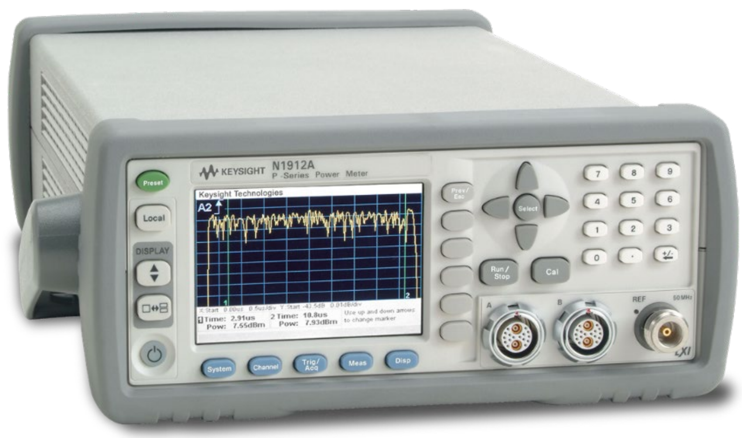
N1911A / N1912A P-Series Power Meters and N1921A / N1922A Wideband Power Sensors



KEYSIGHT

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LXI Class-C-Compliant Power Meter

A P-Series power meter is a LXI Class-C-compliant instrument, developed using LXI Technology. LXI, an acronym for LAN extension for Instrumentation, is an instrument standard for devices that use the Ethernet (LAN) as their primary communication interface.

Hence, it is an easy-to-use instrument especially with the usage of an integrated Web browser that provides a convenient way to configure the instrument's functionality.

The P-Series power meters are supported by the Keysight BenchVue software and BV0007B Power Meter/Sensor Control and Analysis app. BenchVue makes it easy to control your power meter to log data and visualize measurements in a wide array of display options without any programming. BenchVue software license (BV0007B) is now included with your instrument.

For more information, www.keysight.com/find/BenchVue

Specification Definitions

There is one type of product specifications:

- Warranted specifications are specifications which are covered by the product warranty and apply over 0 to 55 ºC unless otherwise noted. Warranted specifications include measurement uncertainty calculated with 95% confidence.
- Characteristic specifications are specifications that are not warranted. They describe product performance as useful in the application of the product.

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 50ohm 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:

- Store for a minimum of two hours at a stable temperature within the operating temperature range and turn on for at least 30 minutes.
- The power meter and sensor are within their recommended calibration period, and
- Used in accordance with the information provided in the User's Guide.

General Features

Number of channels	N1911A P-Series power meter, single channel
	N1912A P-Series power meter, 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 definitions. Time parameter measurements of pulse rise time, fall time, pulse width, time-to-positive occurrence and time-to-negative occurrence are also provided.
Sensor compatibility	P-Series power meters are compatible with all Keysight Technologies, Inc. P-Series wideband power sensors, E-Series sensors, 8480 Series sensors and N8480 Series sensors [1]. Compatibility with the 8480 and E-Series power sensors will be available free-of-charge in firmware release Ax.03.01 and above. Compatibility with N8480 Series power sensors will be available free-of-charge in firmware release A.05.00 and above.

1. Information contained in this document refers to operation with P-Series sensors. For specifications when used with 8480 and E-series sensors (except E9320A range), refer to Lit Number 5965-6382E. For specifications when used with E932XA sensors, refer to Lit Number 5980-1469E.

P-Series Power Meter and Sensor

Key System Specifications and Characteristics [1]

Maximum sampling rate	100 Msamples/sec, continuous sampling
Video bandwidth	≥ 30 MHz
Single-shot bandwidth	≥ 30 MHz
Rise time and fall time	< 13 ns (for frequencies ≥ 500 MHz) [2], see Figure 1
Minimum pulse width	50 ns [3]
Overshoot	< 5 % [2]
Basic accuracy of average power measurement [4]	N1921A: ≤ ± 0.2 dB or ± 4.5 %
	N1922A: ≤ ± 0.3 dB or ± 6.7 %
Dynamic range	–35 to +20 dBm (> 500 MHz)
	–30 to +20 dBm (50 to 500 MHz)
Maximum capture length	1 second
Maximum pulse repetition rate	10 MHz (based on 10 samples per period)

1. See Appendix A for measurement uncertainty calculations.
2. Specification applies only when the Off-video bandwidth is selected.
3. 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.
4. This basic accuracy 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. The accuracy under the other conditions can be obtained with the P-Series measurement uncertainty calculator available on www.keysight.com/find/n1912a.

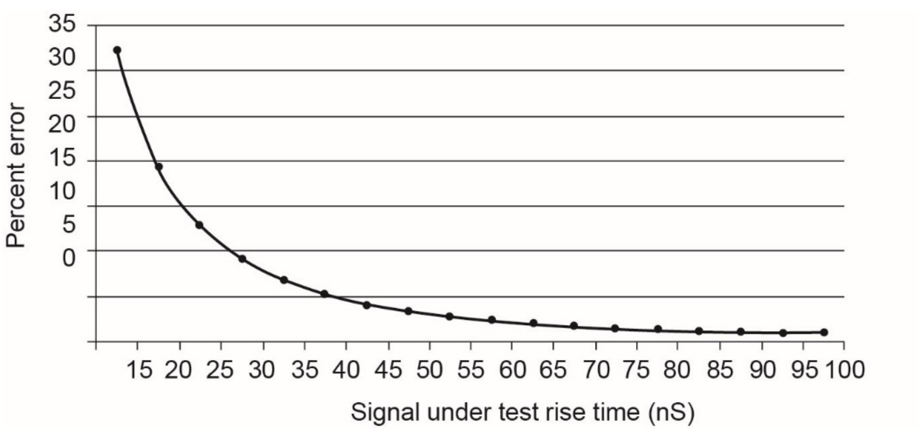


Figure 1. Measured rise time percentage error versus signal under test rise time.

Although the rise time specification is ≤ 13 ns, this does not mean that the P-Series meter and 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):

Measured rise time = √ ((signal under test rise time) ^{2} + (system rise time) ^{2}),

and the % error is:

% Error = ((measured rise time – signal under test rise time) / signal under test rise time) x 100

P-Series Power Meter Specifications

Meter Uncertainty

Instrumentation linearity	± 0.8 %
Timebase	
Timebase range	2 ns to 100 msec/div
Accuracy	± 10 ppm
Jitter	≤ 1 ns
Zero Set	
Zero set (CW)	≤ 0.175 ppm of input range
Zero set (Peak)	≤ 150 ppm of input range
Trigger	
Internal Trigger	
Range	*–20 to +20 dBm*
Resolution	*0.1 dB*
Level accuracy	*± 0.5 dB*
Latency [1]	*160 ns ± 10*
Jitter	*≤ 5 ns rms*
External TTL Trigger Input	
High	*> 2.4 V*
Low	*< 0.7 V*
Latency [2]	*30 ns ± 10 ns*
Minimum trigger pulse width	*15 ns*
Minimum trigger repetition period	*50 ns*
Max trigger voltage input	*15 V emf from 50 dc (current < 100 mA), or*
	60 V emf from 50 Ω (pulse width < 1 s, current < 100 mA)
Impedance	*50 Ω*
Jitter	*≤ 5 ns rms*
External TTL Trigger Output	**Low to High Transition on Trigger Event**
High	*> 2.4 V*
Low	*< 0.7 V*
Latency [3]	*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 Level Threshold Hysteresis	
Range	*± 3 dB*
Resolution	*0.05 dB*
Trigger Hold-Off	
Range	*1 µs to 400 ms*
Resolution	*1 % of selected value (to a minimum of 10 ns)*
Trigger Level Threshold Hysteresis	
Range	*± 3 dB*
Resolution	*0.05 dB*

1. Internal trigger latency is defined as the delay between the applied RF crossing the trigger level and the meter switching into the triggered state.
2. External trigger latency is defined as the delay between the applied trigger crossing the trigger level and the meter switching into the triggered state.
3. 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 only.

Sensor Model	Frequency Range	Dynamic Range	Maximum Input	Connector Type
N1921A	50 MHz to 18 GHz	–35 to +20 dBm (≥ 500 MHz)	+23 dBm (average power)	Type N (m)
		–30 to +20 dBm (50 to 500 MHz)	+30 dBm (< 1 μs duration) (peak power)	
N1922A	50 MHz to 40 GHz	–35 to +20 dBm (≥ 500 MHz)	+23 dBm (average power)	2.4 mm (m)
		–30 to +20 dBm (50 to 500 MHz)	+30 dBm (< 1 μs duration) (peak power)	

Maximum SWR

Frequency Band	N1921A	N1922A
50 MHz to 10 GHz	1.2	1.2
> 10 to 18 GHz	1.26	1.26
> 18 to 26.5 GHz		1.3
> 26.5 to 40 GHz		1.5

Sensor Calibration Uncertainty [1]

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 to 10 GHz	4.0 %	4.4 %
> 10 to 18 GHz	5.0 %	4.7 %
> 18 to 26.5 GHz		5.9 %
> 26.5 to 40 GHz		6.0 %

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

Physical Characteristics

Dimensions in mm with +/- 1 mm	N1921A	135 mm x 40 mm x 27 mm (5.3 in x 1.6 in x 1.1 in)
	N1922A	127 mm x 40 mm x 27 mm (5.0 in x 1.6 in x 1.1 in)
Weights with cable	Option 105	0.4 kg (0.88 lb)
	Option 106	0.6 kg (1.32 lb)
	Option 107	1.4 kg (3.01 lb)
Fixed sensor cable lengths	Option 105	1.5 m (5 feet)
	Option 106	3.0 m (10 feet)
	Option 107	10 m (31 feet)
Recommendation calibration interval	1 year	

Mechanical Characteristic

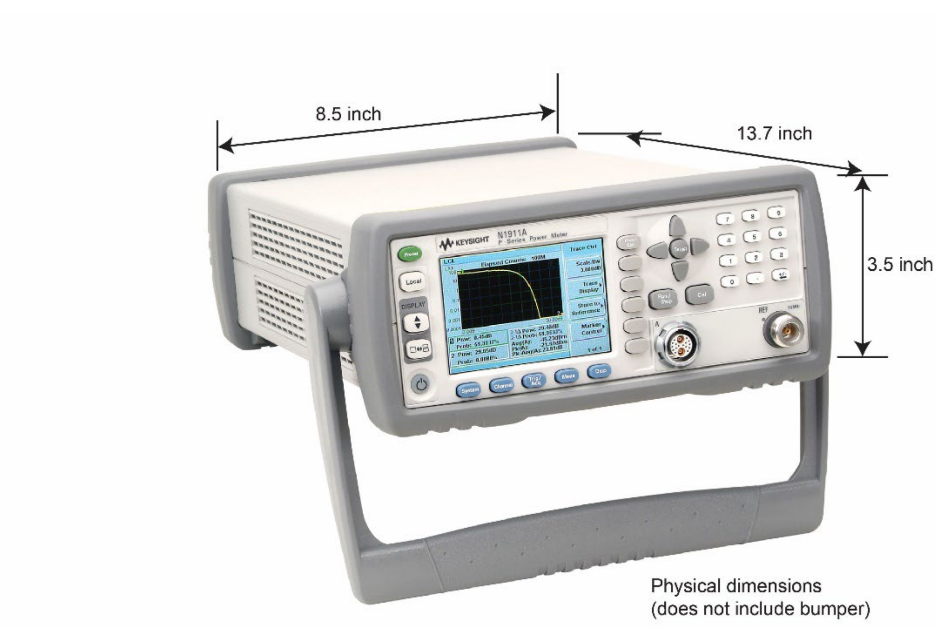
Mechanical characteristics such as center conductor protrusion and pin depth are not performance specifications. They are, however, important supplemental characteristics related to electrical performance. At no time should the pin depth of the connector be protruding.

1 mW Power Reference

Note. The 1 mW power reference is provided for calibration of E-Series, 8480 Series and N8480 Series sensors. The P-Series sensors are automatically calibrated and therefore do not need this reference for calibration.

	Description
Power output	1 mW (0 dBm). Factory set to ± 0.4 % traceable to the National Physical Laboratory (NPL) UK
Accuracy (over 2 years)	± 1.2 % (0 to 55 ºC)
	± 0.4 % (25 ± 10 ºC)
Frequency	50 MHz nominal
SWR	1.08 (0 to 55 ºC)
	1.05 typical
Connector type	Type N (f), 50 Ω
Rear-Panel Inputs/Outputs	
Recorder output	Analog 0-1 Volt, 1 kΩ output impedance, BNC connector. For dual-channel instruments there will be two recorder outputs
GPIB, 10/100BaseT LAN and USB2.0	Interfaces allow communication with an external controller
Ground	Binding post, accepts 4 mm plug or bare-wire connection
Trigger input	Input has TTL compatible logic levels and uses a BNC connector
Trigger output	Output provides TTL compatible logic levels and uses a BNC connector
Line power	
• Input voltage range	90 to 264 Vac, automatic selection
• Input frequency range	47 to 63 Hz and 440 Hz
• Power requirement	N1911A not exceeding 50 VA (30 Watts)
	N1912A not exceeding 75 VA (50 Watts)
Remote Programming	
Interface	GPIB interface operates to IEEE 488.2 and IEC65
	10/100 Base LAN interface
	USB 2.0 interface
Command language	SCPI standard interface commands
GPIB compatibility	SH1, AH1, T6, TE0, L4, LE0, SR1, RL1, PP1, DC1, DT1, C0
Measurement Speed	
Measurement speed via remote interface	≥ 1500 readings per second

	Description
Regulatory Information	
Electromagnetic compatibility	Comply with the following requirements:
	• IEC 61326-1:2005/EN 61326-1:2006
	• CISPR11:2003/, EN 55011:1998+A1:1999+A2:2002 Group 1 Class A
	• Canada: ICES/NMB-001: Issue 4, June 2006
	• Australia/New Zealand: AS/NZS CISPR 11:2004
Product safety	Conforms to the following product specifications:
	• IEC 61010-1:2010/EN 61010-1:2010 (3rd Edition)
	• Canada: CAN/CSA-C22.2 No. 61010-1-12
	• USA: ANSI/UL 61010-1:2012
Physical Characteristics	
Dimensions in mm with +/- 1 mm	The following dimensions exclude front and rear panel protrusions: 88.5 mm H x 212.6 mm W x 348.3 mm D (3.5-inch x 8.5-inch x 13.7-inch)
Net Weight	N1911A ≤ 3.5 kg (7.7 lb) approximate
	N1912A ≤ 3.7 kg (8.1 lb) approximate
Shipping weight	N1911A ≤ 7.9 kg (17.4 lb) approximate
	N1912A ≤ 8.0 kg (17.6 lb) approximate
Display	3.8-inch TFT Color LCD



Physical dimensions
(does not include bumper)

Environmental Conditions	
General	Comply with the requirements of the EMC Directive 89/336/EEC
Operating	
• Temperature	0 to 55 °C
• Maximum humidity	95 % at 40 °C (non-condensing)
• Minimum humidity	15 % at 40 °C (non-condensing)
• Maximum altitude	3,000 meters (9,840 feet)
Storage	
• Non-operating storage temperature	–40 °C to +70 °C
• Non-operating maximum humidity	90% at 65 °C (non-condensing)
• Non-operating maximum altitude	15,420 meters (50,000 feet)
Recommendation calibration interval	2 years

System Specifications and Characteristics

The video bandwidth in the meter can be set to High, Medium, Low and 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 [1]	*< 56 ns*	*< 25 ns*	*≤ 13 ns*	*< 36 ns*	*≤ 13 ns*
Overshoot [2]				*< 5 %*	*< 5 %*

1. Specified as 10% to 90% for rise time and 90% to 10% for the fall time on a 0 dBm pulse. For Option 107 (10 m cable), add 5 ns to the rise time and fall time specifications.
2. Specified as the overshoot relative to the settled pulse top power.

Recorder Output and Video Output

The recorder output is used to output the corresponding voltage for the measurement a 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 50 ohm.

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.

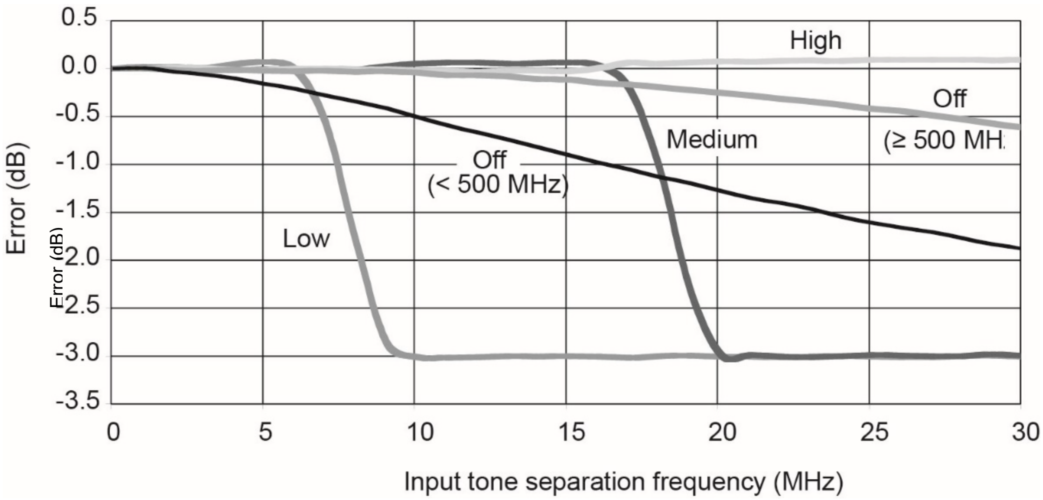


Figure 2. N192XA Error in peak-to-average measurements for a two-tone input (High, Medium, Low and Off filters).

Noise and Drift

Sensor Model	Zeroing	Zero Set		Zero Drift [1]	Noise Per Sample	Measurement Noise (Free Run) [2]
		< 500 MHz	**≥ 500 MHz**			
N1921A / N1922A	No RF on input	*± 200 nW*	*± 200 nW*	*± 100 nW*	*± 2 μW*	*± 50 nW*
	RF present	*± 550 nW*	*± 200 nW*			

1. Within 1 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 set to ON.
2. Measured over a one-minute interval, at a constant temperature, two standard deviations, with averaging set to 1.

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 significantly impact the 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 µs 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.

Ordering Information

	Description
Model	
N1911A	P-Series single channel power meter
N1912A	P-Series dual channel power meter
N1921A	P-Series wideband power sensor, 50 MHz – 18 GHz
N1922A	P-Series wideband power sensor, 50 MHz – 40 GHz
Options	
N191xA-003	P-Series single/dual-channel with rear panel sensors and power ref connectors
N191xA-H01	P-Series single/dual-channel with video output
Sensors	
N192xA-105	P-Series sensors fixed 1.5 m (5 ft) cable length
N192xA-106	P-Series sensors fixed 3.0 m (10 ft) cable length
N192xA-107	P-Series sensors fixed 10 m (31 ft) cable length
Cables	
N1917A	P-Series meter cable adaptor, 1.5 m (5 ft)
N1917B	P-Series meter cable adaptor, 3 m (10 ft)
N1917C	P-Series meter cable adaptor, 10 m (31 ft)
N1917D	P-Series meter cable adaptor, 1.8 m (6 ft)
N1911A-200	11730x cable adaptor
Other Accessories	
34131A	Transit case for half-rack 2U-high instruments (e.g. 34401A)
N191xA-908	Rack mount kit (one instrument)
N191xA-909	Rack mount kit (two instruments)
Software	
BV0007B	BenchVue Power Meter/Sensor Control and Analysis app license
Calibration	
N191xA-1A7	ISO17025 calibration data including Z540 compliance
N191xA-A6J	ANSI Z540 compliant calibration test data
R-50C-011-3	Calibration Assurance Plan - Return to Keysight - 3 years
R-50C-011-5	Calibration Assurance Plan - Return to Keysight - 3 years
R-50C-016-3	ISO 17025 Compliant Calibration up front - 3 years plan
R-50C-016-5	ISO 17025 Compliant Calibration up front - 5 years plan
R-50C-021-3	ANSI Z540-1-1994 Calibration up front - 3 years plan
R-50C-021-5	ANSI Z540-1-1994 Calibration up front - 5 years plan

Standard-Shipped Accessories

- Power cord
- USB cable Type A to Mini-B, 6 ft

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, Noise = Measurement noise x free run multiplier	
• If in Trigger mode, Noise = Noise-per-sample x noise per sample multiplier	
Convert noise contribution to a relative term 1 = <u>Noise/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, $\lvert \rho_{Sensor} \rvert$ = (SWR–1)/(SWR+1) =	
Max DUT SWR (frequency dependent) =	
Convert to reflection coefficient, $\lvert \rho_{DUT} \rvert$ = (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 • 2 =	%

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

Worked Example

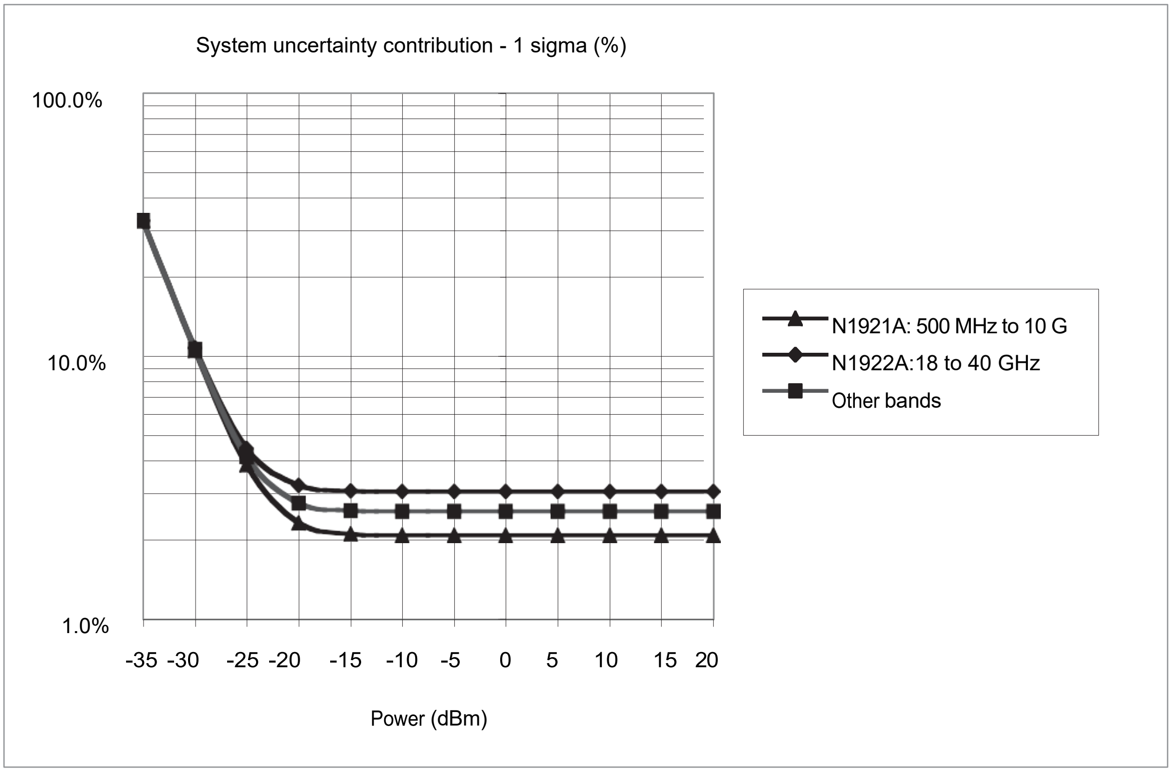
Process

1. Power level	1 mW
2. Frequency	1 GHz
3. Calculate meter uncertainty:	
Calculate noise contribution	
• If in Free Run mode, Noise = Measurement noise x free run multiplier	
• If in Trigger mode, Noise = Noise-per-sample x noise per sample multiplier	
Convert noise contribution to a relative term [1] = Noise/Power	0.03%
Instrumentation linearity	0.8%
Drift	—
RSS of above three terms => Meter uncertainty =	0.8%
4. ***Zero uncertainty***	
(Mode and frequency dependent) = Zero set/Power =	0.03%
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)	4.08%
7. Standard uncertainty of mismatch	
Max SWR (frequency dependent) =	1.25
Convert to reflection coefficient, $\lvert \rho_{Sensor} \rvert$ = (SWR–1)/(SWR+1) =	0.111
Max DUT SWR (frequency dependent) =	1.26
Convert to reflection coefficient, $\lvert \rho_{DUT} \rvert$ = (SWR–1)/(SWR+1) =	0.115
8. Combined measurement uncertainty @ k = 1	
$U_C = \sqrt{\left(\frac{Max(\rho_{DUT}) \cdot Max(\rho_{Sensor})}{\sqrt{2}}\right)^2 + \left(\frac{sys_{rss}}{2}\right)^2}$	2.23
Expanded uncertainty, k = 2, = $U_C \cdot 2$ =	± 4.46%

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

Graphical Example

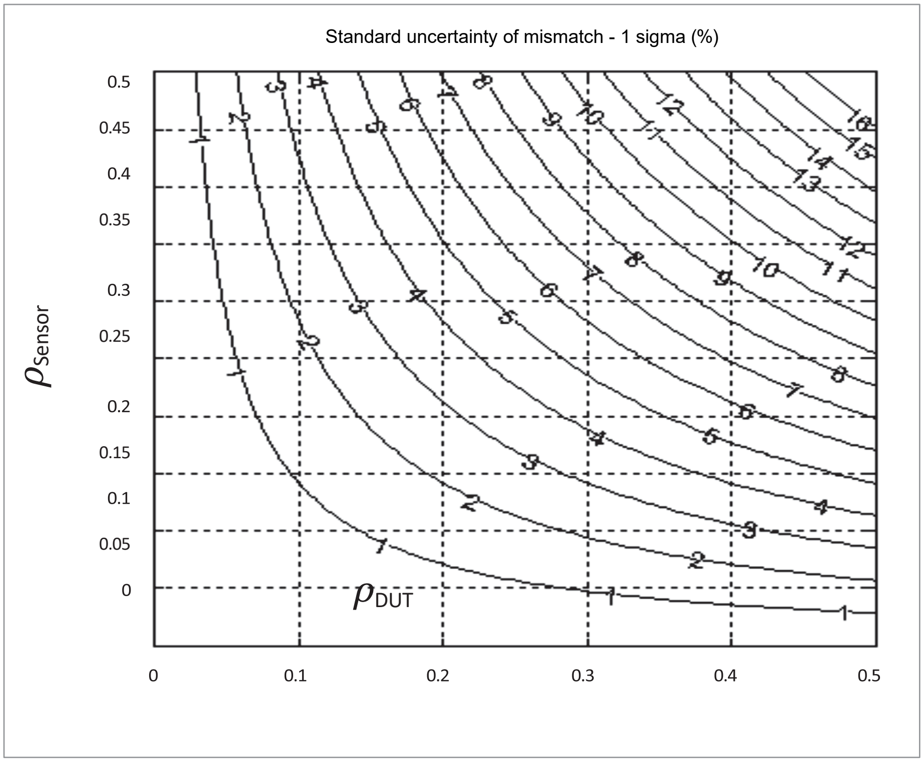
A. System Contribution to Measurement Uncertainty Versus Power Level (Equates to Step 6 Result/2)



Note. This 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



Note. The above graph shows the standard uncertainty of mismatch = ρ_{DUT}. ρ_{Sensor} / √2, rather than the mismatch uncertainty limits. This term assumes that both the source and load have uniform magnitude and uniform phase probability distributions.

SWR	ρ
1.0	0.00
1.05	0.02
1.10	0.05
1.15	0.07
1.20	0.09
1.25	0.11
1.30	0.13
1.35	0.15
1.40	0.17
1.45	0.18
1.5	0.20
1.6	0.23
1.7	0.26

SWR	ρ
1.8	0.29
1.90	0.31
2.00	0.33
2.10	0.35
2.20	0.38
2.30	09
2.40	0.41
2.50	0.43
2.60	0.44
2.70	0.46
2.80	0.47
2.90	0.49
3.00	0.50

C. Combine A and B

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

Expanded uncertainty, k = 2, = U_C • 2 =	**± %**