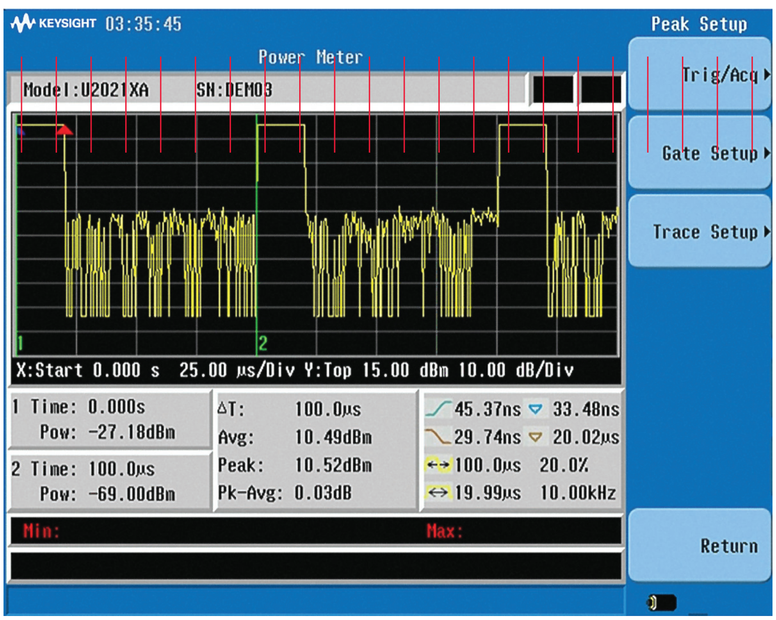
Keysight Technologies
The Easy Way to Make Pulse Signal Measurements

Using the Keysight N934xC Handheld Spectrum Analyzer and U2020 X-Series USB Peak and Average Power Sensors

Application Note



KEYSIGHT TECHNOLOGIES

Introduction

From R&D and manufacturing, to maintenance and repair services, power measurements are ubiquitous in the RF and microwave world. Along with their growing presence, the need to perform peak power measurements is increasing, especially in military and communication applications. These measurements are necessary to test the pulsed transmissions of radar, GSM and WiMAX™ communication devices, and TD-LTE base stations.

While traditional transmission testing in the field has typically relied on the use of a laptop PC, Keysight Technologies' N934XC handheld spectrum analyzer (HSA) and U2020 X-Series peak power sensors offers an alternative solution which makes testing transmissions easier. For example, when you're working in field, the long boot-up time for a laptop PC can be an inconvenience. Additionally, laptop PC software typically includes capabilities, such as multiple channels, feeds, and traces mathematics—functionality that is mainly desired by labs and production lines instead of field applications. The N934xC HSA-based solution provides streamlined functions to address the specific needs of the field engineer. That purpose-driven focus is another reason the N934xC/U2020 X-series solution makes peak power measurement setup in the field simpler.

The Keysight U2020 X-series USB peak and average power sensors enable peak power measurements that have the same accuracy as measurements obtained using traditional peak power meters, while providing the advantages of being a very compact and portable form factor. The U2020 X-series is provided with free PC-based software N1918A Power Analysis Manager. This software enables powerful measurement capability and flexibility. With the built-in internal zeroing and calibration features, U2020 X-series sensors do not require a calibration source. Nor do the sensors need to be disconnected from the DUT while the sensor performs zeroing and calibration. These features make measurement preparation easier.

This application note briefly discusses the principle of the peak power sensor and explains how easy it is to quickly set up peak power measurements using the N934xC HSA/U2020 X-series solution.

Principle of Peak Power Sensors

Power meters (or power sensors), are one of the simplest instruments in the RF and microwave test and measurement world. As shown in Figure 1, in concept the USB peak power sensor can be separated into two functional parts:

- Power detection and acquisition, and
- Data processing and measurement

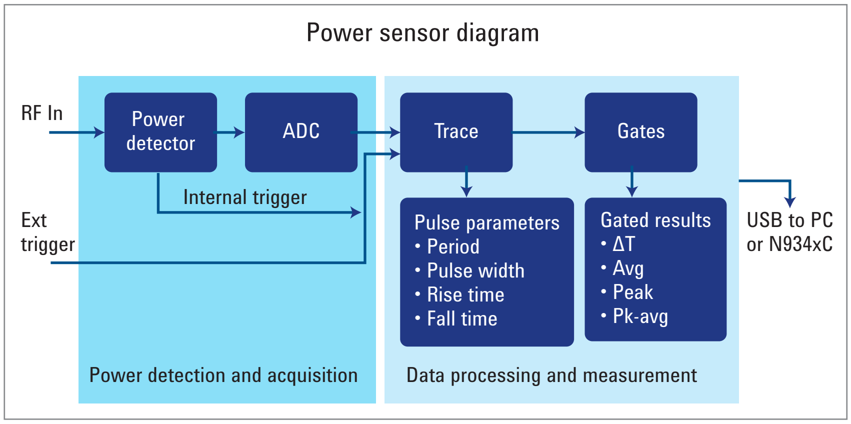


Figure 1. Conceptual diagram of USB peak power sensor

Power detection and acquisition

Typically, the power detector is a diode sensor. It instantly detects any change in the input signal's power level and converts the power level of the RF or microwave signal to a DC voltage. The voltage fluctuates with the change in the input signal's power. The analog-to-digital converter (ADC) converts the analog voltage to digital bits for further logic processing and measurement by a field programmable gate array (FPGA) or microcontroller unit (MCU).

The trigger tells the digital processing unit when it should start data acquisition, and subsequently stores the data for further processing and analysis. The trigger source can be an external input or internally-generated from the RF burst signal. The trigger always comes with a complementary parameter, called the Trigger Delay. Trigger Delay allows adjustment of the time window as it relates to the trigger point so you can view the signal portion of interest.

Data processing and measurement

The second part of the power meter performs data processing and measurement. Classic power meters process data and make measurements in the meter instead of the sensor. However, the U2020 X-series USB sensors have built-in digital processing and calculation capabilities, which are performed by the FPGA and MCU, thus all measurements are made by the sensor itself. The N934xC handheld spectrum analyzer (or the N1918A Power Analysis Manager) provides the graphic user interface for setting parameters and presenting results.

Though not shown in Figure 1, video filtering is done as part of the digital signal processing in the FPGA or MCU, rather than by a physical analog filter. The bandwidth of the video filter determines how fast power changes are reported. The wider the bandwidth, the faster a change of power level can be captured. U2020 X-series sensors have a 30 MHz video bandwidth and can capture the rising and falling power edge in as little as 13 ns.

Trace is a term describing the power level versus time, which is actually a series of data provided by the ADC. All measurements are made based on trace data, and it is displayed on a two-dimensional chart. The X-axis represents the time domain, based on the user-defined start time, and the Y-axis reflects power level in dBm or Watt. Once trace is longer than a cycle of the pulse signal, the sensor automatically detects the pulse parameters, including pulse period, pulse repetition frequency, pulse width, duty cycle, rise time and fall time.

Gate/time gated measurement is another time domain parameter. It defines the power measurements made during the specified period and provides the average power, peak power, and peak-to-average ratio during the gate period. For example, gate can be applied to the top of a pulsed signal to get the average power when pulse is set to On.

Terminology of pulse power measurements

The relationships among trigger, trigger delay, trace, and gate are illustrated in Figure 2.

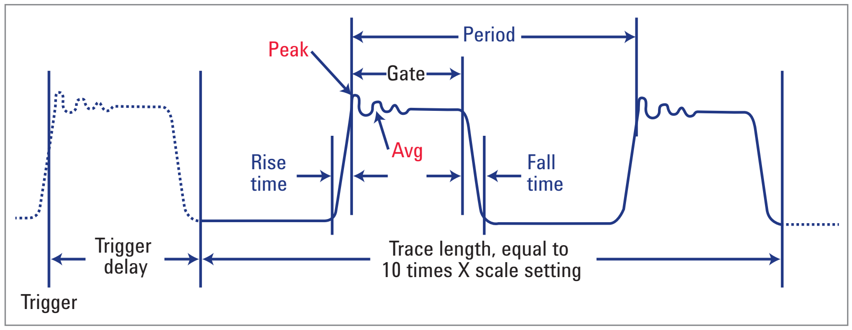


Figure 2. Terminology of pulse power measurements

In this diagram, the words in black (trigger, trigger delay, gate, and trace length), are parameters that need to be set properly before measurements are made. The words in blue (Rise time, Period, Fall time) are results of pulse parameter measurement. This information is displayed in the right bottom of the trace view shown in Figure 3. The words in red (Peak and Avg) are time gated power measurement results, which are displayed in middle bottom of trace view in Figure 3.

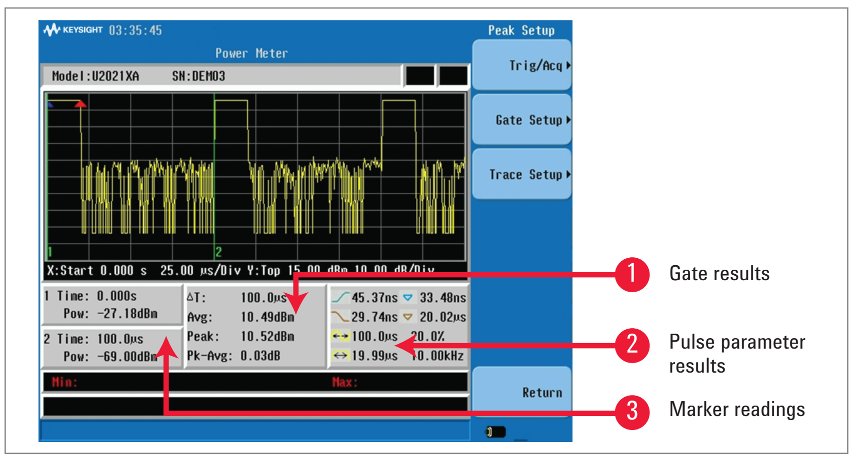


Figure 3. Sample of a pulsed signal measurement in trace view

Operation Steps and Tips

As the following steps illustrate, peak power measurement set up can be done quickly using the N9342C, N9343C, or N9344C handheld spectrum analyzer and a U2020 X-series power sensor. In the examples that follow, hard keys on the N934xC are denoted in [ ], and soft keys appear in bold.

Step 1. Connect the USB peak power sensor to the N934xC

– Insert the USB peak power sensor into the USB port on the top side of the N934xC. The sensor will automatically initialize, perform zeroing (while remaining connected to the device under test), and calibrate without connecting to an external source.

– Choose [**Mode**] and select **Power Meter** mode to access the Power Meter mode root menu.
*Tip: You can manually perform zeroing and calibration at any time after the sensor is connected and initialized. This can be done in root menu, by selecting **Zeroing** then, **Zeroing** or/and **Calibration**.*

Step 2. Set the frequency of the signal under test

– As a wideband device, the power sensor has a frequency response. The power sensor utilizes a complex correction algorithm to remove power measurement error due to linearity error, frequency response, and temperature drift to generate a more accurate measurement.

– To set the signal-under-test frequency, in the root menu of Power Meter mode, select **General Setup > Freq**.

Step 3. Set parameters for pulsed signal measurements

Several parameters are used to set up a pulsed signal measurement.

Trig/Acq menu

As shown in Figure 4, the **Trig/Acq** menu is accessed by selecting **Peak Setup** in the root menu of Power Meter mode and choosing **Trig/Acq**. Under this menu you can set:

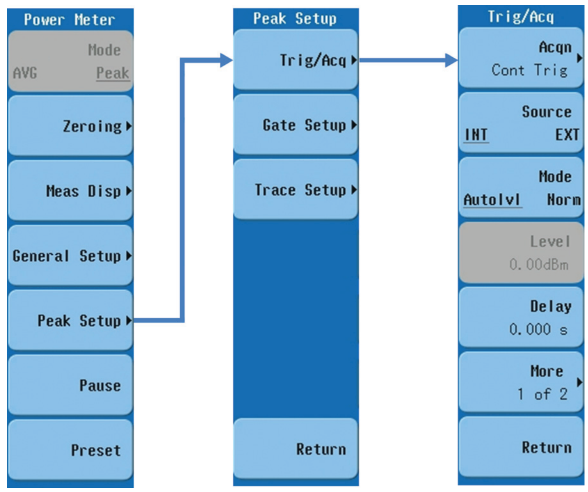


Figure 4. Menu tree for Trig/Acq

– Acqn (acquisition and trigger): Continue (Cont Trig), Single, or Free Run. In Figure 4, Cont Trig has been selected.

– Source: Internal or External. In Figure 4, Internal has been chosen.

– Mode: Auto Level (Autolvl) or Normal (Norm). In Figure 4, Autolvl has been selected.
Tip: Autolvl is the default and the recommended setting. If you know the approximate pulse level, you can set a trigger level slightly lower than it, such as 10 to 20 dB lower.

– Delay: The user-specified time interval.
Tip: You can adjust Trigger Delay to view the pulse in the middle of screen so it is easier to clearly see the rising and falling edge. For example, setting a negative trigger delay to one half of pulse period, you see a pulse in the middle of the screen. If you don't know the pulse period, refer to tips provided under "Trace Setup" to learn how to obtain it.

Trace menu

As shown in Figure 5, to access Trace Setup parameters, select **Peak Setup** from the Power Meter menu and choose **Trace Setup**. This menu allows you to set up the X- and Y-axis parameters.

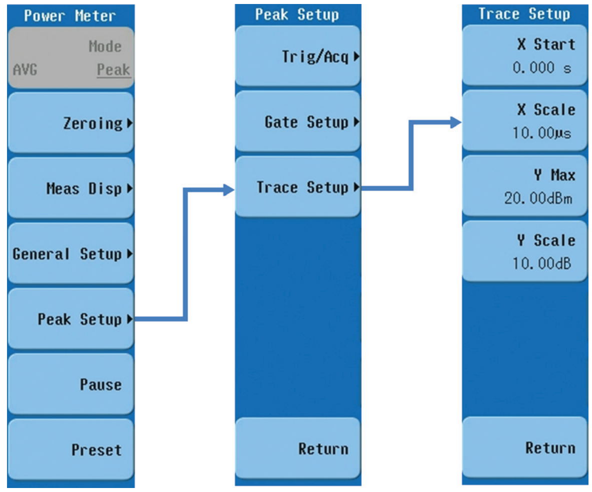


Figure 5. Menu tree for Trace Setup

– *Tip: Since the X-axis has ten divisions, set the X scale larger than one tenth of one pulse period. This will allow you to view a trace longer than one complete period. If you don't know the period of the signal-under-test, use your judgment to start with a large enough X scale. The U2020 X-series peak power sensor will detect the period once your X-axis is longer than one period. You can then revise the X scale to a smaller number based on the measured pulse period. For example, at 1.5 to 2 times of one tenth of measured pulse period, you can view 1.5 to 2 cycles of pulsed signal on a single screen.*

Gate Setup menu

– As shown in Figure 6, the Gate Setup menu is accessed through the **Peak Setup** menu under the Power Meter root by selecting **Gate Setup**.

– If you desire peak or average power measurement for a specific period, such as precisely at the top of a pulse, Gate needs to be set up.

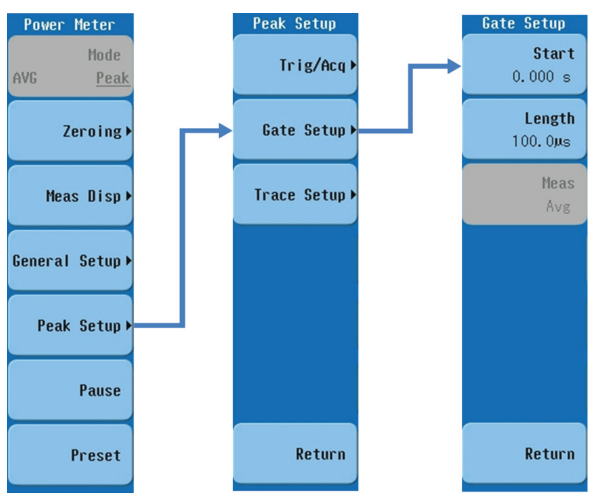


Figure 6. Menu tree for Gate Setup

Other helpful features

Marker is another commonly used feature. Marker is used to test the precise power level at any time you desire. Press **[Marker]** to access the Marker menu. You can set up to two markers. Marker readings are shown at left bottom of trace view in Figure 3.

Another helpful feature is 'Preset' to specific standard. U2020 X-series peak power sensors come with built-in radar and wireless presets, for example DME, GSM, EDGE, CDMA, W-CDMA, WLAN, WiMAX, LTE, etc. Simply select **{Preset}** in the Power Meter root and select the desired standard from the list provided. The power sensor automatically adjusts to the preset parameters that are optimum for the selected standard.

Summary

Using a Keysight N934xC and U2020 X-series peak power sensor in the field is a convenient way to test a pulsed signal, and obtain pulse parameters and peak power. The N934xC HSA provides easy-to-access functions that address the specific needs of the field engineer. Keysight U2020 X-series sensors provide peak and average power measurements with the same accuracy as measurements obtained using traditional peak power meters. Combining both products provide what is necessary to test the pulsed transmissions of radar, GSM and WiMAX communication devices, and TD-LTE base stations.

Related literature

For more information on peak power measurement, please refer to:

- *Keysight Fundamentals of RF and Microwave Power Measurement, Application Note 64-1C*, literature number 5965-6630E
- *Best Practices for Making Accurate Radar Pulse Measurements, Application Note*, literature number 5991-0434EN
- *Keysight N1918A Radar Pulse Measurement, Application Note*, literature number 5990-3415EN

myKeysight
www.keysight.com/find/mykeysight
A personalized view into the information most relevant to you.

www.lxistandard.org
LAN eXtensions for Instruments puts the power of Ethernet and the Web inside your test systems. Keysight is a founding member of the LXI consortium.

www.keysight.com/quality
Keysight Electronic Measurement Group
DEKRA Certified ISO 9001:2008
Quality Management System

Keysight Channel Partners
www.keysight.com/find/channelpartners
Get the best of both worlds: Keysight's measurement expertise and product breadth, combined with channel partner convenience.

www.keysight.com/find/hsa

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

Americas

Canada	(877) 894 4414
Brazil	55 11 33 51 7010
Mexico	001 800 254 2440
United States	(800) 829 4444

Asia Pacific

Australia	1 800 629 485
China	800 810 0189
Hong Kong	800 938 693
India	1 800 112 929
Japan	0120 (421) 345
Korea	080 769 0800
Malaysia	1 800 888 848
Singapore	1 800 375 8100
Taiwan	0800 047 866
Other AP Countries	(65) 375 8100

Europe & Middle East

Belgium	32 (0) 2 404 93 40
Denmark	45 45 80 12 15
Finland	358 (0) 10 855 2100
France	0825 010 700* *0.125 €/minute
Germany	49 (0) 7031 464 6333
Ireland	1890 924 204
Israel	972-3-9288-504/544
Italy	39 02 92 60 8484
Netherlands	31 (0) 20 547 2111
Spain	34 (91) 631 3300
Sweden	0200-88 22 55
United Kingdom	44 (0) 118 927 6201

For other unlisted countries:
www.keysight.com/find/contactus
(BP-04-23-14)

Published in USA, August 2, 2014
5991-1446EN
www.keysight.com