free.

Code-wise, 100% of SCPI codes used on the E-Series sensors are re-usable on the N8480, and this includes most of the ones used on the 8480 Series. For code migration from the 8480 Series, CFT options of the N8480 sensors and these will behave much like the 8480 Series sensors they replace.

Specification definitions

There are two types of product specifications:

- Warranted specifications
- Characteristic specifications

Warranted specifications

Warranted specifications are covered by the product warranty and apply over 0 °C to 55 °C, unless otherwise noted. Warranted specifications include Measurement Uncertainty calculated with 95% confidence.

Characteristic specifications

Characteristic specifications are not warranted. They describe product performance that is useful in the application of the power sensors by giving typical, but non-warranted performance parameters. These characteristics are shown in *italics* or denoted as “*typical*”, “*nominal*” or “*approximate*”.

Characteristic information is representative of the product. In many cases, it may also be supplemental to a warranted specification.

Characteristic specifications are not verified on all power sensors. The types of characteristic specifications can be placed in two groups:

- The first group of characteristic types describes 'attributes' common to all products of a given model or option. Examples of characteristics that describe 'attributes' are product weight, and 50 W input Type- N connector. In these examples product weight is an *approximate* value and a 50 W input is *nominal*. These two terms are most widely used when describing a product's 'attributes'.
- The second group of characteristic types describes 'statistically' the aggregate performance of the population of products. These characteristics describe the expected behavior of the population of products. They do not guarantee the performance of any individual product. No measurement uncertainty value is accounted for in the specification. These specifications are referred to as *typical*.

Conditions

The power meter and sensor meet its specifications when:

- Stored for a minimum of two hours at a stable temperature within the operating temperature range, and turned on for at least 30 minutes.
- The power meter and power sensor are within their recommended calibration periods.
- Used in accordance to the information provided in the power meter's user's guide.

Performance characteristics

Specifications stated hereon refer to all N8480 Series power sensors, unless otherwise stated. The term “standard” refers to all N8480 Series sensors except Option CFT.

Frequency and power ranges

| Model | Sensor option | Power range | Frequency range | Damage level |
|----------------------|---------------|--------------------|--------------------|-------------------------------|
| N8481A | Standard | –35 dBm to +20 dBm | 10 MHz to 18 GHz | 25 dBm avg, 15 W/2 μ s pk |
| | Option CFT | –30 dBm to +20 dBm | | |
| N8482A | Standard | –35 dBm to +20 dBm | 100 kHz to 6 GHz | |
| | Option CFT | –30 dBm to +20 dBm | | |
| N8485A | Standard | –35 dBm to +20 dBm | 10 MHz to 26.5 GHz | |
| | Option CFT | –30 dBm to +20 dBm | | |
| N8485A Option 033 | Standard | –35 dBm to +20 dBm | 10 MHz to 33 GHz | |
| | Option CFT | –30 dBm to +20 dBm | | |

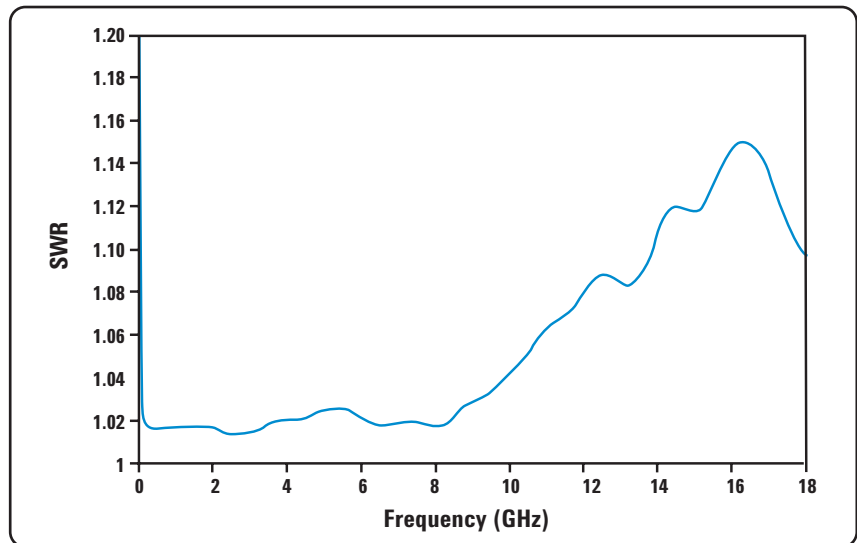
Maximum SWR

| Model | Frequency band | Max SWR (25 °C \pm 10 °C) | Max SWR (0 °C to 55 °C) |
|--------|---------------------------------|--------------------------------|----------------------------|
| N8481A | 10 MHz to 30 MHz | 1.37 | 1.57 |
| | 30 MHz to 50 MHz | 1.10 | 1.16 |
| | 50 MHz to 2 GHz | 1.05 | 1.07 |
| | 2 GHz to 12.4 GHz | 1.16 | 1.16 |
| | 12.4 GHz to 18 GHz | 1.23 | 1.25 |
| N8482A | 100 kHz to 300 kHz | 1.52 | 1.57 |
| | 300 kHz to 1 MHz | 1.12 | 1.13 |
| | 1 MHz to 2 GHz | 1.06 | 1.06 |
| | 2 GHz to 6 GHz | 1.07 | 1.08 |
| N8485A | 10 MHz to 50 MHz | 1.33 | 1.53 |
| | 50 MHz to 100 MHz | 1.06 | 1.11 |
| | 100 MHz to 2 GHz | 1.04 | 1.05 |
| | 2 GHz to 12.4 GHz | 1.13 | 1.14 |
| | 12.4 GHz to 18 GHz | 1.18 | 1.20 |
| | 18 GHz to 26.5 GHz | 1.25 | 1.38 |
| | 26.5 GHz to 33 GHz ¹ | 1.31 | 1.36 |

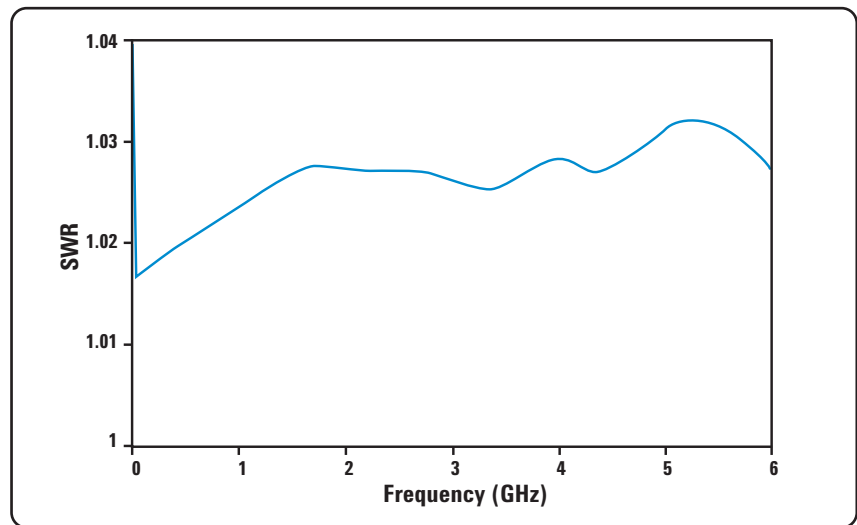
1. Only applicable for N8485A Option 033

Performance characteristics (continued)

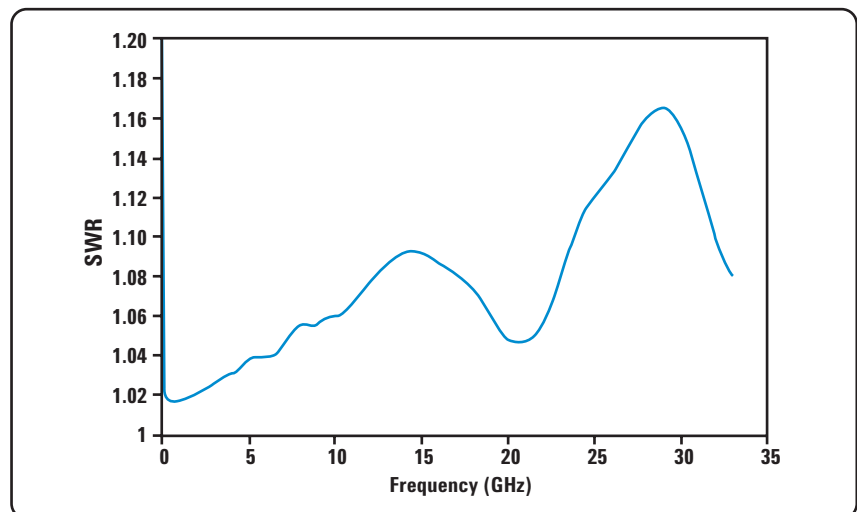
Typical SWR, 10 MHz to 18 GHz
(25 °C ± 10 °C) for N8481A sensor



Typical SWR, 100 kHz to 6 GHz
(25 °C ± 10 °C) for N8482A sensor



Typical SWR, 10 MHz to 26.5 GHz (25 °C ± 10 °C) for N8485A sensor



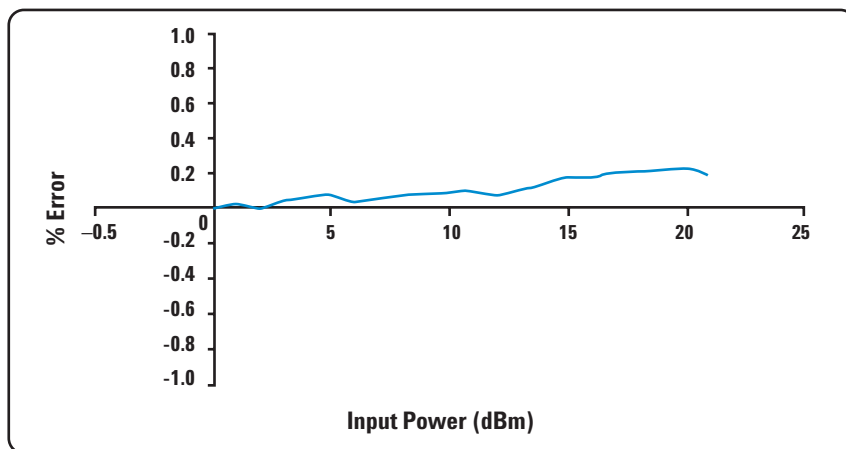
Performance characteristics (continued)

Power linearity*

| Power level | Linearity (25 °C ± 10 °C) | Linearity (0 °C to 55 °C) |
|--------------------|------------------------------|------------------------------|
| -1 dBm to +10 dBm | ±0.52% | ±0.80% |
| +10 dBm to +15 dBm | ±0.52% | ±0.80% |
| +15 dBm to +20 dBm | ±0.80% | ±1.90% |

*after zero and calibration at ambient environment conditions

Typical N8481A/2A/5A power linearity at 25 °C, after zero and calibration with associated measurement uncertainty



| Power level | Measurement uncertainty |
|--------------------|-------------------------|
| -1 dBm to +10 dBm | ±0.35% |
| +10 dBm to +15 dBm | ±0.35% |
| +15 dBm to +20 dBm | ±0.35% |

Zero and measurement noise

| Conditions (RH) ¹ | Sensor option | Zero set | Zero drift ² | Measurement noise ³ |
|------------------------------|---------------|----------|-------------------------|--------------------------------|
| 20% to 70% | Standard | ±25 nW | < ±3 nW | < 80 nW |
| | Option CFT | ±63 nW | < ±7 nW | < 114 nW |

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

Example:
N8481A power sensor, normal mode,
number of averages = 4

Measurement noise calculation:
<80 nW x 2.75 = <220 nW

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

1. RH is the abbreviation for relative humidity.

2. Within one hour after zero set, at a constant temperature, after a 24-hour warm-up of the power meter with 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.

Performance characteristics (continued)

Switching point

The N8480 Series power sensors (standard only, ie. excluding Option CFT) have two measurement ranges: a lower power range and upper power range. The power meter automatically selects the proper power level range. To avoid unnecessary switching when the power level is near the -1 dBm switch point, switching point hysteresis has been added.

This hysteresis causes the lower power range to remain selected until approximately -0.5 dBm as the power level is increased. Above this power, the upper power range is selected.

Likewise, the upper power range remains selected until approximately -1.5 dBm as the signal level decreases. Below this power, the lower power range is selected.

AUTO (default) range: -35 dBm to $+20$ dBm

Upper power range: -1 dBm to $+20$ dBm

Lower power range: -35 dBm to -1 dBm

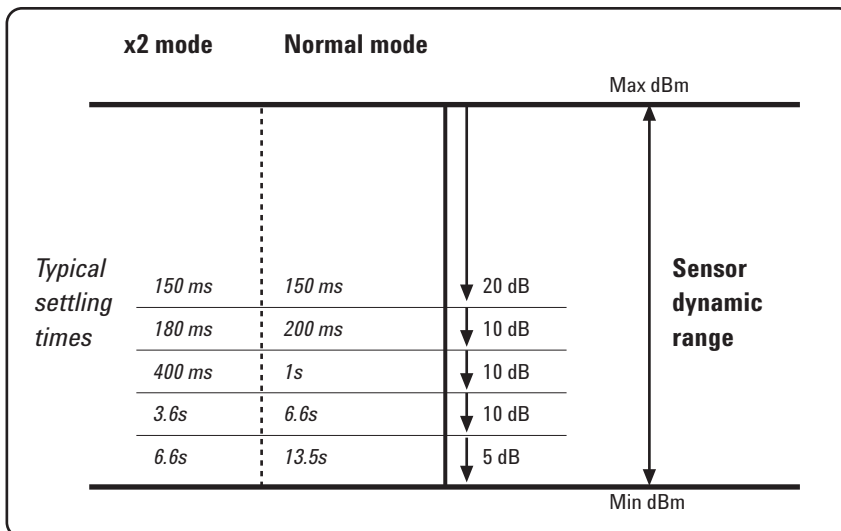
Switching point hysteresis: 0.5 dBm typical

Settling time ¹

Manual filter, 10-dB decreasing power step for normal and x2 modes (not across switching point)

| No. of averages | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 256 | 512 | 1024 |
|-------------------|------|------|------|------|------|-----|-----|-----|-----|------|------|
| Settling time (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 |

Auto filter, default resolution, 10-dB decreasing power step for normal and x2 modes (not across switching point)



1. Settling time: 0 to 99% settled readings over the GPIB

Performance characteristics (continued)

Calibration factor and reflection coefficient

Calibration factor (CF) and reflection coefficient (Rho) data is unique to each sensor. The CF corrects for the frequency response of the sensor. The Agilent EPM Series, EPM-P Series and P-Series power meters automatically read the CF data stored in the sensor's EEPROM and use it to make the corrections.

Reflection coefficient (Rho or ρ) relates to the SWR according to the following formula:

$$\text{SWR} = \frac{1 + \rho}{1 - \rho}$$

Typical measurement uncertainties of the calibration factor (CF) are listed in the following table. There is only one set of CF data used for both high and low range of each sensor. The typical measurement uncertainty data listed in the table is meant to help users on the measurement uncertainty estimation. These values are only a guideline and are not to be used in any accurate uncertainty calculations. For accurate measurement uncertainty values, please refer to the certificate of calibration of the specific sensor.

Calibration factor uncertainty

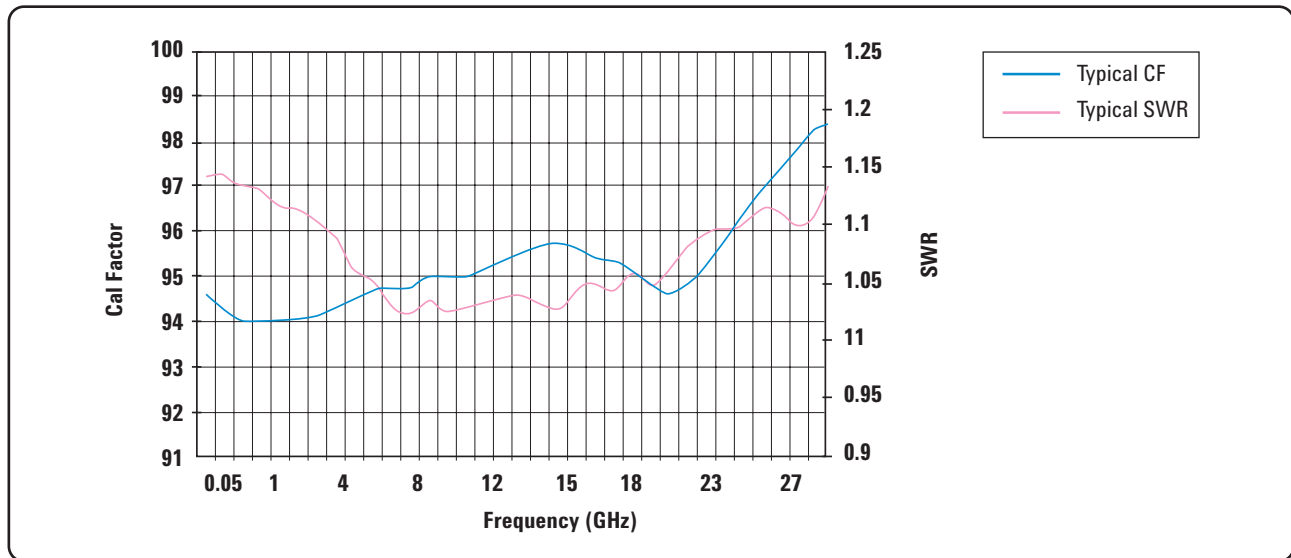
The typical measurement uncertainties listed are not to be taken as the maximum CF measurement uncertainties.

| Frequency | Uncertainty (%) (25 °C ± 10 °C) | | | Uncertainty (%) (0 °C to 55 °C) | | |
|--------------------|------------------------------------|--------|--------|------------------------------------|--------|--------|
| | N8481A | N8482A | N8485A | N8481A | N8482A | N8485A |
| 100 kHz to 10 MHz | - | 1.28 | - | - | 1.59 | - |
| 10 MHz to 30 MHz | 1.63 | 1.03 | 0.94 | 4.71 | 0.88 | 1.25 |
| 30 MHz to 500 MHz | 1.13 | 0.96 | 1.43 | 1.73 | 1.16 | 1.99 |
| 500 MHz to 1.2 GHz | 1.14 | 1.08 | 1.45 | 1.79 | 1.44 | 2.07 |
| 1.2 GHz to 6 GHz | 1.38 | 1.97 | 1.68 | 2.20 | 2.13 | 2.41 |
| 6 GHz to 14 GHz | 1.97 | - | 2.28 | 2.78 | - | 3.05 |
| 14 GHz to 18 GHz | 2.26 | - | 2.51 | 3.47 | - | 3.48 |
| 18 GHz to 26.5 GHz | - | - | 3.81 | - | - | 5.03 |
| 26.5 GHz to 33 GHz | - | - | 4.88 | - | - | 6.78 |

Performance characteristics (continued)

Typical CF and SWR vs. Frequency

Chart shows supplemental characteristics, intended to provide additional information, useful in applying the power sensor by giving a typical but not warranted performance parameters.



General specifications

| Dimensions and weight | |
|---------------------------|---|
| Dimensions (WxHxL) | N8481A/2A: 38 mm x 30 mm x 130 mm N8485A: 38 mm x 30 mm x 121 mm |
| Weight | N8481A/2A: 0.181 kg (0.4 lb) net, 0.90 kg (1.98 lb) shipping N8485A: 0.183 kg (0.4 lb) net, 0.90 kg (1.98 lb) shipping |
| Operating environment | |
| Temperature | 0 °C to 55 °C |
| Humidity | Maximum: 95% RH at 40 °C non-condensing Minimum: 15% RH at 40 °C non-condensing |
| Altitude | Up to 4600 m (15,000 ft) |
| Storage conditions | |
| Temperature | -40 °C to 70 °C |
| Humidity | Up to 90% RH at 65 °C non-condensing |
| Altitude | Up to 4600 m (15,000 ft) |
| Connector ¹ | N8481A/2A: Type-N (m) N8485A: 3.5 mm (m) |
| Programming language | Standard: SCPI code-compatible to E-Series sensors Option CFT: SCPI code-compatible to 8480 Series sensors |
| Safety and EMC compliance | IEC 61326-2002/EN 61326:1997+A1:1998+A3:2003 Canada: ICES-001:2004 Australia/New Zealand: AS/NZS CISPR11:2004 |
| Calibration interval | 1 year |
| Warranty ¹ | 1 year |

1. See "Ordering information" for available options

Ordering information

Power sensors

| Standard power sensors | Description |
|------------------------|--|
| N8481A | Standard N8481A model with EEPROM feature |
| N8482A | Standard N8482A model with EEPROM feature |
| N8485A | Standard N8485A model with EEPROM feature |
| N8485A-033 | Standard N8485A model with EEPROM feature, and frequency range extended up to 33 GHz |
| Other sensor options | Description |
| Option CFT | N8480 sensors without EEPROM feature. Calibration factor data is provided on the label attached to the power sensor. |

The following items are shipped as standard with every power sensor:

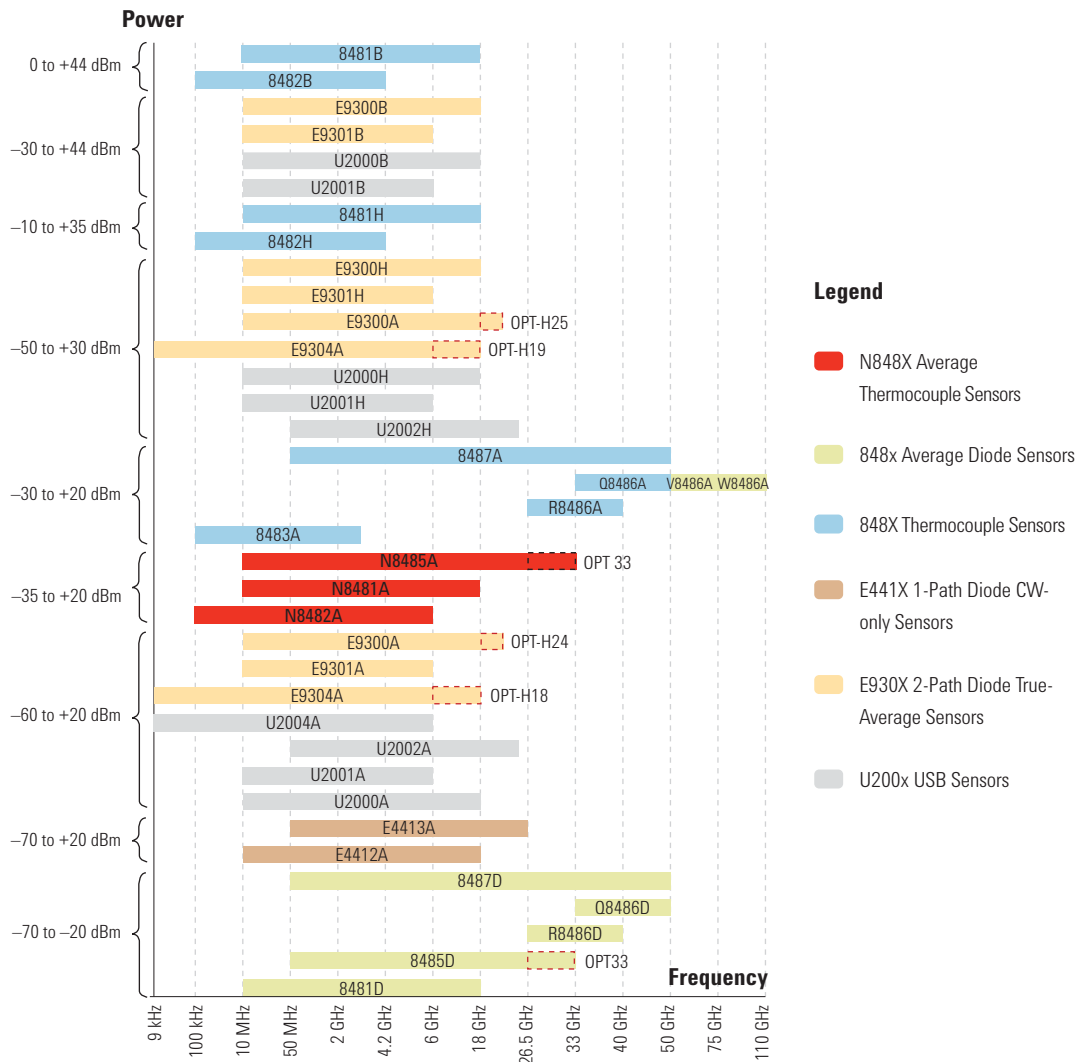
- Certificate of Calibration
- Operating and Service Guide
- Product Reference CD (contains Migration Guide, Operating and Service Guide, firmware upgrades for EPM and EPM-P Series power meters, and upgrade procedures)

Accessories, calibration and documentation options

| Connectors | Description |
|---------------------|---|
| Option 100 | For N8481A/2A sensor: Type-N (m) connector For N8485A sensor: 3.5 mm (m) connector |
| Option 200 | APC-7 connector (only applicable to N8481A/2A) |
| Cables | Description |
| 11730A | For EPM Series power meters: 1.5 m (5 ft), grey |
| 11730B | For EPM Series power meters: 3 m (10 ft) , grey |
| 11730C | For EPM Series power meters: 6.1 m (20 ft) , grey |
| 11730D | For EPM Series power meters: 15.2 m (50 ft) , grey |
| 11730E | For EPM Series power meters: 30.5 m (100 ft) , grey |
| 11730F | For EPM Series power meters: 61 m (200 ft) , grey *operates up to 45 °C |
| E9288A | For EPM and EPM-P Series power meters: 1.5 m (5 ft), blue |
| E9288B | For EPM and EPM-P Series power meters: 3 m (10 ft), blue |
| E9288C | For EPM and EPM-P Series power meters: 10 m (31 ft), blue |
| N1917A | For P-Series power meters: 1.5 m (5 ft) |
| N1917B | For P-Series power meters: 3 m (10 ft) |
| N1917C | For P-Series power meters: 10 m (31 ft) |
| Calibration | Description |
| Option 1A7 | ISO 17025 calibration with test data |
| Option A6J | ANSI Z540 calibration with test data |
| Warranty | Description |
| Option R-51B-001-3C | Extension of warranty and service plan from 1 year to 3 years |
| Option R-51B-001-5C | Extension of warranty and service plan from 1 year to 5 years |
| Documentation | Description |
| Option OB1 | English language Operating and Service Guide |
| Option ABJ | Japanese localization Operating and Service Guide |

Where does the N8480 fit in Agilent's average power sensors offering?

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



Compatible power meters

The N8480 Series power sensors perform accurate, repeatable average power measurements with the following power meters:



Agilent N1911A/12A P-Series power meters

- Single (N1911A) and dual (N1912A) channels
- High resolution color display
- 30 MHz video bandwidth
- 100 Msamples/s continuous sampling rate
- Time-gated and free-run measurement modes
- Rise time, fall time, pulse width, time to positive occurrence and time to negative occurrence measurements
- Includes predefined configurations for WiMAX, HSDPA and DME
- GPIB, LAN and USB interfaces
- Code-compatible with EPM-P and EPM Series power meters
- Optimized for peak power measurements and CCDF statistical analysis with the P-Series power sensors
- Also compatible with all E-Series, N8480 Series and 8480 Series power sensors



Agilent E4416A/17A EPM-P Series power meters

- Single (E4416A) and dual (E4417A) channels
- 5 MHz video bandwidth
- 20 Msamples/s continuous sampling rate
- Time-gated and free-run measurement modes
- Includes predefined configurations for GSM, EDGE, NADC, iDEN, Bluetooth, IS-95 CDMA, W-CDMA and cdma2000
- GPIB, RS-232/422 interfaces
- Code-compatible with EPM Series power meters
- Optimized for peak power measurements with the E9320 E-Series power sensors
- Also compatible with the E9300 and E4410 E-Series, 8480 and N8480 Series power sensors



Agilent E4418B/19B EPM Series power meters

- Single (E4418B) and dual (E4419B) channels
- Clear readings in subdued lighting
- Easy viewing of readings from a distance
- Convenient field usage with operating case and battery option
- GPIB, RS-232/422 interfaces
- Code-compatible with 436A, 437B (E4418B only) and 438A (E4419B only) power meters
- Optimized for average power measurements with the E9300 and E4410 E-Series, 8480 and N8480 Series power sensors

To get your existing power meters up-and-running in supporting the N8480 Series, just download their firmware upgrades online at www.agilent.com > Technical Support > Drivers & Software > Firmware Update.

| Power meter | Model number | Compatible firmware revision |
|--------------|--------------|------------------------------|
| EPM Series | E4418B | A1.09.00 and above |
| | E4419B | A2.09.00 and above |
| EPM-P Series | E4416A | A1.05.00 and above |
| | E4417A | A2.05.00 and above |
| P-Series | N1911A | A.05.00 and above |
| | N1912A | |