

External Source Control Personality Guide

Agilent Technologies PSA Series Spectrum Analyzers

Option 215

**This manual provides documentation for the following instruments
with Option 215 Installed:**

PSA Series

E4440A (3 Hz - 26.5 GHz)

E4443A (3 Hz - 6.7 GHz)

E4445A (3 Hz - 13.2 GHz)

E4446A (3 Hz - 44.0 GHz)

E4448A (3 Hz - 50.0 GHz)



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Where to Find the Latest Information

Documentation is updated periodically. For the latest information about Agilent PSA Spectrum Analyzers, including firmware upgrades, software upgrades, application information, and product information, please visit the Internet URLs listed below.

<http://www.agilent.com/find/psa> (for PSA spectrum analyzers)

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1 Getting Started

Option 215 Description

Option 215 for the PSA series of spectrum analyzers allows you to control supported external signal generators using the spectrum analyzer. For details on suitable signal generators, see [“Hardware and Firmware Requirements” on page 7](#). Using the signal source as a tracking generator lets you make stimulus-response measurements. VSWR/Return Loss measurements can be made with the addition of an external coupler or bridge.

Hardware and Firmware Requirements

One of the following Agilent spectrum analyzers and associated hardware options is required to run Option 215 External Source Control.

NOTE Option 215 External Source Control requires the gated sweep functionality that is provided by the more recent LO synthesizer and front end driver hardware. The part numbers of the boards providing this gated sweep functionality are shown in [Table 1-1](#) (below).

Table 1-1 Compatible Agilent PSA Series Spectrum Analyzers

Analyzer Model Number	Upper Frequency Limit	Firmware	Front End Driver ^{a b}	LO Synthesizer Board ^{c b}
E4440A	26.5 GHz	A.07.09 or later	Any EXCEPT part numbers E444060242 or E444060002	Any EXCEPT part number E444060008
E4443A	6.7 GHz	A.07.09 or later		
E4445A ^d	13.2 GHz	A.07.09 or later		
E4446A	44.0 GHz	A.07.09 or later		
E4448A	50.0 GHz	A.07.09 or later		

- a. Press **System, More 1 of 3, Show Hdwr** to show the part number of your front end driver board.
- b. If you do not have the required hardware, you can order Option 426 to upgrade the hardware.
- c. Press **System, More 1 of 3, Show Hdwr** to show the part number of your LO synthesizer board.
- d. Option 215 will not run on a model E4445A which has the HA5 “Restricted Performance” option installed.

Connection Hardware and Accessories

You will also need:

- An Agilent signal generator that supports LAN connectivity. Examples of suitable signal generators are the ESG-C, the PSG-C, and the PSG-D, but not the PSG-A. The PSG-A signal generator is not supported.

NOTE

The ESG-C signal generator requires version C.03.72 or later of the firmware.

The PSG-C signal generator requires version C.03.76 or later of the firmware.

The PSA-D signal generator requires version C.04.03 or later of the firmware.

- Either one LAN crossover cable, or two LAN cables.
- 3 BNC cables.
- RF cables to connect the signal generator and the PSA to the device under test (DUT).
- When using a PSG signal generator, you will need a 50 Ω feedthrough, or a connector tee with a 50 Ω load.
- (Optional) directional coupler or directional bridge for reflection and VSWR measurements.
- (Optional) open/short devices for reflection and VSWR measurements.

Option 215 Limitations

Frequency Bands

The PSA Series spectrum analyzers have up to six frequency bands depending on the maximum frequency capability of the model. These frequency bands are shown in the table below.

Option 215 cannot sweep across PSA frequency band boundaries. Any frequency sweep required for a measurement must be kept entirely within one of these bands. One way to work around this limitation is to write an external control program to break the measurement down into two or more sweeps, each of which is confined to the bands listed below.

Table 1-2 Frequency Bands in the PSA Series analyzers

Band Number	Frequency Range	Overlap with Next Band
0	3.0 Hz - 3.05 GHz	200 MHz
1	2.85 GHz - 6.6 GHz	400 MHz
2	6.2 GHz - 13.2 GHz	400 MHz
3	12.8 GHz - 19.2 GHz	500 MHz
4	18.7 GHz - 26.8 GHz	400 MHz
5	26.4 GHz - 31.15 GHz	150 MHz
6	31.0 GHz - 50.0 GHz	N/A

Further Frequency Limitations

The frequency range of your source/spectrum analyzer combination is limited by the frequency range limits of both instruments, so you have to look at both instruments to determine this.

In addition, the digital nature of the signal sources and the PSA Series spectrum analyzers means that signals and traces are read and recorded as a series of data points. Each data point on a trace or a measurement corresponds to a frequency 'bucket', which is a finite frequency range into which data falls.

For example, assume we have a ten-point¹ trace over a frequency range of 3.0 GHz to 4.0 GHz. It will take 10 buckets to cover the 1.0 GHz range. So, bucket 1 might collect data for all frequencies from 3.0000 GHz to 3.0999 GHz, bucket 2 might collect from 3.1000 GHz to

1. Although a ten-point sweep has been chosen for clarity in this example, the minimum number of sweep points on a PSA is 101

3.1999 GHz, and so on. This operation is normally not visible because you have so many trace buckets. However, it does have an effect on the behavior of Option 215 External Source Control at the limits of its frequency ranges.

Option 215 External Source Control requires a 'spare' bucket at the beginning and at the end of every sweep on the signal source. In other words, to make the 1.0 GHz sweep from 3.0 GHz to 4.0 GHz in the example above, one 'spare' bucket is required at the start to 'catch' the data between 2.9000 GHz and 2.9999 GHz, and similarly, another 'spare' bucket is required at the end of the sweep.

This means that the number of sweep points on the signal source is always two higher than that specified on the PSA Series analyzer to allow for these 'spare' buckets.

You need to remember this frequency range limitation when setting up your Option 215 measurements. Continuing with the 3.0 GHz to 4.0 GHz example sweep above, a problem arises if your signal source has a maximum frequency of 4.0 GHz. The source can not sweep beyond 4.0 GHz, so the frequency range of the 'spare' bucket at the end of the sweep must fall completely below the 4.0 GHz upper limit of the signal source. This 'spare' bucket therefore 'catches' data from 3.9001 GHz to 4.0000 GHz. The previous bucket (3.8001 GHz to 3.9000 GHz) represents the last bucket actually used in the sweep, so in this example, the maximum frequency that your 4.0 GHz signal source could sweep would actually be 3.9 GHz.

In other words, you can never quite reach the full frequency range of your signal source. How close to the limit you can get depends on the size of your buckets. This is determined by the number of sweep points and the range over which you are sweeping. The more sweep points you use, and the smaller the range of the sweep, the smaller will be the size of the buckets. Therefore, the closer you will be able to get to the frequency limits of your signal source. You can approach, but never quite meet, the frequency limits of your source.

Frequency Calculation Examples

TIP

See the Hints and Tips Chapter for examples of frequency settings that will not work because you are either exceeding the frequency range of your signal source or the frequency band of your spectrum analyzer.

Example 1: A Simple Sweep

Suppose that you specify on your PSA Series analyzer that you wish to sweep from 2.85 GHz to 3.0 GHz using 601 points. What is the actual range that the signal source will sweep?

First, we need to work out our bucket size, or the bucket width. This is given by the range in Hertz divided by (number of points minus 1), or

$$\text{Bucket Width (in Hz)} = \frac{\text{PSA Frequency Span (Hz)}}{\text{PSA number of Sweep Points} - 1}$$

so

$$\text{Bucket Width (in Hz)} = \frac{150,000,000}{601 - 1} = 250,000 \text{ Hz}$$

Now we can work out the external source's start frequency using the following equation:

$$\begin{aligned} & \frac{\text{PSA Start Frequency} + \text{Sweep Offset} - \text{Bucket Width}}{\text{Harmonic Number}} \\ &= \frac{2,850,000,000 + 0.00 - 250,000}{1} \\ &= 2,849,750,000 = 2.84975 \text{ GHz} \end{aligned}$$

Finally we can calculate the external source's stop frequency using the following equation:

$$\begin{aligned} & \frac{\text{PSA Stop Frequency} + \text{Sweep Offset} + \text{Bucket Width}}{\text{Harmonic Number}} \\ &= \frac{3,000,000,000 + 0.00 + 250,000}{1} \\ &= 3,000,250,000 = 3.00025 \text{ GHz} \end{aligned}$$

So if you specify on your PSA Series analyzer that you want to sweep from 2.85 GHz to 3.0 GHz using 601 points, the signal source itself will actually sweep from 2.84975 GHz to 3.00025 GHz.

Example 2: Sweep With An Offset

Suppose that you specify on your PSA Series analyzer that you wish to sweep from 2.85 GHz to 3.00 GHz using 601 points and an offset of 1.0 GHz. What is the actual range that the signal source will sweep?

First of all, we need to work out our bucket size, or the bucket width. This is given by the range in Hertz divided by (number of points minus 1), or

$$\text{Bucket Width (in Hz)} = \frac{\text{PSA Frequency Span (Hz)}}{\text{PSA number of Sweep Points} - 1}$$

so

$$\text{Bucket Width (in Hz)} = \frac{150,000,000}{601 - 1} = 250,000 \text{ Hz}$$

Now we can work out the external source's start frequency using the following equation:

$$\begin{aligned} & \frac{\text{PSA Start Frequency} + \text{Sweep Offset} - \text{Bucket Width}}{\text{Harmonic Number}} \\ &= \frac{2,850,000,000 + 1,000,000,000 - 250,000}{1} \\ &= 3,849,750,000 = 3.84975 \text{ GHz} \end{aligned}$$

Finally we can work out the external source's stop frequency using the following equation:

$$\begin{aligned} & \frac{\text{PSA Stop Frequency} + \text{Sweep Offset} + \text{Bucket Width}}{\text{Harmonic Number}} \\ &= \frac{3,000,000,000 + 1,000,000,000 + 250,000}{1} \\ &= 4,000,250,000 = 4.00025 \text{ GHz} \end{aligned}$$

So if you specify on your PSA Series analyzer that you want to sweep from 2.85 GHz to 3.00 GHz using 601 points and a 1.0 GHz sweep offset, the signal source itself will actually sweep from 3.84975 GHz to 4.00025 GHz.

Example 3: Second Harmonic Sweep With a Sweep Offset

Suppose that you specify on your PSA Series analyzer that you wish to perform a second harmonic sweep from 2.85 GHz to 3.00 GHz using 601 points, and an offset of 1.0 GHz. What is the actual range that the signal source will sweep?

First of all, we need to work out our bucket size, or the bucket width. This is given by the range in Hertz divided by (number of points minus 1), or

$$\text{Bucket Width (in Hz)} = \frac{\text{PSA Frequency Span (Hz)}}{\text{PSA number of Sweep Points} - 1}$$

so

$$\text{Bucket Width (in Hz)} = \frac{150,000,000}{601 - 1} = 250,000 \text{ Hz}$$

Now we can work out the external source's start frequency using the following equation:

$$\begin{aligned} & \frac{\text{PSA Start Frequency} + \text{Sweep Offset} - \text{Bucket Width}}{\text{Harmonic Number}} \\ &= \frac{2,850,000,000 + 1,000,000,000 - 250,000}{2} \\ &= 1,425,000,000 + 500,000,000 - 125,000 = 1,924,875,000 \text{ Hz} = 1.924875 \text{ GHz} \end{aligned}$$

Finally we can work out the external source's stop frequency using the following equation:

$$\begin{aligned} & \frac{\text{PSA Stop Frequency} + \text{Sweep Offset} + \text{Bucket Width}}{\text{Harmonic Number}} \\ &= \frac{3,000,000,000 + 1,000,000,000 - 250,000}{2} \\ &= 1,500,000,000 + 500,000,000 + 125,000 = 2,000,125,000 \text{ Hz} = 2.000125 \text{ GHz} \end{aligned}$$

So if you specify on your PSA Series analyzer that you want to perform a second harmonic sweep from 2.85 GHz to 3.00 GHz using 601 points and a 1.0 GHz sweep offset, the signal source itself will actually sweep from 1.924875 GHz to 2.000125 GHz.

Installing Option 215

You must load the desired personality option into the instrument memory. Loading can be done from a firmware CD-ROM or the internet location. An automatic loading program comes with the files and runs from your PC.

NOTE

When you add a new option, or update an existing option, you will get the updated version of all your current options since they are reloaded simultaneously. This process may also require you to update the instrument core firmware so that it is compatible with the new option.

You may not be able to fit all of the available measurement personalities in instrument memory at the same time. You may need to delete an existing option file from memory and load the one you want. Use the automatic update program that is provided with the files to do this.

The approximate memory requirements for the available options can be found by using the memory calculator on the following internet location: http://www.agilent.com/find/psa_firmware

You can install an updated version of firmware and your licensed options using a LAN connection and your PC. Instructions for loading future firmware updates are available from the following internet location: <http://www.agilent.com/find/psa/>

Installing Optional Measurement Personalities

When you install a measurement personality, you need to follow a three step process:

1. Determine whether your memory capacity is sufficient to contain all the options you want to load. If not, decide which options you want to install now, and consider upgrading your memory. Details follow in “[Do You Have Enough Memory to Load All Your Personality Options?](#)” on page 15.
2. Install the measurement personality firmware into the instrument memory. Details follow in “[Loading an Optional Measurement Personality](#)” on page 18.
3. Enter a license key that activates the measurement personality. Details follow in “[Obtaining and Installing a License Key](#)” on page 18.

Adding measurement personalities requires the purchase of a retrofit kit for the desired option. The retrofit kit contains the measurement personality firmware and an entitlement certificate that is used to generate a license key from the internet website. A separate license key is required for each option on a specific instrument serial number and

host ID.

For the latest information on Agilent Spectrum Analyzer options and upgrade kits, visit the following Internet URL:

http://www.agilent.com/find/sa_upgrades

Do You Have Enough Memory to Load All Your Personality Options?

If you want to operate the instrument with four or fewer personality options installed, you can skip ahead to the next section, [“Loading an Optional Measurement Personality” on page 18](#). If, after installing your options, you get error messages relating to memory issues, you can return to this section to learn more about how to optimize your configuration.

If you want to install your 4th or subsequent option, you should check to see how much memory you have available.

If you have 64 MBytes of memory installed in your instrument, you should have ample memory to install five optional personalities, with plenty of memory to spare for data and states.

If you have less than 64 MBytes of installed memory, depending how much data you save, you are unlikely to have any memory issues until you want to install your 4th option. If this is the case, you can either swap the applications in/out of memory as needed, or you can upgrade your hardware to 64 MBytes of memory.

To see the size of your installed memory for PSA Series Spectrum Analyzers:

1. Ensure that the spectrum analyzer is in spectrum analyzer mode because this can affect the screen size.
2. Press the **System** key, **MORE (1 of 3)**, and **Show Hdwr** keys.
3. Read Flash Memory size on the last line of the table.

PSA Flash Memory Size	Available Memory With No Options	Available Memory With Option B7J and/or Option 122
64 Mbytes	32.5 MBytes	30.0 MBytes
48 Mbytes	16.9 MBytes	14.3 MBytes

If you have 48 MBytes of memory, and you want to install more than 3 optional personalities, you may need to manage your memory resources. The following section, [“How to Predict Your Memory Requirements” on page 16](#), will help you decide how to configure your installed options to provide optimal operation.

How to Predict Your Memory Requirements

If you plan to install many optional personalities, you should review your memory requirements, so you can determine whether you have enough memory. There is an Agilent “Memory Calculator” available online that can help you do this, or you can make a calculated approximation using the information that follows. You will need to know your instrument’s installed memory size as determined in the previous section and then select your desired applications.

For PSA series see: http://www.agilent.com/find/psa_firmware

Select the “Memory Calculator” link. You can try any combination of available personalities to see if your desired configuration is compatible with your installed memory.

NOTE

For PSA: After loading all your optional measurement personalities, you should have a reserve of ~2 MBytes memory to facilitate mode switching. Less available memory will increase mode switching time. For example, if you employ excessive free memory by saving files of states and/or data, your mode switching time can increase to more than a minute.

You can manually estimate your total memory requirements by adding up the memory allocations described in the following steps. The compare the desired total with the available memory that you identified in the previous section.

1. Program memory - Select option requirements from the table “Personality Options” on page 17.
2. For PSA only: shared libraries require 5.68 MBytes
3. For PSA only: recommended mode swap space is 2 MBytes
4. Screens - .gif files need 20-25 kB each
5. State memory - State file sizes range from 21 kB for SA mode to 40 kB for W-CDMA. The state of every mode accessed since power-on will be saved in the state file. File sizes can exceed 150 kB each when several modes are accessed, for each state file saved.

TIP

State memory retains settings for all states accessed before the **Save State** command. To reduce this usage to a minimum, reduce the modes accessed before the **Save State** is executed. You can set the PSA to boot into a selected mode by assessing the desired mode, then pressing the **System**, **Power On/Presets**, **Power On** keys and toggle the setting to **Last**.

Measurement Personality Options and Memory Required

Personality Options ^a (for PSA series Spectrum Analyzers and E4406A Transmitter Tester)	Option	File Size (PSA Rev: A.07) (E4406A Rev: A.08)
cdmaOne measurement personality	BAC	2.00 Mbytes
NADC and PDC measurement personalities (not available separately)	BAE	2.50 Mbytes
W-CDMA or W-CDMA w/ HSDPA measurement personality	BAF, 210	5.18 Mbytes ^b
cdma2000 or cdma2000 w/ 1xEV-DV measurement personality	B78, 214	4.05 Mbytes ^b
1xEV-DO measurement personality	204	4.84 Mbytes ^b
GSM (with EDGE) measurement personality	202	3.61 Mbytes ^b
Shared measurement library ^b	n/a	5.65 Mbytes
PSA only Options:		
Phase noise measurement personality	226	2.93 Mbytes ^c
Noise Figure measurement personality	219	4.76 Mbytes ^c
Basic measurement personality with digital demod hardware	B7J	Cannot be deleted
HP8566B/HP8568B Programming Code Compatibility ^d	266	1.05 Mbytes ^c
TD-SCDMA	211	5.14 Mbytes ^c
Flexible Digital Modulation Analysis	241	1.93 Mbytes ^b
External Source Control	215	0.78 Mbytes ^c
E4406A only Options:		
GSM measurement personality	BAH	3.42 Mbytes ^b
EDGE upgrade from BAH measurement personality	252	3.42 Mbytes ^b
iDEN measurement personality	HN1	1.80 Mbytes ^b
Baseband I/Q Inputs	B7C	n/a (hardware only)

a. Available as of the print date of this guide.

b. Many PSA Series and VSA E4406A personality options use a 5.65 MByte shared measurement library. If you are loading multiple personalities that use this library, you only need to add this memory allocation once.

- c. Shared measurement library allocation not required
- d. This is a no charge option that does not require a license key.

Memory Upgrade Kits The PSA 64 MByte Memory Upgrade kit p/n is E4440AU Option ANE.

For more information about memory upgrade kits contact your local sales/service office, or see:

http://www.agilent.com/find/sa_upgrades

Loading an Optional Measurement Personality

You must use a PC to load the desired personality option into the instrument memory. Loading can be done from a firmware CD-ROM or by downloading the update program from the internet. An automatic loading program comes with the files and runs from your PC.

You can check the Agilent internet website for the latest firmware versions available for downloading:

For PSA, see http://www.agilent.com/find/psa_firmware

NOTE

When you add a new option, or update an existing option, you will get the updated versions of all your current options as they are all reloaded simultaneously. This process may also require you to update the instrument core firmware so that it is compatible with the new option.

Depending on your installed hardware memory, you may not be able to fit all of the available measurement personalities in instrument memory at the same time. You may need to delete an existing option file from memory and load the one you want. Use the automatic update program that is provided with the files. Refer to the table showing “[Measurement Personality Options and Memory Required](#)” on page 17.

The approximate memory requirements for the options are listed above. These numbers are worst case examples. Some options share components and libraries, therefore the total memory usage of multiple options may not be exactly equal to the combined total.

Obtaining and Installing a License Key

If you purchase an optional personality that requires installation, you will receive an “Entitlement Certificate” which may be redeemed for a license key specific to one instrument. Follow the instructions that accompany the certificate to obtain your license key.

To install a license key for the selected personality option, use the following procedure:

NOTE

You can also use this procedure to reinstall a license key that has been deleted during an uninstall process, or lost due to a memory failure.

1. Press **System, More, More, Licensing, Option** to access the alpha editor. Use this alpha editor to enter letters (upper-case), and the front-panel numeric keys to enter numbers for the option designation. You will validate your option entry in the active function area of the display. Then, press the **Enter** key.
2. Press **License Key** to enter the letters and digits of your license key. You will validate your license key entry in the active function area of the display. Then, press the **Enter** key.
3. Press the **Activate License** key.

Viewing a License Key

Measurement personalities purchased with your instrument have been installed and activated at the factory before shipment. The instrument requires a **License Key** unique to every measurement personality purchased. The license key is a hexadecimal number specific to your measurement personality, instrument serial number and host ID. It enables you to install, or reactivate that particular personality.

Use the following procedure to display the license key unique to your personality option that is already installed in your instrument:

Press **System, More, More, Licensing, Show License**. The **System, Personality** key displays the personalities loaded, version information, and whether the personality is licensed.

NOTE

*You will want to keep a copy of your license key in a secure location. Press **System, More**, then **Licensing, Show License**, and print out a copy of the display that shows the license numbers. If you should lose your license key, call your nearest Agilent Technologies service or sales office for assistance.*

Using the Delete License Key

This key will make the option unavailable for use, but will not delete it from memory. Write down the 12-digit license key for the option before you delete it. If you want to use that measurement personality later, you will need the license key to reactivate the personality firmware.

NOTE

Using the **Delete License** key does not remove the personality from the instrument memory, and does not free memory to be available to install another option. If you need to free memory to install another option, refer to the instructions for loading firmware updates located at the URL: <http://www.agilent.com/find/psa/>

1. Press **System, More, More, Licensing, Option**. Pressing the **Option** key will activate the alpha editor menu. Use the alpha editor to enter the letters (upper-case) and the front-panel numeric keyboard to enter the digits (if required) for the option, then press the **Enter** key. As you enter the option, you will see your entry in the active function area of

the display.

2. Press **Delete License** to remove the license key from memory.

Performing a Security Erase on PSA Series Spectrum Analyzers

A Security Erase of a PSA can perform the following functions:

- Blank the display
- Erase user files
- Erase all memory including the operating system

To perform a security erase of your instrument memory you will need to have PSA Option HS7, a free firmware option, installed. For more information see:

<http://www.agilent.com/find/security>

Instructions for security erase procedures and the PSA Option HS7 firmware upgrade are available for downloading.

CAUTION

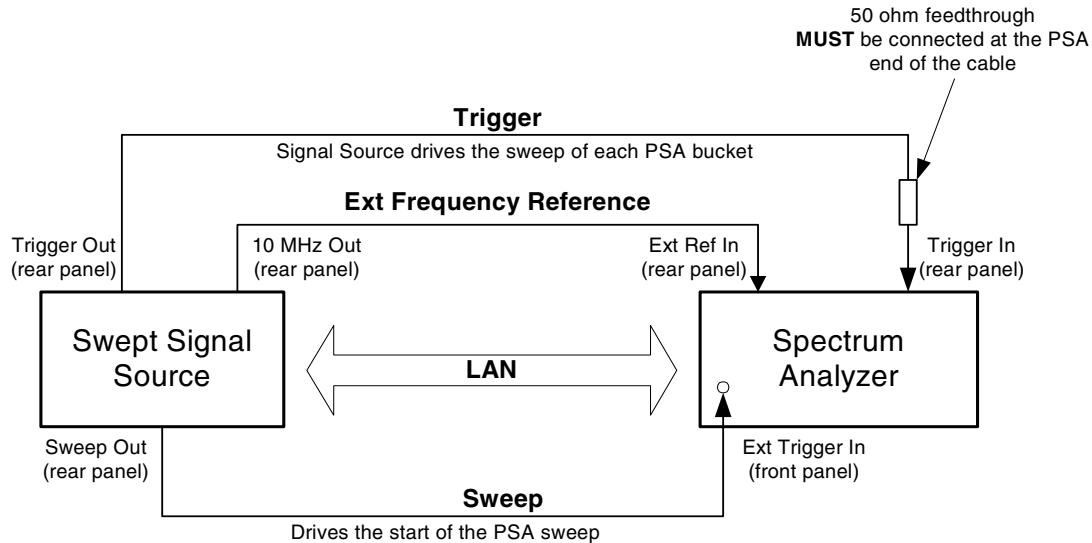
Security Erase procedures can leave your instrument in an inoperative state. Be sure to follow the instructions carefully.

Ordering Optional Measurement Personalities

When you order a personality option, you will receive an entitlement certificate. Then you will need to go to the web site to redeem your entitlement certificate for a license key. You will need to provide your instrument serial number and host ID, and the entitlement certificate number.

Required Information:	Front Panel Key Path:
Model #: (Ex. E4406A)	
Host ID: _____	System, Show System
Instrument Serial Number: _____	System, Show System

Setting Up Your Signal Analyzer and Signal Source



sa_ss_connect.vsd

You will need the following equipment to use your PSA Series spectrum analyzer to control an external signal source:

- A PSA Series analyzer with Option 215 software installed and with time gating capability.

If you are not sure whether your PSA Series analyzer has Option 215 installed, press **System, More, More, Personality**, and look for Option **215 Ext Src Control**. If you cannot see Option 215 listed, it needs to be installed. See [“Installing Option 215” on page 14](#) for instructions on how to do this. Information about the time gating hardware is found in [“Hardware and Firmware Requirements” on page 7](#).

- An Agilent signal generator that supports LAN connectivity.
Examples of signal generators are: the ESG-C, the PSG-C, and the PSG-D, but not the PSG-A. The PSG-A signal source is not supported.
- Either one LAN crossover cable to connect the two instruments directly if you are not connecting to a local area network, or you need two LAN cables to connect both instruments to your local area network
- Three BNC cables.
- Cables to connect to your device under test.

- You may also need accessories such as an open, short, directional coupler, or directional bridge, depending on your particular measurement.

Connecting Your PSA Analyzer to a PSG-C, PSG-D, or ESG-C Signal Source

Once you have the required equipment and cables, you are ready to set up your measurement. You will need to connect the PSA analyzer and the PSG-C, PSG-D, or ESG-C signal source, before configuring the analyzer to recognize the source.

Connecting the Cables

1. Connect the signal source **TRIGGER OUT** to the PSA spectrum analyzer **TRIGGER IN**. The analyzer **TRIGGER IN** connector must be terminated in 50 Ω . This can be done by:
 - a. connecting a 50 Ω feedthrough directly to the PSA **TRIGGER IN** connector and then connecting the BNC cable between the other end of the feedthrough and the PSG or ESG-C **TRIGGER OUT** connector.
 - or
 - b. connecting a tee to the PSA **TRIGGER IN** connector. Then connecting one output of the tee to a 50 Ω load and using the BNC cable to connect the other tee output to the PSG or ESG-C **TRIGGER OUT** connector.
2. Using the second BNC cable, connect **SWEEP OUT** on the rear of the signal source to **EXT TRIGGER INPUT** on the front panel of the PSA Series analyzer.
3. Using the third BNC cable, connect the PSG rear panel **10 MHz OUT** to the PSA rear panel **EXT REF IN**.
4. Either connect each instrument to the LAN using two separate LAN cables, or connect the two instruments together using a single LAN crossover cable.

Configuring the PSA Series Analyzer

After the instruments are connected, you need to configure the PSA to find the IP Address of the ESG-C or PSG Series signal source, so the two instruments can communicate with each other.

Find the IP Address of the ESG-C or PSG Series signal source.

1. Press the **Utility** key on the front panel.
2. Press **GPIB/RS-232 LAN**, then **LAN Setup** to display the IP Address on the second softkey label.

Enter the IP Address of the signal source into the PSA Series analyzer.

3. Press the **MODE** key followed by the **Spectrum Analysis** softkey to put the PSA Series analyzer into Spectrum Analysis mode.
4. Press the Source key to display the **Ext Source** menu.
5. Press the **Ext Src Config** softkey to display the current value for the IP address of an external signal source. If this IP address does not match the IP address of your ESG-C or PSA signal source (from Step 2 above), then you need to change it using Steps 6 and 7.
6. Press the **IP Address** softkey so that the key label is highlighted.
7. Enter the IP Address of the ESG-C or PSG signal source using the numeric keypad, and press the **Enter** key.

NOTE

If you are using a cross-over LAN cable to connect the instruments directly together, then the IP addresses of both the instruments must start with the same two integers. That is, if the spectrum analyzer IP address is 156.121.12.122, the source IP address must be 156.121.xxx.xxx.

Service and Calibration

When your analyzer is returned from an Agilent Technologies service center, you may have to reinstall Option 215. Refer to [“Installing Option 215”](#) on page 14.

Documentation for Option 215

Spectrum Analyzers with Option 215

When you purchase your External Source Control personality (Option 215), you will receive this manual - the *External Source Control Personality Guide*. For information on PSA series analyzers and other related documentation, refer to the PSA web site at <http://www.agilent.com/find/psa/>.

Spectrum Analyzer Updates

For the latest information about this instrument, including software upgrades, application information, and product information, please visit the URLs listed below.

Updating the Firmware and Software

Updated versions of the Agilent Spectrum Analyzers' firmware and software will be available via several sources. Information on the latest firmware and software revision can be accessed through the following URLs.

URLs to Obtain Update Information

For PSA analyzers: <http://www.agilent.com/find/psa/>

NOTE

If you have received Option 215 as an upgrade kit, the latest version of the analyzer's firmware has been included and will be loaded into your instrument while you are installing the Option 215 software.

2 Measurement Concepts

Why Use the Spectrum Analyzer With a Tracking Source?

A spectrum analyzer with a tracking source can make swept scalar-magnitude measurements similar to a single channel network analyzer. The amplitude accuracy of a spectrum analyzer/tracking source combination is not as good as a modern network analyzer, but it has a good dynamic range and excellent frequency selectivity. A spectrum analyzer/tracking source system can be used to make many measurements that would otherwise require a scalar network analyzer.

The output of a tracking source is synchronized to the input frequency of the host spectrum analyzer. The two frequencies are made identical to enable stimulus/response testing similar to a scalar network analyzer. The frequency selectivity of the spectrum analyzer can measure a non-linear device's output at the fundamental frequency, because the spectrum analyzer will not respond to harmonic or other spurious energy created by the device under test.

A spectrum analyzer/tracking source measurement system can be used to do some device characterization. It cannot make ratio measurements or phase measurements, but can make stimulus/response measurements such as:

Reflection measurements

- Reflection coefficient
- Return loss
- SWR

Transmission measurements

- Flatness
- Insertion loss / gain

Some of the devices that can be characterized with a spectrum analyzer/tracking source system include:

- Filters
- Amplifiers
- Mixers

Stimulus Response Measurements

Stimulus/response measurements require a source to stimulate a device under test (DUT), a receiver to analyze the frequency response characteristics of the DUT, and, for return loss measurements, a directional coupler or bridge. Characterization of a DUT can be made in terms of its transmission or reflection parameters. Examples of transmission measurements include flatness and rejection. Return loss is an example of a reflection measurement.

A spectrum analyzer combined with a swept source forms a stimulus/response measurement system that operates the same as a single channel scalar network analyzer. The swept source output frequency must be made to precisely track the analyzer input frequency for good narrow band operation. A narrow band system has a wide dynamic measurement range.

There are four basic steps in performing a stimulus/response measurement, whether it is a transmission or a reflection measurement.

1. Connect the spectrum analyzer and tracking source together, including making the trigger, sweep, reference and LAN connections and entering the external source information. Instructions for doing this can be found in [“Setting Up Your Signal Analyzer and Signal Source” on page 21](#)
2. Select the spectrum analyzer and source measurement settings, and connect the cables and accessories needed to make the desired measurement (but do not include the DUT). Note that the source setup is done using the functions under the spectrum analyzer **Source** key.
3. Do the calibration measurement (error correction).
4. Attach the DUT and perform the measurement.

Frequency and Amplitude Accuracy

Sweep Speed

The maximum and minimum sweep times available for manual selection are constrained to allow coordination of the source and the analyzer.

For stimulus/response measurements, the Q of the DUT can determine the fastest rate at which the analyzer can be swept. (Q is the quality factor, which is the center frequency of the DUT divided by the bandwidth of the DUT.) The Option 215 calculated sweep times are usually fine. You can verify that it is not sweeping too fast by slowing the sweep and noting whether there is a frequency or amplitude shift of the trace. If there is a change, continue to slow the sweep until there is no longer a frequency or amplitude shift.

Tracking Error

Many built-in tracking generators require tracking adjustment by the user to account for circuit drifts. The circuits in Option 215 are all fully frequency synthesized, so no tracking adjustment is required nor is any available.

Power Leveling

Power leveling is not available on any of the PSG-C, PSG-D, or the ESG-C signal sources.

Power Slope Correction

With Option 215 there is no functionality for adding a power slope correction to the source output level, so you may need to find a more accurate source.

Calibration/Normalization

Types of Measurement Errors

There are three basic sources of measurement error: systematic, random and drift.

- Systematic Errors
 - are due to imperfections in the analyzer and the test setup
 - are assumed to be time invariant (predictable)
 - are characterized by the calibration, and can be removed during measurements
- Random Errors
 - vary with time in a random fashion (unpredictable)
 - are mainly a result of instrument noise (source phase noise, analyzer sensitivity)
 - cannot be removed
- Drift Errors
 - are due to instrument or test-system performance changes after a calibration has been done (unpredictable)
 - are primarily caused by temperature variations
 - can be removed by re-doing the calibration

So doing a calibration before making the measurement improves the measurement accuracy. Any time you change the frequency, power settings, or cables within a measurement, you must repeat the calibration routine.

Open/Short Calibration

An open/short calibration is used for reflection measurements and only corrects for system tracking errors (source match and reflection tracking). This type of calibration is essentially a normalized measurement where a reference trace is stored in memory. This memory trace data is then subtracted from later measurement data.

Press **Source, Open/Short Cal** to access this functionality.

The reference trace is created by terminating the directional coupler or bridge in a short and also in an open. These two sets of data are then averaged together. The resulting trace data is used as the reference trace to correct future measurements. This calibration data must be

taken using the same analyzer settings as will be used for the measurement of the DUT. A calibration created by measuring both an open and a short is more accurate than doing a simple normalization using only one or the other of these devices. It is, however, possible to do either an Open Only or a Short Only calibration by simply storing a trace, taken with either an open device or a short device, in the Reference Trace, that is, in Trace 3.

If you terminate a connector in a short, the short cannot dissipate power. Since there is nowhere for the power to go, a reflected wave is returned back down the line. There can be no voltage across a short so the reflected wave is equal in magnitude and 180 degrees out of phase with the incident signal. (The sum of the incident voltage wave and the reflected voltage wave must equal zero at the short.)

In a similar way, an open connection will reflect back a waveform that is of equal magnitude, but is in phase with the incident voltage wave. So the open and short data are 180 degrees out of phase with each other. When they are averaged together they form a more accurate representation of the analyzer characteristics.

NOTE

Any two waves traveling in opposite directions cause a “standing wave” to be formed on the transmission line. Standing wave ratio (SWR) is defined as the standing wave maximum voltage over its minimum voltage.

Normalization Concepts

Normalization can be used on a transmission measurement to correct for frequency response errors. The frequency response of the test system must be measured and stored as a reference trace, and then normalization is used to eliminate this error from the measurement.

To measure the frequency response of the test system, connect the test system as desired for the measurement. Then remove the DUT from the system replacing it with a thru connection. Measure the frequency response of the system, and store this as a reference trace.

Press **Source, Normalize, Store Ref (1 -> 3)** to access this functionality.

The frequency response of the test system is stored and a normalization can be performed. Press **Source, Normalize, Normalize On** to activate normalization. This means that the active displayed trace is now the ratio of the input data to the stored data.

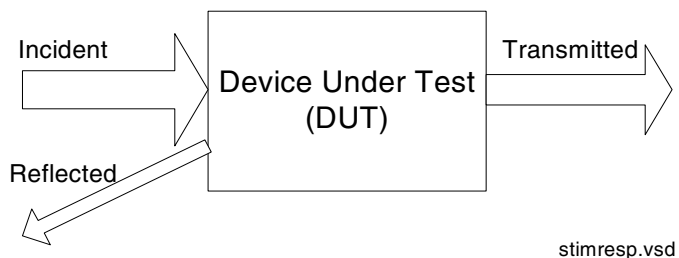
When normalization is on, the normalization reference data is subtracted from the measured data and the normalized reference position/level settings are applied to the displayed trace data. Normalized reference position is indicated by arrowheads at the edges of the graticule.

Reconnect the DUT to the analyzer. Note that the units of the reference

level have changed to dB, indicating that this is now a relative measurement.

Equations and Conversion Table

Figure 2-1 Transmitted and Reflected Power with a DUT



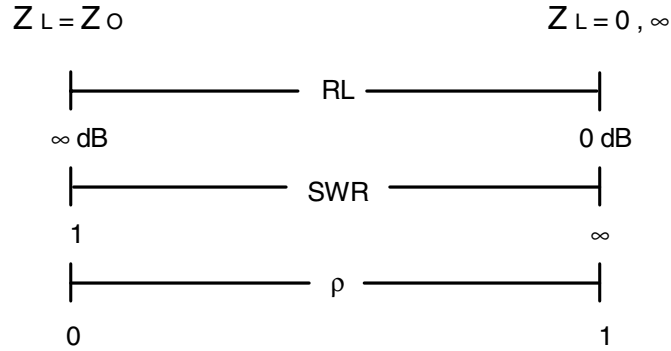
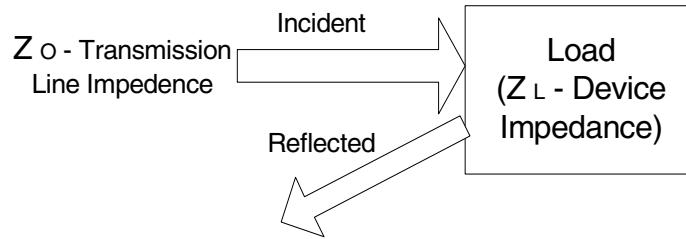
$$\text{Insertion Loss or Gain} = 20\log \frac{V_{\text{transmitted}}}{V_{\text{incident}}}$$

$$\text{Reflection Coefficient } \rho = \frac{V_{\text{reflected}}}{V_{\text{incident}}}$$

Reflection coefficient is actually a complex quantity (Γ). But a tracking source/spectrum analyzer system only makes scalar measurements (ρ).

$$\text{Return Loss} = -20\log \rho$$

Figure 2-2 Ranges and Relationships



$$VSWR = \frac{V_{\max}}{V_{\min}} = \frac{1 + \rho}{1 - \rho} = \frac{1 + 10^{\frac{-RL}{20}}}{1 - 10^{\frac{-RL}{20}}}$$

Where: RL is the measured return loss value.

Note that a VSWR of 1 (sometimes referred to as 1:1) means that all of the transmitted incident power is absorbed at the load and no power is reflected back. (This assumes a perfect impedance match.) Similarly, an infinite VSWR is for a perfect open or short, where all of the incident power is reflected back.

Converting Return Loss to VSWR

Return loss can be expressed as a voltage standing wave ratio (VSWR) value using the following table:

Table 2-1 Return Loss to VSWR Conversion

Return Loss (dB)	VSWR	Return Loss (dB)	VSWR	Return Loss (dB)	VSWR	Return Loss (dB)	VSWR	Return Loss (dB)	VSWR
4.0	4.42	14.0	1.50	18.0	1.29	28.0	1.08	38.0	1.03
6.0	3.01	14.2	1.48	18.5	1.27	28.5	1.08	38.5	1.02
8.0	2.32	14.4	1.47	19.0	1.25	29.0	1.07	39.0	1.02
10.0	1.92	14.6	1.46	19.5	1.24	29.5	1.07	39.5	1.02
10.5	1.85	14.8	1.44	20.0	1.22	30.0	1.07	40.0	1.02
11.0	1.78	15.0	1.43	20.5	1.21	30.5	1.06	40.5	1.02
11.2	1.76	15.2	1.42	21.0	1.20	31.0	1.06	41.0	1.02
11.4	1.74	15.4	1.41	21.5	1.18	31.5	1.05	41.5	1.02
11.6	1.71	15.6	1.40	22.0	1.17	32.0	1.05	42.0	1.02
11.8	1.69	15.8	1.39	22.5	1.16	32.5	1.05	42.5	1.02
12.0	1.67	16.0	1.38	23.0	1.15	33.0	1.05	43.0	1.01
12.2	1.65	16.2	1.37	23.5	1.14	33.5	1.04	43.5	1.01
12.4	1.63	16.4	1.36	24.0	1.13	34.0	1.04	44.0	1.01
12.6	1.61	16.6	1.35	24.5	1.13	34.5	1.04	44.5	1.01
12.8	1.59	16.8	1.34	25.0	1.12	35.0	1.04	45.0	1.01
13.0	1.58	17.0	1.33	25.5	1.11	35.5	1.03	45.5	1.01
13.2	1.56	17.2	1.32	26.0	1.11	36.0	1.03	46.0	1.01
13.4	1.54	17.4	1.31	26.5	1.10	36.5	1.03	46.5	1.01
13.6	1.53	17.6	1.30	27.0	1.09	37.0	1.03	47.0	1.01
13.8	1.51	17.8	1.30	27.5	1.09	37.5	1.03	47.5	1.01

VSWR is sometimes stated as a ratio. For example: 1.2:1 “one point two to one” VSWR. The first number is the VSWR value taken from the table or calculated using the formula. The second number is always 1.

3

Menu Maps

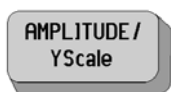
This chapter provides a visual representation of the front-panel keys and their associated menu keys. Refer to [Chapter 4, “Source Key and Programming Commands,”](#) on page 45 for descriptions of the key functions.

What You Will Find in This Chapter

This chapter provides all the menu maps that are found under the Source key.

Key to this chapter's menu map diagrams

In this chapter of menu map diagrams, the following key has been used:



This represents a hardkey, that is, a raised key on the front panel.



This represents a softkey on a menu, that is, a key that is displayed only on the screen



A bar on the left of two or more keys indicates that the keys are a set of mutually exclusive choices.



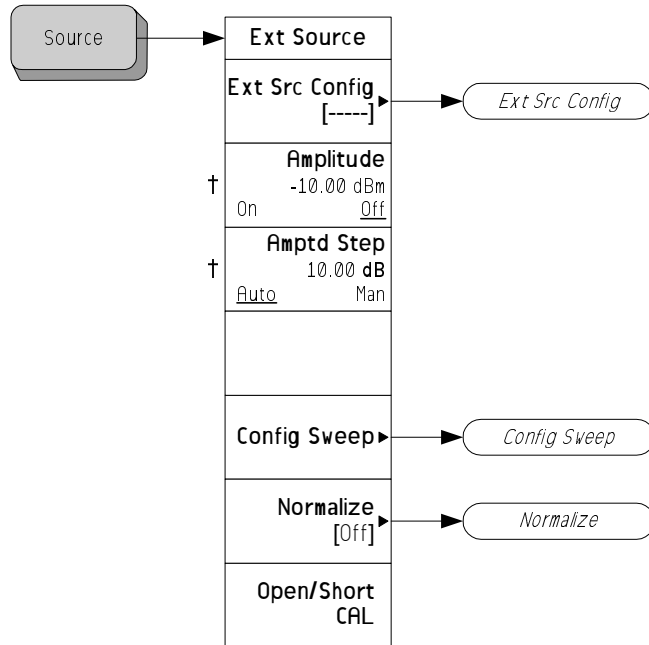
A dagger to the left of the key indicates that this is an active function.



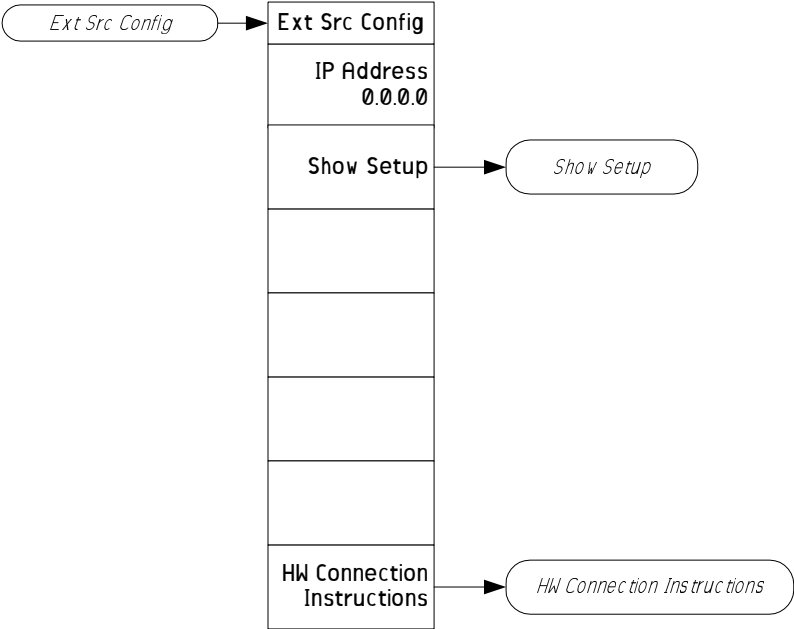
A double-dagger to the left of the key indicates a function that is not always available. It is dependent on other instrument settings.

Menus

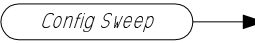
Source



Config Ext Source



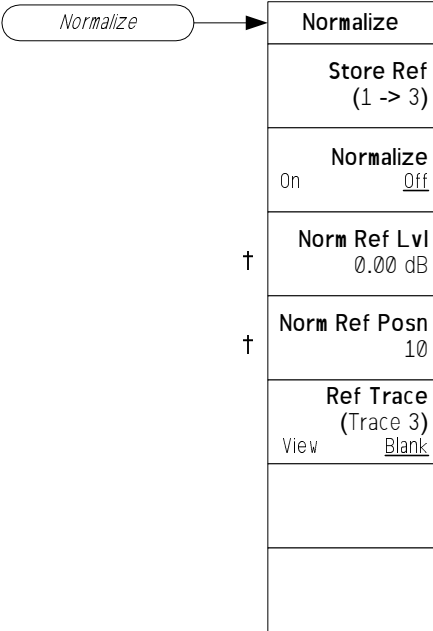
Config Sweep



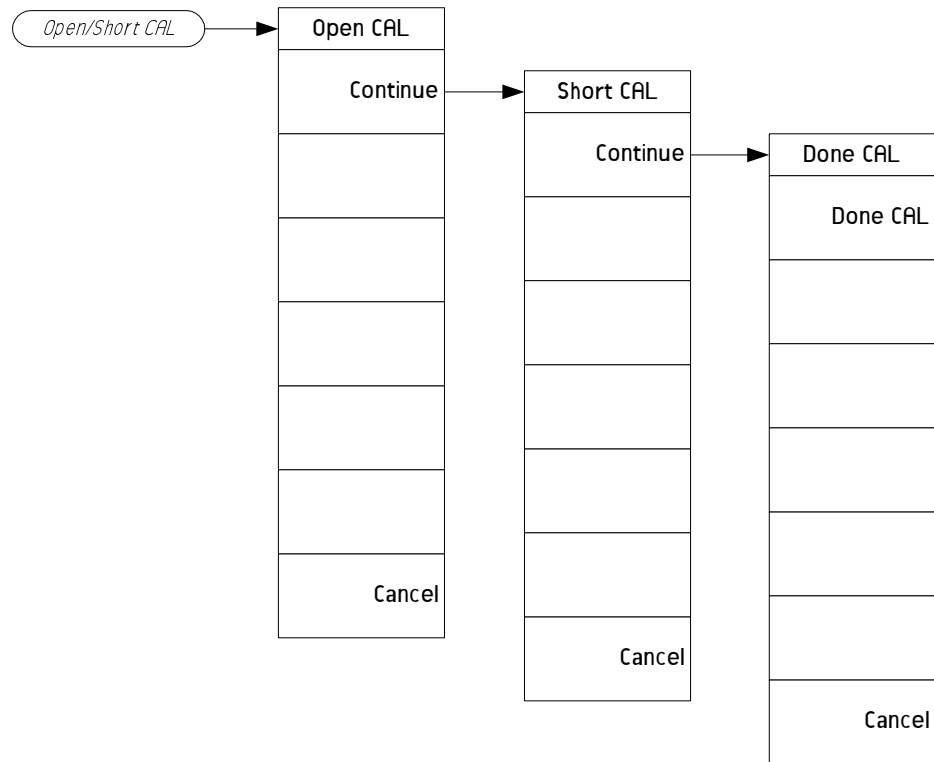
Config Sweep	
†	Offset 0.000 Hz On <u>Off</u>
†	Harmonic 1 On <u>Off</u>
†	Power 0.00 dB On <u>Off</u>

† A dagger to the left of the key indicates that this is an active function.

Normalize



Open/Short Cal



4 Source Key and Programming Commands

External source control functionality available when the currently active mode is Spectrum Analyzer. In all other modes the softkeys displayed under the source key will be grayed out and the functionality disabled.

4.1 External Source Configuration

Figure 4-1 Show Setup Screen

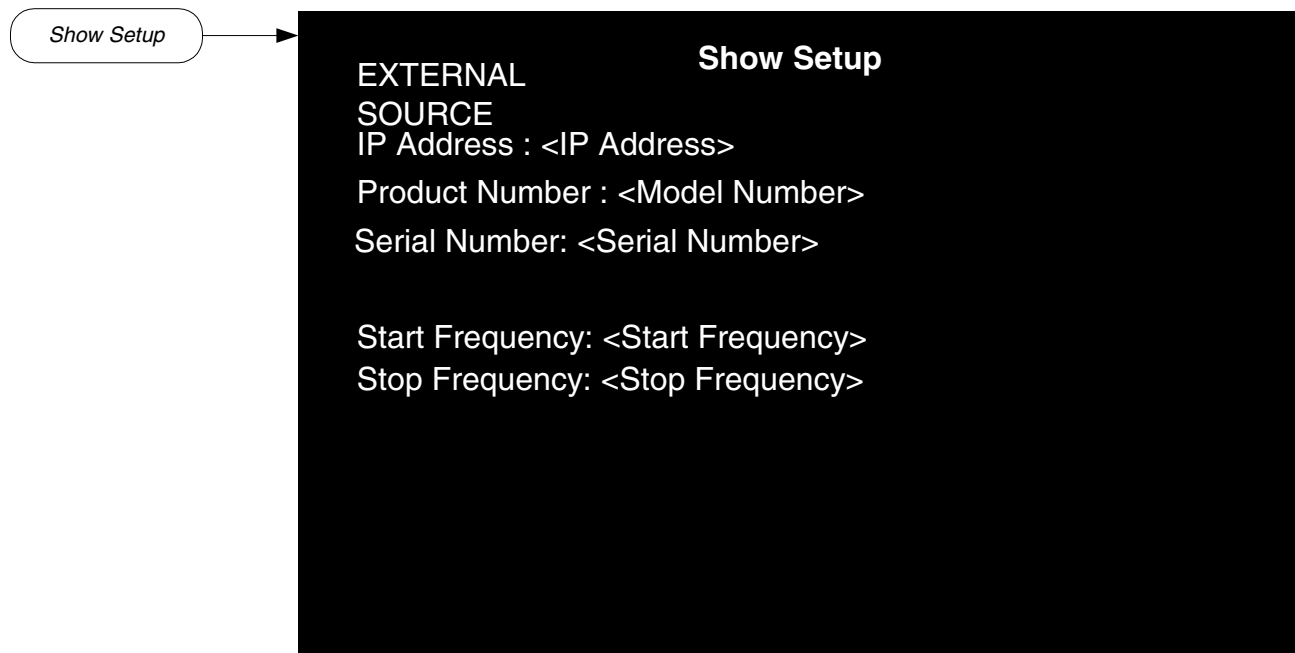
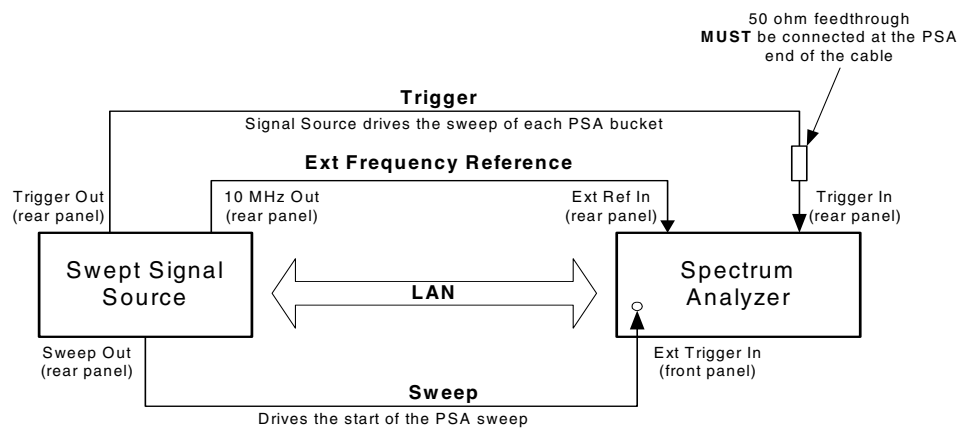


Figure 4-2 Spectrum Analyzer and Signal Source Connections



sa_ss_connect.vsd

4.1.1 IP Address

Sets the IP Address of the external source to be controlled by the PSA.

Mode:	Spectrum Analysis
Key Path:	Source, Ext Src Config, 1 Source, Ext Src Config, Show Setup
Remote Command:	:SYSTem:COMMunicate:LAN:SOURce[:EXTernal]:IP <string> :SYSTem:COMMunicate:LAN:SOURce[:EXTernal]:IP?
Unit/Terminator Keys:	Enter
Factory Preset:	0.0.0.0
State Saved:	Saved in instrument state.
Range:	Numeric and the ‘.’ character. String must be of the form <integer>.<integer>.<integer>.<integer>
Dependencies and Couplings:	Establishes a connection with the entered IP Address at port 5025. If a connection can not be established at any time (perhaps if the entered IP address is incorrect, or if the external source or PSA are disconnected from the LAN) then the IP address is reset to ‘0.0.0.0’. If you are using a cross-over LAN cable to connect the instruments directly together, then the IP addresses of both the instruments must start with the same two integers. That is, if the spectrum analyzer IP address is 156.121.12.122, the source IP address must be 156.121.xxx.xxx. Once a valid connection has been confirmed, if the external source or PSA is disconnected from the LAN the connection will not be identified as invalid until you change a parameter that requires the external source to be reconfigured. The following operations are disabled if a LAN connection is not established with your specified IP Address: <ul style="list-style-type: none"> • External Source Amplitude • External Source Amplitude Step • Configure Sweep functions • Normalize • Open/Short CAL
Factory Preset	Persistent setting survives instrument preset and power cycle.
State Saved	No
Example:	SYST:COMM:LAN:SOUR:IP 123.109.355.12

4.1.2 Show Setup

Pressing this immediate action key displays a form showing you the current configuration of the external source at the specified IP address.

Mode:	Spectrum Analysis
Key Path:	Source, Ext Src Config
Dependencies and Couplings:	Parameter is disabled if active mode is not Spectrum Analyzer or a connection has not been established at the specified IP address.
Remote Command Notes:	No SCPI. Front Panel only.

4.1.3 Model Number

Information parameter which displays the model number of the signal source connected at the specified IP Address. The model number displayed will be determined by sending a “*IDN?” to the entered IP address. The model number is the second field of the “*IDN?” returned value (Format of the *IDN? string is ‘<Company Name>, <Model Number>, <Serial Number>, <Firmware Revision>’).

Mode:	Spectrum Analysis
Key Path:	Source, Ext Src Config, Show Setup
Remote Command:	:SOURce:EXTernal:MODEl?
Factory Preset:	-----
State Saved:	No
Range:	Uppercase, Numeric
Remote Command Notes:	Query Only
Example:	SOUR:EXT:MOD?

4.1.4 Serial Number

Information parameter which displays the serial number of the signal source connected at the specified IP Address. The serial number displayed will be determined by sending a “*IDN?” to the entered IP address. The serial number is the third field of the “*IDN?” returned value (Format of the *IDN? string is ‘<Company Name>, <Model Number>, <Serial Number>, <Firmware Revision>’).

Mode:	Spectrum Analysis
Key Path:	Source, Ext Src Config, Show Setup
Factory Preset:	-----
State Saved:	No
Notes:	This parameter is not user definable and is provided purely for information. It is simply displaying the serial number of the instrument recognized to be at the IP Address you entered.
Remote Command Notes:	Front panel information only

4.1.5 Start Frequency

Information parameter which displays the start frequency of the signal source connected at the specified IP Address.

Mode:	Spectrum Analysis
Key Path:	Source, Ext Src Config, Show Setup
Remote Command:	:SOURce:EXTernal:FREQuency:STARt?
State Saved:	No
Dependencies and Couplings:	The external source start frequency is changed each time the start frequency of the PSA changes. If the calculated external source start frequency exceeds the frequency range of the external source Error Message 13227 will be reported and the sweep stopped until you adjust either PSA Start Freq, PSA Stop Frequency, Frequency Offset (if ON) or Harmonic (if ON) such that the frequency range can be swept by the signal source and PSA simultaneously.
Remote Command Notes:	Query only
Example:	SOUR:EXT:FREQ:STAR?

4.1.6 Stop Frequency

Information parameter which displays the stop frequency of the signal source connected at the specified IP Address.

Mode:	Spectrum Analysis
Key Path:	Source, Ext Src Config, Show Setup
Remote Command:	:SOURce:EXTernal:FREQuency:STOP?
State Saved:	No
Dependencies and Couplings:	The external source stop frequency is changed each time the stop frequency of the PSA changes. If the calculated external source stop frequency exceeds the frequency range of the external source Error Message 13227 will be reported and the sweep stopped until you adjust either analyzer start or stop frequency, the frequency offset (if ON) or harmonic (if ON) so that the frequency range can be swept by the signal source and analyzer simultaneously.
Remote Command Notes:	Query only
Example:	SOUR:EXT:SWE:STOP?

4.1.7 Hardware Connection Instructions

Pressing this immediate action keys displays a form showing you how to set up the connections between the PSA and the external source. The form will be displayed until you press any key. See [Figure 4-2](#).

Mode:	Spectrum Analysis
Key Path:	Source, Ext Src Config
Dependencies and Couplings:	Parameter is disabled if active mode is not Spectrum Analyzer mode.
Remote Command Notes:	No SCPI. Front Panel only.

4.2 Amplitude

The amplitude parameter sets the power level and state of the external source, setting the state to ON initializes the external source based on the current settings of the Spectrum Analyzer.

Mode:	Spectrum Analysis
Key Path:	Source
Remote Command:	<code>:SOURCE:EXTERNAL:POWER[:LEVEL][:IMMEDIATE][:AMPLITUDE]</code> <code><ampl></code> <code>:SOURCE:EXTERNAL:POWER[:LEVEL][:IMMEDIATE][:AMPLITUDE]?</code> <code>:OUTPUT:EXTERNAL[:STATE] OFF ON 1 0</code> <code>:OUTPUT:EXTERNAL[:STATE]?</code>
Factory Preset:	-10.00 dBm, OFF
State Saved:	Saved in instrument state.

Amplitude

Dependencies and Couplings:

Parameter is disabled if active mode is not Spectrum Analyzer or a connection has not been established at the specified IP address.

Setting state to ON initializes the external source based on the current settings of the spectrum analyzer. The external source display will be turned OFF and the following external source parameters will be initialized:

- Start/Stop Frequency
- Start/Stop Amplitude
- Number of Points
- Dwell Time
- Sweep type set to stepped

In addition setting the external source control state to ON also sets the following on the PSA:

- Video Bandwidth = 50 MHz, the PSA video bandwidth is fixed at 50MHz while external source control state is set to ON.
- Detector Type to Sample
- Trigger Polarity
- Trigger Source to External Front
- Gate Polarity to Positive
- Gate Trigger to External Rear
- Gate Delay
- Gate Length
- Sweep Time
- Resolution Bandwidth
- Gate State to ON

If the calculated external source start or stop frequency exceeds the frequency range of the external source the sweep is stopped until you adjust either analyzer start or stop frequency, the frequency offset (if ON) or harmonic (if ON) such that the frequency range can be swept by the signal source and PSA simultaneously. Once the frequency range of the external source is valid, the sweep resumes.

Example:

```
SOUR:EXT:POW -22 dBm
```

```
SOUR:EXT:POW ON
```

4.3 Amplitude Step

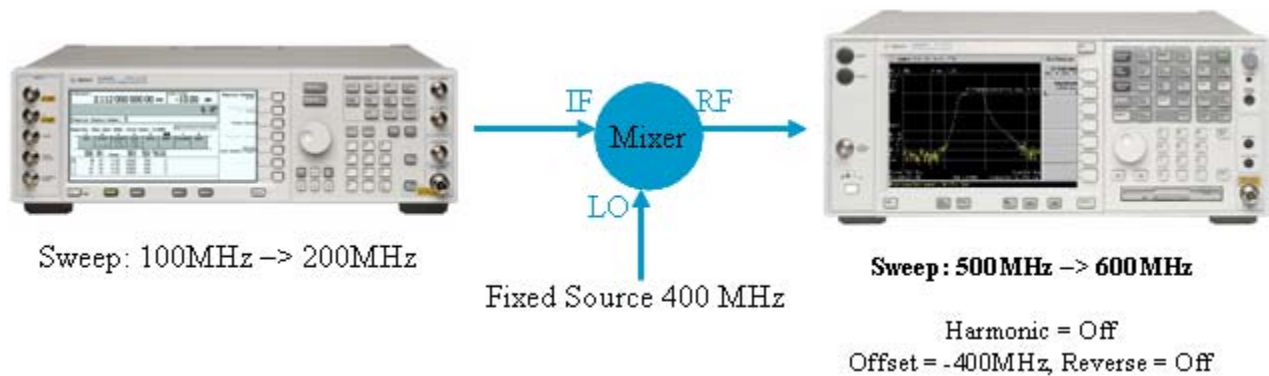
Allows you to specify the step size of the external source power level

Mode:	Spectrum Analysis
Key Path:	Source
Remote Command:	<code>:SOURce:EXTernal:POWer:STEP[:INCRement] <rel_amp1></code> <code>:SOURce:EXTernal:POWer:STEP[:INCRement]?</code> <code>:SOURce:EXTernal:POWer:STEP:AUTO ON OFF 1 0</code> <code>:SOURce:EXTernal:POWer:STEP:AUTO?</code>
Factory Preset:	10.00 dB, ON
State Saved:	Saved in instrument state.
SCPI Resolution Max:	1.00 dB
Example:	<code>SOUR:EXT:POW:STEP 1 dB</code> <code>SOUR:EXT:POW:STEP:AUTO OFF</code>

4.4 Configure Sweep

4.4.1 Offset Sweep

Offset sweep offsets the frequency of the signal generator from the frequency of the PSA. One application for offset sweep is testing mixer conversion loss. See the following graphic.



Mode:	Spectrum Analysis
Key Path:	Source, Config Sweep
Remote Command:	:SOURce:EXTernal:SWEep:OFFSet:FREQuency <freq> :SOURce:EXTernal:SWEep:OFFSet:FREQuency? :SOURce:EXTernal:SWEep:OFFSet[:STATE] ON OFF 1 0 :SOURce:EXTernal:SWEep:OFFSet[:STATE]?
Factory Preset:	0.00 Hz, OFF
State Saved:	Saved in instrument state.
SCPI Resolution Max:	1 Hz

Dependencies and
Couplings:

Parameter is disabled if active mode is not Spectrum Analyzer or a connection has not been established at your specified IP address.

The external source start and stop frequencies are offset from the analyzer start and stop frequencies by the specified amount when the state is set to ON.

If the calculated external source start or stop frequency exceeds the frequency range of the external source, the sweep is stopped until you adjust the analyzer Start Frequency, Stop Frequency, Frequency Offset (if ON) or the harmonic (if ON) such that the frequency range can be swept by the signal source and analyzer simultaneously. Once the frequency range of the external source is valid, the sweep will resume.

The analyzer Start Frequency + Frequency Offset must be greater than the external source Minimum Frequency + 1 Bucket Width.

The analyzer Stop Frequency + Frequency Offset must be less than the external source Maximum Frequency – 1 Bucket Width.

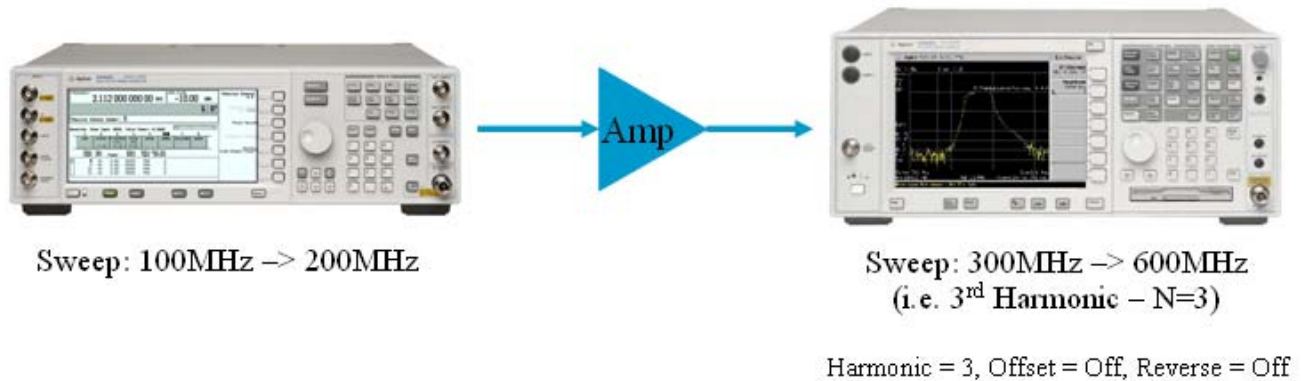
Example:

```
SOUR:EXT:SWE:OFFS:FREQ 200MHz
```

```
SOUR:EXT:SWE:OFFS ON
```

4.4.2 Harmonic Sweep

Harmonic sweep offsets the frequency of the signal generator from the frequency of the PSA. One application for harmonic sweep is amplifier test. See the following graphic.



Mode:	Spectrum Analysis
Key Path:	Source, Config Sweep
Remote Command:	<pre>:SOURce:EXTernal:SWEep:HARMonic <real> :SOURce:EXTernal:SWEep:HARMonic? :SOURce:EXTernal:SWEep:HARMonic:STATE ON OFF 1 0 :SOURce:EXTernal:SWEep:HARMonic:STATE?</pre>
Factory Preset:	1, OFF
State Saved:	Saved in instrument state.
Dependencies and Couplings:	<p>Parameter is disabled if active mode is not Spectrum Analyzer or a connection has not been established at the specified IP address.</p> <p>The harmonic range is restricted by both the frequency range of the spectrum analyzer and the frequency range of the external source.</p> <p>If the calculated external source start or stop frequency exceeds the frequency range of the external source Error Message 13227 will be reported and the sweep stopped until you adjust either analyzer start or stop frequency, the frequency offset (if ON) or harmonic (if ON) such that the frequency range can be swept by the signal source and analyzer simultaneously. Once the frequency range of the external source is valid the error is cleared and the sweep resumes.</p>
Example:	<pre>SOUR:EXT:SWE:HARM 2 SOUR:EXT:SWE:HARM:STAT ON</pre>

4.4.3 Power Sweep

The external source amplitude is swept over the specified number of sweep points.

Mode:	Spectrum Analysis
Key Path:	Source, Config Sweep
Remote Command:	<pre>:SOURce:EXTernal:SWEep:POWer:SPAN <rel_ampl> :SOURce:EXTernal:SWEep:POWer:SPAN? :SOURce:EXTernal:POWer:MODE FIXed SWEep :SOURce:EXTernal:POWer:MODE?</pre>
Factory Preset:	0.00 dB, FIXed
State Saved:	Saved in instrument state.
SCPI Resolution Max:	1.00 dB
Dependencies and Couplings:	Parameter is disabled if active mode is not Spectrum Analyzer mode or a connection has not been established at you specified IP address.
Example:	<pre>SOUR:EXT:SWE:POW:SPAN 10 dB SOUR:EXT:SWE:POW:MODE SWE</pre>

4.5 Normalize

4.5.1 Store Reference Trace

Copies trace 1 into trace 3.

Mode: Spectrum Analysis

Key Path: **Source, Normalize**

Remote Command: :TRACe:COPIY TRACE1, TRACE3

Dependencies and Couplings: Parameter is disabled if active mode is not Spectrum Analyzer or a connection has not been established at the specified IP address.

A reference trace should be stored prior to turning on trace normalization either through pressing the Store Ref Trace softkey or completing an Open/Short calibration.

The stored reference trace (trace 3) is cleared when key is pressed. If you wish to re-use this calibration data you should save the trace (File > Save > Type (Trace) > Save Now) and then recall it following completion of the preset.

Example: TRAC:COPIY TRACE1, TRACE3

4.5.2 Normalize

Enables or disables trace normalization.

Mode:	Spectrum Analysis
Key Path:	Source, Normalize
Remote Command:	<code>:CALCulate:NTData[:STATE] ON OFF 1 0</code> <code>:CALCulate:NTData[:STATE]?</code>
Factory Preset:	OFF
State Saved:	Saved in instrument state.
Dependencies and Couplings:	<p>The parameter is disabled if active mode is not Spectrum Analyzer or a connection has not been established at the specified IP address. Trace normalization cannot be turned ON unless external source control is ON (that is, Amplitude state is set to ON). If external source control is turned OFF while trace normalization is ON, then trace normalization will be turned OFF.</p> <p>If a reference trace has not been stored prior to turning on trace normalization, then trace normalization is turned on but an error message is reported.</p> <p>Turning on trace normalization changes the Y scale units to dB when Preset is pressed. The trace data now displayed in trace 1 is the data measured in trace 1 minus the data in the reference trace (trace 3).</p> <p>Trace normalization will be turned OFF when the reference trace display is set to View.</p>
Example:	<code>CALC:NDAT ON</code>

4.5.3 Normalized Reference Level

Allows you to set the normalized reference level.

Mode:	Spectrum Analysis
Key Path:	Source, Normalize
Remote Command:	:DISPlay:WINDow:TRACe:Y[:SCALe]:NRLevel <rel_amp1> :DISPlay:WINDow:TRACe:Y[:SCALe]:NRLevel?
Factory Preset:	0.00 dB
State Saved:	Saved in instrument state.
SCPI Resolution Max:	0.01 dB
Dependencies and Couplings:	Parameter is disabled if active mode is not Spectrum Analyzer or a connection has not been established at the specified IP address.
Example:	DISP:WIN:TRAC:Y:NRL -1.8 dB

4.5.4 Normalized Reference Position

Allows you to select the position of the normalized reference level; the top and bottom graticule line correspond to 10 and 0 respectively.

Mode:	Spectrum Analysis
Key Path:	Source, Normalize
Remote Command:	:DISPlay:WINDow:TRACe:Y[:SCALe]:NRPosition <integer> :DISPlay:WINDow:TRACe:Y[:SCALe]:NRPosition?
Factory Preset:	10
State Saved:	Saved in instrument state.
Dependencies and Couplings:	Parameter is disabled if active mode is not Spectrum Analyzer or a connection has not been established at the specified IP address.
Example:	DISP:WIN:TRAC:Y:NRP 9 sets it one graticule down from the top.

4.5.5 Reference Trace Display

Mode:	Spectrum Analysis
Key Path:	Source, Normalize
Factory Preset:	Blank
State Saved:	Saved in instrument state.
Dependencies and Couplings:	Parameter is disabled if active mode is not Spectrum Analyzer or a connection has not been established at the specified IP address. When the reference trace is set to View, trace normalization is turned OFF, and Trace 3 (the reference trace) is placed into View mode.
Remote Command Notes:	No SCPI. Front Panel only.

4.6 Open/Short CAL

Figure 4-3 Open Calibration Form

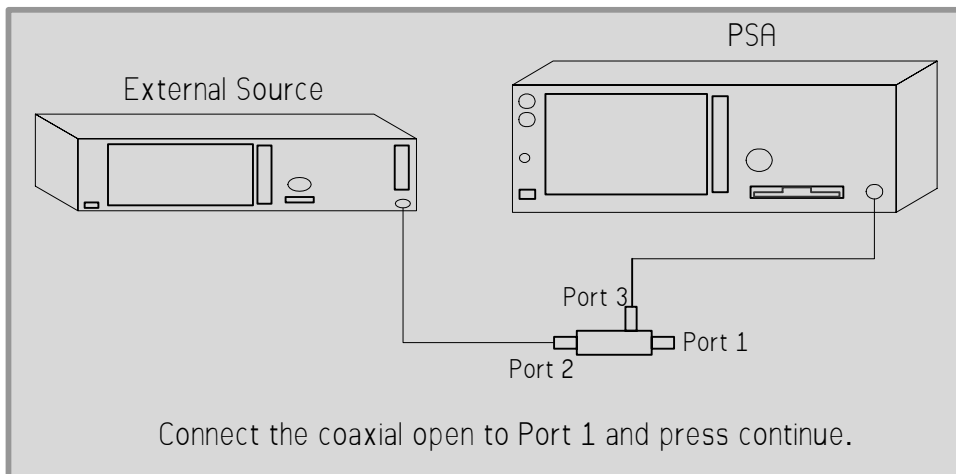
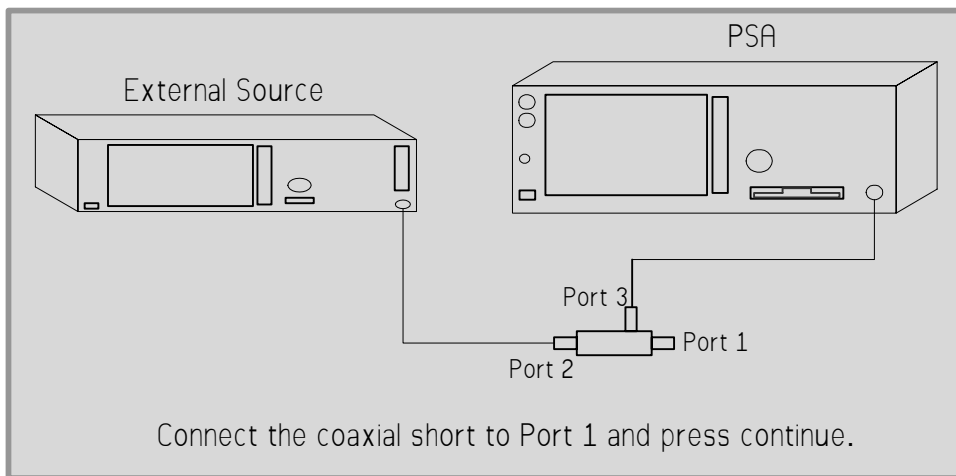


Figure 4-4 Short Calibration Form



Pressing the immediate action Open/Short CAL key directs you through performing an Open/Short Calibration. On pressing the Open/Short CAL softkey the Open Calibration Form (see [Figure 4-3, “Open Calibration Form,”](#)) is displayed and the softkey menu displays a softkey labeled ‘Continue’ and a softkey labeled ‘Cancel’. The form shows a diagrammatic representation of how to connect the external source to the spectrum analyzer to perform the calibration. When you press the Continue softkey, the open calibration sweep is taken and stored in memory.

NOTE

You will get an error if you try to start an Open/Short Cal using frequency span settings that cross band boundaries. (See [“Frequency Bands”](#) on page 9.) The Open/Short Cal will not start until you change the start/stop frequencies to stay within a single band.

On completion of the Open Calibration, you are directed through performing a coaxial short calibration. Once an Open Calibration has been completed the Short Calibration Form (see [Figure 4-4, “Short Calibration Form,”](#)) is displayed and the softkey menu displays a softkey labeled ‘Continue’ and a softkey labeled ‘Cancel’. The form shows a diagrammatic representation of how to connect the external source to the spectrum analyzer to perform the calibration. At this stage you can choose to either complete the Open/Short Calibration by pressing the ‘Done CAL’ softkey or cancel the Open/Short Calibration by pressing the ‘Cancel’ softkey.

The Open/Short Calibration can be canceled at any time by pressing the ‘Cancel’ softkey. If you cancel the Open/Short Calibration at any point, previously stored calibration data will not be overwritten.

4.6.1 Continue Calibration

Mode:	Spectrum Analysis
Key Path:	Source, Open/Short CAL
Dependencies and Couplings:	Parameter is disabled if active mode is not Spectrum Analyzer or a connection has not been established at the specified IP address. When the Open/Short CAL immediate action key is pressed the Open CAL Form is displayed and a continue softkey displayed on the menu. On completion of the Open CAL the Short CAL form is displayed with the continue softkey again displayed. Once the Open CAL and Short CAL have been completed the ‘Done CAL’ softkey is displayed and the calibration can then be completed by pressing this softkey The Open/Short CAL can be canceled at any time by pressing the ‘Cancel’ softkey on the softkey menu. If you cancel the Open/Short Calibration at any point, previously stored calibration data will not be overwritten The stored open and short calibration data is cleared on a preset.
Remote Command Notes:	No SCPI. Front Panel only.

4.6.2 Cancel Calibration

Mode:	Spectrum Analysis
Key Path:	Source, Open/Short CAL

Open/Short CAL

Dependencies and Couplings:

Parameter is disabled if active mode is not Spectrum Analyzer mode or a connection has not been established at you specified IP address.

The Open/Short CAL can canceled at any time by pressing the 'Cancel' softkey on the softkey menu. If you cancel the Open/Short Calibration at any point, previously stored calibration data will not be overwritten

Remote Command Notes:

No SCPI. Front Panel only.

4.6.3 Store Calibration

Mode:

Spectrum Analysis

Key Path:

Source, Open/Short CAL, [Open CAL Form displayed], Continue, [Short CAL Form displayed], Continue

Dependencies and Couplings:

This softkey is only displayed after an Open CAL and a Short CAL have been completed.

The calibration procedure is completed by pressing this key. When you press this key the stored open and short calibration traces are averaged and copied to trace 3 (stored as the reference trace), and you are returned to the Source menu.

The stored reference trace (trace 3) is cleared on a preset; if you wish to re-use this calibration data you should save the trace (File > Save > Type (Trace) > Save Now) and then recall it following completion of the preset.

Remote Command Notes:

No SCPI. Front Panel only.

5 Hints and Tips

This chapter includes a list of helpful hints and tips that will help you get the most from Option 215 on your PSA Series analyzer.

FAQs and Helpful Hints and Tips

These pages lists a few frequently asked questions (**FAQs**), and gives a few hints and tips that will help you get the most from your analyzer and Option 215 External Source Control.

- **Overloading** - if you are overloading the analyzer, connect a 10 dB attenuator to the RF input and set the **Ext Amp Gain** (external amplifier gain) to -10 dB. This softkey is accessed via the Amplitude key and the **More 1 of 3** softkey.
- **How can I increase the measurement speed?** Measurement speed can be increased by reducing the number of points from the default value of 601, or by increasing the resolution bandwidth from the automatically calculated value. Increasing the resolution bandwidth will improve the measurement speed, but at the cost of lower dynamic range.
- **Preselector centering does not appear to be working.** Preselector centering is not compatible with the time gating functionality that Option 215 External Source Control uses. The way around this limitation is to switch Option 215 External Source Control **Off** before centering your preselector. Once the preselector has been successfully centered, you can switch Option 215 External Source Control **On** again.
- **Can I make manual adjustments to the preselector while Option 215 is running?** There are no limitations on making manual adjustments to the preselector when Option 215 External Source Control is operating. You can make manual preselector adjustments with Option 215 External Source Control either **On** or **Off**.
- **I am seeing regularly spaced dropouts (glitches) in my pre-normalized response. How can I stop this?** There are regularly spaces dropouts in Option 215 External Source Control's response. These occur every 1.4 MHz, and are most visible in spans from 8 MHz to 50 MHz. They are about 0.08 dB in size, and are stable enough to be effectively removed by normalizing the measurement.

These dropouts get worse if you change the **Phase Noise Optimization** setting from its default setting of **Fast Tune**. With any non-Fast Tune setting, these dropouts can reach up to 1.6 dB. It is also worth noting that none of the non-Fast Tune settings work below 2 MHz.

- **I can't get my signal source to work to the limits of its frequency range. What is wrong?** You are not necessarily doing anything wrong. If you specify, for example, that the PSA Series analyzer is to sweep using 601 points, the signal source actually uses 601+2 points, that is, 603 points. This is because the source needs a 'spare' point at the start and at the end of every sweep generation. These two extra points, although not visible to you, both need to fall within the frequency range of the signal generator. The frequency span you see can

therefore be slightly offset from the frequency limits of the source. You can increase the number of sweep points or decrease the span of the sweep to get closer to the frequency limit of your signal source, but you will never be able to get right to the limit. See [“Further Frequency Limitations” on page 9](#) for a more detailed discussion of this limitation.

- **Signal Source IP Address Connection Problem** - if you are using a LAN cross-over cable to connect the spectrum analyzer to the source directly, then the IP address of both instruments must start with the same first two integers. For example, if your analyzer IP address is 156.121.102.33, then your source IP address must be set to 156.121.xxx.xxx.

Examples Exceeding the Source Frequency Range or the Spectrum Analyzer Frequency Band.

These examples will all result in an instrument error until the measurement settings are changed.

The following reference information applies to all of the examples.

$$\text{Source Start Freq} = \frac{\text{PSA Start Freq} + \text{Offset Freq} - \left(\frac{\text{PSA Stop Freq} - \text{PSA Start Freq}}{\text{Sweep Points} - 1} \right)}{\text{Harmonic Number}}$$

$$\text{Source Stop Freq} = \frac{\text{PSA Stop Freq} + \text{Offset Freq} + \left(\frac{\text{PSA Stop Freq} - \text{PSA Start Freq}}{\text{Sweep Points} - 1} \right)}{\text{Harmonic Number}}$$

Example 1: Bad Source Start Frequency

Using any PSA and any source:

PSA settings:

- Start Freq = 0 Hz
- Stop Freq = 500 MHz
- Sweep Points = 101
- Offset = OFF
- Harmonic = OFF

This will cause the “Freq range of ext src exceeded” error.

Reason:

The signal source must be able to sweep one “bucket’s” worth of frequency range before the requested PSA start frequency. In this case:

$$\text{Source Start Freq} = \frac{0 + 0 - \left(\frac{500\text{E}(6) - 0}{101 - 1} \right)}{1} = -5\text{E}(6) = -5 \text{ MHz}$$

$$\text{Source Stop Freq} = \frac{500\text{E}(6) + 0 + \left(\frac{500\text{E}(6) - 0}{101 - 1} \right)}{1} = 505\text{E}(6) = 5.05 \text{ MHz}$$

But -5 MHz is not in the range of the signal source.

So the PSA start frequency should be adjusted enough to ensure that it is at least 1 bucket width greater than the source minimum frequency. (Find the source minimum frequency using the PSA command `SOURce:EXtErnal:FREQUency:STARt? MIN`)

Example 2: Bad Source Stop Frequency

Using 50 GHz PSA (E4448A) and 44 GHz source (for example, an E8267D):

PSA settings:

- Start Freq = 42 GHz
- Stop Freq = 44 GHz
- Sweep Points = 101
- Offset = OFF
- Harmonic = OFF

This will cause the “Freq range of ext src exceeded” error.

Reason:

The signal source must be able to sweep one “bucket’s” worth of frequency range after the requested PSA start frequency. In this case:

$$\text{Source Start Freq} = \frac{42\text{E}(9) + 0 - \left(\frac{44\text{E}(9) - 42\text{E}(9)}{101 - 1}\right)}{1} = 41.98\text{E}(9) = 41.98 \text{ GHz}$$

$$\text{Source Stop Freq} = \frac{44\text{E}(9) + 0 + \left(\frac{44\text{E}(9) - 42\text{E}(9)}{101 - 1}\right)}{1} = 44.02\text{E}(9) = 44.02 \text{ GHz}$$

But 44.02 GHz is not in the range of the signal source.

So the PSA stop frequency should be adjusted enough to ensure that it is at least 1 bucket width less than the source maximum frequency. (Find the source maximum frequency using the PSA command `SOURce:EXtErnal:FREQUency:STOP? MAX`)

Example 3: Outside Analyzer Frequency Band

Using any PSA and any source:

PSA settings:

- Start Freq = 2.5 GHz
- Stop Freq = 3.5 GHz

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- Sweep Points = 101
- Offset = OFF
- Harmonic = OFF

This will cause the “Frequency band crossing not supported” error.

Reason:

The PSA band 0 stops at 3.05 GHz, and band 1 starts at 2.85 GHz. So you must change your measurement to be completely in one of these two bands. You can change:

- PSA start frequency > 2.85 GHz
- or
- PSA stop frequency < 3.05 GHz

Table 5-1 Frequency Bands in the PSA Series analyzers

Band Number	Frequency Range	Overlap with Next Band
0	3.0 Hz - 3.05 GHz	200 MHz
1	2.85 GHz - 6.6 GHz	400 MHz
2	6.2 GHz - 13.2 GHz	400 MHz
3	12.8 GHz - 19.2 GHz	500 MHz
4	18.7 GHz - 26.8 GHz	400 MHz
5	26.4 GHz - 31.15 GHz	150 MHz
6	31.0 GHz - 50.0 GHz	N/A

Example 4: Offset Causes Invalid Source Setting

Using any PSA and any source:

PSA settings:

- Start Freq = 2.5 GHz
- Stop Freq = 3.0 GHz
- Sweep Points = 101
- Offset = -2.8 GHz, On
- Harmonic = OFF

This will cause the “Freq range of ext src exceeded” error.

Reason:

The signal source cannot sweep from a negative frequency, but by specifying a Start Frequency of 2.5 GHz and Offset of -2.8 GHz, you are

asking the source to start its sweep at -0.8 GHz. In this case:

$$\text{Source Start Freq} = \frac{2.5\text{E}(9) + (-2.8\text{E}(9)) - \left(\frac{3.0\text{E}(9) - 2.5\text{E}(9)}{101 - 1}\right)}{1} = -0.8\text{E}(9) = -0.8 \text{ GHz}$$

$$\text{Source Stop Freq} = \frac{3.0\text{E}(9) + (-2.8\text{E}(9)) + \left(\frac{3.0\text{E}(9) - 2.5\text{E}(9)}{101 - 1}\right)}{1} = 0.2\text{E}(9) = 200 \text{ MHz}$$

But -0.8 GHz is not in the range of the signal source.

So you can either:

- increase the offset to ≤ -3 GHz
- or
- reduce the stop frequency to ≤ 2.8 GHz

Example 5: Offset Causes Bad Source Stop Frequency

Using PSA (13.2 GHz and above) and a 6 GHz source (for example, an E4438C):

PSA settings:

- Start Freq = 10 GHz
- Stop Freq = 12 GHz
- Sweep Points = 101
- Offset = -5 GHz, On
- Harmonic = OFF

This will cause the “Freq range of ext src exceeded” error.

Reason:

The signal source is being asked to sweep outside its frequency range. In this case:

$$\text{Source Start Freq} = \frac{10\text{E}(9) + (-5\text{E}(9)) - \left(\frac{12\text{E}(9) - 10\text{E}(9)}{101 - 1}\right)}{1} = 4.98\text{E}(9) = 4.98 \text{ GHz}$$

$$\text{Source Stop Freq} = \frac{12\text{E}(9) + (-5\text{E}(9)) + \left(\frac{12\text{E}(9) - 10\text{E}(9)}{101 - 1}\right)}{1} = 7.02\text{E}(9) = 7.02 \text{ GHz}$$

But 7.02 GHz is not in the range of the signal source.

So the offset or stop frequency should be changed until the calculation is less than the source maximum frequency. (Find the source maximum frequency using the PSA command
SOURCE:EXTERNAL:FREQUENCY:STOP? MAX)

Example 6: Offset Causes VALID Negative Source Settings

Using any PSA and any source:

PSA settings:

- Start Freq = 2.5 GHz
- Stop Freq = 3.0 GHz
- Sweep Points = 101
- Offset = -3.1 GHz, On
- Harmonic = OFF

This will not cause the “Freq range of ext src exceeded” error.

Reason:

The signal source Start Frequency and the Stop Frequency are both negative. In this case:

$$\text{Source Start Freq} = \frac{2.5\text{E}(9) + (-3.1\text{E}(9)) - \left(\frac{3.0\text{E}(9) - 2.5\text{E}(9)}{101 - 1}\right)}{1} = -0.605\text{E}(9) = -605 \text{ MHz}$$

$$\text{Source Stop Freq} = \frac{3.0\text{E}(9) + (-3.1\text{E}(9)) + \left(\frac{3.0\text{E}(9) - 2.5\text{E}(9)}{101 - 1}\right)}{1} = -0.095\text{E}(9) = -95 \text{ MHz}$$

In this case both the stop and start frequencies are negative, so this example looks invalid. But in this special case, the PSA can change its internal mixing to use a negative mixing harmonic. Then the PSA sets the source start frequency to the positive value of the calculated stop frequency. It also sets the source stop frequency to the positive value of the calculated start frequency. This causes the mixing products to sweep in reverse, and allows the measurement to be made.

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