Agilent U8480 Series USB Thermocouple Power Sensor

User's Guide

Agilent Technologies

Notices

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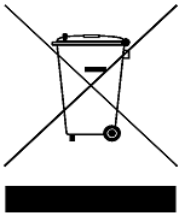
The affixed product label is as shown below:



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www.agilent.com/environment/product

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The Declaration of Conformity (DoC) for this device is available on our Web site. You can search the DoC by its product model or description.

http://regulations.corporate.agilent.com/DoC/search.htm

NOTE If you are unable to search for the respective DoC, contact your local Agilent representative.

Environmental Conditions

This device is designed for indoor use only.

Environmental condition	Requirement
Temperature	Operating condition: • 0 °C to 55 °C Storage condition: • –40 °C to 71 °C
Humidity	Operating condition: • Maximum: 95% RH at 40 °C (non-condensing) • Minimum: 15% RH at 25 °C (non-condensing) Storage condition: • Up to 90% RH at 65 °C (non-condensing)
Altitude	Operating and storage conditions: • Up to 4.6 km (15000 ft)

CAUTION You may experience a warmer sensor body temperature for this power sensor than other Agilent power sensors. Rest assured that this does not affect the sensor performance.

Regulatory Information

The U8480 Series USB thermocouple power sensor complies with the following EMC requirements:

- IEC 61326-1:2005 / EN 61326-1:2006
- Canada: ICES/NMB-001: Issue 4, June 2006
- Australia/New Zealand: AS/NZS CISPR11:2004

Contents

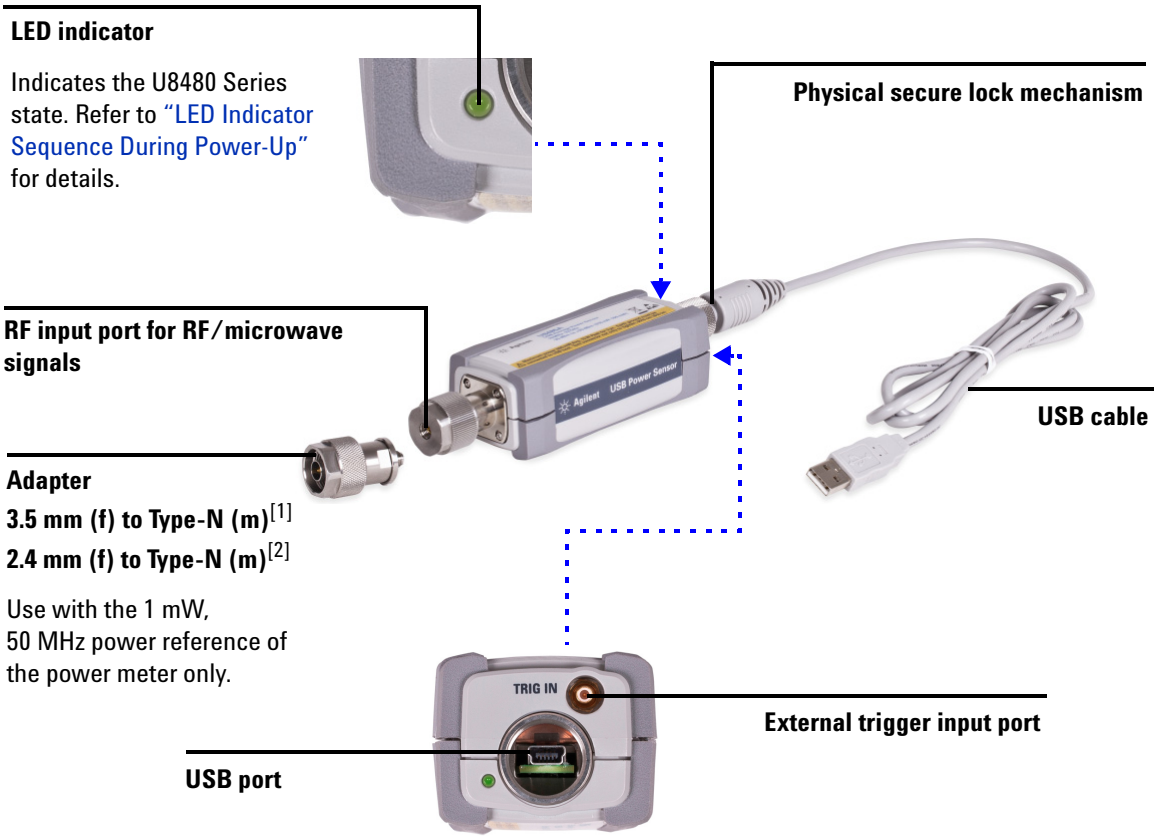
1 Getting Started

This chapter gets you started with the U8480 Series USB thermocouple power sensor.

Overview

The U8480 Series is a USB-based standalone thermocouple power sensor and meter. The U8480 Series consists of four models: U8481A (DC to 18 GHz), U8485A (DC to 33 GHz), U8487A (10 MHz to 50 GHz), and U8488A (10 MHz to 67 GHz).

The U8480 Series is also a heat-based power sensor that responds to the true average power of any signal format, and allows direct measurement of average RF or microwave power through the heating effect it has on a terminating load. It measures power from –35 dBm to 20 dBm, at a DC to 67 GHz frequency range.



[1] Only applicable for the U8485A model.
[2] Only applicable for the U8487A/U8488A model.

Initial Inspection

1. Inspect items for damage.
2. Verify that your order is complete.

- If there is mechanical damage or any missing item, notify the nearest Agilent Sales and Service office.
- Keep the damaged shipping material.
- Refer to the contact list on the last page of this guide for Agilent Sales and Service offices.

Standard Purchase Items

Trigger cable, BNC male to SMB female, 50 Ω, 1.5 m

USB cable, 1.5 m

Documentation CD-ROM

Automation-Ready CD-ROM

N1918A CD-ROM

Hardware Installation and Configuration

Prior to using the U8480 Series, ensure that the following minimum requirements are met:

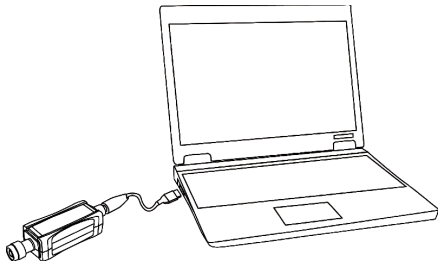
- PC with USB host capability.
- Agilent IO Libraries Suite 16.0 or higher installed.
- Agilent N1918A Power Analysis Manager version R03.09.00 or above installed.[1]
  (Power Panel is bundled with purchase of the U8480 Series. You can also obtain the advanced Power Analyzer which is an optional licensed software with additional features and capabilities.)[2]

[1] If you need help with the installation, refer to the *N1918A Installation Guide.*

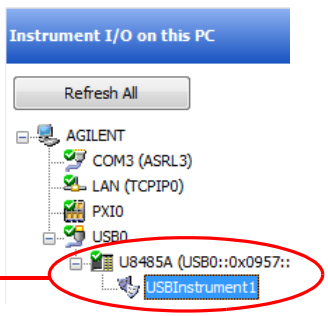
[2] Refer to the *N1918A Data Sheet (5989-6612EN)* or the *Power Panel/Power Analyzer help documentation* for more information on the functions/features.

Install and verify the U8480 Series

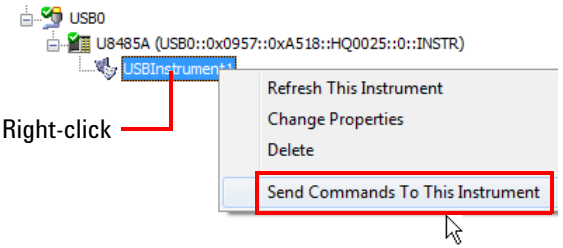
1 Connect the U8480 Series to the PC. The U8480 Series driver is detected and installed automatically.



2 Go to **Start > All Programs > Agilent IO Libraries Suite > Agilent Connection Expert**.

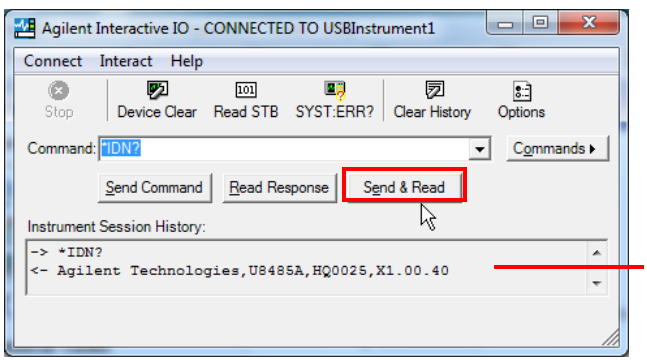


The U8480 Series is detected



Right-click

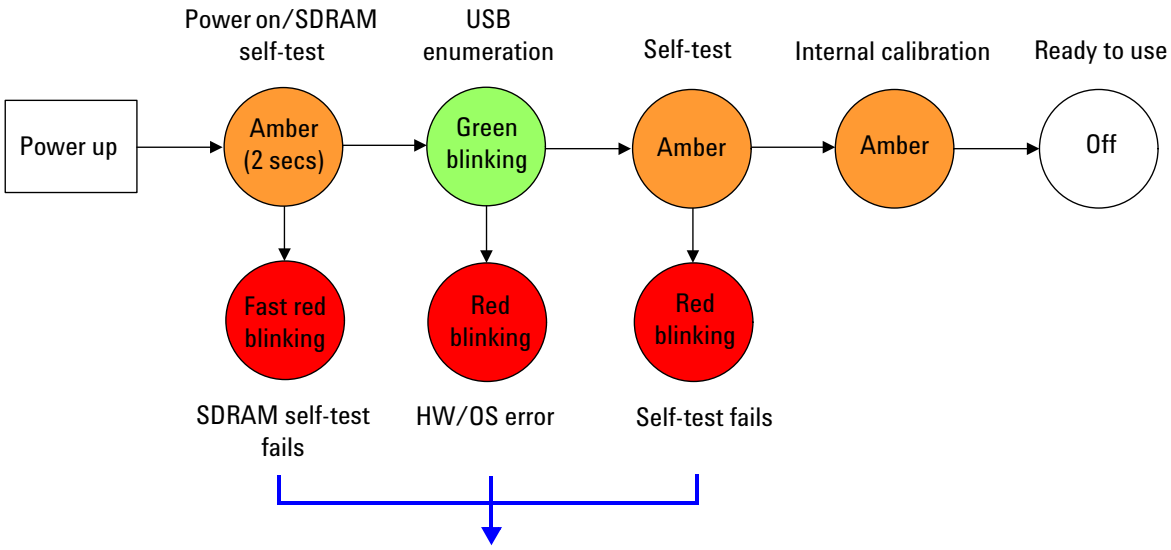
3



The device response appears.

This verifies that the U8480 Series has been connected and properly installed on the PC.

LED Indicator Sequence During Power-Up



Send the `SYST:ERR?` query to read the error message. It is recommended to return the U8480 Series to Agilent if this condition persists after power cycle.

Other LED indicators

Amber blinking	Secure erase, flash formatting, or firmware update in progress.
Red	An error is present in the SCPI error queue including input overload. If the error queue is cleared (via the `*CLS` command) or the last error is read from the queue (via the `SYST:ERR?` query), the indicator will turn off.

Firmware Upgrade

To download the latest firmware version for the U8480 Series, go to www.agilent.com/find/pm_firmware. The latest firmware includes the executable file and help file for installing the Firmware Upgrade Utility application in order to upgrade the U8480 Series.

2
General Operating Information

This chapter describes the general operating information of the U8480 Series.

Using the U8480 Series with the N1918A Power Analysis Manager

The Power Panel application of the N1918A Power Analysis Manager provides a virtual operating interface for the U8480 Series. This chapter describes the U8480 Series functions available in the Power Panel application.

NOTE For details on how to configure each function of the U8480 Series, refer to the *N1918A Power Panel help documentation*.

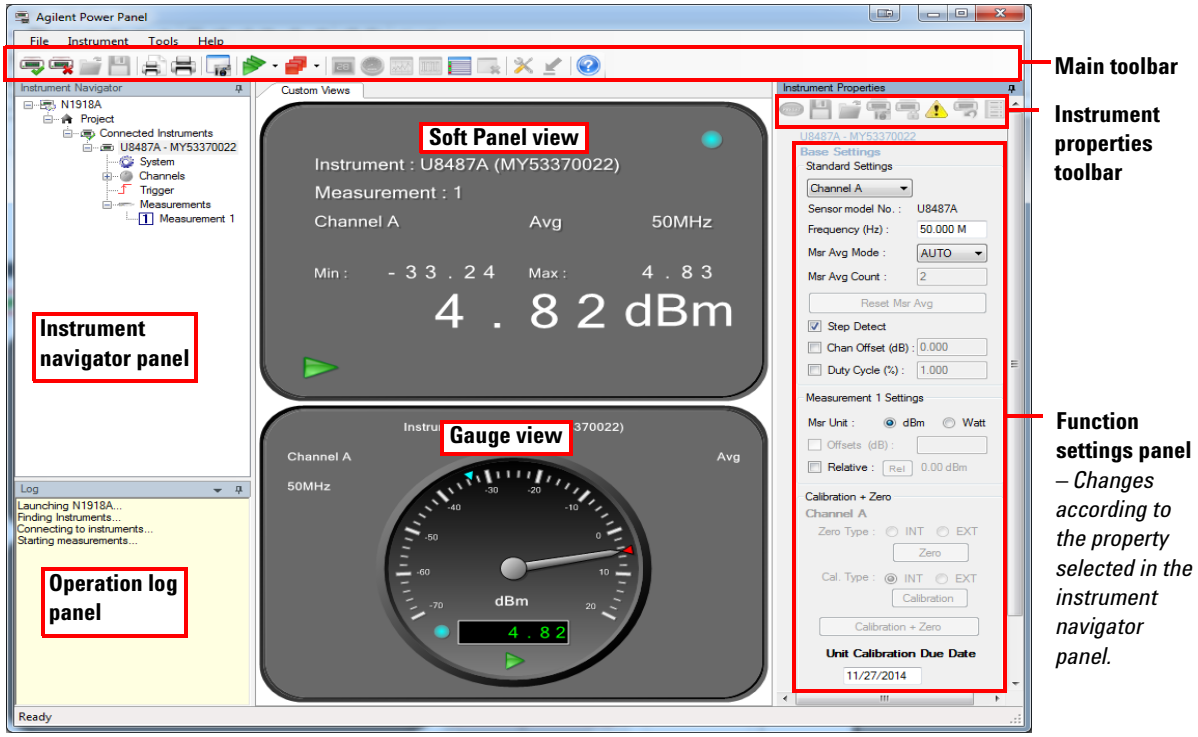


Figure 2-1 General overview of the Power Panel user interface

Main Toolbar Functions

Icon	Function
	Connect to the U8480 Series.
	Disconnect the U8480 Series.
	Open any CSV-supported files.
	Save measurement data as a CSV-supported file.
	Preview a screenshot of the application prior to printing.
	Print a screenshot of the application.
	Save a screenshot of the application as an image file.
	Start the acquisition of all measurements on created tabs/views.
	Stop the acquisition of all measurements on created tabs/views.

Icon	Function
	Create a new soft panel display view[1].
	Create a new gauge display view[1].
	Create a new strip chart display view[1].
	Create a new trace graph display view[1] (not applicable for the U8480 Series).
	Create a multilist display view[1].
	Remove the currently selected view from the application.
	Provide application options and settings configuration.
	Switch between compact mode and full mode display.
	Provide quick access to the help documentation.

[1] When this icon is selected, corresponding function icons will appear on the toolbar. Refer to the *Power Panel help documentation* for details.

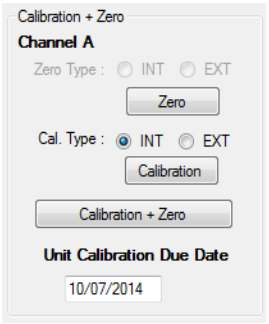
Instrument Properties Toolbar Functions

Icon	Function
	Offer a list of preset options for the U8480 Series properties settings. The data stored in the FDO tables, the selected FDO table, and the zeroing and calibration data are not affected by a preset.
	Save the U8480 Series states.
	Recall any saved U8480 Series states.
	Display the error list.

Icon	Function
	Reset the U8480 Series to its default settings.
	• Set the frequency-dependent offset (FDO) (refer to "Simplified measurement path") which compensates for frequency-related changes in the response of your test system. The U8480 Series can store 10 FDO tables with 80 frequency points each. • Opens the Gamma Correction, S-Parameter Correction, or Measurement Uncertainty menu.

Function Settings

Zero and auto-calibration



Zero the U8480 Series without the presence of input RF power, or auto-calibrate the U8480 Series.

Zeroing is recommended:

- upon power up.
- when a 5 °C change in temperature occurs.
- every 24 hours.
- prior to measuring low-level signals (for example, lowest 10 dB of the dynamic range).
- when switching from or to the fast measurement mode.

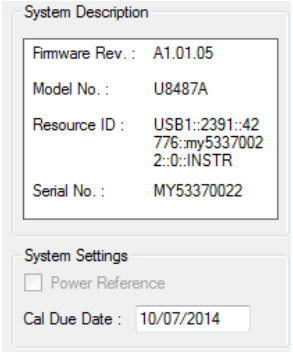
The U8480 Series performs an internal or external calibration. Internal calibration does not require a power reference, while external calibration enables the U8480 Series to perform calibration with a power reference.

The U8480 Series will perform auto-calibration every time it is powered up.

NOTE

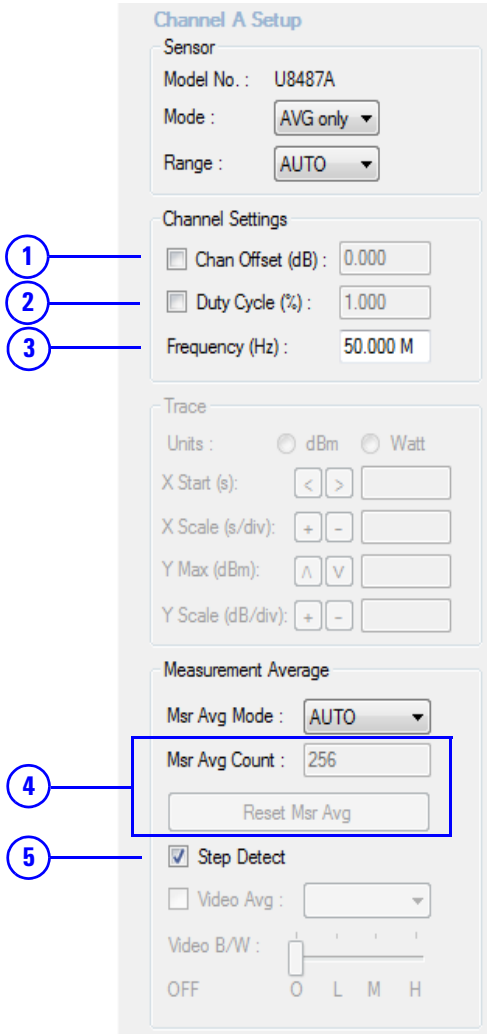
- You are advised to perform zeroing at the test port (without power applied) to obtain the best accuracy when measuring low power in a temperature-changing environment.
- If input RF power to the U8480 Series is not turned off while zeroing is performed, error –231, Data questionable; ZERO ERROR will occur.
- For more details on zeroing and auto-calibration, refer to the *U8480 Series Programming Guide*.

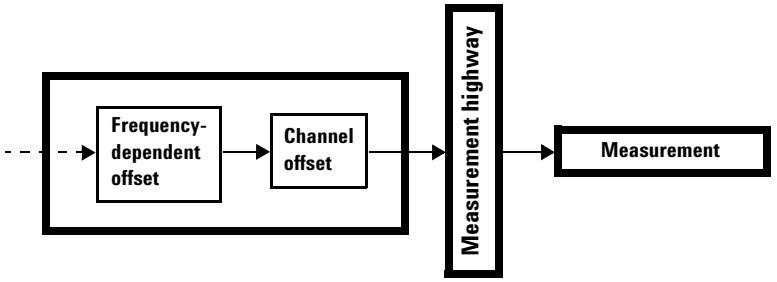
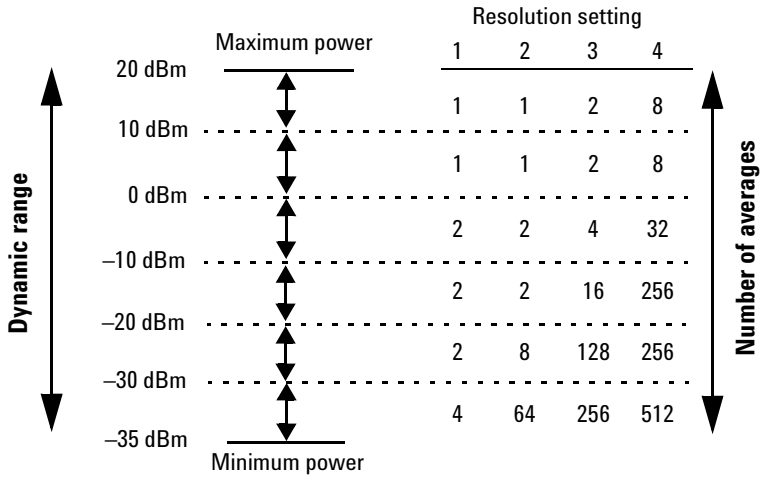
System-related function



Display the system information (firmware revision, model number, instrument identity, and serial number) of the U8480 Series.

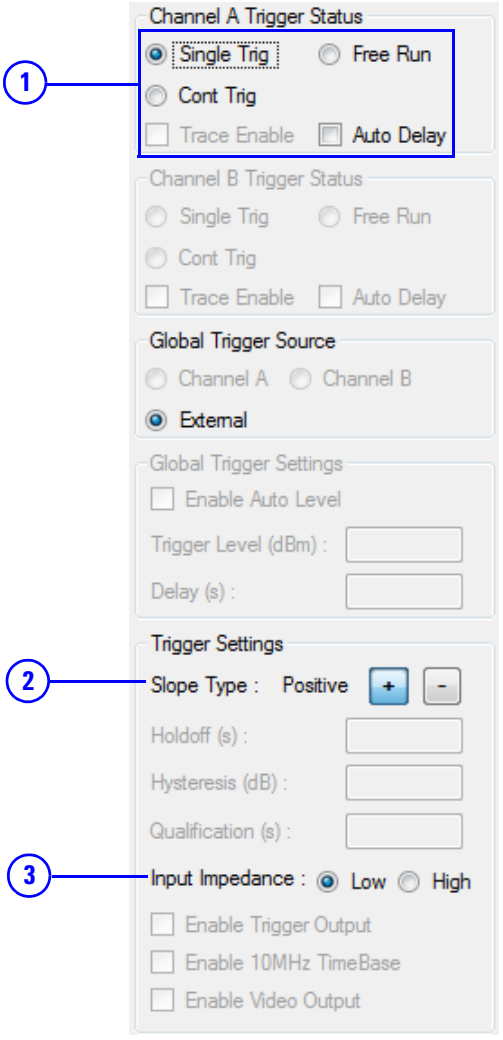
Channel setup functions



No.	Function
1	Set the channel offset which is applied to the measured power prior to any mathematical functions. **Simplified measurement path** 
2	Set the duty cycle.
3	Set the measurement frequency.
4	Set the automatic or manual measurement average mode. The number of readings averaged can range from 1 to 1024. Increasing the value of the measurement average reduces measurement noise, but increases measurement time. Below shows the typical number of averages for each range and resolution when the U8480 Series is in the auto-average mode and set to the normal speed mode.  The four resolution levels represent: • 1, 0.1, 0.01, 0.001 dB respectively if the measurement suffix is dBm. • 1, 2, 3, or 4 significant digits respectively if the measurement suffix is W.

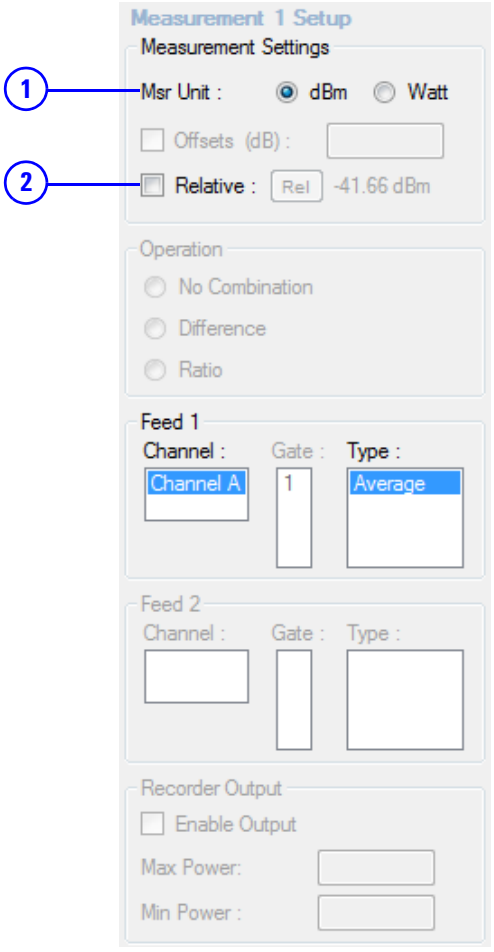
No.	Function
5	Enable step detection in both manual and automatic average modes. The filter can be set to re-initialize upon detection of a step increase or decrease in the measured power to reduce the filter settling time after a significant step in the measured power.

Trigger functions



No.	Function
1	Set the single, free run, or continuous trigger mode. Select to enable automatic trigger delay for the selected trigger mode.
2	Select the positive or negative slope type to determine if the trigger event is recognized on the rising or falling edge of a signal respectively.
3	Set the input impedance for the external TTL trigger to Low (50 Ω) or High (1 MΩ).

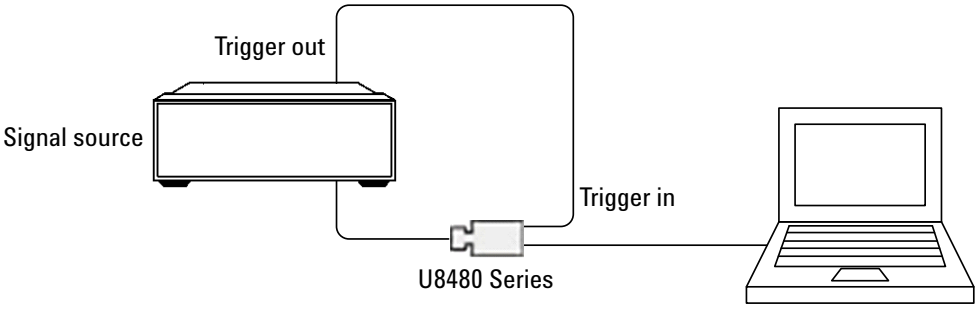
Measurement functions



No.	Function
1	Set the logarithmic (dBm) or linear (Watt) measurement unit for the currently selected measurement.
2	Enable the relative mode, which computes the measurement result relative (as a ratio) to a reference value. When enabled, the reference value can be set using the <**Rel**> control. The relative reading is displayed in either dB or %.

Power sweep and frequency sweep

The sweep feature allows you to make power measurements by quickly stepping through a series of frequencies or power levels. Below shows the connection diagram to perform sweep.



A proper dwell time must be set in the signal generator to ensure all the measurement readings in the U8480 Series are settled before stepping through the next frequency point.

NOTE It is recommended for the dwell time of the signal generator to be minimally set to the settling time (as provided in "Settling time" on page 37), depending on the measurement mode and filter settings.

Gamma correction

NOTE The Gamma correction function is only available in power sensors with firmware version A1.01.06 and above.

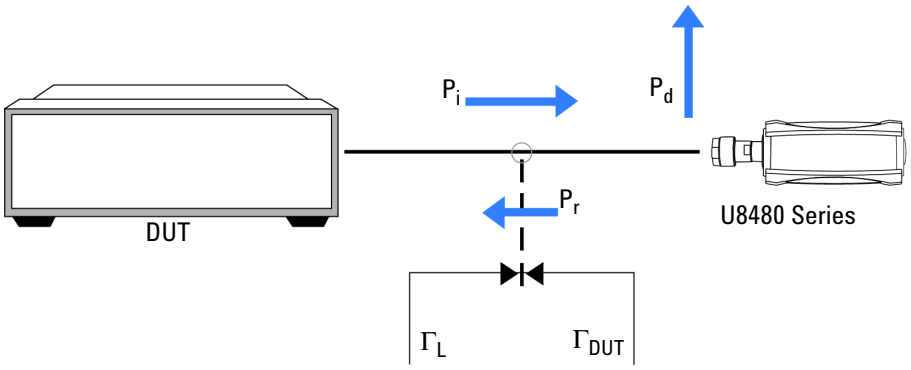


Figure 2-2 DUT to power sensor connection diagram

In a realistic measurement environment, the Device-Under-Test (DUT) impedance or the reference impedance (Z_o) is not equal to the U8480 Series impedance. The mismatch in impedance values causes a portion of the signal voltage to be reflected. This is quantified by the reflection coefficient, or gamma (Γ). A portion of the incident power to the U8480 Series, P_i, is reflected back to the DUT as P_r. The remaining power, P_d, gets delivered to the U8480 Series. A generic DUT will reflect part of P_r back to the U8480 Series, and the reflected portion will be superimposed onto P_i. The nominal power, P_{zo} — the power generated after factoring in Z_o — may be calculated as follows:

$$P_{zo} = P_i|1 - \Gamma_{DUT}\Gamma_L|^2$$

Gamma correction compensates for impedance mismatch via two options, which are Single Point Gamma and Table-Based Gamma.

Single Point Gamma

Single Point Gamma correction is used when you have a known and constant frequency, so a single gamma value can be used for calculation. The value for Γ_{DUT} may be entered as a Single Point Gamma which may be applied across all measurement frequencies in the power sensor operating range. You may input the desired Γ_{DUT} value via the N1918A Power Analysis Manager, as shown in the steps below:

1 Under the **Instrument Properties** toolbar, click the  icon to open the **Corrections and MU** menu.

2 Select **Gamma Table**.

3 Under the **Single Point** tab, enter the desired magnitude and phase.

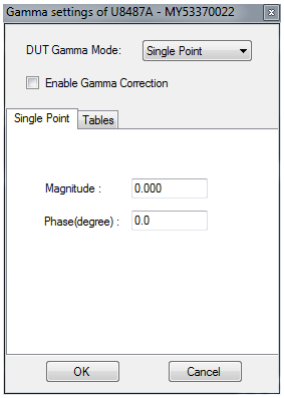


Figure 2-3 Single Point Gamma

4 Select **Enable Gamma Correction** to turn it on.

5 Click **OK** to save your settings and return to the main panel.

You may also input the value for Γ_{DUT} directly into the power sensor via SCPI commands in magnitude-phase format.

NOTE For more details on SCPI commands, refer to the *U8480 Series Programming Guide*.

Table-Based Gamma

Table-Based Gamma is used when there are multiple known frequencies, leading to multiple gamma values. This option supports a list of up to 1024 measurement frequency values. These can be put into a table form via the N1918A Power Analysis Manager, as shown in the steps below:

1 Under the **Instrument Properties** toolbar, click the  icon to open the **Corrections and MU** menu.

2 Select **Gamma Table**.

3 Under the **Tables** tab, select any of the tables and click **Edit**.

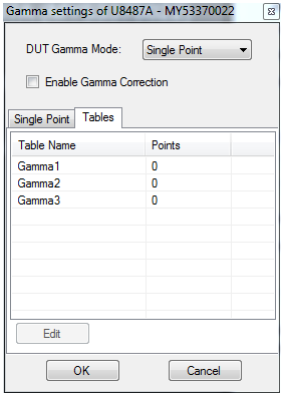


Figure 2-4 Selecting a Gamma table

4 Click **Insert** to add a new data point to the table.

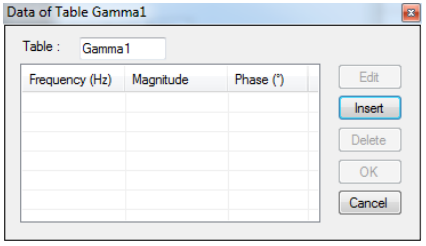


Figure 2-5 Inserting a new data point

5 Enter the desired frequency, magnitude, and phase, then click **OK**. You may repeat this step to enter up to 1024 entries.

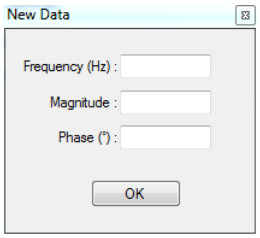


Figure 2-6 Filling in the desired values

6 Click the text box containing the table title to edit it, as shown in Figure 2-7.

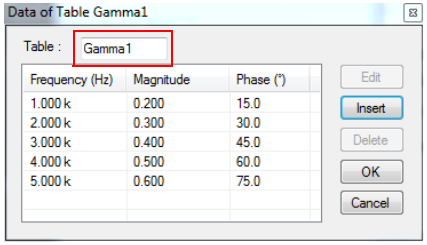


Figure 2-7 Example of a new Gamma table

7 Click **OK** to save the Gamma table.

8 Select the Gamma table from the drop-down menu on the top.

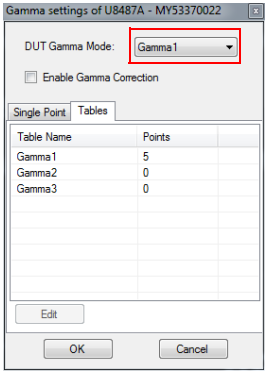


Figure 2-8 Loading the new Gamma table

9 Select **Enable Gamma Correction** to turn it on.

10 Click **OK** to save your settings and return to the main panel.

You may also load the values in table form directly into the power sensor via SCPI commands as a Gamma table to be used for calculation.

NOTE

- The U8480 Series supports up to three Gamma tables that are retained across reset and power cycles.
- For more details on SCPI commands, refer to the *U8480 Series Programming Guide*.

The Γ_L values for factory calibration frequencies within the power sensor operating range are already pre-loaded in the U8480 Series. These Γ_L values are retained across reset and power cycles.

S-Parameter correction

NOTE The S-Parameter correction function is only available in power sensors with firmware version A1.01.06 and above.

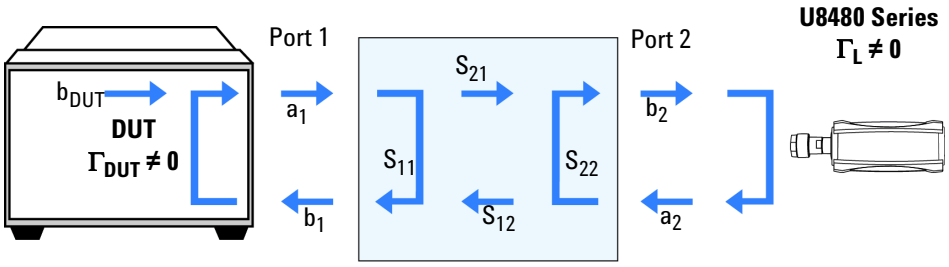


Figure 2-9 Non-ideal 2-port device

A Device-Under-Test (DUT) that has n number of ports has n^2 S-Parameters. These S-Parameters represent reflected energy which interferes with the power measurements. These errors are usually caused by additional components such as attenuators, adapters, or matching pads, which are inserted between the DUT and the U8480 Series. Typically, DUTs are non-ideal, as illustrated in Figure 2-9. When power is transmitted from the DUT, the U8480 Series will reflect a part of its incident wave back to the 2-port device. The 2-port device will reflect this wave back to the power sensor. The power from the DUT may therefore be calculated as follows:

$$b_{DUT} = b_2 \frac{(1 - S_{11}\Gamma_{DUT})(1 - S_{22}\Gamma_L)}{S_{21}} - S_{12}\Gamma_{DUT}\Gamma_L$$

Figure 2-10 Power calculation for a non-ideal 2-port device

The result is the same as if Gamma Correction was enabled.

This feature enables you to correct for the effect of 2-port devices in your test setup. You may enter the S-Parameter data for the DUT in the .S2P file format (magnitude-phase or dB-phase or real-imaginary) via the N1918A Power Analysis Manager, as shown in the following procedure:

1 Under the **Instrument Properties** toolbar, click on the  icon to open the **Corrections and MU** menu.

2 Select **S-Parameter Table**.

3 Select any of the tables and click **Edit**.

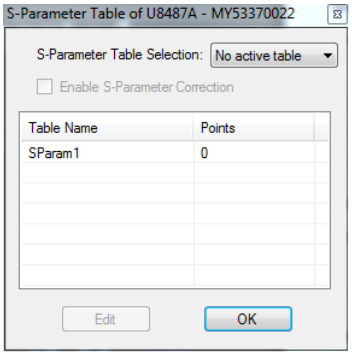


Figure 2-11 S-Parameter menu

4 Click the text box containing the table title to edit it.

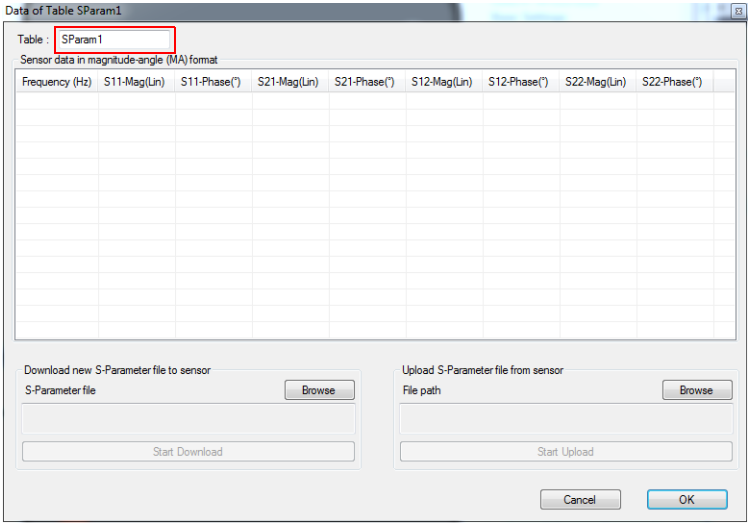


Figure 2-12 Data input menu

5 Use the **Browse** button to:

a Select the desired .S2P file to be downloaded into the power sensor, then click **Start Download** to start the process.

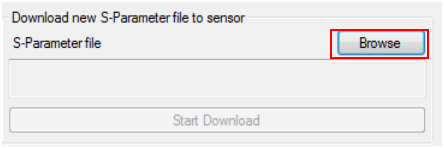


Figure 2-13 Downloading an .S2P file

b Select the desired file path for the uploaded .S2P file from the power sensor, then click **Start Upload** to start the process.

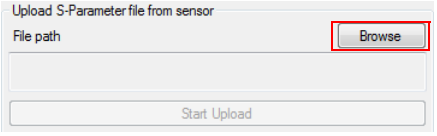


Figure 2-14 Uploading an .S2P file

Click **OK** when the desired .S2P file has been downloaded/uploaded.

6 Select **Enable S-Parameter Correction** to turn it on.

7 Click **OK** to save your settings and return to the main panel.

You may also load the values in table form directly into the power sensor via SCPI commands as a S-Parameter table to be used for calculation.

NOTE

- The U8480 Series supports one S-Parameter table, that is retained across reset and power cycles.
- For more details on SCPI commands, refer to the *U8480 Series Programming Guide*.

Real-Time Measurement Uncertainty

NOTE The Real-Time Measurement Uncertainty function is only available in power sensors with firmware version A1.01.06 and above.

The U8480 series has a built-in Measurement Uncertainty (MU) calculator that is based on the MU method published in Agilent Application Note 64-1A (Fundamentals of RF and Microwave Power Measurements). All the related power sensor parameters for the MU calculations are uniquely kept in the internal memory of each power sensor. Only the reflection coefficient (Γ) of the Device-Under-Test (DUT) needs to be supplied. The MU is calculated dynamically based on the measured power levels, operating frequency, and temperature of the power sensor.

The U8480 Series recognizes the following sources of uncertainty in power measurement:

- Power sensor and Device-Under-Test (DUT) mismatch
- Power sensor zero set
- Power sensor zero drift
- Power sensor linearity
- Power sensor calibration factor uncertainty
- Power sensor internal calibration
- Power sensor measurement noise

The MU associated with the current frequency and measured power of the U8480 Series can be calculated based on these sources of uncertainty. For all calculations, the coverage factor and probability distribution values are kept constant. The table below shows a worked example with typical values at 2 GHz and –13 dBm, and in adherence to ISO GUM.

Table 2-1 Worked example — 2 GHz; –13 dBm; typical values

Symbol	Source of uncertainty	Value ±	Probability distribution	Divisor	Standard uncertainty
M_u	Power sensor and DUT mismatch	$\lvert \Gamma_{DUT} \rvert = 0.111$ $\lvert \Gamma_S \rvert = 0.074$	U-shape	$\sqrt{2}$	0.5820%
D	Power sensor zero drift	5.500×10^{-9} W	Gaussian	2	0.0055%
K_b	Power sensor calibration factor	0.91%	Gaussian	2	0.4550%
P_l	Power sensor linearity	0.00%	Gaussian	2	0.0000%
Z_s	Power sensor zero set	2.50×10^{-8} W	Gaussian	2	0.0249%
N	Power sensor noise	4.50×10^{-8} W	Gaussian	2	0.1176%
P_{cal}	Power sensor internal calibration	5.20×10^{-3}%	Gaussian	2	0.2600%
Combined Uncertainty – RSSed					0.79%
Expanded Uncertainty			Coverage factor, K = 2		1.58%

You may opt for either Single Point Gamma, Table-Based Gamma, or S-Parameter Table as the source of your Γ_{DUT} value, dependent on your test setup:

- If Single Point Gamma is selected, the value of Γ_{DUT} is obtained from the Single Point Gamma value.
- If Table-Based Gamma is selected, the value of Γ_{DUT} is obtained as a frequency dependent value from the currently selected Gamma Table.
- If S-Parameter Table is selected, the value of Γ_{DUT} is obtained from the S-Parameter table.
- If you have a 2-port device connected to your U8480 Series, the value of Γ_{DUT} is taken as S22 of the 2-port device (refer to "S-Parameter correction" for an in-depth explanation); therefore, you should load the desired .S2P file into the power sensor and select S-Parameter Table as the source of your Γ_{DUT} value.

The steps below illustrate the use of the N1918A Power Analysis Manager in selecting the gamma source to be used with the MU calculations:

1 Under the **Instrument Properties** toolbar, click the  icon to open the **Corrections and MU** menu.

2 Select **Meas Uncertainty**.

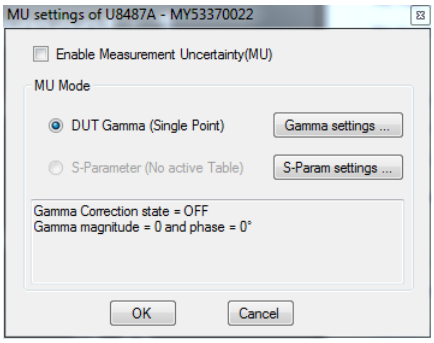


Figure 2-15 Measurement Uncertainty menu

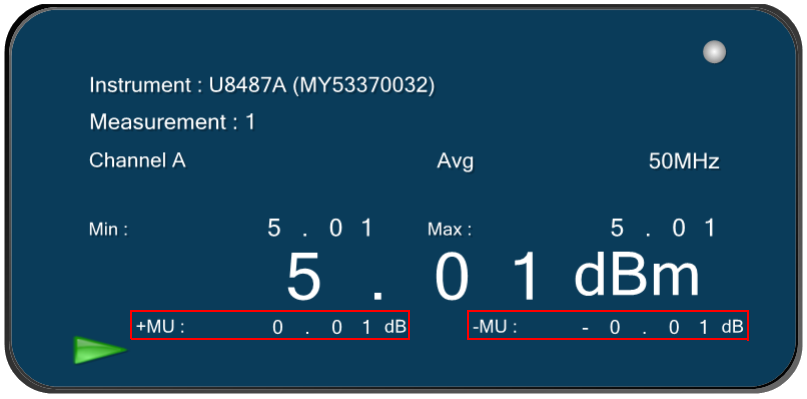
3 Click **Gamma settings** to choose between Single Point Gamma or Table-Based Gamma as the source gamma. (refer to "Gamma correction" for how to configure Gamma Correction)

4 Click **S-Param settings** to select S-Parameter Table as the source gamma. (refer to "S-Parameter correction" for how to configure S-Parameter Correction)

5 Select **Enable Measurement Uncertainty(MU)** to turn it on.

6 Click **OK** to save your settings.

The Soft Panel view will show the following when the Real-Time Measurement Uncertainty is enabled:



The power sensor and Device-Under-Test (DUT) mismatch source of uncertainty will be not be factored into the calculation when:

- Gamma Correction is already enabled
- S-Parameter Correction is already enabled
- Gamma Correction and S-Parameter Correction are both enabled

This is because the mismatch uncertainty would already have been corrected under Gamma or S-Parameter Correction.

NOTE

- When Real-Time Measurement Uncertainty is enabled, fast mode throughput will be reduced.
- For more details on SCPI commands, refer to the *U8480 Series Programming Guide*.

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3
Specifications and Characteristics

This chapter contains the specifications and characteristics of the U8480 Series.

Specifications

NOTE

- Warranted specifications are specifications which are covered by the product warranty, and they apply over a range of 0 to 55 °C and after a 30-minute power-up unless otherwise noted.
- Characteristic specifications are specifications that are not warranted and are shown in *italics*.

Key specification		
Frequency range	U8481A Option 100	10 MHz to 18 GHz
	U8481A Option 200	DC to 18 GHz
	U8485A Option 100	10 MHz to 33 GHz
	U8485A Option 200	DC to 33 GHz
	U8487A Option 100	10 MHz to 50 GHz
	U8488A Option 100	10 MHz to 67 GHz *67 GHz to 70 GHz*
Dynamic power range (average power)	–35 dBm to 20 dBm	
Power linearity[1] [2]	–1 dBm to +15 dBm	±0.50% (25 °C ± 10 °C) ±0.55% (0 to 55 °C)
	+15 to +20 dBm	±0.55% (25 °C ± 10 °C) ±0.60% (0 to 55 °C)
Zero set (20% to 70% RH)[3]	±25 nW[4]	
Maximum SWR	Refer to "Maximum SWR" on page 32	
Internal calibration accuracy[5]	±0.52% (25 ± 10 °C) ±0.59% (0 to 55 °C)	
Zeroing duration	*16 s*	
Internal calibration duration	*1.5 s*	
External calibration duration[6]	*9 s*	
Damage level	AC coupled (Option 100)	*25 dBm (average power), 50 VDC* *15 W (2 µs duration) (peak power)*
	DC coupled (Option 200)	*25 dBm (average power), 4 VDC* *15 W (2 µs duration) (peak power)*

[1] After zeroing and calibration at ambient environment conditions. Refer to "Power linearity" on page 31 for more details.

[2] For U8481/85A power sensors calibrated before December 31, 2013, refer to "Power Linearity" under the Appendix.

[3] RH is the abbreviation for relative humidity.

[4] Tested at 50 MHz.

[5] The U8480 Series is equipped with an internal calibration capability, which means that it does not require a 1 mW power reference for calibration. This specification applies for the 50 MHz frequency and at least 3 hours of settling time with internal calibration.

[6] Only applicable for power sensors with firmware version A1.01.06 and above. For earlier firmware versions, refer to "Appendix" on page 45.

Power linearity

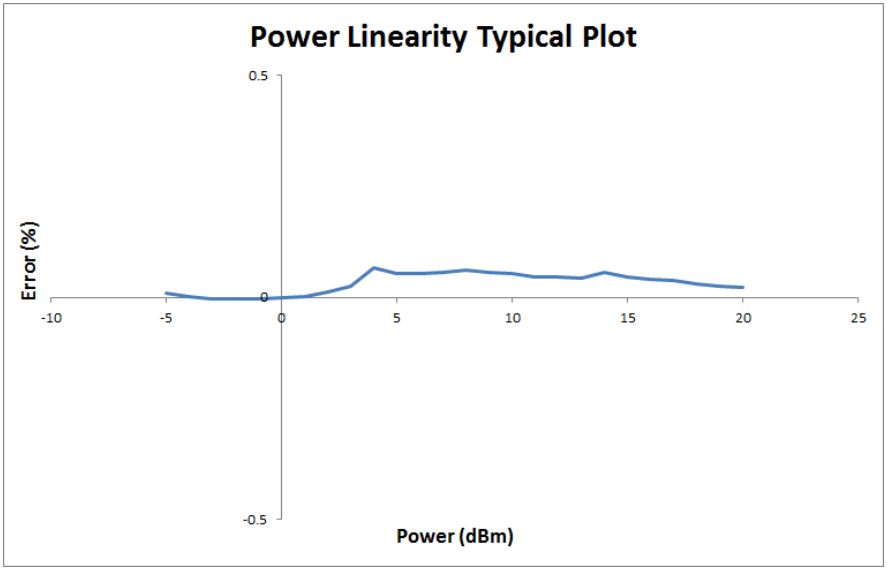

Figure 3-1 Typical U8480 Series power linearity at 25 °C, after zeroing and calibration with associated measurement uncertainty[1]

U8480 Series	–1 to 20 dBm
Measurement uncertainty (%)	*±0.21*

[1] For U8481/85A power sensors calibrated before December 31, 2013, refer to "Power Linearity" under the Appendix.

Maximum SWR

Frequency band	U8481A		Frequency band	U8485A	
	25 °C ±10 °C	0 °C to 55 °C		25 °C ± 10 °C	0 °C to 55 °C
DC to 10 MHz[1]	1.11	1.14	DC to 10 MHz[1]	1.07	1.07
10 MHz to 30 MHz	1.37	1.57	10 MHz to 50 MHz	1.33	1.53
30 MHz to 50 MHz	1.14	1.16	50 MHz to 100 MHz	1.08	1.11
50 MHz to 2 GHz	1.08	1.11	100 MHz to 2 GHz	1.05	1.07
2 GHz to 12.4 GHz	1.16	1.16	2 GHz to 12.4 GHz	1.14	1.14
12.4 GHz to 18 GHz	1.23	1.25	12.4 GHz to 18 GHz	1.19	1.20
—	—	—	18 GHz to 26.5 GHz	1.26	1.28
—	—	—	26.5 GHz to 33 GHz	1.37	1.45

Frequency band	U8487A		Frequency band	U8488A	
	25 °C ±10 °C	0 °C to 55 °C		25 °C ± 10 °C	0 °C to 55 °C
10 MHz to 50 MHz	1.35	1.64	10 MHz to 100 MHz	1.06	1.06
50 MHz to 100 MHz	1.08	1.10	100 MHz to 2.4 GHz	1.06	1.07
100 MHz to 2 GHz	1.05	1.07	2.4 GHz to 12.4 GHz	1.13	1.14
2 GHz 12.4 GHz	1.10	1.10	12.4 GHz to 18 GHz	1.14	1.14
12.4 GHz to 18 GHz	1.16	1.16	18 GHz to 26.5 GHz	1.2	1.2
18 GHz to 26.5 GHz	1.22	1.22	26.5 GHz to 40 GHz	1.25	1.25
26.5 GHz to 40 GHz	1.3	1.3	40 GHz to 67 GHz	1.42	1.43
40 GHz to 50 GHz	1.34	1.33	*67 GHz to 70 GHz*	*1.36*	*1.41*

[1] Only applicable for the U8480 Series Option 200 models.

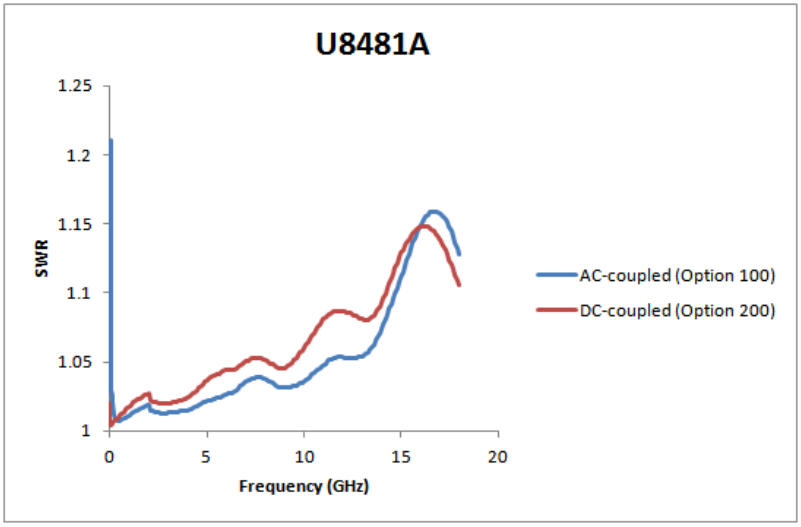

Figure 3-2 Typical SWR for the AC-coupled U8481A (Option 100) and the DC-coupled U8481A (Option 200)

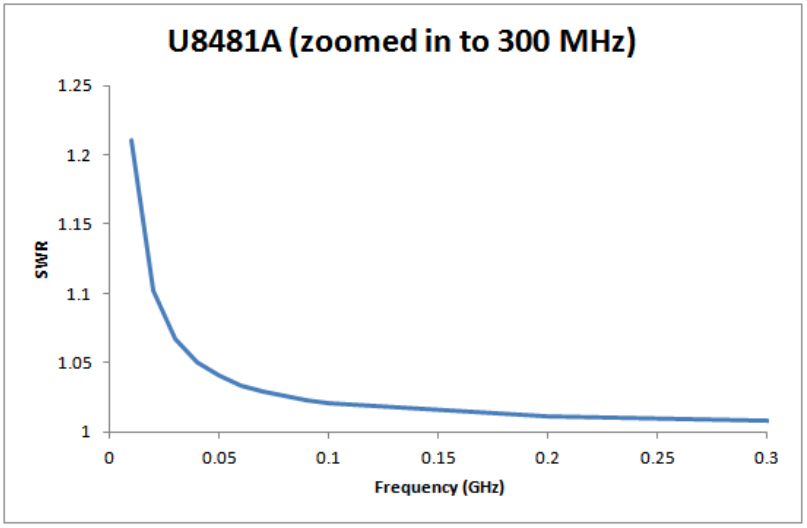

Figure 3-3 Typical SWR for the AC-coupled U8481A (Option 100) when zoomed in to 300 MHz

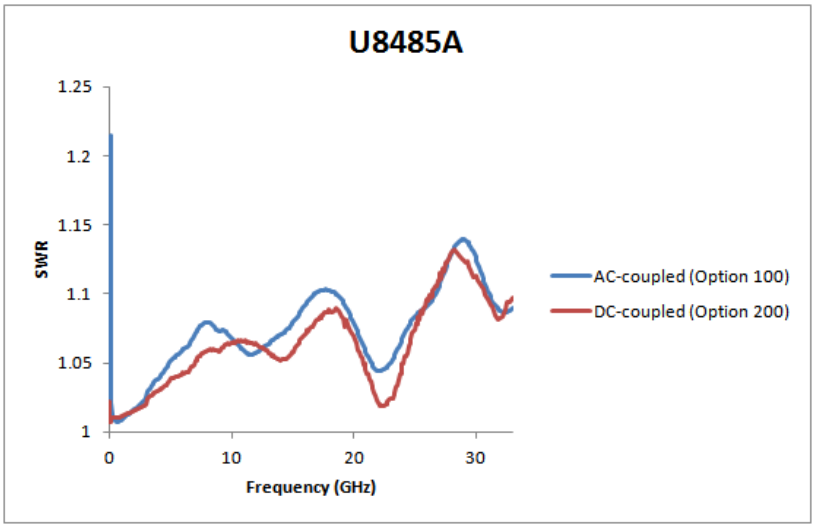

Figure 3-4 Typical SWR for the AC-coupled U8485A (Option 100) and the DC-coupled U8485A (Option 200)

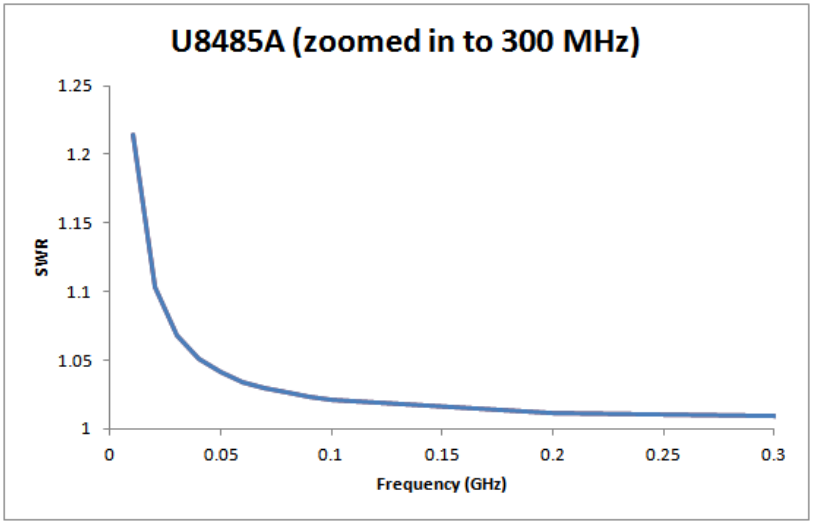

Figure 3-5 Typical SWR for the AC-coupled U8485A (Option 100) when zoomed in to 300 MHz

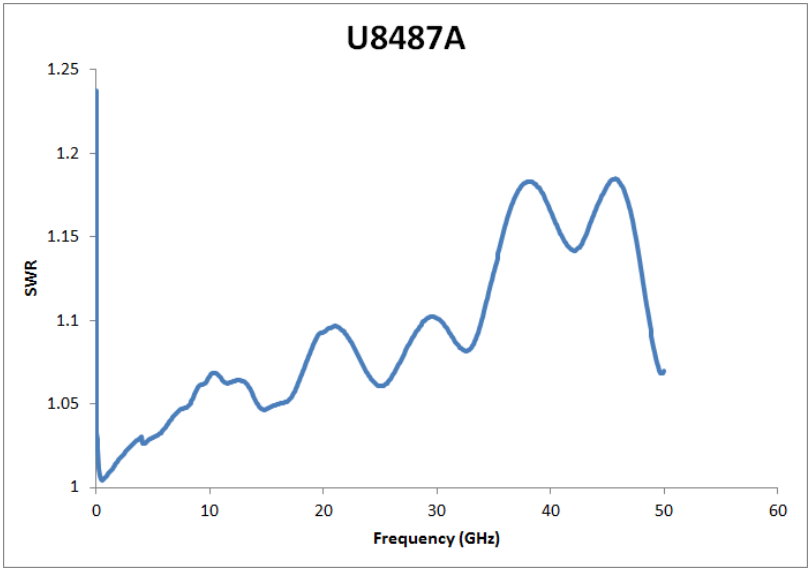

Figure 3-6 Typical SWR for the AC-coupled U8487A (Option 100)

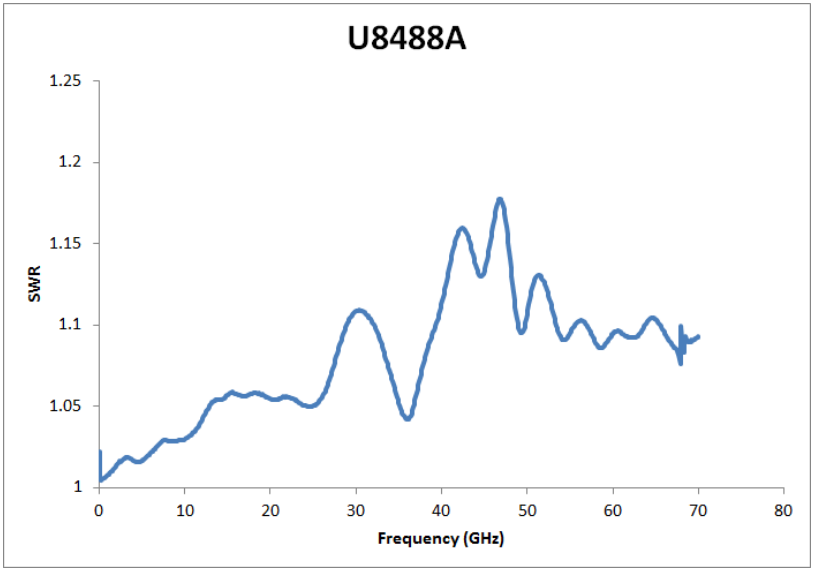

Figure 3-7 Typical SWR for the AC-coupled U8488A (Option 100)

Zero drift and measurement noise

Conditions (RH)[1]	Zero drift[2][3]	Measurement noise[2][4]
20% to 70%	*±5.5 nW*	*±45 nW*

[1] RH is the abbreviation for relative humidity.

[2] Zero drift and measurement noise specifications are tested at 50 MHz.

[3] Within 1 hour of warm up and after zeroing, at a constant temperature, taken over a period of 4 hours of the total measurement time. This drift is calculated based on the average of hourly drifts.

[4] The number of averages at 16 for the normal mode, 32 for the ×2 mode, and 512 for the fast mode, at a constant temperature, measured over a 1-minute interval and two standard deviations.

Noise multiplier[1]

Number of averages	1	2	4	8	16	32	64	128	256	512	1024
Normal mode	*3.17*	*2.62*	*2.02*	*1.54*	*1.00*	*0.82*	*0.60*	*0.50*	*0.37*	*0.27*	*0.15*
×2 mode	*4.55*	*3.76*	*3.00*	*2.25*	*1.59*	*1.00*	*0.85*	*0.63*	*0.47*	*0.42*	*0.23*
Fast mode	*46.88*	*33.06*	*24.00*	*17.19*	*12.24*	*8.39*	*4.93*	*4.11*	*2.48*	*1.00*	*0.83*

Measurement rate[1]

Measurement speed mode	Measurement speed
Normal	*20 readings/s*
Double	*40 readings/s*
Fast[1]	*900 reading/s*[2]

[1] To reduce sensor-dependent delay time, use the measurement buffer by setting the trigger count >1.

[2] The measurement is taken with the averaging state set to off.

[1] Only applicable for power sensors with firmware version A1.01.06 and above. For earlier firmware versions, refer to "Appendix" on page 45.

Settling time[1]

Number of averages	1	2	4	8	16	32	64	128	256	512	1024
Settling time (s) (Normal mode)[1]	*0.10*	*0.15*	*0.25*	*0.45*	*0.84*	*1.63*	*3.20*	*6.36*	*12.6*	*25.2*	*50.4*
Settling time (s) (×2 mode)[1]	*0.08*	*0.10*	*0.15*	*0.25*	*0.45*	*0.89*	*1.63*	*3.20*	*6.35*	*12.6*	*25.2*
Settling time (s) (Fast mode)[1]	*0.003*	*0.005*	*0.007*	*0.011*	*0.020*	*0.036*	*0.069*	*0.134*	*0.265*	*0.528*	*1.053*

[1] Manual filter, 10 dB decreasing power step.

NOTE Noise measurement in fast mode fluctuates at lower power. Although the averaging count (filter) is initially set to 256, if any of the 256 measurement samples taken are higher than –30 dBm, the firmware automatically changes the averaging count to 128.

[1] Only applicable for power sensors with firmware version A1.01.06 and above. For earlier firmware versions, refer to "Appendix" on page 45.

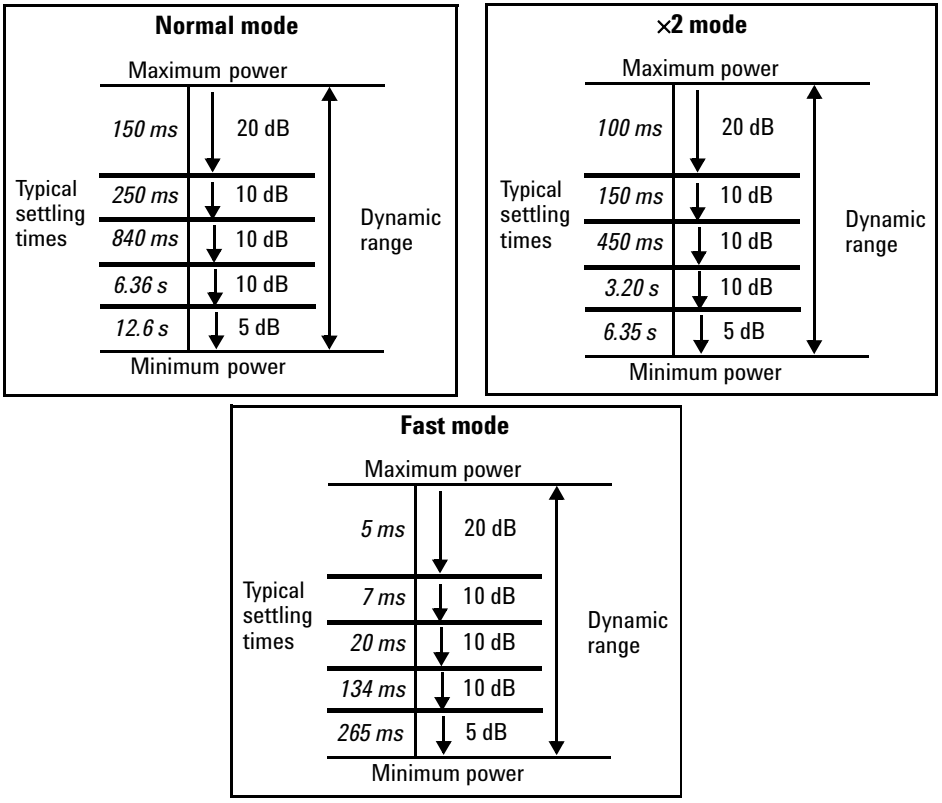

Figure 3-8 Auto-filter, default resolution, 10 dB decreasing power step

Calibration factor (CF) uncertainty

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

NOTE The CF uncertainty is dependent on the calibration standard's uncertainty provided by Calibration Labs. For the exact uncertainty, refer to the individual power sensor calibration report.

U8481A frequency band	25 °C ± 3 °C	25 °C ± 10 °C	0 °C to 55 °C
DC to 10 MHz[1]	*2.63%*	*3.30%*	*3.44%*
10 MHz to 30 MHz	*1.05%*	*1.25%*	*2.35%*
30 MHz to 500 MHz	*0.85%*	*0.89%*	*1.10%*
500 MHz to 1.2 GHz	*0.78%*	*0.87%*	*0.87%*
1.2 GHz to 6 GHz	*0.91%*	*1.10%*	*1.51%*
6 GHz to 14 GHz	*1.26%*	*1.47%*	*2.04%*
14 GHz to 18 GHz	*1.59%*	*1.96%*	*2.39%*

[1] Only applicable for the U8481A Option 200 models.

U8485A frequency band	25 °C ± 3 °C	25 °C ± 10 °C	0 °C to 55 °C
DC to 10 MHz[1]	*2.37%*	*2.80%*	*2.88%*
10 MHz to 30 MHz	*1.50%*	*1.49%*	*2.04%*
30 MHz to 500 MHz	*1.37%*	*1.46%*	*1.98%*
500 MHz to 1.2 GHz	*1.26%*	*1.52%*	*2.07%*
1.2 GHz to 6 GHz	*1.35%*	*1.68%*	*2.40%*
6 GHz to 14 GHz	*1.66%*	*2.26%*	*2.99%*
14 GHz to 18 GHz	*1.83%*	*2.47%*	*3.35%*
18 GHz to 26.5 GHz	*2.67%*	*3.75%*	*4.70%*
26.5 GHz to 33 GHz	*3.32%*	*4.79%*	*6.41%*

[1] Only applicable for the U8485A Option 200 models.

U8487A frequency band	25 °C ± 3 °C	25 °C ± 10 °C	0 °C to 55 °C
10 MHz to 30 MHz	*1.79%*	*2.19%*	*4.15%*
30 MHz to 500 MHz	*1.78%*	*1.90%*	*2.24%*
500 MHz to 1.2 GHz	*1.79%*	*1.98%*	*2.34%*
1.2 GHz to 6 GHz	*1.82%*	*2.06%*	*2.48%*
6 GHz to 14 GHz	*1.88%*	*2.27%*	*2.53%*
14 GHz to 18 GHz	*1.90%*	*2.36%*	*2.71%*
18 GHz to 26.5 GHz	*2.09%*	*2.75%*	*3.23%*
26.5 GHz to 33 GHz	*2.66%*	*3.35%*	*3.92%*
33 GHz to 34 GHz	*2.66%*	*3.37%*	*4.10%*
34 GHz to 35 GHz	*2.66%*	*3.39%*	*4.10%*
35 GHz to 40 GHz	*2.66%*	*4.03%*	*4.69%*
40 GHz to 45 GHz	*3.73%*	*4.58%*	*5.43%*
45 GHz to 50 GHz	*4.68%*	*5.71%*	*6.68%*

U8488A frequency band	25 °C ± 3 °C	25 °C ± 10 °C	0 °C to 55 °C
10 MHz to 50 MHz	*2.04%*	*2.14%*	*2.16%*
50 MHz to 100 MHz	*1.94%*	*2.05%*	*2.05%*
100 MHz to 2 GHz	*1.98%*	*2.18%*	*2.36%*
2 GHz to 12.4 GHz	*2.13%*	*2.80%*	*3.56%*
12.4 GHz to 18 GHz	*2.24%*	*3.01%*	*3.88%*
18 GHz to 26.5 GHz	*2.52%*	*3.09%*	*3.89%*
26.5 GHz to 50 GHz	*4.66%*	*5.49%*	*6.65%*
50 GHz to 67 GHz	*5.14%*	*6.06%*	*7.48%*
67 GHz to 70 GHz	*5.70%*	*8.14%*	*9.16%*

External trigger

External TTL trigger input	
High	*>1.9 V*
Low	*<1.1 V*
Latency[1]	*11 µs ± 2 µs*
Minimum trigger pulse width	*35 ns*
Minimum trigger repetition period	*80 ns*
Impedance	*50 Ω or 1 MΩ*
Trigger delay	
Range	*0 s to 1 s*
Resolution	*10 µs*

[1] External trigger latency is defined as the delay between the applied trigger crossing the trigger level and the U8480 Series switching into the triggered state.

General specifications

Acquisition		
Analog-to-digital converter (ADC) sampling rate	*192 kHz*	
ADC resolution	*24 bits*	
Integration time[1] [2]	*1.024 ms*	
Other		
Current requirement	*400 mA (approximately)*	
Connector	U8481A	N-Type (m), 50 Ω
	U8485A	3.5 mm (m), 50 Ω
	U8487A	2.4 mm (m), 50 Ω
	U8488A	1.85 mm (m), 50 Ω
Cable	USB 2.0 Type A to 5-pin Mini-B	
Interface	USB 2.0 interface, USB-TMC compliant	
Programmability	SCPI, Agilent VEE, LabVIEW®, Microsoft® Visual Basic	
Calibration[3]	1 year	

[1] Integration time is the period during which the U8480 Series ADC samples the input signal for a measurement.

[2] Only applicable for power sensors with firmware version A1.01.06 and above. For earlier firmware versions, refer to "Appendix" on page 45.

[3] Refer to the *U8480 Series Data Sheet* for the ordering information on available options.

Typical plot

The following typical plot is intended to provide additional information, useful in applying to the U8480 Series by giving typical but not warranted performance parameters.

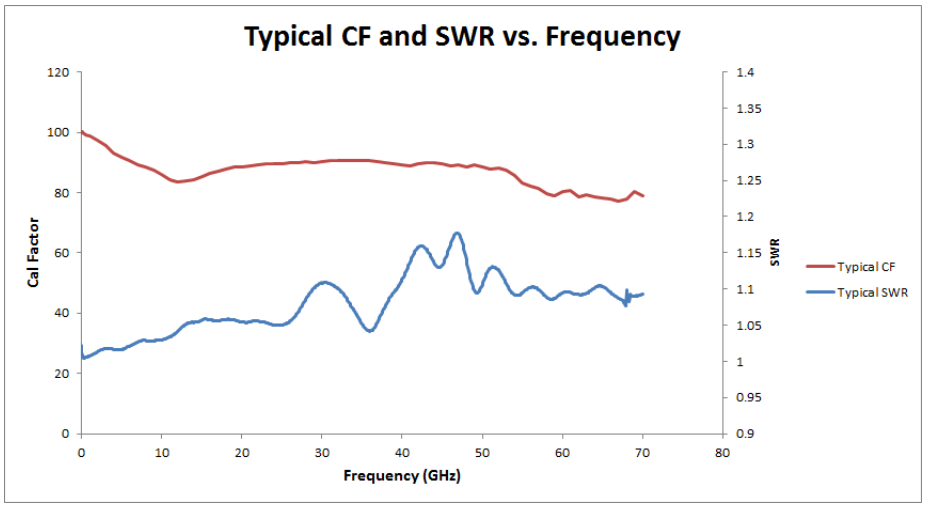

Figure 3-9 Typical calibration factor (CF) and SWR vs. frequency

General Characteristics

ENVIRONMENTAL COMPLIANCE

Refer to "Environmental Conditions" on page IV.

REGULATORY COMPLIANCE

Refer to "Regulatory Information" on page IV.

DIMENSIONS (Length × Width × Height)

- U8481A: *145 mm × 46 mm × 35.90 mm*
- U8485A: *136.50 mm × 46 mm × 35.90 mm*
- U8487A: *127.70 mm × 46 mm × 35.90 mm*
- U8488A: *128.50 mm × 46 mm × 35.90 mm*

WEIGHT

- Net weight:
  - U8481A: *0.256 kg*
  - U8485A: *0.25 kg*
  - U8487A: *0.22 kg*
  - U8488A: *0.22 kg*
- Shipping weight:
  - U8481A: *1.35 kg*
  - U8485A: *1.402 kg*
  - U8487A: *1.37 kg*
  - U8488A: *1.37 kg*

CONNECTIVITY

USB 2.0, with the following cable lengths:

- Option 301: 1.5 m
- Option 302: 3 m
- Option 303: 5 m

RECOMMENDED CALIBRATION INTERVAL

1 year

POLLUTION

Degree 2

WARRANTY[1]

3 years

[1] Refer to the *U8480 Series Data Sheet* for the ordering information on available options.

Appendix

Power Linearity

Key specification		
Power linearity[1]	–1 to 15 dBm	±0.50% (25 °C ± 10 °C) ±0.55% (0 to 55 °C)
	15 to 20 dBm	±0.75% (25 °C ± 10 °C) ±0.80% (0 to 55 °C)

1 After zeroing and calibration at ambient environment conditions. Refer to the figure below for more details.

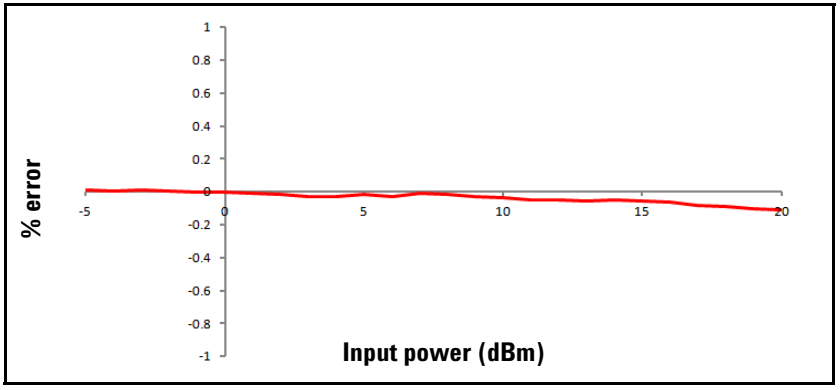

Figure A-1 Typical U8480 Series power linearity at 25 °C, after zeroing and calibration with associated measurement uncertainty

U8480 Series	–1 to 20 dBm
Measurement uncertainty (%)	*±0.21*

External Calibration Duration

Key specifications	
External calibration duration	*15 s*

Measurement Rate

Measurement speed mode	Measurement speed
Normal	*20 readings/s*
Double	*40 readings/s*
Fast[1]	*400 readings/s*[2]

1 To reduce sensor-dependent delay time, use the measurement buffer by setting the trigger count >1.

2 The measurement is taken with the averaging state set to off.

Noise Multiplier

Number of averages	1	2	4	8	16	32	64	128	256	512	1024
Normal mode	*3.17*	*2.62*	*2.02*	*1.54*	*1.00*	*0.82*	*0.60*	*0.50*	*0.37*	*0.27*	*0.15*
×2 mode	*4.55*	*3.76*	*3.00*	*2.25*	*1.59*	*1.00*	*0.85*	*0.63*	*0.47*	*0.42*	*0.23*
Fast mode	*46.88*	*33.06*	*24.00*	*17.19*	*12.24*	*8.39*	*4.93*	*4.11*	*2.48*	*1.00*	*0.83*

General Specifications

Acquisition	
Integration time[1]	*2.048 ms*

1 Integration time is the period during which the U8480 Series ADC samples the input signal for a measurement.

Settling Time

Number of averages	1	2	4	8	16	32	64	128	256	512	1024
Settling time (s) (Normal mode)[1]	*0.15*	*0.23*	*0.32*	*0.53*	*0.90*	*1.68*	*3.24*	*6.44*	*12.7*	*25.3*	*50.5*
Settling time (s) (×2 mode)[1]	*0.14*	*0.16*	*0.23*	*0.33*	*0.51*	*0.91*	*1.70*	*3.28*	*6.45*	*12.7*	*25.3*
Settling time (s) (Fast mode)[1]	*0.003*	*0.005*	*0.009*	*0.018*	*0.036*	*0.069*	*0.134*	*0.265*	*0.528*	*1.05*	*2.10*

1 Manual filter, 10 dB decreasing power step.

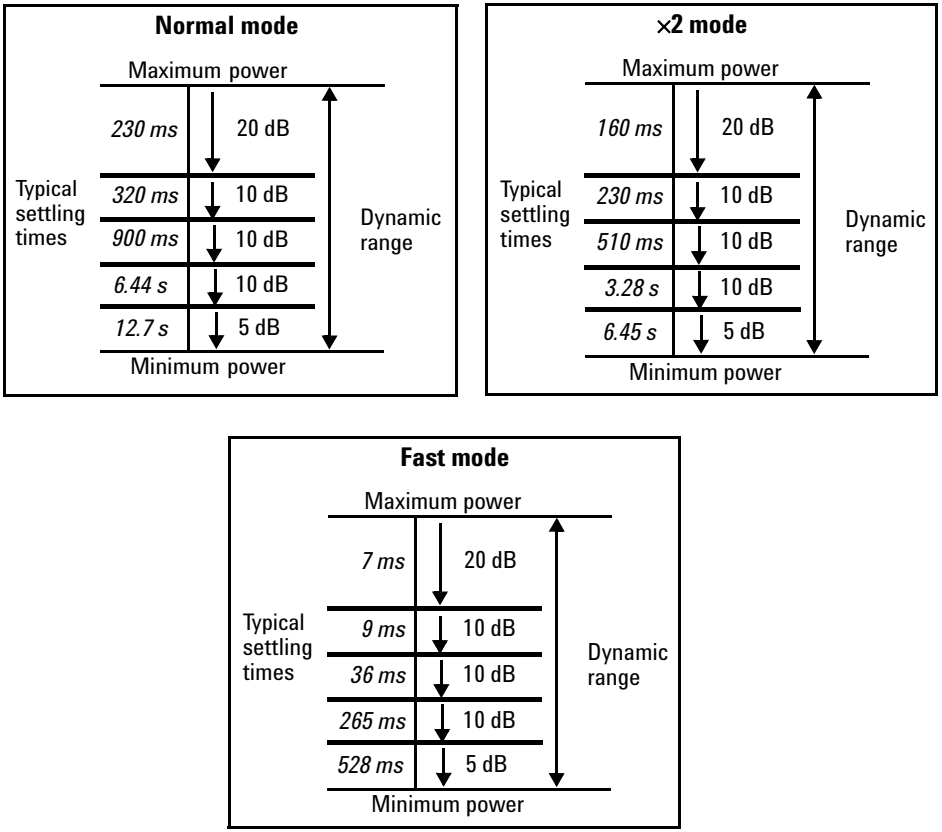

Figure A-2 Auto-filter, default resolution, 10 dB decreasing power step

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