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.

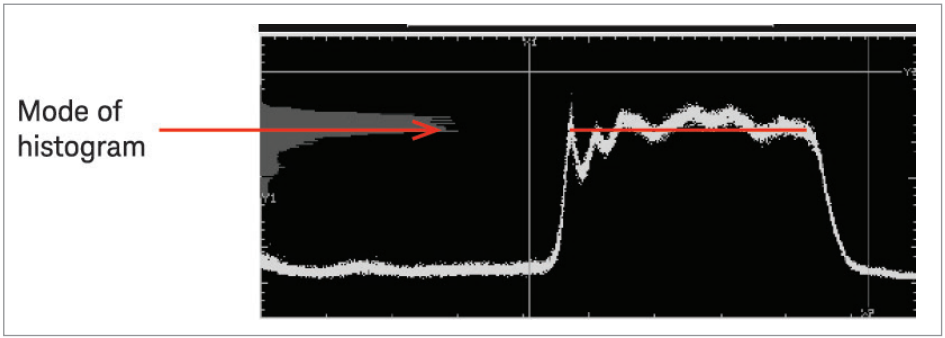

Figure 1. The IEEE STD-181-2011 defines the mode of histogram algorithm needed to determine the reference levels.

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 sensor
- P-Series power meters and P-Series wideband sensors

View the full application note here:

http://literature.cdn.keysight.com/litweb/pdf/5991-0434EN.pdf

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

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

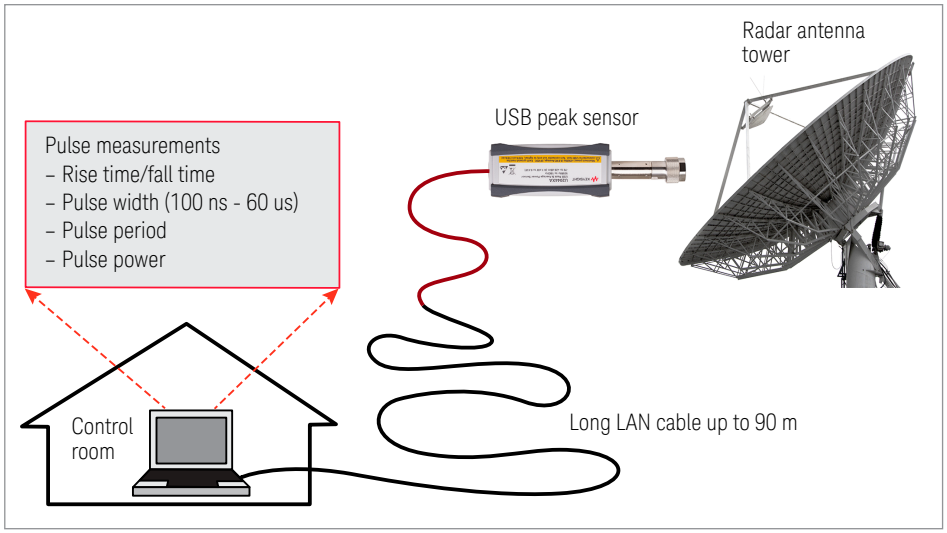

Figure 2. Long distance pulse parameter measurement.

Key products/solution

- USB power sensor solution – U2020 X-Series USB peak and average, U2000A Series USB average, U8480 Series USB thermocouple and U2040/53/63 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:

http://literature.cdn.keysight.com/litweb/pdf/5989-6280EN.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 accurate peak and gated power measurements. These measurements are essential aspects of the production tests conducted for wireless signals used in cellular/mobile phone handset, wireless chipset and amplifier applications. With plug-and-play USB connectivity, high measurement speed and multichannel capability, setting up a high throughput test system is simple, fast and cost effective.

Remote testing for radar installation and maintenance

When a U2020 X-Series 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.

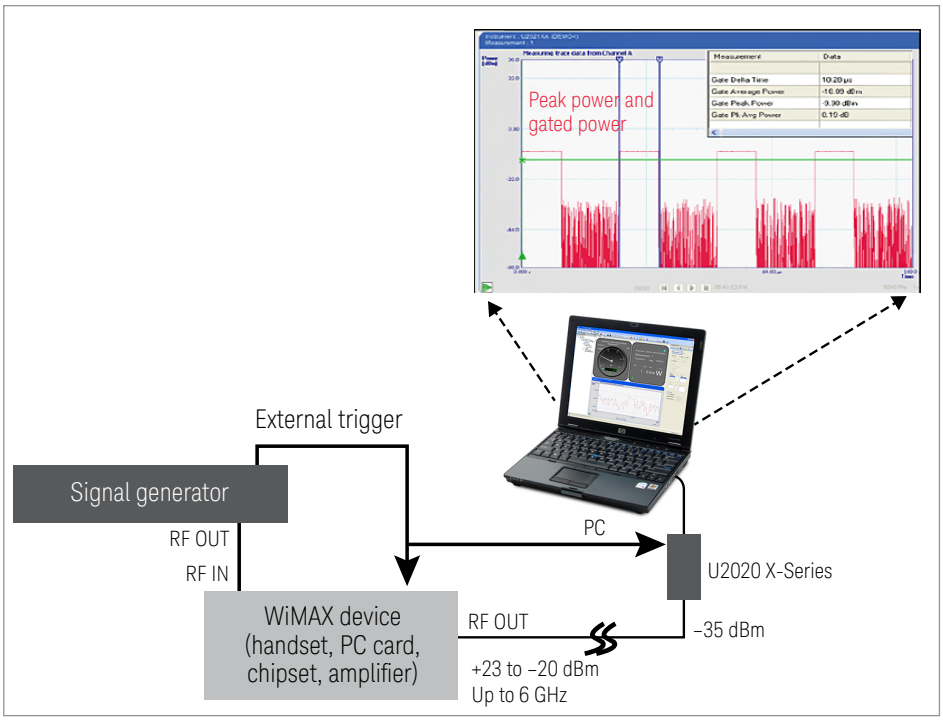

Figure 3. Typical test set up for LTE/WiMAX/WiFi test systems to test handset, PC card, chipset, amplifier with the U2020 X-Series sensor.

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

Testing Radar Transmitter Amplitude and Timing Stability Using the 8990B Peak Power Analyzer

Introduction

During the design, manufacturing, or even maintenance of a radar transmitter, testing and validating the transmitter's RF output stability is one of the key performance parameters. Pulse-to-pulse stability is one of the most important characteristics of a pulsed radar transmitter. It is usually characterized by pulse-to-pulse phase and amplitude variation between successive pulses of a burst or pulse train.

The new multipulse analysis software for the 8990B peak power analyzer (PPA) is the first and only power meter solution for analyzing complex radar signals. It allows users to view, measure, and analyze continuous pulse trains, capture and trigger up to 512 pulses, and adds features crucial for testing and validating the RF output stability of power amplifiers and transmitters such as pulse-to-pulse measurement and histogram distribution graph capabilities.

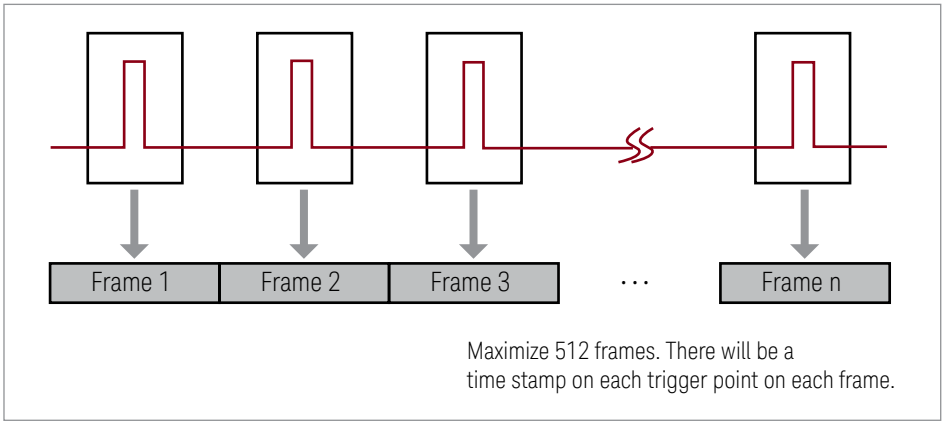

Figure 5. Optimize the pulse(s) into the frame window by adjusting the timescale, trigger settings and trigger delay.

Use cases

- Testing long-pulse repetitive interval (PRI) pulses.
- Trigger and capture on-time pulses and discard off-time pulses in search and tracking radar system. The transmitter emits narrow pulses with very long PRIs, or off-time in between pulses. The PRI duration can be as long as several seconds. Currently, digital oscilloscope (DSO) with a segmented memory feature is used (connected to a diode detector) to convert the RF pulses to analog signal.
- Measuring droop of a radar pulse burst or pulse train.
- Detect any abnormal or missing pulses in the systems where the radar transmitter emits a series of pulse trains or bursts instead of a single pulse over a certain time duration. In this situation, the transmitter must sustain the amplitude of all the pulses inside the burst. Only a small amplitude drop or droop across the pulses in the burst is acceptable.

Testing Radar Transmitter Amplitude and Timing Stability Using the 8990B Peak Power Analyzer (Continued)

Key product/solution

- 8990B peak power analyzer with multipulse analysis software
- 8990B-1FP – Multipulse analysis software, fixed perpetual license purchased with the 8990B
- N6903A – Multipulse analysis software purchased standalone for customers who already have 8990B

Test parameters:

- Pulse-to-pulse amplitude – Scalar pulse measurements such as peak power, top, overshot, width, repetition interval (PRI), rise time, and fall time
- Timing stability – comparisons showing droop across pulse train, abnormal pulses, or even missing pulses
- View the full application note here:

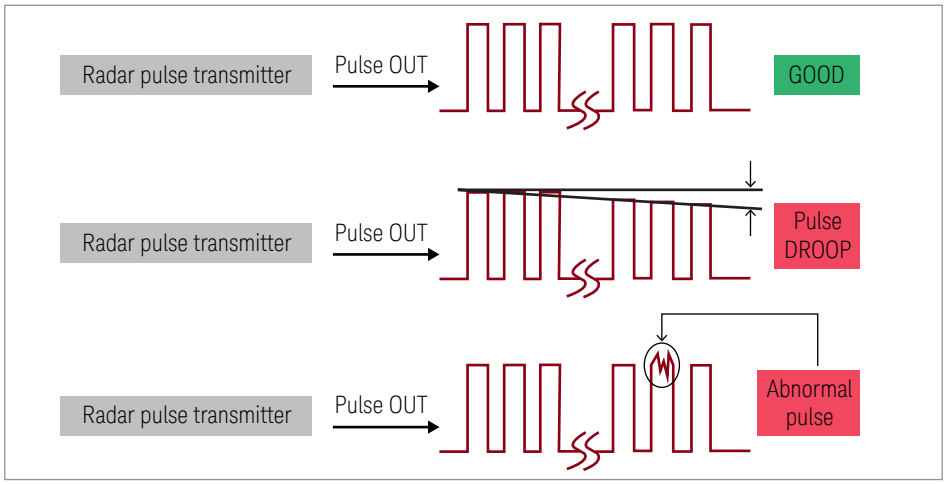

Figure 6. Checking transmitter output pulse stability.

http://literature.cdn.keysight.com/litweb/pdf/5991-3226EN.pdf

Secondary Radar Transponder Testing Using the 8990B Peak Power Analyzer

Introduction

Primary radar works by reflecting a radar pulse off of the target surface (primary radars listen to the reflected echoes). Secondary radars originated from the Identification Friend or Foe (IFF) radar application developed during World War II. It works by transmitting and receiving high-frequency modulated pulses, also called interrogation and reply signals. The ground station sends interrogation signals to the airborne aircraft, and the plane's onboard transponder responds to the interrogation signals by transmitting back reply signals.

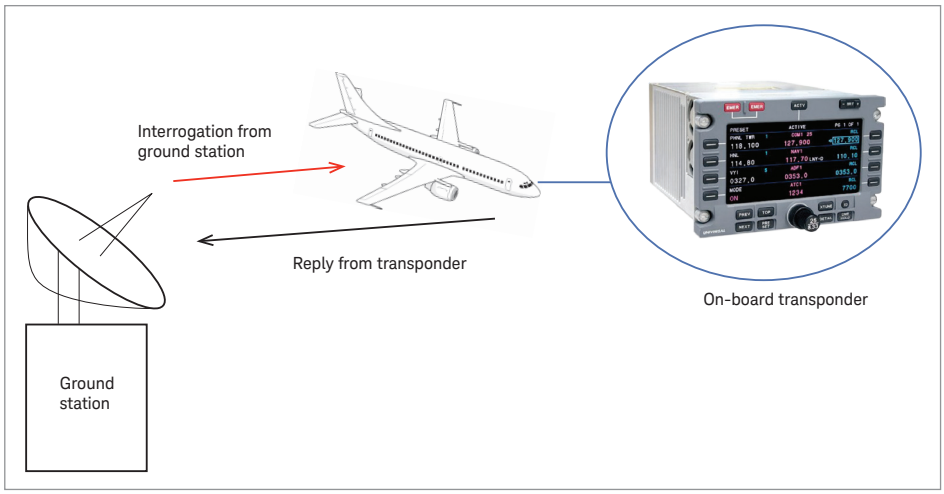

Figure 7. Illustration of the secondary radar operating principle.

Use cases

Federal aviation safety standards require transponders to undergo periodic maintenance and calibration.

- Ensures that the transponder is decoding interrogation pluses correctly and subsequently replying with correct pulses
- Performance checks that ensure the transponder transmit/receive functions conform to specifications

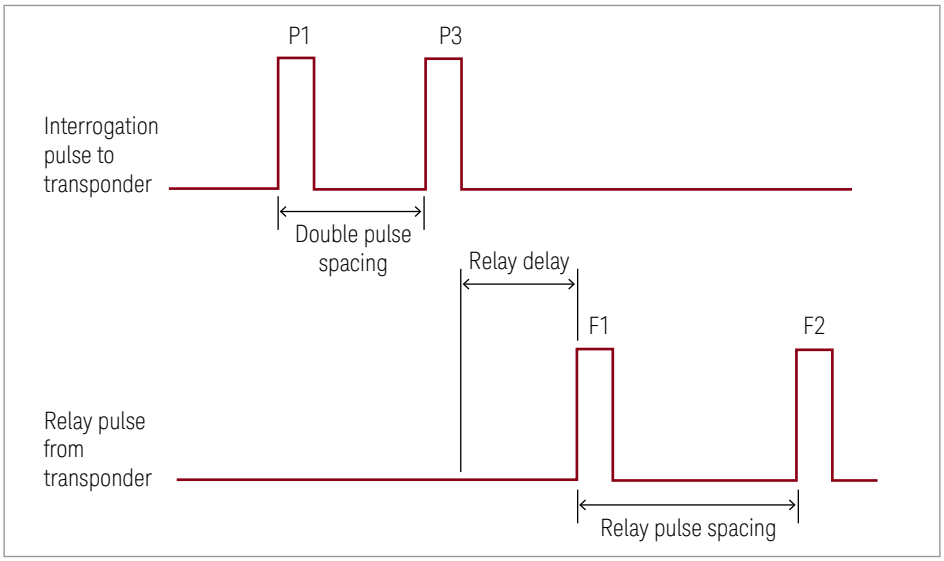

Figure 8. Transponder interrogation and reply pulse pairs timing diagram.

Measurement parameters

- Interrogation and reply transmit power and pulse profiling, double pulse spacing, and reply delay timing measurement.

View the full application note here:

http://literature.cdn.keysight.com/litweb/pdf/5991-1192EN.pdf

How to Measure 5 ns Rise/Fall Time on an RF Pulsed Power Amplifier Using the 8990B Peak Power Analyzer

Introduction

Pulse power amplifier is one of the key components in the transmitter-side of a pulsed radar system (see Figure 9). These power amplifiers used in pulse radar systems need to output up to several kilowatts of power. As such, the design of the power amplifiers is critical in supporting wider bandwidth (> 100 MHz), thus allowing more data to be transferred and power consumption efficiency is enhanced.

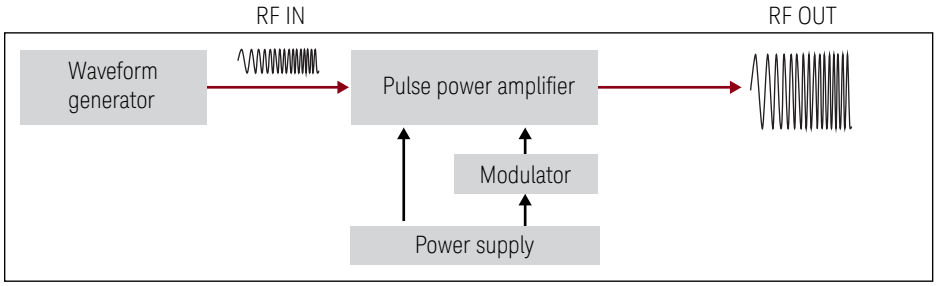

Figure 9. Transmitter block diagram.

Test challenges

- Achieving fast and accurate rise/fall time with minimum measurement uncertainty.
- Equipment capability – measurement device with a rise time that is faster than the expected rise/fall time.

Hints and tips

- Measurement uncertainty can be reduced with direct measurement from the RF pulse of the DUT. Use of adapters and connectors will increase measurement error.
- Use of equivalent time sampling (ETS) feature in the 8990B to increase the sampling rate to capture fast and repetitive signals.

Key product

- 8990B peak power analyzer

View the full application note here:

http://literature.cdn.keysight.com/litweb/pdf/5990-9661EN.pdf

Maximizing Measurement Speed Using P-Series Power Meters

Introduction

Productivity and overall throughput is 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.

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

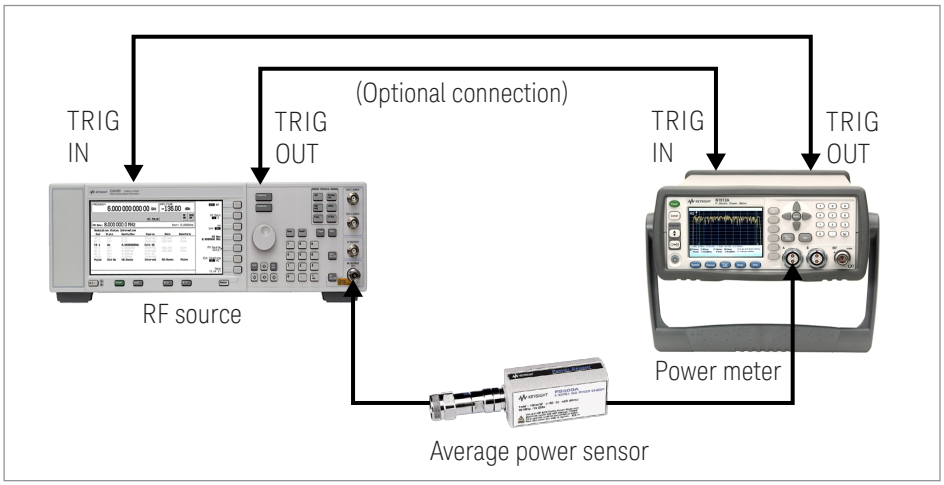

Figure 10. Hardware Connection for External Triggering in CW Mode

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.

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

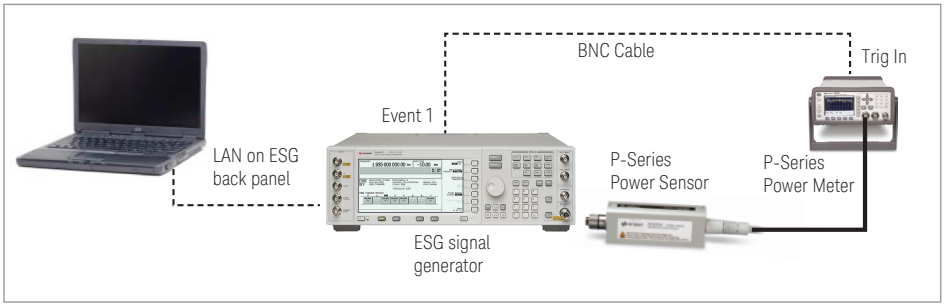

Figure 11. P-Series power meter and ESG signal generator setup diagram for LTE measurements over LAN connection.

Key products

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

View the full application note here:

http://literature.cdn.keysight.com/litweb/pdf/5990-4063EN.pdf

Product Highlights

U2040/53/63 and L2050/60 X-Series USB/LAN Wide Dynamic Range Power Sensors

Accurately measure any modulated signal with U2040/53/63 and 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 LAN power sensor comes with a thermal vacuum option, 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)
- 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 option

Features

Models

- U2041XA USB wide dynamic range average power sensor (10 MHz to 6 GHz; –70 dBm to +26 dBm)
- U2042 XA USB peak and average power sensor (10 MHz to 6 GHz; –70 dBm to +26 dBm)
- U2043XA USB wide dynamic range average power sensor (10 MHz to 18 GHz; –70 dBm to +26 dBm)
- U2044 XA USB peak and average power sensor (10 MHz to 18 GHz; –70 dBm to +26 dBm)
- U2049XA LAN wide dynamic range peak and average power sensor (10 MHz to 33 GHz; –70 dBm to +20 dBm)
- U2053XA USB wide dynamic range average power sensor (10 MHz to 33 GHz; –70 dBm to +26 dBm)
- U2063XA USB wide dynamic range peak and average power sensor (10 MHz to 33 GHz; –70 dBm to +26 dBm)
- L2051XA LAN wide dynamic average range power sensor (10 MHz to 6 GHz; –70 dBm to +26 dBm)
- L2052XA LAN wide dynamic average range power sensor (10 MHz to 18 GHz; –70 dBm to +26 dBm)
- L2053XA LAN wide dynamic average range power sensor (10 MHz to 33 GHz; –70 dBm to +26 dBm)
- L2061XA LAN wide dynamic peak and average range power sensor (10 MHz to 6 GHz; –70 dBm to +26 dBm)
- L2062XA LAN wide dynamic peak and average range power sensor (10 MHz to 18 GHz; –70 dBm to +26 dBm)
- L2063XA LAN wide dynamic peak and average range power sensor (10 MHz to 33 GHz; –70 dBm to +26 dBm)

Features (Continued)

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 –30 dBm to +20 dBm, providing the peak power measurement capability of a power meter in a compact, portable form.

Highlights

- Fast measurement speed of 25,000 readings/second (in buffer mode)
- Wide peak power range of 50 dB, ranging from –30 dBm 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

Features

Models

- U2021XA X-series USB peak and average power sensor (50 MHz to 18 GHz; –35 dBm to +20 dBm)
- U2022XA X-series USB peak and average power sensor (50 MHz to 40 GHz; –35 dBm to +20 dBm)

Specifications

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

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.

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

Features

Models

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

8990B Peak Power Analyzer

The 8990B peak power analyzer comes with two RF channels and two video channels and, when used with a compatible power sensor, measures the dynamic time-dependent aspects of RF and microwave power. Combined with the N1923A/N1924A wideband power sensors, the 8990B achieves 5 nanoseconds RF pulse rise time/fall time. The 8990B provides internal and external trigger functions and the peak power analyzer's video input allows for the simultaneous analysis of time-domain control signals.

Designed with both ease of use and high performance in mind, the 8990B peak power analyzer does more than just measure and analyze – it saves you time and effort, letting you focus on the important details.

The 8990B peak power analyzer has been named one of *Test & Measurement World's Top 50 products for 2011*.

Highlights

- Achieve 5 nanosecond rise time/ fall time – the fastest in the peak power measurement market
- Set, trigger and measure pulse measurements easily
- Perform accurate and more detailed pulse measurements, faster
- Verify design problems quickly with a 15 inch XGA color display
- Compatible with U2000 Series USB power sensors for additional channels

Features

Models

- 8990B peak power analyzer

Specifications

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

Measurement type

- Peak, average, peak-to-average ratio power measurements
- CCDF statistical analysis in graphical and tabular formats
- Rise time, fall time, pulse width, duty cycle, PRI and PRF
- Automated delay measurement, automated droop measurement, pulse spacing measurement
- Multi-pulse analysis (with option 8990B-1FP or N6903A)
- Power-added efficiency (PAE) measurement

Calibration

- Calibration and correction factors in EEPROM (N1923A/N1924A wideband power sensors and P-Series power sensors)
- Internal zeroing and calibration (N1923A/N1924A wideband power sensors and P-Series power sensors)

Remote programmability

- SCPI standard interface command
- LAN and USB interfaces
- GPIB (with N4865A GPIB to LAN adapter)

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.

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

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
-

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

- 5 ns rise time/fall time
- 100 MSa/s sampling rate
- 15 inch XGA color and touchscreen display

N8262A P-Series modular power meters

- 1U half-rack size
- 100 MSa/s continuous sampling, single-shot 30 MHz VBW
- Wireless presets include WLAN, radar and MCPA
- Code-compatible with N1912A P-Series power meter

N1911A/2A P-Series power meters

- 100 MSa/s continuous sampling, single-shot 30 MHz VBW
- Includes time-gated and statistical (CCDF) power measurements
- Wireless presets include WiMAX™, HSDPA and DME

E4416A/7A EPM-P Series power meters

- 20 MSa/s continuous sampling, 5 MHz VBW
- Bundled analyzer software for pulse and statistical analysis
- Wireless presets include GSM, *Bluetooth*™ and W-CDMA

Average power measurement

N1913A/14A EPM Series power meters

- Single, dual or four-channel measurements
- Frequency range of 9 kHz to 110 GHz; power range of –70 dBm to +44 dBm (depending on power sensor)
- Fast measurement speed of 400 readings/s
- Code-compatible with legacy E4418B/9B EPM Series, 436A, 437B and 438A power meters (43X compatibility only with option N191xA-200)

N432A thermistor power meters

- High accuracy (≤ 0.2% ± 0.5 uW), excellent for 1 mW transfer calibration (with 478A-H75/H76)
- Built-in 6.5-digit ADC eliminates the need for an external DMM
- Digital color LCD display, and user-friendly interface

Portable power measurement

V3500A handheld RF power meters

- Broad 10 MHz to 6 GHz frequency range
- Wide dynamic range (–60 dBm to +20 dBm)
- Absolute accuracy up to ± 0.21dB
- Built-in display with backlight and integrated power sensor
- Internal power reference enables self-calibration before use
- 3-ways power up capability (via AA batteries, USB interface, and AC power adaptor)

U2000 Series USB power sensors

- –60 dBm to +44 dBm, 9 kHz to 26.5 GHz average power measurements without power meters
- Quick and easy set up with USB connectivity
- Internal zeroing without disconnecting from device under-test
- Bundled N1918A Power Analysis Manager software for easy monitoring and troubleshooting

U8480 Series USB thermocouple power sensors

- DC to 120 GHz (sensor dependent), –35 dBm to +20 dBm
- Measurement speed of 900 readings/second and power linearity of < 0.8%
- Bundled with N1918A Power Panel software
- Real time measurement uncertainty feature

U2020 X-series USB peak and average power sensors

- –30 dBm to +20 dBm (peak/gated), –45 dBm to 20 dBm (average only mode), 50 MHz to 18 GHz/40 GHz
- 25,000 readings/second measurement speed (buffer mode)
- Internal zero and calibration
- Built-in trigger in/trigger out

U2040/53/63 and L20050/60 X-Series USB/LAN wide dynamic range peak and average power sensors

- –70 dBm to +26 dBm, 10 MHz to 33 GHz
- 50,000 readings/second measurement speed (fast/buffered mode)
- First sensor with thermal vacuum option (U2049XA only)
- USB and LAN connectivity

Power sensors

Peak and average power sensors

- N1921A/22A P-Series power sensors
- N1923A/24A wideband power sensors
- E9320 E-Series power sensors

Average power sensors

- E4410, E9300 E-Series power sensors
- N8480 Series thermocouple power sensors
- 848xD Series
- 478A, 8478B thermistor power sensors

Waveguide power sensors

- E8486A E-band waveguide power sensor
- V8486A V-band waveguide power sensor
- W8486A W-band waveguide power sensor

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
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