Keysight Techologies

External Triggering 2-Way Communication Frequency & Power Sweep Measurement

Using N1911A and N1912A P-Series Power Meters

Application Brief

KEYSIGHT TECHNOLOGIES

Introduction

In many cases, power meters and power sensors are used for system calibration in manufacturing. During system calibration, frequency sweep or power sweep needs to be carried out to compensate for errors or system losses. Sometimes this extends test time, depending on the number of system calibration points used to complete the process.

Conventionally, a signal generator is used as a source and the power meter is connected to the system for system calibration. The signal generator steps thru frequency/power with constant power/frequency. The power meter is set to the frequency based on the signal generator and captures a measurement. This process continues until the end of the frequency/power step point. Completing one system calibration in manufacturing extends test time. To shorten the test time, a new firmware enhancement included in P-series power meters allows users to speed up the measurement or calibration using an external triggering capability. This feature performs the frequency/power sweep automatically with signal source and synchronizes through hardware triggering.

This application note demonstrates the capability of the Keysight Technologies, Inc. N1911A/12A P-Series power meter to perform the external triggering 1-way and 2-way communication frequency and power sweep measurements. In the provided procedures [ ] indicates command keys on the instrument's front panel and bold text indicates a softkey or selection choice on the instrument's screen.

This application note applies to the following products from Keysight:

- N1911/12A P-Series power meter
- Keysight power sensors

Frequency Sweep Mode

Frequency Sweep mode is 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 device under test (DUT).

Table 1. Procedures to configure the N1911A/12A power meter for frequency sweep mode

Step	Procedures
1	Connect the power sensor to the signal generator/signal source
2	Connect the power meter TRIG OUT to the signal source TRIG IN using a BNC cable. The same connection is applied between the signal source TRIG OUT and the power meter TRIG IN
3	Press **[Channel]** on the power meter. Set the **Sensor Mode** to **AVG Only**
4	Press **[Trig/Acq]** on the power meter, **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 the 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]** on the power meter to configure the measurement settings such as averaging, measurement frequency, offsets, and duty cycle
9	Set the frequency range and step by sending the below commands through SCPI: – SENSe:FREQuency:STARt <start_frequency><frequency_unit> – SENSe:FREQuency:STOP <stop_frequency><frequency_unit> – SENSe:FREQuency:STEP <frequency_step_size>
10	Send an *OPC command to the power meter
11	Set the power 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 signal source accordingly
13	Set the signal source trigger input and trigger output, then start sweeping
14	Poll the status of the power meter by sending an *ESR?. *ESR will return 1 when buffering is completed. Use FETCh? to retrieve all buffered measurements

Power Sweep Mode

Power Sweep mode is used in a power level calibration setup when the 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 DUT.

Table 2. Procedures to configure the N1911A/12A power meter for Power Sweep mode

Step	Procedures
1	Connect the power sensor to the signal generator/signal source
2	Connect the power meter TRIG OUT to the signal source TRIG IN using a BNC cable. The same connection is applied between the signal source TRIG OUT and the power meter TRIG IN
3	Press **[Channel]** on the power meter. Set the **Sensor Mode** to **AVG Only**
4	Press **[Trig/Acq]** on the power meter, **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 the 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]** on the power meter to configure the measurement settings such as averaging, measurement frequency, offsets, and duty cycle
10	Send an *OPC command to power meter
11	Set the power 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 signal source accordingly
13	Set the signal source trigger input and trigger output, then start sweeping
14	Poll the status of the power meter by sending an *ESR?. *ESR will return 1 when buffering is completed. Use FETCh? to retrieve all buffered measurements

One-Way External Triggering Communication

The signal source's TRIG OUT is connected to the power meter's TRIG IN (see Figure 1). Then the Start, Stop, and Step frequencies are set for the signal source and power meter. Once the sweeping operation starts, the signal source steps through the frequency points and outputs a trigger signal to the power meter at every step for synchronization purposes. Only 1-way synchronization occurs during this process, which is from the signal source to the power meter. A proper dwell time has to be setup in the signal source to ensure the measurement readings of the power meter are settled before stepping through to the next frequency point. At the end of the frequency step the FETCH? command is used to retrieve all the buffered readings at once. This same process applies for power step. The buffer memory of power meter is a maximum of 2,048 readings.

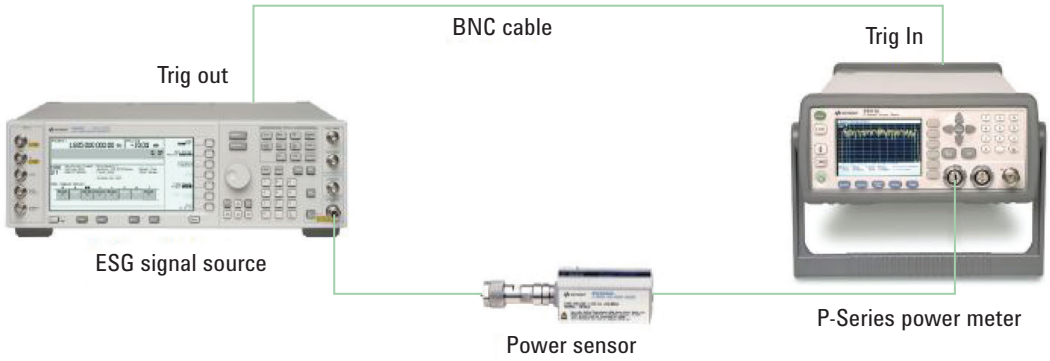

Figure 1. One-way communication external triggering setup diagram

Two-way External Triggering Communication

To set up a 2-way external triggering communication, where the trigger output enables the mode's 2-way handshake, the signal source's TRIG OUT is connected to the power meter's TRIG IN. The power meter's TRIG OUT is connected to the signal source's TRIG IN (see Figure 2). Then the Start, Stop, and Step frequencies are set for the signal source and power meter. Once the sweeping operation begins the signal source steps to the first frequency point and generates a trigger output signal to the power meter, the acquisition begins. After the measurement reading is settled and stored, the power meter outputs a trigger signal back to the signal source to continue with the next frequency step. The sequence is repeated for every frequency step. With this method, there is synchronized communication in 2-way hardware triggering and setting the correct dwell time on the signal source is not required. At the end of the frequency step the FETCH? command is used to retrieve all of the buffered readings at once.

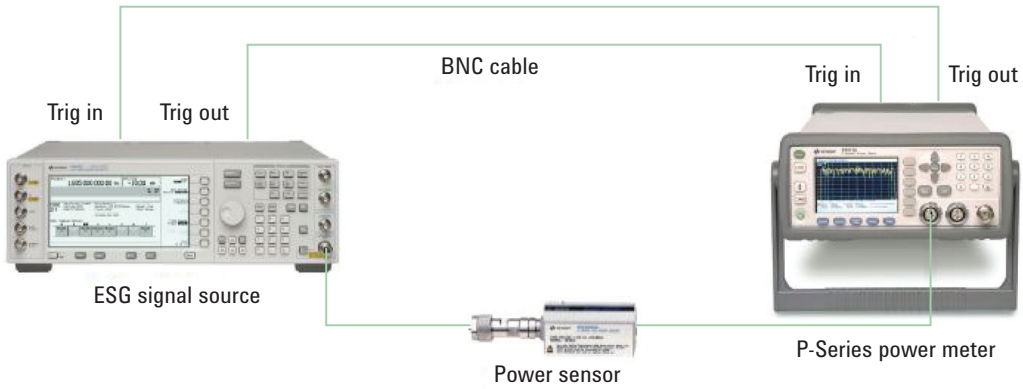

Figure 2. Two-way communication external triggering setup diagram

External triggering 2-way frequency sweep measurement

Use the following SCPI commands for external triggering 2-way frequency sweep measurement.

Table 3. Procedures to configure the N1911A/12A power meter for Power Sweep mode

SCPI	Description
Keysight ESG/MXG/PSG signal generator	
SYST:PRES	Preset the instrument to its default settings
OUTP:STAT ON	Turn on RF output
LIST:TYPE STEP	Enable the frequency/power sweep list
INIT:CONT OFF	Select to single list or step sweep
FREQ:START 50MHz	Set start frequency to 50 MHz (example)
FREQ:STOP 6000MHz	Set stop frequency to 6000 MHz (example)
SWEEP:POINTS 596	Set frequency sweep points to 596 (example)
POWER:LEVEL 5DBM	Set output power level to 5 dBm (example)
TRIG:SOURCE BUS	Enable GPIB triggering using the *TRG command
LIST:TRIG:SOUR EXT	Enable the triggering of a sweep event by an externally applied at the TRIGGER IN connector
LIST:DWEL:TYPE STEP	Select the dwell time from the step sweep
POWER:MODE FIX	Stop a power sweep. Enable signal source to operate at a fixed power level
FREQ:MODE LIST	Select the Swept Frequency mode
Keysight P-Series power meter	
SYST:PRES	Preset the instrument to its default settings
SENS:DET:FUNC AVERAGE	Set measurement mode to average for CW\average power measurement
TRIG:SOUR EXT	Set to external triggering which is require for frequency sweep operation
OUTP:TRIG EXT	Set power meter trigger output to external triggering
OUTP:TRIG ON	Enable trigger output port
SENS:AVER:COUNT 1	Set average count to 1 (example)
SENS:MRATE DOUBLE	Set measurement speed to Double (example) to speed up the measurement
SENS:BUFF COUNT 596	Set buffer count to 596 (example)
SENS:FREQ:START 50MHz	Set start frequency to 50 MHz (example)
SENS:FREQ:STOP 6000MHz	Set stop frequency to 6000 MHz (example)
SENS:FREQ:STEP 596	Set frequency step to accept 596 steps (example)
INIT:CONT ON	Set to Free Run mode to accept continuous trigger cycles
*OPC	Enable the operation complete command and set the operation complete bit in the Standard Event Status Register when all pending device operations have completed
Wait 1 sec	
Keysight ESG/MXG/PSG signal generator	
INIT	Initialize the signal source
*TRG	Trigger the device if BUS is the selected trigger source
Keysight P-Series power meter	
*ESR?	Poll the status of the power meter by sending *ESR?. *ESR will return 1 when buffering is completed
FETCH?	Use FETCh? to retrieve all buffered measurements

External triggering 2-way power sweep measurement

Use the following SCPI commands for external triggering 2-way power sweep measurement.

Table 4.

SCPI	Description
Keysight ESG/MXG/PSG signal generator	
SYST:PRES	Preset the instrument to its default settings
FREQ 1000MHz	Set frequency to 1000 MHz (example)
OUTP:STAT ON	Turn on RF output
LIST:TYPE STEP	Enable the frequency/power sweep list
INIT:CONT OFF	Select to single list or step sweep
POWER:START -20DBM	Set start power to –20 dBm (example)
POWER:STOP 10DBM	Set stop power to 10 dBm (example)
SWEEP:POINTS 121	Set power sweep points to 121 (example)
TRIG:SOURCE BUS	Enable GPIB triggering using the *TRG command
LIST:TRIG:SOUR EXT	Enable the triggering of a sweep event by an externally applied signal at the TRIGGER IN connector
LIST:DWEL:TYPE STEP	Select the dwell time from the step sweep
POWER:MODE LIST	Select the Swept Power mode
POW:ATT:AUTO ON	Enable the signal source's automatic loop control (ALC) to adjust the attenuator so that at a specified RF power level the signal source's RF output connector is maintained
FREQ:MODE FIX	Select the stop frequency sweep and allow signal source to operate at a set frequency sweep
Keysight P-Series power meter	
SYST:PRES	Preset the instrument to its default settings
SENS:FREQ 1000MHz	Set frequency to 1000 MHz (example)
SENS:DET:FUNC AVERAGE	Set Measurement mode to average for CW\average power measurement
TRIG:SOUR EXT	Set to external triggering which is required for the frequency sweep operation
OUTP:TRIG EXT	Set power meter trigger output to external triggering
OUTP:TRIG ON	Enable the trigger output port
SENS:AVER:COUNT 1	Set average count to 1 (example)
SENS:MRATE DOUBLE	Set measurement speed to Double (example) to speed up the measurement
SENS:BUFF COUNT 121	Set buffer count to 121 (example)
INIT:CONT ON	Set to Free Run mode to accept continuous trigger cycles
*OPC	Enable operation complete command and set the operation complete bit in the Standard Event Status Register when all pending device operation have completed
Wait 1 sec	
Keysight ESG/MXG/PSG signal generator	
INIT	Initialize the signal source
*TRG	Trigger the device if BUS is the selected trigger source
Keysight P-Series power meter	
*ESR?	Poll the status of the power meter by sending *ESR?. *ESR will return 1 when buffering is completed
FETCH?	Use FETCh? to retrieve all buffered measurements

Comparison of 1-way and 2-way External Triggering

In 1-way or 2-way external trigger measurement, measurement data is stored in the buffer and the FETCH? command is used to retrieve all the buffered readings at one time. While this method for obtaining data requires more programming or coding, it provides faster measurement speed. One-way external triggering requires proper dwell time for the signal generator in order to let the power meter measurement settled before the signal generator proceeds to next frequency point. This extends measurement speed due to the dwell time.

Table 5. Pros and cons of conventional, 1-way and 2-way external triggering frequency/power sweep measurement

Method	Pros	Cons
Conventional	Less programming/coding	Longer test time
1-way external triggering	Faster test time than conventional method	More programming/coding. Requires dwell/wait time for signal generator
2-way external triggering	Faster test time than 1-way external triggering method. No dwell/wait time for signal generator and power meter	More programming/coding

Conclusion

With the new enhanced P-Series power meter firmware with external triggering in CW mode, the measurement test time can be shortened significantly. Speed improvement is noticeable, especially when there are multiple instruments in a system controlled by a single controller. This new measurement alternative allows power measurements speed to be optimized to produce a reliable result and meet throughput requirements without incurring any additional cost.

References

Maximizing Measurement Speed using P-Series Power Meter - Application Note Literature number 5989-7678EN

Practices to Optimize Power Meter/Sensor Measurement Speed and Shorten Test Times - Application Note, Literature number 5990-8471EN

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Published in USA, August 3, 2014
5991-2645EN
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