Agilent
U2000 Series USB Power Sensors

Data Sheet

Agilent Technologies

Features

- **Perform power measurement without a power meter**
- **Frequency range from 9 kHz to 24 GHz (sensor dependent)**
- **Dynamic range from –60 dBm to +20 dBm**
- **Internal zeroing capability and external calibration-free measurements[1]**
- **Simplified measurement setup with built-in triggering**

Introduction

The Agilent U2000 Series USB power sensors are average, wide dynamic range power sensors that can be used with a PC or any selected Agilent USB-based instrument. With internal zeroing, there is no need to disconnect the sensor or power-off the device-under-test (DUT). The U2000 Series does not require 50 MHz reference signal calibration, thus allowing factory calibration for ensuring measurement accuracy.

All the specifications specified in this datasheet are valid ONLY after proper calibration of the power sensor and apply for continuous wave (CW) signals unless otherwise stated.

Specifications apply over the temperature range 0 °C to +55 °C unless otherwise stated. Specifications quoted over the temperature range 25 °C ±10 °C apply over 15% to 75% relative humidity and conform to the standard environmental test conditions.

The U2000 Series USB power sensors have two independent measurement paths (high and low power paths) as shown below:

Table 1: Low power path and high power path for Agilent U2000 Series USB power sensors

Sensor	Power Range
U2000A, U2001A, U2002A, U2004A	–60 dBm to +20 dBm Low Power Path: –60 dBm to –10dBm High Power Path: –10 dBm to +20 dBm

Table 2: Product specifications for Agilent U2000 Series USB power sensors

Model	Frequency Range	Maximum SWR (25 °C±10 °C)	Maximum SWR (0-55 °C)	Maximum Power	Connector Type
U2000A	10 MHz to 18.0 GHz	10 MHz to 30 MHz: 1.15 30 MHz to 2 GHz: 1.13 2 GHz to 14 GHz: 1.19 14 GHz to 16 GHz: 1.22 16 GHz to 18 GHz: 1.26	10 MHz to 30 MHz: 1.21 30 MHz to 2 GHz: 1.15 2 GHz to 14 GHz: 1.20 14 GHz to 16 GHz: 1.23 16 GHz to 18 GHz: 1.27	+25 dBm (320 mW) average +33 dBm peak (2 W) <10 us	Type-N (m)
U2001A	10 MHz to 6.0 GHz	10 MHz to 30 MHz: 1.15 30 MHz to 2 GHz: 1.13 2 GHz to 6 GHz: 1.19	10 MHz to 30 MHz: 1.21 30 MHz to 2 GHz: 1.15 2 GHz to 6 GHz: 1.20	+25 dBm (320 mW) average +33 dBm peak (2 W) <10 us	Type-N (m)
U2002A	50 MHz to 24 GHz	50 MHz to 2 GHz: 1.13 2 GHz to 14 GHz: 1.19 14 GHz to 16 GHz: 1.22 16 GHz to 18 GHz: 1.26 18 GHz to 24 GHz: 1.30	50 MHz to 2 GHz: 1.15 2 GHz to 14 GHz: 1.20 14 GHz to 16 GHz: 1.23 16 GHz to 18 GHz: 1.27 18 GHz to 24 GHz: 1.30	+25 dBm (320 mW) average +33 dBm peak (2 W) <10 us	3.5 mm (m)
U2004A	9 kHz to 6.0 GHz	9 kHz to 2 GHz: 1.13 2 GHz to 6 GHz: 1.19	9 kHz to 2 GHz: 1.15 2 GHz to 6 GHz: 1.20	+25 dBm (320 mW) average +33 dBm peak (2 W) <10 us	Type-N (m)

1. Users are recommended to perform external zeroing for input signals below –30 dBm for best accuracy.

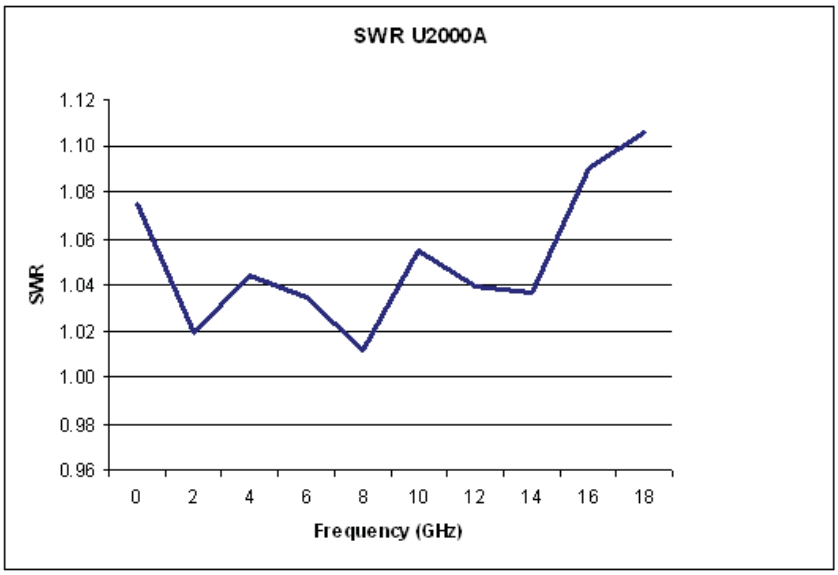


Figure 1: Typical SWR chart for U2000A, 10 MHz to 18 GHz (25 °C ±10 °C)

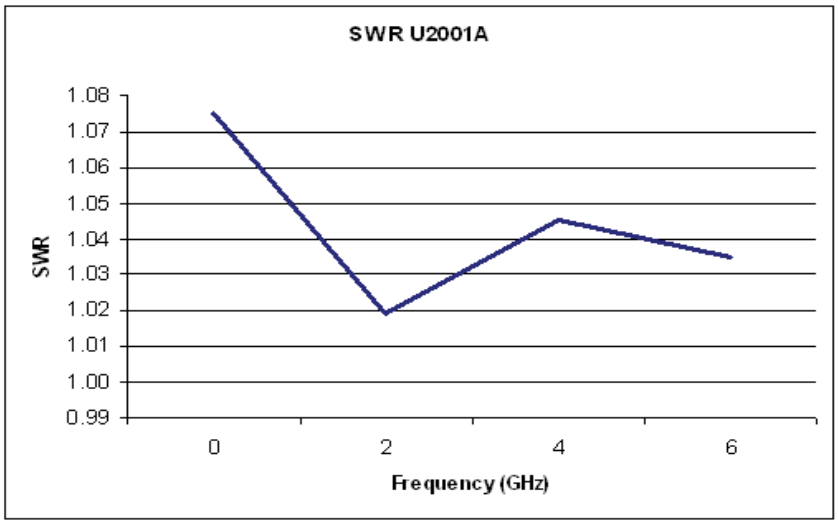


Figure 2: Typical SWR chart for U2001A, 10 MHz to 6 GHz (25 °C ±10 °C)

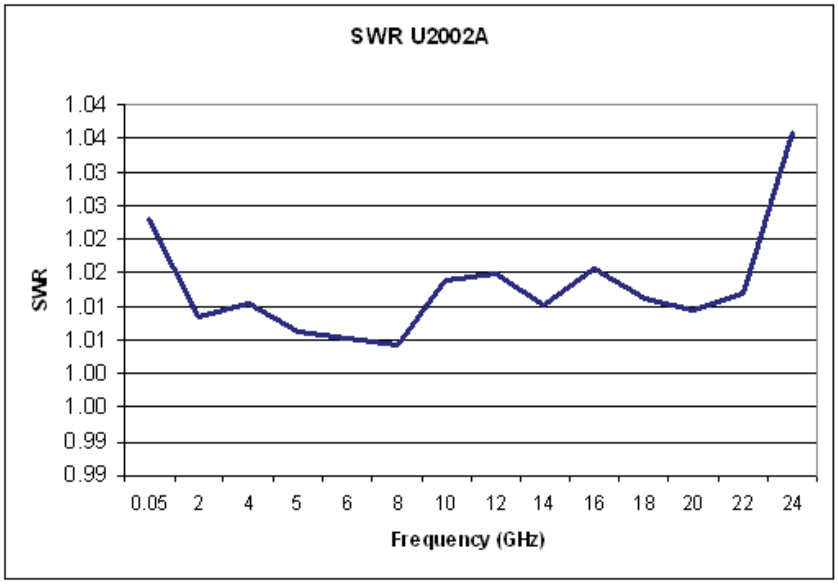


Figure 3: Typical SWR chart for U2002A, 50 MHz to 24 GHz (25 °C ±10 °C)

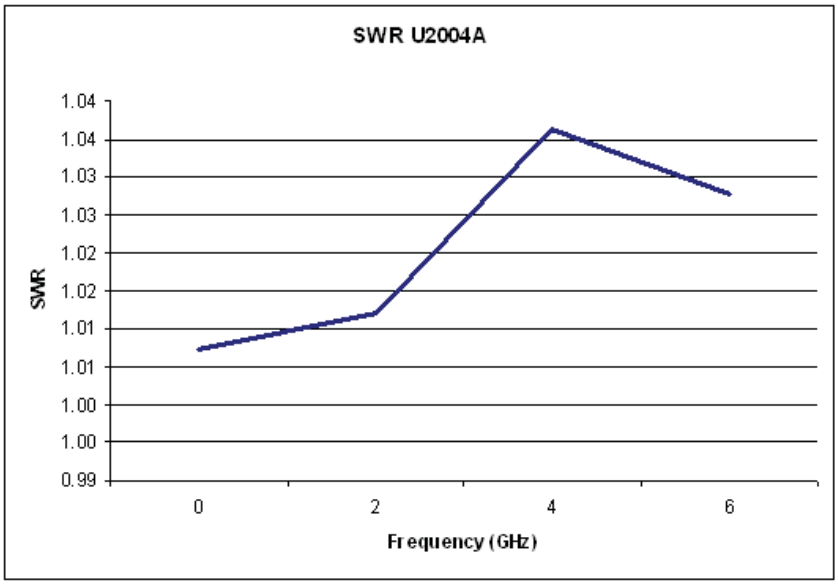
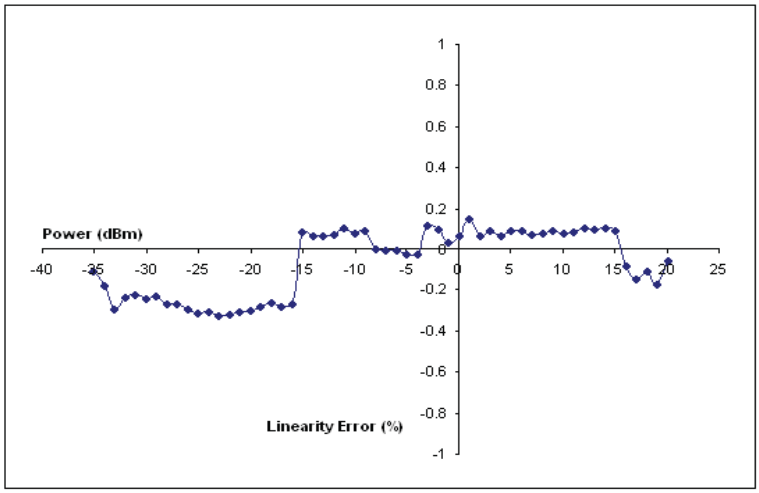


Figure 4: Typical SWR chart for U2001A, 9 kHz to 6 GHz (25 °C ±10 °C)

Power Linearity

Table 3: Power Linearity (after zero and cal at ambient environment conditions)

Sensor	Power	Linearity (25 °C±10 °C)	Linearity (0-55 °C)
U2000A, U2001A, U2002A, U2004A	–60 dBm to –10 dBm	±3.0%	±3.5%
	–10 dBm to 0 dBm	±3.0%	±3.5%
	0 dBm to +20 dBm	±3.0%	±3.5%



Power range	Measurement uncertainty
–60 dBm to –35 dBm	±1.52%
–38 dBm to –15 dBm	±1.52%
–20 dBm to –9 dBm	±1.69%
–11 dBm to –5 dBm	±1.69%
–7 dBm to 15 dBm	±1.96%
10 dBm to 20 dBm	±1.61%

Figure 5: Typical U2000 Series USB power sensors Power Linearity at 25 °C, after zero and calibration, with associated measurement uncertainty

Switching Point

The U2000 Series USB power sensors have two paths, a low power path covering –60 dBm to –10 dBm, and a high power path covering –10 dBm to +20 dBm. The power meter automatically selects the proper power level path. To avoid unnecessary switching when the power level is near to the –10 dBm point, Switching Point Hysteresis is added. This hysteresis causes the low power path to remain selected until approximately –9.5 dBm. As the power level increases above –9.5 dBm, the high power path will be selected. The high power path remains selected until approximately –10.5 dBm. As the power level decreases below –10.5 dBm, the low power path will be selected.

Switching point linearity: **Typically ≤±0.5% (≤±0.02 dB)**
Switching point hysteresis: **0.5 dB**

Table 4: Zero Set, Zero Drift and Measurement Noise with the associated range

Range[1]	Zero Set	Zero Drift[2]	Measurement Noise[3]
–60 dBm to –35 dBm	651 pW	±996 pW	1.91 nW
–38 dBm to –15 dBm	1.13 nW	±400 pW	2.24 nW
–20 dBm to –9 dBm	12.8 nW	±6.01 nW	40.8 nW
–11 dBm to –5 dBm	445 nW	±155 nW	1.63 uW
–7 dBm to 15 dBm	4.26 uW	±3.20 uW	861 nW
10 dBm to 20 dBm	6.84 uW	±3.39 uW	19.5 uW

1. Condition: (i) 0 °C to 55 °C and (ii) 40 °C, 95% relative humidity.

2. Within 1 hour after zero set, at a constant temperature, after a 24 hour warm-up of the power sensor.

3. The number of averages at 16 for Normal mode, measured over one minute interval and two standard deviations.

Calibration Factor (CF) and Reflection Coefficient (Rho)

Calibration Factor (CF) and Reflection Coefficient (Rho) data are provided in the Certificate of Calibration (CoC) that comes with the purchase of U2000 Series USB power sensors. This data is unique to each sensor. If you have more than one sensor, match the serial number on the CoC with the serial number on the power sensor you are using. The CF corrects for the frequency response of the sensor.
Reflection Coefficient (Rho, or r) relates to the SWR based on the following formula:

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SWR = (1 + Rho)/(1 - Rho)
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Maximum uncertainties of the CF data are listed in the following tables.
As the U2000 Series USB power sensors have two independent measurement paths (high and low power paths), there are two calibration factor uncertainty tables for each sensor. The uncertainty analysis for the calibration of the sensors is done in accordance with ISO Guide. The uncertainty data reported on the calibration certificate is the expanded uncertainty with a 95% confidence level and a coverage factor of two.

Table 5: Calibration factor uncertainties for U2000A

Frequency	U2000A	
	Uncertainty (25 °C±10 °C)	
	–60 dBm to –10 dBm	–10 dBm to 20 dBm
10 MHz to 30 MHz	± 1.70%	± 1.69%
30 MHz to 2 GHz	± 1.62%	± 1.62%
2 GHz to 14 GHz	± 1.97%	± 1.96%
14 GHz to 16 GHz	± 2.33%	± 2.33%
16 GHz to 18 GHz	± 3.09%	± 3.08%

Table 6: Calibration factor uncertainties for U2001A

Frequency	U2001A	
	Uncertainty (25 °C±10 °C)	
	–60 dBm to –10 dBm	–10 dBm to 20 dBm
10 MHz to 30 MHz	± 1.70%	± 1.69%
30 MHz to 2 GHz	± 1.62%	± 1.62%
2 GHz to 6 GHz	± 1.78%	± 1.75%

Table 7: Calibration factor uncertainties for U2002A

Frequency	U2002A	
	Uncertainty (25 °C±10 °C)	
	–60 dBm to –10 dBm	–10 dBm to 20 dBm
50 MHz to 2 GHz	± 1.98%	± 1.97%
2 GHz to 14 GHz	± 2.27%	± 2.25%
14 GHz to 16 GHz	± 2.34%	± 2.33%
16 GHz to 18 GHz	± 2.38%	± 2.37%
18 GHz to 24 GHz	± 2.73%	± 2.72%

Table 8: Calibration factor uncertainties for U2004A

Frequency	U2004A	
	Uncertainty (25 °C±10 °C)	
	–60 dBm to –10 dBm	–10 dBm to 20 dBm
9 kHz to 10 MHz	± 1.75%	± 1.72%
10 MHz to 30 MHz	± 1.73%	± 1.71%
30 MHz to 500 MHz	± 1.73%	± 1.71%
500 MHz to 1.2 GHz	± 1.61%	± 1.59%
1.2 GHz to 6 GHz	± 1.69%	± 1.65%

General Characteristics

This instrument is designed for indoor use only. The table shows the general requirements for U2000 Series USB power sensors.

Temperature	0 °C to +55 °C (operating)
	–30 °C to +70 °C (non-operating)
Relative Humidity	Operating up to 95% at 40 °C (non-condensing)
	Non-operating up to 90% at 65 °C (non-condensing)
Altitude	Operating up to 4,600 metres (15,000 feet)
	Non-operating up to 4,600 metres (15,000 feet)
Pollution	Degree 2
Net Weight	U2000/1/4A : 0.262 kg (0.6 lb) U2002A : 0.226 kg (0.5 lb)
Dimensions (U2000/1/4A)	Length: 163.75 mm (6.4 in) Width: 46 mm (1.8 in) Height: 35.9 mm (1.4 in)
Dimensions (U2002A)	Length: 134.37 mm (5.3 in) Width: 46 mm (1.8 in) Height: 35.9 mm (1.4 in)
Storage Environment	The sensor should be stored in a clean, dry environment
Storage Temperature	–30 °C to +70 °C

Figure 6: Dimensional drawing of U2000 Series USB power sensors

Features

- **Enhanced visualization with larger and more flexible display formats**
- **Powerful graph functions**
- **Display multi-channel power measurements (with more than 10 displays on one window)**
- **Convenient data logging and storing up to seven days**
- **Time-saving options to save and restore instrument settings**
- **Measurement limit and alert function optimized for remote operation**
- **Quick and easy application screen printing option**

Agilent N1918A Power Analysis Manager

The Agilent N1918A Power Analysis Manager is a PC-based application software running on Microsoft® Windows® platform that is targeted to extend the capabilities of U2000 Series USB power sensors. The N1918A is a suite of application software that comprises basic version that offers standard graphical user interface (GUI), and advanced version that is an optional licensed software for advanced pulse analysis, multi-channel power measurement, statistical analysis and recording function. Users can use this application software to track problems at any stage of their design process, from simulation to the final prototype. This application software is flexible and able to accept data from multiple front ends.

Shown below are the specifications of Agilent N1918A Power Analysis Manager while using with U2000 Series USB power sensors.

Zero and Cal:
Perform internal zeroing and calibration. Do not need external calibration.

Display units:
Absolute: Watts or dBm
Relative: Percent or dB

Display resolution:
Resolution of 1.0, 0.1, 0.01, and 0.001 dB in Log mode, or one to four digits in linear mode.

Default resolution:
0.01 dB in log mode, three digits in linear mode.

Range:
1 kHz to 999.9 GHz, configurable to 1-kHz step scale.

Relative:
Displays all successive measurements relative to the user defined value.

Offset:
Allows power measurements to be offset by –100 dB to +100 dB, configurable in 0.001 dB increments, to compensate for external loss or gain.

Save and Restore Instrument Settings:
The Power Analysis Manager offers an option that allows users to save the instrument settings in *.prop format files. Thus, allowing users to restore their instrument settings whenever the same settings are required by simply loading the instrument property files.

dBm/W:
Selectable units of either Watts or dBm in absolute power; or percent or dB for relative measurements.

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 display peak power value:

Peak Power
= Measured Power/Duty Cycle

Limits:
High and low limits can be set in the range –150.00 dBm to +230.000 dBm, in 0.001 dBm increments.

Preset default values:
Channel Offset (dB) = 0
Duty Cycle Off
Frequency 50 MHz
AUTO Average
AUTO Range
Free Run Mode
Measurement Unit dBm

Measurement speed:
- 110 readings/sec at FAST mode
- 250 readings/sec at buffered mode of 50 readings

Current requirement:
Approximately 200 mA maximum current for USB

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