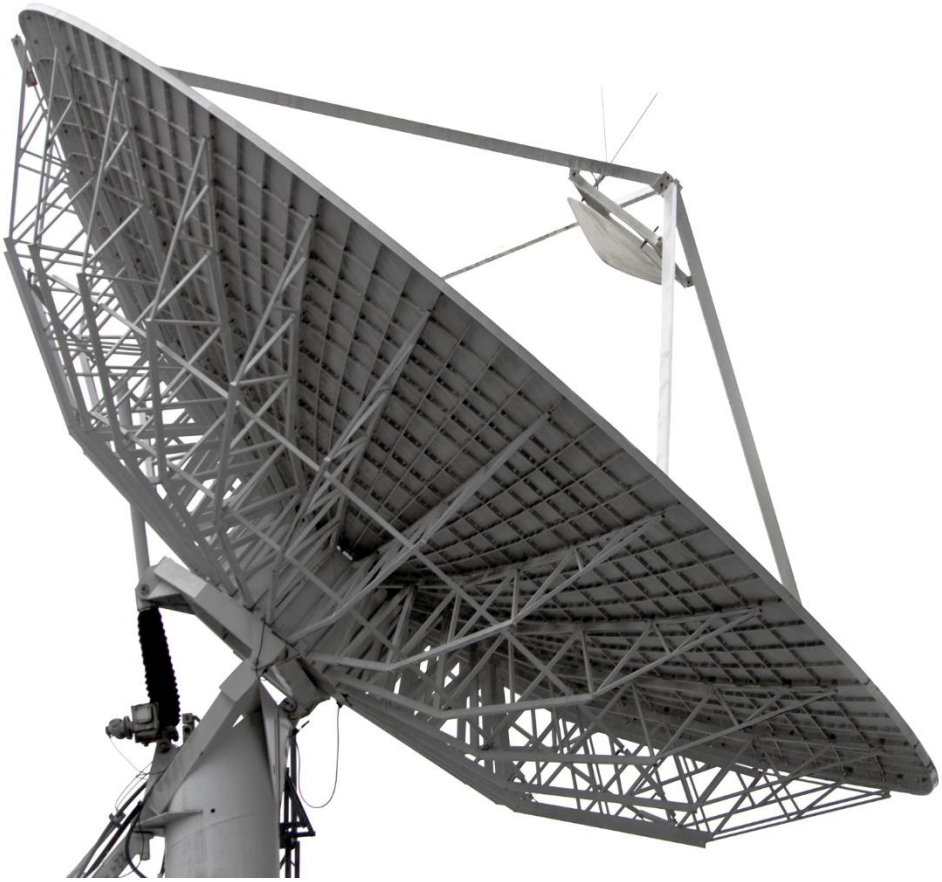
PRODUCT BROCHURE

Peak Power Solutions for Radar and Wireless Applications



KEYSIGHT TECHNOLOGIES

Best Practices for Making the Most Accurate Radar Pulse Measurements

Introduction

Accurate and fast RF and microwave power measurements are critical in radar system life cycles. Power meters and sensors play a critical, yet most cost- effective role in measuring the output power from the radar system. As a long time, manufacturer of power measurement tools for the aerospace and defense industry, Keysight has the following invaluable knowledge to share on making optimal radar measurements accurately and effectively.

IEEE 1394 standard for pulse standard

The power envelope of a radar RF pulse can be analyzed using the IEEE standard 181-2011, “IEEE Standard for Transition, Pulses, and Related Waveforms.” Obtaining a common understanding of each terminology is critical to establish a common ground for parameter and performance comparisons. A list of some commonly used terms in radar pulse measurements are listed in the application note referenced below.

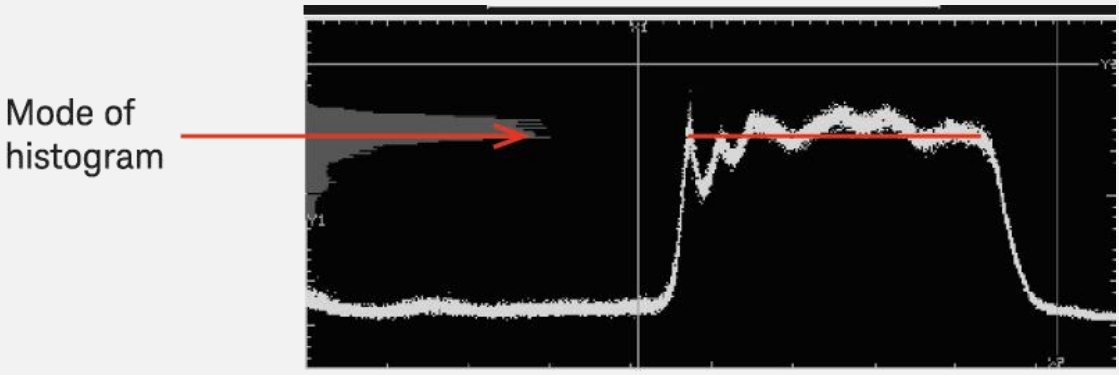


Figure 1. The IEEE STD-181-2011 defines the mode of histogram algorithm needed to determine the reference levels.

Hints and tips

- Reference level adjustment to ensure consistent and accurate transition duration (rise/fall time) measurement
- Tips to achieve accurate and consistent rise/fall time measurement
- Hysteresis and hold-off setting to stable capture of noisy pulse envelope
- Achieving extended dynamic range measurements with different trigger and video bandwidth settings
- Maximizing your measurement speed while maintain same test coverage
- SCPI for ten consecutive pulses for advanced radar measurements

Key products/solutions

- U2020 X-Series USB peak and average power sensors
- P-Series power meters and P-Series wideband sensors

View the full application note here:

https://www.keysight.com/us/en/assets/7018-03483/application-notes/5991-0434.pdf

Single/Multi-Channel and Extended Distance Power Measurement with USB/LAN Power Sensors

Introduction

In today's power measurement applications, there is a need to make multiple power measurements simultaneously. For instance, a base station commonly includes a compact equipment shelter or outdoor enclosure panels along with antennas that may be mounted on a roof, the wall of a building, or on a free-standing mast. A given base station may operate several channels (typically 2 or 3), where each channel uses a specific set of frequencies: one for the uplink and one for the downlink.

Test challenges

- Measurements required from different power sensors and at hourly, daily or monthly intervals
- Distance between the antenna and control room over distances > 5 meters and sometimes as far as 50 meters (exceeds the IEEE industry-specified USB cable length of 5 meters (16 feet))
- Plenty of rack space required for multi-channel power measurement. Costs of a test system increase significantly

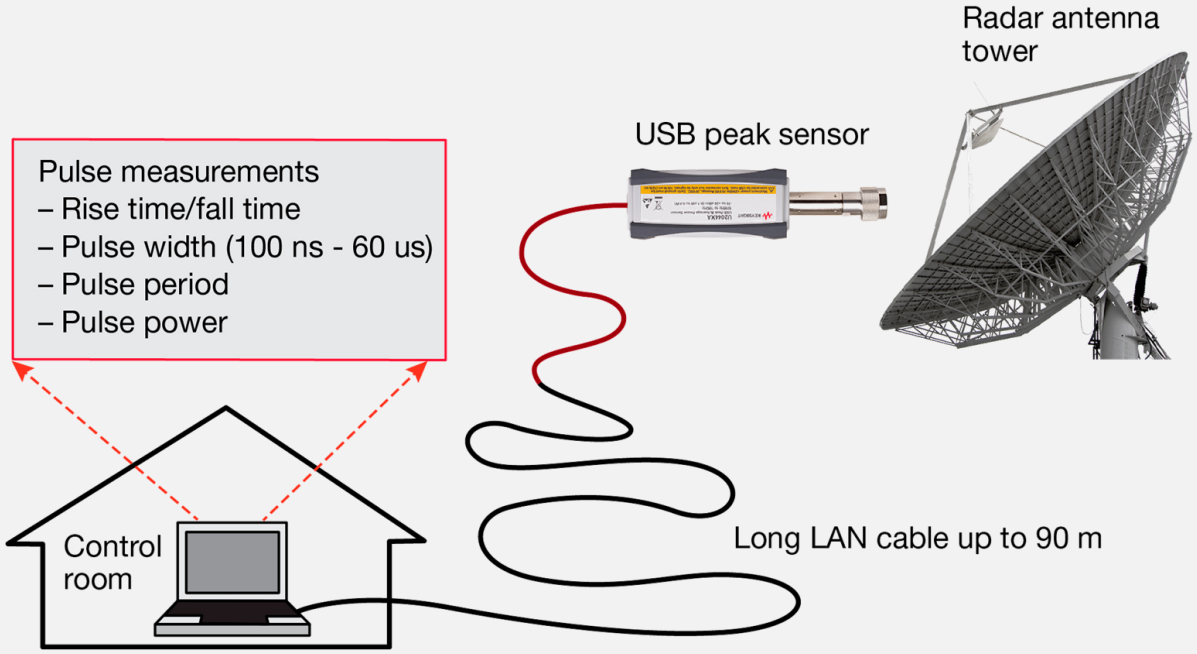


Figure 2. Long distance pulse parameter measurement.

Key products/solution

- USB power sensor solution – U2020 X-Series USB peak and average, U2000A Series USB average, U8480 Series USB thermocouple and U2040/50/60 X-Series USB wide dynamic range peak and average
- LAN power sensor solution - U2049XA and L2050/60 X-Series LAN wide dynamic range peak and average

View the full application note here:

https://www.keysight.com/us/en/assets/7018-01516/application-notes/5989-6280.pdf

Related U2020 X-Series USB Peak and Average Power Sensor Applications

High throughput wireless test systems with up to 20 channels

The U2020 X-Series USB peak and average sensors perform fast and accuratepeak and gated power measurements. These measurements are essential aspects of the production tests conductedfor wireless signals used in cellular/mobile phone handset, wireless chipset, and amplifier applications. With plug-and-playUSB connectivity, high measurement speed and multichannel capability, settingup a high throughput test system is simple, fast, and cost effective.

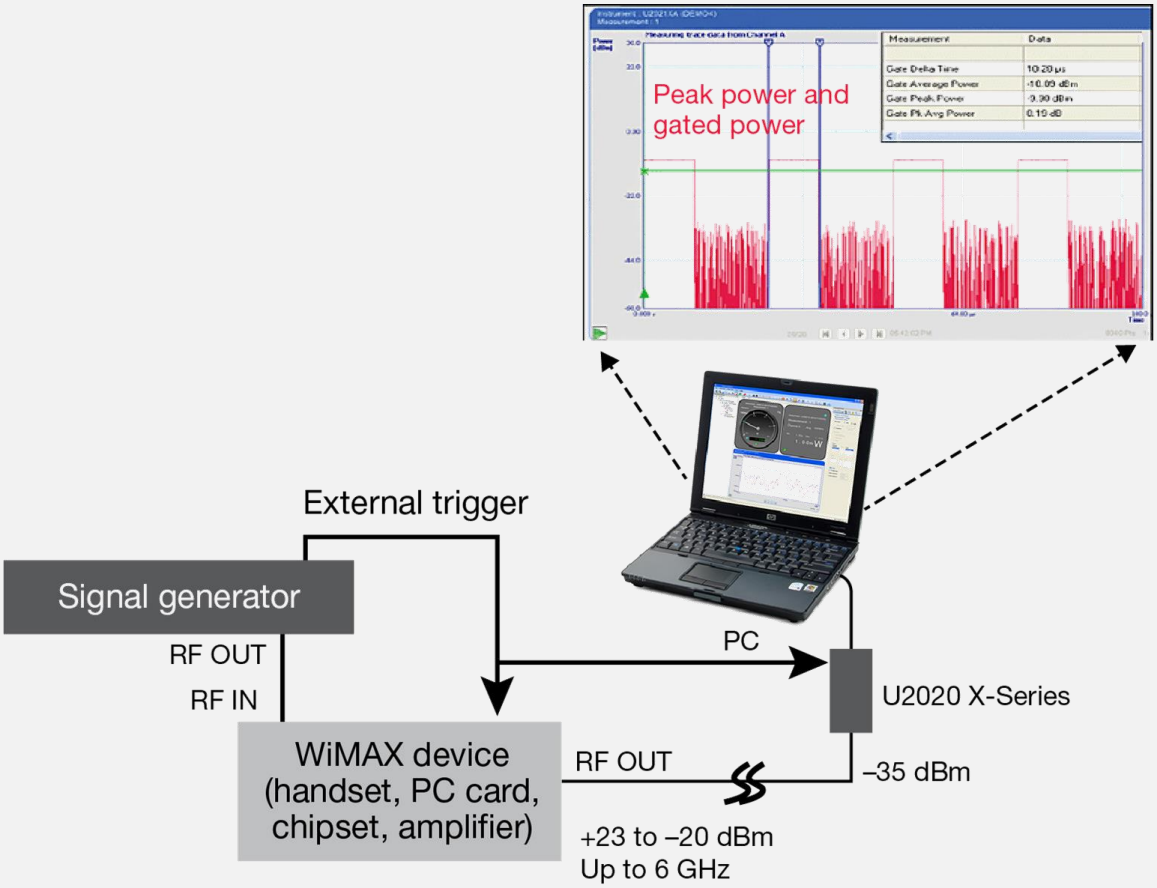


Figure 3. Typical test set up for LTE/WiMAX/WiFi test systems to test handset, PC card, chipset, amplifier with the U2020 X-Series power sensors.

Remote testing for radar installation and maintenance

When a U2020 X-Series power sensor is connected to a LAN-USB adapter, you can perform complex radar pulse analysis and monitor your measurements from a distance up to 200 feet. The built-in internal zero calibration function allows you to permanently connect your sensor to the device-under-test without the hassle of constantly removing and re-installing your sensor.

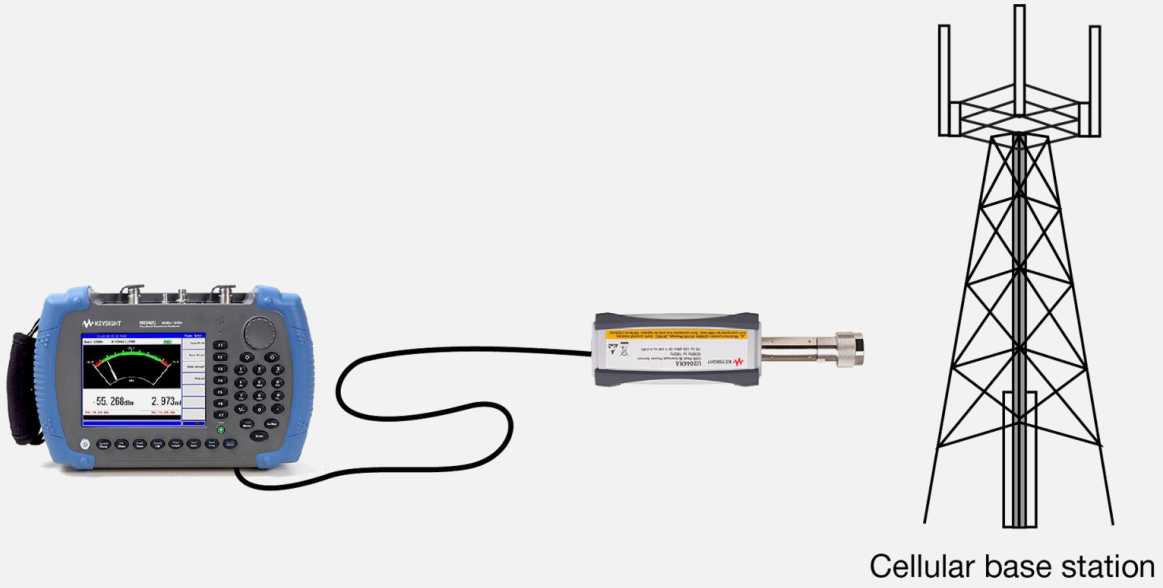


Figure 4. Portable and lightweight solution for cellular base station maintenance.

Maximizing Measurement Speed Using P-Series Power Meters

Introduction

Productivity and overall throughput are important in high volume manufacturing industry. As such, by increasing the speed of measurements, engineers can achieve shorter testing time and accelerate product time-to-market.

Considerations for maximizing measurement speed

- External triggering in CW mode — allows trigger to power meter via an external
- TTL signal for measurement capture with a user-defined buffer size not exceeding 2048 measurement points.
- Sweep trigger mode
  - Power sweep — used in power level calibration setup for flatness, linearity, or gain compression characterization for device under test (DUT)
  - Frequency sweep — used in frequency response calibration system
- External triggering mode — use immediate/free run mode or trigger output enabled mode to synchronize with the signal generators.

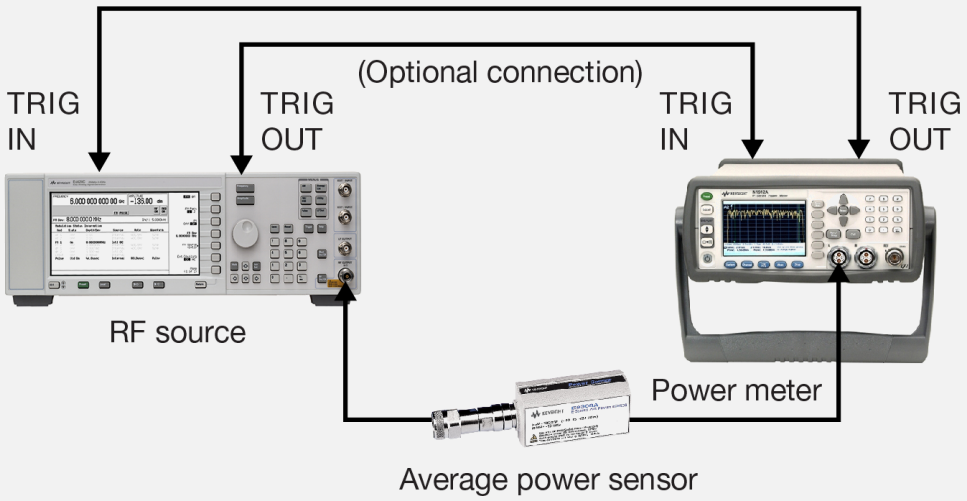


Figure 5. Hardware Connection for External Triggering in CW Mode

Use cases

- Aerospace and defense: radar and pulse component tests
- Wireless communication: base station component and MCPA tests
- Wireless networking: design and manufacturing of network devices
- Broadband communications include WiMAX base station and devices test

Key products

- P-Series power meters N1911A/12A (firmware A.04.01) when used with any of 8480 Series, [1] E4410 Series, E9300 Series or E9320 Series power sensors.

View the full application note here:

http://literature.cdn.keysight.com/litweb/pdf/5989-7678EN.pdf

1. For 8480 Series power sensors, only power sweep is enabled.

Accelerate Your LTE Signal Burst Power Measurement with Keysight P-Series Power Meter/Sensor

Introduction

Long term evolution (LTE) standard from the 3rd Generation Partnership Project (3GPP) is deployed all around the world. The complexity of the LTE system requires comprehensive signal and modulation analysis as well as RF power measurement.

Figure 6. P-Series power meter and ESG signal generator setup diagram for LTE measurements over LAN connection.

Key attributes for LTE

- Downlink capacity — Peak data rates up to 172.8 Mbps with 20 MHz bandwidth and 2x2 SU-MIMO
- Uplink capacity — Peak data rates up to 86.4 Mbps with 20 MHz bandwidth and 64QAM
- Spectrum flexibility — Scalable bandwidth up to 20 MHz
- Spectral efficiency — Increased spectral efficiency over Release 6 HSPA by a factor of two to four
- Latency — Sub-5 ms latency for small internet protocol (IP) packets
- Mobility — Optimized for low mobile speed from 0 to 15 km/h; higher mobile speeds up to 120 km/h supported with high performance
- Support for packet-switched domains only.

Test challenges/measurement parameters

- Perform accurate measurement of Sub-frame signal of time-division-duplex (LTE-TDD)
- Average burst power signal of frequency-division-duplex (LTE-FDD) with built-in LTE predefined measurement setup
- Statistical complementary cumulative distribution function (CCDF) measurement for LTE-TDD and LTE-FDD signals

Key products

- N1911A/12A P-Series power meters
- N1921A/22A wideband power sensors

View the full application note here:

https://www.keysight.com/us/en/assets/7018-02168/technical-overviews/5990-4063.pdf

Product Highlights

U2040 and U/L2050/60 X-Series USB/LAN Wide Dynamic Range Power Sensors

Accurately measure any modulated signal with U2040 and U/L2050/60 X-Series wide dynamic range power sensors. With LAN connectivity, a first in the industry, and USB connectivity, the X-Series USB/LAN wide dynamic range power sensors comes with the world's widest dynamic range in a power sensor, covering a range of -70 to +26 dBm. And because the U2049XA (option TVA), U2065/66/67XT LAN power sensors comes with a thermal vacuum compliance, you can get the same accuracy and performance even in thermal vacuum chambers.

Highlights

- The world's widest dynamic range in a power sensor, spanning -70 to +26 dBm
- Fast measurement speed at 50,000 readings/second (fast/ buffered mode)
- Variable Sampling Rate 1M samples/sec and Long Memory 1M samples data storage
- Average mode time selectivity feature allows the sensor to make both average and time-gated average measurements across the full 96 dB range
- Capture and analyze measurements with the intuitive BenchVue software
- World's first LAN-based sensor with thermal vacuum compliance

Features

Models

- U2041XA & U/L2051XA USB/LAN wide dynamic range average power sensor (10 MHz to 6 GHz; -70 to +26 dBm)
- U2042XA & U/L2061XA USB/LAN peak and average power sensor (10 MHz to 6 GHz; -70 to +26 dBm)
- U2043XA & U/L2052XA USB/LAN wide dynamic range average power sensor (10 MHz to 18 GHz; -70 to +26 dBm)
- U2044XA & U/L2062XA USB/LAN peak and average power sensor (10 MHz to 18 GHz; -70 to +26 dBm)
- U2049XA LAN wide dynamic range peak and average power sensor (10 MHz to 33 GHz; -70 to +20 dBm)
- U/L2053XA USB/LAN wide dynamic range average power sensor (10 MHz to 33 GHz; -70 to +26 dBm)
- U/L2063XA USB/LAN peak and average power sensor (10 MHz to 33 GHz; -70 to +26 dBm)
- U/L2054XA USB/LAN wide dynamic range average power sensor (10 MHz to 40 GHz; -70 to +20 dBm)
- U/L2064XA USB/LAN peak and average power sensor (10 MHz to 40 GHz; -70 to +20 dBm)
- U/L2055XA USB/LAN wide dynamic range average range power sensor (10 MHz to 50 GHz; -70 to +20 dBm)
- U/L2065XA USB/LAN peak and average range power sensor (10 MHz to 50 GHz; -70 to +20 dBm)
- U/L2056XA USB/LAN wide dynamic range average range power sensor (10 MHz to 54 GHz; -70 to +20 dBm)
- U/L2066XA USB/LAN peak and average range power sensor (10 MHz to 54 GHz; -70 to +20 dBm)

- U/L2057XA USB/LAN wide dynamic range average power sensor (10 MHz to 67 GHz; -70 to +20 dBm)
- U/L2067A USB/LAN peak and average range power sensor (10 MHz to 67 GHz; -70 dBm to +20 dBm)
- L2065XT LAN TVA peak and average power sensor (10 MHz to 53 GHz; -70 to +26 dBm)
- L2066XT LAN TVA peak and average power sensor (10 MHz to 54 GHz; -70 to +26 dBm)
- L2067XT LAN TVA peak and average power sensor (10 MHz to 67 GHz; -70 to +26 dBm)

Specifications

- Measurement speed: 50,000 readings/second (fast/buffered mode)
- Sampling rate: 20 MSamples/second

Measurement type

- Peak, min, average, and peak-to-average ratio power measurements
- Time-gated and free-run measurement modes
- Automatic rise time, fall time, pulse width, pulse period, duty cycle, time to positive occurrence, and time to negative occurrence time measurements
- CCDF statistical analysis

Calibration

- Internal zeroing and calibration

Remote programmability

- USB interface
- LAN interface

U2020 X-Series USB Peak and Average Power Sensors

The U2021XA and U2022XA X-series USB peak power sensors are designed to carry out high speed peak and average power measurements. These sensors offer a fast measurement speed of 25,000 readings/ second and a wide peak power dynamic range of –45 to +20 dBm, providing the peak power measurement capability of a power meter in a compact, portable form.

Features

Models

- U2021XA X-series USB peak and average power sensor (50 MHz to 18 GHz; -45 to +20 dBm)
- U2022XA X-series USB peak and average power sensor (50 MHz to 40 GHz; -45 to +20 dBm)

Specifications

- 30 MHz video bandwidth
- 25,000 readings/s measurement speed (in buffer mode)
- Frequency range of 50 MHz to 18/40 GHz

Measurement type

- Peak, min, average, and peak-to-average ratio power measurements
- Time-gated and free-run measurement modes
- Automatic rise time, fall time, pulse width, pulse period, duty cycle, time to positive occurrence, and time to negative occurrence time measurements
- CCDF statistical analysis.

Calibration

- Internal zeroing and calibration

Remote programmability

- USB interface

Highlights

- Fast measurement speed of 25,000 readings/second (in buffer mode)
- Wide peak power range of 50 dB, ranging from –45 to +20 dBm
- Fast rise/fall time of down to 13 nanoseconds and a video bandwidth of 30 MHz
- Standalone peak power measurement capability without the need of a power meter
- Built-in trigger in/trigger out function
- Built-in radar and wireless presets

U8480 Series USB Thermocouple Power Sensors

The U8480 Series USB power sensors is one of the most cost-effective solutions in Keysight's power meter and sensor portfolio, providing top performance features at costs so affordable that every engineer can carry one in their bags. These sensors come with a measurement speed of 900 readings/second and power linearity of less than 0.8%, providing high accuracy and stability to help you make average power measurements from DC to 67 GHz (sensor dependent) quickly and confidently.

Features

Models

- U8481A USB thermocouple power sensor (DC/10 MHz to 18 GHz; -35 to +20 dBm)
- U8485A USB thermocouple power sensor (DC/10 MHz to 33 GHz; -35 to +20 dBm)
- U8487A USB thermocouple power sensor (10 MHz to 50 GHz; -35 to +20 dBm)
- U8488A USB thermocouple power sensor (DC/10 MHz to 67 GHz; -35 to +20 dBm)
- U8489A USB thermocouple power sensor (DC to 120 GHz; -35 to +20 dBm)

Specifications

- 900 readings/s measurement speed
- Power linearity: < 0.55% (–1 to +15 dBm); < 0.80% (+15 to +30 dBm)
- Damage level (RF): 25 dBm (average power); 15 W (2 µs duration) (peak power)
- Damage level (DC): AC coupled (option 100), 50 V; DC coupled (option 200), 4 V
- Zero set: < 25 nW
- Zero drift: < 10 nW
- Measurement noise: < 80 nW

Measurement type

- Average power measurements
- Calibration

Internal calibration

- Remote programmability
- USB interface

Highlights

- Measurement speed of 900 readings/second and power linearity of < 0.8%
- Keysight's first power sensor to measure down to DC (sensor dependent)
- Bundled with N1918A Power Analyzer software
- Add power measurement capabilities to selected Keysight instruments, and switch between power measurements and the
- Instrument's original function when needed
- Improve accuracy with real time measurement uncertainty feature
- Correct for errors with the S-parameter and gamma correction functions

N1911A/12A P-Series Power Meters

The P-Series power meters are LXI Class C compliant, designed for high performance measurement of wireless signals such as WiMAX™ and radar. Predefined settings in the P-Series power meters enable effective capture of unpredictable wireless signals, with their high burst rates and fast, time-varying power levels.

Features

Models

- Single-channel N1911A
- Dual-channel N1912A

Specifications

- 30 MHz video bandwidth
- 100 Msamples/s continuous sampling rate

Measurement type

- Peak, average, peak-to-average ratio power measurements
- Time-gated and free-run measurement modes
- CCDF statistical analysis in graphical and tabular formats
- Rise time, fall time, pulse width, time to positive occurrence and time to negative occurrence measurements
- Includes predefined configurations for WiMAX, HSDPA and DME

Calibration

- Calibration and correction factors in EEPROM (P-Series, E-Series sensors and N8480 Series)
- Internal zeroing and calibration (P-Series sensors)

Remote programmability

- SCPI standard interface commands
- * Also programmable in other languages. See below
- GPIB, LAN and USB interfaces

Highlights

- Quick set up with 22 radio presets
- Automatic pulse capture
- Wide VBW and high sampling rate
- High resolution color display
- External triggerable when used with E-Series average power sensor

System-ready software

- Bundled IVI driver enables programming via your choice of environment, including Keysight VEE, LabVIEW, LabWindows, C, C++, and MATLAB

Backward-compatibility

- Code-compatible with EPM-P and EPM Series power meters

Keysight Power Meters and Sensors

Keysight Technologies offers a complete portfolio of high-performance peak and average power measurement solutions to fit your applications need—from benchtop meters to portable form factors such as USB and LAN, for R&D to manufacturing applications within the aerospace defense and wireless industries.

Peak power measurement			
8990B peak power analyzer	**N8262A P-Series modular power meters**	**N1911A/2A P-Series power meters**	**E4416A/7A EPM-P Series power meters**
			
5 ns rise time/fall time	1U half-rack size	100 MSa/s continuous sampling, single-shot 30 MHz VBW	20 MSa/s continuous sampling, 5 MHz VBW
100 MSa/s sampling rate	100 MSa/s continuous sampling, single-shot 30 MHz VBW	Includes time-gated and statistical (CCDF) power measurements	Bundled analyzer software for pulse and statistical analysis
15-inch XGA color and touchscreen display	Wireless presets include WLAN, radar and MCPA	Wireless presets include WiMAX™, HSDPA and DME	Wireless presets include GSM, *Bluetooth*™ and W-CDMA
	Code-compatible with N1912A P-Series power meter		

Average power measurement	
N1913A/14A EPM Series power meters	**N432A thermistor power meters**
	
Single, dual, or four-channel measurements	High accuracy (≤ 0.2% ± 0.5 uW), excellent for 1 mW transfer calibration (with 478A-H75/H76)
Frequency range of 9 kHz to 110 GHz; power range of -70 to +44 dBm (depending on power sensor)	Built-in 6.5-digit ADC eliminates the need for an external DMM
Fast measurement speed of 400 readings/s	Digital color LCD display, and user-friendly interface
Code-compatible with legacy E4418B/9B EPM Series, 436A, 437B and 438A power meters (43X compatibility only with option N191xA-200)	

Portable power measurement				
V3500A handheld RF power meters	U2000 Series USB power sensors	U8480 Series USB thermocouple power sensors	U2020 X-series USB peak and average power sensors	U2040 and U/L2050/60 X-Series USB/LAN wide dynamic range peak and average power sensors
				
Broad 10 MHz to 6 GHz frequency range	-60 to +44 dBm, 9 kHz up to 26.5 GHz	DC up to 120 GHz (sensor dependent), -35 to +20 dBm	-30 to +20 dBm (peak/ gated), -45 to +20 dBm (average only mode), 50 MHz to 18/40 GHz	-70 to +26 dBm, 10 MHz up to 67 GHz
Wide dynamic range (–60 dBm to +20 dBm)	Quick and easy set up with USB connectivity	Measurement speed of 900 readings/second and power linearity of < 0.8%	25,000 readings/second measurement speed (buffer mode)	50,000 readings/second measurement speed (fast/ buffered mode)
Absolute accuracy up to ± 0.21dB	Internal zeroing without disconnecting from device under-test	Real time measurement uncertainty feature	Internal zero and calibration	First sensor with thermal vacuum compliant (U2049XA option TVA, U2065/66/67XT)
Built-in display with backlight and integrated power sensor	Bundled with BenchVue Power Meters/Sensor App for easy monitoring and troubleshooting	Bundled with BenchVue Power Meters/Sensor App for easy monitoring and troubleshooting	Bundled with BenchVue Power Meters/Sensor App for easy monitoring and troubleshooting	Bundled with BenchVue Power Meters/Sensor App for easy monitoring and troubleshooting
Internal power reference enables self-calibration before use	Built-in trigger in/trigger out	Built-in trigger in/trigger out	Built-in trigger in/trigger out	Built-in trigger in/trigger out
3-ways power up capability (via AA batteries, USB interface, and AC power adaptor)				USB and LAN connectivity

Power sensors		
Peak and average power sensors	Average power sensors	Waveguide power sensors
		
N1921A/22A P-Series power sensors	E4410, E9300 E-Series power sensors	E8486A E-band waveguide power sensor
N1923A/24A wideband power sensors	N8480 Series thermocouple power sensors	V8486A V-band waveguide power sensor
E9320 E-Series power sensors	848xD Series	W8486A W-band waveguide power sensor
	478A, 8478B thermistor power sensors	

Free Power Measurement Hints and Tips

Keysight Technologies offers a wide selection of power meters and sensors for your application needs, and to help you make better measurements in less time, we've compiled an array of resources for you. Visit the Power Measurement Hints and Tips page at www.keysight.com/ find/rfpowertips for application notes, technical overviews and other power meter and sensor related tools.

Here are some key topics that may interest you:

Publication title	Publication number
Long-Term, Remote Monitoring of Satellite Performance	5991-3681EN
Achieving Accurate E-band Power Measurements with Keysight E8486A Waveguide Power Sensors	5991-3776EN
An RF Power Measurement Solution for Multi-antenna MIMO Transmissions	5991-3097EN
Understanding DC-coupled and DC-blocked Power Sensors and How Your Choice of Sensor Would Impact Measurement Accuracy	5990-6745EN
MIMO Measurement Tips with Keysight P-Series Power Meters and U2000 Series USB Power Sensors	5990-3546EN
P-Series and EPM-P Power Meters for Bluetooth Testing	5989-8459EN
4 Steps for Making Better Power Measurements	5965-8167E
Choosing the Right Power Meter and Sensor	5968-7150E

Watch a Live Demonstration or Video Introduction

Visit the Power Meter and Sensor playlist on the Keysight YouTube network at www.keysight.com/find/pmps-video to see the latest videos related to Keysight's power meter and sensor family.

Learn more at: www.keysight.com

For more information on Keysight Technologies' products, applications, or services, please contact your local Keysight office. The complete list is available at: www.keysight.com/find/contactus