Agilent

Maximizing Measurement Speed Using P-Series Power Meters

Application Note

A winning solution in the combination of bandwidth and performance

- ✔ 30 MHz video bandwidth
- ✔ Single-shot real time and repetitive captures at 100 MSa/s
- ✔ Zero and calibrate while still connected to the DUT
- ✔ Peak, average, peak-to-average ratio power measurements plus rise time, fall time, pulse width, pulse period, duty cycle measurements
- ✔ 22 Presets include WiMAX, WLAN, Bluetooth and HSDPA measurements settings
- ✔ LXI-C compliance

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Introduction

In the manufacturing industry, time is priceless especially when we are looking at a high volume manufacturing. In such industries, fast measurement speed is essential to maximize the overall throughput. This way, productivity can eventually be increased.

Let us take a look at the following example: A test engineer would like to optimize the measurements' speed to increase the overall production throughput, and a design and validation engineer found a problem in the prototype and needs to run a few rounds of regression tests to troubleshoot the root cause in order to implement a permanent fix. By increasing the speed of measurements, it can help both engineers to shorten the design cycle and accelerate the product time-to-market.

With the new enhanced P-Series power meters N1911/12A with firmware version A.04.01, you can now enjoy its time-saving feature that allows you to speed up the measurement or calibration using the external triggering capability provided for average power measurement. With this new feature, you can perform automatic power sweeps or frequency sweeps with a signal source synchronization through a hardware trigger. This feature is only applicable when used with any of the 8480[1] Series, E4410 Series, E9300 Series or E9320 Series power sensors.

Optimized for
- ✓ 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

External Triggering in CW Mode

An external trigger in Continuous Wave (CW) mode is included in the P-Series power meter, providing a measurement automation between the power meter and the RF source or signal generator.

This feature allows the user to trigger the power meter via an external TTL signal for measurement capture with a user-defined buffer size not exceeding 2048 measurement points.

In addition, users can choose to enable the TTL trigger output function and use it as a handshaking mechanism with other instruments, such as a signal generator. The external trigger output will only be asserted after a measurement averaging and digital IR filter are settled. Otherwise, it will be asserted immediately after a measurement is taken. To check on the measurement progress, you may use the existing STATus:OPERation:MEASuring summary feature.

If the Operation Complete (*OPC) function is enabled before performing the buffering operation, the Operation Complete bit (OPC) in the standard Event Status Register (ESR) will be set when the user-defined buffer is completely filled. The ESR is then polled programmatically through SCPI for the buffer fill status. This upgrade features a frequency sweep capability similar to the Agilent E4400 Series vector signal generator. The average sensors that can be used with this enhanced feature are 8480 Series, E4410 Series, E9300 Series and E9320 Series (Average mode only) power sensors.

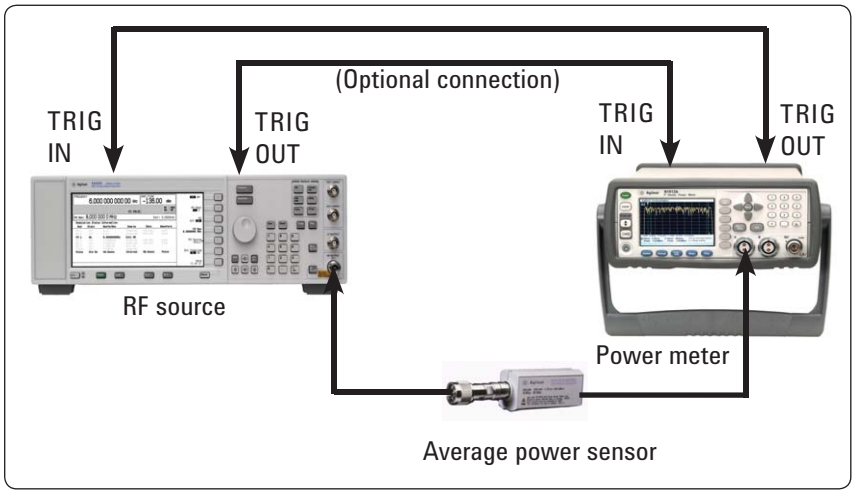

Figure 1. Hardware Connection for External Triggering in CW Mode

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

Frequency Sweep or Power Sweep

There are two modes featured in triggered average power measurement:

- ✔ Frequency sweep mode
- ✔ Power sweep mode

Power Sweep Mode

Power sweep is generally used in a power level calibration setup where frequency is constant (CW frequency) and the amplitude of the power source signal is swept. This mode can be used to characterize the flatness, linearity or gain compression of a device under test (DUT).

In this mode, no specific setting or information is required for the power meter except for the number of measurement steps. To configure the meter for power sweep mode, refer to Table 1. and follow the procedures.

Table 1. Procedures to configure the meter for power sweep mode.

No.	Procedures
1.	Connect sensor to power source.
2.	Connect power meter **TRIG OU**T to power source **TRIG IN** using a BNC cable. The same connection is applied for power source **TRIG OUT** to power meter **TRIG IN.**
3.	Press Channel. Set the **Sensor Mode** to **AVG Only**.
4.	Press Trig/ Acq, **Acqn** and select either **Sing Trig** or **Cont Trig**.
5.	Press **Settings**, **Source**, **Ext** to set the trigger source to external.
6.	Press **1 of 2**, **Output**, **On** to allow TTL level high to be produced at TRIG OUT.
7.	Press **Slope** and select + or - to set the trigger edge.
8.	Set the trigger buffer size by sending the SENSe:BUFFer:COUNt <buffer_size> command to the meter through SCPI.
9.	Press Channel or Meas to configure the measurement settings such as averaging, measurement frequency, offsets, duty cycle and so forth.
10.	Send *OPC command to meter.
11.	Set the meter to continuous trigger mode by sending the INITiate:CONTinuous ON command.
12.	Configure and set the required power sweep range and step on the power source accordingly.
13.	Set the power source trigger input and trigger output, then start sweeping.
14.	Poll the status of the power meter by sending *ESR?. *ESR will return 1 when buffering is completed. Use FETCh? to retrieve all buffered measurements.

Frequency Sweep Mode

Frequency sweep is generally used in a frequency response calibration system where the amplitude is constant, and the frequency of the power source signal is swept. This mode can be used to determine the frequency response of a DUT.

In this mode, you are required to input only the start, stop and step frequencies through SCPI. Buffer size is not required to be set as the meter will automatically calculate from the start, stop and step frequencies. To configure the meter for frequency sweep, refer to Table 2. and follow the procedures.

Table 2. Procedures to configure the meter for frequency sweep mode.

No.	Procedures
1.	Connect sensor to power source.
2.	Connect power meter **TRIG OU**T to power source **TRIG IN** using a BNC cable. The same connection is applied for power source **TRIG OUT** to power meter **TRIG IN.**
3.	Press Channel. Set the **Sensor Mode** to **AVG Only**.
4.	Press Trig/Acq, **Acqn** and select either **Sing Trig** or **Cont Trig**.
5.	Press **Settings**, **Source**, **Ext** to set the trigger source to external.
6.	Press **1 of 2**, **Output**, **On** to allow TTL level high to be produced at TRIG OUT.
7.	Set the trigger buffer size by sending the SENSe:BUFFer:COUNt <buffer_size> command to the meter through SCPI.
8.	Press Channel or Meas to configure the measurement settings such as averaging, measurement frequency, offsets, duty cycle and so forth.
9.	Set the frequency range and step by sending the below command through SCPI. • SENSe:FREQuency:STARt <start_frequency><frequency_unit> • SENSe:FREQuency:STOP <stop_frequency><frequency_unit> • SENSe:FREQuency:STEP <frequency_step_size>
10.	Send the *OPC command to the meter.
11.	Set the meter to continuous trigger mode by sending INITiate:CONTinuous ON command.
12.	Configure and set the required power sweep range and step on the power source accordingly.
13.	Set the power source trigger input and trigger output, then start sweeping.
14.	Poll the status of the power meter by sending *ESR?. *ESR will return 1 when buffering is completed. Use FETCh? to retrieve all the buffered measurement.

External Triggering Mode

There are two operation modes used by the power meter to synchronize with the signal generator. Please refer to the examples described below regarding the frequency sweep operation.

Immediate or Free Run Mode

First, connect the signal source TRIG OUT to the power meter TRIG IN. Then, set the start frequency, stop frequency and step frequency for the signal generator and power meter. Once the sweeping operation starts, the signal generator will start to step through the frequency points and output a trigger signal to the power meter at every step for synchronization purposes. Only one way synchronization occurs during this process, which is from the signal generator to the power meter. A proper dwell time must be set in the signal generator to ensure that all measurement readings in the power meter are settled before stepping through the next frequency point.

Note: The lower the power level is, the longer the settling time for measurement readings. Therefore, the dwell time setting is directly related to the power level.

Trigger Output Enabled

First, connect the signal source TRIG OUT to the power meter TRIG IN. Then, set the start frequency, stop frequency and step frequency for the signal generator and power meter. Once the sweeping operation starts, the signal generator will step to the first frequency point and generate a trigger output signal to the power meter and the acquisition begins. After the measurement reading is settled, the power meter will output a trigger signal back to the signal generator to continue with the next frequency point. This sequence will be repeated for every frequency point. Here, you can see that the synchronized communication operates in two directions and setting the correct dwell time on the signal generator is no longer needed.

Conclusion

With the new enhanced P-Series power meter firmware with external triggering in CW mode, the measurement test time can be shortened significantly.

For the frequency sweep mode, a significant 50-percent test time reduction can be reached compared to the convention "send command-and-measure" method with a comparable measurement accuracy.
Refer to Table 3.

For the power sweep mode, the measurement test time is shortened by a significant 20-percent compared to the conventional method.
Refer to Table 4.

You can see that there is a compelling speed improvement especially when there are multiple instruments in a system controlled by a single controller. Why does this happen? The reason is that the measurement commands are sent only at the beginning of the measurement. Subsequently, the power meter will automatically perform the actual measurements and acquisitions. Therefore, the controller is freed up so that it can execute other measurements simultaneously.

With the new enhanced P-Series firmware version A.04.01, you can now optimize your power measurements speed to produce a reliable result and meet your throughput requirements without any additional cost involved. DOWNLOAD the free firmware now at www.agilent.com/find/pseriesfirmware.

Table 3. Test time improvement in frequency sweep compared to the external triggering method and the conventional "send command-and-measure" method[1].

Start Frequency = 50 MHz
Stop Frequency = 6 GHz
Data taken with E9304A sensor with Trigger Output enabled

Frequency Sweep Points	Frequency Interval (MHz)	Test time through GPIB in seconds		Test Time Improvement (%)
		Conventional	External Triggering	
120	50	15.78	7.412	53
596	10	80.02	31.61	61
1191	5	153.8	62.02	60
1984	3	260.8	102.4	61

Table 4. Test time improvement in power sweep compared to the external triggering method and the conventional "send command-and-measure" method"[2].

Start Power = –40 dm
Stop Power = 20 dBm
Frequency = 1 GHz
Data taken with E9304A sensor with Trigger Output enabled

Power Sweep Points	Power Interval (dB)	Test time through GPIB in seconds		Test Time Improvement (%)
		Conventional	External Triggering	
31	2	13.16	11.28	17
61	1	24.99	20.45	22
121	0.5	48.67	39.85	22
301	0.2	120.6	104.1	16

New SCPI commands Added in A.04.01 Firmware

- ✓ SENSe[1]|2:BUFFer:COUNt <numeric_value>
- ✓ SENSe[1]|2:BUFFer:COUNt?
- ✓ [SENSe[1]]|2:FREQuency[:CW|FIXed]:STARt <numeric_value>
- ✓ [SENSe[1]]|2:FREQuency[:CW|FIXed]:STARt?
- ✓ [SENSe[1]]|2:FREQuency[:CW|FIXed]:STOP <numeric_value>
- ✓ [SENSe[1]]|2:FREQuency[:CW|FIXed]:STOP?
- ✓ [SENSe[1]]|2:FREQuency[:CW|FIXed]:STEP <numeric_value>
- ✓ [SENSe[1]]|2:FREQuency[:CW|FIXed]:STEP?

2. Sample VEE runtime program can be obtained from an Agilent sales and representative. The measurement speed may varies with the number of sweep points and power level.

LXI Class-C compliance

In addition to the external triggering, the enhanced A.04.01 firmware can also transform the P-Series power meter to a LXI-C-compliant instrument (LAN eXtensions for Instrumentation Class C). By specifying the interaction of proven and widely used Ethernet, LXI enables a fast, efficient and cost-effective creation and re-configuration of the test systems. For more information about the benefits of LXI instruments, you may refer to Application Note 1466–21 on "10 Good Reasons to Switch to LXI", literature number 5989-4372EN.

Related Literature

10 Good Reasons to Switch to LXI, Application Note 1465-21, literature number 5989-4372EN

P-Series Power Meters and Power Sensors, Data Sheet, literature number 5989-2471EN

P-Series Power Meters and Power Sensors, Technical Overview, literature number 5989-1049EN

P-Series Power Meters and Power Sensors, Configuration Guide, literature number 5989-1252EN

Fundamental of RF and Microwave Power Measurements (Part 1), Application Note 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 Note 1449-3, literature number 5988-9215EN

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LXI

www.lxistandard.org
LXI is the LAN-based successor to GPIB, providing faster, more efficient connectivity. Agilent is a founding member of the LXI consortium.

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