Agilent
N8262A P-Series Modular Power Meter and Power Sensors

Data Sheet

Agilent Technologies

Specification Definitions

There are two types of product specifications:

Warranted Specifications

Warranted specifications are specifications which are covered by the product warranty and apply over 0 to 55°C unless otherwise noted. Warranted specifications include measurement uncertainty calculated with a 95% confidence.

Characteristic Specifications

Characteristic specifications are specifications that are not warranted. They describe product performance that is useful in the application of the product. These characteristic specifications are shown in *italics*.

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 units. There are several types of characteristic specifications. These types can be placed in two groups:

One 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 ohm input Type-N connector. In these examples product weight is an 'approximate' value and a 50 ohm input is 'nominal'. These two terms are most widely used when describing a product's 'attributes'.

The second group 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 will 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 sensor are within their recommended calibration period, and
- used in accordance to the information provided in the *N8262A P-Series Modular Power Meter User's Guide*.

General Features

Number of channels	Dual channel
Frequency range	**N1921A** P-Series wideband power sensor, 50 MHz to 18 GHz **N1922A** P-Series wideband power sensor, 50 MHz to 40 GHz
Measurements	Average, peak and peak-to-average ratio power measurements are provided with free-run or time gated definition. Time parameter measurements of pulse rise time, fall time, pulse width, time to positive occurance and time to negative occurance are also provided.
Sensor compatibility	P-Series modular power meter is compatible with all Agilent P-Series wideband power sensors, E-Series power sensors (except E9320 range) and 8480 Series power sensors[1].

1. Information contained in this document refers to operation with P-Series power sensors. For specifications when used with 8480 and E-Series power sensors (except E9320 range), refer to Lit Number 5965-6382E.

P-Series Modular Power Meter and Sensor Key System Specifications and Characteristics[2]

Maximum sampling rate	*100 Msamples/sec, continuous sampling*
Video bandwidth	$\geq$ *30 MHz*
Single shot bandwidth	$\geq$ *30 MHz*
Rise time and fall time	$\leq$ *13 ns* (for frequencies $\geq$ 500 MHz)[3], see Figure 1
Minimum pulse width	*50 ns*[4]
Overshoot	$\leq$ *5%*[3]
Average power measurement accuracy	N1921A: $\leq \pm$ 0.2 dB or $\pm$ 4.5%[5] N1922A: $\leq \pm$ 0.3 dB or $\pm$ 6.7%
Dynamic range	*–35 dBm to +20 dBm (> 500 MHz)* *–30 dBm to +20 dBm (50 MHz to 500 MHz)*
Maximum capture length	*1 second*
Maximum pulse repetition rate	*10 MHz (based on 10 samples per period)*

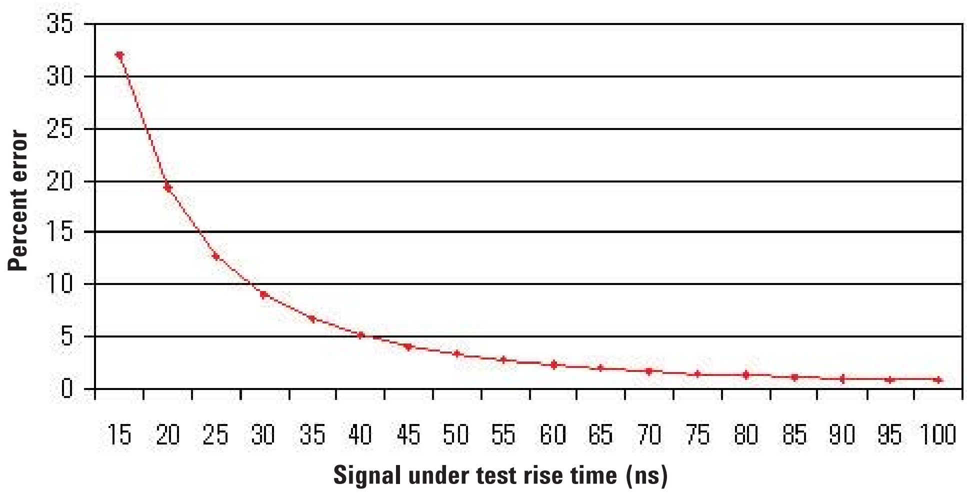


Figure 1. Measured rise time percentage error versus signal under test rise

Although the rise time specification is less than or equal to 13 ns, this does not mean that the P-Series modular power meter and power sensor combination can accurately measure a signal with a known rise time of 13 ns. The measured rise time is the root sum of the squares (RSS) of the signal under test rise time and the system rise time (13 ns):

$$\text{Measured rise time} = \sqrt{((\text{signal under test rise time})^2 + (\text{system rise time})^2)},$$

and the percent error is:

$$\text{\% Error} = ((\text{measured rise time - signal under test rise time})/\text{signal under test rise time}) \times 100$$

2. See Appendix A on page 9 for measurement uncertainty calculations.
3. Specification applies only when the Off video bandwidth is selected.
4. The Minimum Pulse Width is the recommended minimum pulse width viewable on the power meter, where power measurements are meaningful and accurate, but not warranted.
5. Specification is valid over –15 to +20 dBm, and a frequency range 0.5 to 10 GHz, DUT Max. SWR < 1.27 for the N1921A, and a frequency range 0.5 to 40 GHz, DUT Max. SWR < 1.2 for the N1922A. Averaging set to 32, in Free Run mode.

P-Series Modular Power Meter Specifications

Meter uncertainty

Instrumentation linearity	± 0.8%

Timebase

Timebase range	*2 ns to 100 msec/div*
Accuracy	± 10 ppm
Jitter	≤ *1 ns*

Trigger

Internal Trigger	
Range	*–20 to +20 dBm*
Resolution	*0.1 dB*
Level Accuracy	± *0.5 dB*
Latency[6]	*160 ns ± 10 ns*
Jitter	≤ *5 ns rms*
External TTL trigger input	
High	*> 2.4 V*
Low	*< 0.7 V*
Latency[7]	*90 ns ± 10 ns*
Minimum trigger pulse width	*15 ns*
Minimum trigger repitition period	*50 ns*
Impedance	*50 Ω*
Jitter	≤ *5 ns rms*
Maximum trigger voltage input	*15 V emf from 50 Ω dc (current < 100 mA), or*
	60 V emf from 50 Ω dc (pulse width < 1 s, current < 100 mA)
External TTL trigger output	Low to high transition on trigger event
High	*> 2.4 V*
Low	*< 0.7 V*
Latency[8]	*30 ns ± 10 ns*
Impedance	*50 Ω*
Jitter	≤ *5 ns rms*
Trigger delay	
Delay range	± *1.0 s, maximum*
Delay resolution	*1% of delay setting, 10 ns maximum*
Trigger hold-off	
Range	*1 µs to 400 ms*
Resolution	*1% of selected value (to minimum of 10 ns)*
Trigger level threshold hysteresis	
Range	± *3 dB*
Resolution	*0.05 dB*

6. Internal trigger latency is defined as the delay between the applied RF crossing the trigger level and the meter switching into the triggered state.
7. External trigger latency is defined as the delay between the applied trigger crossing the trigger level and the meter switching into the triggered state.
8. External trigger output latency is defined as the delay between the meter entering the triggered state and the output signal switching.

P-Series Wideband Power Sensor Specifications

The P-Series wideband power sensors are designed for use with the P-Series power meters N1911/12A and the P-Series modular power meter N8262A only.

Sensor model	Frequency range	Dynamic range	Damage level	Connector type
N1921A	50 MHz to 18 GHz	*–35 dBm to +20 dBm (≥ 500 MHz)* *–30 dBm to +20 dBm (50 MHz to 500 MHz)*	+23 dBm (average power); +30 dBm (< 1 µs duration) (peak power)	Type N (m)
N1922A	50 MHz to 40 GHz	*–35 dBm to +20 dBm (≥ 500 MHz)* *–30 dBm to +20 dBm (50 MHz to 500 MHz)*	+23 dBm (average power); +30 dBm (< 1 µs duration, peak power)	2.4 mm (m)

Maximum SWR

Frequency band	N1921A/N1922A
50 MHz to 10 GHz	1.2
10 GHz to 18 GHz	1.26
18 GHz to 26.5 GHz	1.3
26.5 GHz to 40 GHz	1.5

Sensor Calibration Uncertainty[9]

Definition: Uncertainty resulting from non-linearity in the sensor detection and correction process. This can be considered as a combination of traditional linearity, cal factor and temperature specifications and the uncertainty associated with the internal calibration process.

Frequency band	N1921A	N1922A
50 MHz to 500 MHz	4.5%	4.3%
500 MHz to 1 GHz	4.0%	4.2%
1 GHz to 10 GHz	4.0%	4.4%
10 GHz to 18 GHz	5.0%	4.7%
18 GHz to 26.5 GHz		5.9%
26.5 GHz to 40 GHz		6.0%

Physical characteristics

Dimensions *(Length x Width x Heigth)*	N1921A N1922A	*135 mm x 40 mm x 27 mm* *127 mm x 40 mm x 27 mm*
Weights with cable	Option 105 Option 106 Option 107	*0.4 kg* *0.6 kg* *1.4 kg*
Fixed sensor cable lengths	Standard Option 106 Option 107	*1.5 m (5-feet)* *3.0 m (10-feet)* *10 m (31-feet)*

9. Beyond 70 % Humidity, an additional 0.6 % should be added to these values.

1 mW Power Reference

Note: The 1 mW power reference is provided for calibration of E-Series (except E9320 range) and 8480 Series power sensors. The P-Series sensors are automatically calibrated and do not need this reference for calibration.

Power output	1.00 mW (0.0 dBm). Factory set to ± 0.4% traceable to the National Physical Laboratory (NPL) UK
Accuracy (over 2 years)	± 1.2% (0 to 55° C) ± 0.4% (25 ± 10° C)
Frequency	*50 MHz nominal*
SWR	1.08 (0 to 55° C) *1.05 typical*
Connector type	Type N (f), 50 Ω

Front panel inputs/outputs

Recorder output(s)	Analog 0 to 1 Volt, 1 kΩ output impedance. There are two recorder outputs with SMB connector
Trigger input	Input has TTL compatible logic levels and uses a SMB connector
Trigger output	Output provides TTL compatible logic levels and uses a SMB connector

Rear panel inputs/outputs

100BaseT LAN	Interface allow communication with an external controller
Ground	Binding post, accepts 4 mm plug or bare-wire connection
Line Power Input voltage range	 100 to 120 V ± 10% 220 to 240 V ± 10%
Input frequency range	50 to 60 Hz ± 10% (all voltages) 400 to 440 Hz (100 to 120 V only)
Power requirement	not exceeding 75 VA (50 Watts)

Remote programming

Interface	10/100BaseT LAN interface
Command language	SCPI standard interface commands.

Measurement speed

Measurement speed via remote interface	≥ *1500 readings per second*

Regulatory information

Electromagnetic compatibility	Complies with the requirements of the EMC Directive 89/336/EEC
Product safety	Conforms to the following product specifications: EN61010-1: 2001/IEC 1010-1:2001 EN 55011:1991 IEC 61326-1:1997+A1:1998/EN 61326-1:1997+A1:1998 CISPR 11:1990/EN 55011:1991 Canada: CSA C22.2 No. 61010- 1:2004 USA: UL: 61010- 1:2004

Physical Characteristics

Dimensions	The following dimensions exclude front and rear panel protrusions: 44.2 mm H x 212.6 mm W x 420.3 mm D (1.75 in x 8.5 in x 19.63 in)
Net weight	*≤ 3.5 kg (7.7 lb) approximate*
Shipping weight	*≤ 7.7 kg (17.0 lb) approximate*

Environmental conditions

General	Complies with the requirements of the EMC Directive 89/336/EEC.
Operating Temperature Maximum humidity Minimum humidity Maximum altitude	 0 °C to 55 °C 95% at 40 °C (non-condensing) 15% at 40 °C (non-condensing) 3,000 meters (9,840 feet)
Storage Non-operating storage temperature Non-operating maximum humidity Non-operating maximum altitude	 –40 °C to +70 °C 90% at 65 °C (non-condensing) 15,420 meters (50,000 feet)

System Specifications and Characteristics

The video bandwidth in the power meter can be set to High, Medium, Low or Off. The video bandwidths stated in the table below are not the 3 dB bandwidths, as the video bandwidths are corrected for optimal flatness (except the Off filter). Refer to Figure 2 for information on the flatness response. The Off video bandwidth setting provides the warranted rise time and fall time specification and is the recommended setting for minimizing overshoot on pulse signals.

Dynamic response - rise time, fall time, and overshoot versus video bandwidth settings

Parameter	Video bandwidth setting				
	Low : 5 MHz	Medium : 15 MHz	High : 30 MHz	Off	
				< 500 MHz	> 500 MHz
Rise time / fall time[10]	*< 56 ns*	*< 25 ns*	*≤ 13 ns*	*< 36 ns*	*≤ 13 ns*
Overshoot[11]				*< 5%*	*< 5%*

For Option 107 (10 m cable), add 5 ns to the rise time and fall time specifications.

Recorder Output and Video Output

The recorder output is used to output the corresponding voltage for the measurement that user sets on the Upper/Lower window of the power meter.

The video output is the direct signal output detected by the sensor diode, with no correction applied. The video output provides a DC voltage proportional to the measured input power through a BNC connector on the rear panel. The DC voltage can be displayed on an oscilloscope for time measurement. This option replaces the recorder output on the rear panel. The video output impedance is 50ohm.

10. Specified as 10% to 90% for rise time and 90% to 10% for fall time on a 0 dBm pulse.
11. Specified as the overshoot relative to the settled pulse top power.

Characteristic Peak Flatness

The peak flatness is the flatness of a peak-to-average ratio measurement for various tone-separations for an equal magnitude two-tone RF input. Figure 2 refers to the relative error in peak-to-average ratio measurements as the tone separation is varied. The measurements were performed at –10 dBm with power sensors with 1.5 m cable lengths.

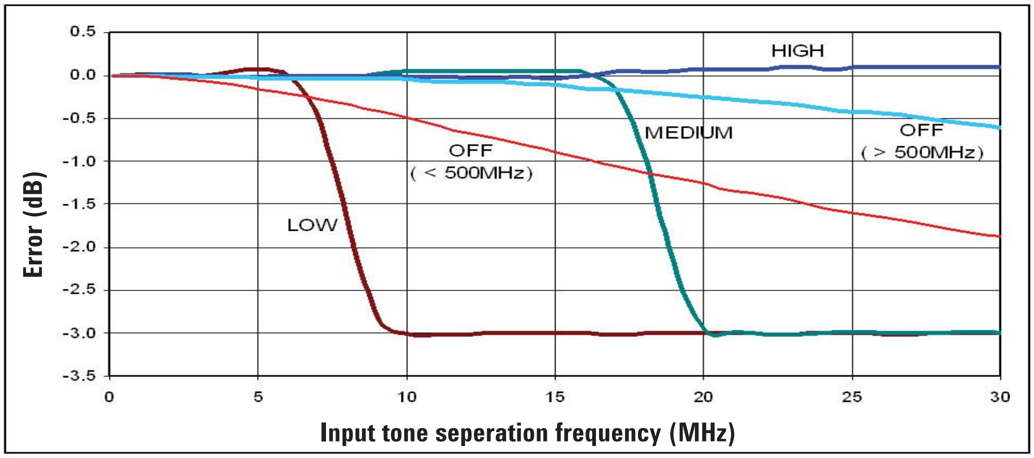


Figure 2. N192XA Error in peak-to-average measurements for a two-tone input (High, Medium, Low or Off filters)

Noise and drift

Sensor model	Zeroing	Zero set < 500 MHz	Zero set > 500 MHz	Zero drift[12]	Noise per sample	Measurement noise (Free run)[13]
N1921A / N1922A	No RF on input	200 nW		*100 nW*	*2 µW*	*50 nW*
	RF present	*550 nW*	*200 nW*			

Measurement average setting	1	2	4	8	16	32	64	128	256	512	1024
Free run noise multiplier	*1*	*0.9*	*0.8*	*0.7*	*0.6*	*0.5*	*0.45*	*0.4*	*0.3*	*0.25*	*0.2*

Video BW setting		Low 5 MHz	Medium 15 MHz	High 30 MHz	Off
Noise per sample multiplier	< 500 MHz	*0.5*	*1*	*2*	*1*
	≥ 500 MHz	*0.45*	*0.75*	*1.1*	*1*

Effect of video bandwidth setting

The noise per sample is reduced by applying the meter video bandwidth filter setting (High, Medium or Low). If averaging is implemented, this will dominate any effect of changing the video bandwidth.

Effect of time-gating on measurement noise

The measurement noise on a time-gated measurement will depend on the time gate length. 100 averages are carried out every 1 us of gate length. The Noise-per-Sample contribution in this mode can approximately be reduced by √(gate length/10 ns) to a limit of 50 nW.

12. Within one hour after a zero, at a constant temperature, after 24 hour warm-up of the power meter. This component can be disregarded with Auto-zero mode is set to ON.
13. Measured over a one-minute interval, at a constant temperature, two standard deviations, with averaging set to 1.

Appendix A

Uncertainty calculations for a power measurement (settled, average power)

[Specification values from this document are in ***bold italic***, values calculated on this page are <u>underlined</u>.]

Process:

1. Power level: . . . . W
2. Frequency: . . . .

3. Calculate meter uncertainty:

    Calculate noise contribution

    - If in Free Run mode, <u>Noise</u> = **Measurement noise x free run multiplier**
    - If in Trigger mode, <u>Noise</u> = **Noise-per-sample x noise per sample multiplier**

Convert noise contribution to a relative term[14] = <u>Noise</u>/<u>Power</u> . . . . %

Instrumentation linearity . . . . %

Drift . . . . %

RSS of above three terms => <u>Meter uncertainty</u> = ... %

4. Zero Uncertainty

    (Mode and frequency dependent) = Zero set/<u>Power</u> = ... %

5. Sensor calibration uncertainty

    (Sensor, frequency, power and temperature dependent) = ... %

6. <u>System contribution</u>, coverage factor of 2 => sys_{rss} = ... %

    (RSS three terms from steps 3, 4 and 5)

7. Standard uncertainty of mismatch

    Max SWR (Frequency dependent) = ...

    convert to reflection coefficient, $|\rho_{Sensor}|$ = (SWR–1)/(SWR+1) = ...

    Max DUT SWR (Frequency dependent) = ...

    convert to reflection coefficient, $|\rho_{DUT}|$ = (SWR–1)/(SWR+1) = ...

8. Combined measurement uncertainty @ k=1

$$U_C = \sqrt{\left(\frac{Max(\rho_{DUT}) \cdot Max(\rho_{Sensor})}{\sqrt{2}}\right)^2 + \left(\frac{sys_{rss}}{2}\right)^2}$$ . . . .

Expanded uncertainty, k = 2, = $U_C \cdot 2$ = ... %

14. The noise to power ratio is capped for powers > 100 uW, in these cases use: Noise/100 µW.

Worked Example

Uncertainty calculations for a power measurement (settled, average power)

[Specification values from this document are in ***bold italic***, values calculated on this page are <u>underlined</u>.]

Process:

1. Power level:	*1 mW*
2. Frequency:	*1 GHz*

3. Calculate meter uncertainty:

Calculate noise contribution

- If in Free Run mode, <u>Noise</u> = **Measurement noise x free run multiplier**
- If in Trigger mode, <u>Noise</u> = **Noise-per-sample x noise per sample multiplier**

Convert noise contribution to a relative term[15] = <u>Noise</u>/<u>Power</u>	<u>*0.03%*</u>
Instrumentation linearity	*0.8%*
Drift	*–*
RSS of above three terms => <u>Meter uncertainty</u> =	*0.8%*

4. **Zero Uncertainty**

(Mode and frequency dependent) = Zero set/<u>Power</u> =	<u>*0.03%*</u>

5. Sensor calibration uncertainty

(Sensor, frequency, power and temperature dependent) =	*4.0%*

6. System contribution, coverage factor of 2 => sys_{rss} = (RSS three terms from steps 3, 4 and 5)	<u>*4.08%*</u>

7. Standard uncertainty of mismatch

Max SWR (Frequency dependent) =	*1.25*
convert to reflection coefficient, $\|\rho_{Sensor}\|$ = (SWR–1)/(SWR+1) =	<u>*0.111*</u>
Max DUT SWR (Frequency dependent) =	*1.26*
convert to reflection coefficient, $\|\rho_{DUT}\|$ = (SWR–1)/(SWR+1) =	<u>*0.115*</u>

8. Combined measurement uncertainty @ k=1

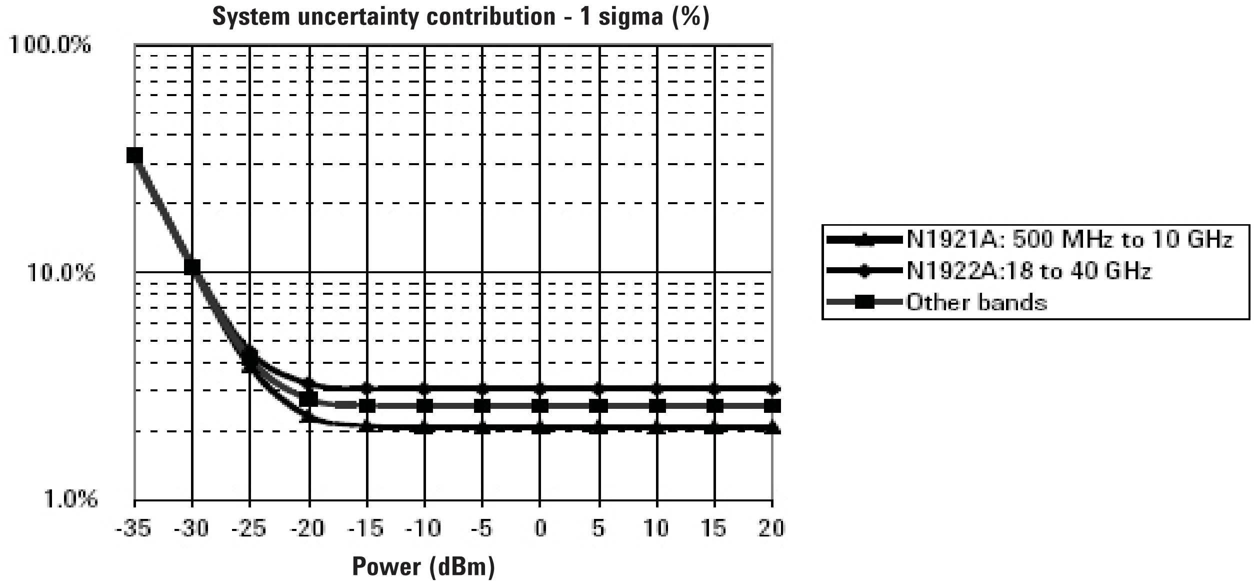
$$U_C = \sqrt{\left(\frac{Max(\rho_{DUT}) \cdot Max(\rho_{Sensor})}{\sqrt{2}}\right)^2 + \left(\frac{sys_{rss}}{2}\right)^2} \quad \ldots \quad \underline{2.23\%}$$

Expanded uncertainty, k = 2, = $U_C \cdot 2$ =	*± 4.46%*

15. The noise to power ratio is capped for powers > 100 uW, in these cases use: Noise/100 µW.

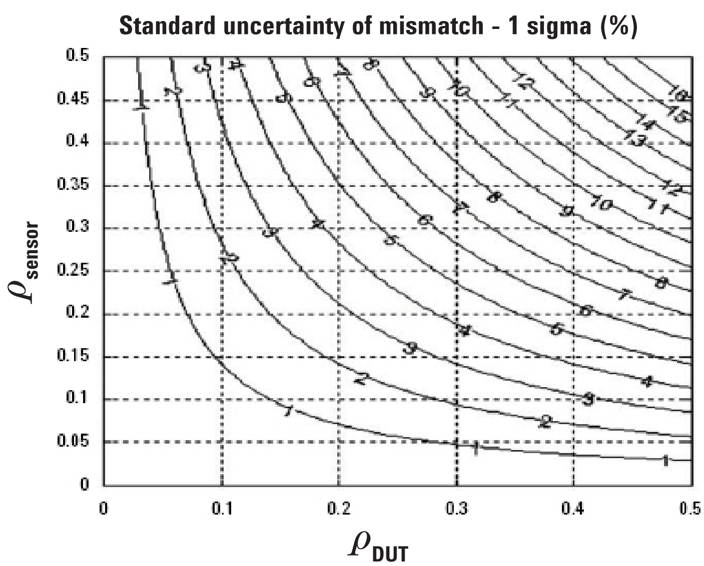
Graphical Example

A. System contribution to measurement uncertainty versus power level (equates to step 6 result/2)



Note: The above graph is valid for conditions of free-run operation, with a signal within the video bandwidth setting on the system. Humidity < 70%.

B. Standard uncertainty of mismatch



SWR	ρ	SWR	ρ
1.0	0.00	1.8	0.29
1.05	0.02	1.90	0.31
1.10	0.05	2.00	0.33
1.15	0.07	2.10	0.35
1.20	0.09	2.20	0.38
1.25	0.11	2.30	0.39
1.30	0.13	2.40	0.41
1.35	0.15	2.50	0.43
1.40	0.17	2.60	0.44
1.45	0.18	2.70	0.46
1.5	0.20	2.80	0.47
1.6	0.23	2.90	0.49
1.7	0.26	3.00	0.50

Note: The above graph shows the Standard Uncertainty of Mismatch = ρDUT. ρSensor /√2, rather than the Mismatch Uncertainty Limits. This term assumes that both the Source and Load have uniform magnitude and uniform phase probability distributions.

C. Combine A & B

$$U_C = \sqrt{(Value\ from\ Graph\ A)^2 + (Value\ from\ Graph\ B)^2}$$

Expanded Uncertainty, k = 2, = 2 • U_c = ... | ± % |

Related Literature List

Agilent N8262A P-Series Modular Power Meter and Power Sensors Configuration Guide, literature number 5989-6608EN

Agilent N8262A P-Series Modular Power Meter and Power Sensors Technical Overview, literature number 5989-6606EN

Agilent N8262A P-Series Modular Power Meter Demo Guide, literature number 5989-6636EN

Fundamental of RF and Microwave Power Measurements (Part 1) Application Notes 1449-1, literature number 5988-9213EN

Fundamental of RF and Microwave Power Measurements (Part 2) Application Note 1449-2, literature number 5988-9214EN

Fundamental of RF and Microwave Power Measurements (Part 3) Application Notes 1449-3, literature number 5988-9215EN

Fundamental of RF and Microwave Power Measurements (Part 4) Application Notes 1449-4, literature number 5988-9216EN

4 Steps for Making Better Power Measurement Application Note 1449-3, literature number 5988-9215EN

Related Web Resources

For more information on the P-Series modular power meter and sensors, visit:
www.agilent.com/find/N8262A

For the latest literature updates, visit:
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Revised: 1/6/06

Product specifications and descriptions in this document subject to change without notice.

Printed in Malaysia, March 11, 2008
5989-6605EN

Agilent Technologies