

# **WLAN Guide**

## **PSA Series Spectrum Analyzers**

### **Option 217**

**This manual provides documentation for the following instruments:**

**Spectrum Analyzers:**

**E4440A (3 Hz - 26.5 GHz)**

**E4443A (3 Hz - 6.7 GHz)**

**E4445A (3 Hz - 13.2 GHz)**



**Agilent Technologies**

**Manufacturing Part Number: E4440-90280**

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# 1 Introduction

This chapter provides overall information on the Agilent PSA Series WLAN Option 217 and describes the measurements made by the analyzer. Installation instructions for adding this option to your analyzer are provided in this section, in case you purchased this option separately.

## What Does the Agilent PSA Option 217 Do?

The PSA Option 217 measurement personality can help determine if a WLAN device is working correctly, which has been manufactured according to IEEE standards 802.11a, b, or g. The instrument automatically makes measurements using the measurement methods and limits defined in the following standards documents:

- Supplement to IEEE Standard for Information Technology, IEEE Std 802.11a-1999 (Supplement to ANSI/IEEE Std 802.11, 1999 Edition)
- Higher Speed Physical Layer in the 2.4 GHz Band, IEEE Std 802.11b-1999 (Supplement to ANSI/IEEE Std 802.11, 1999 Edition)
- Higher Speed Physical Layer in the 2.4 GHz Band, IEEE Std 802.11g/D8.2, Jun. 2003 (Supplement to ANSI/IEEE Std 802.11, 1999 (Reaff 2003))

The instrument can test signals that conform to the following standard formats:

- 802.11a: OFDM
- 802.11b: DSSS, CCK, PBCC
- 802.11g: ERP-OFDM, ERP-DSSS, ERP-CCK, ERP-PBCC, DSSS-OFDM

The detailed results displayed by the measurements allow you to analyze WLAN system performance. You may alter the measurement parameters for specialized analysis.



The WLAN measurement personality makes the following measurements:

- Transmit Power
- Transmit Spectrum Mask
- Spectral Flatness (802.11a / 802.11g only)
- Power versus Time (802.11b only)
- Modulation Accuracy
- Power Statistics CCDF
- Spectrum (Freq Domain)
- Waveform (Time Domain)

The PSA Option 217 requires PSA Option 122 or 140 (80/40 MHz WB DIF) to enable the WLAN personality. To measure a WLAN signal above 3 GHz, like a 802.11a signal, PSA Option 123 (High Band Preselector Bypass, above 3 GHz) is required.

For more information on individual measurements, see [Chapter 2](#) , “Making Measurements” on page 35.

## 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 26.
2. Install the measurement personality firmware into the instrument memory. Details follow in [“Loading an Optional Measurement Personality”](#) on page 30.
3. Enter a license key that activates the measurement personality. Details follow in [“Obtaining and Installing a License Key”](#) on page 30.

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](http://www.agilent.com/find/sa_upgrades)

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

If you do not have memory limitations then you can skip ahead to the next section [“Loading an Optional Measurement Personality”](#) on page 30. 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 have 64 MBytes of memory installed in your instrument, you should have enough memory to install at least four optional personalities, with plenty of memory for data and states.

The optional measurement personalities require different amounts of memory. So the number of personalities that you can load varies. This is also impacted by how much data you need to save. If you are having memory errors you must swap the applications in/out of memory as needed. If you only have 48 MBytes of memory, you can upgrade your

hardware to 64 MBytes.

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.

<b>PSA Flash Memory Size</b>	<b>Available Memory With No Options</b>	<b>Available Memory With Option B7J and/or Option 122 or 140</b>
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 28](#), 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](http://www.agilent.com/find/psa_firmware)

For PSA 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. Compare the desired total with the available memory that you identified in the previous section.

1. Program memory - Select option requirements from the table “[Measurement Personality Options and Memory Required](#)” on [page 29](#).
2. For PSA only: shared libraries require 7.02 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/Preset, Power On** keys and toggle the setting to **Last**.

---

### Measurement Personality Options and Memory Required

Personality Options for PSA Series Spectrum Analyzers <sup>a</sup>	Option	File Size (PSA Rev: A.08)
cdmaOne measurement personality	<b>BAC</b>	1.91 Mbytes
NADC and PDC measurement personalities (not available separately)	<b>BAE</b>	2.43 Mbytes
W-CDMA or W-CDMA w/ HSDPA measurement personality	<b>BAF, 210</b>	5.11 Mbytes <sup>b</sup>
cdma2000 or cdma2000 w/ 1xEV-DV measurement personality	<b>B78, 214</b>	4.00 Mbytes <sup>b</sup>
1xEV-DO measurement personality	<b>204</b>	5.11 Mbytes <sup>b</sup>
GSM (with EDGE) measurement personality	<b>202</b>	3.56 Mbytes <sup>b</sup>
Shared measurement library <sup>b</sup>	n/a	7.02 Mbytes
Phase Noise measurement personality	<b>226</b>	2.82 Mbytes <sup>c</sup>
Noise Figure measurement personality	<b>219</b>	4.68 Mbytes <sup>c</sup>
Basic measurement personality with digital demod hardware	<b>B7J</b>	Cannot be deleted (2.34 Mbytes)
HP8566B/HP8568B Programming Code Compatibility <sup>d</sup>	<b>266</b>	1.12 Mbytes <sup>c</sup>
TD-SCDMA	<b>211</b>	5.30 Mbytes <sup>c</sup>
Flexible Digital Modulation Analysis	<b>241</b>	2.05 Mbytes <sup>b</sup>
WLAN measurement personality	<b>217</b>	3.18 Mbytes <sup>b</sup>
External Source Control	<b>215</b>	0.72 Mbytes <sup>c</sup>

- a. Available as of the print date of this guide.
- b. Many PSA Series personality options use a 7.02 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 part number is E4440AU-ANE.

For more information about memory upgrade kits contact your local

sales/service office, or see:  
[http://www.agilent.com/find/sa\\_upgrades](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](http://www.agilent.com/find/psa_firmware)

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### 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 29.

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 number for the selected personality option, use the following procedure:

---

### NOTE

You can also use this procedure to reinstall a license key number 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 number 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 number 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 number 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 number, 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 number for the option before you delete it. If you want to use that measurement personality later, you will need the license key number 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 erase all memory including the operating system.

To perform a security erase of your instrument memory, you will need to download “WipeSA” from the Agilent Web site. For more information see:

[http://www.agilent.com/find/sa\\_security](http://www.agilent.com/find/sa_security)

Instructions for security erase procedures 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.

<b>Required Information:</b>	<b>Front Panel Key Path:</b>
Model #: (Ex. E4440A)	
Host ID: _____	System, Show System
Instrument Serial Number: _____	System, Show System



---

---

## 2

# Making Measurements

This chapter describes procedures used for making measurements of WLAN signals. Instructions to help you set up and perform the measurements are provided, and examples of WLAN measurement results for analysis of various WLAN modulation formats are shown.

## Introduction

This chapter details all WLAN measurements available by pressing the **MEASURE** key and also shows example results obtained using the WLAN measurements.

There are eight measurements available in WLAN mode:

- Transmit Power
- Transmit Spectrum Mask
- Power versus Time
- Spectrum Flatness
- Modulation Accuracy
- Power Stat CCDF
- Spectrum (Freq Domain)
- Waveform (Time Domain)

All the measurements above are one-button measurements. When you press the key to select a measurement, it will become active, using settings and displays unique to that measurement. Data acquisition will automatically begin when the equipment is correctly set up and trigger requirements are met. The pass/fail indicators quickly give a visual indication of standards conformance.

You can also customize signal parameters and parameter limits of each measurement, based on user-defined constraints and tolerances. The settings will be used thereafter in making one-button measurements.

---

**NOTE**

PSA option 217 needs option 122 (80 MHz Wideband Digital IF) or 140 (40 MHz Wideband Digital IF) to enable WLAN personality.

Option 123 (Microwave Preselector Bypass) is highly recommended for making measurements of signals with center frequency above 3 GHz, for instance, 802.11a signals.

---

The following subjects are presented in this chapter:

- “Setting Up Test Equipment and DUT” on page 38
- “The 3 Steps to Set Up and Make Measurements” on page 39
- “Setting Mode-Level Parameters” on page 40
- “Making One Button Measurements” on page 44
- “One Button Measurement Examples” on page 45
- “Using Basic Mode” on page 64
- “Interpreting Error Codes” on page 65

---

NOTE

The spectrum and waveform measurements available in PSA Option 217 are the same as those available in basic mode. Spectrum and waveform measurements are provided in the modulation analysis mode for your convenience to avoid having to switch to basic mode for their use. See the *PSA Basic Mode User's Guide Option B7J* for more detail on the spectrum and waveform measurements, remote commands, front-panel keys, conceptual information and menu maps.

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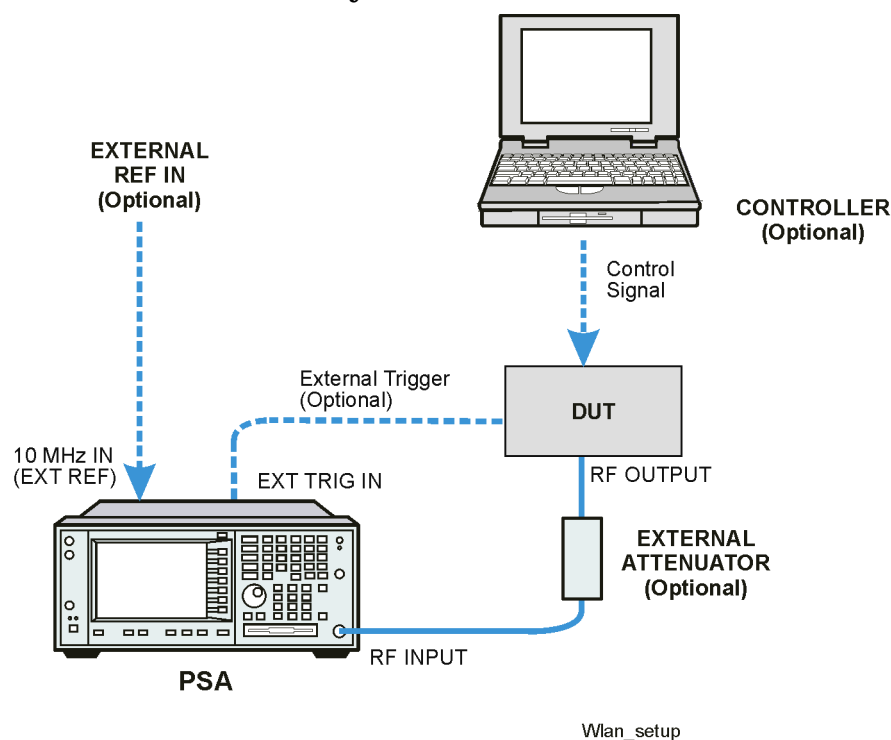
## Setting Up Test Equipment and DUT

**CAUTION** Before connecting a signal to the instrument, make sure the instrument can safely accept the signal level provided. The signal level limits are marked next to the connectors on the front panel.

**NOTE** Before you can begin making measurements, make sure you have Option 217 application firmware installed. In case you have purchased this firmware separately as an optional upgrade, refer to [“Installing Optional Measurement Personalities”](#) on page 26.

The device under test (DUT), which generates WLAN signals, is connected to the PSA RF input port. The DUT may possibly be controlled externally by a computer. External attenuator, external trigger and external reference are optional. Using the appropriate cables, connect the equipment as shown.

**Figure 2-1** WLAN Measurement System



## The 3 Steps to Set Up and Make Measurements

All measurements need to be set up in 3 steps: first at the Mode level, second at the Measurement level, then finally the result display may be adjusted.

### 1. Select and Set Up the Mode

Press **MODE** - All licensed, installed Modes available are shown. Press **WLAN**, or select **Basic** mode to make measurements of signals with non-standard formats.

Press **Mode Setup** - Make any required adjustments to the mode settings. These settings apply to all measurement in the mode.

### 2. Select and Set Up the Measurement

Press **MEASURE** - Select a specific measurement to be performed (e.g. Transmit Power or Modulation Accuracy). The measurement begins as soon as any required trigger conditions are met. The resulting data is shown on the display or is available for export.

Press **Meas Setup** - Make any adjustments as required to the selected measurement settings. The settings only apply to this measurement.

### 3. Select and Set Up a View of the Results

Press **Trace/View** - Select a display format for the current measurement data. Depending on the mode and measurement selected, other graphical and tabular data presentations may be available. **X-Scale** and **Y-Scale** adjustments may also be made now.

**NOTE**

A setting may be reset at any time, and will be in effect on the next measurement cycle or View.

Step	Primary Key	Setup Keys	Related Keys
1. Select & set up a Mode	<b>MODE</b>	Mode Setup, Input/Output, FREQUENCY Channel	System
2. Select & set up a Measurement	<b>MEASURE</b>	Meas Setup	Meas Control, Restart
3. Select & set up a View of the Results	<b>Trace/View</b>	SPAN X Scale, AMPLITUDE Y Scale, Display, Next Window, Zoom	File, Save, Print, Print Setup, Marker, Peak Search

---

## Setting Mode-Level Parameters

### Selecting a WLAN Standard

---

**NOTE** Make sure you have connected the signal under test has been connected to the instrument RF input as shown in [Figure 2-1, “WLAN Measurement System”](#).

---

- Step 1.** Press **Preset** to initialize the PSA default settings.
- Step 2.** Press **MODE, WLAN** to invoke the WLAN Mode.
- Step 3.** Press **MODE Setup, WLAN Std**, then select the appropriate standard from the following menu: **802.11a, 802.11b, 802.11g** (Default).
- Step 4.** When **802.11g** is selected, press **MODE Setup, Oper Mode**, then select the specific operating mode from the following menu: **ERP-OFDM** (Default), **ERP-DSSS/CCK/PBCC, DSSS-OFDM**.

---

**NOTE** To measure only the DSSS portion of a DSSS-OFDM signal, select **802.11b** to perform DSSS modulation analysis on the specific portion, because the DSSS portion conforms to the 802.11b standard.

---

### Setting Frequency Parameters

---

**NOTE** Make sure you have set the mode and the WLAN standard as shown in [Figure 2-1, “WLAN Measurement System”](#).

---

- Step 1.** To set the center frequency to your signal’s carrier frequency, you may enter either a frequency or a channel number:

Press **FREQUENCY/Channel**, select **Center Freq** then use the front-panel keypad to input a center frequency value, and press a units key to complete the entry;

Or,

Press **FREQUENCY/Channel**, select **Channel No.** then use the front-panel keypad to input a channel number, and press **Enter** key to complete the entry.

The **Center Freq** and **Channel No.** parameters are coupled together.

See [“The relationship between Center Frequency \(CtrFreq\) and Channel No. \(nch\):”](#) on page 77 for details.

Default settings for 802.11b/g standard are **2.412 GHz** and **Channel No.1**;  
Default settings for 802.11a standard are **5 GHz** and **Channel No.0**.



## Adjusting Input Parameters

---

**NOTE** Make sure you have set the mode and the WLAN standard as shown in [“Selecting a WLAN Standard” on page 40](#).

---

- Step 1.** To access the **Input** menu, You can press **Input/Output**; or press **Mode Setup, Input**.
- Step 2.** The default instrument signal **Input** setting is **RF**. You can press **Input/Output, Input Port**, then select a different signal input source.
- Step 3.** Make sure the **Preselector** setting is appropriate for your signal. To measure a signal with center frequency greater than 3 GHz, press **Input/Output, Microwave Preselector**, toggle from **On** to **Off**.
- Step 4.** Adjust the input attenuation by pressing **Input Atten**, then enter a value and press a unit key, like **dB**, to complete the entry.
- Step 5.** Adjust the external RF attenuation by providing an external attenuator and pressing **Ext RF Atten**, then enter a value and press a unit key, like **dB**, to complete the entry.

---

**NOTE** The signal spectrum should appear as a distinct, elevated region of noise 20 dB or more above the analyzer noise floor. If your signal is not significantly above the measurement noise floor, you may need to modify your measurement configuration by pressing **Meas Setup, Wideband Setup, Wideband IF Gain** and adjust the value of **IF Gain** between -12 dB to + 12 dB. The adjustment is valid only for the current measurement.

---

## Setting Trigger Parameters (for burst signals)

---

**NOTE** Make sure you have set the mode and the WLAN standard as shown in [“Selecting a WLAN Standard” on page 40](#).

---

You can use the default trigger settings with most WLAN measurements. If you are making **Power vs. Time** measurements with a “burst” signal, you may need to adjust the trigger parameters.

Use the waveform measurement to view your signal in the time domain and to help select the appropriate trigger to acquire your signal.

- Step 1.** Activate the waveform measurement view:  
Press **MEASURE, Waveform (Time Domain)**.
- Step 2.** Adjust the scale of the x-axis to view the complete signal waveform:  
Press **SPAN X Scale, Scale/Div**, then use the front-panel keypad to input the scale/div, then press a units key, like  $\mu\text{s}$ , to complete the entry.

**Step 3.** Select a trigger source (free run is the default setting):

Press **Meas Setup**, **Trig Source**, then select one of the available trigger sources.

---

**NOTE** Make sure the external trigger source has been set up correctly before you select an external trigger source.

---

**Step 4.** To access the **Trig Setup** menu, press the **Trig** key or **Mode Setup**, **Trigger**.

**Step 5.** Set up the trigger conditions:

Select a trigger mode from the menu, then set the **Delay**, **Peak Level** and **Positive** or **Negative** edge slope.

You can also adjust **Trigger Holdoff**, **Auto Trigger** and **Frame Timer** settings.

---

**NOTE** The trigger setup settings are valid for the entire WLAN mode. The trigger source setting is only valid for the selected measurement.

---

Refer to the *PSA Basic Mode User's Guide Option B7J* for more Wideband setting stuff details on setting up the trigger.

## Setting Demod Parameters

---

**NOTE** Make sure you have set the mode and the WLAN standard as shown in [“Selecting a WLAN Standard” on page 40](#).

---

**Step 1.** To access the **Demod Setup** menu, press **Mode Setup**, **Demod**.

**Step 2.** To select a modulation format, press **Modulation Format** and select from the following menu:

For **802.11a** and **802.11g** (ERP-OFDM, DSSS-OFDM) signals, select from the following formats: **Auto Detect** (Default), **BPSK**, **QPSK**, **16QAM**, and **64QAM**.

For **802.11b** signals, select from following formats and data rates: **Auto Detect** (Default), **DSSS 1 Mbps**, **DSSS 2 Mbps**, **CCK 5.5 Mbps**, **CCK 11 Mbps**, **PBCC 5.5 Mbps**, and **PBCC 11 Mbps**.

For **802.11g** (ERP-DSSS/CCK/PBCC) signals, select from the following formats and data rates: **Auto Detect** (Default), **DSSS 1 Mbps**, **DSSS 2 Mbps**, **CCK 5.5 Mbps**, **CCK 11 Mbps**, **PBCC 5.5 Mbps**, **PBCC 11 Mbps**, **PBCC 22 Mbps**, and **PBCC 33 Mbps**.

**Step 3.** For an OFDM signal, like **802.11a** or **802.11g** (ERP-OFDM, DSSS-OFDM), you can adjust OFDM specific parameters:

To adjust the subcarrier frequency spacing, press **Mode Setup**, **Demod**, **SubCarrier Spacing**, enter a value, then select a unit key to complete

entry.

To adjust the guard interval length for each symbol time, press **Mode Setup, Demod, Guard Int**, then enter a value.

---

NOTE

The term Guard Interval specifies a fraction of each symbol time, as a fraction of FFT length. For instance, the symbol time of a OFDM signal is 3.2  $\mu\text{s}$  and its Guard is 0.8  $\mu\text{s}$ , so the Guard Int is 0.25. The value of **Guard Int** should be between zero and one. Values entered outside that range are clipped to [0, 1].

---

## Using Instrument Mode and Measurement Presets

To set your current measurement personality to a known, factory default state, use instrument preset by simply pressing **Preset**. This initializes the instrument by returning the mode setup and all of the measurement setups in the mode to the factory default parameters.

---

NOTE

Note that pressing the **Preset** key will switch instrument modes unless the type of preset is selected under **System, Power On/Preset** is set to **Mode** or **Save User Preset**.

---

To preset only the parameters that are specific to an active, selected measurement, press **Meas Setup**, then **Restore Meas Defaults**. **Restore Meas Defaults** will return all the measurement setup parameters to the factory defaults, but only for the currently selected measurement. The **Restore Meas Defaults** key may not appear on the first page of the **Meas Setup** menu. If not, press **More** until the key is available.

## Making One Button Measurements

After you have connected the instrument and DUT, and have setup WLAN Mode parameters so that the signal can be captured, you can start to make WLAN measurements.

If your signal under test conforms to the standards, all measurements can be done by pressing the specific measurement button.

- Step 1.** Press **MEASURE** to access the **Measure** menu
- Step 2.** Select a specific measurement to be performed, like **Transmit Power**, or **Power Stat CCDF**. See [“One Button Measurement Examples” on page 45](#) for measurement examples.

The measurement begins as soon as any required trigger conditions are met. The resulting data is shown on the display or is available for export.

---

**NOTE**

**Power vs. Time** measurement is available only when 802.11b or 802.11g ERP-DSSS/CCK/PBCC standard and operating mode is selected.

**Spectral Flatness** measurement is available only when 802.11a, 802.11g ERP-OFDM or 802.11g DSSS-OFDM standard and operating mode is selected.

---

## One Button Measurement Examples

Most one button measurements provide **PASS/FAIL** indication. The measured results are compared to limits set by WLAN standards, or custom limits set by the user. If any measurement result exceeds the limit, a red “F” mark will appear next to the specific test that fails in Metrics window. **PASS/FAIL** indicator bar will show “**FAIL**” if the measurement results meet its Fail condition.

You can use the default limits for each measurement, or you can press **Meas Setup**, **Limits** keys and adjust the limit value/mask, for the currently selected measurement. The **Limits** key may not appear on the first page of the **Meas Setup** menu. If not, press **More** until the key is available.

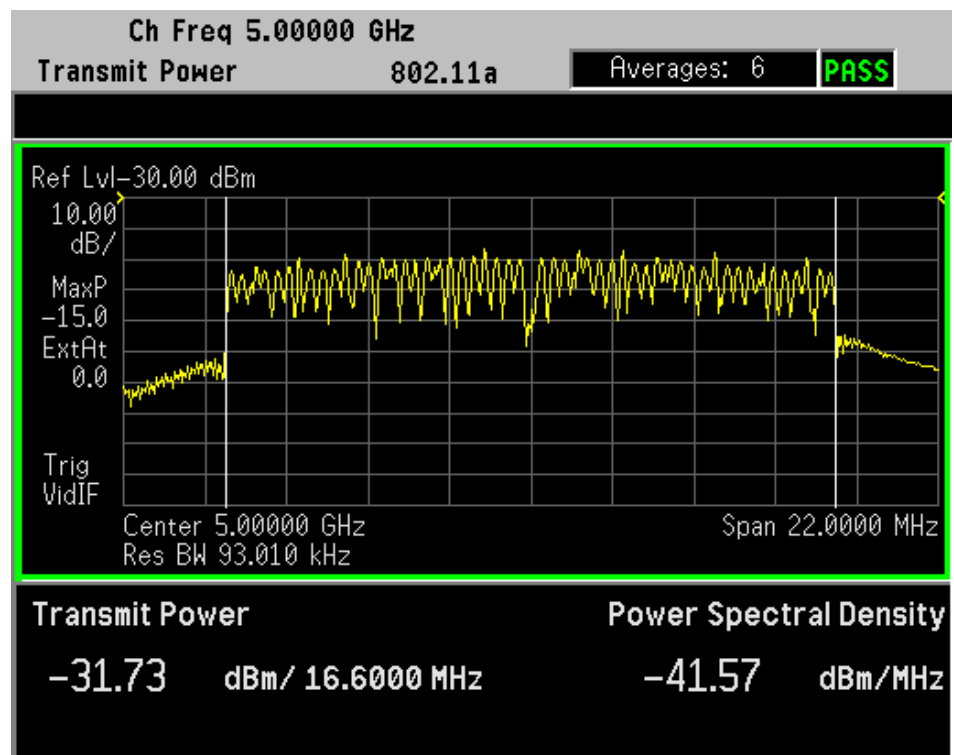
### Transmit Power Measurement

This section explains how to make a Transmit Power measurement on a WLAN signal. This test measures the total RF power present in the channel bandwidth specified.

The Transmit Power results are displayed graphically in a Spectrum window with **Transmit Power** in dBm, and **Power Spectral Density** in dBm/MHz, shown as Metrics window.

Figure 2-2

Transmit Power Measurement Result - 802.11a Signal (Default)

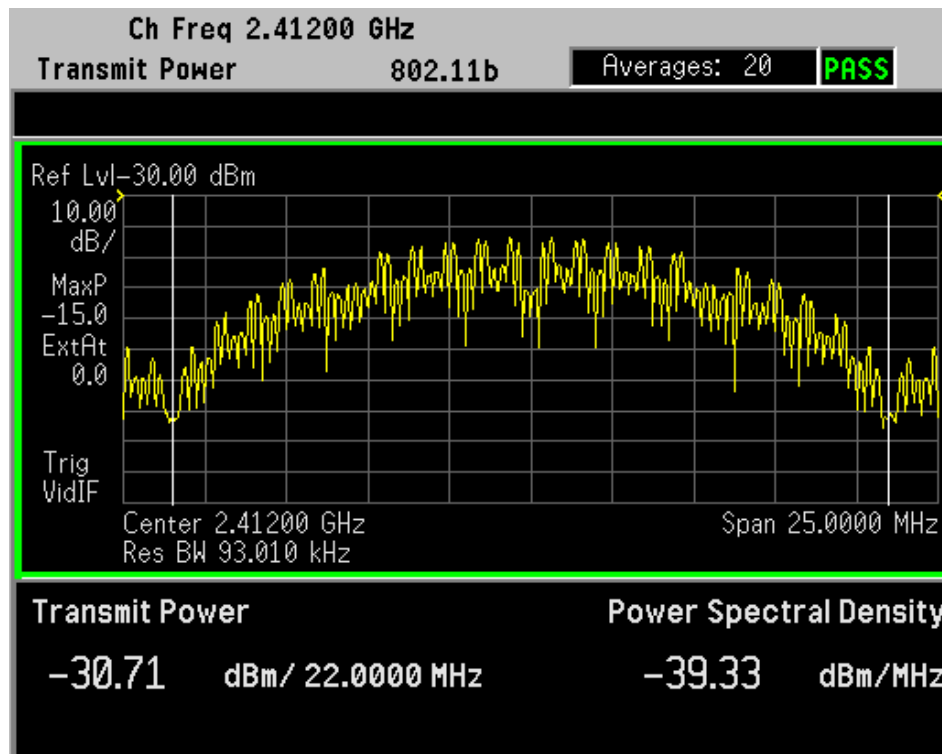


### Transmit Power Measurement Procedure

**Step 1.** Press the **MEASURE**, **Transmit Power** keys to initiate the transmit power measurement.

The **Transmit Power** measurement result should look like [Figure 2-2 on page 45](#) and [Figure 2-3 on page 46](#). The **Spectrum** window and the **Metrics** window show the total power in a specified bandwidth and the **Power Spectral Density** in the occupied channel.

**Figure 2-3** **Transmit Power Measurement Result - 802.11b Signal (Default)**



**Step 2.** Press the **Meas Setup** to change the measurement parameters from their default conditions.

To change the **Transmit Power Span**, press **Integ BW**, **Transmit Pwr Span** and enter a value, then select a unit key.

To change **Transmit Power** measurement limits, press **Limits**, **Pwr Limits** or **Psd Limits** and enter a value.

For more details about changing measurement parameters, see **Transmit Power "Meas Setup" on page 107**.

**Step 3.** To adjust the display:

Press the **AMPLITUDE/Y Scale** key, enter a value for **Scale/Div** key, then press the unit key.

To change the absolute power reference, press **Ref Value** and enter a

value, then select a unit key.

To change the vertical display reference, press **Ref Position** to switch among **Top**, **Ctr** or **Bot**.

To switch the scale coupling function between **On** and **Off**, press **Scale Coupling** key.

---

NOTE

To change a display parameter like **AMPLITUDE/Y Scale**, **Scale/Div**, the window must be made “active”, which is shown on the display as the window with a green outline. Press **Next Window** to activate the other window, and **Zoom** to display only a single window.

---

If you have a problem, and get an error message, see “[Interpreting Error Codes](#)” on page 65 or the “*Instrument Messages and Functional Tests*” manual.

## Transmit Spectrum Mask Measurement

This section explains how to make a Transmit Spectrum Mask measurement on a WLAN signal.

This measurement compares the Power Spectral Density (PSD) within the given offset channels on both sides of the carrier frequency, to levels allowed by the standard.

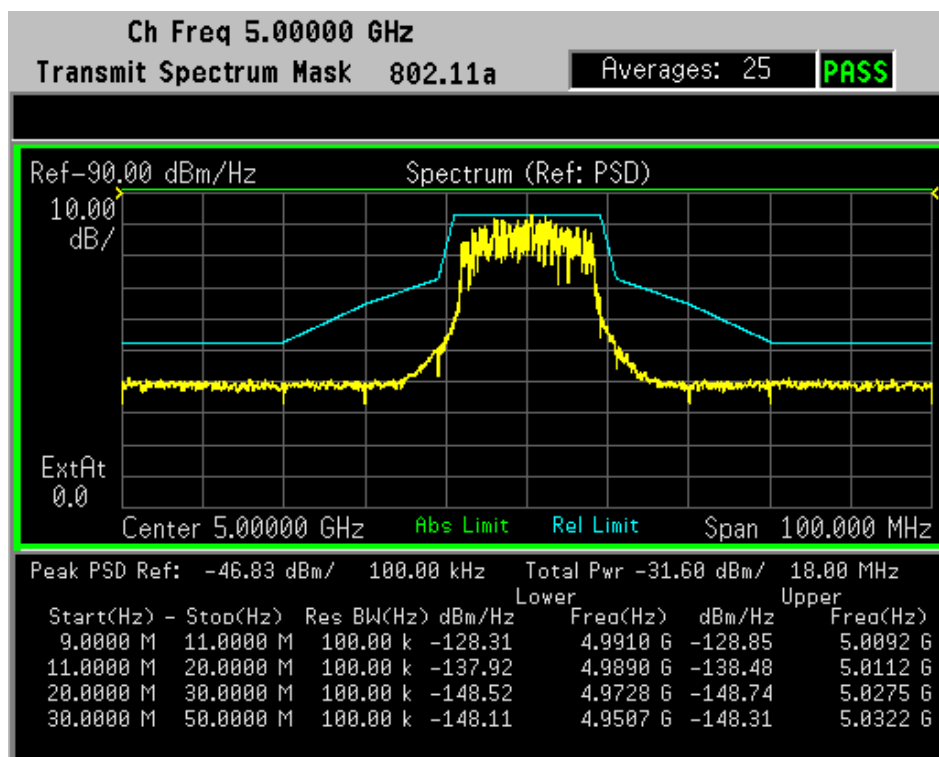
The results are shown in Spectrum window as well as in Metrics window. The results of each offset segment can be viewed separately.

### Transmit Spectrum Mask Measurement Procedure

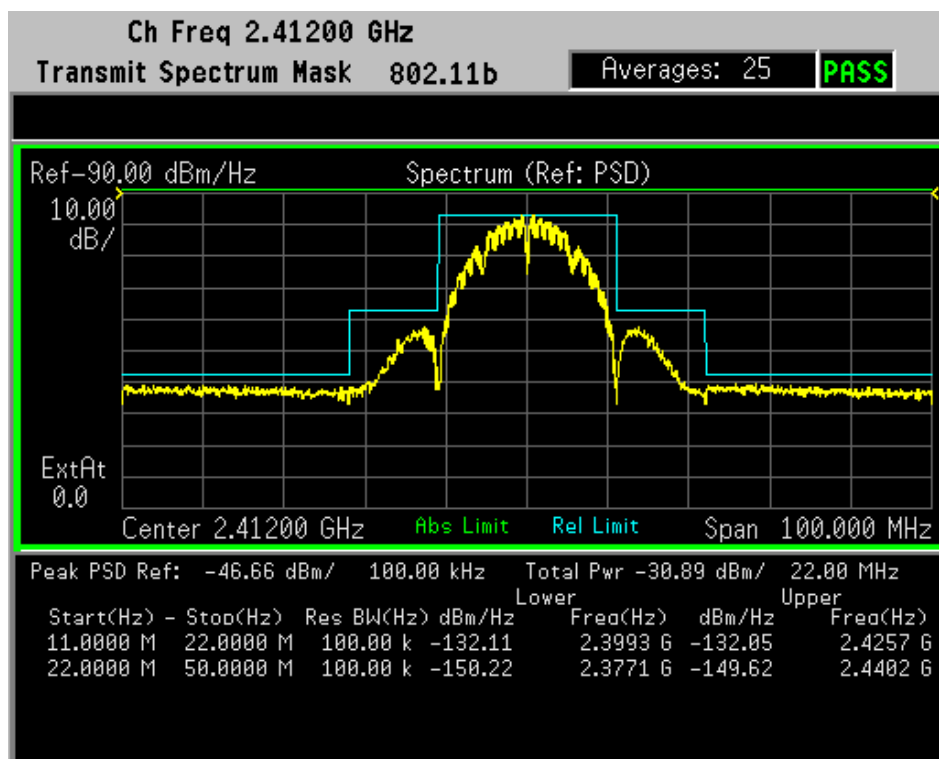
- Step 1.** Press the **MEASURE**, **Transmit Spectrum Mask** keys to initiate the spectrum emission mask measurement.

The Transmit Spectrum Mask measurement result to display all segment should look like [Figure 2-4 on page 48](#) and [Figure 2-5 on page 48](#). The Metrics window shows the reference PSD and the absolute peak PSD which correspond to the frequency bands on both sides of the reference channel. The absolute PSD is indicated by the yellow lines.

**Figure 2-4** Transmit Spectrum Mask Result - 802.11a Offset All (Default)



**Figure 2-5** Transmit Spectrum Mask Result - 802.11b Offset All (Default)





**Step 2.** Press the **Meas Setup** to change the measurement parameters from their default conditions. For example, you can:

To change the reference channel parameters, press **Ref Channel**, then enter values for **Chan Integ BW**, **Chan Span** and **Res BW**.

To change the spectrum mask limits, press **Offset/Limits**, **More** and **Limits**, then enter values for **Abs Start**, **Abs Stop**, **Rel Start** and **Rel Stop**, and select a **Fail Mask**.

To specify the offset frequency, press **Offset/Limits**, then cycle **Offset** to select an offset from **A** to **E**, and set values for **Start Freq**, **Stop Freq** and **Res BW**.

For more details about changing measurement parameters, see Transmit Spectrum Mask [“Meas Setup” on page 124](#).

**Step 3.** To change the display scale:

Press **AMPLITUDE/Y Scale**, enter a value for **Scale/Div** key, then press the unit key, like **dB** key.

Enter a value for **Ref Value** key, then press the unit key, like **dBm/Hz** key.

Switch among **Top**, **Ctr** or **Bot** by pressing **Ref Position** key.

Switch between **On** or **Off** by pressing **Scale Coupling** key.

**Step 4.** To change the display view, press the **TRACE/VIEW** key, then select from the following settings or toggle the display function of the offset sides between negative and positive:

Press **ALL** (Default) key to display all the frequency offset segments.

Press **Offset A** key to display the frequency offset A.

Press **Offset B** key to display the frequency offset B.

Press **Offset C** key to display the frequency offset C.

Press **Offset D** key to display the frequency offset D.

Press **Offset E** key to display the frequency offset E.

Switch between **Neg** or **Pos** by pressing **Offset** key.

To change a display parameter like **AMPLITUDE/Y Scale**, **Scale/Div** the window must be made “active”, which is shown on the display as the window with a green outline. Press **Next Window** to activate the other window, and **Zoom** to display only a single window.

If you have a problem, and get an error message, see [“Interpreting Error Codes” on page 65](#) or the “Instrument Messages and Functional Tests” manual.

The **FAIL** indicator is displayed, when any offset result fails, no matter

which offset view you are using.

Only when all results of the valid offsets are successful will Pass/Fail indicator bar show “PASS”.

## Power vs. Time Measurement

This section explains how to make a Power versus Time measurement on a WLAN signal.

This measurement indicates whether the timing of the transmission of the 802.11b/g signal is consistent with the WLAN 802.11b/g standard.

The results are displayed graphically as well as in Metrics window.

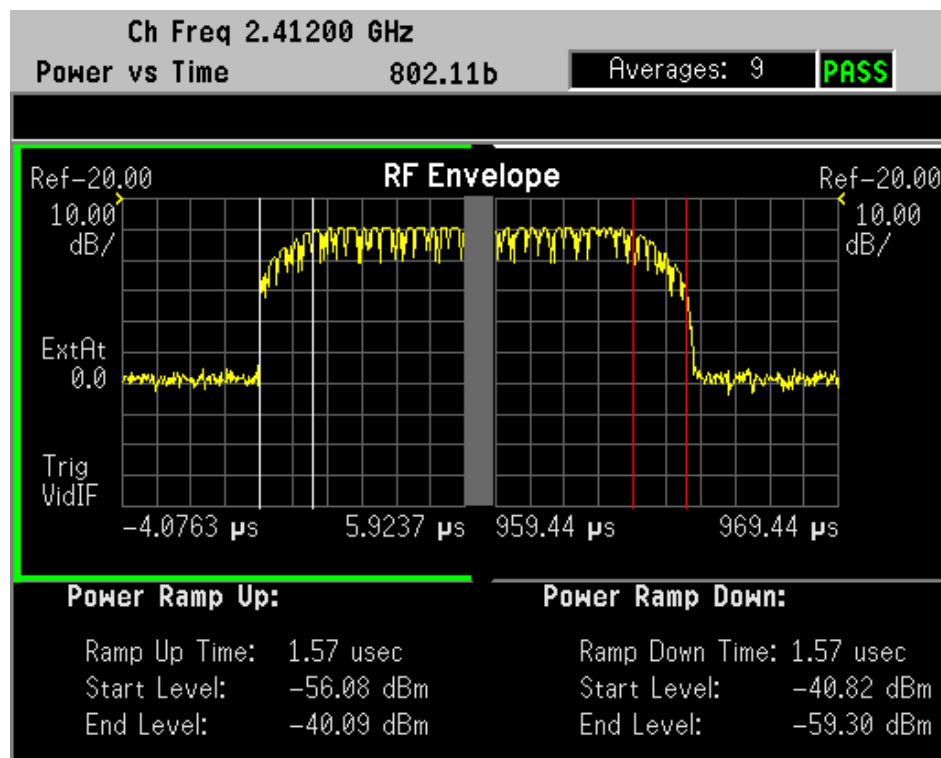
### NOTE

This measurement is available only when 802.11b or 802.11g ERP-DSSS/CCK/PBCC standard and operating mode is selected.

### Power vs. Time Measurement Procedure

- Step 1.** Press the **MEASURE**, **Power vs Time** keys to initiate the Power versus Time measurement. The measurement result should look like [Figure 2-6 on page 50](#).

**Figure 2-6** Power Vs Time Result - 802.11b RF Envelope View (Default)



**Step 2.** Press the **Meas Setup** to change the measurement parameters from their default conditions. For example, you can:

Press **Burst Time** and enter an appropriate value. The Burst Time should be no less than the total length of a burst.

To change the searching window length, press **Ramp Time Length** and entering a value. You need to set the Ramp Time Length longer than the actual ramp time, otherwise the ramp may be lost.

To change the measurement limits, press **Limits**, then set values for **Max Ramp Up Time**, **Max Ramp Down Time** and select a **Fail mask**.

**Power-on ramp** mask means when ramp up exceeds the limit, the measurement overall result fails regardless of ramp down results. **Both** mask means when both ramp up and ramp down exceed the limits, the measurement overall result fails.

For more details about changing measurement parameters, see Power vs. Time “[Meas Setup](#)” on page 139.

**Step 3.** To change the display scale, press the **AMPLITUDE/Y Scale** key, then you can change any of the following settings:

Enter a value for **Scale/Div** key, then press the unit key.

Enter a value for **Ref Value** key, then press the unit key.

Switch among **Top**, **Ctr** or **Bot** by pressing **Ref Position** key.

Switch between **On** or **Off** by pressing **Scale Coupling** key.

**Step 4.** To change the display view, press the **TRACE/VIEW** key, then select from the following settings:

Press **Burst** key to display Power vs. Time view.

Press **Rise & Fall** key to display Power-on and Power-down Ramp view.

To change a display parameter like **AMPLITUDE/Y Scale**, **Scale/Div** the window must be made “active”, which is shown on the display as the window with a green outline. Press **Next Window** to activate the other window, and **Zoom** to display only a single window.

If you have a problem, and get an error message, see “[Interpreting Error Codes](#)” on page 65 or the “Instrument Messages and Functional Tests” manual.

## Spectral Flatness Measurement

**NOTE** Spectral Flatness measurement is available only when 802.11a, 802.11g ERP-OFDM, or 802.11g DSSS-OFDM standard and operating mode is selected.

This section explains how to make a Spectral Flatness measurement on a WLAN signal.

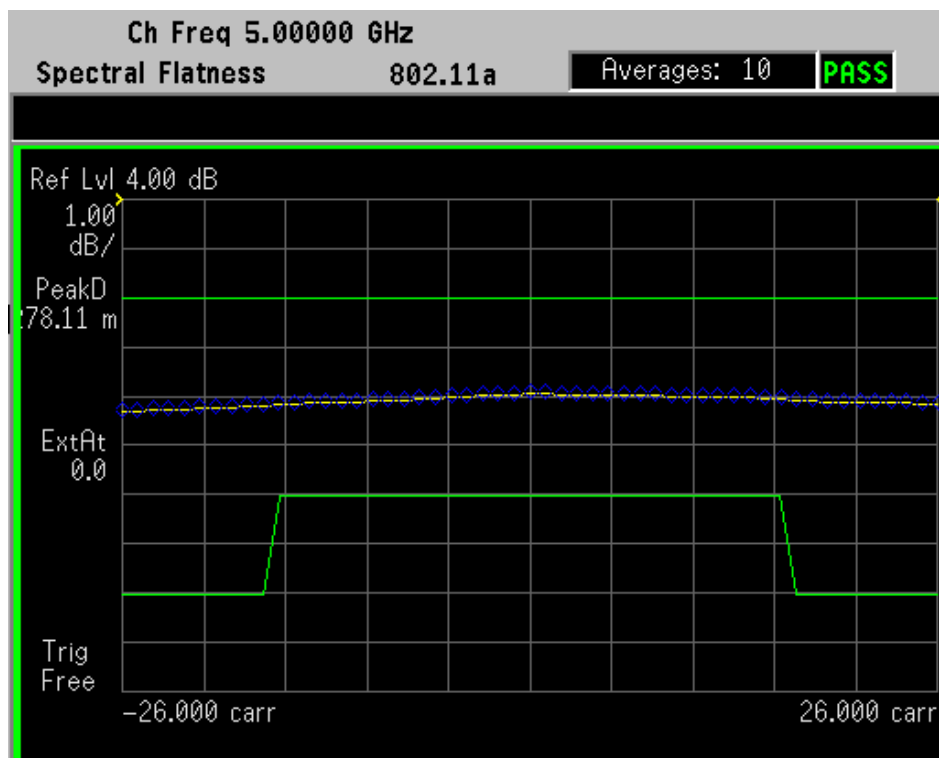
The Spectral Flatness measurement can test energy flatness of sub-carriers on an OFDM signal.

**NOTE** In conformance with the WLAN standard, the zero sub-carrier is not included in this measurement computation. See [“The relationship between Center Frequency \(CtrFreq\) and Channel No. \(nch\):”](#) on page 77.

### Spectral Flatness Measurement Procedure

- Step 1.** Press the **MEASURE, Spectral Flatness** keys to initiate the spectral flatness measurement. The Spectral Flatness measurement result should look like [Figure 2-7 on page 52](#).

**Figure 2-7** Spectral Flatness Measurement Result - 802.11a Signal (Default)



- Step 2.** Press the **Meas Setup** to change the measurement parameters from

their default conditions. For example, you can:

Press **Search Length** and entering a value no less than the total length of a burst.

To change the measurement limits, press **Limits**, then select **Offset A** or **B**, and set **Upper Limit** and **Lower Limit** for the selected offset segment.

**Offset A** for 802.11a includes the carriers –16 to 16.

**Offset B** for 802.11a includes the carriers –26 to –17 and 17 to 26.

For more details about changing measurement parameters, see Spectral Flatness [“Meas Setup” on page 152](#).

**Step 3.** To change the display scale, press the **SPAN/X Scale** or **AMPLITUDE/Y Scale** keys, then you can change any of the following settings:

Enter a value for **Scale/Div** key, then press the unit key.

Enter a value for **Ref Value** key, then press the unit key.

Switch reference position by pressing **Ref Position** key.

Switch between **On** or **Off** by pressing **Scale Coupling** key.

To change a display parameter like **AMPLITUDE/Y Scale**, **Scale/Div** the window must be made “active”, which is shown on the display as the window with a green outline. Press **Next Window** to activate the other window, and **Zoom** to display only a single window.

If you have a problem, and get an error message, see [“Interpreting Error Codes” on page 65](#) or the “Instrument Messages and Functional Tests” manual.

## Modulation Accuracy Measurements

This section explains how to make a Modulation Accuracy measurement on a WLAN 802.11 signal.

Modulation Accuracy is a measure of phase and amplitude modulation quality that relates the performance of the actual signal compared to an ideal signal as a percentage, calculated over the course of the ideal constellation.

The results are displayed graphically as well as in Metrics windows.

### Modulation Accuracy Measurement Procedure

- Step 1.** Press the **MEASURE, Modulation Accuracy** keys to initiate the modulation accuracy measurement.

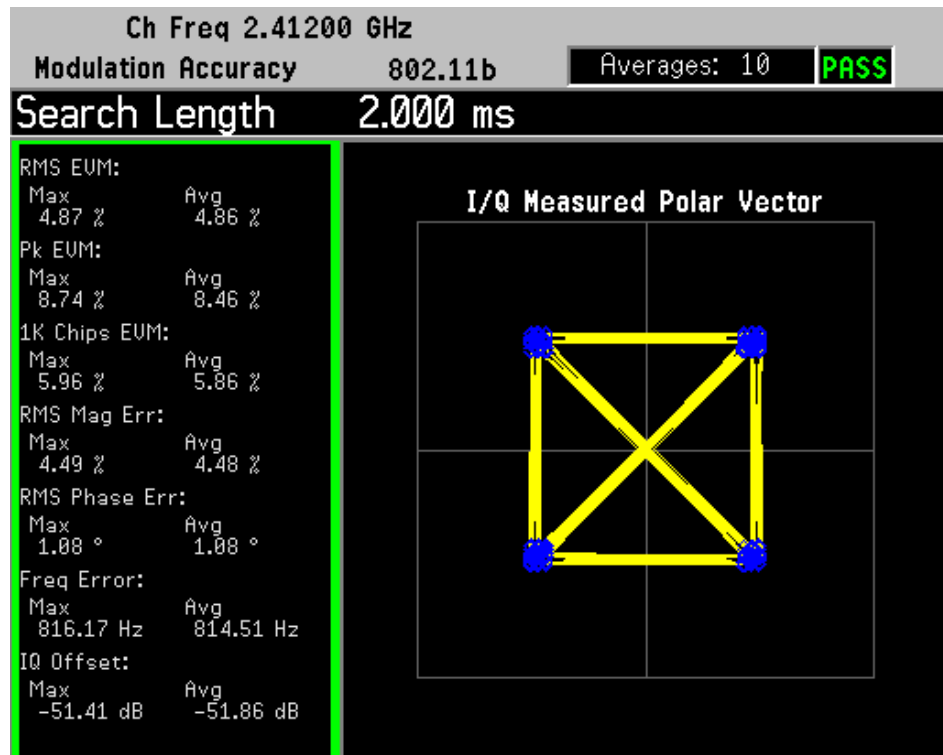
The Modulation Accuracy measurement result should look like [Figure 2-8 on page 54](#) for 802.11a signal and [Figure 2-9 on page 55](#) for 802.11b signal. The measurement values for RMS EVM, Pk EVM, Freq Error, Sym Clock Err and IQ Offset are shown in the summary result window.

**Figure 2-8**

#### Modulation Accuracy Result - 802.11a Polar View (Default)



**Figure 2-9 Modulation Accuracy Result - 802.11b Polar View (Default)**



**Step 2.** Press the **Meas Setup** to change the measurement parameters from their default conditions.

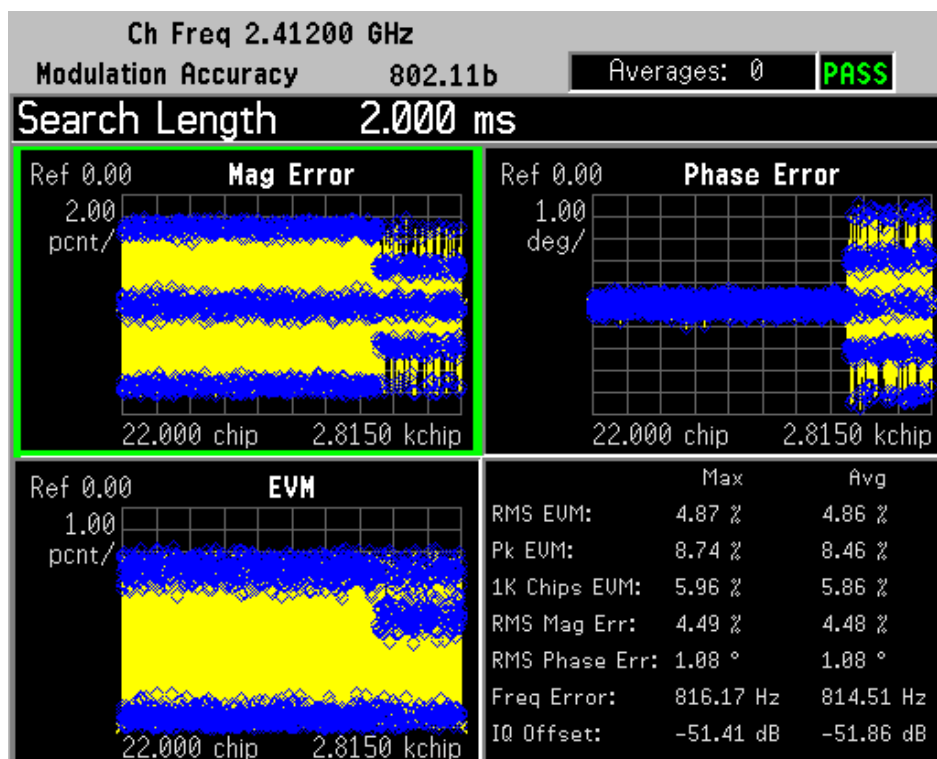
For more details about changing measurement parameters, see Modulation Accuracy [“Meas Setup” on page 172](#).

**Step 3.** Press the **View/Trace**, **I/Q Error** keys to select the alternate display combination of a magnitude error window, a phase error window, a EVM graph window, and a modulation summary result window. See [Figure 2-10 on page 56](#).

**NOTE**

**I/Q Error** key is available only when 802.11b or 802.11g ERP-DSSS/CCK/PBCC standard and operating mode is selected.

**Figure 2-10 Modulation Accuracy Result - 802.11b Signal I/Q Error View**



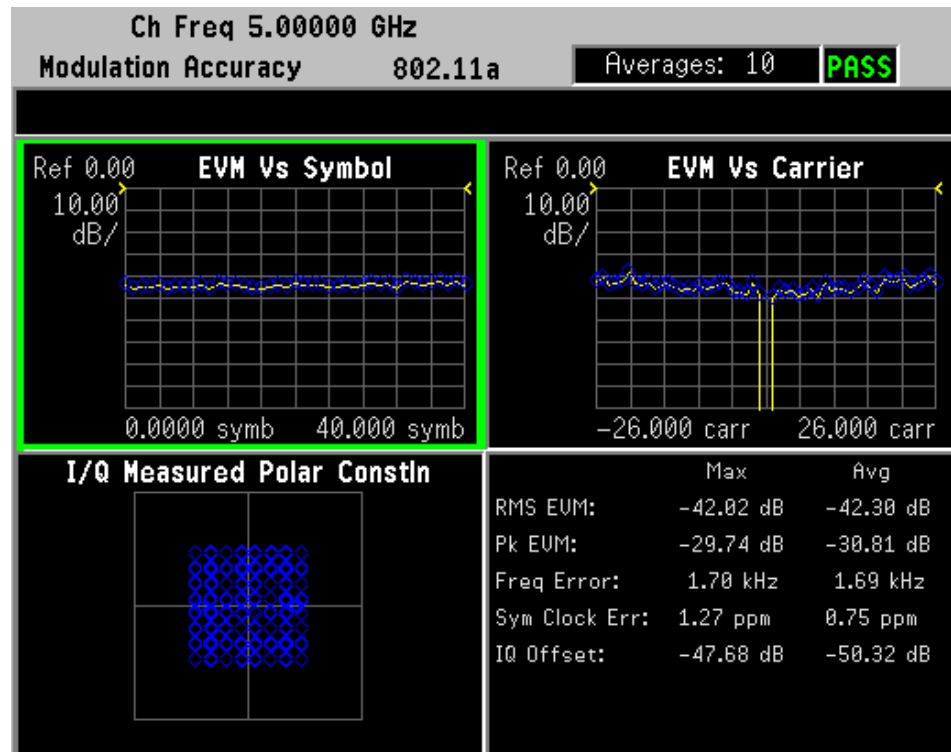
To change a display parameter like **AMPLITUDE/Y Scale**, **Scale/Div** the window must be made “active”, which is shown on the display as the window with a green outline. Press **Next Window** to activate the other window, and **Zoom** to display only a single window.



**Step 4.** Press the **View/Trace, OFDM EVM** key to select the alternate display combination of a EVM vs. Carrier window, a EVM vs. Symbol window, a I/Q Measured Polar Constellation window and a Numeric Results window. See [Figure 2-11 on page 57](#).

**NOTE** OFDM EVM key is available only when 802.11a, 802.11g EPR-OFDM or 802.11g DSSS-OFDM standard and operating mode is selected.

**Figure 2-11 Modulation Accuracy Result - 802.11a Signal OFDM EVM View**



**Step 5.** Press the **View/Trace, Demod Bits** key to display a demodulated data bits window. See [Figure 2-12 on page 58](#) for 802.11a and [Figure 2-13 on page 58](#) for 802.11b.

Figure 2-12 Modulation Accuracy Result - 802.11a Signal Demod Bits View

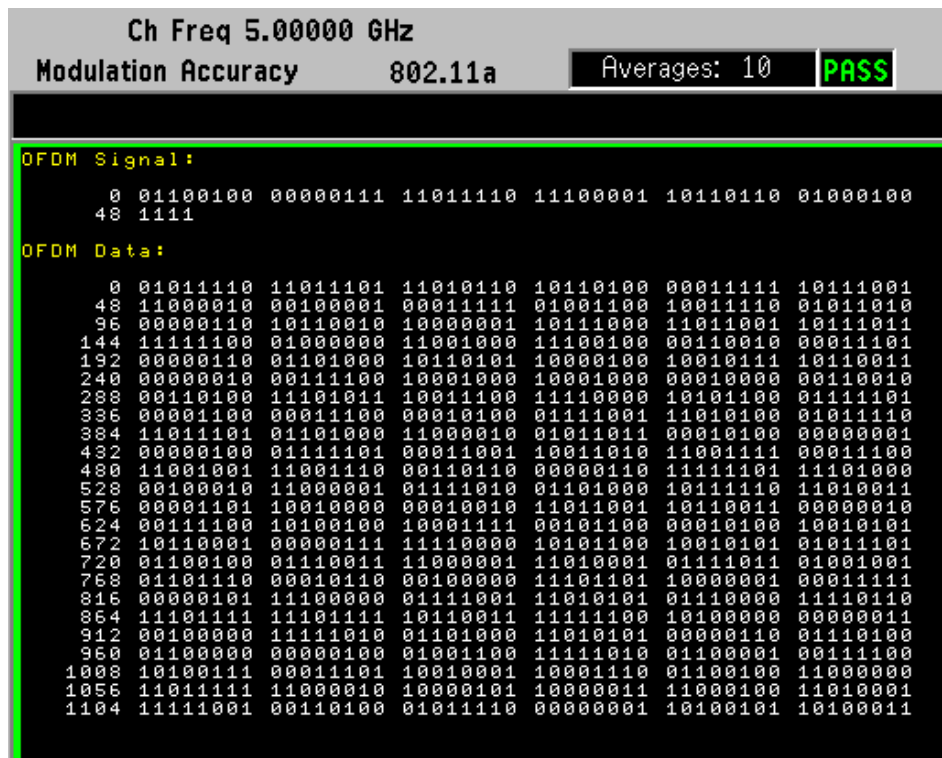
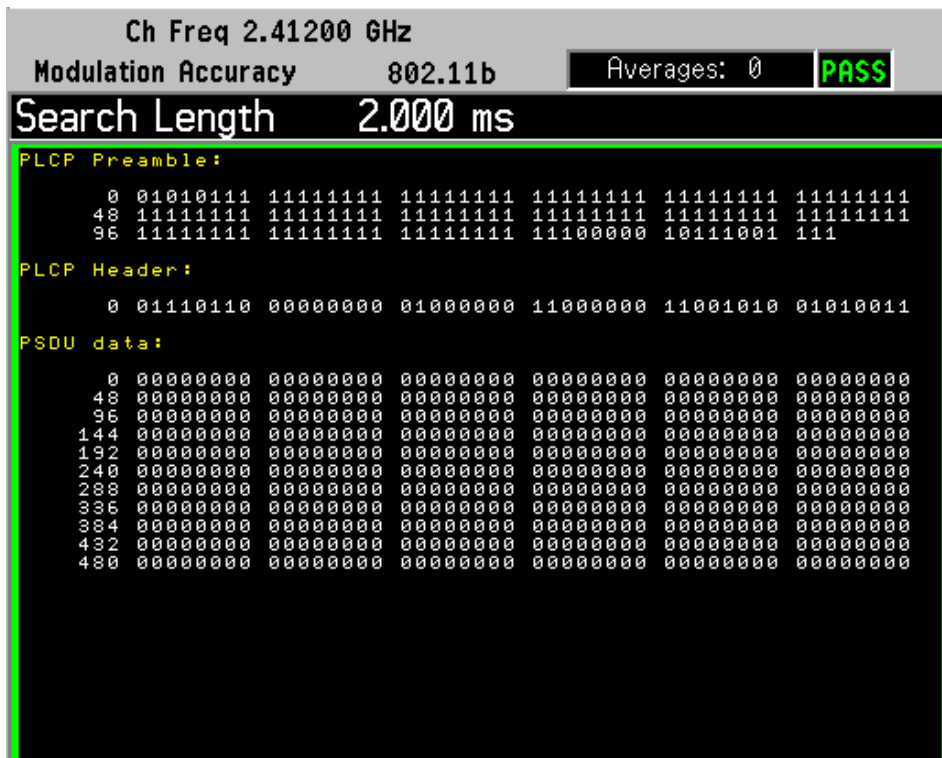


Figure 2-13 Modulation Accuracy Result - 802.11b Signal Demod Bits View



**Step 6.** Press the **View/Trace, Numeric Results** key to display the modulation accuracy summary data, peak and rms EVM, frequency error, symbol clock error, IQ offset, quadrature error and IQ gain imbalance in a text window. See [Figure 2-14 on page 59](#) and [Figure 2-15 on page 60](#).

**Figure 2-14**

**Modulation Accuracy Result - 802.11a Numeric Results View**

Ch Freq 5.00000 GHz			
Modulation Accuracy		802.11a	Averages: 10 <b>PASS</b>
	Max	Avg	Limit
RMS EVM	-42.02 dB	-42.30 dB	-25.00 dB
Peak EVM	-29.74 dB at sym 23	-30.81 dB at sym 9	N/A
Frequency Error	339.08 mppm	337.94 mppm	20.00 ppm
Sym Clock Err	1.27 ppm	0.75 ppm	20.00 ppm
IQ Offset	-47.68 dB	-50.32 dB	-15.00 dB
Quadrature Skew	-0.09 °	-0.07 °	N/A
IQ Gain Imbalance	-0.01 dB	-0.01 dB	N/A

**Step 7.** Press the **Display** to change display parameters from the default settings.

Switch from constellation, vector or vector&constellation graph by pressing the **I/Q Polar Vector/ConstIn** key.

The default polar graph setting is constellation graph for 802.11a signals, and the vector&constellation graph for 802.11b.

Enter a value for the **I/Q Points** key and press the unit key **symbols**, to specify the total number of I/Q points displayed during each measurement interval.

Enter a value as an offset from the first I/Q points for the **I/Q Points Offset** key.

Switch between **On** or **Off** by pressing **I/Q Rotation 45.0 deg** key.

Switch between **On** or **Off** by pressing **Full Vector (Background)** key.

**Figure 2-15 Modulation Accuracy Result - 802.11b Numeric Results View**

Ch Freq 2.41200 GHz					
Modulation Accuracy		802.11b		Averages: 0	PASS
Search Length		2.000 ms			
	Max	Min	Avg	Limit	
RMS EUM	4.87 %		4.86 %	16.00 %	
Peak EUM	8.74 %	at chip 1639	8.46 % at chip 451	N/A	
1k Chips EUM	5.96 %		5.86 %	35.00 %	
RMS Mag Error	4.49 %		4.48 %	N/A	
Peak Mag Error	-8.73 %	at chip 1639	-8.45 % at chip 451	N/A	
RMS Phase Error	1.08 °		1.08 °	N/A	
Peak Phase Error	-4.78 °	at chip 2577	-0.93 ° at chip 2218	N/A	
Frequency Error	338.38 mppm		337.69 mppm	25.00 ppm	
Chip Clock Err	1.08 ppm		0.85 ppm	25.00 ppm	
IQ Offset	-51.41 dB		-51.86 dB	N/A	
Quadrature Skew	-0.06 °		-0.05 °	N/A	
IQ Gain Imbalance	-0.04 dB		-0.03 dB	N/A	
Carrier Suppression	42.41 dB		42.86 dB	15.00 dB	

If you have a problem, and get an error message, see “[Interpreting Error Codes](#)” on page 65 or the “Instrument Messages and Functional Tests” manual.

### Power Stat CCDF Measurements

This section explains how to make a power statistics CCDF measurement on a WLAN device.

Power Complementary Cumulative Distribution Function (CCDF) curves characterize the higher level power statistics of a digitally modulated signal.

The results are displayed graphically as well as in Metrics window.

**NOTE** The CCDF measurement does not have Pass/Fail indicators.

#### Power Stat CCDF Measurement Procedure

- Step 1.** Press the **MEASURE**, **Power Stat CCDF** keys to initiate the power statistics CCDF measurement.

The CCDF measurement result should look like [Figure 2-16 on page 61](#) and [Figure 2-17 on page 61](#). The measurement results for Average Power, Peak Power and the power statistic data are shown in Metrics window of the left screen. The tested CCDF curve is indicated by the

yellow lines.

Figure 2-16

Power Statistics CCDF Result - 802.11a Signal (Default)

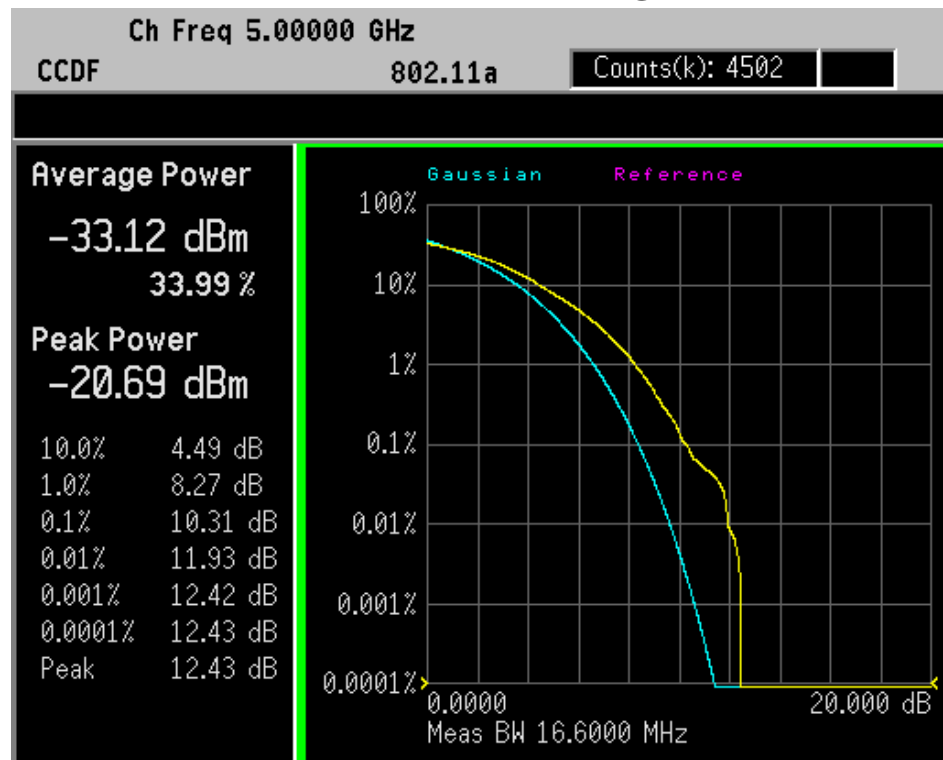
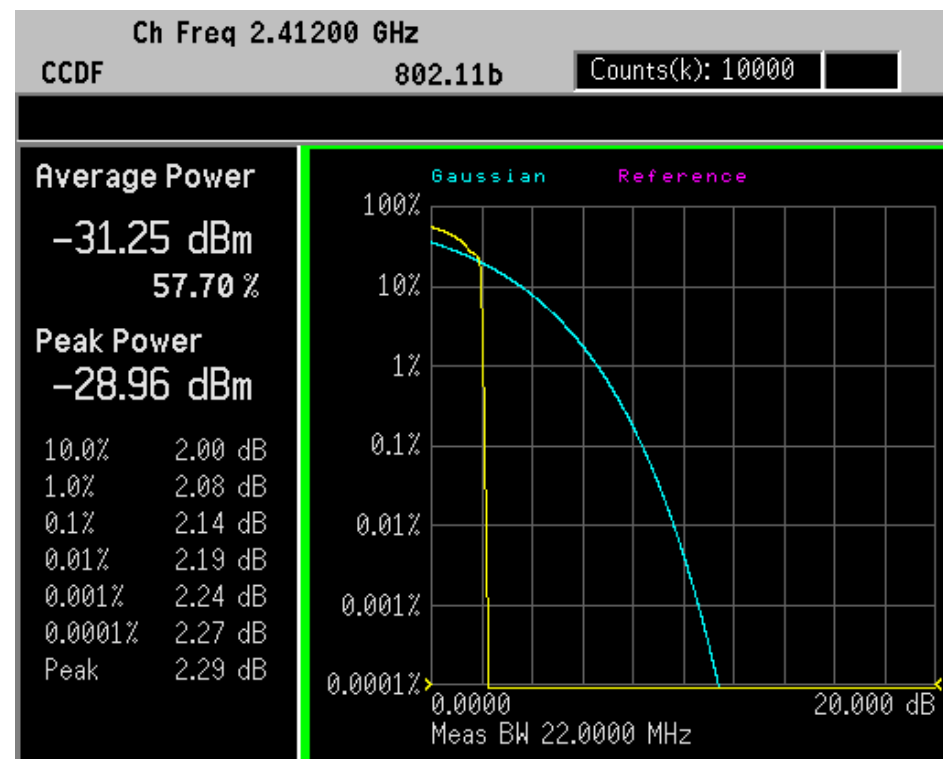


Figure 2-17

Power Statistics CCDF Result - 802.11b Signal (Default)



- Step 2.** Press the **Meas Setup** to change the measurement parameters from their default conditions.

In an OFDM signal, the burst includes training symbols, the signal field and the data field. To accurately perform a useful CCDF measurement of a device such as a power amplifier (PA), only the signal and data portions of the burst should be included and the measurement must be made on the data portion. This can be done by adjusting the trigger parameters within the CCDF measurement:

First, identify the total length of the burst. This can be done using the **Waveform Measurement**. You can use **Waveform (Time Domain)** measurement to show the whole burst, place a marker on the left edge of the burst, then use the knob to place a delta marker at the falling edge of the same burst. The length of the burst will display on the top left of Waveform window. You need to elect the correct trigger source to get a stable signal display and then use marker to determine the burst length. For example, you read the burst length as 104 us.

Second, select the **Power Stat CCDF** measurement and set the correct **Trig Source** in **Meas Setup** menu, like **Ext Front**.

Third, select the appropriate **Meas Interval** in **Meas Setup** menu, like 88 us. Then set trigger offset 16 us for CCDF measurement by pressing **Trig** and **Ext Front**.

The training portion of the OFDM burst occupies the first 16 us, so the CCDF measurement should only analyze the portion of the burst between 16 us and 104 us.

Now you can get CCDF result. If not, press **Restart**.

For more details about changing measurement parameters, see Power Stat CCDF [“Meas Setup” on page 202](#).

- Step 3.** To change the display scale, press the **SPAN/X Scale** key, enter a value for **Scale/Div** key, then press the **dB** key.

- Step 4.** To change the display parameters, press the **Display** key:

Press **Store Ref Trace** to define user's reference trace.

Switch between **On** or **Off** by pressing **Ref Trace** key.

Switch between **On** or **Off** by pressing **Gaussian Line** key.

To change a display parameter like **AMPLITUDE/Y Scale**, **Scale/Div** the window must be made “active”, which is shown on the display as the window with a green outline. Press **Next Window** to activate the other window, and **Zoom** to display only a single window.

If you have a problem, and get an error message, see [“Interpreting Error Codes” on page 65](#) or the “Instrument Messages and Functional Tests” manual.

## **Spectrum and Waveform Measurements**

The Spectrum and Waveform measurements available in PSA Option 217 are the same as those available in basic mode. See the PSA *Basic Mode User's Guide Option B7J* for more detail on the Spectrum and Waveform measurements, remote commands, front-panel keys, conceptual information and menu maps.

## Using Basic Mode

Basic mode is a standard feature of E4406A Transmitter Testers, and is part of Option B7J for the PSA Series Spectrum Analyzers. Basic mode is *not* related to a particular communications standard. That is, it does not default to measurement settings that are for any specific standard. You may want to use Basic Mode if you are making measurements on a signal that is not based on a specific digital communications standard.

### Basic Mode in E4406A VSA Series Transmitter Testers

There are five generic measurements available under the **MEASURE** key in Basic mode:

- Adjacent Channel Power (ACP)
- Channel Power
- Power Statistics CCDF
- Spectrum measurement (frequency domain).
- Waveform measurement (time domain)

The ACP, Channel Power, and Power Stat CCDF measurements are fully described in the VSA Series User's Guide. Please refer to that manual for complete information on these measurements.

### Spectrum and Waveform Measurements

These measurements provide a spectrum measurement mode that is similar to a standard spectrum analyzer, and a waveform measurement mode that is similar to a microwave oscilloscope. Unlike those standard analyzers, these measurements are optimized for digitally modulated signals, so they can be used to output the measured I/Q data.

For your convenience, Spectrum and Waveform measurements are also available in this mode, with the same functionality, so you can refer to the sections included in this chapter for information about using them.

### Basic Mode in PSA Series Spectrum Analyzers

There are two generic measurements available under the **MEASURE** key in Basic mode:

- Spectrum measurement (frequency domain).
- Waveform measurement (time domain)

These Spectrum and Waveform measurements are also available in this mode, with the same functionality, so you can refer to the sections included in this chapter for information about using them.



---

## Interpreting Error Codes

During the execution of your measurement you may encounter problems which generate error codes. Reference to the following common errors may be helpful.

If **ERR** is shown in the annunciator bar, press the **System, Show Errors** to read the detailed error information.

- **Awaiting Trig, no AUTO Trig**

Press **Meas Setup, Trig Source**, and then select the proper trigger source. And check the trig type is correct by pressing **Trig** hardkey.

Press **Restart** to make another measurement and observe the results. Re-adjust the ADC as necessary to obtain a valid measurement.

- **Error Code 16 “Input overload”**

This error means that your measurement has erroneous results due to the excessive input power level. To correct this condition, the input signal level must be reduced by using the internal and/or external attenuator.

Press the **Mode Setup, Input, Input Atten** keys to enter an attenuation value to reduce the transmitted power from the MS. This allowable range is up to 40 dB.

To attenuate more than 40 dB, connect your external attenuator between the **RF INPUT** port and the DUT. Be sure to add its attenuation value to the readings of the measurement result.

To automate this calculation, press the **Mode Setup, Input, Ext Atten** keys to enter the additional attenuation value. The allowable range is up to 100 dB. The power readings of the measurement will take into account the external attenuation value.

- **Error Code 601 “Signal too noisy”**

This error means that your input signal is too noisy to capture the correct I/Q components. To make a more stable measurement the trigger source may need to be set to **Frame**, for example.

- **Error Code 604 “Can not correlate to input signal”**

This error means that the tester has failed to find any active channels in the input signal as specified. To improve the correlation some critical parameter needs to be adjusted, like the input signal level or scramble code, for example.

For more details consult the chapter in this book dedicated to the measurement in question, or see the “*Instrument Messages and Functional Tests*” manual.



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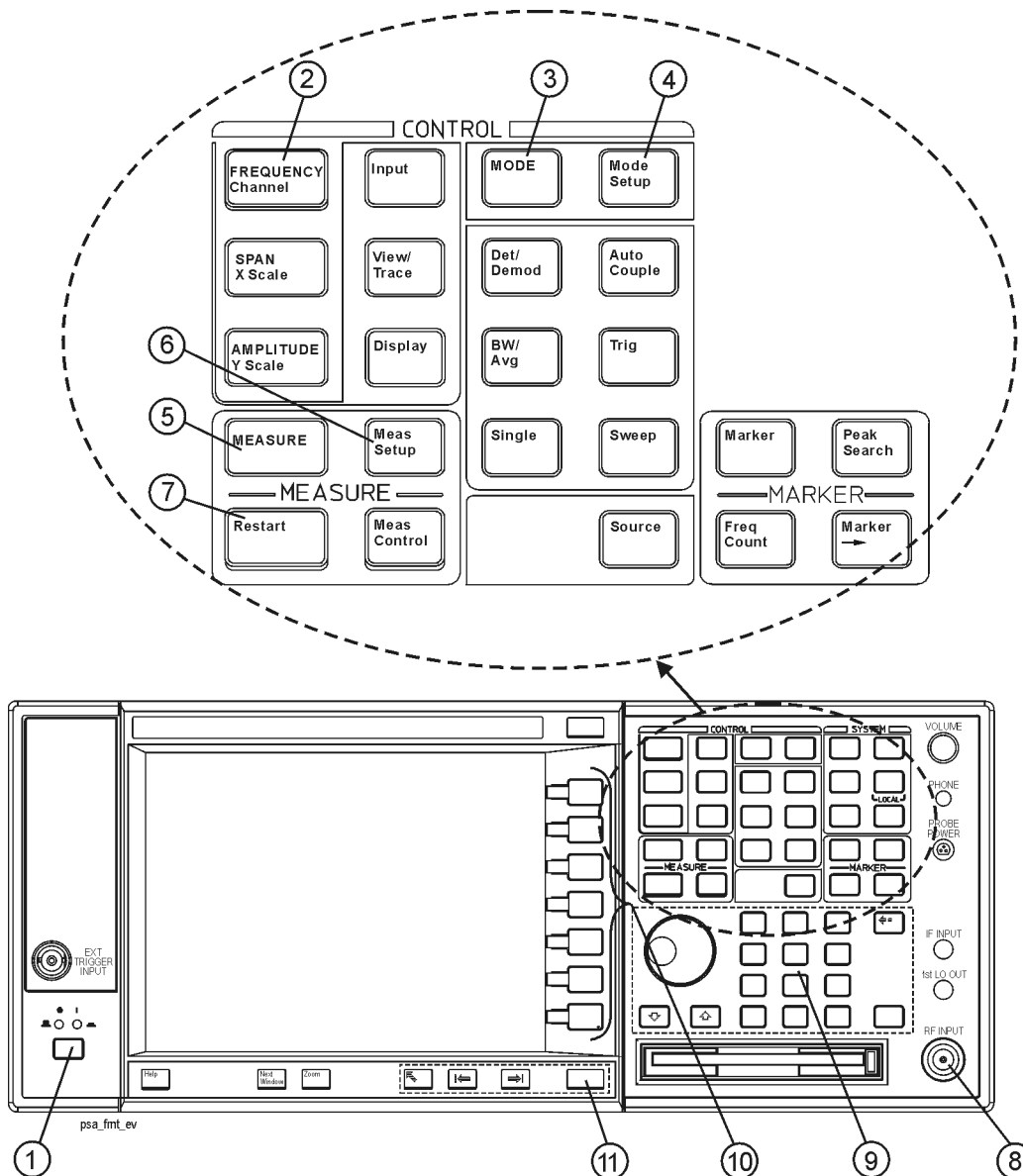
## **3 Front-Panel Key and SCPI Command Reference**

This chapter provides detailed descriptions of the front-panel keys and the associated SCPI commands and screens used to set up and make WLAN measurements.

### 3.1 Instrument Front Panel Highlights

The most commonly used function keys on the PSA front panel are located as shown in the illustrations below. The operation of the keys is briefly explained on the following page. Refer to your User's Guide for complete details on all keys.

**Figure 3-1 PSA Selected Front Panel Key Locations**



1. The **On/Off** switch toggles the AC Line power on or off. A green LED will light when the instrument is On. When energized in the standby mode, a yellow LED is lit above the **On/Off** switch.
2. **FREQUENCY Channel** accesses a display key menu that to set the analyzer center frequency in units of Hz, kHz, MHz, or GHz, or by channel number. These parameters apply to all measurements in the current mode.
3. **MODE** accesses a key menu to select one of the measurement personalities installed in the instrument. Each mode is independent from all other modes.
4. **Mode Setup** accesses a key menu that sets parameters specific to the current mode and affect all measurements within that mode.
5. **MEASURE** accesses a display key menu to initiate one of the various measurements that are specific to the current mode.
6. **Meas Setup** accesses the menus of test parameters that are specific to the current measurement.
7. **Restart** causes a measurement to start again from the initial process according to the current measurement setup parameters.
8. The **RF INPUT** port “N” connector allows you to apply an external RF signal. The maximum input power level is shown next to the port.
9. The **Data Entry** keypad is used to enter numeric values to parameters. A value from this keypad will be displayed in the active function area of the screen, then the value will become valid for the current measurement upon pressing the **Enter** key or selecting a unit of measurement depending on the parameter.
10. The Display Menu keys allow you either to activate a feature or to access a more detailed sub-menu. An arrow on the right side of a softkey label indicates that the key has a further selection menu. The active menu key is highlighted, however, grayed-out keys are currently unavailable for use or are only to show information. If a menu has multiple pages, successive pages are accessed by pressing the **More** key located at the bottom of the menu.
11. Pressing the **Return** key allows you to exit from the current menu and display the previous menu. Often, pressing a menu key will invoke a multi-page sub-menu. Pressing the **Return** key will show the menu “above” it, not a previous page. When you activate another measurement, the return list is cleared. The **Return** key will not return you to a previously activated mode, nor will it alter any values you have entered in previous menus.

## 3.2 Programming Command Compatibility Across Model Numbers and Across Modes

### 3.2.1 Across PSA Modes: Command Subsystem Similarities

When you select different modes you get different sets of available programming commands. That is, *only* the commands that are appropriate for the current mode are available. Also, some commands have the same syntax in different modes but have different ranges or settings that are only appropriate to the current mode.

The following table shows which command subsystems are the same across different modes. If there is no “X” by a particular subsystem, then the set of available commands is different in those modes. Command ranges or defaults may also be different. Refer to the programming command descriptions in the documentation for each mode for details.

Command Subsystem	Same command set is available:  SA mode compared with the application modes: Digital Modulation, Basic, WLAN, W-CDMA, cdmaOne, cdma2000, 1xEV-DO, GSM, EDGE, NADC, or PDC	Same command set is available:  SA mode compared with the application modes: Phase Noise, Noise Figure, TD-SCDMA
IEEE common commands	X	X
ABORt	X	X
CALCulate		
CALibration	X	X
CONFigure		
COUPLE	not available in these application modes	not available in these application modes
DISPlay		
FETCh		
FORMat		X
HCOPy	X	X
INITiate		
INPut	not available in these application modes	X
MEASure		
MEMory	X	X

Command Subsystem	Same command set is available:  SA mode compared with the application modes: Digital Modulation, Basic, WLAN, W-CDMA, cdmaOne, cdma2000, 1xEV-DO, GSM, EDGE, NADC, or PDC	Same command set is available:  SA mode compared with the application modes: Phase Noise, Noise Figure, TD-SCDMA
MMEMory	X	X
MMEMory:STORe:TRACe	not available in these application modes	X
READ		
[SENSe]		
[SENSe:]CHANnel		
[SENSe:]CORRection		
[SENSe:]FEED		
[SENSe:]FREQuency:CE NTer	X	
[SENSe:]FREQuency:<other subsystems>	not available in these application modes	not available in these application modes
[SENSe:]<measurement>		
[SENSe:]POWer		
[SENSe:]RADio		
[SENSe:]SYNC		
STATUs	X	X
SYSTem	X	X
TRACe	not available in these application modes	X
TRIGger		
UNIT	X	X

### 3.2.2 Across PSA Modes: Specific Command Differences

Some programming commands operate differently depending on which Mode the analyzer is set to.

Command	Spectrum Analysis, Phase Noise and Noise Figure Mode	Basic, cdmaOne, cdma2000, 1xEV-DO, W-CDMA, GSM, EDGE, NADC, PDC Modes
CONFigure: <measurement>	Accesses the measurement and sets the instrument settings to the defaults. Averaging is turned on and set to 10. The instrument is put in single measurement mode. It does not initiate a measurement. Use INIT:IMM to make one measurement.	Accesses the measurement and sets the instrument settings to the defaults. If you were already in single measurement mode, it takes one measurement and then waits. If you were in continuous measurement mode it continues to measure.
*ESE default	Default is 255 which means that every error/status bit change that has occurred will be returned with a *ESR? query. You must set the value of *ESE to choose only the bits/status that you want returned.	Default is 0 which means that none of the error/status bit changes that have occurred will be returned with a *ESR? query. You must set the value of *ESE to choose the bits/status that you want returned.
TRIGger commands	For these modes, only one trigger source can be selected and it will be common across the modes. Also, only one value can be set for the trigger delay, level, or polarity.	For these modes, a unique trigger source can be selected for each mode. Also, each trigger source can have unique settings for the its delay, level, and polarity.
Saving and recalling traces	Traces can only be saved when in the Spectrum Analysis mode (MMEM:STOR:TRAC). This is because the instrument state must be saved along with the trace data and the state data varies depending on the number of modes currently available in the instrument.	



### 3.2.3 Using Applications in PSA Series vs. VSA E4406A

**NOTE** This information *only* applies to the application modes:  
 Basic, cdmaOne, cdma2000, 1xEV-DO, W-CDMA, GSM, EDGE,  
 NADC, and PDC.

Command	PSA Series	VSA E4406A: A.04.00	VSA E4406A: A.05.00
*RST	Resets instrument, putting it in continuous measurement mode. Use INIT:CONT OFF to select single measurement mode and INIT:IMM to start one measurement.	Resets instrument, putting it in single measurement mode. One measurement is initiated when the command is sent.	Resets instrument, putting it in single measurement mode. No measurement is initiated when the command is sent. Use INIT:IMM to start one measurement.
CONFigure: <measurement>	Accesses the measurement and sets the instrument settings to the defaults. If you were already in single measurement mode, it takes one measurement and then waits.	Same as PSA.  Accesses the measurement and sets the instrument settings to the defaults. If you were already in single measurement mode, it takes one measurement and then waits.	Accesses the measurement and sets the instrument settings to the defaults. If you were already in single measurement mode, it does not initiate a measurement. Use INIT:IMM to make one measurement.
*ESE default	Default is 255 which means that every error/status bit change that has occurred will be returned with a *ESR? query. You must set the value of *ESE to choose only the bits/status that you want returned.	Default is 0 which means that none of the error/status bit changes that have occurred will be returned with a *ESR? query. You must set the value of *ESE to choose the bits/status that you want returned.	Same as VSA A.04.00.  Default is 0 which means that none of the error/status bit changes that have occurred will be returned with a *ESR? query. You must set the value of *ESE to choose the bits/status that you want returned.
*LRN	The command is <i>not</i> available.	The command is available.	The command is available.

Command	PSA Series	VSA E4406A: A.04.00	VSA E4406A: A.05.00
TRIGger commands	<p>In Spectrum Analysis mode only one value can be set for the trigger's source, delay, level, or polarity.</p> <p>Basic, GSM, EDGE, cdmaOne, cdma2000, W-CDMA, NADC, PDC modes function the same as VSA</p>	<p>You can select a unique trigger source for each mode. Each trigger source can have unique settings for the its delay, level, and polarity.</p>	<p>Same as VSA A.04.00.</p> <p>You can select a unique trigger source for each mode. Each trigger source can have unique settings for the its delay, level, and polarity.</p>
<p>AUTO ON   OFF control and setting manual values</p>	<p>We recommend that you set a function's automatic state to OFF, before you send it your manual value.</p> <p>Some functions will turn off the automatic mode when you send a specific manual value, but others will not. This also varies with the instrument model.</p>	<p>We recommend that you set a function's automatic state to OFF, before you send it your manual value.</p> <p>Some functions will turn off the automatic mode when you send a specific manual value, but others will not. This also varies with the instrument model.</p>	<p>We recommend that you set a function's automatic state to OFF, before you send it your manual value.</p> <p>Some functions will turn off the automatic mode when you send a specific manual value, but others will not. This also varies with the instrument model.</p>

## 3.3 Front-Panel Keys

---

**NOTE** Only front panel keys affected by selection of WLAN mode are described here. For a complete description of all front panel keys see the *PSA Series User's Guide*.

---

### 3.3.1 FREQUENCY Channel

Displays the menu of frequency functions.

#### 3.3.1.1 Center Frequency

Sets the center frequency to be measured for the selected band. It is coupled with Channel No..

Mode:	WLAN
Key Path:	<b>FREQUENCY/Channel</b>
Remote Command:	[ :SENSe ] :FREQuency:CENTer <freq> [ :SENSe ] :FREQuency:CENTer?
Unit:	Hz   kHz   MHz   GHz
Default:	2.412 GHz (See <a href="#">Table 3-1, "Center Frequency Factory Preset"</a> )
State Saved:	Saved in instrument state.
Range:	See <a href="#">Table 3-2, "Center Frequency Range"</a>
Dependencies/Couplings:	Couple with Channel No., see Note below.
Remote Command Notes:	You must be in the WLAN mode to use this command. Changing Center Frequency will effect all measurements in the selected WLAN standard.
Example:	FREQ:CENT 2.412 GHz FREQ:CENT?

---

**NOTE** If the Center Frequency value entered does not exactly correlate with a Channel No., the key label changes to display the closest Channel No. to the selected frequency.

---

**Table 3-1 Center Frequency Factory Preset**

Radio	Center Frequency (Preset/Default):
802.11a	5 GHz
802.11b	2.412 GHz
802.11g ERP-OFDM	2.412 GHz
802.11g ERP-DSSS/CCK/PBCC	2.412 GHz
802.11g DSSS-OFDM	2.412 GHz

**Table 3-2 Center Frequency Range**

Model	Center Frequency Range:
E4440A	1 kHz ~ 26.5 GHz
E4443A	1 kHz ~ 6.7 GHz
E4445A	1 kHz ~ 13.2 GHz

---

**NOTE** Although the analyzer allows entry of frequencies greater than its specified range, analyzer performance will be degraded if it is used beyond the specified frequency range.

---

### 3.3.1.2 Channel No.

Sets the analyzer to a frequency that corresponds to the Channel No.. You can enter the number of channel to be measured for the selected band. It is coupled with Center Frequency.

---

**NOTE** Channel No. Range is limited to valid channels for the selected band.

---

Mode: WLAN

Key Path: FREQUENCY/Channel

Remote Command: [:SENSe]:CHANnel <integer>  
 [:SENSe]:CHANnel?

Default: 1 (See Table 3-3, "Channel No. Factory Preset")

State Saved: Saved in instrument state.

Range: See [Table 3-3, “Channel No. Factory Preset”](#)

Dependencies/Couplings: Couple with Center Freq (See Note below)

Remote Command Notes: You must be in the WLAN mode to use this command. Changing Channel No. will effect all measurements in the selected WLAN standard.

**Table 3-3 Channel No. Factory Preset**

Radio	Channel No. (Preset/Default):	Channel No. Range
802.11a	0	0 ~ 200
802.11b	1	1 ~ 14
802.11g ERP-OFDM	1	1 ~ 14
802.11g ERP-DSSS/CCK/PBCC	1	1 ~ 14
802.11g DSSS-OFDM	1	1 ~ 14

**NOTE** The relationship between Center Frequency (CtrFreq) and Channel No. (nch):

- For 802.11b/g:

$$\text{CtrFreq (MHz)} = 2407 + 5 * \text{nch}, \text{ where nch} = 1, 2, \dots, 13$$

$$\text{CtrFreq (MHz)} = 2484, \text{ where nch} = 14$$

- For 802.11a:

$$\text{CtrFreq (MHz)} = 5000 + 5 * \text{nch}, \text{ where nch} = 0, 1, 2, \dots, 200$$

### 3.3.2 Meas Control

These functions allow you to pause and resume the currently selected measurement and to select between continuous or single measurements.

#### 3.3.2.1 Restart

Press this key to repeat the current measurement from the beginning, while retaining the current measurement settings. This is equivalent to the **Restart** front panel key.

Key Path: **Meas Control**

## Front-Panel Keys

Remote Command:	:INITiate:REStart
Remote Command Notes:	This command is equivalent to sending an :ABORt command followed by an:INITiate[:IMMediate] command.
Example:	:INIT:REST

**3.3.2.2 Measure**

Press this key to toggle the measurement state between **Single** and **Cont** (continuous). **NOTE:** This key has a different function than the **MEASURE** front panel key. When set to **Single**, the measurement will continue until it has reached the specified number of averages set by the average counter. When set to **Cont**, the measurement will run continuously and execute averaging according to the current average mode, either repeat or exponential.

Key Path	<b>Meas Control</b>
Factory Preset	Cont
State Saved	Saved in instrument state.
Remote Command	:INITiate:CONTinuous OFF ON
Remote Command Notes	When ON, at the completion of each trigger cycle, the trigger system immediately initiates another trigger cycle.  When OFF, the trigger system remains in an “idle” state until CONTinuous is set to ON or an :INITiate[:IMMediate] command is received. On receiving the :INITiate[:IMMediate] command, it will go through a single trigger cycle, and then return to the “idle” state.  The query INIT:CONT? returns 1 or 0. 1 is returned when the instrument is continuous triggering. 0 is returned when it is single triggering.
Example	:INIT:CONT OFF

**3.3.2.3 Pause/Resume**

Press this key to pause the current measurement until you reactivate the measurement. Once toggled, the label of the **Pause** key changes to read **Resume**. The **Resume** key, once pressed, continues the active measurement from the point at which it was paused.

Key Path:	<b>Meas Control</b>
Remote Command:	:INITiate:PAUSE :INITiate:RESume
Example:	:INIT:PAUS

### 3.3.3 Mode

Accesses any installed personality modes. The minimum set of available modes will be:

- **Spectrum Analysis**
- **Basic**
- **WLAN**

This menu will have additional entries if other personalities have been installed, for example GSM/EDGE Option 202 or cdmaOne Option BAC.

For information related to the operation of the Spectrum Analysis mode refer to the *PSA User's/Programmer's Guide*.

For information related to the operation of the Basic mode refer to the *PSA Basic Mode Guide*.

The WLAN mode provides you the ability to set up your own measurement environment to analyze signals comply with IEEE 802.11a/b/g standards.

#### 3.3.3.1 Instrument Selection by Name (Remote command only)

This remote command allows you to use SCPI to change from the current mode to WLAN mode. This has the same effect as pressing the **WLAN** key.

Key Path:	<b>Mode</b>
Remote Command:	:INSTrument [:SElect] SA BASIC WLAN :INSTrument [:SElect] ?
Example:	INST WLAN INST?

#### 3.3.3.2 Instrument Selection by Number (Remote command only)

This remote command allows you to use SCPI to change from the current mode to WLAN mode (Option 217). This has the same effect as pressing the **WLAN** key.

Key Path:	<b>Mode</b>
Remote Command:	:INSTrument :NSElect 18 :INSTrument :NSElect ?
Example:	INST:NSEL 18 INST:NSEL?

### 3.3.4 Mode Setup

Accesses all menus that enable you to change parameters for the available measurements.

#### 3.3.4.1 Radio

Accesses the radio standards menus.

Mode:	WLAN
Key Path:	<b>Mode Setup</b>

##### 3.3.4.1.1 WLAN Std

Selects the standard variant that applies to the radio to be tested. The WLAN standards available are:

- 802.11a
- 802.11b
- 802.11g

Mode:	WLAN
Key Path	<b>Mode Setup, Radio</b>
Remote Command	[ :SENSe ] :RADio:STANdard:WLAN A11   B11   G11 [ :SENSe ] :RADio:STANdard:WLAN?
Default	G11
State Saved	Saved in instrument state.
Remote Command Notes	You must be in the WLAN mode to use this command. Changing Radio will effect all measurements in the WLAN mode.
Example:	RAD:STAN: WLAN A11 RAD:STAN: WLAN?

##### 3.3.4.1.2 Oper Mode

---

**NOTE** Oper Mode is available only when WLAN Std is 802.11g.

---

Sets the operation mode for 802.11g standard. The supported operation modes include:

- ERP-OFDM
- ERP-DSSS/CCK/PBCC



- **DSSS-OFDM**

Mode:	WLAN
Key Path	<b>Mode Setup, RadioMode Setup key: Demod;Demod key:Mode Setup</b>
Remote Command	[ :SENSE ] :RADio:STANdard:OPMode EDCP   EOFDM   DOFDM [ :SENSE ] :RADio:STANdard:OPMode?
Default	EOFDM
State Saved	Saved in instrument state.
Remote Command Notes	You must be in the WLAN mode to use this command. Changing Oper Mode will effect all measurements in the WLAN mode.
Example:	RAD:STAN: OPM EDCP RAD:STAN: OPM?

### 3.3.4.2 Input

Displays the keys that control some of the signal inputs. You can also access this menu by pressing Input/Output front-panel key. Please refer to *PSA Series Basic Mode Guide* for the keys usage and the remote command details.

Mode:	WLAN
Key Path:	<b>Mode Setup</b>

### 3.3.4.3 Trigger

Displays the keys that control the signal trigger. You can also access this menu by pressing Trig front-panel key. Please refer to *PSA Series Basic Mode Guide* for the keys usage and the remote command details.

Mode:	WLAN
Key Path:	<b>Mode Setup</b>

### 3.3.4.4 Demod

Displays the menu keys that set the demodulation parameters.

Mode:	WLAN
Key Path:	<b>Mode Setup</b>

**3.3.4.4.1 Modulation Format** Accesses the demodulation format menu keys allowing you to specify the demodulation format to use. Modulation Format is automatically set when a radio standard is selected. You can also specify a modulation format for your testing.

---

**NOTE** Following Modulation Format menu is available only when 802.11a, 802.11g ERP-OFDM, or 802.11g DSSS-OFDM mode is selected.

---

Selects the Demod format in 802.11a or 802.11g OFDM mode.

Mode	WLAN
Key Path	<b>Mode Setup, Demod</b>
Default	AUTO
State Saved	Saved in instrument state.
Remote Command	[ :SENSe ] :SYNC:DEMod AUTO BPSK QPSK QAM16 QAM64 [ :SENSe ] :SYNC:DEMod?
Remote Command Notes	You must be in the WLAN mode to use this command. Changing Modulation Format will effect all measurements in the selected WLAN mode.
Example	SYNC:DEM AUTO SYNC:DEM?

---

**NOTE** Following Modulation Format menu is available only when 802.11b is selected.

---

Select the Demod Type in 802.11b mode.

Mode	WLAN
Key Path	<b>Mode Setup, Demod</b>
Default	AUTO
State Saved	Saved in instrument state.
Remote Command	[ :SENSe ] :SYNC:DEMod AUTO DSSS1 DSSS2 CCK55 CCK11 PBCC55 PBCC11 [ :SENSe ] :SYNC:DEMod?
Remote Command Notes	You must be in the WLAN mode to use this command. Changing Modulation Format will effect all measurements in the selected WLAN mode.

Example SYNC:DEM DSSS2  
 SYNC:DEM?

---

**NOTE** Following Modulation Format menu is available only when WLAN Std is 802.11g ERP-DSSS/CCK/PBCC mode is selected.

---

Select the Demod Type in 802.11g ERP-DSSS/CCK/PBCC mode.

Mode	WLAN
Key Path	<b>Mode Setup, Demod</b>
Default	AUTO
State Saved	Saved in instrument state.
Remote Command	[ :SENSe ] :SYNC:DEMod AUTO   DSSS1   DSSS2   CCK55   CCK11   PBCC55   PBCC11   PBCC22   PBCC33 [ :SENSe ] :SYNC:DEMod?
Remote Command Notes	You must be in the WLAN mode to use this command. Changing Modulation Format will effect all measurements in the selected WLAN standard and/or operation mode.
Example	SYNC:DEM PBCC33 SYNC:DEM?

**3.3.4.4.2 Subcarrier Spacing** Specifies the subcarrier frequency spacing of the input signal. Subcarrier Spacing must match the actual subcarrier frequency spacing of the input signal, otherwise demodulation will almost certainly fail. The default 312.5 kHz matches the 802.11a/g standards.

---

**NOTE** Subcarrier Spacing is available only when 802.11a, 802.11g ERP-OFDM or 802.11g DSSS-OFDM mode is selected.

---

Mode	WLAN
Key Path	<b>Mode Setup, Demod</b>
Unit	Hz   kHz   MHz   GHz
Default	312.5 kHz
State Saved	Saved in instrument state.

Front-Panel Keys

Range	Option 122: 156.25 kHz — 1.25 MHz Option 140: 156.25 kHz — 0.625 MHz
Remote Command	[ :SENSe ] :DEMod:SUBCarrier:SPACing <freq> [ :SENSe ] :DEMod:SUBCarrier:SPACing?
Example	DEM:SUBC:SPA 312.5 kHz DEM:SUBC:SPA?

**3.3.4.4.3 Guard Interval** Specifies the guard interval (also called cyclic extension) length for each symbol time, as a fraction of the FFT length. The value must match the guard interval length actually used in the input signal in order for demodulation to work properly. The value should be between zero and one, and values outside that range are clipped to be within the range. The value is rounded to the nearest 1/128th. The 802.11a/g standards require that the guard interval always be 0.25 of the FFT length. The HIPERLAN/2 standard allows values of either 0.25 or 0.125.

---

**NOTE** Guard Interval is available only when 802.11a, 802.11g ERP-OFDM or 802.11g DSSS-OFDM mode is selected.

---

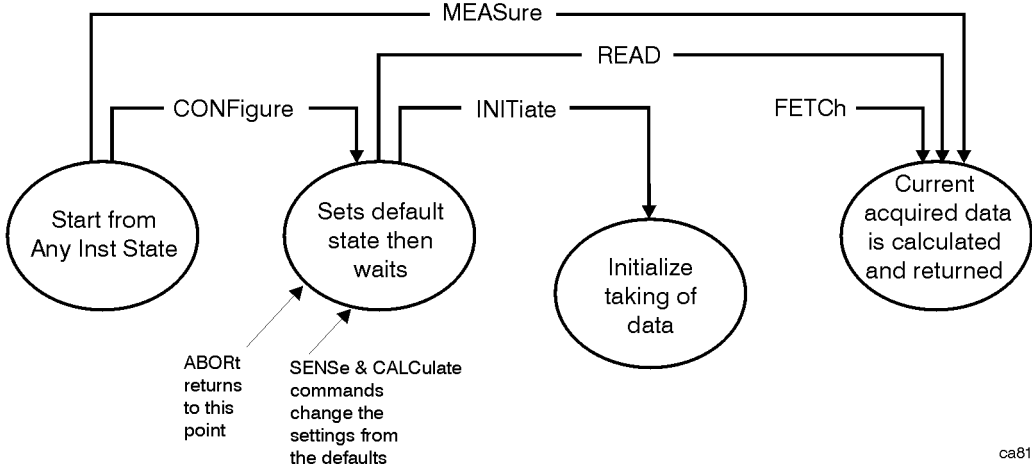
Mode:	WLAN
Key Path:	<b>Mode Setup, Demod</b>
Remote Command:	[ :SENSe ] :DEMod:GINTerval <value> [ :SENSe ] :DEMod:GINTerval?
Remote Command Notes	The value should be between zero and one, and values outside that range are clipped to be within the range. The value is rounded to the nearest 1/128th. The 802.11a/g standards require that the guard interval always be 0.25 of the FFT length.
Default:	0.25
State Saved:	Saved in instrument state.
Range:	0.0078125 — 1.0
Example	DEM:GINT 0.25 DEM:GINT?

### 3.4 Measure

Accesses the Measure menus.

#### 3.4.1 Command Interactions: MEASure, CONFigure, FETCh, INITiate and READ

Figure 1 Measurement Group of Commands



**Measure Commands:**

:MEASure:<measurement>[n]?

This is a fast single-command way to make a measurement using the factory default instrument settings. These are the settings and units that conform to the Mode Setup settings (e.g. radio standard) that you have currently selected.

- Stops the current measurement (if any) and sets up the instrument for the specified measurement using the factory defaults
- Initiates the data acquisition for the measurement
- Blocks other SCPI communication, waiting until the measurement is complete before returning results.
- After the data is valid it returns the scalar results, or the trace data, for the specified measurement. The type of data returned may be defined by an [n] value that is sent with the command.

The scalar measurement results will be returned if the optional [n] value is not included, or is set to 1. If the [n] value is set to a value other than 1, the selected trace data results will be returned. See each command for details of what types of scalar results or trace data results are available.

ASCII is the default format for the data output. (Older versions of Spectrum Analysis and Phase Noise mode measurements only use ASCII.) The binary data formats should be used for handling large blocks of data since they are smaller and faster than the ASCII format. Refer to the FORMat:DATA command for more information.

If you need to change some of the measurement parameters from the factory default settings you can set up the measurement with the CONFigure command. Use the commands in the SENSE:<measurement> and CALCulate:<measurement> subsystems to change the settings. Then you can use the READ? command to initiate the measurement and query the results. See [Figure 1](#).

If you need to repeatedly make a given measurement with settings other than the factory defaults, you can use the commands in the SENSE:<measurement> and CALCulate:<measurement> subsystems to set up the measurement. Then use the READ? command to initiate the measurement and query results.

Measurement settings persist if you initiate a different measurement and then return to a previous one. Use READ:<measurement>? if you want to use those persistent settings. If you want to go back to the default settings, use MEASure:<measurement>?.

**Configure Commands:**

:CONFigure:<measurement>

This command stops the current measurement (if any) and sets up the instrument for the specified measurement using the factory default instrument settings. It sets the instrument to single measurement mode but should not initiate the taking of measurement data unless INIT:CONTinuous is ON. After you change any measurement settings, the READ command can be used to initiate a measurement without changing the settings back to their defaults.

The CONFigure? query returns the current measurement name.

**Fetch Commands:**

`:FETCh:<measurement> [n] ?`

This command puts selected data from the most recent measurement into the output buffer. Use FETCh if you have already made a good measurement and you want to return several types of data (different [n] values, e.g. both scalars and trace data) from a single measurement. FETCh saves you the time of re-making the measurement. You can only FETCh results from the measurement that is currently active, it will not change to a different measurement.

If you need to get new measurement data, use the READ command, which is equivalent to an INITiate followed by a FETCh.

The scalar measurement results will be returned if the optional [n] value is not included, or is set to 1. If the [n] value is set to a value other than 1, the selected trace data results will be returned. See each command for details of what types of scalar results or trace data results are available. The binary data formats should be used for handling large blocks of data since they are smaller and transfer faster than the ASCII format. (FORMat:DATA)

FETCh may be used to return results other than those specified with the original READ or MEASure command that you sent.

**INITiate Commands:**

`:INITiate:<measurement>`

This command is not available for measurements in all the instrument modes:

- Initiates a trigger cycle for the specified measurement, but does not output any data. You must then use the FETCh<meas> command to return data. If a measurement other than the current one is specified, the instrument will switch to that measurement and then initiate it.  
For example, suppose you have previously initiated the ACP measurement, but now you are running the channel power measurement. If you send INIT:ACP? it will change from channel power to ACP and will initiate an ACP measurement.
- Does not change any of the measurement settings. For example, if you have previously started the ACP measurement and you send INIT:ACP? it will initiate a new ACP measurement using the same instrument settings as the last time ACP was run.
- If your selected measurement is currently active (in the idle state) it triggers the measurement, assuming the trigger conditions are met. Then it completes one trigger cycle. Depending upon the measurement and the number of averages, there may be multiple data acquisitions, with multiple trigger events, for one full trigger cycle. It also holds off additional commands on GPIB until the acquisition is complete.

**READ Commands:****:READ:<measurement> [n] ?**

- Does not preset the measurement to the factory default settings. For example, if you have previously initiated the ACP measurement and you send READ:ACP? it will initiate a new measurement using the same instrument settings.
- Initiates the measurement and puts valid data into the output buffer. If a measurement other than the current one is specified, the instrument will switch to that measurement before it initiates the measurement and returns results.

For example, suppose you have previously initiated the ACP measurement, but now you are running the channel power measurement. Then you send READ:ACP? It will change from channel power back to ACP and, using the previous ACP settings, will initiate the measurement and return results.

- Blocks other SCPI communication, waiting until the measurement is complete before returning the results

If the optional [n] value is not included, or is set to 1, the scalar measurement results will be returned. If the [n] value is set to a value other than 1, the selected trace data results will be returned. See each command for details of what types of scalar results or trace data results are available. The binary data formats should be used when handling large blocks of data since they are smaller and faster than the ASCII format. (FORMat:DATA)

**3.4.2 Transmit Power**

This key allows the user to switch to the Transmit Power measurement.

Mode:	WLAN
Key Path:	<b>MEASURE</b>
Remote Command:	See “ <a href="#">SCPI Only Commands</a> ” on page 88
Example:	CONF:TXP

**3.4.2.1 SCPI Only Commands**

```
:CONFigure:TXPower
:INITiate:TXPower
:FETCh:TXPower [n] ?
:MEASure:TXPower [n] ?
:READ:TXPower [n] ?
```



Index: n <Mnemonic>	Results Returned
0	Returns unprocessed I/Q trace data, as a series of comma-separated trace points, in volts. The I values are listed first in each pair, using the 0 through even-indexed values. The Q values are the odd-indexed values.
not specified or n = 1	Returns the following 5 values: <ol style="list-style-type: none"> <li>1. Transmit Power: (floating) [dBm] The Transmit Power is the total power measured in the specified integration bandwidth.</li> <li>2. Power Spectral Density: (floating) [dBm/MHz] The power spectral density is the measured maximum transmit power in 1MHz band width</li> <li>3. Transmit Power Pass/Fail: (boolean) 1 for Pass; 0 for Fail</li> <li>4. Power Spectral Density Pass/Fail: (boolean) 1 for Pass; 0 for Fail</li> <li>5. Transmit Power &amp; Power Spectral Density Pass/Fail: (boolean) 1 for Pass; 0 for Fail</li> </ol>
2	Returns a series of floating point numbers that represent the powers at those FFT points in the span bandwidth.

### 3.4.3 Modulation Accuracy

This key allows the user to switch to the Modulation Accuracy measurement.

Mode: WLAN  
 Key Path: MEASURE  
 Remote Command: See “SCPI Only Commands” on page 89  
 Example: CONF:EVM

#### 3.4.3.1 SCPI Only Commands

##### 3.4.3.1.1 802.11a/g SCPI Only Commands

```
:CONFigure:EVM
:INITiate:EVM
:FETCh:EVM [n] ?
:READ:EVM [n] ?
```

:MEASure :EVM [n] ?

Index: n <Mnemonic >	Results Returned
n = 0	Returns unprocessed I/Q trace data of Capture Interval, as a series of trace point values. The I values are listed first in each pair, using the 0 through even-indexed values. The Q values are the odd-indexed values.
Not specified or n = 1	<p>Returns the following 34 comma-separated scalar results:</p> <p>“Avg” means the average of the individual measurements when averaging is on.  “Max” means the maximum of the individual measurements when averaging is on.</p> <ol style="list-style-type: none"> <li>1. RMS EVM Max (dB)</li> <li>2. RMS EVM Avg (dB)</li> <li>3. Peak EVM Max (dB)</li> <li>4. Peak EVM Avg (dB)</li> <li>5. Max Peak EVM Index</li> <li>6. Peak EVM Index</li> <li>7. Frequency Error Max (Hz)</li> <li>8. Frequency Error Avg (Hz)</li> <li>9. Frequency Error Max (ppm)</li> <li>10. Frequency Error Avg (ppm)</li> <li>11. Symbol Clock Error Max (ppm)</li> <li>12. Symbol Clock Error Avg (ppm)</li> <li>13. I/Q Origin Offset Max (dB)</li> <li>14. I/Q Origin Offset Avg (dB)</li> <li>15. Gain Imbalance Max</li> <li>16. Gain Imbalance Avg</li> <li>17. Quadrature error Max (degrees)</li> <li>18. Quadrature error Avg (degrees)</li> <li>19. Reserved for 802.11b, returns -999.0</li> <li>20. Reserved for 802.11b, returns -999.0</li> </ol> <p>(Continued on next page)</p>

Index: n <Mnemonic >	Results Returned
Not specified or n = 1 (Cont'd)	21. Reserved for 802.11b, returns –999.0 22. Reserved for 802.11b, returns –999.0 23. Reserved for 802.11b, returns –999.0 24. Reserved for 802.11b, returns –999.0 25. Reserved for 802.11b, returns –999.0 26. Reserved for 802.11b, returns –999.0 27. Reserved for 802.11b, returns –999.0 28. Reserved for 802.11b, returns –999.0 29. Reserved for 802.11b, returns –999.0 30. Reserved for 802.11b, returns –999.0 31. Reserved for 802.11b, returns –999.0 32. Reserved for 802.11b, returns –999.0 33. Reserved for 802.11b, returns –999.0 34. Reserved for 802.11b, returns –999.0
n = 2	EVM vs. Symbol trace returns series of floating point numbers (in percent) that represent each sample in the EVM vs. Symbol trace of Capture Interval. The first number is the symbol 0 decision point.
n = 3	EVM vs. Carrier trace returns series of floating point numbers (in percent) that represent each sample in the EVM vs. Carrier trace of Capture Interval.
n = 7	Corrected measured trace returns series of floating point numbers that alternately represent I and Q pairs of the corrected measured trace. The magnitude of each I and Q pair are normalized to 1.0, when the IQ Normalize is turned on. The first number is the in-phase (I) sample and the second is the quadrature-phase (Q) sample.
n = 8	Returns Decoded Bits
n = 9	Returns 4 comma-separated scalar values of the pass/fail (0.0 = passed, or 1.0 = failed) results determined by testing the following items. And the pass/fail is for the peak-hold value. Because the test on peak-hold value should be greater than the average value, if it fails on the average, it will fail on peak-hold. <ol style="list-style-type: none"> <li>1. Test result of RMS EVM</li> <li>2. Test result of Frequency Error</li> <li>3. Test result of symbol clock error</li> <li>4. Test result of I/Q Origin Offset</li> </ol>

### 3.4.3.1.2 802.11b/g SCPI Only Commands

See “802.11a/g SCPI Only Commands” on page 89.

Index: n <Mnemonic >	Results Returned
n = 0	Returns unprocessed I/Q trace data of Capture Interval, as a series of trace point values. The I values are listed first in each pair, using the 0 through even-indexed values. The Q values are the odd-indexed values.
Not specified or n = 1	<p>Returns the following 34 comma-separated scalar results:</p> <p>“Avg” means the average of the individual measurements when averaging is on.                      “Max” means the maximum of the individual measurements when averaging is on.                      “Min” means the minimum of the individual measurements when averaging is on.</p> <ol style="list-style-type: none"> <li>1. RMS EVM Max (%)</li> <li>2. RMS EVM Avg (%)</li> <li>3. Peak EVM Max (%)</li> <li>4. Peak EVM Avg (%)</li> <li>5. Max Peak EVM Index</li> <li>6. Peak EVM Index</li> <li>7. Frequency Error Max (Hz)</li> <li>8. Frequency Error Avg (Hz)</li> <li>9. Frequency Error Max (ppm)</li> <li>10. Frequency Error Avg (ppm)</li> <li>11. Symbol Clock Error Max (ppm)</li> <li>12. Symbol Clock Error Avg (ppm)</li> <li>13. I/Q Origin Offset Max (dB)</li> <li>14. I/Q Origin Offset Avg (dB)</li> <li>15. Gain Imbalance Max</li> </ol> <p>(Continued on next page)</p>

Index: n <Mnemonic >	Results Returned
Not specified or n=1 (Cont'd)	16. Gain Imbalance Avg 17. Quadrature error Max (degrees) 18. Quadrature error Avg (degrees) 19. 1000chips Peak EVM Max (%) 20. 1000 chips Peak EVM Avg (%) 21. RMS Magnitude Error Max (%) 22. RMS Magnitude Error Avg (%) 23. Peak Magnitude Error Max (%) 24. Peak Magnitude Error Avg (%) 25. Max Peak Magnitude Error Index 26. Peak Magnitude Error Index 27. RMS Phase Error Max (%) 28. RMS Phase Error Avg (%) 29. Peak Phase Error Max (%) 30. Peak Phase Error Avg (%) 31. Max Peak Phase Error Index 32. Peak Phase Error Index 33. Carrier suppression Min (dB) 34. Carrier suppression Avg (dB)
n = 4	EVM trace returns series of floating point numbers (in percent) that represent EVM value for each chip in the measurement interval.
n = 5	Magnitude error trace returns series of floating point numbers (in percent) that represent the magnitude error value for each chip in the measurement interval.
n = 6	Phase error trace returns series of floating point numbers (in degrees) that represent the phase error value for each chip in the measurement interval.
n = 7	Corrected measured trace returns series of floating point numbers that alternately represent I and Q pairs of the corrected measured trace. The magnitude of each I and Q pair are normalized to 1.0. The first number is the in-phase (I) sample of symbol 0 decision point and the second is the quadrature-phase (Q) sample of symbol 0 decision point.
n = 8	Returns Decoded Bits

Index: n <Mnemonic >	Results Returned
n = 9	<p>Returns 5 comma-separated scalar values of the pass/fail (0.0 = passed, or 1.0 = failed) results determined by testing the following items. And the pass/fail is for the peak-hold value. Because the test on peak-hold value should be server than the average value. Regarding the case that it passes on peak-hold but fails on the average, it definitely does not happen.</p> <ol style="list-style-type: none"> <li>1. Test result of RMS EVM</li> <li>2. Test result of 1000 Chips EVM</li> <li>3. Test result of Frequency Error</li> <li>4. Test result of RF Carrier Suppression</li> <li>5. Test result of Chip clock error</li> </ol>

### 3.4.4 Transmit Spectrum Mask

This key allows the user to switch to the Transmit Spectrum Mask measurement.

Mode:	WLAN
Key Path:	MEASURE
Remote Command:	See “SCPI Only Commands” on page 94
Example:	CONF:SEM

#### 3.4.4.1 SCPI Only Commands

:CONFigure:SEMask

:FETCh:SEMask [n] ?

:MEASure:SEMask [n] ?

:READ:SEMask [n] ?

---

**NOTE** Offsets that are turned off (inactive) will return -999.0 when their results are queried over SCPI.

---

<b>Index: n</b> <Mnemonic>	Results Returned
not specified or n = 1	<p>Power Spectral Density Reference</p> <p>Returns 60 comma-separated scalar results, in the following order:</p> <ol style="list-style-type: none"> <li>1. Reserved for the future use, returns -999.0</li> <li>2. Absolute power at the center frequency (reference) area (dBm)</li> <li>3. Reserved for the future use, returns -999.0</li> <li>4. Reserved for the future use, returns -999.0</li> <li>5. Reserved for the future use, returns -999.0</li> <li>6. Reserved for the future use, returns -999.0</li> <li>7. Reserved for the future use, returns -999.0</li> <li>8. Reserved for the future use, returns -999.0</li> <li>9. Reserved for the future use, returns -999.0</li> <li>10. Reserved for the future use, returns -999.0</li> <li>11. Reserved for the future use, returns -999.0</li> <li>12. Reserved for the future use, returns -999.0</li> <li>13. Relative peak power spectral density on the negative offset A (dB/Hz)</li> <li>14. Absolute peak power spectral density on the negative offset A (dBm/Hz)</li> <li>15. Peak frequency in the negative offset A (Hz)</li> <li>16. Reserved for the future use, returns -999.0</li> <li>17. Reserved for the future use, returns -999.0</li> <li>18. Relative peak power spectral density on the positive offset A (dB/Hz)</li> <li>19. Absolute peak power spectral density on the positive offset A (dBm/Hz)</li> <li>20. Peak frequency in the positive offset A (Hz)</li> <li>21. Reserved for the future use, returns -999.0</li> <li>22. Reserved for the future use, returns -999.0</li> <li>23. Relative peak power spectral density on the negative offset B (dB/Hz)</li> <li>24. Absolute peak power spectral density on the negative offset B (dBm/Hz)</li> <li>25. Peak frequency in the negative offset B (Hz)</li> </ol> <p>(Continued on next page)</p>

Index: n <Mnemonic>	Results Returned
not specified or n = 1  (Cont'd)	<p><b>Power Spectral Density Reference</b></p> <p>Returns 60 comma-separated scalar results, in the following order:</p> <p>26. Reserved for the future use, returns -999.0</p> <p>27. Reserved for the future use, returns -999.0</p> <p>28. Relative peak power spectral density on the positive offset B (dB/Hz)</p> <p>29. Absolute peak power spectral density on the positive offset B (dBm/Hz)</p> <p>30. Peak frequency in the positive offset B (Hz)</p> <p>31. Reserved for the future use, returns -999.0</p> <p>32. Reserved for the future use, returns -999.0</p> <p>33. Relative peak power spectral density on the negative offset C (dB/Hz)</p> <p>34. Absolute peak power spectral density on the negative offset C (dBm/Hz)</p> <p>35. Peak frequency in the negative offset C (Hz)</p> <p>36. Reserved for the future use, returns -999.0</p> <p>37. Reserved for the future use, returns -999.0.</p> <p>38. Relative peak power spectral density on the positive offset C (dB/Hz)</p> <p>39. Absolute peak power spectral density on the positive offset C (dBm/Hz)</p> <p>40. Peak frequency in the positive offset C (Hz)</p> <p>41. Reserved for the future use, returns -999.0</p> <p>42. Reserved for the future use, returns -999.0</p> <p>43. Relative peak power spectral density on the negative offset D (dB/Hz)</p> <p>44. Absolute peak power spectral density on the negative offset D (dBm/Hz)</p> <p>45. Peak frequency in the negative offset D (Hz)</p> <p>(Continued on next page)</p>



<b>Index: n</b> <Mnemonic>	Results Returned
not specified or n = 1  (Cont'd)	<p>Power Spectral Density Reference</p> <p>Returns 60 comma-separated scalar results, in the following order:</p> <p>46. Reserved for the future use, returns -999.0</p> <p>47. Reserved for the future use, returns -999.0.</p> <p>48. Relative peak power spectral density on the positive offset D (dB/Hz)</p> <p>49. Absolute peak power spectral density on the positive offset D (dBm/Hz)</p> <p>50. Peak frequency in the positive offset D (Hz)</p> <p>51. Reserved for the future use, returns -999.0</p> <p>52. Reserved for the future use, returns -999.0</p> <p>53. Relative peak power spectral density on the negative offset E (dB/Hz)</p> <p>54. Absolute peak power spectral density on the negative offset E (dBm/Hz)</p> <p>55. Peak frequency in the negative offset E (Hz)</p> <p>56. Reserved for the future use, returns -999.0</p> <p>57. Reserved for the future use, returns -999.0</p> <p>58. Relative peak power spectral density on the positive offset E (dB/Hz)</p> <p>59. Absolute peak power spectral density on the positive offset E (dBm/Hz)</p> <p>60. Peak frequency in the positive offset E (Hz)</p>
2	Returns the displayed frequency domain spectrum trace data separated by comma. The number of data is determined by the setting of the trace points parameter
3	Returns the displayed frequency domain absolute limit trace data separated by comma. The number of data is determined by the setting of the trace points parameter
4	Returns the displayed frequency domain relative limit trace data separated by comma. The number of data is determined by the setting of the trace points parameter.

<b>Index: n</b> <Mnemonic>	Results Returned
5	<p>Power Spectral Density Reference</p> <p>Returns 12 comma-separated scalar values (in dBm/Hz) of the absolute power spectral density of the segment frequencies:</p> <ol style="list-style-type: none"> <li>1. Absolute power spectral density reference (dBm/Hz)</li> <li>2. Reserved for the future use, returns -999.0</li> <li>3. Absolute power spectral density for negative offset frequency (A)</li> <li>4. Absolute power spectral density for positive offset frequency (A)</li> <li>5. Absolute power density for negative offset frequency (B)</li> <li>6. Absolute power density for positive offset frequency (B)</li> <li>7. Absolute power density for negative offset frequency (C)</li> <li>8. Absolute power density for positive offset frequency (C)</li> <li>9. Absolute power density for negative offset frequency (D)</li> <li>10. Absolute power density for positive offset frequency (D)</li> <li>11. Absolute power density for negative offset frequency (E)</li> <li>12. Absolute power density for positive offset frequency (E)</li> </ol>
6	<p>Power Spectral Density Reference</p> <p>Returns 12 comma-separated scalar values (in dB/Hz) of the power spectral density relative to the carrier at the segment frequencies:</p> <ol style="list-style-type: none"> <li>1. Relative power spectral density reference (dB/Hz)</li> <li>2. Reserved for the future use, returns -999.0</li> <li>3. Relative power spectral density for negative offset frequency (A)</li> <li>4. Relative power spectral density for positive offset frequency (A)</li> <li>5. Relative power spectral density for negative offset frequency (B)</li> <li>6. Relative power spectral density for positive offset frequency (B)</li> <li>7. Relative power spectral density for negative offset frequency (C)</li> <li>8. Relative power spectral density for positive offset frequency (C)</li> <li>9. Relative power spectral density for negative offset frequency (D)</li> <li>10. Relative power spectral density for positive offset frequency (D)</li> <li>11. Relative power spectral density for negative offset frequency (E)</li> <li>12. Relative power spectral density for positive offset frequency (E)</li> </ol>

Index: n <Mnemonic>	Results Returned
7	<p>Returns 12 comma-separated pass/fail test results (0 = passed, or 1 = failed) determined by testing the absolute power spectral density of the offset frequencies:</p> <ol style="list-style-type: none"> <li>1. Reserved for the future use, returns -999.0</li> <li>2. Reserved for the future use, returns -999.0</li> <li>3. For negative offset frequency (A)</li> <li>4. For positive offset frequency (A)</li> <li>5. For negative offset frequency (B)</li> <li>6. For positive offset frequency (B)</li> <li>7. For negative offset frequency (C)</li> <li>8. For positive offset frequency (C)</li> <li>9. For negative offset frequency (D)</li> <li>10. For positive offset frequency (D)</li> <li>11. For negative offset frequency (E)</li> <li>12. For positive offset frequency (E)</li> </ol>
8	<p>Returns 12 comma-separated scalar values of the pass/fail (0=passed, or 1=failed) results determined by testing the power spectral density of the segment frequencies relative to reference channel:</p> <ol style="list-style-type: none"> <li>1. Reserved for the future use, returns -999.0</li> <li>2. Reserved for the future use, returns -999.0</li> <li>3. For negative offset frequency (A)</li> <li>4. For positive offset frequency (A)</li> <li>5. For negative offset frequency (B)</li> <li>6. For positive offset frequency (B)</li> <li>7. For negative offset frequency (C)</li> <li>8. For positive offset frequency (C)</li> <li>9. For negative offset frequency (D)</li> <li>10. For positive offset frequency (D)</li> <li>11. For negative offset frequency (E)</li> <li>12. For positive offset frequency (E)</li> </ol>

Index: n <Mnemonic>	Results Returned
9	<p>Returns 12 comma-separated scalar values of frequency (in Hz) that have peak power in each offset:</p> <ol style="list-style-type: none"> <li>1. Reserved for the future use, returns -999.0</li> <li>2. Reserved for the future use, returns -999.0</li> <li>3. For negative offset frequency (A)</li> <li>4. For positive offset frequency (A)</li> <li>5. For negative offset frequency (B)</li> <li>6. For positive offset frequency (B)</li> <li>7. For negative offset frequency (C)</li> <li>8. For positive offset frequency (C)</li> <li>9. For negative offset frequency (D)</li> <li>10. For positive offset frequency (D)</li> <li>11. For negative offset frequency (E)</li> <li>12. For positive offset frequency (E)</li> </ol>
10	Returns the band power result

### 3.4.5 Power vs. Time

This key allows the user to switch to the Power vs. Time measurement.

Mode: WLAN  
 Key Path: **MEASURE**  
 Remote Command: See [“SCPI Only Commands” on page 100](#)  
 Example: CONF:PVT

#### 3.4.5.1 SCPI Only Commands

```
:CONFigure:PVTime
:INITiate: PVTime
:FETCh: PVTime [n]?
:MEASure: PVTime [n]?
:READ: PVTime [n]?
```

<b>Index: n</b> <Mnemonic>	Results Returned
0	Returns unprocessed I/Q trace data, as a series of comma-separated trace points, in volts. The I values are listed first in each pair, using the 0 through even-indexed values. The Q values are the odd-indexed values.
not specified or n = 1	Returns comma-separated scalar results, in the following order: <ol style="list-style-type: none"> <li>1. Reserved, 0</li> <li>2. Return Power-on Ramp Time (us)</li> <li>3. Return Power-down Ramp Time (us)</li> <li>4. Return overall PASS/FAIL (0: Fail, 1: Pass)</li> <li>5. Return Power-on Ramp PASS/FAIL (0: Fail, 1: Pass)</li> <li>6. Return Power-down Ramp PASS/FAIL (0: Fail, 1: Pass)</li> <li>7. Return Start Level (dBm) for ramp up</li> <li>8. Return Start Level (dBm) for ramp down</li> <li>9. Return Stop Level (dBm) for ramp up</li> <li>10. Return Stop Level (dBm) for ramp down</li> <li>11. Return Max Ramp Up Time (us) (limit value)</li> <li>12. Return Max Ramp Down Time (us) (limit value)</li> </ol>
2	Return waveform of Power-on Ramp, the length is determined by Ramp Time Length
3	Return waveform of Power-down Ramp, the length is determined by Ramp Time Length
4	Return waveform of full burst, the length is actual burst length

### 3.4.6 Power Stat CCDF

This key allows the user to switch to the Power Stat CCDF measurement.

Mode: WLAN  
Key Path: MEASURE  
Remote Command: See “[SCPI Only Commands](#)” on page 102  
Example: CONF:CCDF

### 3.4.6.1 SCPI Only Commands

```
:CONFigure:CCDF
:INITiate:CCDF
:FETCh:CCDF [n] ?
:READ:CCDF [n] ?
:MEASure:CCDF [n] ?
```

N	Results Returned
N	Results Returned
0	Returns unprocessed I/Q trace data, as a series of trace point values, in volts. The I values are listed first in each pair, using the 0 through even-indexed values. The Q values are the odd-indexed values,
not specified or 1	Returns 11 scalar results: <ol style="list-style-type: none"> <li>1. Average input power (in dBm)</li> <li>2. Probability at the average input power level (in %)</li> <li>3. Power level that has 10% of the power</li> <li>4. Power level that has 1% of the power</li> <li>5. Power level that has 0.1% of the power</li> <li>6. Power level that has 0.01% of the power</li> <li>7. Power level that has 0.001% of the power</li> <li>8. Power level that has 0.0001% of the power</li> <li>9. Peak power relative to average (in dB)</li> <li>10. Peak power (in dBm)</li> <li>11. Count</li> </ol>
2	Returns a series of 5001 floating the current measured power stat trace. This is the probability at particular power levels (average power), in the following order: <ol style="list-style-type: none"> <li>1. Probability at 0.0 dB power</li> <li>2. Probability at 0.01 dB power</li> <li>3. Probability at 0.02 dB power</li> <li>4. ...</li> <li>5000. Probability at 49.99 dB power</li> <li>5001. Probability at 50.00 dB power</li> </ol>

N	Results Returned
3	<p>Returns a series of 5001 floating point numbers (in percent) that represent the Gaussian trace. This is the probability at particular power levels (average power), in the following order:</p> <ol style="list-style-type: none"> <li>1. Probability at 0.0 dB power</li> <li>2. Probability at 0.01 dB power</li> <li>3. Probability at 0.02 dB power</li> <li>4. ...</li> <li>5000. Probability at 49.99 dB power</li> <li>5001. Probability at 50.00 dB power</li> </ol>
4	<p>Returns a series of 5001 floating point numbers (in percent) that represent the user-definable reference trace. This is the probability at particular power levels (average power), in the following order:</p> <ol style="list-style-type: none"> <li>1. Probability at 0.0 dB power</li> <li>2. Probability at 0.01 dB power</li> <li>3. Probability at 0.02 dB power</li> <li>4. ...</li> <li>5000. Probability at 49.99 dB power</li> <li>5001. Probability at 50.00 dB power</li> </ol>

### 3.4.7 Transmit Spectral Flatness

This key allows the user to switch to the Transmit Spectral Flatness measurement.

Mode: WLAN  
 Key Path: MEASURE  
 Remote Command: See “SCPI Only Commands” on page 103  
 Example: CONF:FLAT

#### 3.4.7.1 SCPI Only Commands

```
:CONFigure:FLATness
:INITiate:FLATness
:FETCh:FLATness [n]?
:MEASure:FLATness [n]?
:READ:FLATness [n]?
```

<b>Index: n</b> <Mnemonic>	Results Returned
Index: n <Mnemonic>	Results Returned
0	Returns unprocessed I/Q trace data, as a series of comma-separated trace points, in volts. The I values are listed first in each pair, using the 0 through even-indexed values. The Q values are the odd-indexed values.
not specified or n = 1	Returns comma-separated scalar results, in the following order: <ol style="list-style-type: none"> <li>1. Return peak energy deviation of 52 sub-carriers</li> <li>2. Return PASS/FAIL (0:Fail, 1: Pass)</li> </ol>
2	Return 52 float values which are the energy deviations of each of spectral lines -26 ... 26 from the average energy of spectral line -16 ... 16

### 3.4.8 Spectrum (Freq Domain)

This key allows the user to switch to the Spectrum (Freq Domain) measurement.

This measurement provides you with the ability to analyze signals in the frequency domain. Refer to the key reference and programming commands chapters in the PSA Basic Mode Guide for information on using this measurement.

Mode: WLAN  
 Key Path: MEASURE, More  
 Remote Command: :CONFIgure:SPECTrum  
 Example: CONF:SPEC

### 3.4.9 Waveform (Time Domain)

This key allows the user to switch to the Waveform (Time Domain) measurement.

This measurement provides you with the ability to analyze signals in the time domain. Refer to the key reference and programming commands chapters in the PSA Basic Mode Guide for information on using this measurement.

Mode: WLAN  
 Key Path: MEASURE, More  
 Remote Command: :CONFIgure:WAVE  
 Example: CONF:WAV



## 3.5 Measurement Keys

### 3.5.1 Transmit Power Measurement

Transmit Power measurement has only one view. This view has two windows:

- Spectrum Graph window (upper)
- Metrics window (lower)

#### 3.5.1.1 AMPLITUDE/Y Scale

The **AMPLITUDE/Y Scale** key accesses the menu to set the desired vertical scale and associated settings.

---

**NOTE** Default numbers are independent for each window.

---

**3.5.1.1.1 Scale/Div** Allows you to enter a numeric value to change the vertical display sensitivity.

Mode:	WLAN
Key Path:	<b>AMPLITUDE/Y Scale</b>
Remote Command:	:DISPlay:TXPower:WINDow:TRACe:Y[:SCALe]:PDIVision <rel_ampl> :DISPlay:TXPower:WINDow:TRACe:Y[:SCALe]:PDIVision?
Unit/Termination:	dB
Default:	10.00
Range:	0.1 — 20
State Saved:	Saved in instrument state.
Dependencies/Couplings:	When the Scale Coupling default is On, this value is automatically determined by the measurement result. When you set a value manually, Scale Coupling automatically changes to Off.
Example:	DISP:TXP:WIND:TRAC:Y:PDIV 10.0

**3.5.1.1.2 Ref Value** Allows you to set the absolute power reference.

Mode: WLAN

Key Path: **AMPLITUDE/Y Scale**

Remote Command: :DISPlay:TXPower:WINDow:TRACe:Y[:SCALe]:RLEVel <ampl>  
:DISPlay:TXPower:WINDow:TRACe:Y[:SCALe]:RLEVel?

Unit/Termination: dBm

Default: 0.0

Range: -250 — 250

State Saved: Saved in instrument state.

Dependencies/Couplings: When the Scale Coupling default is On, this value is automatically determined by the measurement result. When you set a value manually, Scale Coupling automatically changes to Off.

Example: DISP:TXP:WIND:TRAC:Y:RLEV 10.0

**3.5.1.1.3 Ref Position** Allows you to set the vertical reference value.

Mode: WLAN

Key Path: **AMPLITUDE/Y Scale**

Remote Command: :DISPlay:TXPower:WINDow:TRACe:Y[:SCALe]:RPOsition  
TOP|CENTer|BOTTom  
:DISPlay:TXPower:WINDow:TRACe:Y[:SCALe]:RPOsition?

Default: TOP

State Saved: Saved in instrument state.

Dependencies/Couplings : NA

Example: DISP:TXP:WIND:TRAC:Y:RPOS BOTT

**3.5.1.1.4 Scale Coupling** Allows you to toggle the scale coupling function between On and Off.

Mode: WLAN

Key Path: **AMPLITUDE/Y Scale**

Remote Command: :DISPlay:TXPower:WINDow:TRACe:Y[:SCALe]:COUPlE 0|1|OFF|ON  
:DISPlay:TXPower:WINDow:TRACe:Y[:SCALe]:COUPlE?

Default:	ON
State Saved:	Saved in instrument state.
Dependencies/Couplings :	When you set a value to either Scale/Div or Ref Value manually, Scale Coupling automatically changes to Off.  When Scale Coupling is set to On, the scale coupling function automatically determines the scale per division and reference values based on the measurement results when you press the Restart front-panel key or Restart key under the Meas Control menu.
Example:	DISP:TXP:WIND:TRAC:Y:COUP ON

### 3.5.1.2 Meas Setup

Displays the measurement setup menu for the Transmit Power Measurement when the **Transmit Power Measurement** key has been selected in the **Measure** menu.

**3.5.1.2.1 Avg Number** Sets the number of data acquisitions that will be averaged. After the specified number of average counts, the averaging mode (terminal control) setting determines the averaging action.

Mode:	WLAN
Key Path:	<b>Meas Setup</b>
Remote Command:	[ :SENSe ] :TXPower:AVERage:COUNT <integer> [ :SENSe ] :TXPower:AVERage:COUNT? [ :SENSe ] :TXPower:AVERage [ :STATe ] OFF   ON   0   1 [ :SENSe ] :TXPower:AVERage [ :STATe ] ?
Default:	Count: 20 State: ON
Range:	1 — 1000
State Saved:	Saved in instrument state.
Example:	TXP:AVER:COUN 15 TXP:AVER:COUN? TXP:AVER ON TXP:AVER?

**3.5.1.2.2 Avg Mode** Allows you to choose either exponential or repeat averaging. This selection only affects the averaging after the number of N averages is reached.

- **Exponential:** When Measure in the Measure Control menu is set as Cont, data acquisitions will continue infinitely. After N averages, exponential averaging weights new data more than old data, which allows tracking of slow-changing signals. The weighting factor N is set using Avg

Number key.

- **Repeat:** When Measure in the Measure Control menu is set as Cont, data acquisitions will continue infinitely. After N averages, all previous result data is cleared and the average count is set back to 1. This is equivalent to being in Measure set as Single and pressing the Restart key when the single measurement is done.

Mode:	WLAN
Key Path:	<b>Meas Setup</b>
Remote Command:	[ :SENSE ] :TXPower:AVERage:TCONtrol EXPonential REPeat [ :SENSE ] :TXPower:AVERage:TCONtrol?
Default:	REPeat
State Saved:	Saved in instrument state.
Example:	TXP:AVER:TCON EXP

**3.5.1.2.3 Integration Bandwidth** This is used to specify the range of integration used in calculating the power in the channel.

Mode:	WLAN
Key Path:	<b>Meas Setup</b>
Remote Command:	[ :SENSe ] :TXPower:BANDwidth BWIDth:INTEgration <bandwidth> [ :SENSe ] :TXPower:BANDwidth BWIDth:INTEgration?
Unit/Terminator Keys:	Hz   kHz   MHz
Default:	16.6 MHz (See <a href="#">Table 3-4, “Integration Bandwidth Default Setting”</a> )
State Saved:	Saved in instrument state.
Dependencies/Couplings :	Changing Integration Bandwidth will also change the vaule of Transmit Power Span. Transmit Power Span will be equal to 1.2 times of Integration Bandwidth. But Transmit Power Span can't be greater than the maximum value of Integration Bandwidth.
Range:	Option 122: 1 kHz — 80 MHz Option 140: 1 kHz — 40 MHz
Example:	TXP:BAND:INT 16.6M TXP:BAND:INT?

**Table 3-4 Integration Bandwidth Default Setting**

Radio	Default
802.11a	16.6 MHz
802.11b	22 MHz
802.11g ERP-OFDM	16.6 MHz
802.11g ERP-DSSS/CCK/PBCC	22 MHz
802.11g DSSS-OFDM	22 MHz

**3.5.1.2.4 Transmit Power Span** Allows the user to set the span of the analyzer.

Changing the span causes the resolution bandwidth to change automatically, and will affect data acquisition time.

Mode:	WLAN
Key Path:	<b>Meas Setup</b>
Remote Command:	[ :SENSE ] :TXPower:FREQuency:SPAN <freq> [ :SENSE ] :TXPower:FREQuency:SPAN?
Unit/Terminator Keys:	Hz   kHz   MHz
Default:	22 MHz (See <a href="#">Table 3-5, “Transmit Power Span Default Setting”</a> )
State Saved:	Saved in instrument state.
Dependencies/Couplings:	Changing Integration Bandwidth causes the change of Transmit Power Span. Span is equal to 1.2 times of Integration Bandwidth, but it can't exceed its max value.
Range:	Option 122: Max of (1 MHz, Integ BW) — 80 MHz Option 140: Max of (1 MHz, Integ BW) — 40 MHz
Example:	TXP:FREQ:SPAN 22M TXP:FREQ:SPAN?

**Table 3-5 Transmit Power Span Default Setting**

Radio	Default
802.11a	22 MHz
802.11b	25 MHz

**Table 3-5 Transmit Power Span Default Setting**

Radio	Default
802.11g ERP-OFDM	22 MHz
802.11g ERP-DSSS/CCK/PBCC	25 MHz
802.11g DSSS-OFDM	25 MHz

**3.5.1.2.5 Limits** Allows you to access the menu to set the total power and power spectrum density limits.

Mode: WLAN  
Key Path: Meas Setup

**3.5.1.2.5.1 Power Limits**

Allows you to set the Power Limits.

Mode: WLAN  
Key Path: Meas Setup, Limits  
Remote Command: :CALCulate:TXPower:LIMit:TPOWer <ampl>  
:CALCulate:TXPower:LIMit:TPOWer?  
:CALCulate:TXPower:LIMit:TPOWer:STATe ON|OFF|1|0  
:CALCulate:TXPower:LIMit:TPOWer:STATe?  
Unit/Terminator Keys: dBm  
Default: Power: 30  
State: ON  
State Saved: Saved in instrument state.  
Range: -200 — 200  
Example: CALC:TXP:LIM:TPOW -20  
CALC:TXP:LIM:TPOW?  
CALC:TXP:LIM:TPOW:STAT ON  
CALC:TXP:LIM:TPOW:STAT?

**3.5.1.2.5.2 Power Spectral Density Limits**

Allows you to set the Power Spectral Density Limits.

Mode: WLAN

Key Path: **Meas Setup, Limits**

Remote Command: :CALCulate:TXPower:LIMit:PSDensity  
:CALCulate:TXPower:LIMit:PSDensity?  
:CALCulate:TXPower:LIMit:PSDensity:STATe ON|OFF|1|0  
:CALCulate:TXPower:LIMit:PSDensity:STATe?

Unit/Terminator Keys: dBm/MHz

Default: PSD Density: 18  
State: ON

State Saved: Saved in instrument state.

Range: -200 — 200

Example: CALC:TXP:LIM:PSD 18  
CALC:TXP:LIM:PSD?  
CALC:TXP:LIM:PSD:STAT ON  
CALC:TXP:LIM:PSD:STAT?

**3.5.1.2.6 Advanced** Allows you to access Advanced Menus.

Mode: WLAN

Key Path: **Meas Setup, More**

**3.5.1.2.6.1 Meas Time**

Sets the Meas Time (measurement acquisition time). It is used to specify the length of the time capture record. If the value you specified is less than the capture time required for the specified span and resolution bandwidth, the value is ignored. The value is set at its auto value when auto is selected.

---

**NOTE** This is an advanced control that normally does not need to be changed.

---

Mode: WLAN

Key Path: **Meas Setup, More, Advanced**

Remote Command:	[:SENSE]:TXPower:SWEep:TIME <seconds> [:SENSE]:TXPower:SWEep:TIME? [:SENSE]:TXPower:SWEep:TIME:AUTO ON OFF 1 0 [:SENSE]:TXPower:SWEep:TIME:AUTO?
Unit/Terminator Keys:	s   ms   us
Default:	Time: 20.48 $\mu$ s Auto State: ON
Range:	1 $\mu$ s — 1 s
State Saved:	Saved in instrument state.
Dependencies/Couplings:	When Meas Time is set to Man, the value for Data Points is calculated from Meas Time automatically. Changing the value of Meas Time also causes the value of Data Points to change.
Example:	TXP:SWE:TIME 20.48e-6 TXP:SWE:TIME? TXP:SWE:TIME:AUTO ON TXP:SWE:TIME:AUTO?

### 3.5.1.2.6.2 Data Points

Specifies the number of points per Meas Time.

---

**NOTE** Because Meas Time and Data Points are coupled, only one can be set to Man at a time.

---

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Advanced</b>
Remote Command:	[:SENSE]:TXPower:SWEep:POINTs <integer> [:SENSE]:TXPower:SWEep:POINTs? [:SENSE]:TXPower:SWEep:POINTs:AUTO ON OFF 1 0 [:SENSE]:TXPower:SWEep:POINTs:AUTO?
Default:	Points: 1024 Auto state: ON
Range:	8 — 1048576
State Saved:	Saved in instrument state.



**Dependencies/Couplings:** When Data Points state is set to Man, the value of Meas Time should be calculated from Data Points automatically. And the change of Data Points also causes the change of Meas Time.

**Remote Command Notes:** (<value> pts) bottom right of graph.

**Example:**  
 TXP:SWE:POIN 1024  
 TXP:SWE:POIN?  
 TXr:SWE:POIN:AUTO ON  
 TXP:SWE:POIN:AUTO?

**3.5.1.2.6.3 Resolution Bandwidth** This is an informational parameter, and can be computed from Span and Data Points.

---

**NOTE** Resolution Bandwidth can not be changed by the user.

---

**3.5.1.2.7 Trigger Source** Selects the trigger source for the measurement.

- Free Run trigger occurs at the time the data is requested, completely asynchronous to the RF or IF signal.
- Video (IF Envlp) trigger occurs at the absolute threshold level of the IF signal level.
- Ext Front trigger activates the external 1 trigger input.
- Ext Rear trigger activates the external 2 trigger input.

---

**NOTE** The external trigger must be a signal between  $-5 \sim +5$  volts.

---

**Mode:** WLAN

**Key Path:** Meas Setup, More

**Remote Command:** [:SENSe]:TXPower:TRIGger:SOURce  
 IMMEDIATE|IF|EXTernal[1]|EXTernal2  
 [:SENSe]:TXPower:TRIGger:SOURce?

**Default:** IF

**State Saved:** Saved in instrument state.

**Example:** TXP:TRIG:SOUR IF  
 TXP:TRIG:SOUR?

**3.5.1.2.8 Restore Meas Defaults** Sets the measure setup parameters to the factory defaults only for the currently selected measurement.

Mode:	WLAN
Key Path:	<b>Meas Setup, More</b>
Remote Command:	[ :SENSe ] :TXPower:RESTore:DEFaults
Dependencies/Couplings :	Selecting measurement preset will restore all measurement parameters to their default values.
Example:	TXP:RES:DEF

**3.5.1.2.9 Wideband Setup** This key invokes the WBIF Setup menu from which the user can set parameters of WB path.

Mode:	WLAN
Key Path:	<b>Meas Setup</b>

#### 3.5.1.2.9.1 Wideband IF Gain

Sets the Wideband IF Gain.

---

**NOTE** You must have selected IF Path Wide. Increasing the gain can increase the amplitude of small signals as long as you don't overdrive the hardware. Wideband gain should usually be adjusted after setting the input attenuation.

---

Mode:	WLAN
Key Path:	<b>Meas Setup, Wideband Setup</b>
Remote Command:	[ :SENSe ] :TXPower:WBIF:IFGain <integer> [ :SENSe ] :TXPower:WBIF:IFGain?
Unit/Termination:	dB
Default:	0
State Saved:	Saved in instrument state.
Range:	-12 — 12
Example:	TXP:WBIF:IFG 0 TXP:WBIF:IFG?

### 3.5.1.2.9.2 Wideband Filtering

Allows the user to access the Wideband Filtering setup menu which has three keys available: Filter Type, Filter Alpha and Filter BW.

Mode: WLAN  
Key Path: Meas Setup, Wideband Setup

- Filter Type

Depressing the Wide Band Filter Type key causes a submenu of enumerated filter types to be displayed. Note that these filters are channel filters applied digitally to the I/Q data stream. The available filters include:

- None
- Raised Cosine
- Root Raised Cosine
- Nyquist
- Root Nyquist
- Gaussian

Mode: WLAN  
Key Path: Meas Setup, Wideband Setup, Wideband Filtering  
Remote Command: [:SENSe]:TXPower:WBIF:FILTer[:TYPE] NONE|RCOSine|RRCosine|NYQuist|RNYQuist|GAUSSian  
[:SENSe]:TXPower:WBIF:FILTer[:TYPE]?  
Default: NONE  
State Saved: Saved in instrument state.  
Example: TXP:WBIF:FILT RCOS  
TXP:WBIF:FILT?

- Filter Alpha

Specifies the Channel filter alpha for cosine and Nyquist filters applied within the wideband digital IF. This filter alpha is the ratio of half of transition bandwidth to filter bandwidth.

---

**NOTE** The value of Filter Alpha is unitless.

---

Depressing the Filter Alpha key allows the numeric entry of this value.

Mode: WLAN

Key Path: **Meas Setup, Wideband Setup, Wideband Filtering**

Remote Command: [:SENSe]:TXPower:WBIF:FILTer:ALPHa <real>  
[:SENSe]:TXPower:WBIF:FILTer:ALPHa?

Default: 0.30

State Saved: Saved in instrument state.

Range: 0.01 — 1.00

Example: TXP:WBIF: FILT:ALPH 0.30  
TXP:WBIF: FILT:ALPH?

- Filter BW

Specifies the bandwidth of the filter with respect to the sample rate (i.e. Bandwidth/SampleRate) of channel filter.

Mode: WLAN

Key Path: **Meas Setup, Wideband Setup, Wideband Filtering**

Remote Command: [:SENSe]:TXPower:WBIF:FILTer:BANDwidth|BWIDth <real>  
[:SENSe]:TXPower:WBIF:FILTer:BANDwidth|BWIDth?

Default: 0.50

State Saved: Saved in instrument state.

Range: 0.01 — 1.00

Example: TXP:WBIF: FILT:BAND 0.50  
TXP:WBIF: FILT:BWID?

### 3.5.1.2.9.3 Wideband Advanced

Allows you to change the Wideband Advanced values.

---

**NOTE** Parameters under the Wideband Advanced key seldom need to be changed. Any changes from the default advanced values may result in invalid measurement data.

---

Mode: WLAN

Key Path: **Meas Setup, Wideband Setup**

- ADC Correction

Performs the ADC calibration to reduce the spectral image and applies the correction.

Mode: WLAN  
 Key Path: **Meas Setup, Wideband Setup, Wideband Advanced**  
 Remote Command: [:SENSe]:TXPower:WBIF:ADCCorrect OFF|ON|0|1  
 [:SENSe]:TXPower:WBIF:ADCCorrect?  
 Default: ON  
 State Saved: Saved in instrument state.  
 Dependencies/Couplings: C with ADC Correction of other measurements.  
 Example: TXP:WBIF:ADCC ON  
 TXP:WBIF:ADCC?

- IF Flatness Correction

Turns IF flatness corrections on and off in all wideband IF measurements.

Mode: WLAN  
 Key Path: **Meas Setup, Wideband Setup, Wideband Advanced**  
 Remote Command: [:SENSe]:TXPower:WBIF:FLATness OFF|ON|0|1  
 [:SENSe]:TXPower:WBIF:FLATness?  
 Default: ON  
 State Saved: Saved in instrument state.  
 Dependencies/Couplings: Coupled with WBIF Flatness of other measurements.  
 Example: TXP:WBIF:FLAT ON  
 TXP:WBIF:FLAT?

- WB ADC Dither

Turns the wideband dither signal on or off.

The “ADC dither” refers to the introduction of noise to the digitized steps of the analog-to-digital converter; the result is an improvement in amplitude accuracy.

Use of the ADC dither, however, reduces dynamic range by approximately 3dB. It should only be turned off when measuring a noise-like signal and the 1 to 2 dB extra dynamic range is needed. This control is independent of the narrowband ADC dither.

Mode: WLAN  
 Key Path: **Meas Setup, Wideband Setup, Wideband Advanced**

Remote Command:            [:SENSe]:TXPower:WBIF:ADC:DITHer OFF|ON|0|1  
                                  [:SENSe]:TXPower:WBIF:ADC:DITHer?

Default:                      ON

State Saved:                 Saved in instrument state.

Example:                      TXP:WBIF:ADC:DITH ON  
                                  TXP:WBIF:ADC:DITH?

### 3.5.2 Transmit Spectrum Mask Measurement

The Transmit Spectrum Mask consists of up to six views. They are:

- All
- Offset A
- Offset B
- Offset C
- Offset D
- Offset E

Each view has two windows:

- Spectrum Emission window (upper, Window 1)
- Metrics window (lower, Window 2)

Parameter Name	Corresponding Results
Total Power	Total Power in Integrated Bandwidth of reference channel
Peak PSD Ref	The peak power spectral density per RBW in Integrated Bandwidth of reference channel. For example, when RBW = 20 kHz, the peak power density should be of some form like -30 dBm / 20 kHz
Start	Start frequency of offset segment
Stop	Stop frequency of offset segment
dBm/Hz (Lower)	The max power spectral density in negative offset segment
Freq (Hz) (Lower)	The frequency point of the max power spectral density in negative offset segment
dBm/Hz (Upper)	The max power spectral density in positive offset segment

Parameter Name	Corresponding Results
Freq (Hz) (Upper)	The frequency point of the max power spectral density in positive offset segment

Parameter Name	Corresponding Results
Total Power	Total Power in Integrated Bandwidth of reference channel
Peak PSD Ref	The peak power spectral density per RBW in Integrated Bandwidth of reference channel. For example, when RBW = 20 kHz, the peak power density should be of some form like -30 dBm / 20 kHz
Start	Start frequency of offset segment
Stop	Stop frequency of offset segment
dB/Hz (Lower)	The max relative power spectral density (PSD) in negative offset segment relative PSD = PSD in current channel / PSD in reference channel
Freq (Hz) (Lower)	The frequency point of the max relative PSD in negative offset segment
dBm/Hz (Upper)	The max relative PSD in reference channel in positive offset segment relative PSD = PSD in current channel / PSD in reference channel
Freq (Hz) (Upper)	The frequency point of the max relative PSD in positive offset segment

### 3.5.2.1 AMPLITUDE/Y Scale

The **AMPLITUDE/Y Scale** key accesses the menu to set the desired vertical scale and associated settings.

---

**NOTE** Scale settings are independent for each window.

---

**3.5.2.1.1 Scale/Div** Allows you to enter a numeric value to change the vertical display sensitivity.

Mode: WLAN

Key Path: **AMPLITUDE/Y Scale**

Remote Command: :DISPlay:SEMask:WINDow:TRACe:Y[:SCALE]:PDIVision <rel\_aml>  
:DISPlay:SEMask:WINDow:TRACe:Y[:SCALE]:PDIVision?

Unit/Termination: dB

Default:	10.00
Range:	0.1 — 20
State Saved:	Saved in instrument state.
Dependencies/Couplings:	When the Scale Coupling default is On, this value is automatically determined by the measurement result. When you set a value manually, Scale Coupling automatically changes to Off.
Example:	DISP:SEM:WIND:TRAC:Y:PDIV 10.0 DISP:SEM:WIND:TRAC:Y:PDIV?

### 3.5.2.1.2 Ref Value

Allows you to set the absolute power reference.

Mode:	WLAN
Key Path:	<b>AMPLITUDE/Y Scale</b>
Remote Command:	:DISPlay:SEMAsk:WINDow:TRACe:Y[:SCALe]:RLEVel <ampl> :DISPlay:SEMAsk:WINDow:TRACe:Y[:SCALe]:RLEVel?
Unit/Termination:	dBm
Default:	-40.0
Range:	-250 — 250
State Saved:	Saved in instrument state.
Dependencies/Couplings:	When the Scale Coupling default is On, this value is automatically determined by the measurement result. When you set a value manually, Scale Coupling automatically changes to Off.
Example:	DISP:SEM:WIND:TRAC:Y:RLEV 10.0 DISP:SEM:WIND:TRAC:Y:RLEV?

### 3.5.2.1.3 Ref Position

Allows you to set the vertical reference value.

Mode:	WLAN
Key Path:	<b>AMPLITUDE/Y Scale</b>
Remote Command:	:DISPlay:SEMAsk:WINDow:TRACe:Y[:SCALe]:RPOSition TOP CENTer BOTTom :DISPlay:SEMAsk:WINDow:TRACe:Y[:SCALe]:RPOSition?
Default:	TOP
State Saved:	Saved in instrument state.



Example:                   DISP:SEM:WIND:TRAC:Y:RPOS BOTT  
                              DISP:SEM:WIND:TRAC:Y:RPOS?

**3.5.2.1.4 Scale Coupling** Allows you to toggle the scale coupling function between On and Off.

Mode	WLAN
Key Path	<b>AMPLITUDE/Y Scale</b>
Remote Command	:DISPlay:SEMAsk:WINDow:TRACe:Y[:SCALe]:COUPlE 0 1 OFF ON :DISPlay:SEMAsk:WINDow:TRACe:Y[:SCALe]:COUPlE?
Default	ON
State Saved	Saved in instrument state.
Dependencies/Couplings	When you set a value to either Scale/Div or Ref Value manually, Scale Coupling automatically changes to Off.  When Scale Coupling is set to On, the scale coupling function automatically determines the scale per division and reference values based on the measurement results when you press the Restart front-panel key or Restart key under the Meas Control menu.
Example	DISPl:SEM:WIND:TRAC:Y:COUP ON DISPl:SEM:WIND:TRAC:Y:COUP?

**3.5.2.2 Trace/View**

Allows you to access Trace/View menus.

**3.5.2.2.1 View** Allows you to select the desired measurement view from the following selections:

- All – provides all the frequency offset segments, including Offset A, B, C, D, E.
- Offset A, B, C, D, E – provides a corresponding offset segment.

---

**NOTE**           By default, Offset E is invalid (grey). You can manually set Offset E valid by pressing Meas Setup and Offset/Limits, selecting Offset to E and setting Start Freq to On.

---

Mode:	WLAN
Key Path:	<b>View/Trace</b>
Remote Command:	:DISPlay:SEMAsk:VIEW ALL A B C D E :DISPlay:SEMAsk:VIEW?

Default: All  
 State Saved: Saved in instrument state.  
 Example: DISP:SEM:VIEW A  
 DISP:SEM:VIEW?

**3.5.2.2.2 Offset Display Side Selection** Allows you to toggle the display function of the offset sides between Neg (negative) and Pos (positive).

Mode: WLAN  
 Key Path: **View/Trace**  
 Remote Command: :DISPlay:SEMAsk:VIEW:SIDE NEG|POS  
 :DISPlay:SEMAsk:VIEW:SIDE?  
 Default: POS  
 State Saved: Saved in instrument state.  
 Example: DISP:SEM:VIEW:SIDE NEG  
 DISP:SEM:VIEW:SIDE?

**3.5.2.2.3 Window Selection** This remote command allows you to use SCPI to set the active window. You can also use **Next Window** Front Panel key to select the active window.

Mode: WLAN  
 Remote Command: :DISPlay:SEMAsk:WINDow:SELEct 1|2  
 :DISPlay:SEMAsk:WINDow:SELEct?  
 Default: 1  
 State Saved: No  
 Dependencies/Couplings : The 'green border' round the window shows the active window.  
 Example: DISP:SEM:WIND:SEL 1  
 DISP:SEM:WIND:SEL?

### 3.5.2.3 Display

Allows you to access Display menus.

**3.5.2.3.1 Absolute Limit Lines** Allows you to toggle the absolute limit lines display function for **Transmit Spectrum Mask** measurements between **On** and **Off**. When set to **On**, the absolute limit lines are shown on the Transmit Spectrum Mask measurement display.

Mode: WLAN

Key Path: **Display**

Remote Command: :DISPlay:SEMask:LIMit:ABSolute:MASK OFF|ON|0|1  
:DISPlay:SEMask:LIMit:ABSolute:MASK?

Default: ON

State Saved: Saved in instrument state.

Example: DISP:SEM:LIM:ABS:MASK ON  
DISP:SEM:LIM:ABS:MASK?

**3.5.2.3.2 Relative Limit Lines** Allows you to toggle the relative limit lines display function for **Transmit Spectrum Mask** measurements between **On** and **Off**. When set to **On**, the relative limit lines are shown on the Transmit Spectrum Mask measurement display.

Mode: WLAN

Key Path: **Display**

Remote Command: :DISPlay:SEMask:LIMit:RELative:MASK OFF|ON|0|1  
:DISPlay:SEMask:LIMit:RELative:MASK?

Default: ON

State Saved: Saved in instrument state.

Example: DISP:SEM:LIM:REL:MASK ON  
DISP:SEM:LIM:REL:MASK?

### 3.5.2.3.3 Display Selection

**Abs Peak Pwr & Freq** - Allows you to read the absolute peak power spectrum density levels in dBm/Hz and corresponding frequencies in the Metrics (text) window.

**Rel Peak Pwr & Freq** - Allows you to read the relative peak power spectrum density levels in dB/Hz and corresponding frequencies in the Metrics (text) window.

Mode: WLAN

Key Path: **Display**

Remote Command: :DISPlay:SEMask:SElect ABSpsd|RELpsd  
:DISPlay:SEMask:SElect?

Default: ABSpsd

State Saved: Saved in instrument state.  
 Example: DISP:SEM:SEL ABS  
 DISP:SEM:SEL?

### 3.5.2.4 Meas Setup

Displays the measurement setup menu for the Transmit Spectrum Mask Measurement when the Transmit Spectrum Mask Measurement key has been selected in the **Measure** menu.

**3.5.2.4.1 Avg Number** Allows you to specify the number of measurement averages used when calculating the measurement result. The average will be displayed at the end of each sweep.

Average State allows the user to turn averaging on or off.

Mode: WLAN  
 Key Path: **Meas Setup**  
 Remote Command: [:SENSe]:SEMAsk:AVERAge:COUNT <integer>  
 [:SENSe]:SEMAsk:AVERAge:COUNT?  
 [:SENSe]:SEMAsk:AVERAge[:STATe] ON|OFF|1|0  
 [:SENSe]:SEMAsk:AVERAge[:STATe]?  
 Default: Count: 25  
 State: ON  
 Range: 1 — 1000  
 State Saved: Saved in instrument state.  
 Example: SEM:AVER:COUNT 100  
 SEM:AVER:COUNT?  
 SEM:AVER ON  
 SEM:AVER?

**3.5.2.4.2 Wideband Setup** This key invokes the WBIF Setup menu from which the user can set parameters for WB path.

Mode: WLAN  
 Key Path: **Meas Setup**

**3.5.2.4.2.1 Wideband IF Gain** Sets the Wideband IF Gain.

Mode: WLAN

Key Path:	<b>Meas Setup, Wideband Setup</b>
Remote Command:	<code>[ :SENSe ] :SEMask:WBIF:IFGain &lt;integer&gt;</code> <code>[ :SENSe ] :SEMask:WBIF:IFGain?</code>
Unit/Termination:	dB
Default:	0
State Saved:	Saved in instrument state.
Range:	-12 — 12
Example:	SEM:WBIF:IFG 0 SEM:WBIF:IFG?

**3.5.2.4.2.2 Wideband Advanced** This key invokes the Wideband IF Setup menu from which the user can set the advanced parameters of WB path.

- **ADC Correction**  
Performs the ADC calibration to reduce the spectral image and applies the correction.

Mode:	WLAN
Key Path:	<b>Meas Setup, Wideband Setup, Wideband Advanced</b>
Remote Command:	<code>[ :SENSe ] :SEMask:WBIF:ADCCorrect OFF ON 0 1</code> <code>[ :SENSe ] :SEMask:WBIF:ADCCorrect?</code>
Default:	ON
State Saved:	Saved in instrument state.
Dependencies/Couplings:	Coupled with ADC Correction of other measurements.
Example:	SEM:WBIF:ADCC ON SEM:WBIF:ADCC?

- **IF Flatness Correction**  
Turns IF flatness corrections on and off in all wideband IF measurements.

Mode:	WLAN
Key Path:	<b>Meas Setup, Wideband Setup, Wideband Advanced</b>
Remote Command:	<code>[ :SENSe ] :SEMask:WBIF:FLATness OFF ON 0 1</code> <code>[ :SENSe ] :SEMask:WBIF:FLATness?</code>
Default:	ON
State Saved:	Saved in instrument state.

Dependencies/Couplings: Coupled with WBIF Flatness of other measurements.  
 Example: SEM:WBIF:FLAT ON  
 SEM:WBIF:FLAT?

- WB ADC Dither

Turns the wideband dither signal on or off. This control is independent of the narrowband ADC dither.

Mode: WLAN  
 Key Path: **Meas Setup, Wideband Setup, Wideband Advanced**  
 Remote Command: [:SENSe]:SEMAsk:WBIF:ADC:DITHer OFF|ON|0|1  
 [:SENSe]:SEMAsk:WBIF:ADC:DITHer?  
 Default: ON  
 State Saved: Saved in instrument state.  
 Example: SEM:WBIF:ADC:DITH ON  
 :SEM:WBIF:ADC:DITH?

### 3.5.2.4.3 Reference Channel

This key invokes the Reference Channel menu.

Mode: WLAN  
 Key Path: **Meas Setup**

#### 3.5.2.4.3.1 Channel Integration BW

Allows you to specify the integration bandwidth used in calculating the power in the main channel.

Mode: WLAN  
 Key Path: **Meas Setup, Ref Channel**  
 Remote Command: [:SENSe]:SEMAsk:BANDwidth|BWIDth:INTegration <bandwidth>  
 [:SENSe]:SEMAsk:BANDwidth|BWIDth:INTegration?  
 Unit/Termination: Hz | kHz | MHz  
 Default: 18 MHz (See [Table 3-6, “Channel Integration BW Default Setting”](#))  
 Range: 100 kHz — Channel Span  
 State Saved: Saved in instrument state.

**Dependencies/Couplings:** Channel Integration BW will change when you set Channel Span with a value less than the current Integration BW. The new Integration BW will be equal to the Channel Span.

**Example:** SEM:BAND:INT 18 MHz  
SEM:BWID:INT?

**Table 3-6 Channel Integration BW Default Setting**

Radio	Default
802.11a	18 MHz
802.11b	22 MHz
802.11g ERP-OFDM	18 MHz
802.11g ERP-DSSS/CCK/PBCC	22 MHz
802.11g DSSS-OFDM	18 MHz

**3.5.2.4.3.2 Channel Span**

Allows you to specify the span used in calculating the power in the main channel.

**Mode:** WLAN

**Key Path:** Meas Setup, Ref Channel

**Remote Command:** [:SENSe]:SEMAsk:FREQuency:SPAN <freq>  
[:SENSe]:SEMAsk:FREQuency:SPAN?

**Default:** 22 MHz (See [Table 3-7, “Channel Span Default Setting”](#))

**Range:** opt 122: 100 kHz — 80 MHz  
opt 140: 100 kHz — 40 MHz

**State Saved:** Saved in instrument state.

**Dependencies/Couplings:** Channel Integration BW will change when you set Channel Span with a value less than the current Integration BW. The new Integration BW will be equal to the Channel Span.

**Example:** SEM:FREQ:SPAN 18 MHz  
SEM:FREQ:SPAN?

**Table 3-7 Channel Span Default Setting**

Radio	Default
802.11a	22 MHz
802.11b	25 MHz
802.11g ERP-OFDM	22 MHz
802.11g ERP-DSSS/CCK/PBCC	25 MHz
802.11g DSSS-OFDM	22 MHz

**3.5.2.4.3.3 Channel Resolution BW**

Allows you to specify the resolution bandwidth used in calculating the power in the main channel and specify whether it is automatically or manually determined.

Mode: WLAN

Key Path: **Meas Setup, Ref Channel**

Remote Command: [:SENSe]:SEMAsk:BANDwidth|BWIDth:RESolution <bandwidth>  
[:SENSe]:SEMAsk:BANDwidth|BWIDth:RESolution?  
[:SENSe]:SEMAsk:BANDwidth|BWIDth:RESolution:AUTO  
OFF|ON|1|0  
[:SENSe]:SEMAsk:BANDwidth|BWIDth:RESolution:AUTO?

Unit/Termination: Hz | kHz | MHz

Default: Res BW: 100 kHz  
State: Man

Range: 1 kHz — 7.5 MHz

State Saved: Saved in instrument state.

Dependencies/Couplings: When Auto is set, Resolution BW is automatically calculated as (0.02\*Channel Integration BW).

Example: SEM:BAND:RES 100 kHz  
:SEM:BAND:RES?  
SEM:BWID:RES:AUTO OFF  
SEM:BWID:RES:AUTO?



**3.5.2.4.4 Offsets/Limits** Invokes the Offsets/Limits menu.

Mode: WLAN  
Key Path: Meas Setup

**3.5.2.4.4.1 Offset** Allows you to specify offset range.

---

**NOTE** There is no SCPI command to set parameters for only one specific offset range. When you use the SCPI command, all offset ranges parameters need to be set.

---

Mode: WLAN  
Key Path: Meas Setup, Offset/Limits  
Default: A  
Range: A | B | C | D | E

**3.5.2.4.4.2 Start Freq**

Allows you to specify the offset start frequencies and toggle this function between On and Off, using front panel for the selected offset and using SCPI for all offsets.

---

**NOTE** Offsets that are turned off (inactive) will return -999.0 when their results are queried over SCPI and save measurement results as NA.

---

Mode: WLAN  
Key Path: Meas Setup, Offset/Limits  
Remote Command: [:SENSE] :SEMask:OFFSet:LIST:FREQuency:STARt <freq>  
[:SENSE] :SEMask:OFFSet:LIST:FREQuency:STARt?  
[:SENSE] :SEMask:OFFSet:LIST:STATe OFF|ON|1|0  
[:SENSE] :SEMask:OFFSet:LIST:STATe?  
Unit/Terminator Keys: Hz | kHz | MHz  
Default: See [Table 3-8, “Start Frequency Default Setting”](#)  
Range: 10 kHz — 100 MHz  
State Saved: Saved in instrument state.  
Dependencies/Couplings: Star freq cannot go above Stop Freq minus 100Hz

Example: SEM:OFFS:LIST:FREQ:START 9 MHz,11 MHz,20 MHz,30 MHz,50 MHz  
SEM:OFFS:LIST:FREQ:START?  
SEM:OFFS:LIST:STAT 1,1,1,1,0  
SEM:OFFS:LIST:STAT?

**Table 3-8 Start Frequency Default Setting**

Radio	Start Frequency Default (Offset A, B, C, D, E)	State Default (Offset A, B, C, D, E)
802.11a	9.0MHz, 11.0MHz, 20.0MHz, 30.0 MHz, 50.0MHz	1,1,1,1,0
802.11b	11.0MHz, 22.0MHz, 50.0MHz, 70MHz, 90MHz	1,1,0,0,0
802.11g ERP-OFDM	9.0MHz, 11.0MHz, 20.0MHz, 30.0MHz, 50.0MHz	1,1,1,1,0
802.11g ERP-DSSS/CCK/PBCC	11.0MHz, 22.0MHz, 50.0MHz, 70MHz, 90MHz	1,1,0,0,0
802.11g DSSS-OFDM	9.0MHz, 11.0MHz, 20.0MHz, 30.0MHz, 50.0MHz	1,1,1,1,0

**3.5.2.4.4.3 Stop Freq**

Allows you to specify the stop frequency using front panel for the selected offset and using SCPI for all offsets.

Mode: WLAN

Key Path: Meas Setup, Offset/Limits

Remote Command: [:SENSe]:SEMAsk:OFFSet:LIST:FREQuency:STOP <freq>  
[:SENSe]:SEMAsk:OFFSet:LIST:FREQuency:STOP?

Unit/Terminator Keys: Hz | kHz | MHz

Default: See [Table 3-9, “Stop Frequency Default Setting”](#)

Range: 10 kHz — 100 MHz

State Saved: Saved in instrument state.

Dependencies/Couplings: Stop freq cannot go below Start Freq plus 100Hz

Example: SEM:OFFS:LIST:FREQ:STOP 11.0MHz, 20.0MHz, 30.0MHz, 50.0MHz, 100MHz  
SEM:OFFS:LIST:FREQ:STOP?

**Table 3-9 Stop Frequency Default Setting**

Radio	Stop Frequency Default (Offset A, B, C, D, E)
802.11a	11.0MHz, 20.0MHz, 30.0MHz, 50.0MHz, 100MHz
802.11b	22.0MHz, 50.0MHz, 70.0MHz, 90.0MHz, 100.0MHz
802.11g ERP-OFDM	11.0MHz, 20.0MHz, 30.0MHz, 50.0MHz, 100MHz
802.11g ERP-DSSS/CCK/PBCC	22.0MHz, 50.0MHz, 70.0MHz, 90.0MHz, 100.0MHz
802.11g DSSS-OFDM	11.0MHz, 20.0MHz, 30.0MHz, 50.0MHz, 100MHz

**3.5.2.4.4.4 Resolution Bandwidth**

Allows you to specify the Resolution BW and toggle this function between Auto and Man, using front panel for the selected offset and using SCPI for all offsets.

Auto mode allows the instrument to automatically determine the optimum Resolution BW.

Mode: WLAN

Key Path: Meas Setup, Offset/Limits

Remote Command: [:SENSe]:SEMAsk:OFFSet:LIST:BANDwidth|BWIDth <freq>  
[:SENSe]:SEMAsk:OFFSet:LIST:BANDwidth|BWIDth?  
[:SENSe]:SEMAsk:OFFSet:LIST:BANDwidth|BWIDth:AUTO  
OFF|ON|0|1  
[:SENSe]:SEMAsk:OFFSet:LIST:BANDwidth|BWIDth:AUTO?

Unit/Terminator Keys: Hz | kHz | MHz

Default: Res BW: 100 kHz, 100 kHz, 100 kHz, 100 kHz, 100 kHz  
State: 0,0,0,0,0

Range: 300 Hz — 25 MHz

State Saved: Saved in instrument state.

Example: SEM:OFFS:LIST:BAND 100 kHz,100 kHz,100 kHz,100 kHz,100 kHz  
SEM:OFFS:LIST:BAND?  
SEM:OFFS:LIST:BWID:AUTO 1,1,1,1,1  
SEM:OFFS:LIST:BWID:AUTO?

### 3.5.2.4.4.5 Relative Attenuation

Allows you to enter an attenuation value to adjust the relative level limits. The default attenuation is the same as the one used by Ref Channel, which is defined as Input Atten in Input menu.

---

**NOTE** The actual attenuation equals Relative Atten plus Input Atten. For example, Input Atten is set as 10 dB and Relative Atten is set as 5 dB, then the signal attenuation is 15 dB.

---

Mode: WLAN

Key Path: **Meas Setup, Offset/Limits, More**

Remote Command: [:SENSe]:SEMAsk:OFFSet:LIST:RATTenuation <rel\_amp1>  
[:SENSe]:SEMAsk:OFFSet:LIST:RATTenuation?

Unit/Terminator Keys: dB

Default: 0,0,0,0,0

Range: -40 — 40

Example: SEM:OFFS:LIST:RATT 0,0,0,0,0  
SEM:OFFS:LIST:RATT?

### 3.5.2.4.4.6 Offset Side

Allows you to specify which offset side is to be measured. Selections are Neg (negative offset), Both, and Pos (positive offset)

Mode: WLAN

Key Path: **Meas Setup, Offset/Limits, More**

Remote Command: [:SENSe]:SEMAsk:OFFSet:LIST:SIDE  
NEGative|BOTH|POSitive  
[:SENSe]:SEMAsk:OFFSet:LIST:SIDE?

Default: BOTH, BOTH, BOTH, BOTH, BOTH

State Saved: Saved in instrument state.

Example: SEM:OFFS:LIST:SIDE BOTH,BOTH,BOTH,BOTH,BOTH  
SEM:OFFS:LIST:SIDE?

### 3.5.2.4.4.7 Limits

Allows you to access Limits menu.

Mode: WLAN  
Key Path: Meas Setup, Offset/Limits, More

- Absolute Start

Allows you to enter an absolute level limit at Start Freq of each offset.

Mode: WLAN  
Key Path: Meas Setup, Offset/Limits, More, Limits  
Remote Command: [:SENSe]:SEMask:OFFSet:LIST:STARt:ABSolute <ampl>  
[:SENSe]:SEMask:OFFSet:LIST:STARt:ABSolute?  
Unit/Terminator Keys: dBm  
Default: -10.0, -30.0, -30.0, -30.0, -30.0  
Range: -200 — 50  
State Saved: Saved in instrument state.  
Example: SEM:OFFS:LIST:STAR:ABS -10, -30, -30, -30, -30  
SEM:OFFS:LIST:STAR:ABS?

- Absolute Stop

Allows you to enter an absolute level limit at Stop Freq, and to toggle this function between Couple and Man.

When set to Couple, Absolute Stop is coupled to Abs Start to make a flat limit line. When set to Man, Abs Start and Abs Stop can take different values to make a sloped limit line.

Mode: WLAN  
Key Path: Meas Setup, Offset/Limits, More, Limits  
Remote Command: [:SENSe]:SEMask:OFFSet:LIST:STOP:ABSolute <ampl>  
[:SENSe]:SEMask:OFFSet:LIST:STOP:ABSolute?  
[:SENSe]:SEMask:OFFSet:LIST:STOP:ABSolute:COUple  
OFF|ON|0|1  
[:SENSe]:SEMask:OFFSet:LIST:STOP:ABSolute:COUple?  
Unit/Terminator Keys: dBm

Measurement Keys

Default:                   Abs Stop: -10.0, -30.0, -30.0, -30.0, -30.0  
                               Couple State: 1,1,1,1,1

Range:                    -200 — 50

Dependencies/Couplings :   When coupling is set to “Couple”, Abs Stop changes to the same as Abs Start.

Example:                   SEM:OFFS:LIST:STOP:ABS -10.0, -30.0, -30.0, -30.0, -30.0  
                               SEM:OFFS:LIST:STOP:ABS?  
                               SEM:OFFS:LIST:STOP:ABS:COUP 1,1,1,1,1  
                               SEM:OFFS:LIST:STOP:ABS:COUP?

- Relative Start

Allows you to enter a relative level limit at Start Freq.

Mode:                      WLAN

Key Path:                 **Meas Setup, Offset/Limits, More, Limits**

Remote Command:         [:SENSe]:SEMAsk:OFFSet:LIST:STARt:RCARrier <rel\_ampl>  
                               [:SENSe]:SEMAsk:OFFSet:LIST:STARt:RCARrier?

Unit/Terminator Keys:   dB

Default:                 0, -20, -28, -40, -40 (See [Table 3-10, “Relative Start/Stop Default Setting”](#))

Range:                    -150 — 50

State Saved:             Saved in instrument state.

Example:                 SEM:OFFS:LIST:STAR:RCAR 0, -20, -28, -40, -40  
                               SEM:OFFS:LIST:STAR:RCAR?

**Table 3-10           Relative Start/Stop Default Setting**

Radio	Relative Start Default	Relative Stop Default	Couple State Default
802.11a	0dB, -20dB, -28dB, -40dB, -40dB	-20dB, -28dB, -40dB, -40dB, -40dB	0, 0, 0, 1, 1
802.11b	-30dB, -50dB, -50dB, -50dB, -50dB	-30dB, -50dB, -50dB, -50dB, -50dB	1, 1, 1, 1, 1

**Table 3-10 Relative Start/Stop Default Setting**

Radio	Relative Start Default	Relative Stop Default	Couple State Default
802.11g ERP-OFDM	0dB, -20dB, -28dB, -40dB, -40dB	-20dB, -28dB, -40dB, -40dB, -40dB	0, 0, 0, 1, 1
802.11g ERP-DSSS/CCK/PBCC	-30dB, -50dB, -50dB, -50dB, -50dB	-30dB, -50dB, -50dB, -50dB, -50dB	1, 1, 1, 1, 1
802.11g DSSS-OFDM	0dB, -20dB, -28dB, -40dB, -40dB	-20dB, -28dB, -40dB, -40dB, -40dB	0, 0, 0, 1, 1

- Relative Stop

Allows you to enter a relative level limit at Stop Freq.

**Mode:** WLAN

**Key Path:** Meas Setup, Offset/Limits, more, Limits

**Remote Command:** [:SENSE]:SEMAsk:OFFSet:LIST:STOP:RCARrier <rel\_amp>  
[:SENSE]:SEMAsk:OFFSet:LIST:STOP:RCARrier?  
[:SENSE]:SEMAsk:OFFSet:LIST:STOP:RCARrier:COUPLE  
OFF|ON|0|1  
[:SENSE]:SEMAsk:OFFSet:LIST:STOP:RCARrier:COUPLE?

**Unit/Terminator Keys:** dB

**Default:** Rel Stop: -20, -28, -40, -40,-40 (See [Table 3-10, “Relative Start/Stop Default Setting”](#))  
Couple State: 0,0,0,1,1

**Range:** -150 — 50

**Dependencies/Couplings :** When coupling is set to “Couple”, Rel Stop changes to the same as Rel Start.

**Example:** SEM:OFFS:LIST:STOP:RCAR -30.0, -50.0, -50.0, -50.0, -50.0  
SEM:OFFS:LIST:STOP:RCAR?  
SEM:OFFS:LIST:STOP:RCAR:COUP 1,1,1,1,1  
SEM:OFFS:LIST:STOP:RCAR:COUP?

- Fail Mask

Allows you to select one of the logic keys for fail conditions between the measurement results and the test limits:

- Absolute checks the results against the absolute limits;
- Relative checks the results against the relative limits;
- Abs AND Rel checks against both limits and display a fail when both of the limits are broken.
- Abs OR Rel checks against both limits and display a fail when either of the limits is broken.

Mode: WLAN

Key Path: **Meas Setup, Offset/Limits, more, Limits**

Remote Command: [:SENSe]:SEMask:OFFSet:LIST:TEST  
ABSolute|AND|RELative|OR  
[:SENSe]:SEMask:OFFSet:LIST:TEST?

Default: REL, REL, REL, REL, REL

Example: SEM:OFFS:LIST:TEST ABS  
SEM:OFFS:LIST:TEST?

#### 3.5.2.4.5 Trigger Source Selects the trigger source for the measurement.

Mode: WLAN

Key Path: **Meas Setup**

Remote Command: [:SENSe]:SEMask:TRIGger:SOURce IMMEDIATE|IF|EXTERNAL [1]  
|EXTERNAL2  
[:SENSe]:SEMask:TRIGger:SOURce?

Default: IF

State Saved: Saved in instrument state.

Example: SEM:TRIG:SOUR IMM  
SEM:TRIG:SOUR?

#### 3.5.2.4.6 Restore Meas Defaults Sets the measure setup parameters to the factory defaults only for the currently selected measurement.

Mode: WLAN

Key Path: **Meas Setup**

Remote Command: [:SENSe]:SEMask:RESTore:DEFaults

Dependencies/Couplings : Selecting measurement preset will restore all measurement parameters to their default values.

Example: SEM:REST:DEF



### 3.5.3 Power vs. Time Measurement

Power vs. Time contains two views:

- Rise & Fall view. There are three windows for this view:
  - Power-on ramp window
  - Power-down ramp window
  - Metrics window
- Burst view. There are two windows for this view:
  - Full Burst window
  - Metrics window

#### 3.5.3.1 AMPLITUDE/Y Scale

The **AMPLITUDE/Y Scale** key accesses the menu to set the desired vertical scale and associated settings:

---

**NOTE** Default numbers are independent for each window.

---

**3.5.3.1.1 Scale/Div** Allows you to enter a numeric value to change the vertical display sensitivity.

Mode:	WLAN
Key Path:	<b>AMPLITUDE/Y Scale</b>
Remote Command:	:DISPlay:PVTtime:WINDow:TRACe:Y[:SCALe]:PDIVision <rel_ampl> :DISPlay:PVTtime:WINDow:TRACe:Y[:SCALe]:PDIVision?
Unit/Terminator Keys:	dB
Default:	10.00
Range:	0.1 — 20
State Saved:	Saved in instrument state.
Example:	DISP:PVT:WIND:TRAC:Y:PDIV 10.0 DISP:PVT:WIND:TRAC:Y:PDIV?

**3.5.3.1.2 Ref Value** Allows you to set the absolute power reference.

Mode:	WLAN
-------	------

Key Path:	<b>AMPLITUDE/Y Scale</b>
Remote Command:	:DISPlay:PVTTime:WINDow:TRACe:Y[:SCALe]:RLEVel <ampl> :DISPlay:PVTTime:WINDow:TRACe:Y[:SCALe]:RLEVel?
Unit/Terminator Keys:	dBm
Default:	0
Range:	-250 — 250
State Saved:	Saved in instrument state.
Dependencies/Couplings:	When the Scale Coupling default is On, this value is automatically determined by the measurement result. When you set a value manually, Scale Coupling automatically changes to Off.
Example:	DISP:PVT:WIND:TRAC:Y:RLEV 10.0 DISP:PVT:WIND:TRAC:Y:RLEV?

### 3.5.3.1.3 Ref Position

Allows you to set the vertical reference value.

Mode:	WLAN
Key Path:	<b>AMPLITUDE/Y Scale</b>
Remote Command:	:DISPlay:PVTTime:WINDow:TRACe:Y[:SCALe]:RPOStion TOP CENTer BOTTom :DISPlay:PVTTime:WINDow:TRACe:Y[:SCALe]:RPOStion?
Default:	TOP
State Saved:	Saved in instrument state.
Example:	DISP:PVT:WIND:TRAC:Y:RPOS BOTT DISP:PVT:WIND:TRAC:Y:RPOS?

### 3.5.3.1.4 Scale Coupling

Allows you to toggle the scale coupling function between On and Off.

Mode:	WLAN
Key Path:	<b>AMPLITUDE/Y Scale</b>
Remote Command:	:DISPlay:PVTTime:WINDow:TRACe:Y[:SCALe]:COUPlE 0 1 OFF ON :DISPlay:PVTTime:WINDow:TRACe:Y[:SCALe]:COUPlE?
Default:	ON
State Saved:	Saved in instrument state.

**Dependencies/Couplings:** When you set a value to either Scale/Div or Ref Value manually, Scale Coupling automatically changes to Off.  
When Scale Coupling is set to On, the scale coupling function automatically determines the scale per division and reference values based on the measurement results when you press the Restart front-panel key or Restart key under the Meas Control menu.

**Example:** DISP:PVT:WIND:TRAC:Y:COUP ON  
DISP:PVT:WIND:TRAC:Y:COUP?

### 3.5.3.2 Meas Setup

Displays the measurement setup menu for the Power vs. Time Measurement when the **Power vs. Time Measurement** key has been selected in the **Measure** menu.

**3.5.3.2.1 Burst Time** Specifies the accurate burst time for the burst to be measured. It is needed to be set as accurate as possible, or the ramp down time may be lost.

**Mode:** WLAN

**Key Path:** **Meas Setup**

**Remote Command:** [:SENSe]:PVTime:BURSttime <time>  
[:SENSe]:PVTime:BURSttime?

**Unit:** s | ms | us | ns

**Default:** 1.0 ms

**Range:** 96 μs — 20 ms

**State Saved:** Saved in instrument state.

**Dependencies/Couplings :** The MAX Burst Time is coupled with IF BW and Ramp Time Length to ensure:  $(1.25 * IF BW * (Burst Time + Ramp Time Length)) \leq 1.0e6$

**Example:** PVT:BURS 965.455e-6  
PVT:BURS?

**3.5.3.2.2 Ramp Time Length** Indicates the searching window length from which the ramp on and down is searched.

---

**NOTE** If Ramp Time Length is set shorter than actual ramp time, the ramp may be lost. It must exceed twice of actual ramp time of the signal under test.

---

**Mode:** WLAN

Key Path:	<b>Meas Setup</b>
Remote Command:	<code>[[:SENSe]:PVTime:RTIME &lt;time&gt;</code> <code>[[:SENSe]:PVTime:RTIME?</code>
Unit/Terminator Keys:	s   ms   us
Default:	15.0 $\mu$ s
Range:	0.5 $\mu$ s — 50 $\mu$ s
State Saved:	Saved in instrument state.
Example:	PVT:RTIM 15 us PVT:RTIM?

### 3.5.3.2.3 IF BW Sets the Wideband IF BW.

Mode:	WLAN
Key Path:	<b>Meas Setup</b>
Remote Command:	<code>[[:SENSe]:PVTime:IFBW &lt;real&gt;</code> <code>[[:SENSe]:PVTime:IFBW?</code>
Unit/Terminator Keys:	Hz   kHz   MHz   GHz
Default:	25.0000 MHz
Range:	opt 122: 8 MHz — 80 MHz opt 140: 8 MHz — 40 MHz
State Saved:	Saved in instrument state.
Example:	PVT:IFBW 25e6 PVT:IFBW?

### 3.5.3.2.4 Threshold Allows you to access Threshold menu.

Mode:	WLAN
Key Path:	<b>Meas Setup, More</b>

#### 3.5.3.2.4.1 Ramp

Specifies ramp parameters (Start Level, End Level) are for power up transition or for power down transition.

Mode:	WLAN
-------	------

**Key Path:** Meas Setup, More, Threshold

**Default:** UP

**Dependencies/Couplings:** When the Ramp state is UP, the values (Start Level, End Level) are for power up transition.  
When the Ramp state is DOWN, the values (Start Level, End Level) are for power down transition.

### 3.5.3.2.4.2 Start Level

Specifies the level at which the power-up or power-down transition ramp should begin.

**Mode:** WLAN

**Key Path:** Meas Setup, More, Threshold

**Remote Command:** [:SENSe]:PVTime:LIST:LEVel:STARt <percent>  
[:SENSe]:PVTime:LIST:LEVel:STARt?

**Unit/Terminator Keys:** pcnt

**Default:** Power-up: 10  
Power-down: 90

**Range:** 1 to 100

**State Saved:** Saved in instrument state.

**Example:** PVT:LIST:LEV:STAR 10 pcnt  
PVT:LIST:LEV:STAR?

### 3.5.3.2.4.3 End Level

Specifies the level at which the power-up or power-down transition ramp should end.

**Mode:** WLAN

**Key Path:** Meas Setup, More, Threshold

**Remote Command:** [:SENSe]:PVTime:LIST:LEVel:END <percent>  
[:SENSe]:PVTime:LIST:LEVel:END?

**Unit/Terminator Keys:** pcnt

**Default:** Power-up: 90  
Power-down: 10

**Range:** 1 to 100

**State Saved:** Saved in instrument state.

Example: PVT:LIST:LEV:END 90 pcnt  
PVT:LIST:LEV:END?

**3.5.3.2.5 Wideband Setup** This key invokes the WBIF Setup menu from which the user can set parameters for the WB path.

Mode: WLAN  
Key Path: Meas Setup

#### 3.5.3.2.5.1 Wideband IF Gain

Sets the Wideband IF Gain.

Mode: WLAN  
Key Path: Meas Setup, Wideband Setup  
Remote Command: [:SENSe]:PVTtime:WBIF:IFGain <integer>  
[:SENSe]:PVTtime:WBIF:IFGain?  
Unit/Termination: dB  
Default: 0  
State Saved: Saved in instrument state.  
Range: -12 to 12  
Example: PVT:WBIF:IFG 0  
PVT:WBIF:IFG?

#### 3.5.3.2.5.2 Wideband Advanced

Allows you to access Wideband Advanced menu.

Mode: WLAN  
Key Path: Meas Setup, Wideband Setup

- ADC Correction

Performs the ADC calibration to reduce the spectral image and applies the correction.

Mode: WLAN  
Key Path: Meas Setup, Wideband Setup, Wideband Advanced

**Remote Command:** [:SENSe]:PVTtime:WBIF:ADCCorrect OFF|ON|0|1  
[:SENSe]:PVTtime:WBIF:ADCCorrect?

**Default:** ON

**State Saved:** Saved in instrument state.

**Dependencies/Couplings:** Coupled with ADC Correction of other measurements.

**Example:** PVT:WBIF:ADCC ON  
PVT:WBIF:ADCC?

- IF Flatness Correction

Turns IF flatness corrections on and off in all wideband IF measurements.

**Mode:** WLAN

**Key Path:** **Meas Setup, Wideband Setup, Wideband Advanced**

**Remote Command:** [:SENSe]:PVTtime:WBIF:FLATness OFF|ON|0|1  
[:SENSe]:PVTtime:WBIF:FLATness?

**Default:** ON

**State Saved:** Saved in instrument state.

**Dependencies/Couplings:** Coupled with WBIF Flatness of other measurements.

**Example:** PVT:WBIF:FLAT ON  
PVT:WBIF:FLAT?

- WB ADC Dither

Turns the wideband dither signal on or off. This control is independent of the narrowband ADC dither.

**Mode:** WLAN

**Key Path:** **Meas Setup, Wideband Setup, Wideband Advanced**

**Remote Command:** [:SENSe]:PVTtime:WBIF:ADC:DITHer OFF|ON|0|1  
[:SENSe]:PVTtime:WBIF:ADC:DITHer?

**Default:** ON

**State Saved:** Saved in instrument state.

**Example:** PVT:WBIF:ADC:DITH ON  
PVT:WBIF:ADC:DITH?

- Trigger Interpolation

Turns Trigger Interpolation function on and off.

When interpolation is turned off, the trigger offset is returned by means of the SCPI Command PVT:WBIF:TRIG:EOFF.

Applies only for external trigger.

Mode:	WLAN
Key Path:	<b>Meas Setup, Wideband Setup, Wideband Advanced</b>
Remote Command:	[ :SENSe ] :PVTtime:WBIF:TRIGger:INTerpolate OFF ON 0 1 [ :SENSe ] :PVTtime:WBIF:TRIGger:INTerpolate?
Default:	OFF
State Saved:	Saved in instrument state.
Example:	PVT:WBIF:TRIG:INT ON PVT:WBIF:TRIG:INT?

### 3.5.3.2.6 Average Allows you to access Average menu.

Mode:	WLAN
Key Path:	<b>Meas Setup</b>

#### 3.5.3.2.6.1 Avg Number

Allows you to specify the number of measurement averages used when calculating the measurement result. The average will be displayed at the end of each sweep.

Average State allows the user to turn averaging on or off.

Mode:	WLAN
Key Path:	<b>Meas Setup, Average</b>
Remote Command:	[ :SENSe ] :PVTtime:AVERage:COUNT <integer> [ :SENSe ] :PVTtime:AVERage:COUNT? [ :SENSe ] :PVTtime:AVERage [ :STATe ] ON OFF 1 0 [ :SENSe ] :PVTtime:AVERage [ :STATe ] ?
Default:	Count: 10 State: ON
Range:	1 — 1000
State Saved:	Saved in instrument state.



Example: PVT:AVER:COUNT 10  
PVT:AVER:COUNT?  
PVT:AVER ON  
PVT:AVER?

### 3.5.3.2.6.2 Avg Mode

Allows you to choose either exponential or repeat averaging. This selection only affects the averaging after the number of N averages is reached (set using Avg Number key). See “Avg Mode” on page 107.

Mode: WLAN  
Key Path: Meas Setup, Average  
Remote Command: [:SENSe]:PVTime:AVERage:TCONtrol EXPonential|REPeat  
[:SENSe]:PVTime:AVERage:TCONtrol?  
Default: REPeat  
State Saved: Saved in instrument state.  
Example: PVT:AVER:TCON REP  
PVT:AVER:TCON?

### 3.5.3.2.6.3 Avg Type

Selects the averaging type from the following selections:

- **Pwr Avg (RMS):** Equivalent to taking the RMS value of the voltage. It is the most accurate type of averaging.
- **Log-Pwr Avg (Video):** Simulates the traditional analyzer type of averaging by averaging the log of the power.
- **Maximum:** Keeps track of the maximum values.
- **Minimum:** Keeps track of the minimum values.
- **Max & Min:** Keeps track of the maximum and minimum values.

Mode: WLAN  
Key Path: Meas Setup, Average  
Remote Command: [:SENSe]:PVTime:AVERage:TYPE LOG|LPOWer|MAXimum|MINimum  
|MXMinimum|RMS|POWer  
[:SENSe]:PVTime:AVERage:TYPE?  
Default: RMS  
State Saved: Saved in instrument state.

Example:                   PVT:AVER:TYPE RMS  
                              PVT:AVER:TYPE?

### 3.5.3.2.7 Limits Allows you to access Limits menu.

Mode:                      WLAN  
Key Path:                 **Meas Setup, More**

#### 3.5.3.2.7.1 Max Ramp Up Time

Specifies the maximum limit which the measured ramp time can not exceed.

Mode:                      WLAN  
Key Path:                 **Meas Setup, More, Limits**  
Remote Command:         :CALCulate:PVTime:LIMit:URTime <time>  
                              :CALCulate:PVTime:LIMit:URTime?  
Unit/Terminator Keys:     $\mu$ s  
Default:                  2.0  
Range:                    0.1 to 10  
State Saved:              Saved in instrument state.  
Example:                  CALC:PVT:LIM:URT 2 us  
                              CALC:PVT:LIM:URT?

#### 3.5.3.2.7.2 Max Ramp Down Time

Specifies the maximum limit which the measured ramp time can not exceed.

Mode:                      WLAN  
Key Path:                 **Meas Setup, More, Limits**  
Remote Command:         :CALCulate:PVTime:LIMit:DRTime <time>  
                              :CALCulate:PVTime:LIMit:DRTime?  
Unit/Terminator Keys:     $\mu$ s  
Default:                  2.0  
Range:                    0.1 — 10  
State Saved:              Saved in instrument state.

Example:                   CALC:PVT:LIM:DRT 2 us  
                              CALC:PVT:LIM:DRT?

### 3.5.3.2.7.3 Fail

Fail is used to indicate how to judge a measurement pass or fail.

- **Power-on ramp:** Whether the measurement is passed or fail just depends on ramp up time: when ramp up time passes, the measurement passes; when ramp up time fails, the measurement fails.
- **Power-down ramp:** Whether the measurement is passed or fail just depends on ramp down time: when ramp down time passes, the measurement passes; when ramp down time fails, the measurement fails.
- **Both:** When both Up and Down fail, the measurement fails.

Mode:                        WLAN  
Key Path:                   **Meas Setup,More, Limits**  
Remote Command:         [:SENSe]:PVTime:LIST:FAIL UP|DOWN|BOTH  
                              [:SENSe]:PVTime:LIST:FAIL?  
Default:                    BOTH  
State Saved:                Saved in instrument state.  
Example:                    PVT:LIST:FAIL UP  
                              PVT:LIST:FAIL?

**3.5.3.2.8 Trigger Source** Displays menu keys that enable you to select the trigger mode of a measurement. The available trigger modes are as follows:

- **Video (IF Envlp):** An internal IF envelope trigger that occurs at the absolute threshold level of the IF signal level.
- **Ext Front:** Sets the trigger directly to an external signal connected to the front-panel EXT TRIGGER INPUT connector. No measurement will be made unless a signal is connected to the EXT TRIGGER INPUT connector on the front-panel.
- **Ext Rear:** Sets the trigger directly to an external signal connected to the rear-panel TRIGGER IN connector. No measurement will be made unless a signal is connected to the TRIGGER IN connector on the rear panel.

Mode:                        WLAN  
Key Path:                    **Meas Setup**  
Remote Command:         [:SENSe]:PVTime:TRIGger:SOURce  
                              IF|EXTErnal [1] |EXTErnal2  
                              [:SENSe]:PVTime:TRIGger:SOURce?

Default: IF  
 State Saved: Saved in instrument state.  
 Example: PVT:TRIG:SOUR IF  
 PVT:TRIG:SOUR?

**3.5.3.2.9 Restore Meas Defaults** Sets the measure setup parameters to the factory defaults only for the currently selected measurement.

Mode: WLAN  
 Key Path: **Meas Setup, More**  
 Remote Command: [:SENSe]:PVTime:RESTore:DEFaults  
 Dependencies/Couplings: Selecting measurement preset will restore all measurement parameters to their default values.  
 Example: PVT:REST:DEF

### 3.5.4 Spectral Flatness Measurement

There is only one view available for this measurement and there is one window in this view:

- Spectrum Flatness Graph window

#### 3.5.4.1 SPAN X Scale

The **SPAN X Scale** key accesses the menu to set the desired horizon scale and associated settings.

**3.5.4.1.1 Scale/Div** Allows you to enter a carriers number value to change the horizontal scale.

Mode: WLAN  
 Key Path: **Span X Scale**  
 Remote Command: :DISPlay:FLATness:WINDow:TRACe:X[:SCALE]:PDIVision <real>  
 :DISPlay:FLATness:WINDow:TRACe:X[:SCALE]:PDIVision?  
 Unit/Terminator Keys: Carriers  
 Default: 5.2  
 Range: 0.1 to 6.4.  
 State Saved: Saved in instrument state.

**Dependencies/Couplings:** When the Scale Coupling is set to On, this value is automatically determined by the measurement result.  
When you set this value manually, Scale Coupling automatically changes to Off.

**Example** DISP:FLAT:WIND:TRAC:X:PDIV 5.2  
DISP:FLAT:WIND:TRAC:X:PDIV?

**3.5.4.1.2 Ref Value** Allow you to set the display reference.

**Mode:** WLAN

**Key Path:** **Span X Scale**

**Remote Command:** :DISPlay:FLATness:WINDow:TRACe:X[:SCALE]:RLEVel <real>  
:DISPlay:FLATness:WINDow:TRACe:X[:SCALE]:RLEVel?

**Unit/Terminator Keys:** Carriers

**Default:** -26.0

**Range:** -32.0 — 32.0.

**State Saved:** Saved in instrument state.

**Dependencies/Couplings:** When the Scale Coupling is set to On, this value is automatically determined by the measurement result.  
When you set this value manually, Scale Coupling automatically changes to Off.

**Example** DISP:FLAT:WIND:TRAC:X:RLEV 0  
DISP:FLAT:WIND:TRAC:X:RLEV?

**3.5.4.1.3 Ref Position** Allows you to set the display reference position by cycling the key.

**Mode:** WLAN

**Key Path:** **Span X Scale**

**Remote Command:** :DISPlay:FLATness:WINDow:TRACe:X[:SCALE]:RPOSition  
LEFT|CENTer|RIGHT  
:DISPlay:FLATness:WINDow:TRACe:X[:SCALE]:RPOSition?

**Default:** LEFT

**State Saved:** Saved in instrument state.

**Example** DISP:FLAT:WIND:TRAC:X:RPOS LEFT  
DISP:FLAT:WIND:TRAC:X:RPOS?

**3.5.4.1.4 Scale Coupling** Allows you to toggle the scale coupling function between On and Off.

Mode:	WLAN
Key Path:	<b>Span X Scale</b>
Remote Command:	:DISPlay:FLATness:WINDow:TRACe:X[:SCALE]:COUPle 0 1 OFF ON  :DISPlay:FLATness:WINDow:TRACe:X[:SCALE]:COUPle?
Default:	ON
State Saved:	Saved in instrument state.
Dependencies/Couplings:	When you set a value to either Scale/Div or Ref Value manually, Scale Coupling automatically changes to Off.  When Scale Coupling is set to On, the scale coupling function automatically determines the scale per division and reference values based on the measurement results when you press the Restart front-panel key or Restart key under the Meas Control menu.
Example	DISP:FLAT:WIND:TRAC:X:COUP ON  DISP:FLAT:WIND:TRAC:X:COUP?

### 3.5.4.2 AMPLITUDE/Y Scale

The **AMPLITUDE/Y Scale** key accesses the menu to set the desired vertical scale and associated settings.

**3.5.4.2.1 Scale/Div** Allows you to enter a numeric value to change the vertical display sensitivity.

Mode:	WLAN
Key Path:	<b>Amplitude Y Scale</b>
Remote Command:	:DISPlay:FLATness:WINDow:TRACe:Y[:SCALE]:PDIVision <real>  :DISPlay:FLATness:WINDow:TRACe:Y[:SCALE]:PDIVision?
Unit:	dB
Default:	1.0
Range:	1.0 — 5.0.
State Saved:	Saved in instrument state.

**Dependencies/Couplings :** When the Scale Coupling is set to On, this value is automatically determined by the measurement result.  
When you set this value manually, Scale Coupling automatically changes to Off.

**Example** FLAT:WIND:TRAC:Y:PDIV 1.0  
FLAT:WIND:TRAC:Y:PDIV?

**3.5.4.2.2 Ref Value** Allows you to set the absolute power reference.

**Mode:** WLAN

**Key Path:** **Amplitude Y Scale**

**Remote Command:** :DISPlay:FLATness:WINDow:TRACe:Y[:SCALE]:RLEVel <real>  
:DISPlay:FLATness:WINDow:TRACe:Y[:SCALE]:RLEVel?

**Unit:** dB

**Default:** 4

**Range:** -20.0 — 20.0.

**State Saved:** Saved in instrument state.

**Dependencies/Couplings:** When the Scale Coupling is set to On, this value is automatically determined by the measurement result.  
When you set this value manually, Scale Coupling automatically changes to Off.

**Example** FLAT:WIND:TRAC:Y:RLEV 4  
FLAT:WIND:TRAC:Y:RLEV?

**3.5.4.2.3 Ref Position** Allows you to set the display reference position by cycling the key.

**Mode:** WLAN

**Key Path:** **Amplitude Y Scale**

**Remote Command:** :DISPlay:FLATness:WINDow:TRACe:Y[:SCALE]:RPOSition  
TOP|CENTer|BOTTom  
:DISPlay:FLATness:WINDow:TRACe:Y[:SCALE]:RPOSition?

**Default:** TOP

**State Saved:** Saved in instrument state.

**Example** FLAT:WIND:TRAC:Y:RPOS BOTT  
FLAT:WIND:TRAC:Y:RPOS?

**3.5.4.2.4 Scale Coupling** Allows you to toggle the scale coupling function between On and Off.

Mode:	WLAN
Key Path:	<b>Amplitude Y Scale</b>
Remote Command:	:DISPlay:FLATness:WINDow:TRACe:Y[:SCALE]:COUPle 0 1 OFF ON  :DISPlay:FLATness:WINDow:TRACe:Y[:SCALE]:COUPle?
Default:	ON
State Saved:	Saved in instrument state.
Dependencies/Couplings:	When you set a value to either Scale/Div or Ref Value manually, Scale Coupling automatically changes to Off.  When Scale Coupling is set to On, the scale coupling function automatically determines the scale per division and reference values based on the measurement results when you press the Restart front-panel key or Restart key under the Meas Control menu.
Example	FLAT:WIND:TRAC:Y:COUP ON  FLAT:WIND:TRAC:Y:COUP?

**3.5.4.3 Meas Setup**

Displays the measurement setup menu for the Spectrum Flatness Measurement when the **Spectrum Flatness Measurement** key has been selected in the **Measure** menu.

**3.5.4.3.1 Search Length** Sets the search time length.

---

**NOTE** Search Length determines the length of data to be acquired. To assure adequate length estimation, the preamble should be included. Total Search Length should not be less than the summation of the long preamble, the short preamble and the payload, or actual data.

---

Mode:	WLAN
Key Path:	<b>Meas Setup</b>
Remote Command:	[:SENSe]:FLATness:TIME:SEARChlen <time> [:SENSe]:FLATness:TIME:SEARChlen?
Unit:	us
Default:	500 $\mu$ s
Range:	(7.5 / Subcarrier Spacing) — 1000000 $\mu$ s
State Saved:	Saved in instrument state.



Dependencies/Couplings    Coupled with Subcarrier Spacing and Guard Int  
:  
Example:                    FLAT:TIME:SEAR 500  
                              FLAT:TIME:SEAR?

**3.5.4.3.2 IF BW** Sets the Wideband IF Bandwidth.

Mode:                        WLAN  
Key Path:                    **Meas Setup**  
Remote Command:            [:SENSE]:FLATness:IFBW <real>  
                              [:SENSE]:FLATness:IFBW?  
Unit:                        Hz | kHz | MHz | GHz  
Default:                     32.0000 MHz  
Range:                      opt 122: 8 MHz — 80 MHz  
                              opt 140: 8 MHz — 40 MHz  
State Saved:                Saved in instrument state.  
Example:                    FLAT:IFBW 32 MHz  
                              FLAT:IFBW?

**3.5.4.3.3 Wideband Setup** This key invokes the WBIF Setup menu from which the user can set parameters for the WB path.

Mode:                        WLAN  
Key Path:                    **Meas Setup**

**3.5.4.3.3.1 Wideband IF Gain**

Sets the Wideband IF Gain.

Mode:                        WLAN  
Key Path:                    **Meas Setup, Wideband Setup**  
Remote Command:            [:SENSE]: Flatness:WBIF:IFGain <integer>  
                              [:SENSE]: Flatness:WBIF:IFGain?  
Unit/Termination:            dB  
Default:                     0 dB

State Saved: Saved in instrument state.  
 Range: -12 — 12  
 Example: FLAT:WBIF:IFG 0  
 FLAT:WBIF:IFG?

**3.5.4.3.3.2 Wideband Advanced** Allows you to access Wideband Advanced menu.

Mode: WLAN  
 Key Path: Meas Setup, Wideband Setup

- ADC Correction

Performs the ADC calibration to reduce the spectral image and applies the correction.

Mode: WLAN  
 Key Path: Meas Setup, Wideband Setup, Wideband Advanced  
 Remote Command: [:SENSe]:FLATness:WBIF:ADCCorrect OFF|ON|0|1  
 [:SENSe]:FLATness:WBIF:ADCCorrect?  
 Default: ON  
 State Saved: Saved in instrument state.  
 Dependencies/Couplings: Coupled with ADC Correction of other measurements.  
 Example: FLAT:WBIF:ADCC ON  
 FLAT:WBIF:ADCC?

- IF Flatness Correction

Turns IF Flatness corrections on and off in all wideband IF measurements.

Mode: WLAN  
 Key Path: Meas Setup, Wideband Setup, Wideband Advanced  
 Remote Command: [:SENSe]:FLATness:WBIF:FLATness OFF|ON|0|1  
 [:SENSe]:FLATness:WBIF:FLATness?  
 Default: ON  
 State Saved: Saved in instrument state.  
 Dependencies/Couplings: Coupled with WBIF Flatness of other measurements.

- **WB ADC Dither**

Turns the wideband dither signal on or off. This control is independent of the narrowband ADC dither.

Mode:	WLAN
Key Path:	<b>Meas Setup, Wideband Setup, Wideband Advanced</b>
Remote Command:	<code>[ :SENSe ] :FLATness:WBIF:ADC:DITHer OFF ON 0 1</code> <code>[ :SENSe ] :FLATness:WBIF:ADC:DITHer?</code>
Default:	ON
State Saved:	Saved in instrument state.
Example:	<code>:Flatness:WBIF:ADC:DITHer ON</code> <code>:Flatness:WBIF:ADC:DITHer?</code>

- **Trigger Interpolation**

Turns trigger interpolation on and off.

When interpolation is turned off, the trigger offset is returned by means of the `FLATNESS:WBIF:TRIG:EOFFset` command.

Applies only for external trigger.

Mode:	WLAN
Key Path:	<b>Meas Setup, Wideband Setup, Wideband Advanced</b>
Remote Command:	<code>[ :SENSe ] :FLATness:WBIF:TRIGger:INTerpolate OFF ON 0 1</code> <code>[ :SENSe ] :FLATness:WBIF:TRIGger:INTerpolate?</code>
Default:	OFF
State Saved:	Saved in instrument state.
Example:	<code>:Flatness:WBIF:TRIGger:INTerpolate ON</code> <code>:Flatness:WBIF:TRIGger:INTerpolate?</code>

#### 3.5.4.3.4 Avg Number

Sets the number that will be averaged. After the specified number (average counts) have been averaged, the averaging mode (termination control) setting determines the averaging action.

Mode	WLAN
Key Path	<b>Meas Setup</b>

Remote Command	<pre>[ :SENSe ] :FLATness :AVERage :COUNT &lt;integer&gt; [ :SENSe ] :FLATness :AVERage :COUNT? [ :SENSe ] :FLATness :AVERage [ :STATe ] OFF   ON   0   1 [ :SENSe ] :FLATness :AVERage [ :STATe ] ?</pre>
Default	<pre>Count: 10 State: ON</pre>
State Saved	Saved in instrument state.
Range	1 — 10000
Example	<pre>FLAT:AVER:COUN 10 FLAT:AVER:COUN? FLAT:AVER: ON FLAT:AVER?</pre>

### 3.5.4.3.5 Avg Mode

Allows you to choose either exponential or repeat averaging. This selection only affects the averaging after the number of N averages is reached (set using Avg Number key). See [“Avg Mode” on page 107](#).

Mode:	WLAN
Key Path:	<b>Meas Setup</b>
Remote Command:	<pre>[ :SENSe ] :FLATness :AVERage :TCONtrol EXPonential   REPeat [ :SENSe ] :FLATness :AVERage :TCONtrol?</pre>
Default:	REPeat
State Saved:	Saved in instrument state.
Remote Command Notes:	You must be in the WLAN mode to use this command. Use INSTRUMENT:SELEct to set the mode.
Example	<pre>FLAT:AVER:TCON REP FLAT:AVER:TCON?</pre>

**3.5.4.3.6 Trigger Source** Displays menu keys that enable you to select the trigger mode of a measurement. The available trigger modes are as follows:

- **Free Run:** The next measurement is taken immediately, capturing the signal asynchronously (also called ‘immediate’).
- **Video:** An internal IF envelope trigger that occurs at the absolute threshold level of the IF signal level.
- **Ext Front:** Sets the trigger directly to an external signal connected to the front-panel EXT

TRIGGER INPUT connector. No measurement will be made unless a signal is connected to the EXT TRIGGER INPUT connector on the front-panel.

- **Ext Rear:** Sets the trigger directly to an external signal connected to the rear-panel TRIGGER IN connector. No measurement will be made unless a signal is connected to the TRIGGER IN connector on the rear panel.

Key Path	<b>Meas Setup</b>
Default	IMMediate
State Saved	Saved in instrument state.
Remote Command	[ :SENSe] :FLATness :TRIGger :SOURce IMMediate   IF   EXTeRnal [1]   EXTeRnal2 [ :SENSe] :FLATness :TRIGger :SOURce?
Example	FLAT:TRIG:SOUR IF FLAT:TRIG:SOUR?

**3.5.4.3.7 Advanced** Allows you to set some advanced parameters for 802.11a, 802.11g ERP-OFDM and 802.11g DSSS-OFDM.

Mode:	WLAN
Key Path:	<b>Meas Setup, More</b>

**3.5.4.3.7.1 Symbol Timing Adjust**

Symbol Timing Adjust controls how far the FFT part of the symbol is adjusted away from the end of the symbol time. The value is in terms of percent of the used (FFT) part of the symbol time.

---

**NOTE** The value must be between  $(-100 * \text{Guard Interval})$  and zero which means no adjustment. Values outside of that range are clipped to the limit. The value is negative, because the FFT start time is moved back by.

---

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Advanced</b>
Remote Command:	[ :SENSe] :FLATness :TIMadj <percent> [ :SENSe] :FLATness :TIMadj?
Unit:	pcnt
Default:	-3.12500 pcnt
Range:	$(-100 * \text{Guard Interval}) - 0$

State Saved: Saved in instrument state.

Dependencies/Couplings : Coupled by Guard Int and will be clipped to times of 1/128 of Guard Int

Example: FLAT:TIM -3.125  
FLAT:TIM?

### 3.5.4.3.7.2 Sync Training Seq

Specifies synchronization method to use when synchronizing to the start of the OFDM burst. The valid values are Short or Long. If an invalid value is received, it is converted to Long.

A value of Short means to search for and synchronize to an 802.11a preamble short symbol sequence.

---

**NOTE** Short value should not be used for 802.11g DSSS-OFDM, because the DSSS-OFDM preamble does not contain the short symbol sequence.

---

A value of Long means to search for and synchronize to an 802.11a/g preamble long symbol sequence (also called the channel estimation sequence).

Mode: WLAN

Key Path: **Meas Setup, More, Advanced**

Remote Command: [:SENSe]:FLATness:SYNCseq LONG|SHORT|0|1  
[:SENSe]:FLATness:SYNCseq?

Default: SHORT

State Saved: Saved in instrument state.

Example: FLAT:SYNC LONG  
FLAT:SYNC?

### 3.5.4.3.7.3 Mirror Spectrum

Sets Mirror Spectrum to On to conjugate the input time data before any processing of the signal. This will mirror the frequency spectrum of the input data around the center frequency. Most measurement results are computed using frequency mirroring, but the exception is the Freq Error measurement. This result is computed relative to the original unmodified input signal.

Mode: WLAN

Key Path: **Meas Setup, More, Advanced**

Remote Command: [:SENSe]:FLATness:MIRRorspec OFF|ON|0|1  
[:SENSe]:FLATness:MIRRorspec?

Default: OFF

State Saved: Saved in instrument state.  
 Example: FLAT:MIRR OFF  
 FLAT:MIRR?

**3.5.4.3.8 Limits** Allows you to access Limits menu.

Mode: WLAN  
 Key Path: Meas Setup, More

**3.5.4.3.8.1 Segment**

Allows you to select the segment for which you can set limits. From IEEE 802.11a specification, Segment A includes the carriers -16...16, and Segment B includes -26...-17 and 17... 26.

Mode: WLAN  
 Key Path: Meas Setup, More, Limits  
 Default: A  
 Range: A | B

**3.5.4.3.8.2 Upper limit**

Allows you to specify upper deviation limit (dB) of the selected segment

Mode: WLAN  
 Key Path: Meas Setup, More, Limit  
 Remote Command: :CALCulate:FLATness:SEGment:LIST:LIMit:UPPer  
 :CALCulate:FLATness:SEGment:LIST:LIMit:UPPer?  
 Unit: dB  
 Default: 2.00 (Segment A), 2.00 (Segment B)  
 Range: 0.1 — 10.0  
 State Saved: Saved in instrument state.  
 Example: CALC:FLAT:SEGM:LIST:LIM:UPP 2, 2  
 CALC:FLAT:SEGM:LIST:LIM:UPP?

**3.5.4.3.8.3 Lower limit**

Allows you to specify lower deviation limit (dB) of the selected segment

Mode: WLAN

Key Path: **Meas Setup, More, Limit**

Remote Command: :CALCulate:FLATness:SEGMent:LIST:LIMit:LOWer  
:CALCulate:FLATness:SEGMent:LIST:LIMit:LOWer?

Unit: dB

Default: -2.00 (Segment A), -4.00 (Segment B)

Range: -10.0 — -0.1

State Saved: Saved in instrument state.

Example: CALC:FLAT:SEGM:LIST:LIM:LOW -2, -4  
CALC:FLAT:SEGM:LIST:LIM:LOW?

**3.5.4.3.9 Restore Meas Defaults** Sets the measure setup parameters to the factory defaults only for the currently selected measurement.

Mode: WLAN

Key Path: **Meas Setup, More**

Remote Command: [:SENSe]:FLATness:REStore:DEFaults

Dependencies/Couplings : Selecting measurement preset will restore all measurement parameters to their default values.

Example: FLAT:REST:DEF

### 3.5.5 Modulation Accuracy Measurement

Modulation Accuracy measurement consists of up to 5 views which have different windows. See [Table 3-11, “Modulation Accuracy Measurement Views and Windows”](#).

**Table 3-11 Modulation Accuracy Measurement Views and Windows**

NO.	View	NO. of Windows	Window No.	Window
1	I/Q Measured Polar Graph	Dual (Horizontal)	1	Numeric Results
			2	I/Q Measured Polar Vector



**Table 3-11 Modulation Accuracy Measurement Views and Windows**

NO.	View	NO. of Windows	Window No.	Window
2	I/Q Error (See Note 1)	Quad	1	Magnitude Error
			2	Phase Error
			3	EVM
			4	Numeric Results
3	OFDM EVM (See Note 2)	Quad	1	EVM vs. Symbol
			2	EVM vs. Carrier
			3	I/Q Measured Polar Vector
			4	Numeric Results
4	Demod Bits	Single	1	Demod Bits
5	Result Metrics	Single	1	Result Metrics

---

**NOTE**

1. I/Q Error view is available only when the 802.11b or 802.11g ERP-DSSS/CCK/PBCC mode is selected. This case will be named as 802.11b/g mode in the following sections.
2. OFDM EVM view is available only when the 802.11a, 802.11g ERP-OFDM, or 802.11g DSSS-OFDM mode is selected. This case will be named as 802.11a/g mode in the following sections.

---

### 3.5.5.1 SPAN X Scale

The **SPAN/X Scale** key accesses the menu to set the desired horizon scale and associated settings. X Scale menu is only enabled for following windows/views:

- 802.11b/g mode, I/Q Error view:
  - Window1: Magnitude Error
  - Window2: Phase Error
  - Window3: EVM
- 802.11a/g mode, OFDM EVM view:
  - Window1: EVM vs Symbols
  - Window2: EVM vs Carriers

**3.5.5.1.1 Scale/Div** Allows you to enter a carriers number value to change the horizontal scale.

Mode: WLAN

Key Path: **Span X Scale**

Remote Command: :DISPlay:EVM[1] | 2 | 3 | 4 | 5 :WINDow [1] | 2 | 3 | 4 :TRACe:X[:SCALE]:PDIVis  
ion <real>  
  
:DISPlay:EVM[1] | 2 | 3 | 4 | 5 :WINDow [1] | 2 | 3 | 4 :TRACe:X[:SCALE]:PDIVis  
ion?

Default: 5.9 (See [Table 3-12, “Scale/Div Setting”](#))

Range: 0.1 to 136.6 (See [Table 3-12, “Scale/Div Setting”](#))

State Saved: Saved in instrument state.

Dependencies/Couplings: When the Scale Coupling is set to On, this value is automatically determined by the measurement result.  
  
When you set this value manually, Scale Coupling automatically changes to Off.

Example: DISP:EVM3:WIND1:TRAC:X:PDIV 6.0  
DISP:EVM3:WIND2:TRAC:X:PDIV?

**Table 3-12 Scale/Div Setting**

View	Window	Default	Range	Unit
EVM3 (OFDM EVM view, 802.11a/g)	1 (EVM vs. Symbol)	5.9	0.1 ~ 136.6	Symbols
	2 (EVM vs. Carriers)	5.2	0.1 ~ 6.4	Carriers
EVM2 (I/Q Error view, 802.11b/g)	1 (Magnitude Error)	279.3	1 ~ 9636	chip
	2 (Phase Error)			
	3 (EVM)			

**3.5.5.1.2 Ref Value** Allows you to set the display reference.

Mode: WLAN

Key Path: **Span X Scale**

**Remote Command:** :DISPlay:EVM[1] | 2 | 3 | 4 | 5 :WINDow [1] | 2 | 3 | 4 :TRACe:X [:SCALE] :RLEVEl <integer>  
:DISPlay:EVM[1] | 2 | 3 | 4 | 5 :WINDow [1] | 2 | 3 | 4 :TRACe:X [:SCALE] :RLEVEl?

**Default:** 0 (See [Table 3-13, “Ref Value Setting”](#))

**Range:** 0 — 1366 (See [Table 3-13, “Ref Value Setting”](#))

**State Saved:** Saved in instrument state.

**Dependencies/Couplings:** When the Scale Coupling is set to On, this value is automatically determined by the measurement result.  
When you set this value manually, Scale Coupling automatically changes to Off.

**Example:** DISP:EVM3:WIND1:TRAC:X:RLEV 0  
DISP:EVM3:WIND2:TRAC:X:RLEV?

**Table 3-13 Ref Value Setting**

View	Window	Default	Range	Unit
EVM3 (OFDM EVM view, 802.11a/g)	1 (EVM vs. Symbol)	0.0	0 ~ 1366	Symbols
	2 (EVM vs.) Carriers	-26	-32 ~ 32	Carriers
EVM2 (I/Q Error view, 802.11b/g)	1 (Magnitude Error)	22	0 ~ 96360	chip
	2 (Phase Error)			
	3 (EVM)			

**3.5.5.1.3 Ref Position** Allows you to set the display reference position to either Left, Ctr (center), or Right.

**Mode:** WLAN

**Key Path:** **Span X Scale**

**Remote Command:** :DISPlay:EVM[1] | 2 | 3 | 4 | 5 :WINDow [1] | 2 | 3 | 4 :TRACe:X [:SCALE] :RPOSi tion LEFT | CENTer | RIGHT  
:DISPlay:EVM[1] | 2 | 3 | 4 | 5 :WINDow [1] | 2 | 3 | 4 :TRACe:X [:SCALE] :RPOSi tion?

**Default:** LEFT

**Default:** Left | Ctr | Right

State Saved:	Saved in instrument state.
Dependencies/Couplings:	When the Scale Coupling is set to On, this value is automatically determined by the measurement result.  When you set this value manually, Scale Coupling automatically changes to Off.
Example:	DISP:EVM3:WIND2:TRAC:X:RPOS LEFT DISP:EVM3:WIND2:TRAC:X:RPOS?

#### 3.5.5.1.4 Scale Coupling

Allows you to toggle the scale coupling function between On and Off.

Mode:	WLAN
Key Path:	<b>Span X Scale</b>
Remote Command:	:DISPlay:EVM[1]   2   3   4   5 : WINDow [1]   2   3   4 : TRACe : X [ : SCALe ] : COUPle OFF   ON   0   1  :DISPlay:EVM[1]   2   3   4   5 : WINDow [1]   2   3   4 : TRACe : X [ : SCALe ] : COUPle?
Default:	ON
Default:	On   Off
State Saved:	Saved in instrument state.
Dependencies/Couplings:	When the Scale Coupling is set to On, this value is automatically determined by the measurement result.  When you set this value manually, Scale Coupling automatically changes to Off.
Example:	DISP:EVM3:WIND2:TRAC:X:COUP ON DISP:EVM3:WIND2:TRAC:X:COUP?

#### 3.5.5.2 AMPLITUDE Y Scale

The **AMPLITUDE/Y Scale** key accesses the menu to set the desired vertical scale and associated settings.

##### 3.5.5.2.1 Scale/Div

Allows you to enter a numeric value to change the vertical display sensitivity.

Mode:	WLAN
Key Path:	<b>AMPLITUDE Y Scale</b>

**Remote Command:**           :DISPlay:EVM[1] | 2 | 3 | 4 | 5 :WINDow [1] | 2 | 3 | 4 :TRACe:Y [:SCALe] :P  
DIVision <real>  
  
:DISPlay:EVM[1] | 2 | 3 | 4 | 5 :WINDow [1] | 2 | 3 | 4 :TRACe:Y [:SCALe] :P  
DIVision?

**Default:**                    10.0 (See [Table 3-14, “Scale/Div Setting”](#))

**Default:**                    0.1 ~ 20.0 (See [Table 3-14, “Scale/Div Setting”](#))

**State Saved:**                Saved in instrument state.

**Dependencies/Couplings:**   When the Scale Coupling is set to On, this value is automatically  
determined by the measurement result.  
  
When you set this value manually, Scale Coupling automatically  
changes to Off.

**Example:**                    DISP:EVM3:WIND:TRAC:Y:PDIV 6.0  
DISP:EVM3:WIND2:TRAC:Y:PDIV?

**Table 3-14           Scale/Div Setting**

View	Window	Default	Range	Unit
EVM3 (OFDM Error view, 802.11a/g)	1 (EVM vs. Symbol)	10.0	0.1 ~ 20.0	dB
	2 (EVM vs. Carriers)			
EVM2 (I/Q Error view, 802.11b/g)	1 (Magnitude Error)	3	0.1 ~ 50	pcnt
	2 (Phase Error)	7.50	0.01 ~ 3600.0	deg
	3 (EVM)	1.5	0.1 ~ 50	pcnt

**3.5.5.2.2 Ref Value** Allows you to set the absolute power reference.

**Mode:**                        WLAN

**Key Path:**                    **AMPLITUDE Y Scale**

**Remote Command:**           :DISPlay:EVM[1] | 2 | 3 | 4 | 5 :WINDow [1] | 2 | 3 | 4 :TRACe:Y [:SCALe] :R  
LEVel <integer>  
  
:DISPlay:EVM[1] | 2 | 3 | 4 | 5 :WINDow [1] | 2 | 3 | 4 :TRACe:Y [:SCALe] :R  
LEVel?

**Default:**                    0 (See [Table 3-15, “Ref Value Setting”](#))

**Default:**                    -100.0 ~ 100.0 (See [Table 3-15, “Ref Value Setting”](#))

**State Saved:**                Saved in instrument state.

**Dependencies/Couplings:** When the Scale Coupling is set to On, this value is automatically determined by the measurement result.

When you set this value manually, Scale Coupling automatically changes to Off.

**Example:** DISP:EVM3:WIND:TRAC:Y:RLEV 0  
DISP:EVM3:WIND2:TRAC:Y:RLEV?

**Table 3-15 Ref Value Setting**

View	Window	Default	Range	Unit
EVM3 (OFDM Error view, 802.11a/g)	1 (EVM vs. Symbol)	0	-100.0 ~ 100.0	dB
	2(EVM vs. Carriers)			
EVM2 (I/Q Error view, 802.11b/g)	1(Magnitude Error)	0	-500 ~ 500	pcnt
	2 (Phase Error)	0	-36000.0 ~ 36000.0	deg
	3 (EVM)	0	-500 ~ 500	pcnt

**3.5.5.2.3 Ref Position** Allows you to set the display reference position to either Top, Ctr (center), or Bot (Bottom).

**Mode:** WLAN

**Key Path:** Span X Scale

**Remote Command:** :DISPlay:EVM[1] | 2 | 3 | 4 | 5:WINDow [1] | 2 | 3 | 4 :TRACe:Y[:SCALe]  
:RPOSition TOP|CENTer|BOTTom  
  
:DISPlay:EVM[1] | 2 | 3 | 4 | 5:WINDow [1] | 2 | 3 | 4 :TRACe:Y[:SCALe] :R  
POSition?

**Default:** TOP (See [Table 3-16, “Ref Position Default Setting”](#))

**State Saved:** Saved in instrument state.

**Dependencies/Couplings:** When the Scale Coupling is set to On, this value is automatically determined by the measurement result.

When you set this value manually, Scale Coupling automatically changes to Off.

**Example:** DISP:EVM3:WIND2:TRAC:Y:RPOS TOP  
DISP:EVM3:WIND2:TRAC:Y:RPOS?

**Table 3-16 Ref Position Default Setting**

View	Window	Default
EVM3 (OFDM Error view, 802.11a/g)	1 (EVM vs. Symbol)	Top
	2 (EVM vs. Carriers)	
EVM2 (I/Q Error view, 802.11b/g)	1 (Magnitude Error)	Center
	2 (Phase Error)	Center
	3 (EVM)	Bottom

**3.5.5.2.4 Scale Coupling** Allows you to toggle the scale coupling function between On and Off.

Mode: WLAN

Key Path: **Span X Scale**

Remote Command: :DISPlay:EVM[1] | 2 | 3 | 4 | 5 :WINDow [1] | 2 | 3 | 4 :TRACe:Y [:SCALe] :COUPle OFF|ON|0|1  
:DISPlay:EVM[1] | 2 | 3 | 4 | 5 :WINDow [1] | 2 | 3 | 4 :TRACe:Y [:SCALe] :COUPle?

Default: OFF

Default: On | Off

State Saved: Saved in instrument state.

Dependencies/Couplings: When the Scale Coupling is set to On, this value is automatically determined by the measurement result.  
When you set this value manually, Scale Coupling automatically changes to Off.

Example: DISP:EVM3:WIND2:TRAC:Y:COUP ON  
DISP:EVM3:WIND2:TRAC:Y:COUP?

**3.5.5.3 Trace/View**

Allows you to access Trace/View menus to select the desired measurement view from the following selections:

- **I/Q Measured Polar Graph** - Provides a combination view of an I/Q measured polar vector graph and the summary data as shown below
- **I/Q Error** - Provides a combination view of a magnitude error, phase error, EVM graphs. This view is only available for 802.11b and 802.11g ERP-DSSS/CCK/PBCC mode.
- **OFDM EVM** - Provides a combination view of a EVM vs. Carrier, EVM vs. Symbol, Numeric

Results. This view is only available for 802.11a and 802.11g ERP-OFDM/DSSS-OFDM mode.

- **Demod Bits**- Provides the demodulated data bits.
- **Result Metrics** - Provides a table of the modulation accuracy summary data such as, peak and rms EVM, magnitude error, phase error, and so forth in a text window, in terms of averaged and detected peak/maximum value in the average cycle.

Mode:	WLAN
Key Path:	<b>View/Display</b>
Remote Command:	:DISPlay:EVM:VIEW PGRaph ERRor OFDM BITS SUMMary :DISPlay:EVM:VIEW?
Default:	PGRaph
State Saved:	Saved in instrument state.
Example:	DISP:EVM:VIEW PGR DISP:EVM:VIEW?

**3.5.5.3.1 Window Selection** This remote command allows you to use SCPI to set the active window. You can also use **Next Window** Front Panel key to select the active window.

Mode:	WLAN
Remote Command:	:DISPlay:WINDow:SElect 1 2 3 4 :DISPlay:WINDow:SElect?
Default:	1
State Saved:	No
Dependencies/Couplings :	Changing the selected window changes the value displayed on the Window Content key. The 'green border' round the window shows the active window.
Example:	DISP:WIND:SEL 2 DISP:WIND:SEL?

---

**NOTE** Selection parameters 1 | 2 | 3 | 4 are different for different views. See [Table 3-17, "Window Selection Parameters,"](#) for parameter mapping.

---



**Table 3-17 Window Selection Parameters**

View	Parameter meaning			
	1	2	3	4
I/Q Measured Polar Graph	Numeric Results	Polar Graph	NA	NA
I/Q Error	Magnitude Error	Phase Error	EVM	Numeric Results
OFDM EVM	EVM vs. Symbols	EVM vs. Carriers	Polar Graph	Numeric Results
Decoded Bits	Decoded Bits	NA	NA	NA
Summary Table	Summary	NA	NA	NA

**3.5.5.4 Display**

Allows you to access Display menus.

**3.5.5.4.1 I/Q Polar** Selects from one of the following polar display types:

- **Vec&Constin**: Sets the view to display both the vector and constellation diagrams. Numeric results also appear on the left side of the screen.
- **Vector**: Sets the view to display an I/Q polar vector diagram and numeric results.
- **Constellation**: Sets the view to display numeric results and the constellation diagram.

Mode: WLAN

Key Path: **Display**

Remote Command: :DISPlay:EVM:IQPTType VCONstIn|VECTor|CONStIn  
:DISPlay:EVM:IQPTType?

Default: CONSTIn (See [Table 3-18, “I/Q Polar Default Setting”](#))

State Saved: Saved in instrument state.

Example: DISP:EVM:IQPT VCON  
DISP:EVM:IQPT?

**Table 3-18 I/Q Polar Default Setting**

Radio	I/Q Polar Default
802.11a	CONSTIn

**Table 3-18 I/Q Polar Default Setting**

802.11b	VCONStIn
802.11g ERP-OFDM	CONStIn
802.11g DSSS/CCK/PBCC	VCONStIn
802.11g DSSS-OFDM	CONStIn

**3.5.5.4.2 I/Q Points** Specify the total number of I/Q points displayed during each measurement interval in the **I/Q Measured Polar Vector Graph**.

Mode: WLAN

Key Path: Display

Remote Command: :DISPlay:EVM:IQPoints <integer>  
:DISPlay:EVM:IQPoints?

Default: 60 (See [Table 3-19, “I/Q Points Default Setting”](#))

Range: 1 — (Meas Interval), when Meas Interval <= 24564  
1 — 24564, when Meas Interval > 24564

State Saved: Saved in instrument state.

Dependencies/Couplings: Change of Meas Interval sets I/Q Points same number as Meas Interval, when Meas Interval is no greater than 24564. Otherwise, it will be clipped to 24564.

Example: DISP:EVM:IQP 60  
DISP:EVM:IQP?

**Table 3-19 I/Q Points Default Setting**

Radio	Front Panel Unit/Terminator Keys	Default
802.11a	Symbols	60
802.11b	chips	2794
802.11g ERP-OFDM	symbols	60
802.11g DSSS/CCK/PBCC	chips	2794
802.11g DSSS-OFDM	symbols	60

**3.5.5.4.3 I/Q Points Offset** Specify an offset from the first I/Q point in the constellation. If you choose to display only a subset of the I/Q points, this subset of displayed points is offset from the first I/Q point.

Mode: WLAN

Key Path: Display

Remote Command: :DISPlay:EVM:IQPoints:OFFSet <integer>  
:DISPlay:EVM:IQPoints:OFFSet?

Default: 0

Range: 0 ~ (Meas Interval – I/Q Points)

State Saved: Saved in instrument state.

Dependencies/Couplings: Change of Meas Interval sets I/Q Points Offset 0.

Example: DISP:EVM:IQP:OFFS 15  
DISP:EVM:IQP:OFFS?

I/Q Points Offset	Front Panel Unit/Terminator Keys
802.11a	Symbols
802.11b	chips
802.11g ERP-OFDM	symbols
802.11g DSSS/CCK/PBCC	chips
802.11g DSSS-OFDM	symbols

**3.5.5.4.4 I/Q Rotation** Specifies whether or not rotation is applied to the I/Q constellation. The I/Q constellation can be rotated from 0 to 359.5 degrees.

Mode: WLAN

Key Path: Display

Remote Command: :DISPlay:EVM:IQRotation <degrees>  
:DISPlay:EVM:IQRotation?  
:DISPlay:EVM:IQRotation:STATe ON|OFF|1|0  
:DISPlay:EVM:IQRotation:STATe?

Unit/Termination: DEG

Default:	Rotation: 45.0 State: OFF
State Saved:	Saved in instrument state.
Range:	0 — 359.5
Example:	DISP:EVM:IQR 276.5 DISP:EVM:IQR?

**3.5.5.4.5 Full Vector** When the **I/Q Points** value is less than **Meas Interval**, the non-selected portion of the I/Q vector is not displayed. When **Full Vector** is on, the trace of the hidden portion is displayed in grey.

Mode	WLAN
Key Path	<b>Display</b>
Default	OFF
State Saved	Saved in instrument state.
Remote Command	:DISPlay:EVM:FVEctor[:STATe] OFF ON 0 1 :DISPlay:EVM:FVEctor[:STATe] ?
Example	DISP:EVM:VECT ON DISP:EVM:VECT?

### 3.5.5.5 Meas Setup

**3.5.5.5.1 802.11a/g Meas Setup** Displays the measurement setup menu for the Modulation Accuracy Measurement when the **Modulation Accuracy Measurement** key has been selected.

**3.5.5.5.1.1 Meas Time** Sets the Measure Time parameter for WLAN measurement.

Mode:	WLAN
Key Path:	<b>Meas Setup</b>

- Search Length

Sets the length of time to acquire the input signal. This defines the length of time that the pulse search is performed.

The analyzer searches within the specified search length and demodulates the first complete pulse (or burst). The pulse can occur anywhere within the search length. Pulses beyond the first complete pulse are disregarded and are not demodulated.

Mode: WLAN

Key Path: Meas Setup, Meas Time

Remote Command: [:SENSe]:EVM:TIME:SEARChlength <real>  
[:SENSe]:EVM:TIME:SEARChlength?

Unit: s | ms | us

Default: 1 ms

Range: See [Table 3-20, "Search Length Setting"](#)

State Saved: Saved in instrument state.

Dependencies/Couplings : When Result Length is set to Man  
(5+2.5+ Result Length \*(1+Guard Interval))/ Subcarrier Spacing s  
When Result Length is set to Auto  
(5+2.5+ Max Result Length \*(1+Guard Interval))/ Subcarrier Spacing s

Example: EVM:TIME:SEAR 500 us  
EVM:TIME:SEAR?

**Table 3-20 Search Length Setting**

Radio	Preset/Default	Range
802.11a	1 ms	When Result Length is set to Man Min: (5+2.5+ Result Length *(1+Guard Interval))/ Subcarrier Spacing s Max: 800000/(IF BW * 1.25) s When Result Length is set to Auto Min: (5+2.5+Max Result Length*(1+Guard Interval))/ Subcarrier Spacing s Max: 800000/(IF BW * 1.25) s
802.11b	1 ms	When Result Length is set to Man Ceil (Result Length/Chip Rate) μsec When Result Length is set to Auto Ceil (Max Result Length/Chip Rate) μsec

**Table 3-20 Search Length Setting**

Radio	Preset/Default	Range
802.11g ERP-OFDM	1 ms	When Result Length is set to Man Min: $(5+2.5+ \text{Result Length} * (1+\text{Guard Interval}))/ \text{Subcarrier Spacing } s$ Max: $800000/(IF \text{ BW} * 1.25) s$ When Result Length is set to Auto Min: $(5+2.5+\text{Max Result Length}*(1+\text{Guard Interval}))/ \text{Subcarrier Spacing } s$ Max: $800000/(IF \text{ BW} * 1.25) s$
802.11g DSSS/CCK/PBC C	1 ms	When Result Length is set to Man Min: $\text{Ceil} (\text{Result Length}/\text{Chip Rate}) \mu\text{se}$ Max: $800000/(IF \text{ BW} * 1.25) s$ When Result Length is set to Auto Min: $\text{Ceil} (\text{Max Result Length}/\text{Chip Rate}) \mu\text{sec}$ Max: $800000/(IF \text{ BW} * 1.25) s$
802.11g DSSS-OFDM	1 ms	When Result Length is set to Man Min: $(5+2.5+ \text{Result Length} * (1+\text{Guard Interval}))/ \text{Subcarrier Spacing } s$ Max: $800000/(IF \text{ BW} * 1.25) s$ When Result Length is set to Auto Min: $(5+2.5+\text{Max Result Length}*(1+\text{Guard Interval}))/ \text{Subcarrier Spacing } s$ Max: $800000/(IF \text{ BW} * 1.25) s$

- Meas Interval

- 11a:

Specifies the measurement interval (length), in symbol times, of the portion of the OFDM burst that will be analyzed. This analyzed portion of the OFDM burst starts at a measurement offset specified by Meas Offset.

When Result Length is Auto, then the specified measurement interval will be clipped to be less than or equal to the value of Max Result Length. If the length of the auto-detected burst is shorter than the sum of the measurement interval and measurement offset, the actual results returned will be shortened so that they don't go beyond the end of the detected burst. If the detected burst is short enough, this may mean that many of the results are empty.

When Result Length is Man, then the specified measurement interval will be clipped to be less than or equal to the value of Result Length. In this case the results returned will be for exactly this many symbol times, regardless of the actual length of the burst.

- 11b:

Used to set the measurement interval (length), in chips, of the portion of the WLAN burst that will

be analyzed. This analyzed portion of the WLAN burst starts at a measurement offset specified by Meas Offset.

When Result Length is Auto, then the specified measurement interval will be clipped to be less than or equal to the value of Max Result Length. If the length of the auto-detected burst is shorter than the sum of the measurement interval and measurement offset, the actual results returned will be shortened so that they don't go beyond the end of the detected burst. If the detected burst is short enough, this may mean that many of the results are empty.

When Result Length is Man, then the specified measurement interval will be clipped to be less than or equal to the value of Result Length. In this case the results returned will be for exactly this many symbol times, regardless of the actual length of the burst.

Mode: WLAN

Key Path: **Meas Setup, Meas Time**

Remote Command: [:SENSe]:EVM:TIME:INTerval <integer>  
[:SENSe]:EVM:TIME:INTerval?

Default: 60 (See [Table 3-21, “Meas Interval Setting”](#))

Range: See [Table 3-21, “Meas Interval Setting”](#)

State Saved: Saved in instrument state.

Example: EVM:TIME:INT 60  
EVM:TIME:INT?

**Table 3-21 Meas Interval Setting**

Radio	Front Panel Unit/Terminat or Keys	Preset/Default	Range
802.11a	Symbols	60	2 — 1367
802.11b	chips	2794	2 — 96360
802.11g ERP-OFDM	symbols	60	2 — 1367
802.11g DSSS/CCK/PBCC	chips	2794	2 — 96360
802.11g DSSS-OFDM	symbols	60	2 — 1367

- Meas Offset

— 11a:

Specifies the measurement offset, in symbol times, of the portion of the OFDM burst that will be

analyzed. The length of this analyzed portion of the OFDM burst is specified by Meas Interval. If the specified measurement offset is less than zero, a value of zero is used instead.

When Result Length is Auto, then the specified measurement offset will be clipped to be less than or equal to the value of Max Result Length – Meas Interval.

When Result Length is Man, then the specified measurement offset will be clipped to be less than or equal to the value of Result Length – Meas Interval.

— 11b:

Used to set the measurement offset, in chips, of the portion of the WLAN burst that will be analyzed. The length of this analyzed portion of the WLAN burst is specified by Meas Interval. If the specified measurement offset is less than zero, a value of zero is used instead.

The measurement interval and offset are relative to the ideal starting point of the PLCP preamble portion of the burst. For a signal that uses the long PLCP format, the ideal starting point of the PLCP preamble is exactly 128 symbol times (128\*11 chip times) before the start of the SFD sync pattern. For a signal that uses the short PLCP format, the ideal starting point of the PLCP preamble is exactly 56 symbol times (56\*11 chip times) before the start of the SFD sync pattern.

When Result Length is Auto, then the specified measurement offset will be clipped to be less than or equal to the value of Max Result Length – Meas Interval.

When Result Length is Man, then the specified measurement offset will be clipped to be less than or equal to the value of Result Length – Meas Interval.

Mode: WLAN

Key Path: **Meas Setup, Meas Time**

Remote Command: [:SENSE]:EVM:TIME:OFFSet <integer>  
[:SENSE]:EVM:TIME:OFFSet?

Default: See [Table 3-22, “Meas Offset Default Setting”](#)

State Saved: Saved in instrument state.

Example: EVM:TIME:OFFS 0  
EVM:TIME:OFFS?

**Table 3-22 Meas Offset Default Setting**

Radio	Front Panel Unit/Terminator Keys	Preset/Default
802.11a	Symbols	0
802.11b	chips	22
802.11g ERP-OFDM	symbols	0



**Table 3-22 Meas Offset Default Setting**

Radio	Front Panel Unit/Terminator Keys	Preset/Default
802.11g DSSS/CCK/PBCC	chips	22
802.11g DSSS-OFDM	symbols	0

- Result Length

- 11a:

When Result Length is Auto, the length of the OFDM burst is auto-detected. For 802.11a/g, the result length is determined from the decoded SIGNAL symbol. The value of Max Result Length specifies the maximum result length for the burst; any burst longer than that will be treated as though that were the length of the burst.

When Result Length is Man, the user can specify the result length of the OFDM burst, in symbol times, regardless of the actual length of the burst.

This length includes the SIGNAL symbol in 802.11a/g, but does not include any part of the burst preamble.

If this value is greater than 1367, a value of 1367 is used instead. The 1367 value is the maximum possible burst length of an 802.11a/g burst.

Result Length specifies the length of the OFDM burst. The actual results returned will be for a subset of this, as specified by Meas Interval and Meas Offset.

- 11b:

When Result Length is Auto, the length of the WLAN burst is auto-detected from the LENGTH and SERVICE portions of the PLCP header. The value of Max Result Length specifies the maximum result length for the burst; any burst longer than that will be treated as though that were the length of the burst.

When Result Length is Man, the user can specify the result length of the WLAN burst, in chip times. This length includes the PLCP preamble and PLCP header. The default value corresponds to a result length of 256  $\mu$ s at the default chip rate.

Mode: WLAN

Key Path: Meas Setup, Time

Remote Command: [:SENSe]:EVM:TIME:RESult:LENGth <integer>  
[:SENSe]:EVM:TIME:RESult:LENGth?  
[:SENSe]:EVM:TIME:RESult[:STATe]:AUTO OFF|ON|0|1  
[:SENSe]:EVM:TIME:RESult[:STATe]:AUTO?

Default: 60 (See Table 3-23, “Result Len Setting”)

State Saved: Saved in instrument state.

Example: EVM:TIME:RES:LENG 60  
EVM:TIME:RES:LENG?  
EVM:TIME:RES:AUTO ON  
EVM:TIME:RES:AUTO?

**Table 3-23 Result Len Setting**

Result Len	Front Panel Unit/Terminat or Keys	Preset/Default	Range
802.11a	Symbols	60	2 — 1367
802.11b	chips	2816	2 — 96360
802.11g ERP-OFDM	symbols	60	2 — 1367
802.11g DSSS/CCK/PBCC	chips	2816	2 — 96360
802.11g DSSS-OFDM	symbols	60	2 — 1367

- Max Result Length

- 11a:

Specifies a maximum result length, in symbol times. This length includes the SIGNAL symbol in 802.11a/g, but does not include any part of the burst preamble. Max Result Length is used only when Result Length is Auto. In that case, the length of the burst is auto-detected, but when the auto-detected length is greater than the specified maximum result length, the maximum result length is used instead. This provides a way for the user to limit the required length of the input data, and the maximum length of the results returned. This is useful because OFDM burst lengths can potentially vary from very short to very long.

If this value is greater than 1367, a value of 1367 is used instead. The 1367 value is the maximum possible burst length of an 802.11a/g burst.

Max Result Length specifies a maximum result length. The actual results returned will be for a subset of this maximum, as specified Meas Interval and Meas Offset, and will be further limited to the auto-detected result length if that is shorter than the maximum result length.

When Max Result Length is greater-than the burst length, the measurement result length will be the number of symbol-times detected within the burst.

- 11b:

Specifies a maximum result length, in chips. This length includes the PLCP preamble and PLCP header. Max Result Length is used only when Result Length is Auto. In that case, the length of the burst is auto-detected, but if the auto-detected length is greater than the specified maximum result length, the maximum result length is used instead. This provides a way for the user to limit the

required length of the input data, and the maximum length of the results returned. This is useful because WLAN burst lengths can potentially vary from very short to very long. The default value corresponds to a result length of 256  $\mu$ s at the default chip rate.

When Max Result Length is greater the burst length, the measurement result length will default to the number of chips detected within the burst.

Mode: WLAN

Key Path: Meas Setup, Time

Remote Command: [:SENSe]:EVM:TIME:RESMax <integer>  
[:SENSe]:EVM:TIME:RESMax?

Default: 60 (See Table 3-24, “Max Result Length Setting”)

State Saved: Saved in instrument state.

Dependencies/Couplings : Used only when the Result Length is set to "Auto".

Example: EVM:TIME:RESM 60  
EVM:TIME:RESM?

**Table 3-24 Max Result Length Setting**

Radio	Front Panel Unit/Terminator Keys	Preset/Default	Max
802.11a	Symbols	60	1367
802.11b	chips	2816	96360
802.11g ERP-OFDM	symbols	60	1367
802.11g DSSS/CCK/PBCC	chips	2816	96360
802.11g DSSS-OFDM	symbols	60	1367

**3.5.5.5.1.2 IF BW** Sets the Wideband IF BW.

Mode: WLAN

Key Path: Meas Setup

Remote Command: [:SENSe]:EVM:IFBW <real>  
[:SENSe]:EVM:IFBW?

Unit: Hz | kHz | MHz | GHz

Range: Opt.122: 8 MHz — 80 MHz  
Opt.140: 8 MHz — 40 MHz

Default: 32.000 MHz (See [Table 3-25](#), “IF BW Default Setting”)

State Saved: Saved in instrument state.

Example: EVM:IFBW 22.0 MHz  
EVM:IFBW?

**Table 3-25 IF BW Default Setting**

Radio	Preset/Default
802.11a	32.000 MHz
802.11b	35.200 MHz
802.11g ERP-OFDM	32.000 MHz
802.11g DSSS/CCK/PBC C	35.200 MHz
802.11g DSSS-OFDM	32.000 MHz

**3.5.5.5.1.3 Wideband Setup** This key invokes the WBIF Setup menu from which the user can set parameters of WB path.

Mode: WLAN

Key Path: **Meas Setup**

- Wideband IF Gain  
Sets the Wideband IFGain.

Mode: WLAN

Key Path: **Meas Setup, Wideband Setup**

Remote Command: [:SENSe]: EVM:WBIF:IFGain <integer>  
[:SENSe]: EVM:WBIF:IFGain?

Unit/Termination: dB

Default: 0 dB  
 State Saved: Saved in instrument state.  
 Example: EVM:WBIF:IFG 0  
 EVM:WBIF:IFG?

- Wideband Advanced  
 Allows you to access Wideband Advanced menu.

Mode: WLAN  
 Key Path: Meas Setup

— ADC Correction

This SCPI command initiates the ADC calibration to reduce the spectral imaging and applies the correction.

Mode: WLAN  
 Key Path: Meas Setup, Wideband Setup, Wideband Advanced  
 Remote Command: [:SENSe]:EVM:WBIF:ADCCorrect OFF|ON|0|1  
 [:SENSe]:EVM:WBIF:ADCCorrect?  
 Default: ON  
 State Saved: Saved in instrument state.  
 Dependencies/Couplings: Coupled with ADC Correction of other measurements.  
 Example: EVM:WBIF:ADCC ON  
 EVM:WBIF:ADCC?

— IF Flatness Correction

Turns IF flatness corrections on and off in all wideband IF measurements.

Mode: WLAN  
 Key Path: Meas Setup, Wideband Setup, Wideband Advanced  
 Remote Command: [:SENSe]:EVM:WBIF:FLATness OFF|ON|0|1  
 [:SENSe]:EVM:WBIF:FLATness?  
 Default: ON  
 State Saved: Saved in instrument state.

**Dependencies/Couplings:** Coupled with WBIF Flatness of other measurements.

**Example:** EVM:WBIF:FLAT ON  
EVM:WBIF:FLAT?

— WB ADC Dither

This turns the wideband dither signal on or off. This control is independent of the narrowband ADC dither.

**Mode:** WLAN

**Key Path:** **Meas Setup, Wideband Setup, Wideband Advanced**

**Remote Command:** [:SENSe]:EVM:WBIF:ADC:DITHer OFF|ON|0|1  
[:SENSe]:EVM:WBIF:ADC:DITHer?

**Default:** OFF

**State Saved:** Saved in instrument state.

**Example:** EVM:WBIF:ADC:DITH ON  
EVM:WBIF:ADC:DITH?

— Trigger Interpolation

Turns trigger interpolation on and off. At lower sample rates for interpolating the trigger results in a loss of the LO phase lock. To allow for continuous lock, a method of turning off the trigger interpolation has been added. When interpolation is turned off, the trigger offset is returned by means of the EVM:WBIF:TRIG:EOFFset command. Applies only for external trigger.

**Mode:** WLAN

**Key Path:** **Meas Setup, Wideband Setup, Wideband Advanced**

**Remote Command:** [:SENSe]:EVM:WBIF:TRIGger:INTerpolate OFF|ON|0|1  
[:SENSe]:EVM:WBIF:TRIGger:INTerpolate?

**Default:** OFF

**State Saved:** Saved in instrument state.

**Example:** EVM:WBIF:TRIG:INT ON  
EVM:WBIF:TRIG:INT?

**3.5.5.5.1.4 Avg Number** Sets the number that will be averaged. After the specified number (average counts) have been averaged, the averaging mode (termination control) setting determines the averaging action.

Mode	WLAN
Key Path	<b>Meas Setup</b>
Default	10
State Saved	Saved in instrument state.
Remote Command	<code>[ :SENSe ] :EVM:AVERage:COUNT &lt;integer&gt;</code> <code>[ :SENSe ] :EVM:AVERage:COUNT?</code>
Remote Command Notes	You must be in the WLAN mode to use this command. Use <code>INSTRument:SElect</code> to set the mode.
Example	<code>:EVM:AVER:COUN 10</code> <code>:EVM:AVER:COUN?</code> <code>:EVM:AVER ON</code> <code>:EVM:AVER?</code>

**3.5.5.5.1.5 Average Mode** Selects the type of termination control used for averaging. This setting determines the averaging action after the specified number of frames (average count) is reached.

**Exponential** - Each successive data acquisition after the average count is reached, is exponentially weighted and combined with the existing average.

**Repeat** - After reaching the average count, the averaging is reset and a new average is started.

Mode:	WLAN
Key Path:	<b>Meas Setup</b>
Remote Command:	<code>[ :SENSe ] :EVM:AVERage:TCONtrol EXPonential REPeat</code> <code>[ :SENSe ] :EVM:AVERage:TCONtrol?</code>
Default:	REPeat
State Saved:	Saved in instrument state.
Remote Command Notes:	You must be in the WLAN mode to use this command. Use <code>INSTRument:SElect</code> to set the mode.
Example:	<code>:EVM:AVER:TCON REP</code> <code>:EVM:AVER:TCON?</code>

**3.5.5.5.1.6 Trigger Source** Displays menu keys that enable you to select the trigger mode of a measurement. When in a trigger mode other than Free Run, the analyzer will begin the measurement only when the trigger condition is met. The available trigger modes are as follows:

- **Free Run:** The next measurement is taken immediately, capturing the signal asynchronously (also called 'immediate').
- **Video:** An internal IF envelope trigger that occurs at the absolute threshold level of the IF signal level.

- **Ext Front:** Sets the trigger directly to an external signal connected to the front-panel EXT TRIGGER INPUT connector. No measurement will be made unless a signal is connected to the EXT TRIGGER INPUT connector on the front-panel.
- **Ext Rear:** Sets the trigger directly to an external signal connected to the rear-panel TRIGGER IN connector. No measurement will be made unless a signal is connected to the TRIGGER IN connector on the rear panel. **Mode Setup** key or the measurement firmware, but not both. Refer to the specific measurement section for details.

Mode: WLAN

Key Path: **Meas Setup**

Remote Command: [:SENSe]:EVM:TRIGger:SOURce IMMEDIATE|IF|EXTeRnal [1] |EXTeRnal2  
[:SENSe]:EVM:TRIGger:SOURce?

Default: IMMEDIATE

State Saved: Saved in instrument state.

Example: EVM:TRIG:SOUR IMM  
EVM:TRIG:SOUR?

**3.5.5.5.1.7 Subcarrier** Specifies whether the demodulation results are for all subcarriers in the signal, or for a single subcarrier, or for just the pilot subcarriers.

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**NOTE** The Subcarrier key is available only for 802.11a/g mode.

---

Mode: WLAN

Key Path: **Meas Setup, More**

Remote Command: [:SENSe]:EVM:SUBCarrier ALL|PILOt |SINGLE  
[:SENSe]:EVM:SUBCarrier?

Default: ALL

State Saved: Saved in instrument state.

Example: EVM:SUBC ALL  
EVM:SUBC?

**3.5.5.5.1.8 Subcarrier Number** Specifies the demodulation results are for which subcarrier.

---

**NOTE** is available only for 802.11a/g mode.

---



Mode	WLAN
Key Path	<b>Meas Setup, More</b>
Default	1
State Saved	Saved in instrument state.
Dependencies/Couplings	Valid only when subcarrier is set to single.
Remote Command	[ :SENSe ] :EVM:SUBCarrier:COUNT <integer> [ :SENSe ] :EVM:SUBCarrier:COUNT?
Example	EVM:SUBC:COUN 1 EVM:SUBC:COUN?

### 3.5.5.5.1.9 Advanced

---

**NOTE** This subsection is available only for 802.11a/g mode.

---

Allows you to set some advanced parameters for 802.11a, 802.11g ERP-OFDM and 802.11g DSSS-OFDM.

Mode:	WLAN
Key Path:	<b>Meas Setup, More</b>

- Symbol Timing Adjust

Normally, when demodulating an OFDM symbol, the guard interval is skipped over, and an FFT is performed on the last portion of the symbol time. However, this means that the FFT would include the transition region between this symbol and the following symbol. To avoid this, it is generally beneficial to back up away from the end of the symbol time, and use a part of the guard interval.

Symbol Timing Adjust controls how far the FFT part of the symbol is adjusted away from the end of the symbol time. The value is in terms of percent of the used (FFT) part of the symbol time. The value must be between zero (meaning no adjustment) and (-100 \* Guard Interval). Values outside of that range are clipped to the limit. Note that value is negative, because the FFT start time is moved back by.

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Advanced</b>
Remote Command:	[ :SENSe ] :EVM:TADJust <percent> [ :SENSe ] :EVM:TADJust?
Unit:	%
Default:	-3.125

State Saved:	Saved in instrument state.
Remote Command Notes:	Min value = $-100 \times \text{Guard Interval}$
Example:	:EVM:TADJ -3.125 :EVM:TADJ?

- Sync Training Seq

Specifies synchronization method to use when synchronizing to the start of the OFDM burst. The valid values are Short or Long. If an invalid value is received, it is converted to Long.

A value of Short means to search for and synchronize to an 802.11a preamble short symbol sequence. This value should not be used for 802.11g DSSS-OFDM, because the DSSS-OFDM preamble does not contain the short symbol sequence.

A value of to Long means to search for and synchronize to an 802.11a/g preamble long symbol sequence (also called the channel estimation sequence).

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Advanced</b>
Remote Command:	[ :SENSe ] :EVM:SYNCseq LONG   SHORt   0   1 [ :SENSe ] :EVM:SYNCseq?
Default:	SHORt
State Saved:	Saved in instrument state.
Example:	EVM:SYNC SHOR EVM:SYNC?

- Pilot Track

Specifies how to track the pilot.

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Advanced</b>

- Track Amplitude

Specifies whether the demodulation will track the pilot amplitude over the course of the OFDM burst.

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Advanced, Pilot Track</b>

**Remote Command:** [:SENSe]:EVM:TRACk:PILot:AMP OFF|ON|0|1  
[:SENSe]:EVM:TRACk:PILot:AMP?

**Default:** OFF

**State Saved:** Saved in instrument state.

**Example:** EVM:TRAC:PIL:AMP OFF  
EVM:TRAC:PIL:AMP?

— Track Phase

Specifies whether the demodulation will track the pilot phase over the course of the OFDM burst.

**Mode:** WLAN

**Key Path:** **Meas Setup, More, Advanced, Pilot Track**

**Remote Command:** [:SENSe]:EVM:TRACk:PILot:PHASe OFF|ON|0|1  
[:SENSe]:EVM:TRACk:PILot:PHASe?

**Default:** ON

**State Saved:** Saved in instrument state.

**Example:** EVM:TRAC:PIL:PHAS ON  
EVM:TRAC:PIL:PHAS?

— Track Timing

Specifies whether the demodulation will track the pilot timing over the course of the OFDM burst.

**Mode:** WLAN

**Key Path:** **Meas Setup, More, Advanced, Pilot Track**

**Remote Command:** [:SENSe]:EVM:TRACk:PILot:TIMing OFF|ON|0|1  
[:SENSe]:EVM:TRACk:PILot:TIMing?

**Default:** OFF

**State Saved:** Saved in instrument state.

**Example:** EVM:TRAC:PIL:TIM OFF  
EVM:TRAC:PIL:TIM?

- Equalizer Training

Specifies how the equalizer is initialized, or "trained". The valid values are Channel Estimation Seq Only and Channel Estimation Seq & Data. The value Channel Estimation Seq Only, which is the default, specifies that the equalizer is trained using only the channel estimation sequence (also called

the "long sync") portion of the burst preamble. The 802.11a/g standards imply that the equalizer should be implemented this way when measuring EVM, and this matches how a real receiver would probably implement an equalizer.

The value and Channel Estimation Seq & Data specifies that the equalizer should be trained using both the channel estimation sequence and the entire data portion of the burst. This usually gives a more accurate estimate of the equalizer response. It also typically lowers the EVM by one or two dB.

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Advanced</b>
Remote Command:	<code>[ :SENSe ] :EVM:EQUalizer:TRAIning SEQ SDATa</code> <code>[ :SENSe ] :EVM:EQUalizer:TRAIning?</code>
Default:	SEQ
State Saved:	Saved in instrument state.
Example:	EVM:EQU:TRA SEQ EVM:EQU:TRA?

- I/Q Normalize

Specifies if the I/Q signals will be normalized.

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Advanced</b>
Remote Command:	<code>[ :SENSe ] :EVM:IQNorm OFF ON 0 1</code> <code>[ :SENSe ] :EVM:IQNorm?</code>
Default:	ON
State Saved:	Saved in instrument state.
Example:	EVM:IQN ON EVM:IQN?

- Mirror Spectrum

Sets Mirror Spectrum to On to conjugate the input time data before any processing of the signal. This will mirror the frequency spectrum of the input data around the center frequency. Most measurement results are computed using frequency mirroring, but the exception is the Freq Error measurement. This result is computed relative to the original unmodified input signal.

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Advanced</b>

**Remote Command:**        [:SENSe]:EVM:MIRRorspec OFF|ON|0|1  
                              [:SENSe]:EVM:MIRRorspec?

**Default:**                OFF

**State Saved:**         Saved in instrument state.

**Example:**                EVM:MIRR OFF  
                              EVM:MIRR?

### 3.5.5.5.1.10 Limits

---

**NOTE**                This subsection is available only for 802.11a/g mode.

---

- 6 Mbits/s RMS EVM

Sets 6 Mbits/s RMS EVM limit to warn you when the measured average RMS EVM value exceeds a limit. When the average RMS EVM result exceeds the limit, a red **FAIL** indicator appears in the PASS/FAIL window. When the average RMS EVM result is less than the limit, a green **PASS** indicator appears in the PASS/FAIL window.

**Mode:**                    WLAN

**Key Path:**                **Meas Setup, More, Limits**

**Remote Command:**        :CALCulate:EVM:LIMit:RMS:M6 <real>  
                              :CALCulate:EVM:LIMit:RMS:M6?

**Unit/Termination:**        dB

**Default:**                -5.00 dB

**State Saved:**         Saved in instrument state.

**Example:**                CALC:EVM:LIM:RMS:M6 -5.0  
                              CALC:EVM:LIM:RMS:M6?

- 9 Mbits/s RMS EVM

Sets 9 Mbits/s RMS EVM limit to warn you when the measured average RMS EVM value exceeds a limit. When the average RMS EVM result exceeds the limit, a red **FAIL** indicator appears in the PASS/FAIL window. When the average RMS EVM result is less than the limit, a green **PASS** indicator appears in the PASS/FAIL window.

**Mode:**                    WLAN

**Key Path:**                **Meas Setup, More, Limits**

Remote Command:           :CALCulate:EVM:LIMit:RMS:M9 <real>  
                              :CALCulate:EVM:LIMit:RMS:M9?

Unit/Termination:         dB

Default:                   -8.00 dB

State Saved:               Saved in instrument state.

Example:                   CALC:EVM:LIM:RMS:M9 -8.0  
                              CALC:EVM:LIM:RMS:M9?

- 12 Mbits/s RMS EVM

Sets 12 Mbits/s RMS EVM limit to warn you when the measured average RMS EVM value exceeds a limit. When the average RMS EVM result exceeds the limit, a red **FAIL** indicator appears in the PASS/FAIL window. When the average RMS EVM result is less than the limit, a green **PASS** indicator appears in the PASS/FAIL window.

Mode:                       WLAN

Key Path:                   **Meas Setup, More, Limits**

Remote Command:           :CALCulate:EVM:LIMit:RMS:M12 <real>  
                              :CALCulate:EVM:LIMit:RMS:M12?

Unit/Termination:         dB

Default:                   -10.00 dB

State Saved:               Saved in instrument state.

Example:                   CALC:EVM:LIM:RMS:M12 -10.0  
                              CALC:EVM:LIM:RMS:M12?

- 18 Mbits/s RMS EVM

Sets 18 Mbits/s RMS EVM limit to warn you when the measured average RMS EVM value exceeds a limit. When the average RMS EVM result exceeds the limit, a red **FAIL** indicator appears in the PASS/FAIL window. When the average RMS EVM result is less than the limit, a green **PASS** indicator appears in the PASS/FAIL window.

Mode:                       WLAN

Key Path:                   **Meas Setup, More, Limits**

Remote Command:           :CALCulate:EVM:LIMit:RMS:M18 <real>  
                              :CALCulate:EVM:LIMit:RMS:M18?

Unit/Termination:         dB

Default:                   -13 dB

State Saved: Saved in instrument state.  
 Example: CALC:EVM:LIM:RMS:M18 -13.0  
 CALC:EVM:LIM:RMS:M18?

- 24 Mbits/s RMS EVM

Sets 24 Mbits/s RMS EVM limit to warn you when the measured average RMS EVM value exceeds a limit. When the average RMS EVM result exceeds the limit, a red FAIL indicator appears in the PASS/FAIL window. When the average RMS EVM result is less than the limit, a green PASS indicator appears in the PASS/FAIL window.

Mode: WLAN  
 Key Path: Meas Setup, More, Limits  
 Remote Command: :CALCulate:EVM:LIMit:RMS:M24 <real>  
 :CALCulate:EVM:LIMit:RMS:M24?  
 Unit/Termination: dB  
 Default: -16 dB  
 State Saved: Saved in instrument state.  
 Example: CALC:EVM:LIM:RMS:M24 -16.0  
 CALC:EVM:LIM:RMS:M24?

- 36 Mbits/s RMS EVM

Sets 36 Mbits/s RMS EVM limit to warn you when the measured average RMS EVM value exceeds a limit. When the average RMS EVM result exceeds the limit, a red FAIL indicator appears in the PASS/FAIL window. When the average RMS EVM result is less than the limit, a green PASS indicator appears in the PASS/FAIL window.

Mode: WLAN  
 Key Path: Meas Setup, More, Limits  
 Remote Command: :CALCulate:EVM:LIMit:RMS:M36 <real>  
 :CALCulate:EVM:LIMit:RMS:M36?  
 Unit/Termination: dB  
 Default: -19 dB  
 State Saved: Saved in instrument state.  
 Example: CALC:EVM:LIM:RMS:M36 -19.0  
 CALC:EVM:LIM:RMS:M36?

- 48 Mbits/s RMS EVM

Sets 48 Mbits/s RMS EVM limit to warn you when the measured average RMS EVM value exceeds a limit. When the average RMS EVM result exceeds the limit, a red `FAIL` indicator appears in the PASS/FAIL window. When the average RMS EVM result is less than the limit, a green `PASS` indicator appears in the PASS/FAIL window.

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Limits, More</b>
Remote Command:	:CALCulate:EVM:LIMit:RMS:M48 <real> :CALCulate:EVM:LIMit:RMS:M48?
Unit/Termination:	dB
Default:	-22 dB
State Saved:	Saved in instrument state.
Example:	CALC:EVM:LIM:RMS:M48 -22.0 CALC:EVM:LIM:RMS:M48?

- 54 Mbits/s RMS EVM

Sets 54 Mbits/s RMS EVM limit to warn you when the measured average RMS EVM value exceeds a limit. When the average RMS EVM result exceeds the limit, a red `FAIL` indicator appears in the PASS/FAIL window. When the average RMS EVM result is less than the limit, a green `PASS` indicator appears in the PASS/FAIL window.

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Limits, More</b>
Remote Command:	:CALCulate:EVM:LIMit:RMS:M54 <real> :CALCulate:EVM:LIMit:RMS:M54?
Unit/Termination:	dB
Default:	-25 dB
State Saved:	Saved in instrument state.
Example:	CALC:EVM:LIM:RMS:M54 -25.0 CALC:EVM:LIM:RMS:M54?

- Freq Error Limit

Sets a frequency error limit to warn you when the measured average frequency error value exceeds a limit. When the average frequency error result exceeds the limit, a red `FAIL` indicator appears in the PASS/FAIL window. When the average frequency error result is less than the limit, a green `PASS` indicator appears in the PASS/FAIL window.



Mode: WLAN

Key Path: Meas Setup, More, Limits, More

Remote Command: :CALCulate:EVM:LIMit:FERRor <freq>  
:CALCulate:EVM:LIMit:FERRor?

Unit/Termination: ppm

Default: 20.00 ppm

Range: 0 — 500

State Saved: Saved in instrument state.

Example: CALC:EVM:LIM:FERR 20  
CALC:EVM:LIM:FERR?

IF BW	Front Panel Access	Preset/Default
802.11a	Meas Setup, More, Limits, More, 3	20.00 ppm
802.11b	Meas Setup, More, Limits, 3	25.00 ppm
802.11g ERP-OFDM	Meas Setup, More, Limits, More, 3	20.00 ppm
802.11g DSSS/CCK/P BCC	Meas Setup, More, Limits, 3	25.00 ppm
802.11g DSSS-OFDM	Meas Setup, More, Limits, More, 3	20.00 ppm

- Clock Error Limit

Sets a clock error limit to warn you when the measured clock error value exceeds a limit. When the clock error result exceeds the limit, a red FAIL indicator appears in the PASS/FAIL window. When the clock error result is less than the limit, a green PASS indicator appears in the PASS/FAIL window.

Mode: WLAN

Key Path: **Meas Setup, More, Limits, More**

Remote Command: :CALCulate:EVM:LIMit:CLKerror <real>  
:CALCulate:EVM:LIMit:CLKerror?

Unit/Termination: ppm

Default: 20.00 ppm

State Saved: Saved in instrument state.

Remote Command Notes: Default see [Table 3-26, “Clock Error Default Settings”](#)

Example: CALC:EVM:LIM:CLK 43  
CALC:EVM:LIM:CLK?

**Table 3-26 Clock Error Default Settings**

IF BW	Front Panel Access	Preset/Default	Key Label	Active Function Text
802.11a	Meas Setup, More, Limits, More, 4	20.00	Symbol clock error	Symbol clock error
802.11b	Meas Setup, More, Limits, 4	25.00	Chip clock error	Chip clock error
802.11g ERP-OFDM	Meas Setup, More, Limits, More, 4	20.00	Symbol clock error	Symbol clock error
802.11g DSSS/CCK/PBCC	Meas Setup, More, Limits, 4	25.00	Chip clock error	Chip clock error
802.11g DSSS-OFDM	Meas Setup, More, Limits, More, 4	20.00	Symbol clock error	Symbol clock error

- I/Q Origin Offset

Sets an I/Q Origin Offset limit to warn you when the measured I/Q Origin Offset exceeds a limit. When the I/Q Origin Offset result exceeds the limit, a red FAIL indicator appears in the PASS/FAIL window. When the Chip clock error result is less than the limit, a green PASS indicator appears in the PASS/FAIL window.

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Limits, More</b>
Remote Command:	:CALCulate:EVM:LIMit:IQOFset <real> :CALCulate:EVM:LIMit:IQOFset?
Unit/Termination:	dB
Default:	-15.00 dB
State Saved:	Saved in instrument state.
Remote Command Notes:	Default see the following table
Example:	CALC:EVM:LIM: IQOF -15 CALC:EVM:LIM: IQOF?

**3.5.5.5.1.11 Restore Meas Defaults** Sets the measure setup parameters to the factory defaults only for the currently selected measurement. This function is only on MUI (Front Panel), and not equipped with SCPI.

Mode:	WLAN
Key Path:	<b>Meas Setup, More</b>
Remote Command:	[:SENSe]:EVM:REStore:DEFaults
Dependencies/Couplings:	Selecting measurement preset will restore all measurement parameters to their default values for the current measurement.

**3.5.5.5.2 802.11b/g Meas Setup** Displays the measurement setup menu for the 802.11b Modulation Accuracy Measurement when the **Modulation Accuracy Measurement** key has been selected in the **Measure** menu and the **Radio | WLAN Std | 802.11b** key has been selected in the **Mode Setup** menu.

---

**NOTE** Those keys covered in the previous 802.11a/g Meas Setup refer to [Section 3.5.5.5.1.1 “Meas Time”](#), [Section 3.5.5.5.1.2 “IF BW”](#), [Section 3.5.5.5.1.3 “Wideband Setup”](#), [Section 3.5.5.5.1.4 “Avg Number”](#), [Section 3.5.5.5.1.5 “Average Mode”](#), [Section 3.5.5.5.1.6 “Trigger Source”](#), and [Section 3.5.5.5.1.11 “Restore Meas Defaults”](#).

---

**3.5.5.5.2.1 Filter** Sets the Filter parameter for WLAN measurement.

- Reference Filter

Controls the reference filter type used when calculating the reference data for EVM.

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Filter</b>
Remote Command:	[ :SENSe ] :EVM:FILTer:REFerence:TYPE GAUS   RECT   RC [ :SENSe ] :EVM:FILTer:BT?
Default:	RECT
State Saved:	Saved in instrument state.
Example:	EVM:FILT:REF:TYPE RECT EVM:FILT:REF:TYPE?

- BT

BT is used only when the Reference Filter is set to "GAUSSIAN" or "Raised Cosine", or the measurement filter is set to "RC". In these cases, BT controls the BT value for the Gaussian filter and alpha values for Raised Cosine and RC filters.

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Filter</b>
Remote Command:	[ :SENSe ] :EVM:FILTer:BT <real> [ :SENSe ] :EVM:FILTer:BT?
Default:	0.5
Range:	Gaussian: 0.05 — 100.0 Raised Cosine: 0.05 — 1.0
State Saved:	Saved in instrument state.
Dependencies/Couplings	Yes
:	
Example:	EVM:FILT:BT 0.5 EVM:FILT:BT?

**3.5.5.5.2.2 Advanced** Used to set some advanced parameters for WLAN measurement.

- Chip Rate

Specifies the fundamental chip rate of the signal to be analyzed. The value must be positive. Non-positive values are converted to 1 Hz. The default is 11 MHz, which matches the chip rate of 802.11b/g.

The only special case is the optional 802.11g 33Mbit PBCC mode. In this mode, the chip rate of the transmitted signal starts at 11 MHz, but changes to 16.5 MHz in the middle of the burst. For signals of this type, the CHIP\_RATE should still be specified as 11 MHz, and the measurement will automatically switch to 16.5 MHz at the appropriate place in the burst.

Mode: WLAN

Key Path: **Meas Setup, More, Advanced**

Remote Command: [:SENSE]:EVM:CHPRate <frequency>  
[:SENSE]:EVM:CHPRate?

Unit: Hz | kHz | MHz

Default: 11.0 MHz

State Saved: Saved in instrument state.

Example: EVM:CHPR 11.0 MHz  
EVM:CHPR?

- Clock Adjust

In a normal measurement, the signal is synchronized to the chip timing. In unusual cases, it is possible for the synchronization to be off slightly. The Clock Adjust key allows the user to specify a timing offset which is added to the chip timing detected. This key should only be used when trying to debug unusual signals.

The maximum value for is 0.5 chips, and the minimum valid value is -0.5 chips.

Mode: WLAN

Key Path: **Meas Setup, More, Advanced**

Remote Command: [:SENSE]:EVM:CLKadj <real>  
[:SENSE]:EVM:CLKadj?

Default: 0.0 chips

State Saved: Saved in instrument state.

Example: EVM:CLK -0.1  
EVM:CLK?

- Equalizer Len

Specifies the total length of the equalizer filter's impulse response in chips.

The minimum valid value for is 3. The maximum valid value is 99, and also must be less than either Max Result Length or Result Length. The value must be an odd number. The impulse response is centered, so that it extends  $(EQ\_FILT\_LEN-1)/2$  chips on either side of  $t=0$ .

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Advanced</b>
Remote Command:	[:SENSe]:EVM:EQUalizer:LENGth <integer> [:SENSe]:EVM:EQUalizer:LENGth? [:SENSe]:EVM:EQUalizer[:STATe] OFF ON  0 1 [:SENSe]:EVM:EQUalizer[:STATe]?
Default:	21 chips
State Saved:	Saved in instrument state.
Example:	EVM:EQU:LENG 21 EVM:EQU:LENG? EVM:EQU ON EVM:EQU ON?

- Descramble

Specifies what type of descrambling to do when producing bit vector results. The valid values are: On, Off, Preamble Only, Preamble & Header Only. OFF means no descrambling is done at all. Preamble Only means only the PLCP preamble is descrambled. Preamble & Header Only means that the PLCP preamble and PLCP header are descrambled. ON means that all parts of the burst are descrambled.

Normally, an 802.11b/g signal has all bits scrambled before transmission, so normally you would want to descramble all of the bit vector results. However, when debugging an 802.11b/g transmitter, it is sometimes helpful to disable scrambling in the transmitter, in which case you would disable descrambling.

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Advanced</b>
Remote Command:	[:SENSe]:EVM:PREamble ALL NONE PONLy PHONLy [:SENSe]:EVM:PREamble?
Default:	ALL
State Saved:	Saved in instrument state.
Example:	EVM:PRE ALL EVM:PRE?

- Track Phase

Specifies whether to perform phase tracking, that is to track carrier frequency changes during the course of the WLAN burst. The default is FALSE, because the 802.11b/g standards do not appear to call for phase tracking. If Track Phase is TRUE, phase tracking is performed after all frequency/phase/timing synchronization, and before any equalization or computation of EVM.

Mode: WLAN

Key Path: **Meas Setup, More, Advanced**

Remote Command: [:SENSe]:EVM:TRACk:PHASe OFF|ON|0|1  
[:SENSe]:EVM:TRACk:PHASe?

Default: OFF

State Saved: Saved in instrument state.

Example: EVM:TRAC:PHAS OFF  
EVM:TRAC:PHAS?

**3.5.5.5.2.3 Limits** Accesses the **Limits** key menu to change the following parameters:

- **RMS EVM Limit**

Sets an RMS EVM limit to warn you when the measured average RMS EVM value exceeds a limit. When the average RMS EVM result exceeds the limit, a red **FAIL** indicator appears in the **PASS/FAIL** window. When the average RMS EVM result is less than the limit, a green **PASS** indicator appears in the **PASS/FAIL** window.

Mode: WLAN

Key Path: **Meas Setup, More, Limits**

Remote Command: :CALCulate:EVM:LIMit:RMS <real>  
:CALCulate:EVM:LIMit:RMS?

Unit/Termination: pcnt

Default: 16.0

State Saved: Saved in instrument state.

Range: 0 — 100

Example: CALC:EVM:LIM:RMS 43  
CALC:EVM:LIM:RMS?

- **1000 Chips EVM Limit**

Sets an 1000 Chips EVM limit to warn you when the measured average 1000 Chips value exceeds a limit. When the average 1000 Chips EVM result exceeds the limit, a red **FAIL** indicator appears in the **PASS/FAIL** window. When the average 1000 Chips EVM result is less than the limit, a green **PASS** indicator appears in the **PASS/FAIL** window.

Mode: WLAN

Key Path: **Meas Setup, More, Limits**

Remote Command:	:CALCulate:EVM:LIMit:CHIPs1000 <real> :CALCulate:EVM:LIMit:CHIPs1000?
Unit/Termination:	pcnt
Default:	35.0
State Saved:	Saved in instrument state.
Range:	0 — 100
Example:	CALC:EVM:LIM:CHIP 43 CALC:EVM:LIM:CHIP?

- RF Carrier Suppression Limit

Sets an RF Carrier Suppression limit to warn you when the measured RF Carrier Suppression value is less than a limit. When the RF Carrier Suppression result is less than the limit, a red FAIL indicator appears in the PASS/FAIL window. When the RF Carrier Suppression result exceeds the limit, a green PASS indicator appears in the PASS/FAIL window.

Mode:	WLAN
Key Path:	<b>Meas Setup, More, Limits</b>
Remote Command:	:CALCulate:EVM:LIMit:CARRiersuppression <real> :CALCulate:EVM:LIMit:CARRiersuppression?
Unit/Termination:	dB
Default:	15.00 dB
State Saved:	Saved in instrument state.
Range:	0 — 100
Example:	CALC:EVM:LIM:CARR 43 CALC:EVM:LIM:CARR?

### 3.5.6 Power Stat CCDF Measurement

There is only one view available for this measurement and there are two windows in this view:

- Metrics window (left)
- Graph display window (right)

#### 3.5.6.1 Span X Scale

The **Span X Scale** key accesses the menu to set the desired horizon scale and associated settings.

**3.5.6.1.1 Scale/Div** Allows you to enter a dB value to change the horizontal scale.



Mode:	WLAN
Key Path:	<b>Span X Scale</b>
Remote Command:	:DISPlay:CCDF:WINDow:TRACe:X[:SCALe]:PDIvIson <rel_ampl> :DISPlay:CCDF:WINDow:TRACe:X[:SCALe]:PDIvIson?
Unit/Terminator Keys:	dB
Default:	2.00
State Saved:	Saved in instrument state.
Range:	0.10 — 20.00
Dependencies/Couplings :	When the Scale Coupling default is On, this value is automatically determined by the measurement result. When you set a value manually, Scale Coupling automatically changes to Off.
Example:	DISP:CCDF:WIND:TRAC:X:PDIV 10.0 DISP:CCDF:WIND:TRAC:X:PDIV?

### 3.5.6.2 Display

Allows you to access Display menu.

**3.5.6.2.1 Store Reference Trace** Allows you to copy the currently measured curve as the user-definable reference trace. The captured data will remain until the other mode is chosen. Pressing this key refreshes the reference trace.

Mode:	WLAN
Key Path:	<b>Display</b>
Remote Command:	:CALCulate:CCDF:STORe:REFerence
Example:	CALC:CCDF:STOR:REF

**3.5.6.2.2 Reference Trace** Allows you to toggle reference trace display between On and Off.

Mode:	WLAN
Key Path:	<b>Display</b>
Remote Command:	[:SENSe]:CCDF:REFerence[:STATe] OFF ON 0 1 [:SENSe]:CCDF:REFerence[:STATe]?
Default:	OFF

State Saved: Saved in instrument state.  
 Example: CCDF:REF:STAT ON  
 CCDF:REF:STAT?

### 3.5.6.2.3 Gaussian Line

Allows you to toggle Gaussian trace display between On and Off.

Mode: WLAN  
 Key Path: **Display**  
 Remote Command: [:SENSE]:CCDF:GAUSSian[:STATe] OFF|ON|0|1  
 [:SENSE]:CCDF:GAUSSian[:STATe]?  
 Default: ON  
 State Saved: Saved in instrument state.  
 Example: CCDF:GAUS:STAT ON  
 CCDF:GAUS:STAT?

### 3.5.6.3 Meas Setup

Displays the measurement setup menu when the **Power Stat CCDF Measurement** key has been selected in the **Measure** menu.

#### 3.5.6.3.1 Meas BW

Allows you to set the measurement bandwidth according to the channel bandwidth

Mode: WLAN  
 Key Path: **Meas Setup**  
 Remote Command: [:SENSE]:CCDF:BANDwidth|BWIDth <freq>  
 [:SENSE]:CCDF:BANDwidth|BWIDth?  
 Unit/Terminator Keys: Hz | kHz | MHz | GHz  
 Default: 16.6 MHz (See [Table 3-27, "Meas BW Default Setting"](#))  
 State Saved: Saved in instrument state.  
 Range: Option 122: 10 kHz — 80 MHz  
 Option 140: 10 kHz — 40 MHz  
 Example: CCDF:BAND|BWID 16.6 MHz  
 CCDF:BAND|BWID?

**Table 3-27 Meas BW Default Setting**

Radio	Default
802.11a	16.6 MHz
802.11b	22 MHz
802.11g ERP-OFDM	16.6 MHz
802.11g ERP-DSSS/CCK/PBCC	22 MHz
802.11g DSSS-OFDM	22 MHz

**3.5.6.3.2 Meas Interval** Sets the number of data points that will be used as the measurement interval.

Mode: WLAN  
 Key Path: **Meas Setup**  
 Remote Command: [:SENSe]:CCDF:SWEep:TIME <time>  
 [:SENSe]:CCDF:SWEep:TIME?  
 Unit/Terminator Keys: ns | us | ms | s  
 Default: 1.0 ms  
 Range: 100 ns — 100 s  
 State Saved: Saved in instrument state.  
 Example: CCDF:SWE:TIME 2 ms  
 CCDF:SWE:TIME?

**3.5.6.3.3 Counts** Allows you to set the accumulated number of sampling points for data acquisition. The range is 1.000 kpt (k point) to 2.00000 Gpt (G point) with 1 kpt resolution. While this key is activated, enter a value from the numeric keypad by terminating with one of the unit keys shown.

Mode: WLAN  
 Key Path: **Meas Setup**  
 Remote Command: [:SENSe]:CCDF:COUNTs <integer>  
 [:SENSe]:CCDF:COUNTs?  
 Unit/Terminator Keys: kPT | MPT | GPT  
 Default: 10 MPT

State Saved:	Saved in instrument state.
Range:	1 kPT — 1 GPT
Example:	CCDF:COUN 1 Mpt CCDF:COUN?

**3.5.6.3.4 Wideband Setup** This key invokes the WBIF Setup menu from which you can set parameters of WB path.

**3.5.6.3.4.1 Wideband IF Gain** Sets the Wideband IF Gain.

You must have selected IF Path Wide. Increasing the gain can increase the amplitude of small signals as long as you don't overdrive the hardware. Wideband gain should usually be adjusted after setting the input attenuation.

Mode:	WLAN
Key Path:	<b>Meas Setup, Wideband Setup</b>
Remote Command:	[:SENSe]:CCDF:WBIF:IFGain <integer> [:SENSe]:CCDF:WBIF:IFGain?
Unit/Termination:	dB
Default:	0
State Saved:	Saved in instrument state.
Range:	-12 — 12
Example:	CCDF:WBIF:IFG 0 CCDF:WBIF:IFG?

**3.5.6.3.4.2 Wideband Filtering** Allows you to access the Wideband Filtering setup menu.

- Filter Type

Depressing the Wide Band Filter Type key causes a submenu of enumerated filter types to display. Note that these filters are channel filters applied digitally to the I/Q data stream. The available filters include:

- None
- Raised Cosine
- Root Raised Cosine
- Nyquist
- Root Nyquist
- Gaussian

Mode:	WLAN
Key Path:	<b>Meas Setup, Wideband Setup, Wideband Filtering</b>
Remote Command:	<code>[ :SENSe ] :CCDF:WBIF:FILTer [ :TYPE ] NONE   RCOSine   RRCosine   NYQuist   RNYQuist   GAUSSian [ :SENSe ] :CCDF:WBIF:FILTer [ :TYPE ] ?</code>
Default:	None
State Saved:	Saved in instrument state.
Example:	CCDF:WBIF:FILT RCOS CCDF:WBIF:FILT?

- Filter Alpha

Specifies the Channel filter alpha for cosine and Nyquist filters applied within the wideband digital IF. This filter alpha is the ratio of transition bandwidth / 2 to filter bandwidth. The value is unitless.

Depressing the Filter Alpha key allows the numeric entry of this value.

Mode:	WLAN
Key Path:	<b>Meas Setup, Wideband Setup, Wideband Filtering</b>
Remote Command:	<code>[ :SENSe ] :CCDF:WBIF:FILTer:ALPHa &lt;value&gt; [ :SENSe ] :CCDF:WBIF:FILTer:ALPHa?</code>
Default:	0.30
State Saved:	Saved in instrument state.
Range:	0.01 — 1.00
Example:	CCDF:WBIF: FILT:ALPH 0.30 CCDF:WBIF: FILT:ALPH?

- Filter BW

Specifies the bandwidth of the filter with respect to the sample rate (i.e. Bandwidth/SampleRate) of channel filter.

Mode:	WLAN
Key Path:	<b>Meas Setup, Wideband Setup, Wideband Filtering</b>
Remote Command:	<code>[ :SENSe ] :CCDF:WBIF:FILTer:BANDwidth   BWIDth &lt;value&gt; [ :SENSe ] :CCDF:WBIF:FILTer:BANDwidth   BWIDth?</code>
Default:	0.50

State Saved: Saved in instrument state.  
 Range: 0.01 to 1.00  
 Example: CCDF:WBIF: FILT:BWID 0.50  
 CCDF:WBIF: FILT:BAND?

**3.5.6.3.4.3 Wideband Advanced** Allows you to change the Wideband Advanced values.

---

**NOTE** Parameters under the Wideband Advanced key seldom need to be changed. Any changes from the default advanced values may result in invalid measurement data.

---

- **ADC Correction**

This SCPI performs the ADC calibration to reduce the spectral image and applies the correction.

Mode: WLAN  
 Key Path: **Meas Setup, Wideband Setup, Wideband Advanced**  
 Remote Command: [:SENSe]:CCDF:WBIF:ADCCorrect OFF|ON|0|1  
 [:SENSe]:CCDF:WBIF:ADCCorrect?  
 Default: ON  
 State Saved: Saved in instrument state.  
 Dependencies/Couplings: Coupled with ADC Correction of other measurements.  
 Example: CCDF:WBIF:ADCC ON  
 CCDF:WBIF:ADCC?

- **IF Flatness Correction**

Turns IF flatness corrections on and off in all wideband IF measurements.

Mode: WLAN  
 Key Path: **Meas Setup, Wideband Setup, Wideband Advanced**  
 Remote Command: [:SENSe]:CCDF:WBIF:FLATness OFF|ON|0|1  
 [:SENSe]:CCDF:WBIF:FLATness?  
 Default: ON  
 State Saved: Saved in instrument state.  
 Dependencies/Couplings: Coupled with WBIF Flatness of other measurements.

Example:                   CCDF:WBIF:FLAT ON  
                              CCDF:WBIF:FLAT?

- WB ADC Dither

This turns the wideband dither signal on or off. The “ADC dither” refers to the introduction of noise to the digitized steps of the analog-to-digital converter; the result is an improvement in amplitude accuracy. Use of

the ADC dither, however, reduces dynamic range by approximately 3dB. It should only be turned off when measuring a noise-like signal and the 1 to 2 dB extra dynamic range is needed. This control is independent of the narrowband ADC dither.

Mode:                        WLAN  
Key Path:                   **Meas Setup, Wideband Setup, Wideband Advanced**  
Remote Command:         [:SENSe]:CCDF:WBIF:ADC:DITHer OFF|ON|0|1  
                              [:SENSe]:CCDF:WBIF:ADC:DITHer?  
Default:                    ON  
State Saved:                Saved in instrument state.  
Example:                    CCDF:WBIF:ADC:DITH ON  
                              CCDF:WBIF:ADC:DITH?

### 3.5.6.3.5 Trigger Source Used to select the trigger source for the measurement.

Mode:                        WLAN  
Key Path:                   **Meas Setup**  
Remote Command:         [:SENSe]:CCDF:TRIGger:SOURce  
                              IMMediate|IF|EXTernal[1]|EXTernal2  
                              [:SENSe]:CCDF:TRIGger:SOURce?  
Default:                    IMMediate  
State Saved:                Saved in instrument state.  
Example:                    CCDF:TRIG:SOUR EXT  
                              CCDF:TRIG:SOUR?

### 3.5.6.3.6 Restore Meas Defaults Sets the measure setup parameters to the factory defaults only for the currently selected measurement.

Mode:                        WLAN

Front-Panel Key and SCPI Command Reference  
Measurement Keys

Key Path:	<b>Meas Setup, More</b>
Remote Command:	<code>[ :SENSe ] :CCDF:RESTore:DEFaults</code>
Dependencies/Couplings :	Selecting measurement preset will restore all measurement parameters to their default values.
Example:	<code>CCDF:REST:DEF</code>



---

## 4 Concepts

This chapter describes the concepts and theory of WLAN signals and explains how the various measurements are performed by the instrument. Suggestions for optimizing and troubleshooting your setup are provided, along with a list of related Agilent documents that are referenced for further information.

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## Introduction

This chapter introduces concepts of WLAN to better relate the features and attributes of PSA Series Spectrum Analyzer (PSA) option 217, to measurements.

- “What Is the WLAN Communication System?”, on page 211, briefly explains the WLAN system, some devices involved in the system and two topologies to build up the system.
- “What is a WLAN device?”, on page 213, shows a diagram of the typical WLAN transceiver and some WLAN products.
- “Digital Modulation Format Standards”, on page 215, contains a general description of the modulation format families, including basic formats and WLAN specific formats.
- “Spread Spectrum Concepts”, on page 223, explains the DSSS concepts and theories.
- “Orthogonal Frequency Division Multiplexing (OFDM) Concepts”, on page 225, explains the OFDM concepts and theories.
- “WLAN Standards”, on page 226, introduces the popular WLAN standards, IEEE 802.11 standard family and gives a summary table of IEEE 802.11 standards.
- “WLAN Measurement Concepts”, on page 233, explains the WLAN measurement concepts and theories.
- “Other Sources of Measurement Information”, on page 243, are given along with a list of related Agilent documents for further reading.
- “References”, on page 244, are given along with a list of reference documents for further reading.

## What Is the WLAN Communication System?

Wireless Local Area Network (WLAN) is a high bandwidth, two-way data communications network that operates over a limited geographic area using radio as the medium of transmission, rather than optical fibre or copper cable.

WLAN is basically an extension of the functionality of wired LAN. WLAN allows mobile computer users to connect to a network and access resources while on the move, or without being physically connected to the network.

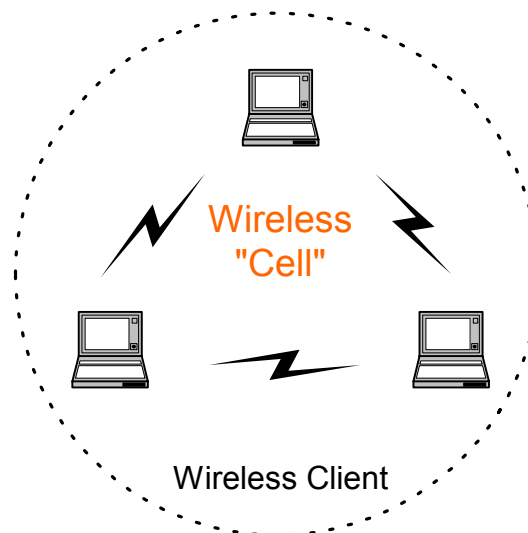
The most widely used WLAN systems involve Network Interface Cards (NICs), also referred to as Stations (STA), and Access Points (APs). The NIC is an expansion board, like a PC (PCMCIA) card, that you can insert into a mobile terminal (MT) so the MT can be connected to the WLAN. The AP acts not only to transfer data between wired and wireless devices, but is also responsible for allocation of the radio channel to the clients it serves.

WLAN can be built with either of two topologies: peer-to-peer or access point-based.

In a peer-to-peer topology, WLAN devices within the wireless “cell” communicate directly to each other as shown in [Figure 4-1 on page 211](#).

**Figure 4-1**

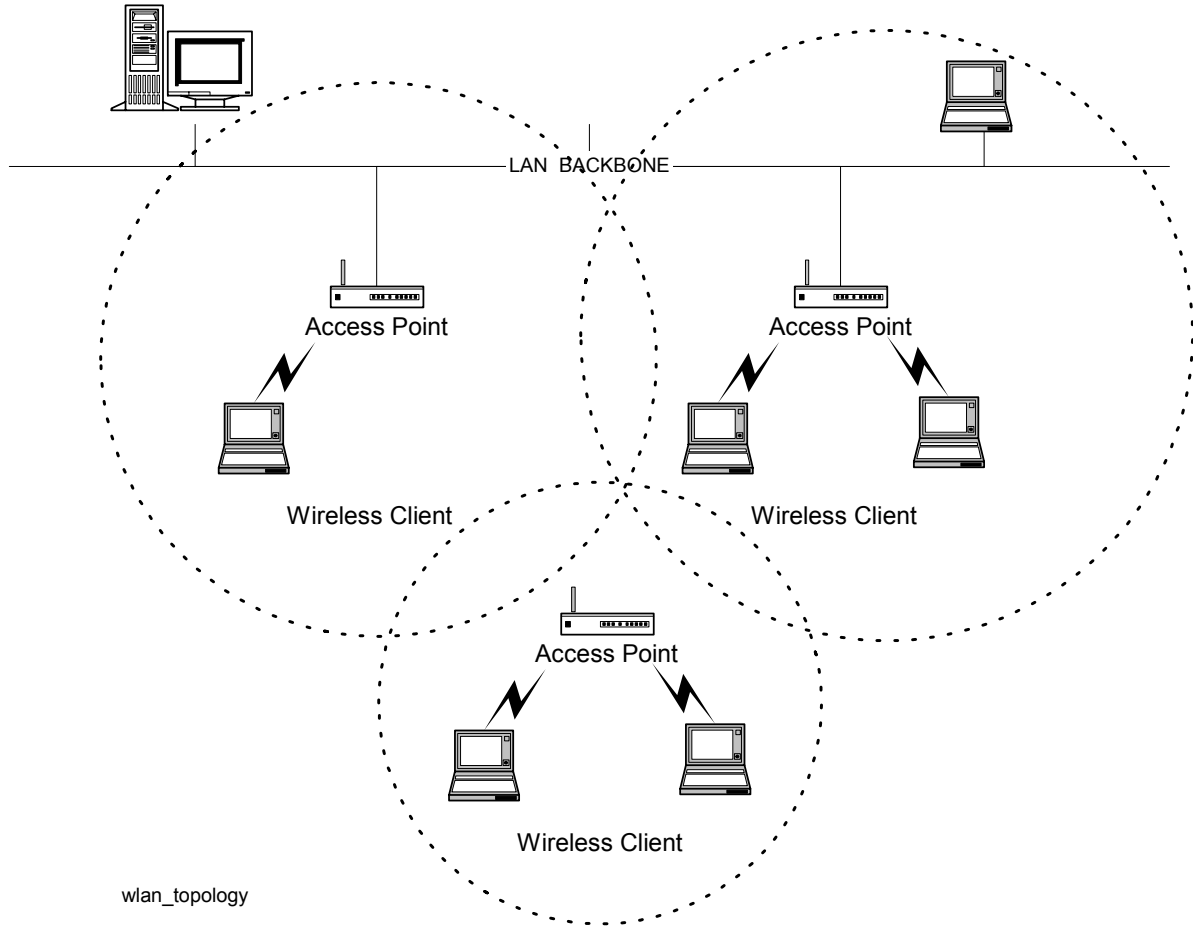
### Peer to Peer Topology



An access point is a bridge that connects a wireless client device to the wired network. An access point-based topology uses access points to bridge traffic onto a wired (Ethernet or Token Ring) or wireless backbone as shown in [Figure 4-2 on page 212](#). The access point enables a wireless client device to communicate with any other wired or

wireless device on the network. The access point topology is more commonly used, demonstrating that WLANs do not replace wired LANs, they extend connectivity to mobile devices.

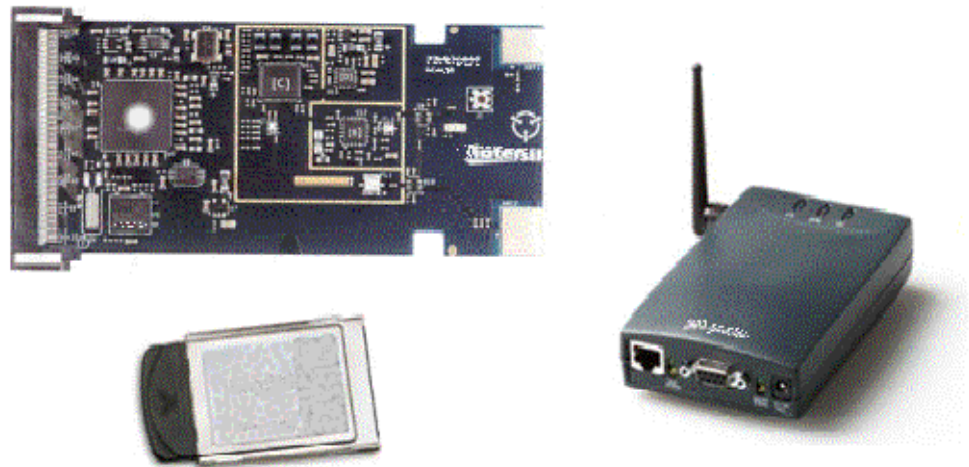
**Figure 4-2** Access Point-Based Topology



## What is a WLAN device?

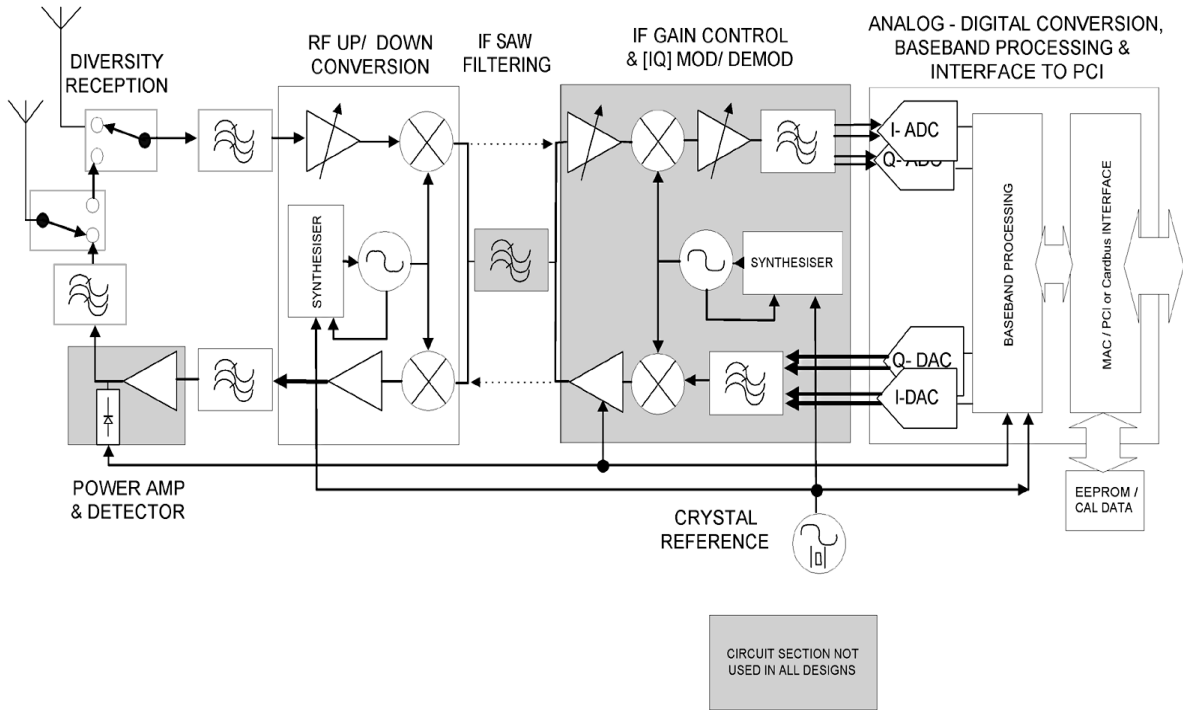
Besides stand-alone laptop PC cards WLAN chipsets are now being integrated into many other devices, for example, monitor displays, cell phones, Personal Data Assistants (PDA) devices. Follow figure shows some WLAN products.

**Figure 4-3** WLAN product examples



The most common format of a WLAN device is a PC (PCMCIA) card suitable for direct connection to a laptop computer. Electrically, the WLAN card is split into two major sections: the analog RF (PHY layer) and the digital baseband (MAC) processing. In many cases the baseband transceiver and processing is on a separate chip from the IF and RF transceiver chain, although newer designs may have higher levels of integration. The diagram below illustrates a block diagram of a typical WLAN transceiver.

**Figure 4-4** Block diagram of a typical WLAN transceiver



## Digital Modulation Format Standards

### Introduction

This section introduces digital modulation formats supported by WLAN standards and the concepts behind the individual formats.

The RF carrier(s) must be modulated. All the WLAN systems described in this book use a form of phase-shift keying for the preamble. More complex schemes, such as 64QAM (Quadrature Amplitude Modulation) give faster bit rates for user data, but require better radio performance and less noise to work to their full potential. BPSK (Phase Shift Keying), QPSK, and QAM are described in standard RF texts. Often the modulation format changes during the transmission. This is because the early part of the burst contains important information about the burst, including analog characteristics such as frequency, and digital information such as burst length. Simpler modulation formats are less prone to bit errors, and thus are more suitable to use early in a burst.

### Modulation Formats and WLAN standards

Table 4-1 shows modulation formats supported in PSA Option 217, grouped by the WLAN standards.

**Table 4-1 Families of Digital Modulation Formats**

WLAN Standard	Carrier Type	Modulation Format
802.11a	OFDM	BPSK
		QPSK
		16 QAM
		64 QAM
802.11b	DSSS	DSSS 1 Mbps
		DSSS 2 Mbps
		CCK 5.5 Mbps
		CCK 11 Mbps
		PBCC 5 Mbps
		PBCC 11 Mbps

**Table 4-1 Families of Digital Modulation Formats**

WLAN Standard	Carrier Type	Modulation Format
802.11g	DSSS	DSSS 1 Mbps
		DSSS 2 Mbps
		CCK 5.5 Mbps
		CCK 11 Mbps
		PBCC 5 Mbps
		PBCC 11 Mbps
		PBCC 22Mbps
		PBCC 33Mbps
	OFDM	BPSK
		QPSK
		16 QAM
		64 QAM

To find out more about an individual format, see:

- [“Phase Shift Keying \(PSK\) Concepts”, on page 216](#)
- [“Quadrature Amplitude Modulation \(QAM\) Concepts”, on page 220](#)

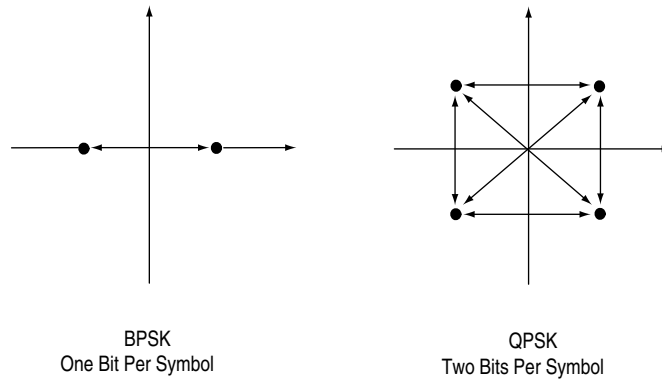
### Phase Shift Keying (PSK) Concepts

One of the simplest forms of digital modulation is Binary or Bi-Phase Shift Keying (BPSK). One application where this is used is for deep space telemetry. The phase of a constant amplitude carrier signal moves between zero and 180 degrees. On an I/Q diagram, the I state has two different values. There are two possible locations in the constellation diagram, so a binary one or zero can be sent. The bit rate is one bit per symbol.

A more common type of phase modulation is Quadrature Phase Shift Keying (QPSK). It is used extensively in applications including CDMA (Code Division Multiple Access) cellular service, wireless local loop, and DVB-S (Digital Video Broadcasting — Satellite). Quadrature means that the signal shifts between phase states which are separated by 90 degrees. The signal shifts in increments of 90 degrees from 45 to 135, -45, or -135 degrees. These points are chosen as they can be easily implemented using an I/Q modulator. Only two I values and two Q values are needed and this gives two bits per symbol. There are four states because  $2^2 = 4$ . It is therefore a more bandwidth-efficient type of modulation than BPSK, potentially twice as efficient.



**Figure 4-5** Phase Shift Keying (PSK)

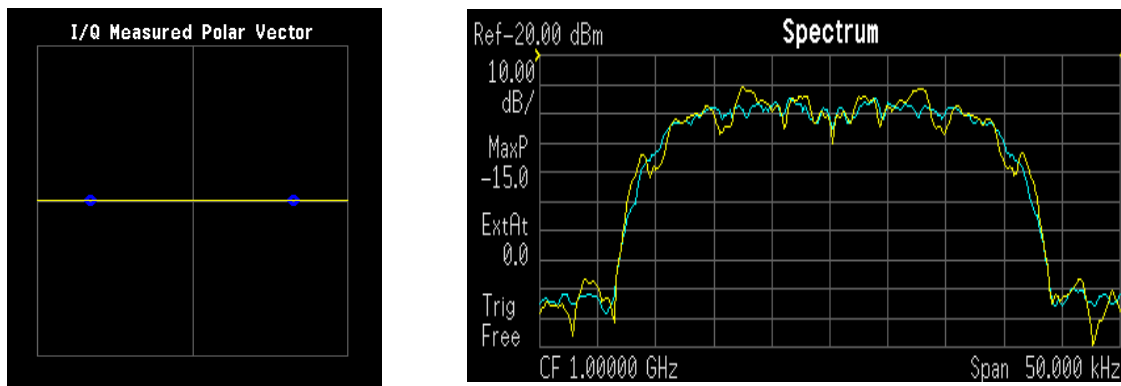


For more information on other types of PSK, see

- “BPSK Modulation Characteristics”, on page 217
- “QPSK Modulation Characteristics”, on page 218
- “DQPSK Modulation Characteristics”, on page 219

### BPSK Modulation Characteristics

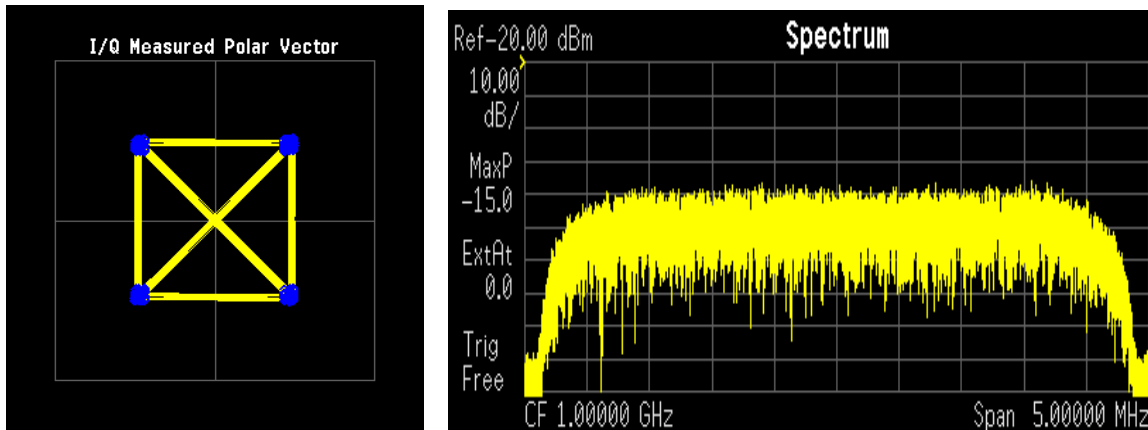
**Figure 4-6** BPSK Constellation and Spectrum View



LEFT: BPSK constellation  
RIGHT: BPSK spectrum center freq 1 GHz

## QPSK Modulation Characteristics

Figure 4-7 QPSK Constellation and Spectrum View



LEFT: QPSK constellation  
RIGHT: QPSK spectrum center freq 1 GHz

### Differential Modulation Concepts

A variation of standard PSK is differential modulation as used in differential QPSK (DQPSK). Differential means that the information is not carried by the absolute state, it is carried by the transition between states. In some cases there are also restrictions on allowable transitions. This occurs in  $\pi/4$  DQPSK where the carrier trajectory does not go through the origin. A DQPSK transmission system can transition from any symbol position to any other symbol position. The  $\pi/4$  DQPSK modulation format is widely used in many applications including

#### CELLULAR

- NADC- IS-54 (North American digital cellular)
- PDC (Pacific Digital Cellular)

#### CORDLESS

- PHS (personal handyphone system)

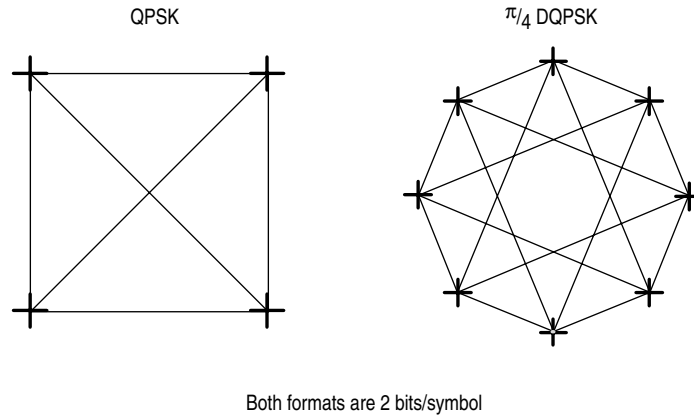
#### TRUNKED RADIO

- TETRA (Trans European Trunked Radio)

The  $\pi/4$  DQPSK modulation format uses two QPSK constellations offset by 45 degrees ( $\pi/4$  radians). Transitions must occur from one constellation to the other. This guarantees that there is always a change in phase at each symbol, making clock recovery easier. The data is encoded in the magnitude and direction of the phase shift, not in the absolute position on the constellation. One advantage of  $\pi/4$  DQPSK is that the signal trajectory does not pass through the origin, thus simplifying transmitter design. Another is that  $\pi/4$  DQPSK, with root

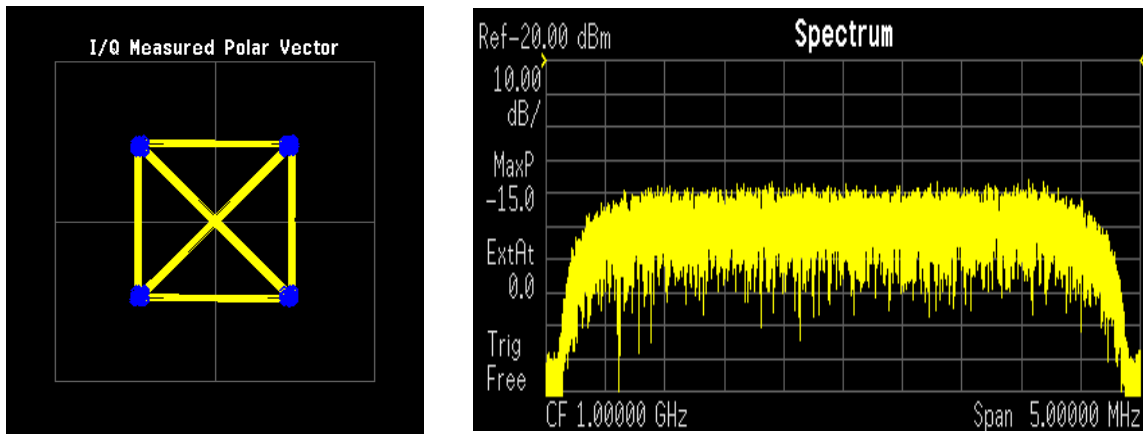
raised cosine filtering, has better spectral efficiency than GMSK, the other common cellular modulation type.

**Figure 4-8 Differential Modulation**



**DQPSK Modulation Characteristics**

**Figure 4-9 DQPSK Constellation and Spectrum View**



LEFT: DQPSK constellation  
RIGHT: DQPSK spectrum center freq 1 GHz

Concepts

## Quadrature Amplitude Modulation (QAM) Concepts

Quadrature amplitude modulation (QAM) is used in applications including microwave digital radio, DVB-C (Digital Video Broadcasting—Cable), and modems.

### 16 QAM

In 16-state quadrature amplitude modulation (16QAM), there are four I values and four Q values. This results in a total of 16 possible states for the signal. It can transition from any state to any other state at every symbol time. Since  $16 = 2^4$  four bits per symbol can be sent. This consists of two bits for I, and two bits for Q. The symbol rate is one fourth of the bit rate. So this modulation format produces a more spectrally efficient transmission. It is more efficient than BPSK, QPSK, or 8PSK.

QPSK is practically the same as 4QAM.

### 32 QAM

Another variation of QAM is 32QAM. In this case there are six I values and six Q values resulting in a total of 36 possible states ( $6 \times 6 = 36$ ). This number is too many states for a power of two (the closest power of two is 32). So the four corner symbol states, which take the most power to transmit, are omitted. This reduces the amount of peak power the transmitter has to generate. Since  $2^5 = 32$ , there are five bits per symbol and the symbol rate is one fifth of the bit rate.

The current practical limits for broadcast transmission of QAM signals are approximately 256QAM, though work is underway to extend the limits to 512 or 1024 QAM. High state QAM formats are better suited to cable delivery where the noise is lessened.

A 256QAM system uses 16 I-values and 16 Q-values, giving 256 possible states. Since  $2^8 = 256$ , each symbol can represent eight bits. A 256QAM signal that can send eight bits per symbol is very spectrally efficient. However, for a given maximum power, the symbols are closer together than lower-valued QAM's and are thus more subject to errors due to noise and distortion. Such a signal may have to be transmitted with extra power (to effectively spread the symbols out more) and this reduces power efficiency as compared to simpler schemes.

Figure 4-10

## Quadrature Amplitude Modulation

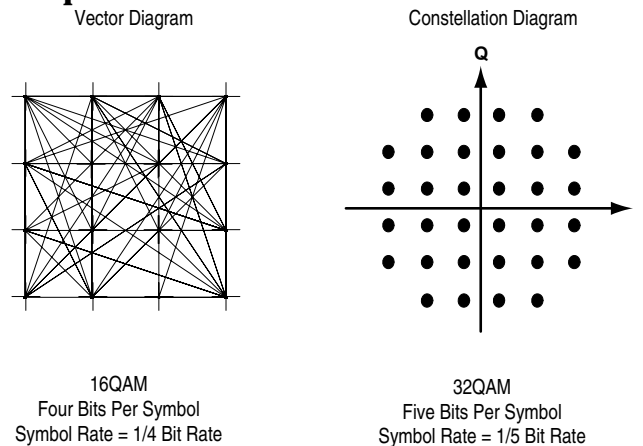


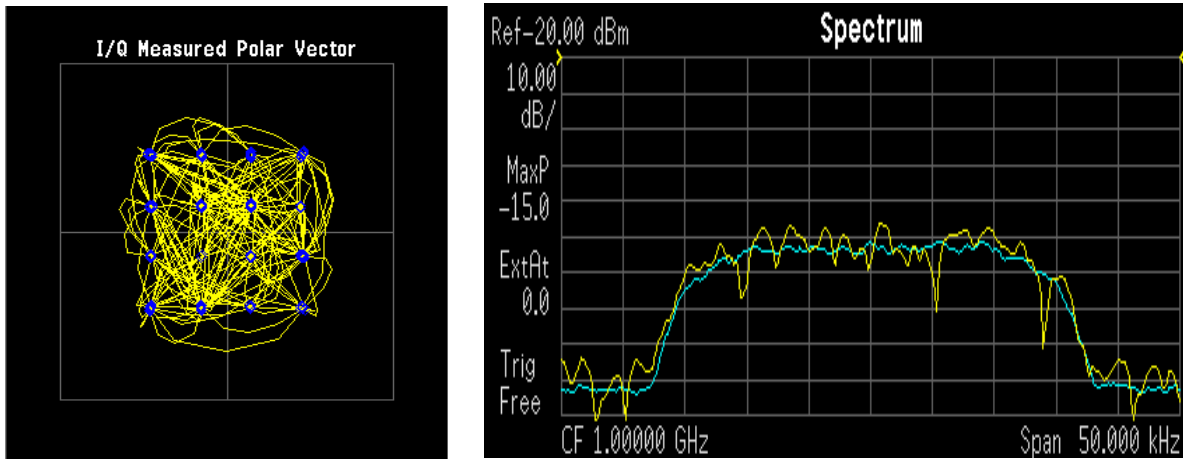
Fig. 14

However, bandwidth efficiency is better for higher QAM's. For example, BPSK uses 80 Ksymbols-per-second sending 1 bit per symbol. A system using 256QAM sends eight bits per symbol so the symbol rate would be 10 Ksymbols per second. A 256QAM system enables the same amount of information to be sent as BPSK using only one eighth of the bandwidth. It is eight times more bandwidth efficient. However, there is a trade-off. The radio becomes more complex and is more susceptible to errors caused by noise and distortion. Error rates of higher-order QAM systems such as this degrade more rapidly than QPSK as noise or interference is introduced. A measure of this degradation would be a higher bit error rate (BER).

In any digital modulation system, if the input signal is distorted or severely attenuated the receiver will eventually lose symbol lock completely. If the receiver can no longer recover the symbol clock, it cannot demodulate the signal or recover any information. With less degradation, the symbol clock can be recovered, but it is noisy, and the symbol locations themselves are noisy. In some cases, a symbol will fall far enough away from its intended position that it will cross over to an adjacent position. The I and Q level detectors used in the demodulator would misinterpret such a symbol as being in the wrong location, causing bit errors. QPSK is not as efficient, but the states are much farther apart for a given power and the system can tolerate a lot more noise before suffering symbol errors. QPSK has no intermediate states between the four corner-symbol locations, so there is less opportunity for the demodulator to misinterpret symbols. QPSK requires less transmitter power than QAM to achieve the same bit error rate.

### QAM Modulation Characteristics

**Figure 4-11** 16 QAM Constellation and Spectrum View



LEFT: 16 QAM constellation  
RIGHT: 16 QAM spectrum center freq 1 GHz

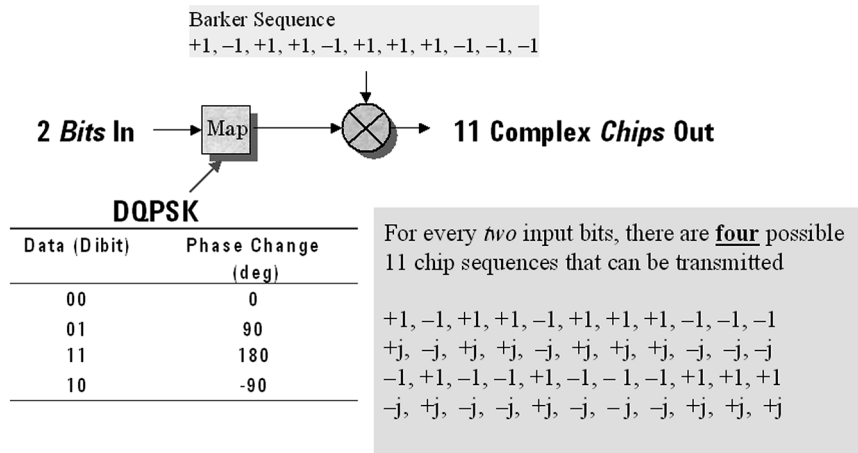
## Spread Spectrum Concepts

### Direct Sequence Spread Spectrum (DSSS) Concepts

DSSS (Direct Sequence Spread Spectrum) - The energy in a single carrier is spread over a wider spectrum by multiplying data bit(s) with a special 11-bit pattern, called a Barker key. This is done at a chip rate of 11 MHz. This technique can help reduce interference from narrow-band sources. The IEEE 802.11 b uses an 8-bit key.

As shown in <Figure 2.1.1 from 1380-1 Page 10>, to create a DSSS signal, a lower rate signal is multiplied by a higher rate signal. For 1 Mbps, the 1 MHz (D)BPSK signal is multiplied by an 11 MHz BPSK signal. Although not generally true of DSSS signals, for this particular signal it can be said that the input bits determine the phase rotation of the spreading code or that it is a (D)BPSK data signal spread by a BPSK spreading sequence, producing a BPSK constellation.

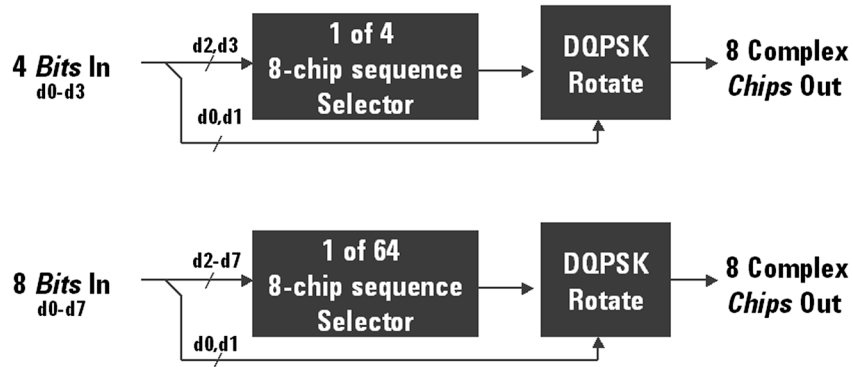
**Figure 4-12 DSSS signal spreading for 2 Mbps data rate**



### Complementary Code Keying (CCK) Concepts

CCK (Complementary Code Keying) - Changing both the spreading factor and/or the modulation format varies the bit rate. CCK is used to increase IEEE 802.11 b's peak data rate from 2 to 11 Mbps, while still using QPSK (Quadrature Phase Shift Keying) modulation. To achieve 5.5 and 11 Mbps rates, the spreading length is first reduced from 11 to 8. This increase the symbol rate from 1 Msps to 1.375 Msps, then taking data in 4-bit blocks (4\*1.375 = 5.5) or 8-bit blocks (8\*1.375 = 11), i.e. 4 bits/symbol or 8 bits/symbol. Six of the 8 bits are used to choose 1 of 64 complementary codes, which are 8 chips long and clocked out at 11 MHz. Thus all 8 chips are "used up" in (1/1.375) us - the time before another byte is ready. The other 2 bits are combined with the code in the QPSK modulator.

Figure 4-13 CCK Modulation



## Packet Binary Convolutional Coding (PBCC) Concepts

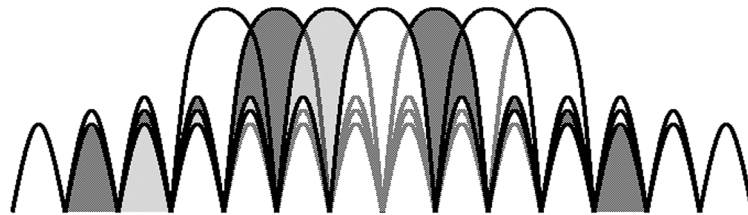
PBCC (Packet Binary Convolutional Coding) - This scheme is optional for IEEE 802.11 b and g. It is basically a more complex version of CCK, allowing twice as much data to be encoded for a given bandwidth. Normally, a doubling of the data rate within a given bandwidth requires the signal-to-noise ratio of the channel to increase by 3 dB. By using PBCC, only a 0.5 dB increase is required for this data rate increase. In PBCC, the real data rate increase comes from moving from QPSK to 8PSK as the modulation technique, while the reduction in required signal-to-noise ratio comes from using PBCC over CCK. It makes use of Forward Error Correction to improve the link performance when noise is the limitation. Scrambled data is fed into a convolutional encoder. The encoder consists of a 6-stage memory, with specific taps combined to give two outputs. The four possible output states (00, 01, 10, 11) are mapped into two possible QPSK states (11 Mbps). A codeword controls how the chosen state alternates over time. The RF modulator is driven from this point.



## Orthogonal Frequency Division Multiplexing (OFDM) Concepts

OFDM (Orthogonal Frequency Division Multiplexing) - OFDM uses multiple carriers, of which there are 52, spaced 312.5 kHz apart. Data is sent on 48 carriers simultaneously, with 4 used as pilots. The time to transmit each bit increases in proportion to the number of carriers. This makes the system less sensitive to multipath interference, a major source of distortion.

**Figure 4-14** OFDM Carriers Separation

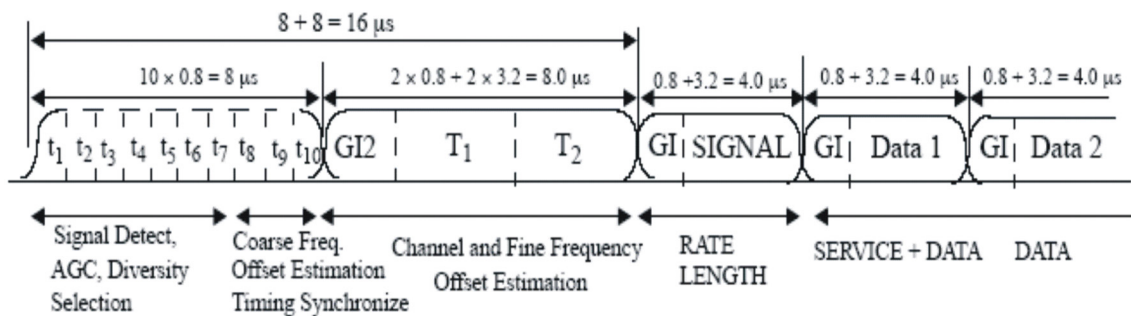


802.11a uses OFDM as its transmission scheme. For 802.11a there are 52 carriers in all, 48 of which are used to carry data and 4 which are used as pilots.

Orthogonal Frequency Division Multiplexing (OFDM) has been formally accepted as the method to achieve high data rates, better than 20 Mbps in the WLAN systems. OFDM provides multiple frequency channels at regular spacing, each modulated by M-ary QAM. An OFDM signal consists of the sum of a number of sub-carriers that are modulated using some form of PSK or QAM. Data interleavers “spread” the information throughout the carriers.

As shown in [Figure 4-15](#), “OFDM training structure” an OFDM burst actually has four distinct regions. The first is the *Short training sequence*, followed by a *Long training sequence* and finally by the *Signal and Data symbols*. From a RF standpoint, the Signal symbol and the rest of the OFDM symbols are similar.

**Figure 4-15** OFDM training structure



## WLAN Standards

### Overview

Over the past few years, several different WLAN technologies and standards have been developed. This section concentrates on the IEEE 802.11 standards: 802.11b, 802.11a and 802.11g.

There are various modulation schemes, data rates, and frequency ranges contained in the IEEE 802.11 standards family, as summarized in the table below.

**Table 4-2 IEEE 802.11 Standards Family**

	Wireless LAN Standards			
	802.11b	802.11a	802.11g	
Frequency band	2.4 GHz	5 GHz	2.4 GHz	
Channel separation	25 MHz	20 MHz	25 MHz	
Maximum raw data rate	11 Mbps	54 Mbps	54 Mbps	
Carrier Type	DSSS	OFDM	DSSS	OFDM
Modulation	DSSS, CCK, PBCC	BPSK, QPSK, 16 QAM, 64 QAM	DSSS, CCK, PBCC	BPSK, QPSK, 16 QAM, 64 QAM

The progression of technology in the IEEE 802.11 standard family is 802.11 to 802.11b to 802.11a, and eventually to 802.11g. These IEEE 802.11 systems use either direct sequence spread spectrum (DSSS) techniques or orthogonal frequency division multiplexing (OFDM) schemes.

### 802.11b

The 802.11b operates in the 2.4 GHz and uses DSSS techniques to spread the energy in a single carrier over a wider spectrum. See [“Direct Sequence Spread Spectrum \(DSSS\) Concepts” on page 223](#). Two coding schemes are used in the 802.11b to spread the spectrum of a single carrier. Complementary code keying (CCK) is mandatory, while packet binary convolutional coding (PBCC) is optional. CCK is used to increase the 802.11b peak data rate to 11 Mbps using QPSK modulation. See [“Complementary Code Keying \(CCK\) Concepts” on page 223](#). PBCC makes use of forward error correction to improve the link performance when noise is the limitation. See [“Packet Binary Convolutional Coding \(PBCC\) Concepts” on page 224](#).

The 802.11b allows 1 Mbps, 2 Mbps, 5.5 Mbps and 11 Mbps operation using various modulation schemes. The 1 and 2 Mbps rates use DBPSK and DQPSK modulation schemes. For 5.5 and 11 Mbps operation, CCK modulation is used.

To achieve 5.5 and 11 Mbps rates, the spreading length is first reduced from 11 to 8. This increases the symbol rate from 1 Msps to 1.375 Msps. So, for 5.5 Mbps bit rates one needs to transmit  $5.5/1.375$  or 4 bits/symbol and for 11 Mbps, 8 bits/symbol.

**Table 4-3 802.11b Rate-dependent parameters**

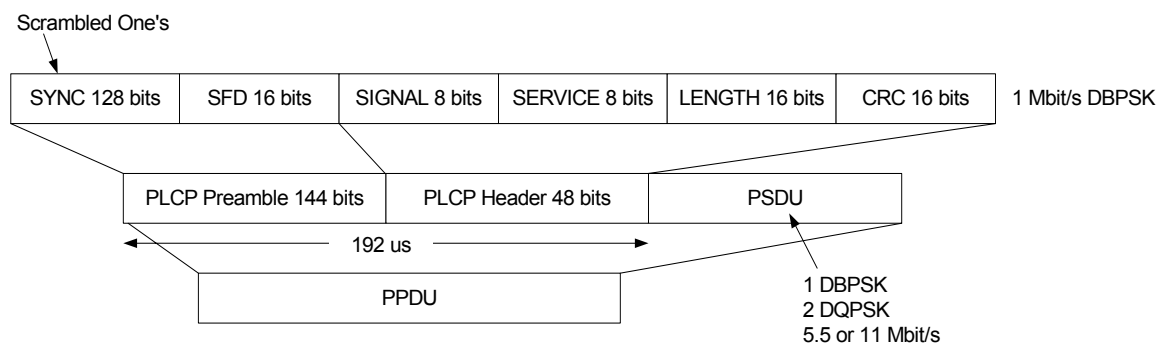
Data rate (Mbps)	Modulation	Symbol rate (MSps)
1	DBPSK	
2	DQPSK	
5.5	CCK	1.375
	PBCC	
11	CCK	1.375
	PBCC	

The approach taken for 802.11b, which keeps the QPSK spread spectrum signal and still provides the required number of bits/symbol, uses all but two of the bits to select from a set of spreading sequences. It uses the remaining two bits to rotate the sequence.

An important difference between the sets of spreading sequences used here and the single Barker code sequence used for the 1 and 2 Mbps rates is that these sequences are complex. In other words, the signal is a (D)QPSK signal with QPSK spreading.

Figure 4-16, “802.11b signal” shows a plot of 802.11b signal burst. For all 802.11b bit rates, the preamble and header are sent at the 1 Mbps rate. The header is 192 usec long (192 bits). This translates to a total of 2112 chips. The payload data is then appended using one of the four modulation rates.

**Figure 4-16 802.11b signal**



## 802.11a

802.11a operates in the 5 GHz band and uses OFDM as its transmission scheme.

The 802.11a offers 6, 12 and 24 Mbps and optionally 9, 18, 36, 48 and 54 Mbps bit-rates. The OFDM physical layer uses 52 sub-carriers with 0.3125 MHz spacing, of which 48 are used to carry data and 4 are used as pilots. The occupied bandwidth is 16.6 MHz. Forward error correction coding (convolutional coding) is used with a coding rate of 1/2, 2/3, or 3/4.

The modulation of the individual carriers in the OFDM depends on the data rates. For 6 and 9 Mbps BPSK is used, 12 and 18 Mbps uses QPSK, 24 and 36 Mbps uses 16 QAM, and 48 and 54 Mbps operation uses 64 QAM. [Table 4-4 on page 228](#) provides a summary of the different modulation formats used in OFDM systems and their associated rate-dependent parameters.

**Table 4-4** 802.11a Rate-dependent parameters

Data rate (Mbps)	Modulation	Coding rate (R)	Coded bits per subcarrier (NBPS)	Coded bits per OFDM symbol (NCBPS)	Data bits per OFDM symbol (NDBPS)
6	BPSK	1/2	1	48	24
9	BPSK	3/4	1	48	36
12	QPSK	1/2	2	96	48
18	QPSK	3/4	2	96	72
24	16-QAM	1/2	4	192	96
36	16-QAM	3/4	4	192	144
48	64-QAM	2/3	6	288	192
54	64-QAM	3/4	6	288	216

OFDM systems use fixed modulation formats for the preamble. Varying data rates are achieved by changing the modulation for the data transmission portion of a packet. In some cases, the modulation format changes during the data transmission. Simpler modulation formats (such as BPSK) are often used in the early part of the burst, which contains important information such as frequency and burst length, because these formats are less prone to bit errors.

[Figure 4-17, “802.11a Signal”](#) shows the format for the PPDU including the OFDM preamble, header, PSDU, tail bits, and pad bits. The header

contains the following fields: LENGTH, RATE, a reserved bit, an even parity bit, and the SERVICE field. In terms of modulation, the LENGTH, RATE, reserved bit, and parity bit (with 6 “zero” tail bits appended) constitute a separate single OFDM symbol, denoted SIGNAL, which is transmitted with the most robust combination of BPSK modulation and a coding rate of  $R = 1/2$ . The SERVICE field of the header and the PSDU (with 6 “zero” tail bits and pad bits appended), denoted as DATA, are transmitted at the data rate described in the RATE field and may constitute multiple OFDM symbols.

**Figure 4-17 802.11a Signal**

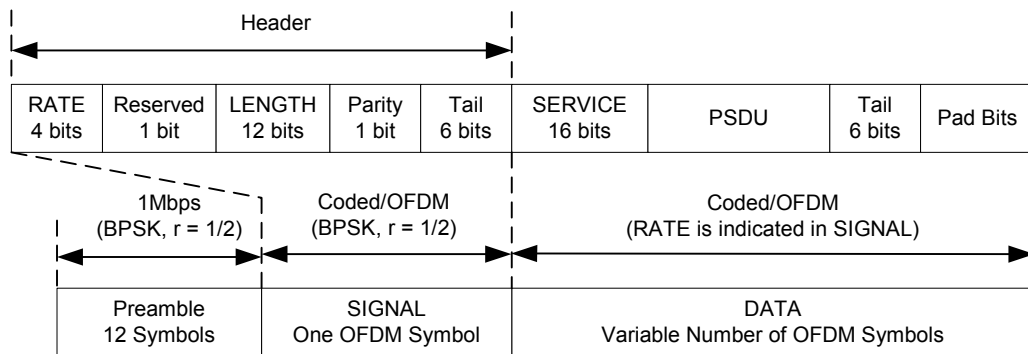
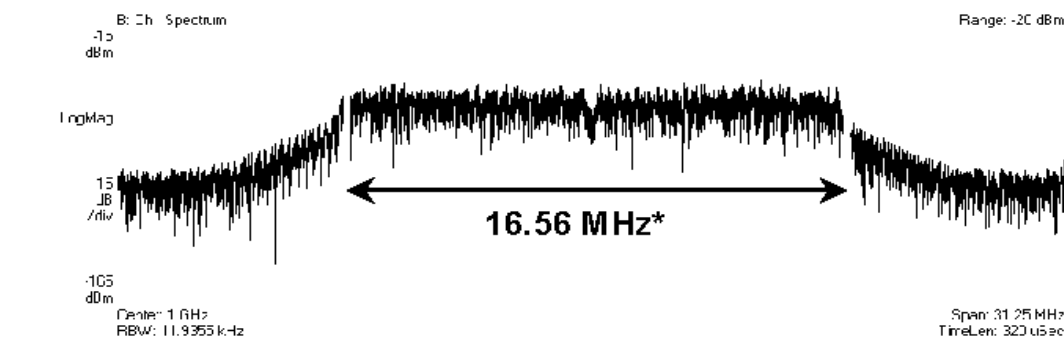
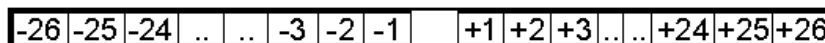


Figure 4-18, “802.11a Spectrum View” shows an 802.11 a signal burst. The spectrum is not very uniform. This is caused in part by the preambles, but mostly by the data being transmitted.

**Figure 4-18 802.11a Spectrum View**



Carrier numbering convention



Data carriers:

Pilot carriers:

Carrier 0:

The 802.11a uses 5.15–5.25, 5.25–5.35 and 5.725–5.825 GHz unlicensed national information infrastructure (UNII) bands, each having restrictions imposed on the maximum allowed output power. Table

defines the maximum allowable output power for the United States.

**Table 4-5 Transmit power level for the United States**

Frequency band (GHz)	Maximum output power with up to 6 dBi antenna gain (mW)
5.15-5.25	40 (2.5 mW/MHz)
5.25-5.35	200 (12.5 mW/MHz)
5.725-5.825	800 (50 mW/MHz)

Channel center frequencies are defined at every integral multiple of 5 MHz above 5 GHz. The relationship between center frequency and channel number is given by the following equation:

$$\text{Channel center frequency} = 5000 + 5 \times \text{nch (MHz)} \dots\dots\dots (27)$$

where

$$\text{nch} = 0, 1, \dots, 200$$

This definition provides a unique numbering system for all channels with 5 MHz spacing from 5 GHz to 6 GHz, as well as the flexibility to define channelization sets for all current and future regulatory domains. The set of valid operating channel numbers by regulatory domain is defined in [Table 4-6](#).

**Table 4-6 Valid operating channel numbers by regulatory domain and band**

Regulatory domain	Band (GHz)	Operating channel numbers	Channel center frequencies (MHz)
United States	U-NII lower band (5.15 - 5.25)	36	5180
		40	5200
		44	5220
		48	5240
United States	U-NII middle band (5.25 - 5.35)	52	5260
		56	5280
		60	5300
		64	5320
United States	U-NII upper band (5.725 - 5.825)	149	5745
		153	5765
		157	5785
		161	5805

## 802.11g

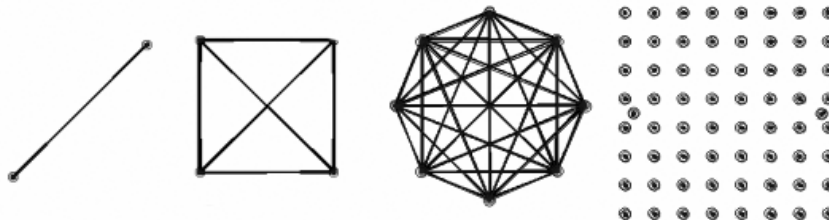
IEEE 802.11g is an extension of the 802.11b standard. So the 802.11g system can interoperate with the 802.11b system. The 802.11g standard adds 802.11a OFDM transmission modes to the 802.11b standard. This provides the 802.11a throughput improvement in the 2.4 GHz band. In addition to the 802.11a OFDM modes, 802.11g also defines optional modes of increased throughput PBCC utilizing 8PSK, and an optional CCK-OFDM mode, which combines the 802.11b preamble with an OFDM packet.

In addition to data rates the 802.11b supports, the 802.11g also allows various data rates using various modulation schemes, such as 11 Mbps using PBCC-11, 22 Mbps using PBCC-22 or CCK-PBCC, 33 Mbps operation using PBCC-33, respectively. For 54 Mbps operation, CCK-OFDM modulation is used.

Similar to the 802.11a, 802.11g OFDM modes map data symbols using BPSK and QPSK for lower data rates and QAM for faster bit rates.

Figure 4-19

**Example 802.11g (OFDM) modulation types (left to right: BPSK, QPSK, 8PSK, and 64QAM)**



### 802.11g Specific Modes of Carrier Operation

There are several modes of carrier operation:

- ERP (Extended Rate PHYs) - Shown as Figure 11g\_Page15\_F7.3.2.13, ERP information element defines the rate extension of the PHY for the Direct Sequence Spread Spectrum (DSSS) system. The ERP builds on the payload data rates of 1 and 2 Mbit/s that use DSSS modulation and builds on the payload data rates of 1, 2, 5.5 and 11 Mbit/s that use DSSS, CCK and optional PBCC modulations. The ERP draws, to provide additional payload data rates of 6, 9, 12, 18, 24, 36, 48, and 54 Mbit/s. Of these rates, transmission and reception capability for 1, 2, 5.5, 6, 12, and 24 Mbit/s data rates is mandatory. Two additional optional ERP-PBCC modulation modes with payload data rates of 22 and 33 Mbit/s are defined. An ERP-PBCC station may implement 22 Mbit/s alone or 22 and 33 Mbit/s. An optional

modulation mode known as DSSS-OFDM is also incorporated with payload data rates of 6, 9, 12, 18, 24, 36, 48 and 54 Mbit/s.

- ERP (Extended Rate PHYs) - Shown as Figure 11g\_Page15\_F7.3.2.13, ERP information element defines the rate extension of the PHY for the Direct Sequence Spread Spectrum (DSSS) system. The ERP builds on the payload data rates of 1 and 2 Mbit/s that use DSSS modulation and builds on the payload data rates of 1, 2, 5.5 and 11 Mbit/s that use DSSS, CCK and optional PBCC modulations. The ERP draws, to provide additional payload data rates of 6, 9, 12, 18, 24, 36, 48, and 54 Mbit/s. Of these rates, transmission and reception capability for 1, 2, 5.5, 6, 12, and 24 Mbit/s data rates is mandatory. Two additional optional ERP-PBCC modulation modes with payload data rates of 22 and 33 Mbit/s are defined. An ERP-PBCC station may implement 22 Mbit/s alone or 22 and 33 Mbit/s. An optional modulation mode known as DSSS-OFDM is also incorporated with payload data rates of 6, 9, 12, 18, 24, 36, 48 and 54 Mbit/s. The ERP modulations (ERP-OFDM, ERP-PBCC, and DSSS-OFDM) have been designed to coexist with existing.
- ERP-DSSS/CCK -- The PHY uses the capabilities with the following exceptions: Support of the short PLCP PPDU header format capability is mandatory; Clear Channel Assessment has a mechanism that will detect all mandatory sync symbols; the maximum input signal level (ref 18.4.8.2) is 20 dBm; Locking the transmit center frequency and the symbol clock frequency to the same reference oscillator is mandatory.
- ERP-OFDM -- The PHY uses the capabilities of clause 17 with the following exceptions: The frequency plan is in accordance with sub clauses 18.4.6.1 and 18.4.6.2 instead of 17.3.8.3; CCA has a mechanism that will detect all mandatory clause 19 sync symbols; The frequency accuracy (ref 17.3.9.4 and 17.3.9.5) is  $\pm 25$  PPM; The maximum input signal level (ref 17.3.10.4) is  $-20$  dBm; The slot time is  $20 \mu\text{s}$  in accordance with 18.3.3 except that an optional  $9 \mu\text{s}$  slot time may be used when the BSS consists of only ERP STAs; SIFS time is  $10 \mu\text{s}$  in accordance with 18.3.3. See 19.3.2.3 for more detail.
- ERP-PBCC (Optional) -- This is a single carrier modulation scheme that encodes the payload using a 256-state packet binary convolutional code. These are extensions to the PBCC modulation in clause 18. ERP-PBCC modes with payload data rates of 22 and 33 Mbit/s are defined in 19.6.
- DSSS-OFDM (Optional) -- This is a hybrid modulation combining a DSSS preamble and header with an OFDM payload transmission. DSSS-OFDM modes with payload data rates of 6, 9, 12, 18, 24, 36, 48 and 54 Mbit/s are defined in 19.7; If the optional DSSS-OFDM mode is used, the supported rates in that mode are the same as the ERP-OFDM supported rates.



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## WLAN Measurement Concepts

There are a number of different ways to measure the quality of a digitally modulated signal. These usually involve precision demodulation of the transmitted signal and comparison of this transmitted signal with a mathematically generated ideal or reference signal.

### Transmit Power Measurement Concepts

#### Purpose

The Transmit Power measurement is used to find the total power presented in a specified bandwidth. This procedure also measures the power spectral density (the peak power on 1 MHz bandwidth). This measurement is applied to design, characterize, evaluate, and verify transmitters and their components.

#### Measurement Method

This measurement will include the following functionality:

- Averaging
- Flexibility for measuring any signal bandwidth
- Integration BW markers

The Transmit Power measurement uses the FFT method to compute signal transmit power. The FFT is done on entire Span set by customer. The transmit power in Integ. BW is computed by adding up the energy of each FFT point in Integ BW around center frequency. The peak power spectral density is defined as the maximum transmit power in 1 MHz bandwidth.

Please note, this peak power spectral density is searched within Span/2 around center frequency for 802.11 a/b/g. So Span can't be less than 1 MHz peak transmit power. The measurement acquires a number of points representing the input signal in the time domain. It transforms this information into the frequency domain using FFT and then calculates the channel power. The effective resolution bandwidth of the frequency domain trace is proportional to the number of points acquired for the FFT. The fastest FFT process is achieved using a number of acquired points that is a power of 2 (for example: 64, 128, 512).

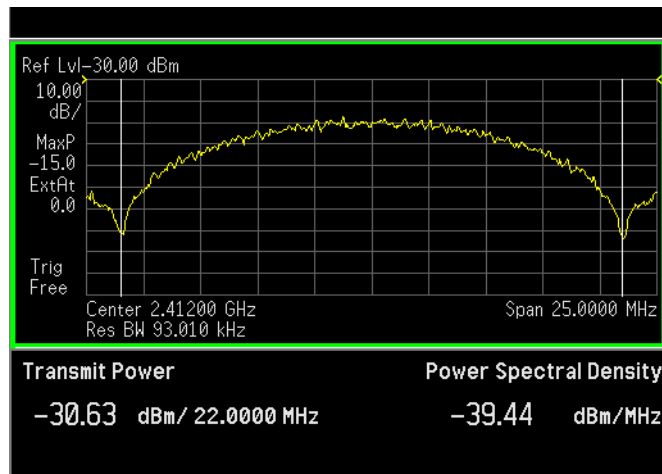
Since the measurement is optimized for speed and accuracy, the user is permitted to change only the number of acquired data points in powers of 2, not the actual resolution bandwidth which is shown in gray. However, if absolute sweep time is required, it can be changed to the user's specific value at the expense of reduced speed. At no time will

both sweep time and data points be set to manual because of conflicting parameter settings. This flexibility is available through the **Advanced** menu of the transmit power measurement.

To improve repeatability, the user can increase either the number of averages or the number of data points with longer time record length. The transmit power graph is shown in the graph window, while the absolute transmit power in dBm and the mean power spectral density in dBm/Hz are shown in the text window.

**Figure 4-20**

**Transmit Power Measurement (802.11b)**



For E4440 Option 217, this measurement is available for use with either the 802.11a/g or 802.11b.

## Transmit Spectrum Mask Measurement Concepts

### Purpose

The Transmit Spectrum Mask measurement is used to test the in-band spurious emissions. It may be expressed as a ratio of power spectral densities between the carrier and the specified offset frequency band. The transmitted spectral density of the transmitted signal shall fall within the spectral mask.

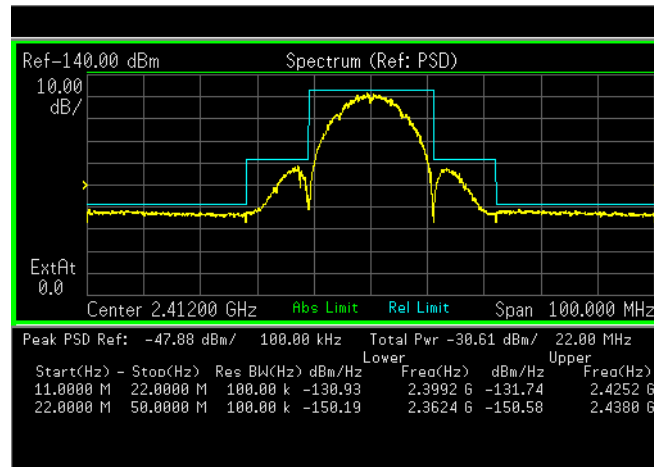
### Measurement Method

The Transmit Spectrum Mask measurement measures spurious signal levels in up to five pairs of offset frequencies and relates them to the carrier power. PSD (Power Spectral Density) is used for this measurement. Transmit Spectrum Mask measurement is made with both sides centered at the carrier channel frequency bandwidth. The specifications require the reference to be the PSD of the signal. The reference power therefore can be obtained in 100kHz resolution bandwidth as a reference PSD related to 100kHz. Each offset peak PSD displayed is either a relative PSD to the peak PSD in the signal or an

absolute PSD. This peak PSD reference is located at the bottom right of the results window, and the total integrated power, on the left.

This measurement requires the user to specify measurement bandwidths of the carrier channel and each of the offset frequency pairs A to E. Each pair may be defined with unique measurement bandwidths. The results are displayed as relative PSD to peak reference channel PSD in dB/Hz or absolute peak PSD.

**Figure 4-21**



## Power vs. Time Measurement Concepts

### Purpose

The Power vs. Time measurement is used to test power-on and power-down transition for 802.11 b.

To prevent the interference caused by bursting the RF carrier, the associated standard specifies a power versus time template to which a device must conform.

This template defines the burst length, the rising and falling edges, the masks for regions of power on and power off.

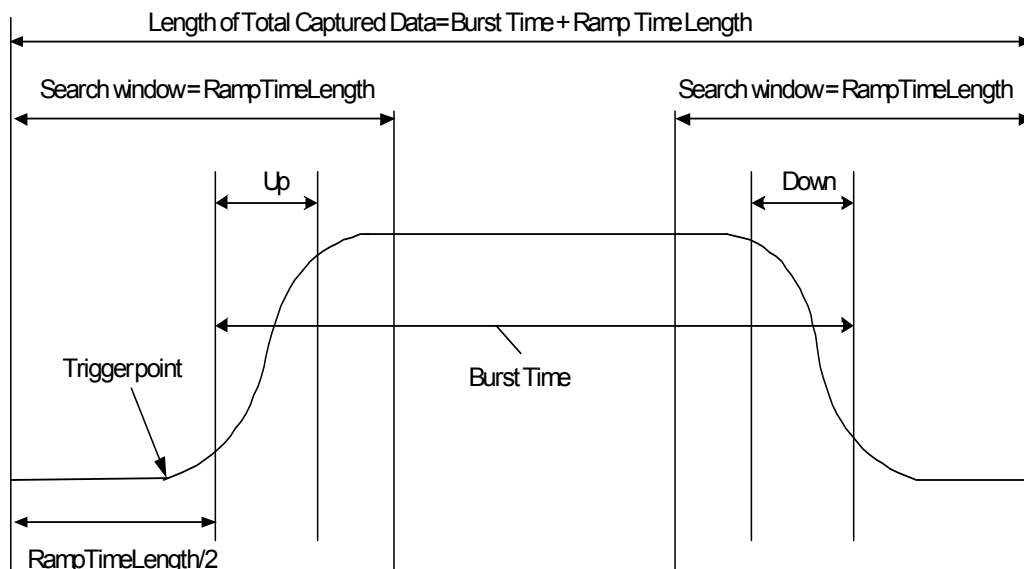
### Measurement Method

The WLAN specifications do not detail a standard test procedure for PvT measurements. A PvT measurement requires a burst signal to be supplied periodically. Under normal operating conditions, this is not a typical transmission pattern, and you must configure the DUT to produce this type of signal to perform a PvT measurement. Further details are offered in the following section. Once supplied, a single burst is captured as a time domain data acquisition, with a single trigger. The rising and falling edges are detected at the crossing points with the burst search threshold level. The burst center point in time is

determined, and then the required masks are aligned in time with the center point. To make a precise slope detection, its threshold level and detection interval techniques are incorporated to extract only steep enough slopes out from the noise-like signals.

In this measurement, one more 802.11b bursts are captured. Burst Time is a search window length in which an entire burst should be captured and also set by customer in mode setup. The captured data in search window is then smoothed to determine max power point. By use of max power point, the ramp up and down can be determined in term of 10% to 90% power range of max power point. Some parameters mentioned above can be explained clearly from Figure below,

**Figure 4-22 Explanation for parameters in Power-on and Power-down Ramp**



## Spectral Flatness Measurement Concepts

### Purpose

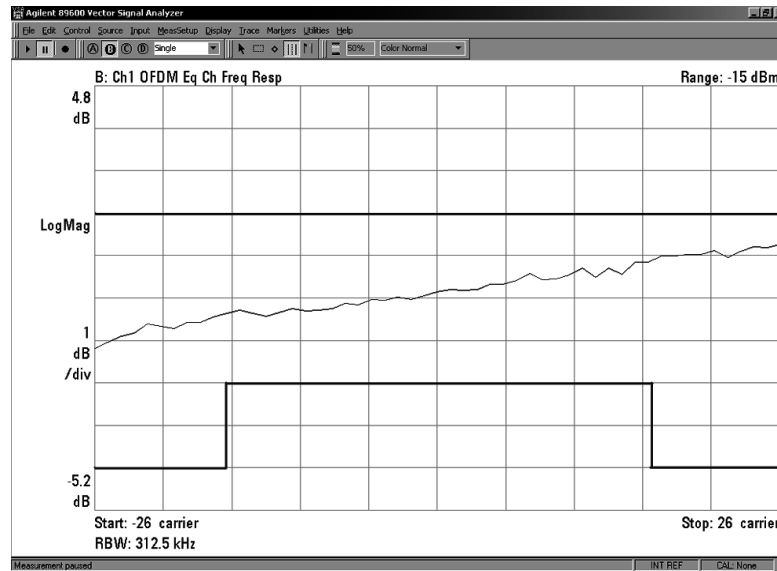
Variation in carrier flatness of OFDM signals in IEEE 802.11a/g will reduce demodulation margins and degrade link performance. This measurement applies to test carrier flatness of OFDM signals in IEEE 802.11a/g.

### Measurement Method

The spectrum flatness measurement measures energy flatness of sub-carriers in OFDM system. The average energy of the constellations in each of the spectral lines  $-16 \dots -1$  and  $+1 \dots +16$  will deviate no more than  $\pm 2$  dB from their average energy. The average energy of the constellations in each of the spectral lines  $-26 \dots -17$  and  $+17 \dots +26$  will

deviate no more than  $+2/-4$  dB from the average energy of spectral lines  $-16... -1$  and  $+1... +16$ . The average energy can be computed by averaging energy on the sub-carriers from  $-16$  to  $16$ . Please note, zero sub-carrier is not included in this computation phase.

**Figure 4-23 Spectral Flatness Measurement**



## Modulation Accuracy Measurement Concepts

### Purpose

Error Vector Magnitude (EVM) is a very common modulation quality metric widely used in digital communication systems. EVM is the scalar distance between the measured signal and the time-aligned reference signal. In most standards, EVM is defined as the root-mean-square of error values at the symbol decision positions. Measurements of EVM and related quantities can pinpoint the causes for any problems uncovered by identifying exactly the type of degradation present in the signal and even help reveal any impairments that occur at the base-band filters, I/Q modulators, IF and RF sections of the transmitter.

This measurement works in conjunction with the DSP measurement engine to complete the measurement. The hardware setup, IF path calibration, UI, measurement cycle, averaging and display are handled by the platform DLP. The interface for these systems is described in detail below.

The reference position is determined from a reference signal that is synthesized by demodulating the data bits from the received signal and then re-modulating these bits "perfectly" for a generic QPSK signal.

The root mean square (RMS) of the error vectors is computed and

expressed as a percentage of the square root of the mean power of the ideal signal<sup>1</sup>. This is the error vector magnitude (EVM). EVM is a common modulation quality metric widely used in digital communication systems.

For a regular QAM or a Phase Shift Keyed (PSK) signal, the ideal symbol points always map onto a few specific locations in the I/Q plane.

### Measurement Method

The signal to be measured needs to be a single coded signal such as one DPCH, a single DPDCH, or a DPDCH and a DPCCH. The phase error of the unit under test is measured by computing the difference between the phase of the transmitted signal and the phase of a theoretically perfect signal.

The instrument samples the transmitter output in order to capture the actual phase trajectory. This is then demodulated and the ideal phase trajectory is mathematically derived using detected bits and root-raised cosine channel filtering. Subtracting one from the other results in a phase error signal.

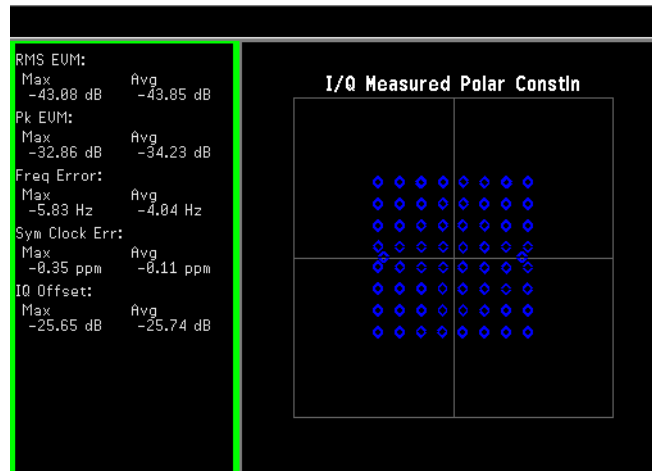
This measurement allows you to display these errors numerically and graphically on the instrument display. There are graphs for I/Q Measured Polar Vector, I/Q Measured Polar Constellation, EVM, Phase Error and Mag Error in the graph windows. In the text window, there are both maximum and average data for Evm: in % rms, in % peak, RMS Mag Error: in %, Phase Error: in degrees, Freq Error: in Hz, and IQ Origin Offset: in dB.

The modulation accuracy measurement is made to get results for a composite error vector magnitude and code domain error from this difference. The code domain error is computed by projecting the error vector power onto the code domain at the maximum spreading factor. The error vector for each power code is defined as the ratio to the mean power of the reference waveform expressed in dB.

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1. The actual calculation method of the percentage depends on the specific standard. The EVM may be normalized to the amplitude of the outermost symbol, the square root of the average symbol power, or the square root of the mean power of the ideal signal. In the case of W-???, the specifications require normalization to the square root of the mean power of the ideal signal (see section on Composite EVM).

**Figure 4-24 I/Q Polar Constellation and Related Parameters**



When a modulation accuracy measurement is performed, the following data is provided (See [Figure 4-24 on page 239](#)):

- RMS EVM Max
- RMS EVM Avg
- Peak EVM Max
- Peak EVM Avg
- 1000 Chips EVM Max
- 1000 Chips EVM Avg
- RMS Magnitude Error Max
- RMS Magnitude Error Avg
- Peak Magnitude Error Max
- Peak Magnitude Error Avg
- RMS Phase Error Max
- RMS Phase Error Avg
- Peak Phase Error Max
- Peak Phase Error Avg
- Freq Error Max
- Freq Error Avg
- Chip Clock Error Max
- Chip Clock Error Avg
- I/Q Origin Offset Max,
- I/Q Origin Offset Avg

- Gain Imbalance Max
- Gain Imbalance Avg
- Quadrature Error Max
- Quadrature Error Avg
- Carrier Suppression Min
- Carrier Suppression Avg

## Power Stat CCDF Measurement Concepts

### Purpose

Many of the digitally modulated signals now look noise-like in the time and frequency domain. This means that statistical measurements of the signals can be a useful characterization. Power Complementary Cumulative Distribution Function (CCDF) curves characterize the higher level power statistics of a digitally modulated signal. The curves can be useful in determining design parameters for digital communications systems.

In mobile communications, battery life is one of the most important characteristics of the device. The efficiency of the power amplifier is key to maximizing battery life. The Peak to Average Ratio (PAR) of the signal is a concern. The PAR is defined as the ratio of the peak envelope power to the average envelope power of a signal. A signal with a high PAR requires more headroom in the amplifier, which makes it less efficient. The PAR for the basic configuration (one DPDCCH and one DPCCH) is equal or larger than 3.6 dB during 0.1 percent of the time.

The power statistics CCDF measurement can be affected by many factors. For example, modulation filtering, modulation format, combining the multiple signals at different frequencies, number of active codes, and correlation between symbols on different codes with spread spectrum systems will all affect measurement results. These factors are all related to modulation and signal parameters. External factors such as signal compression and expansion by nonlinear components, group delay distortion from filtering, and power control within the observation interval also affect the measurement.

The complementary cumulative distribution function (CCDF) fully characterizes the power statistics of a signal. It provides PAR versus probability. [Figure 4-25 on page 241](#) shows the CCDF curves for a WLAN 802.11b signal. For a probability of 0.1 percent, the PAR of the signal with one DPCCH and five DPDCH is 2.85 dB higher than that of the signal with one DPCCH and one DPDCH.

CCDF curves can help you in several situations:

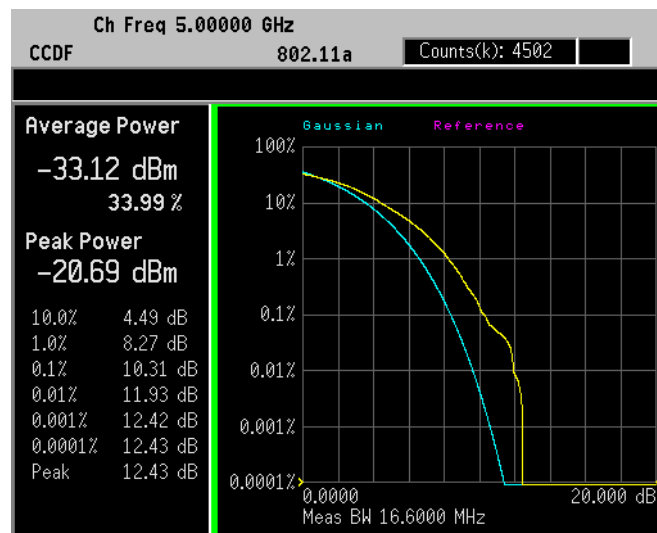
- To determine the headroom required when designing a component.



- To confirm the power statistics of a given signal or stimulus. CCDF curves allow you to verify if the stimulus signal provided by another design team is adequate. For example, RF designers can use CCDF curves to verify that the signal provided by the digital signal processing (DSP) section is realistic.
- To confirm that a component design is adequate or to troubleshoot your subsystem or system design, you can make CCDF measurements at several points of a system. For example, if the ACLR of a transmitter is too high, you can make CCDF measurements at the input and output of the PA. If the PA design is correct, the curves will coincide. If the PA compresses the signal, the PAR of the signal is lower at the output of the PA (Figure 4-25 on page 241).

Figure 4-25

### CCDF Measurement



### Measurement Method

The power measured in power statistics CCDF curves is actually instantaneous envelope power defined by the equation:

$$P = (I^2 + Q^2)/Z_0$$

(where I and Q are the quadrature voltage components of the waveform and  $Z_0$  is the characteristic impedance).

A CCDF curve is defined by how much time the waveform spends at or above a given power level. The percent of time the signal spends at or above the level defines the probability for that particular power level. For capturing a lower probability down to 0.0001%, this measurement is made in the single mode by setting **Measure** under **Meas Control** to **Single**. To make the power statistics CCDF measurement, the instrument uses digital signal processing (DSP) to sample the input signal in the channel bandwidth.

The Gaussian distribution line as the band-limited Gaussian noise CCDF reference line, the user-definable reference trace, and the currently measured trace can be displayed on a semi-log graph. If the currently measured trace is above the user reference trace, it means that the higher peak power levels against the average power are included in the input signal.

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## Other Sources of Measurement Information

Additional measurement application information is available through your local Agilent Technologies sales and service office. The following application notes treat digital communications measurements in much greater detail than discussed in this measurement guide.

- Application Note 1298  
Digital Modulation in Communications Systems - An Introduction  
Agilent part number 5965-7160E
- Application Note 1311  
Understanding CDMA Measurements for Base Stations and Their Components  
Agilent part number 5968-0953E
- Application Note 1486  
WLAN RF and Baseband Transmitter Analysis Using Agilent Infiniium Oscilloscopes and 89600 Software, literature number 5989-0327EN.
- Application Note 1380-1  
RF Testing of Wireless LAN Products, literature number 5988-3762EN.
- Application Note 1380-2  
IEEE 802.11 Wireless LAN PHY Layer (RF) Operation and Measurement, literature number 5988-5411EN.
- Application Note 1380-4  
Making 802.11G Transmitter Measurements, literature number 5988-7813EN.
- Application Note  
Characterizing Digitally Modulated Signals with CCDF Curves  
Agilent part number 5968-5858E
- Application Note  
Characterizing Digitally Modulated Signals with CCDF Curves  
Agilent part number 5968-5858E

### Instrument Updates at [www.agilent.com](http://www.agilent.com)

This web location can be used to access the latest information about the instrument, including the latest firmware version.

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

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## References

1. Supplement to IEEE Standard for Information Technology, IEEE Std 802.11a-1999 (Supplement to ANSI/IEEE Std 802.11, 1999 Edition)
2. Higher Speed Physical Layer in the 2.4 GHz Band, IEEE Std 802.11b-1999 (Supplement to ANSI/IEEE Std 802.11, 1999 Edition)
3. Higher Speed Physical Layer in the 2.4 GHz Band, IEEE Std 802.11g/D8.2, Apr. 2003 (Supplement to ANSI/IEEE Std 802.11, 1999 (Reaff 2003))

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## **5** **Menu Maps**

These menu maps are in alphabetical order by the front panel key label or oval cross-reference label. You can locate detailed information about each key/function at the page number listed in the figure title for each menu.

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## WLAN Measurement Key Flow

The key flow diagrams, shown in a hierarchical manner on the following pages, will help grasp the overall functional relationships for the front-panel keys and the softkeys displayed at the extreme right side of the screen. The diagrams are:

- “Mode Selection Key flow” on page 256
- “Mode Setup Selection Key Flow” on page 257
- “Mode Setup Demod (802.11 a) Key Flow” on page 258
- “Mode Setup Demod (802.11 b) Key Flow” on page 259
- “Mode Setup Demod (802.11g) Key Flow (1 of 2)” on page 260
- “Mode Setup Input Key Flow” on page 262
- “Mode Setup Radio Key Flow” on page 263
- “Mode Setup Trigger Key Flow (1 of 3)” on page 264
- “Frequency Channel Key Flow” on page 254
- “Measurement Selection Key Flow” on page 255
- “CCDF Display Selection Key Flow” on page 249
- “CCDF Span Selection Key Flow” on page 250
- “CCDF Measurement Setup Key Flow (1 of 3)” on page 251
- “Modulation Accuracy (802.11a and 802.11g) Amplitude Selection Key Flow” on page 267
- “Modulation Accuracy (802.11a and 802.11g) Display Selection Key Flow” on page 268
- “Modulation Accuracy (802.11a and 802.11g) Span Selection Key Flow” on page 269
- “Modulation Accuracy (802.11a and 802.11g) Trace/View Selection Key Flow” on page 270
- “Modulation Accuracy (802.11a and 802.11g) Measurement Setup Key Flow (1 of 4)” on page 271
- “Modulation Accuracy (802.11b) Amplitude Selection Key Flow” on page 275
- “Modulation Accuracy (802.11b) Display Selection Key Flow” on page 276
- “Modulation Accuracy (802.11b) Span Selection Key Flow” on page 277
- “Modulation Accuracy (802.11b) Trace/View Selection Key Flow” on page 278
- “Modulation Accuracy (802.11b) Measurement Setup Key Flow (1 of 4)” on page 279
- “Power vs Time Amplitude Selection Key Flow” on page 283
- “Power vs Time Measurement Setup Key Flow (1 of 3)” on page 284


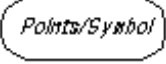




- “SEM Amplitude Selection Key Flow” on page 287
- “SEM Display Selection Key Flow” on page 288
- “SEM Trace/View Selection Key Flow” on page 289
- “SEM Measurement Setup Key Flow (1 of 4)” on page 290
- “Spectral Flatness Amplitude Selection Key Flow” on page 294
- “Spectral Flatness Span Selection Key Flow” on page 295
- “Spectral Flatness Measurement Setup Key Flow (1 of 3)” on page 296
- “Transmit Power Amplitude Selection Key Flow” on page 299
- “Transmit Power Measurement Setup Key Flow (1 of 3)” on page 300

## Directions for Use

Refer to the following notes to utilize the key-flow diagrams:

- Start from the upper left corner of each measurement diagram. Go to the right, and go from the top to the bottom.
- When changing a key from auto (with underline) to manual, just press that key one time.
- When entering a numeric value for **frequency**, a value with units, use the numeric keypad and terminate the entry with the appropriate unit selection from the softkeys displayed.
- When entering a numeric value for a unitless value, like **Avg Number**, use the numeric keypad and terminate the entry with the **Enter** front-panel key.
- Instead of using the numeric keypad to enter a value, it may be easier to use the front-panel knob or **Up/Down** arrow keys.

**Table 5-1 Menu Map Legend**

Icon	Description
	This represents the analyzer front-panel key.
	An oval represents additional levels of menus.
	This box shows how the softkey default condition is displayed. Default parameters or values are underlined wherever possible.
	A dagger to the left of a softkey indicates that when the key is pressed this is an active function.
	A double-dagger to the left of the softkey indicates a function that is not always available. It is dependent on other instrument settings.
	A bar on the left of two or more softkeys indicates that the keys are a mutually exclusive choice.



**Figure 5-1 CCDF Display Selection Key Flow**

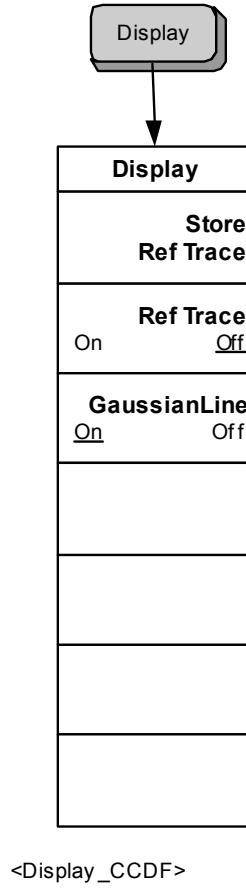
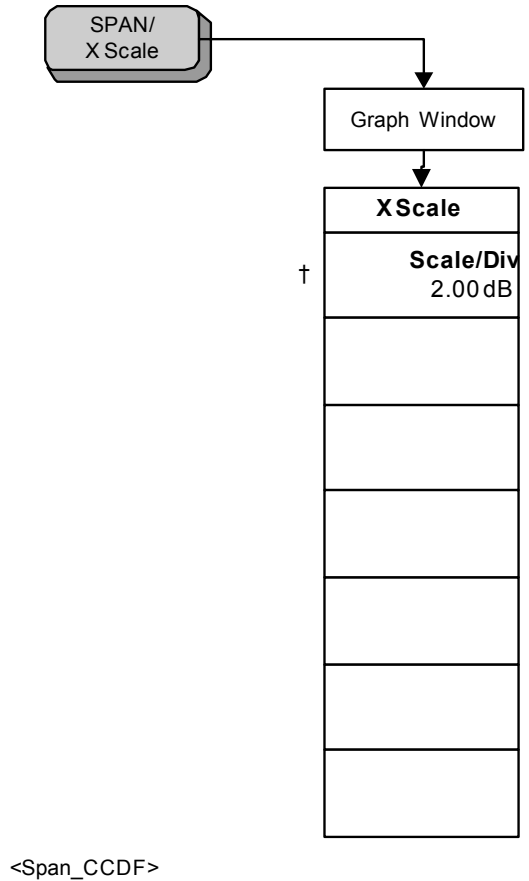


Figure 5-2 CCDF Span Selection Key Flow



**Figure 5-3 CCDF Measurement Setup Key Flow (1 of 3)**

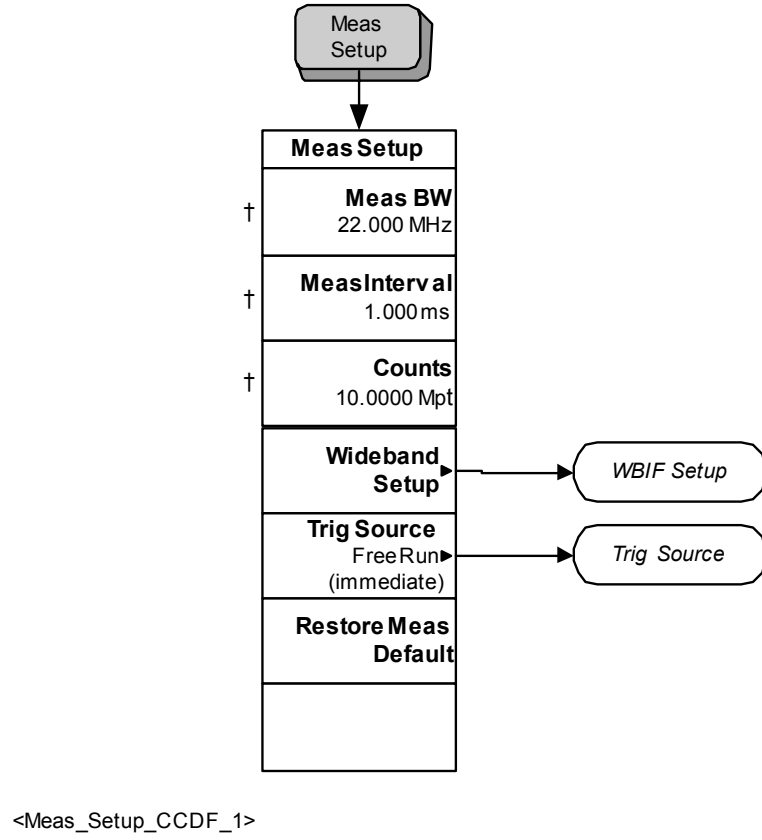
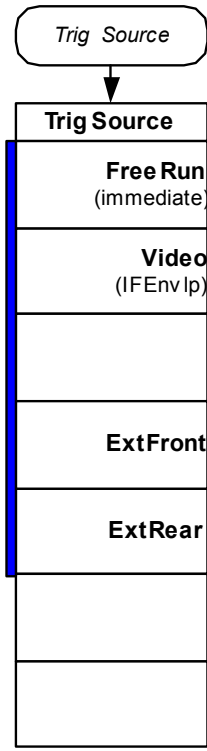
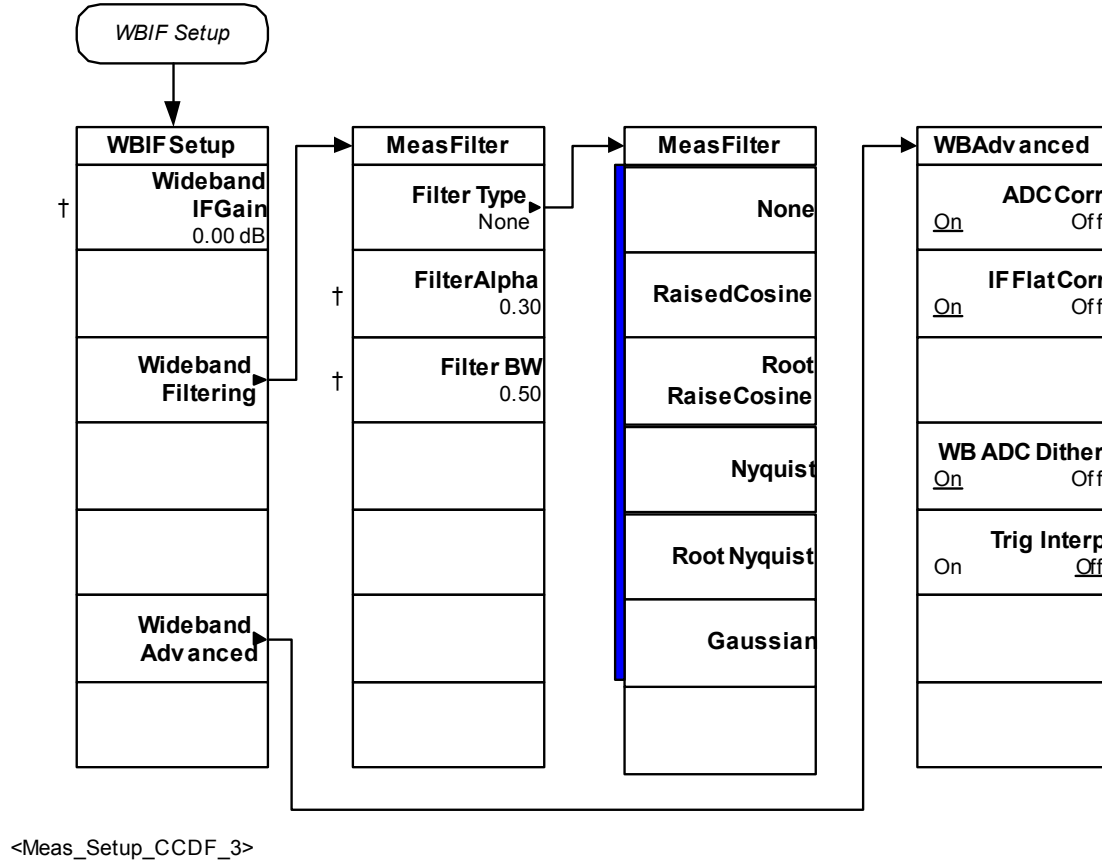


Figure 5-4 CCDF Measurement Setup Key Flow (2 of 3)



<Meas\_Setup\_CCDF\_2>

Figure 5-5 CCDF Measurement Setup Key Flow (3 of 3)



**Figure 5-6**      **Frequency Channel Key Flow**

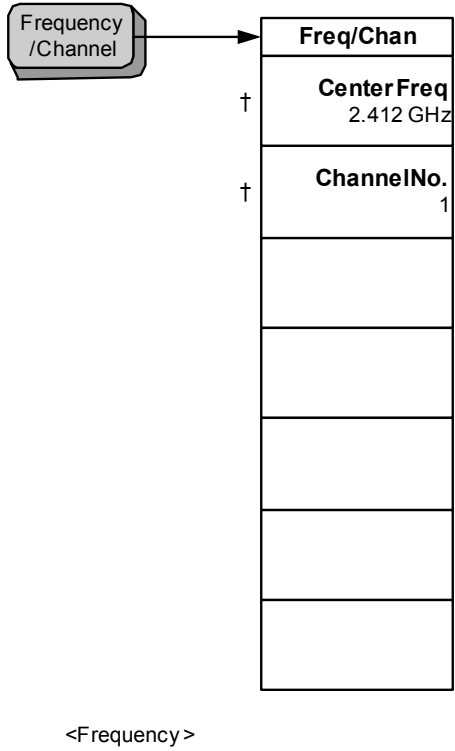
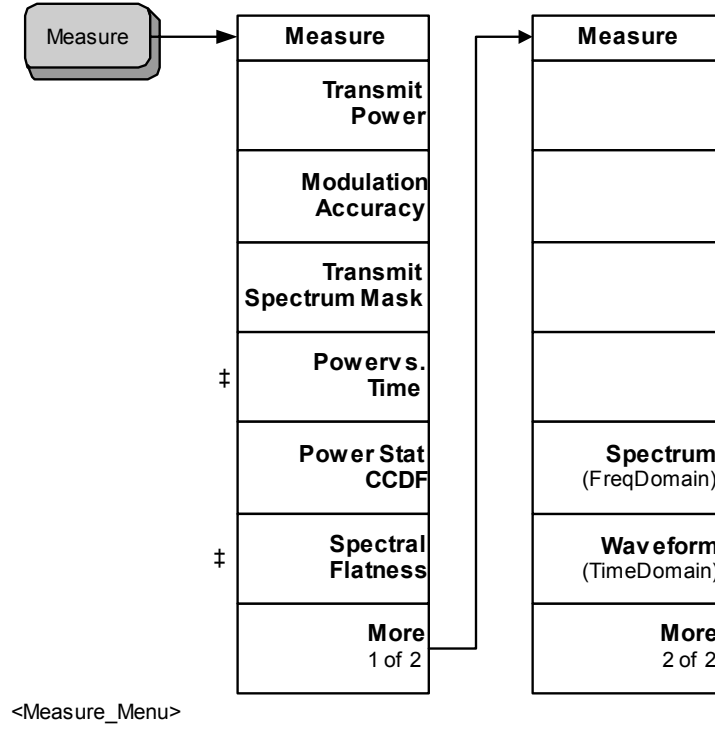
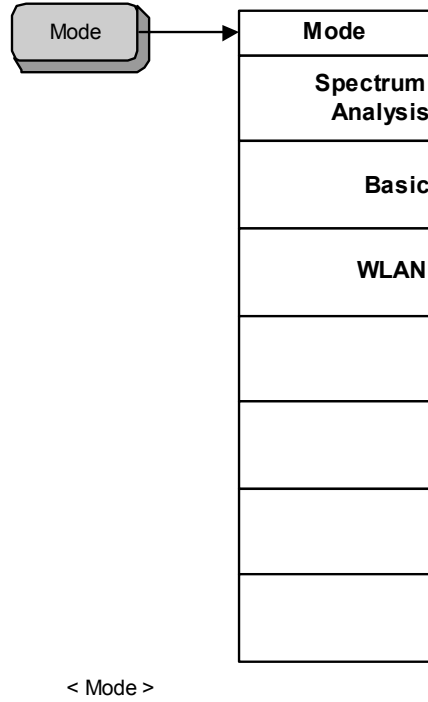


Figure 5-7 Measurement Selection Key Flow



**Figure 5-8 Mode Selection Key flow**





**Figure 5-9 Mode Setup Selection Key Flow**

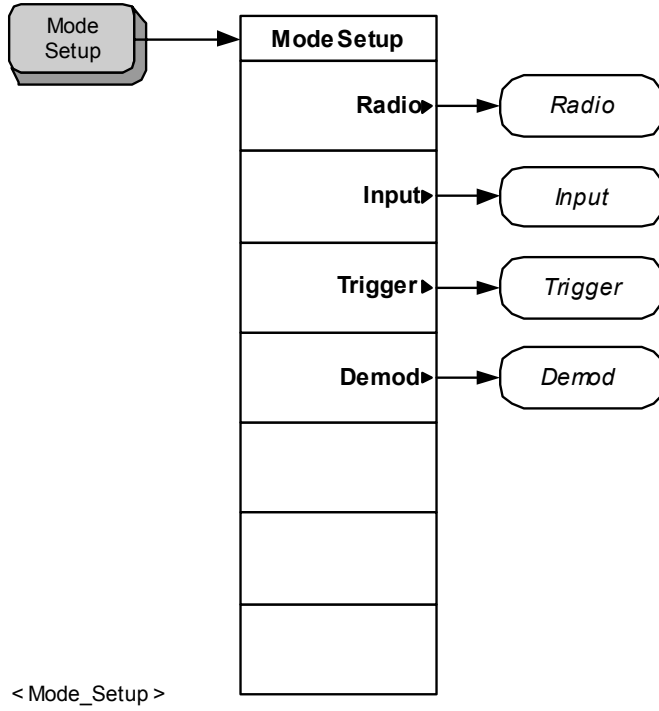


Figure 5-10 Mode Setup Demod (802.11 a) Key Flow

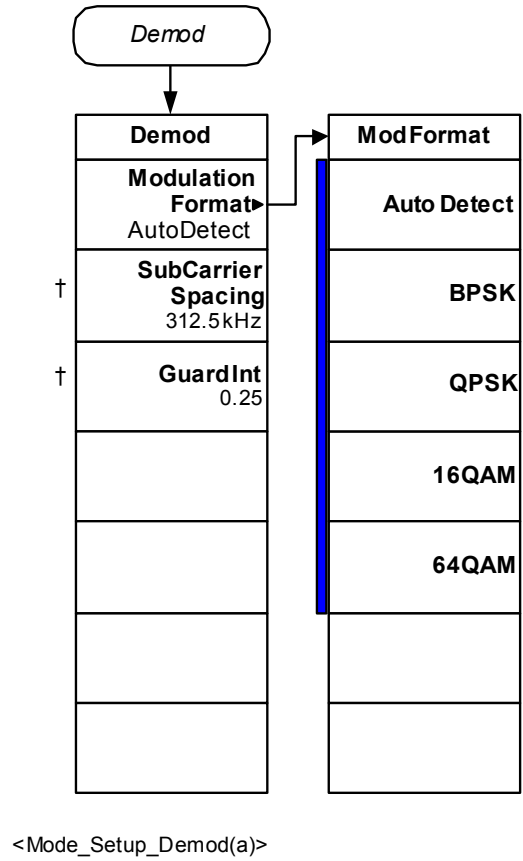


Figure 5-11 Mode Setup Demod (802.11 b) Key Flow

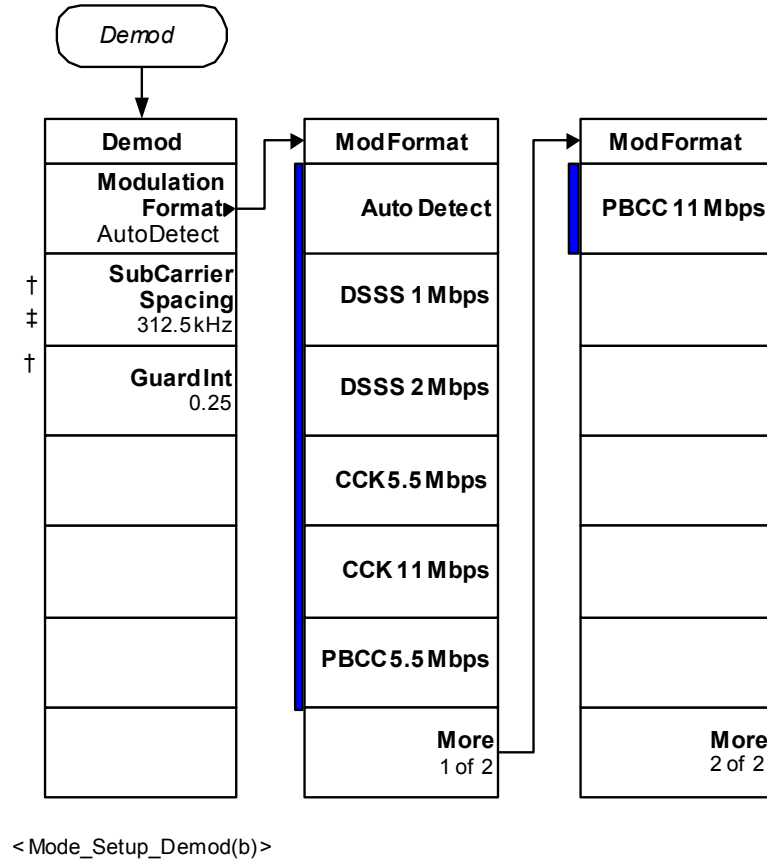


Figure 5-12 Mode Setup Demod (802.11g) Key Flow (1 of 2)

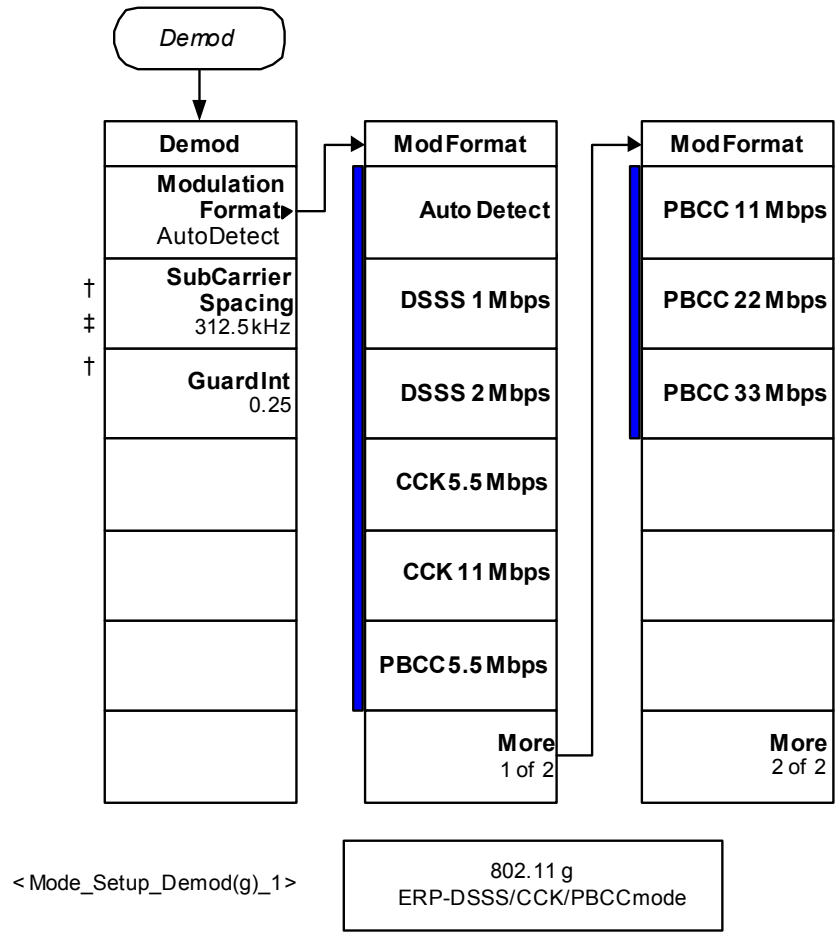
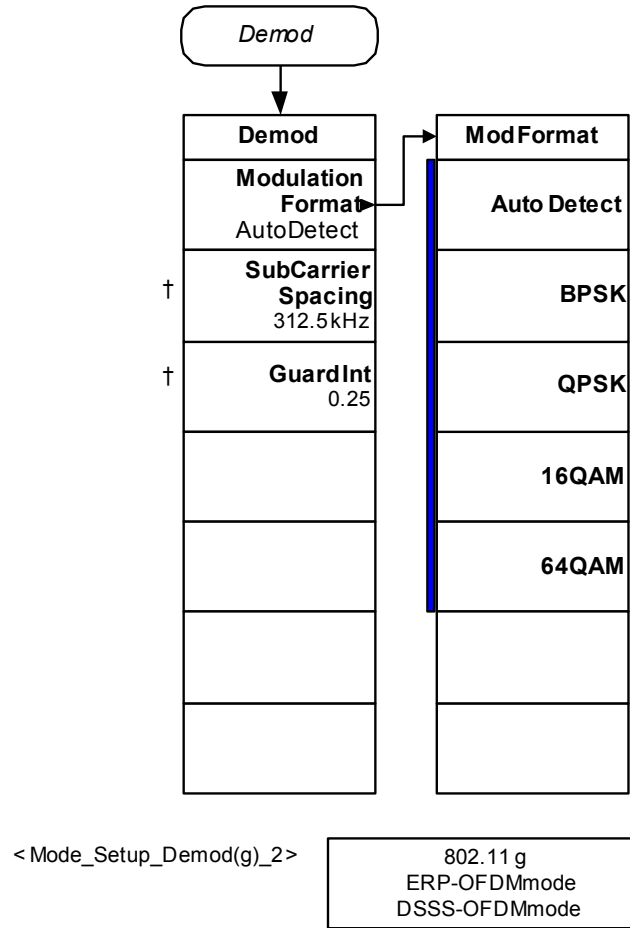


Figure 5-13 Mode Setup Demod (802.11g) Key Flow (2 of 2)



**Figure 5-14 Mode Setup Input Key Flow**

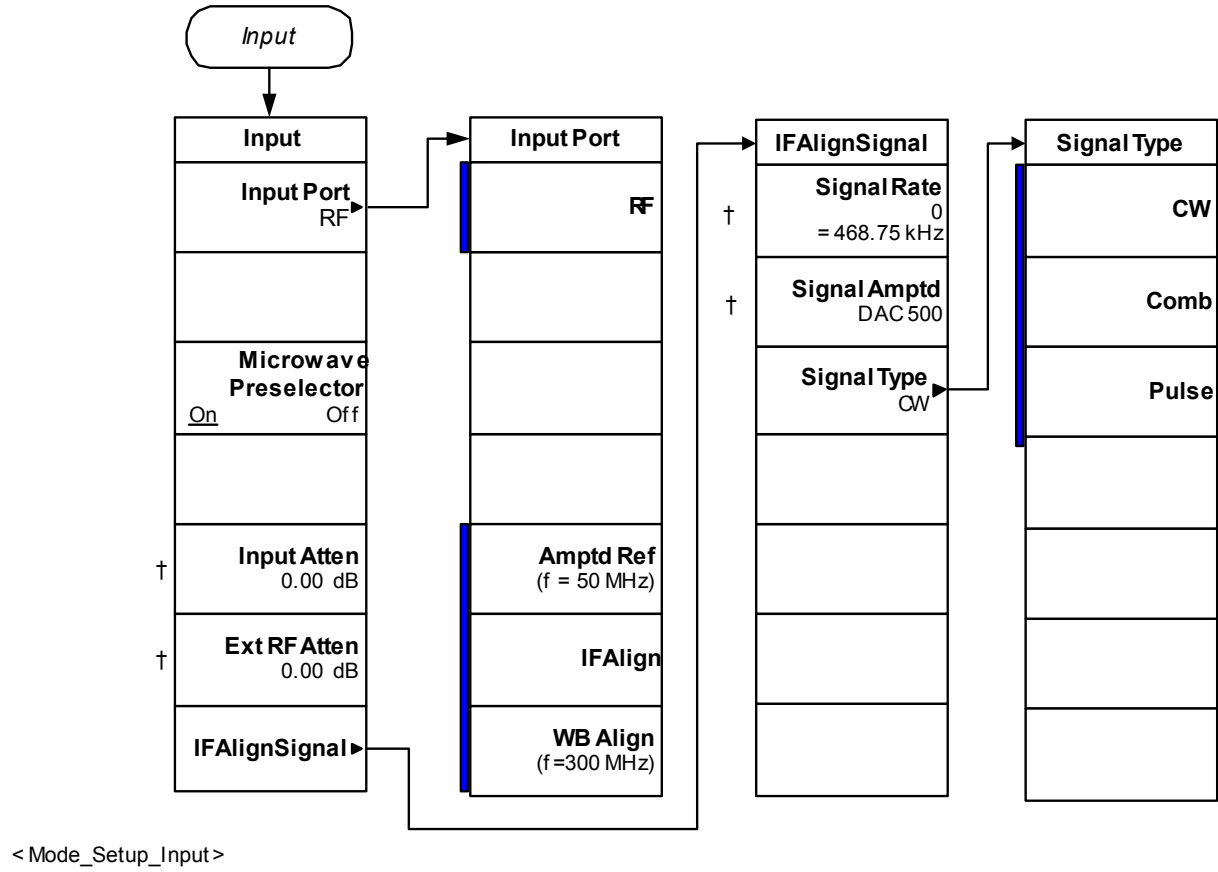
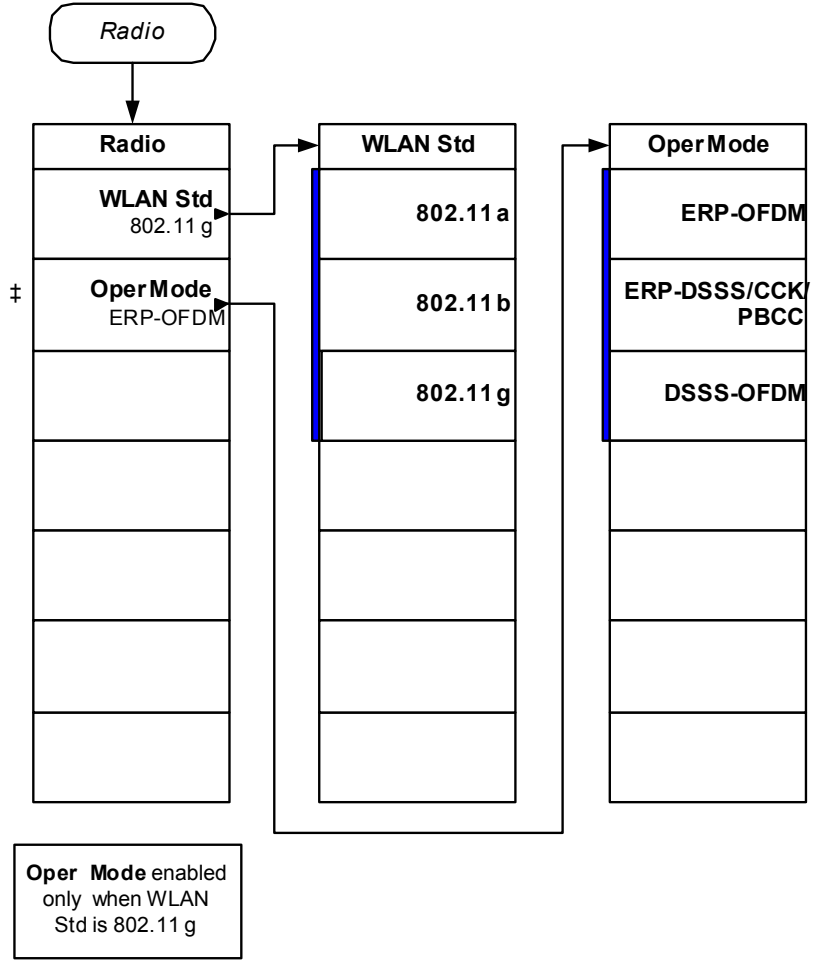
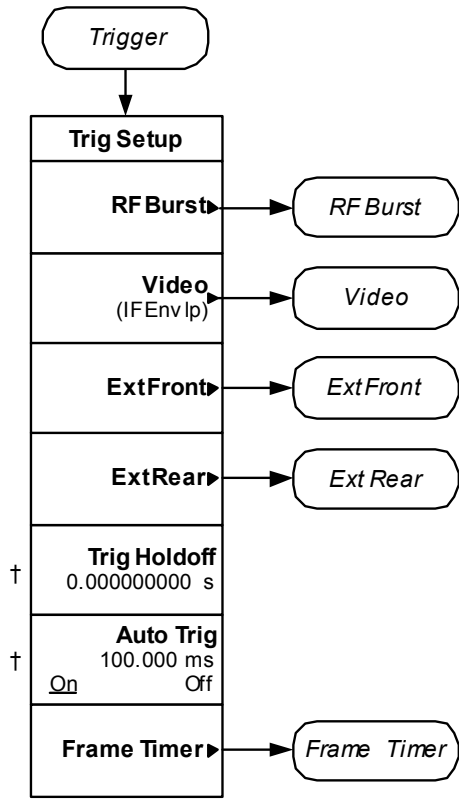


Figure 5-15 Mode Setup Radio Key Flow



< Mode\_Setup\_Radio >

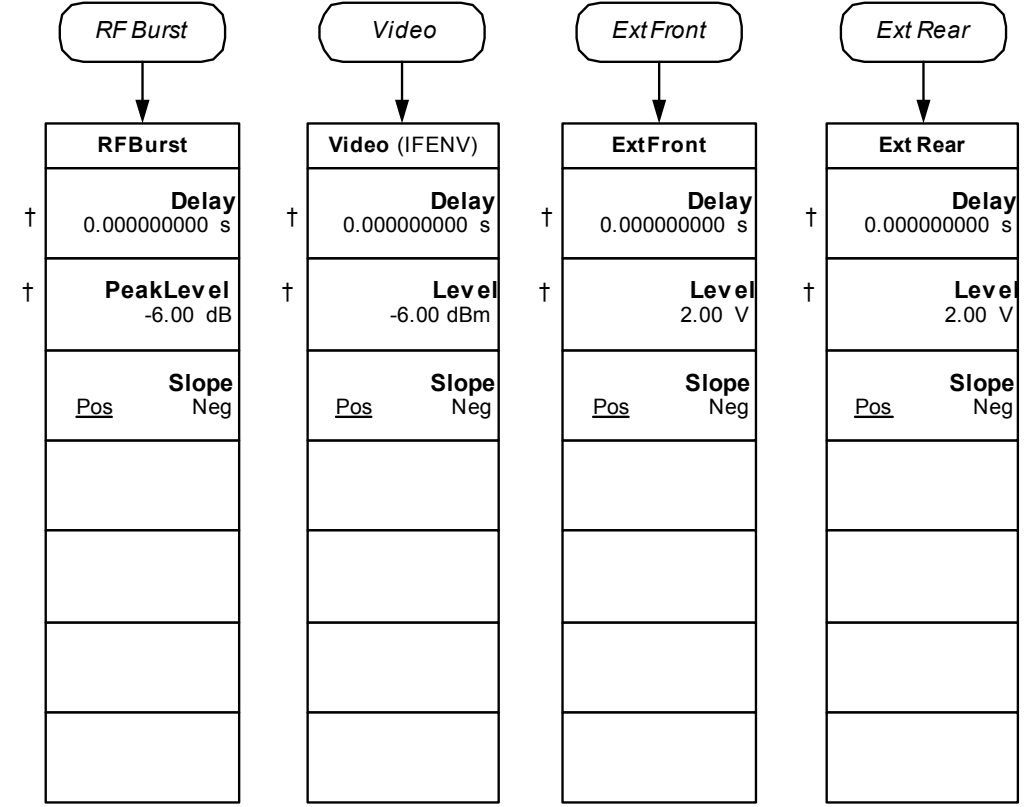
Figure 5-16 Mode Setup Trigger Key Flow (1 of 3)



< Mode\_Setup\_Trigger\_1 >



**Figure 5-17 Mode Setup Trigger Key Flow (2 of 3)**



< Mode\_Setup\_Trigger\_2 >

Figure 5-18 Mode Setup Trigger Key Flow (3 of 3)

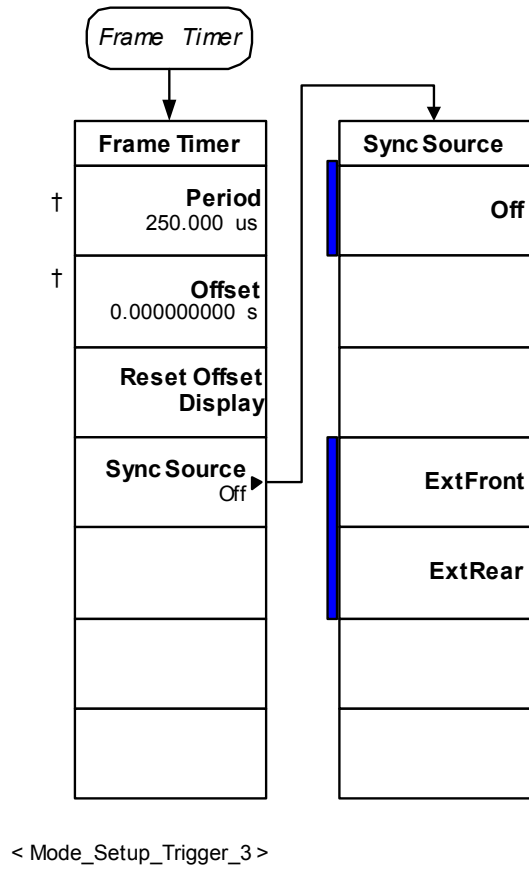
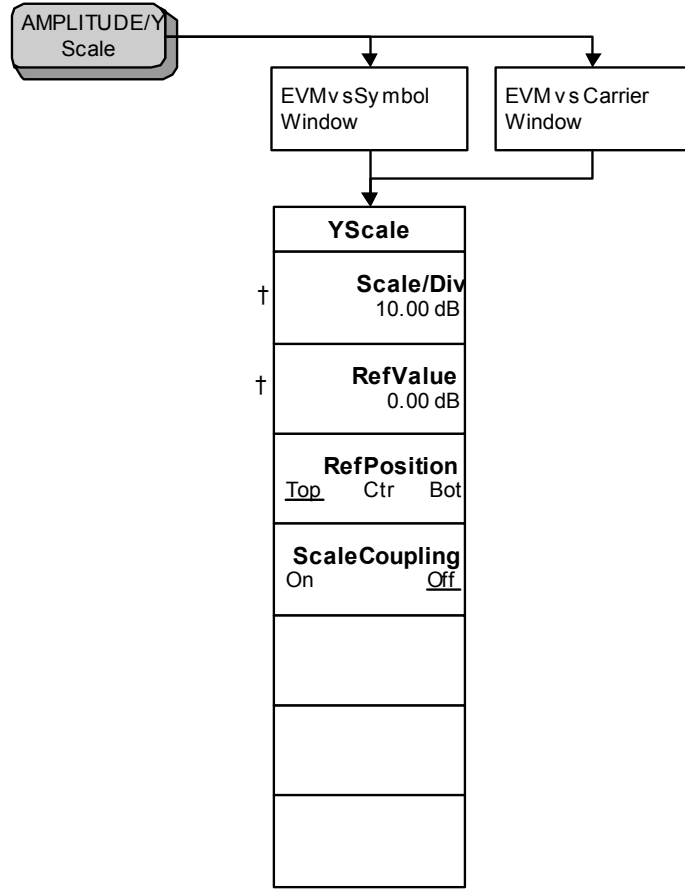


Figure 5-19 Modulation Accuracy (802.11a and 802.11g) Amplitude Selection Key Flow



< Amplitude\_EVM(ag) >

**Figure 5-20 Modulation Accuracy (802.11a and 802.11g) Display Selection Key Flow**

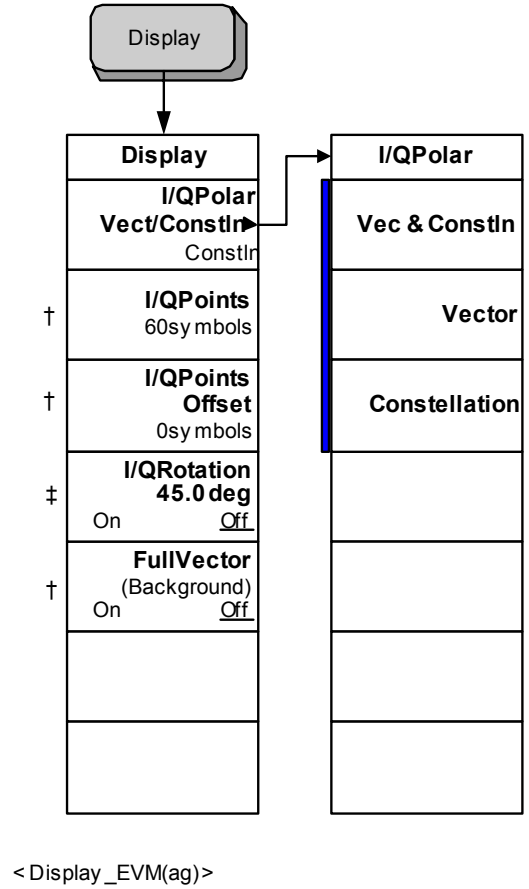
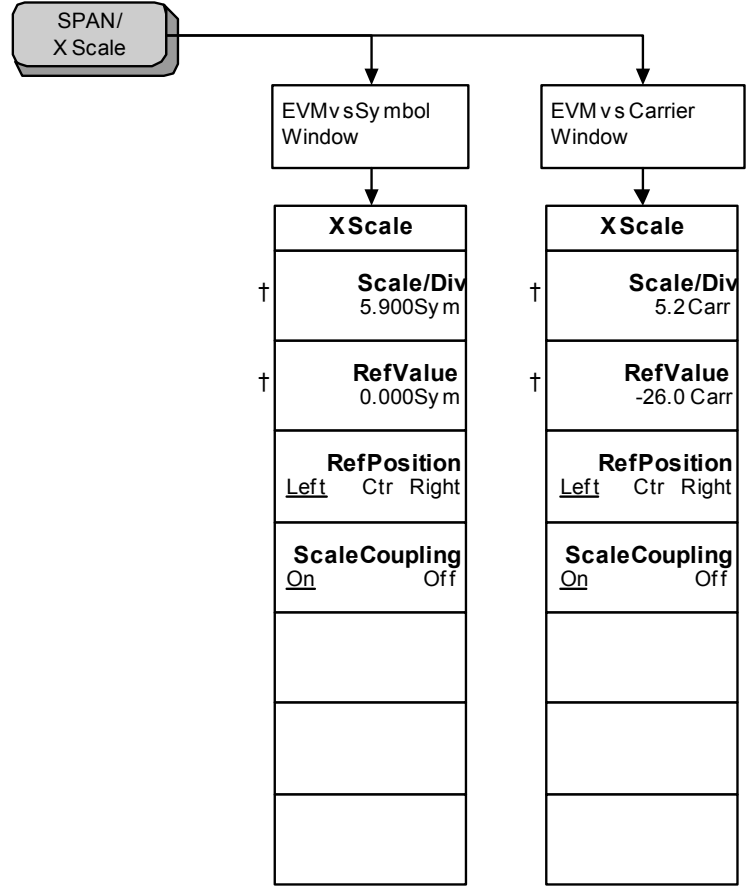
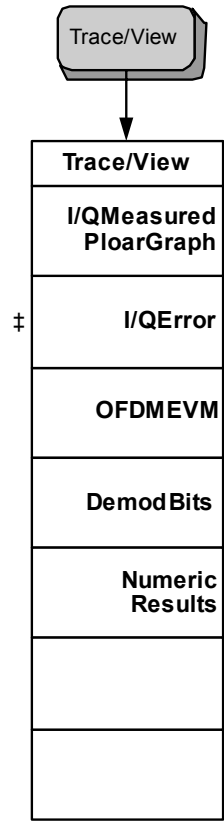


Figure 5-21 Modulation Accuracy (802.11a and 802.11g) Span Selection Key Flow



< Span\_EVM(ag)>

**Figure 5-22 Modulation Accuracy (802.11a and 802.11g) Trace/View Selection Key Flow**



< TraceView\_EVM(ag) >

Figure 5-23 Modulation Accuracy (802.11a and 802.11g) Measurement Setup Key Flow (1 of 4)

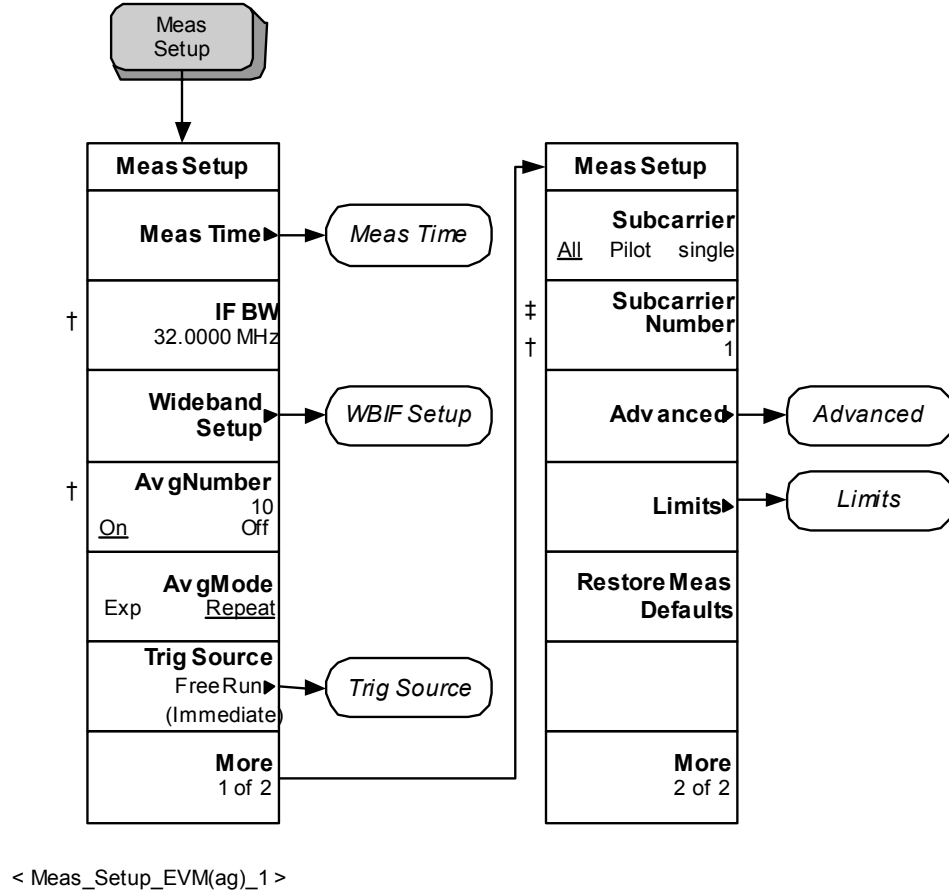
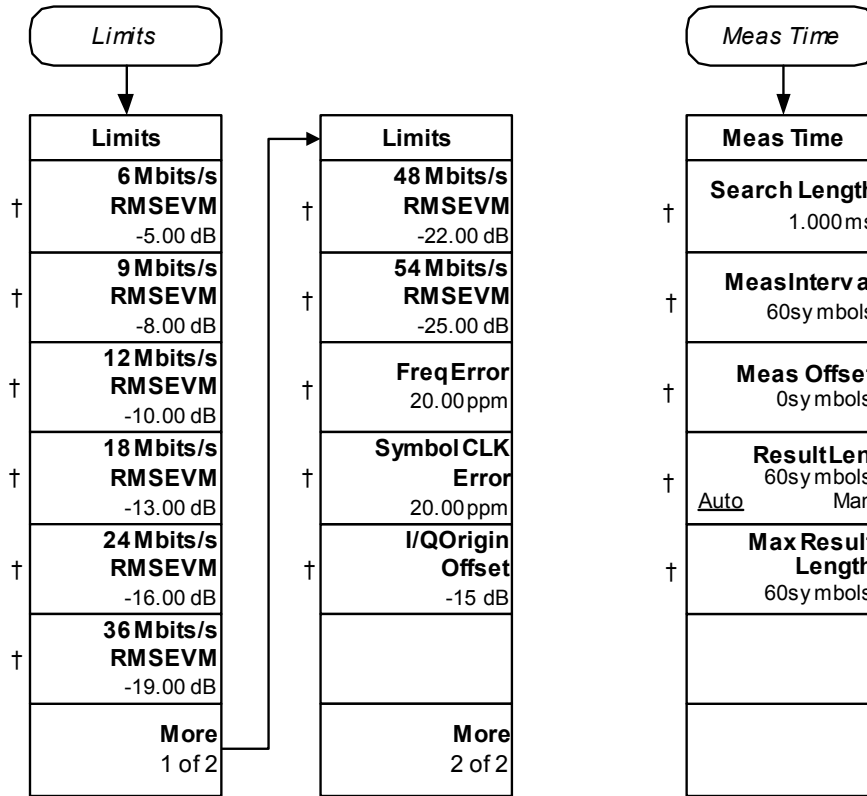


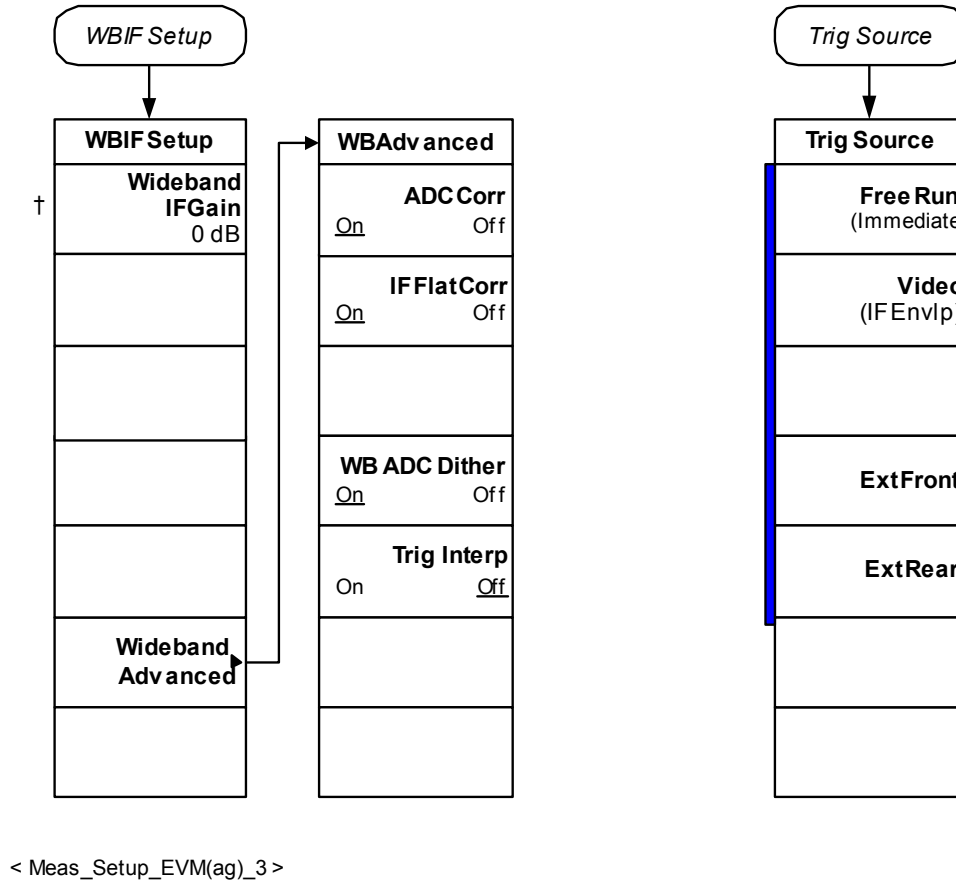
Figure 5-24 Modulation Accuracy (802.11a and 802.11g) Measurement Setup Key Flow (2 of 4)



< Meas\_Setup\_EVM(ag)\_2 >



**Figure 5-25 Modulation Accuracy (802.11a and 802.11g) Measurement Setup Key Flow (3 of 4)**



**Figure 5-26 Modulation Accuracy (802.11a and 802.11g) Measurement Setup Key Flow (4 of 4)**

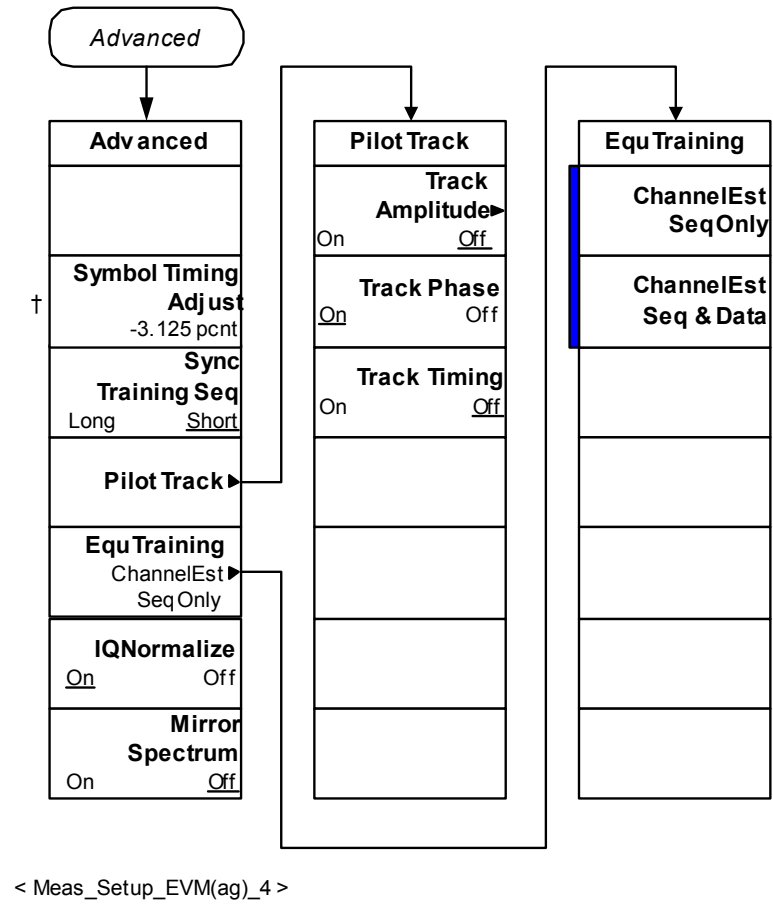
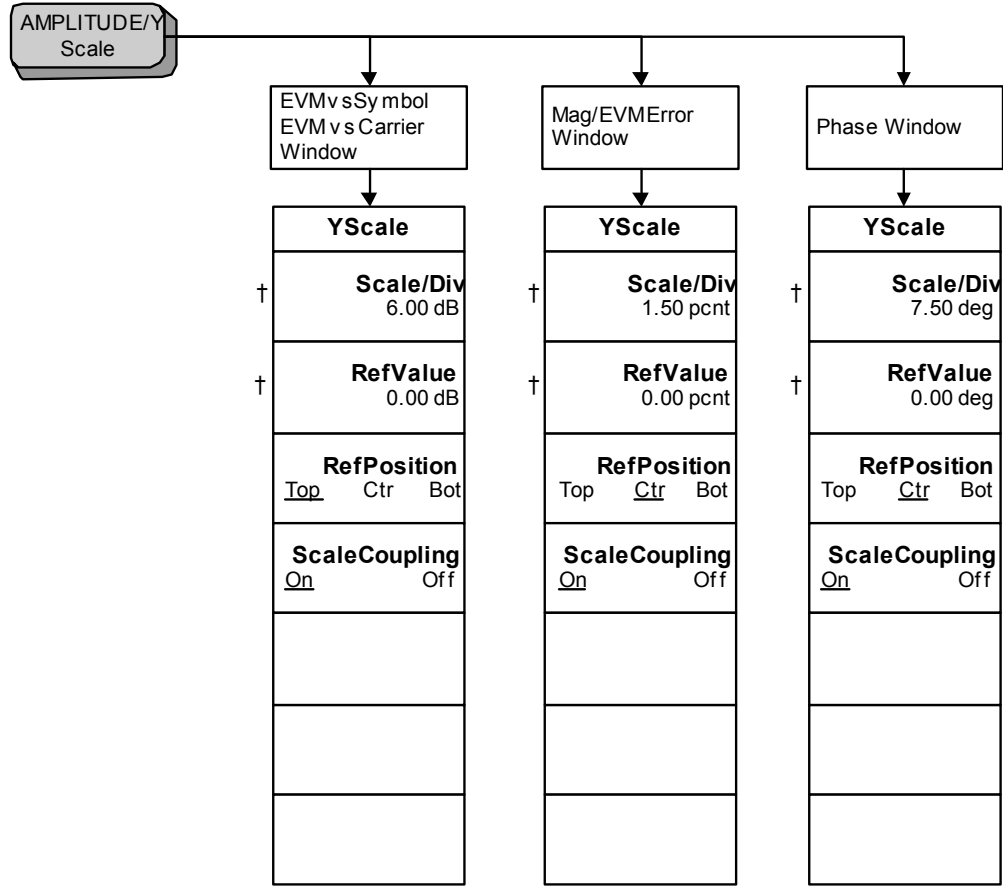
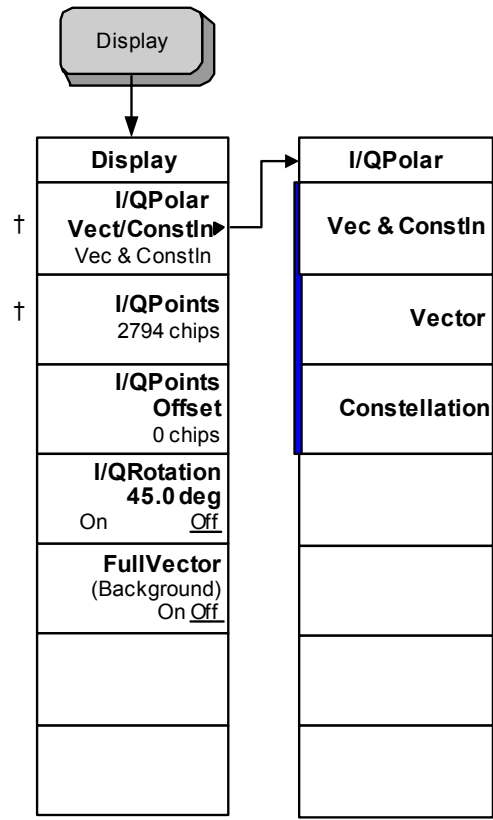


Figure 5-27 Modulation Accuracy (802.11b) Amplitude Selection Key Flow



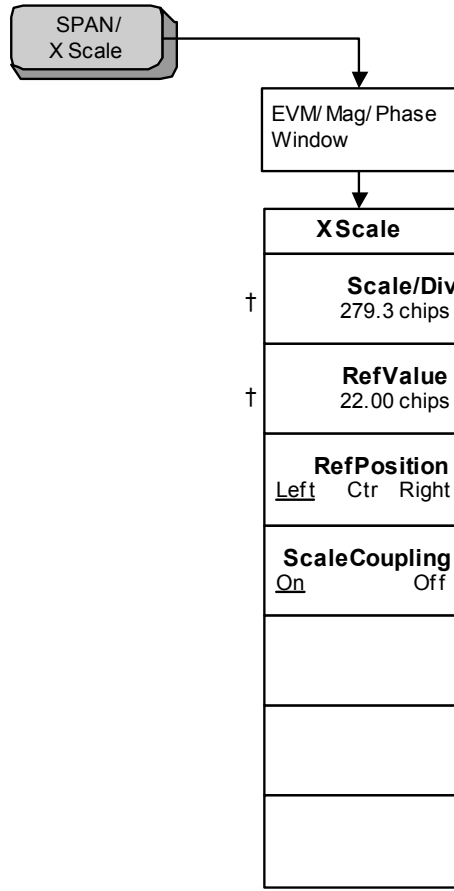
< Amplitude\_EVM(b) >

**Figure 5-28 Modulation Accuracy (802.11b) Display Selection Key Flow**



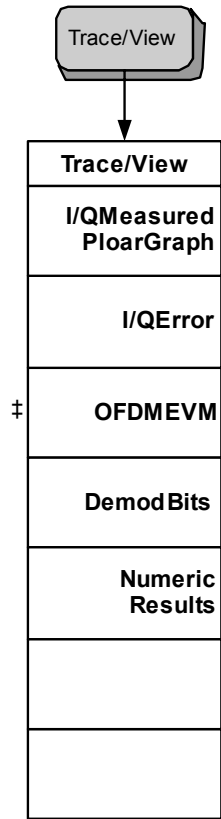
< Display\_EVM(b) >

**Figure 5-29 Modulation Accuracy (802.11b) Span Selection Key Flow**



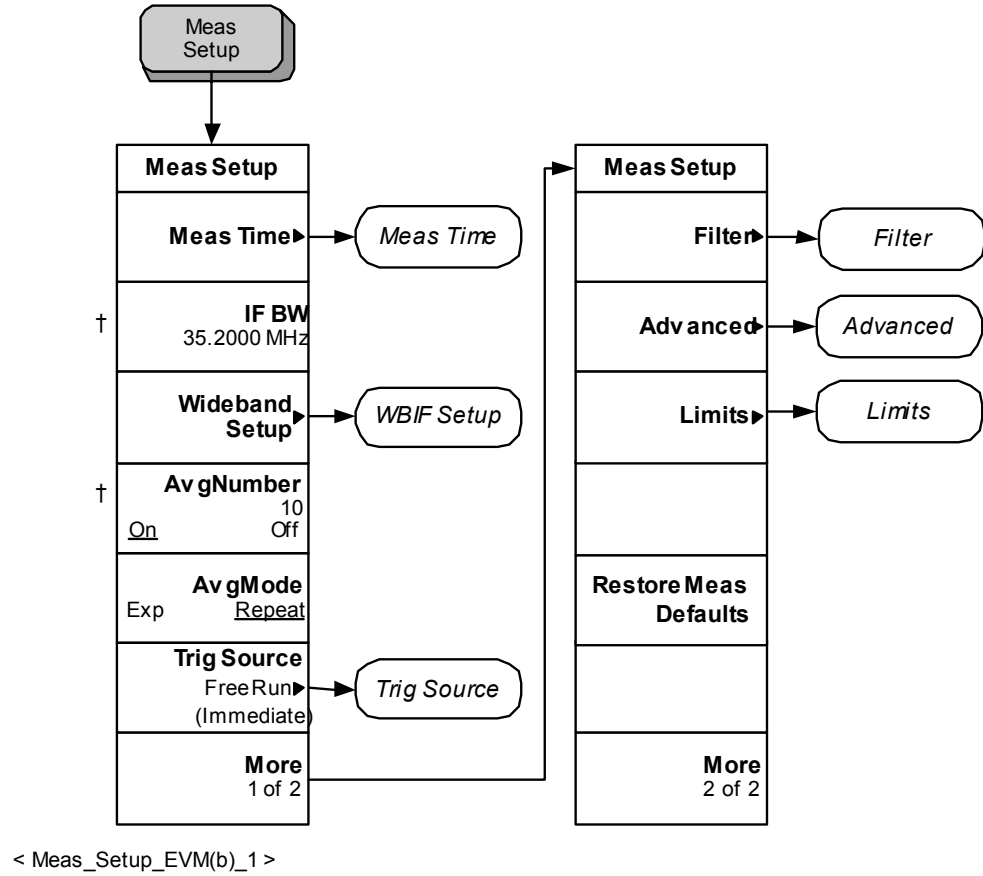
< Span\_EVM(b)>

**Figure 5-30 Modulation Accuracy (802.11b) Trace/View Selection Key Flow**

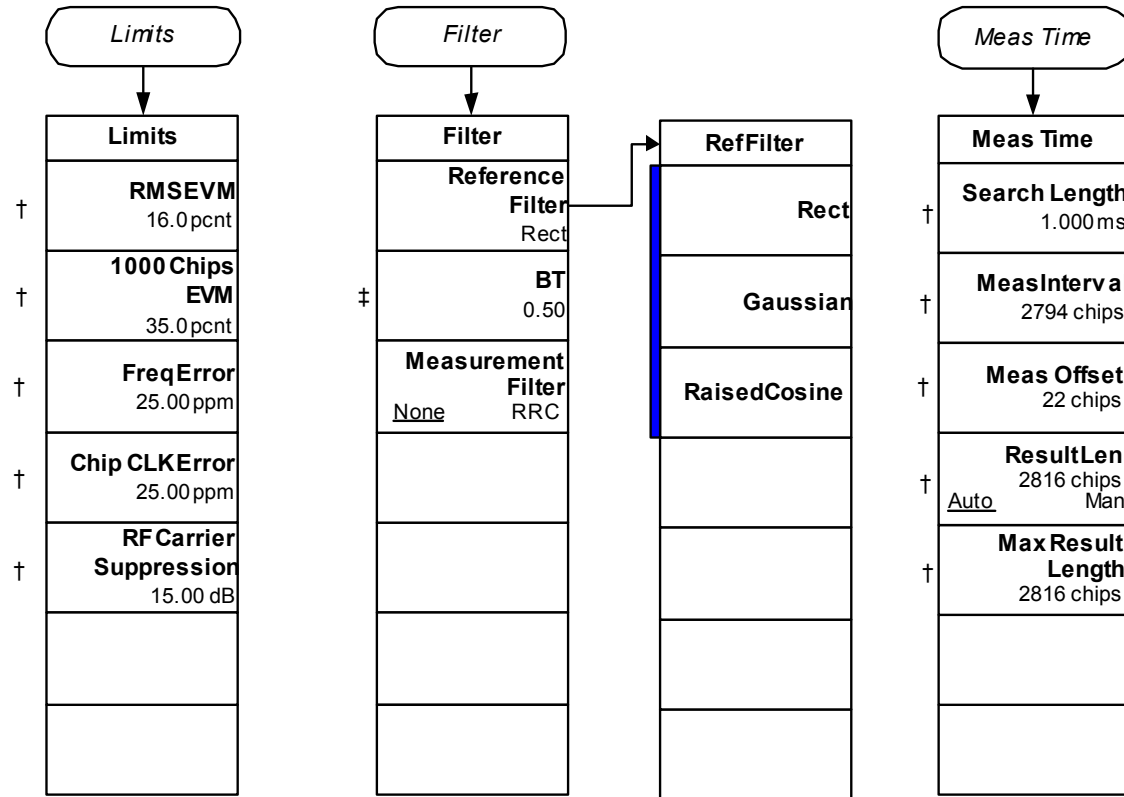


< TraceView\_EVM(b) >

Figure 5-31 Modulation Accuracy (802.11b) Measurement Setup Key Flow (1 of 4)



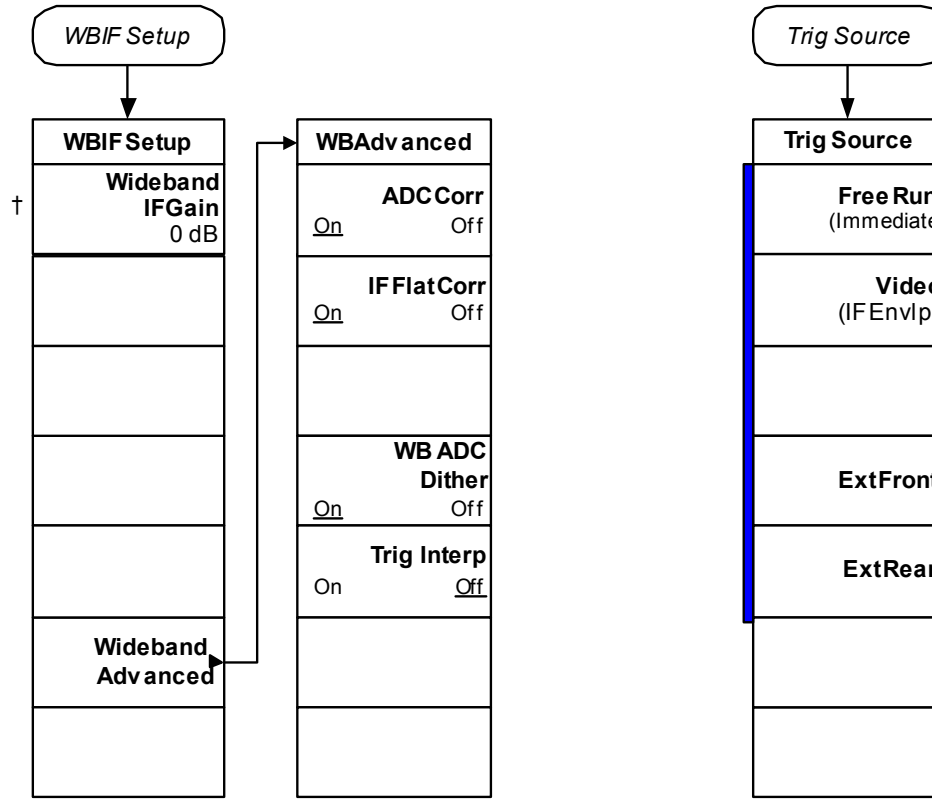
**Figure 5-32 Modulation Accuracy (802.11b) Measurement Setup Key Flow (2 of 4)**



< Meas\_Setup\_EVM(b)\_2>

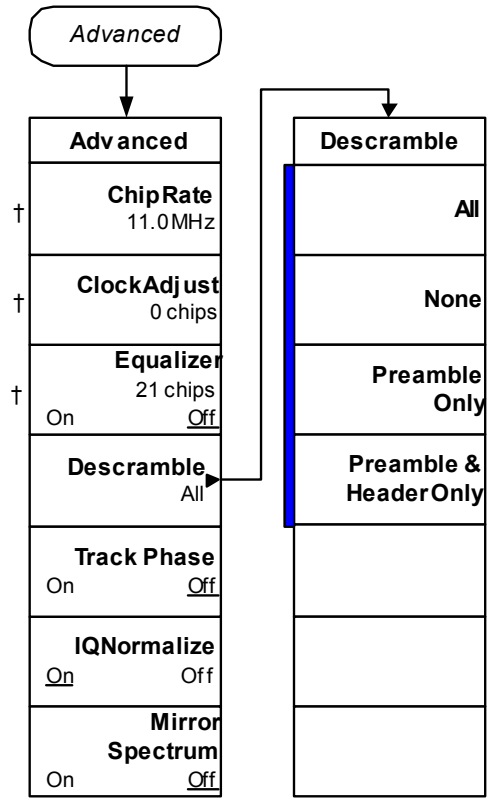


Figure 5-33 Modulation Accuracy (802.11b) Measurement Setup Key Flow (3 of 4)



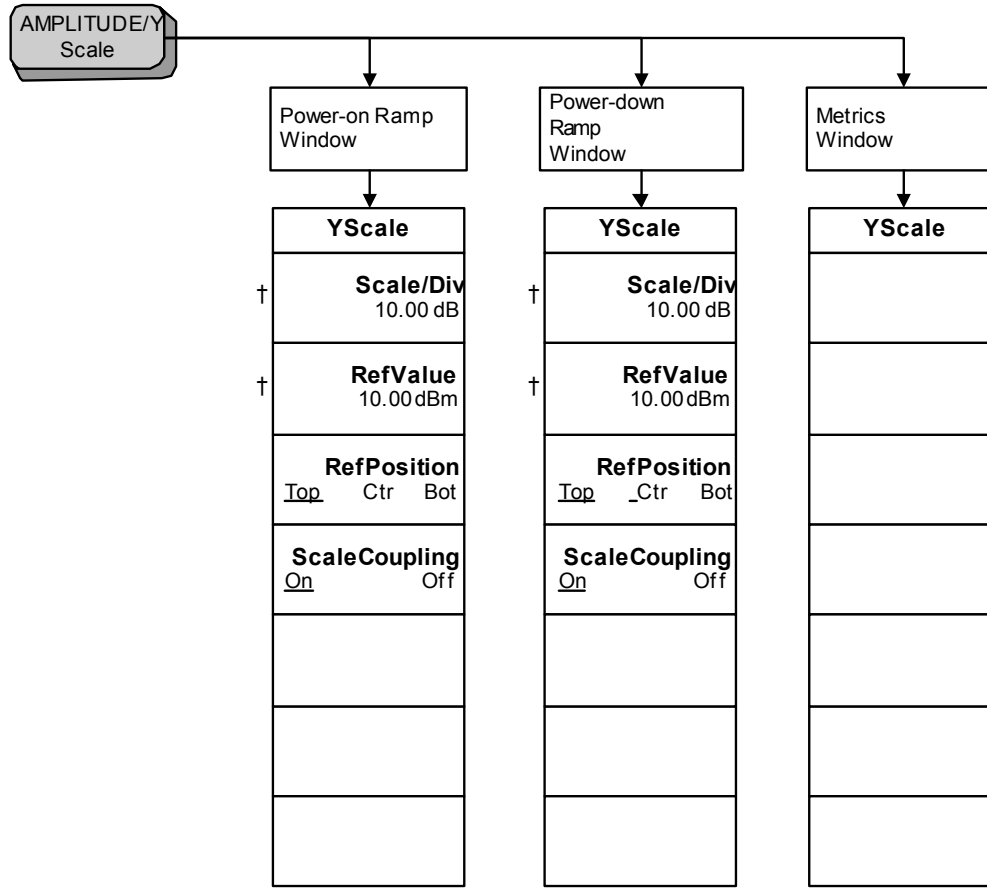
< Meas\_Setup\_EVM(b)\_3 >

**Figure 5-34 Modulation Accuracy (802.11b) Measurement Setup Key Flow (4 of 4)**



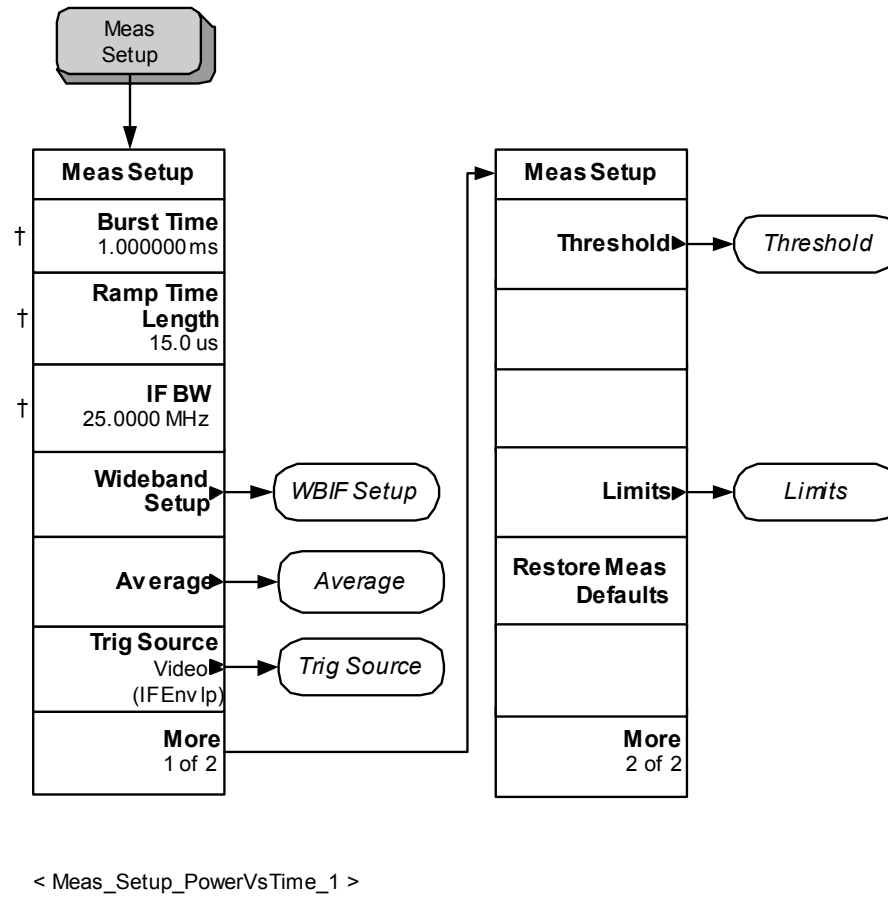
< Meas\_Setup\_EVM(b)\_4 >

Figure 5-35 Power vs Time Amplitude Selection Key Flow



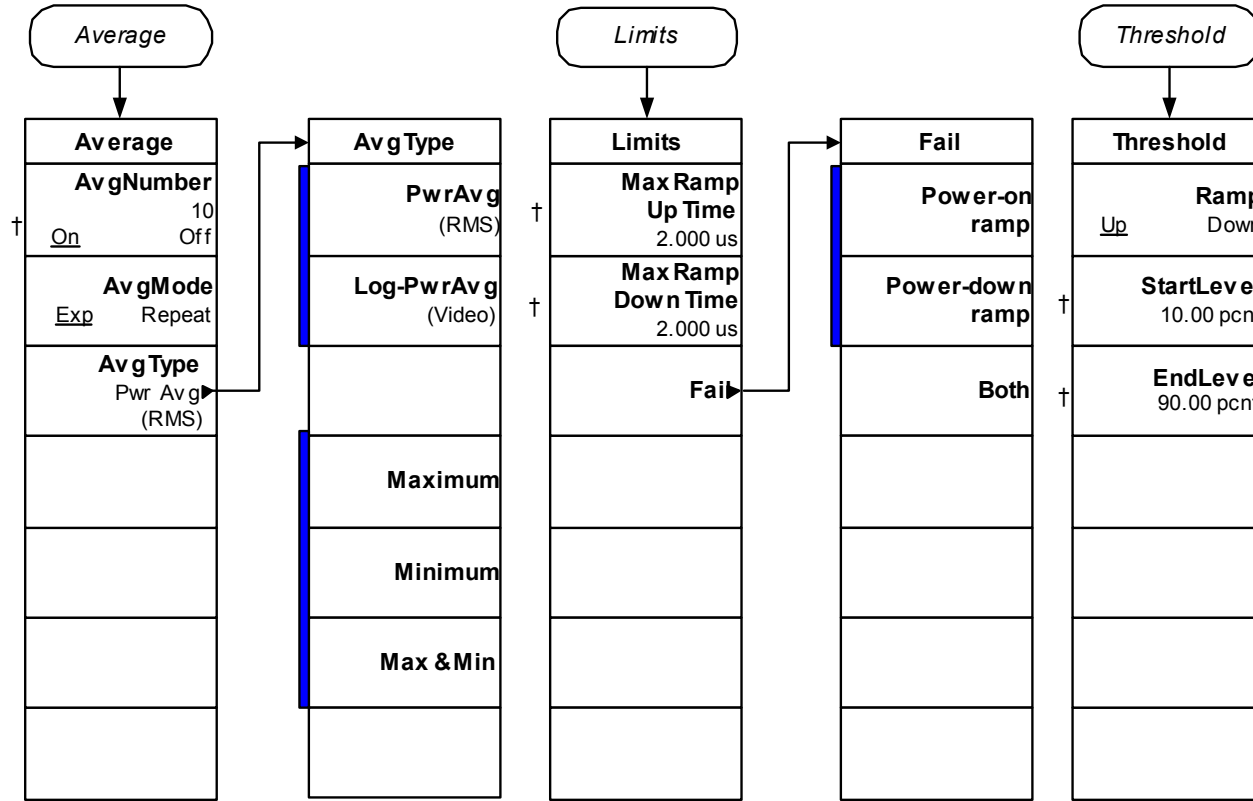
< Amplitude\_PowerVsTime >

Figure 5-36 Power vs Time Measurement Setup Key Flow (1 of 3)

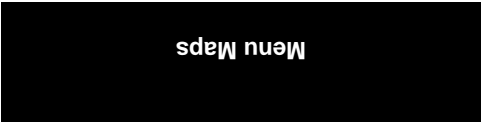


< Meas\_Setup\_PowerVsTime\_1 >

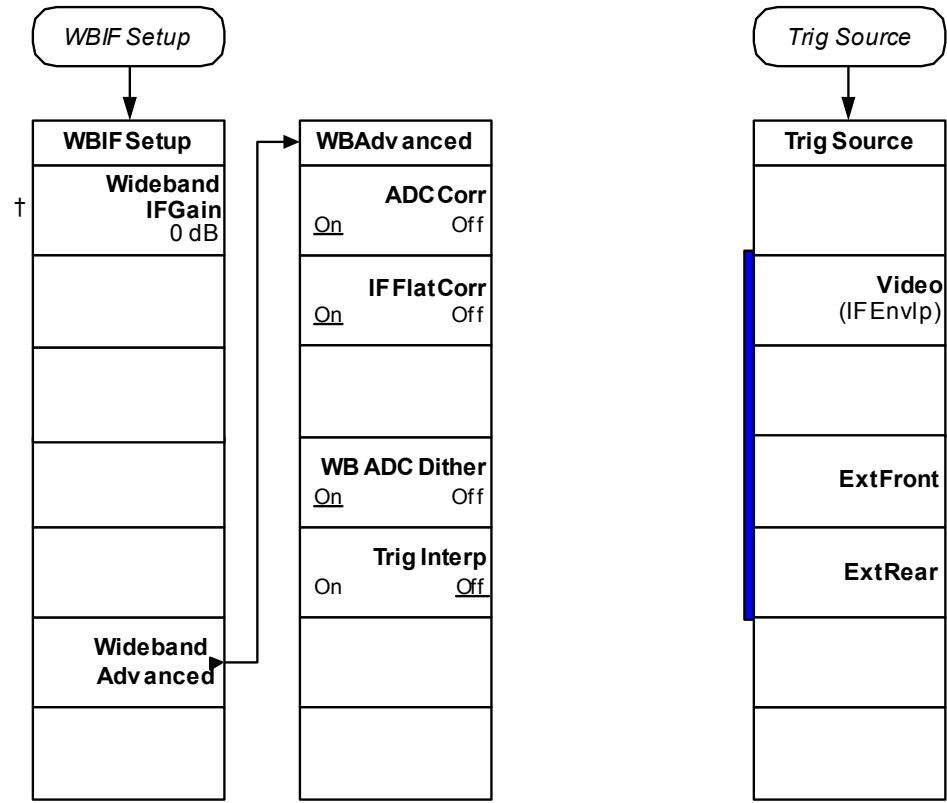
**Figure 5-37 Power vs Time Measurement Setup Key Flow (2 of 3)**



< Meas\_Setup\_PowerVsTime\_2 >



**Figure 5-38 Power vs. Time Measurement Setup Key Flow (3 of 3)**



< Meas\_Setup\_PowerVsTime\_3 >

Figure 5-39 SEM Amplitude Selection Key Flow

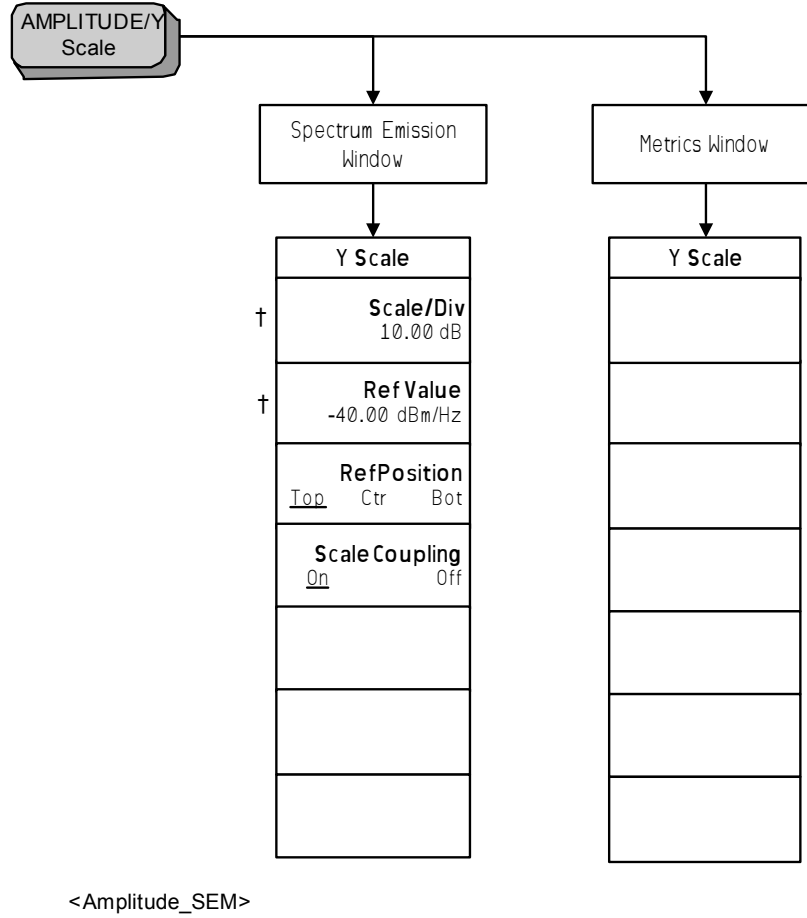
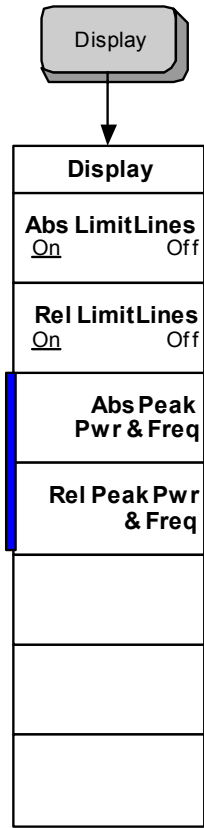


Figure 5-40 SEM Display Selection Key Flow



<Display\_SEM>



**Figure 5-41 SEM Trace/View Selection Key Flow**

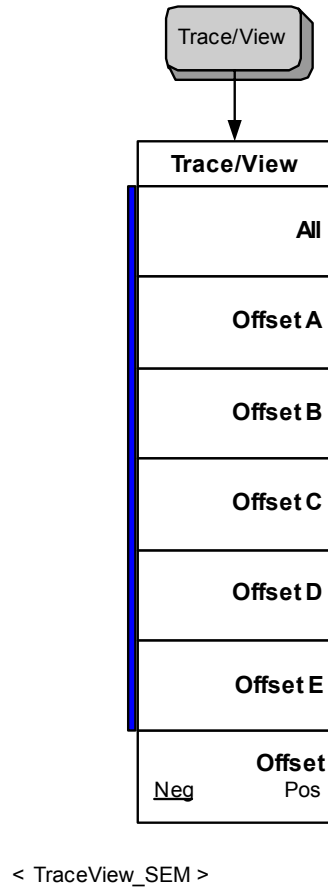
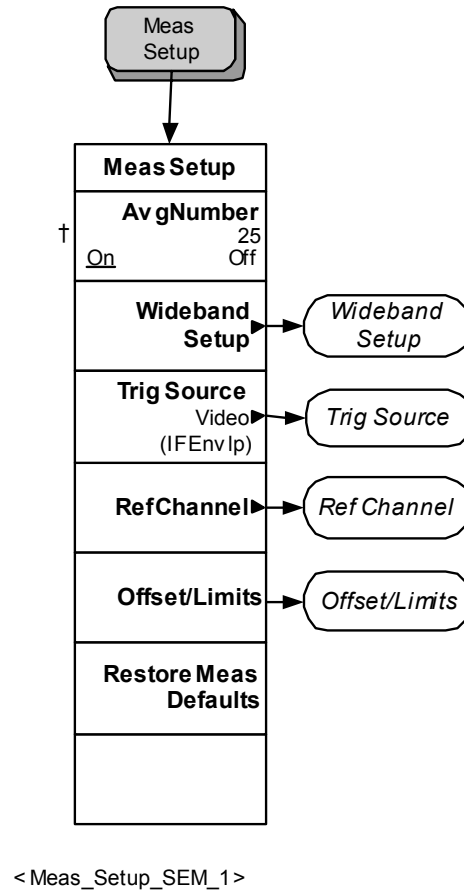
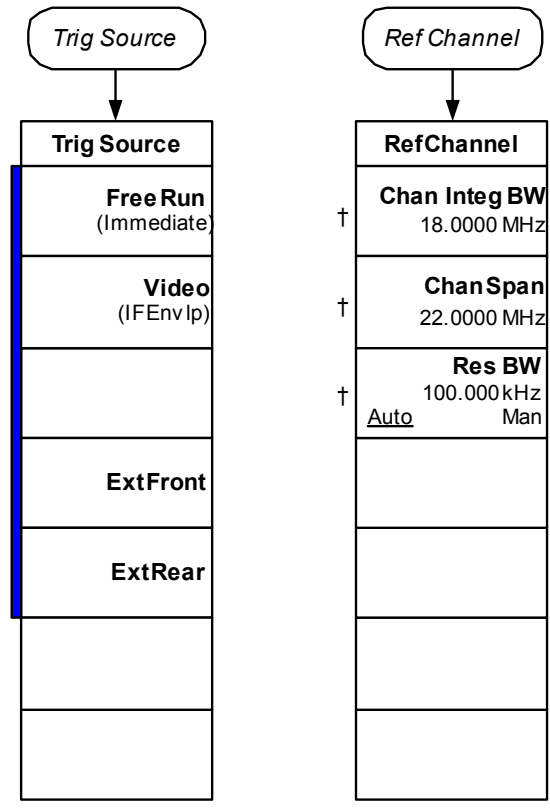


Figure 5-42 SEM Measurement Setup Key Flow (1 of 4)

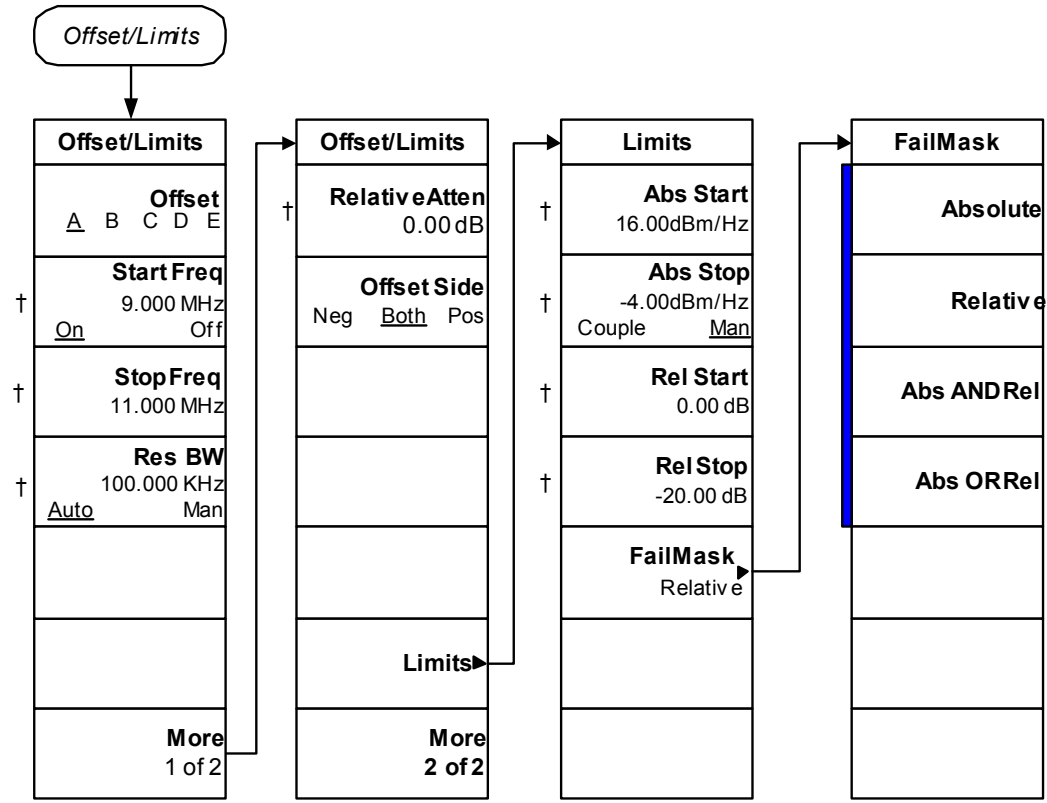


**Figure 5-43 SEM Measurement Setup Key Flow (2 of 4)**



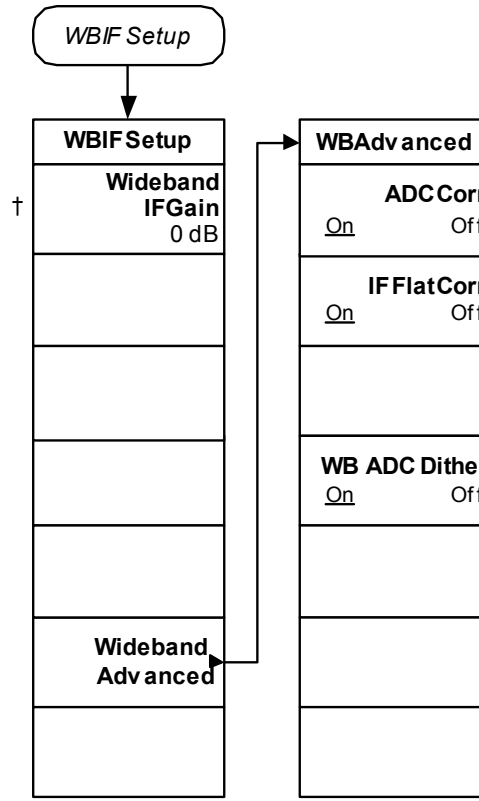
< Meas\_Setup\_SEM\_2 >

**Figure 5-44 SEM Measurement Setup Key Flow (3 of 4)**



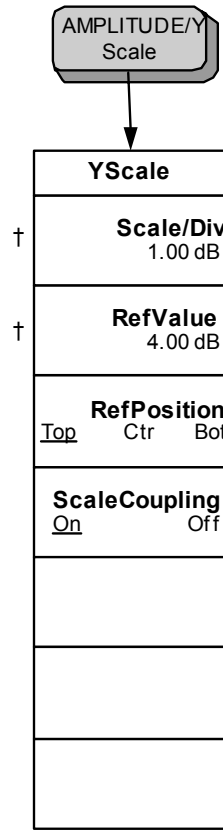
< Meas\_Setup\_SEM\_3 >

Figure 5-45 SEM Measurement Setup Key Flow (4 of 4)



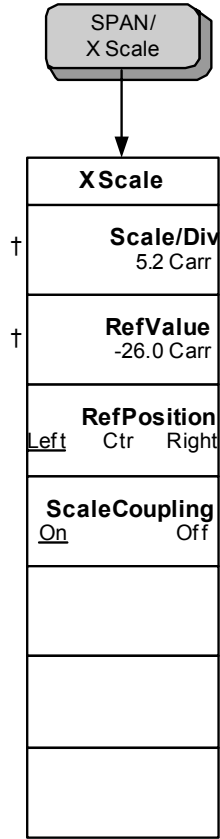
< Meas\_Setup\_SEM\_4 >

**Figure 5-46 Spectral Flatness Amplitude Selection Key Flow**



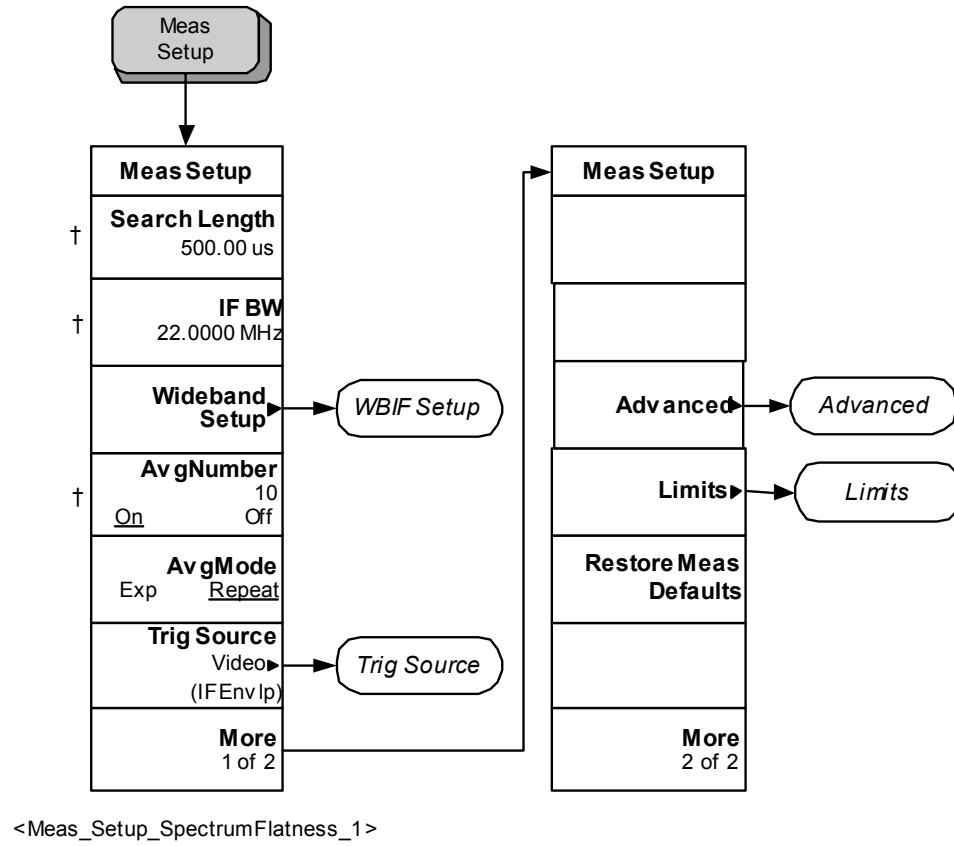
<Amplitude\_SpectrumFlatness>

**Figure 5-47 Spectral Flatness Span Selection Key Flow**



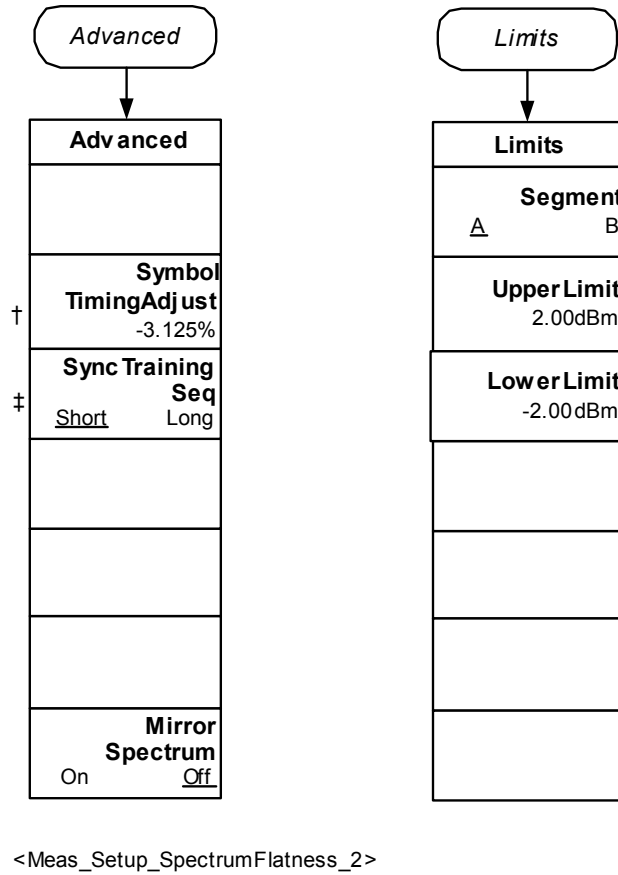
<Span\_SpectrumFlatness>

**Figure 5-48 Spectral Flatness Measurement Setup Key Flow (1 of 3)**

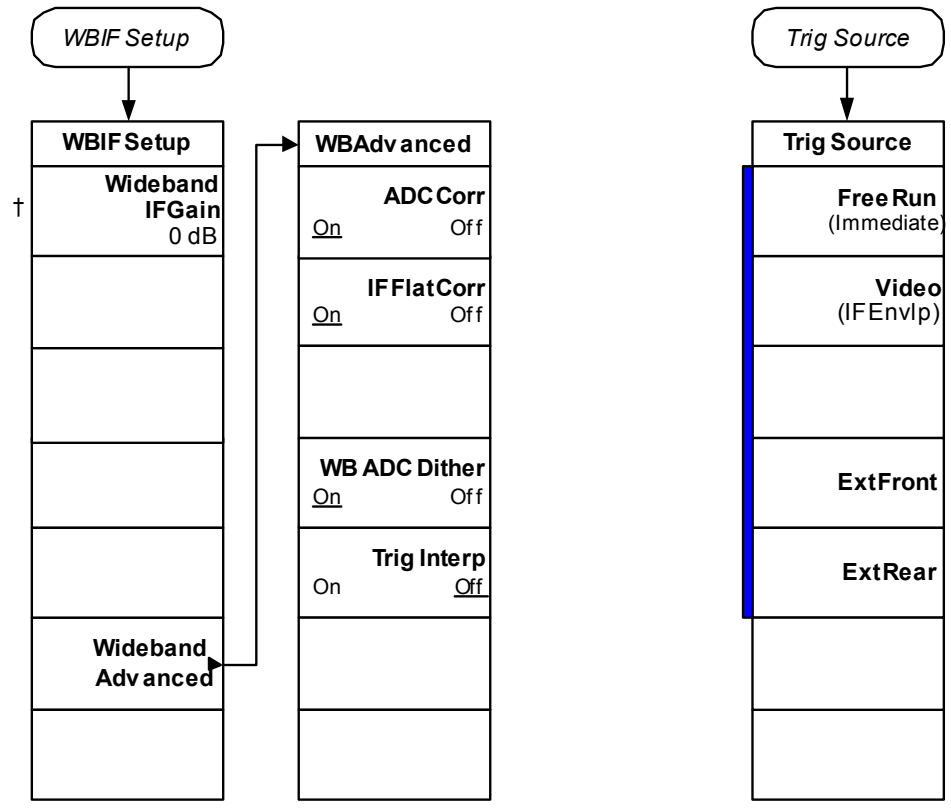




**Figure 5-49 Spectral Flatness Measurement Setup Key Flow (2 of 3)**



**Figure 5-50 Spectral Flatness Measurement Setup Key Flow (3 of 3)**



<Meas\_Setup\_SpectrumFlatness\_3>

Figure 5-51 Transmit Power Amplitude Selection Key Flow

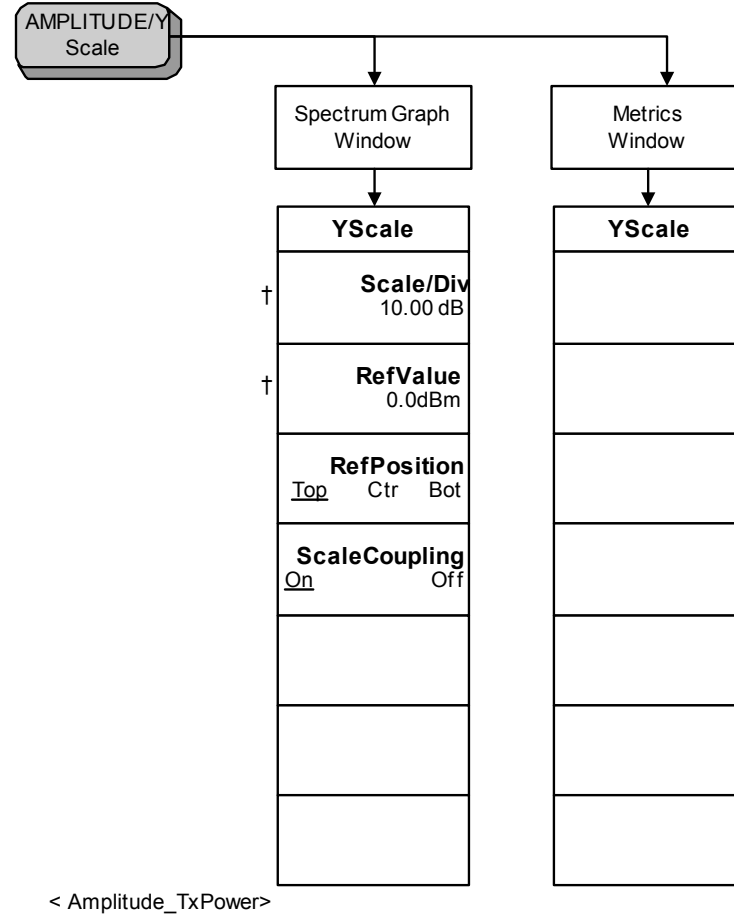
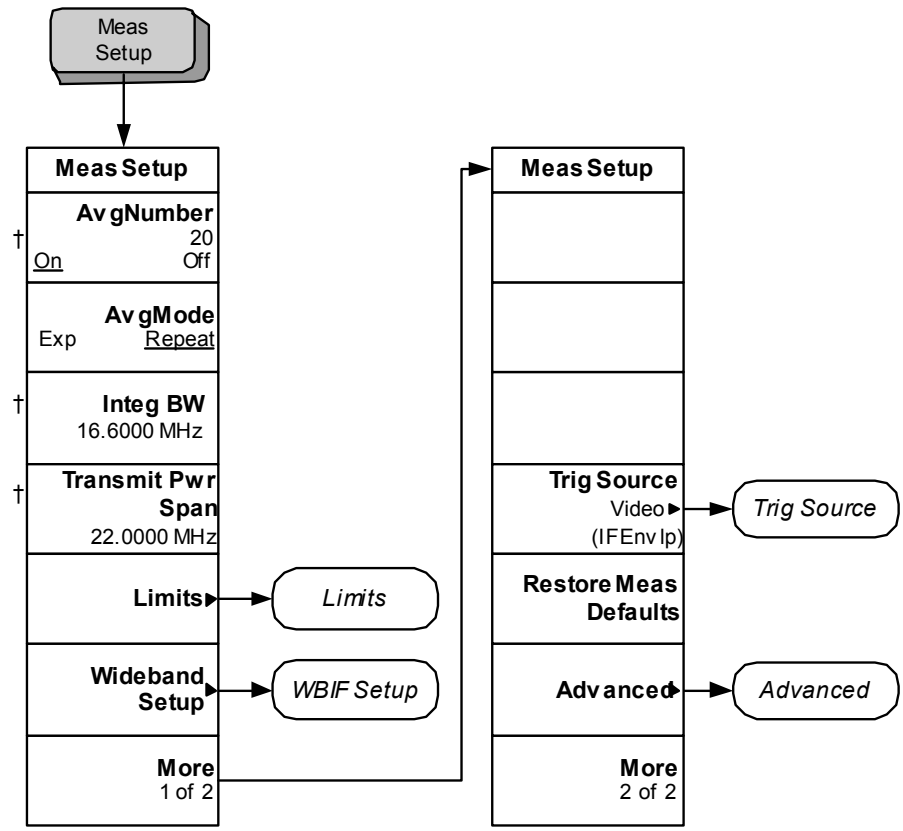
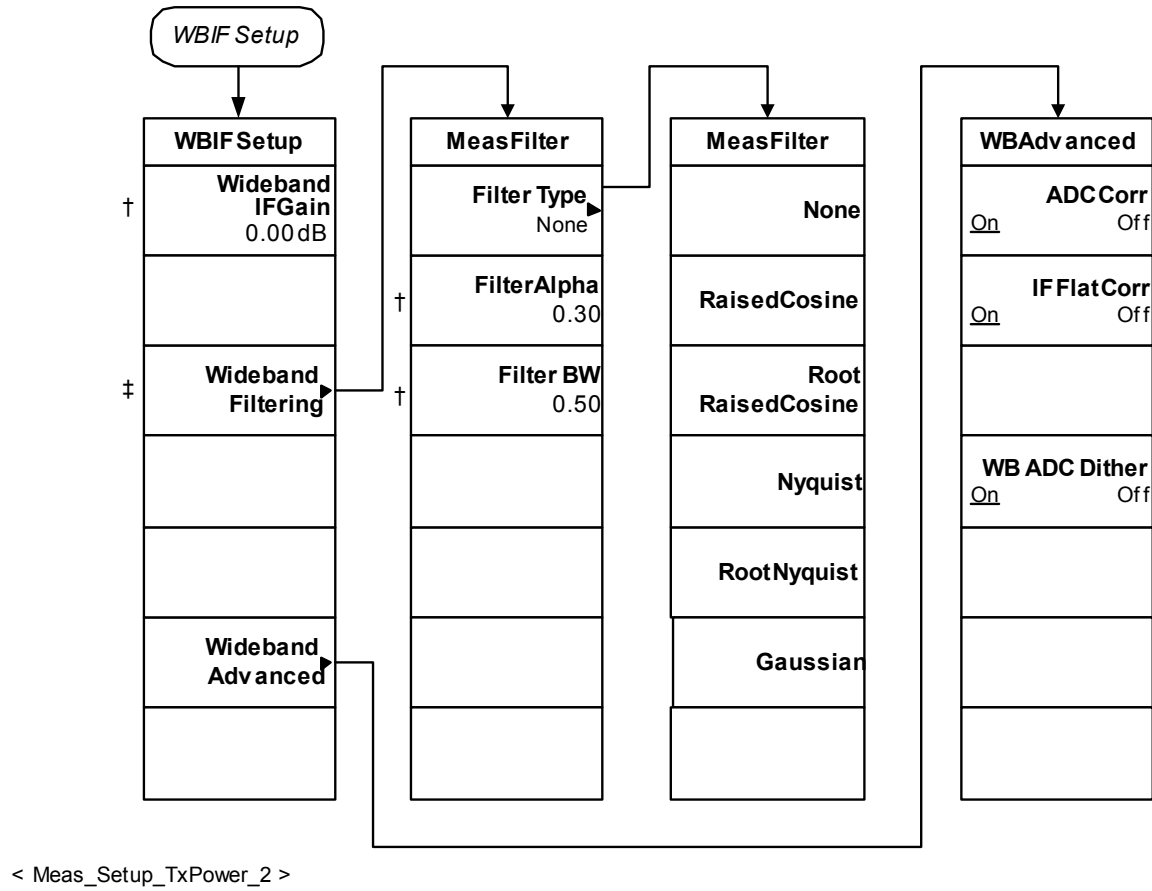


Figure 5-52 Transmit Power Measurement Setup Key Flow (1 of 3)

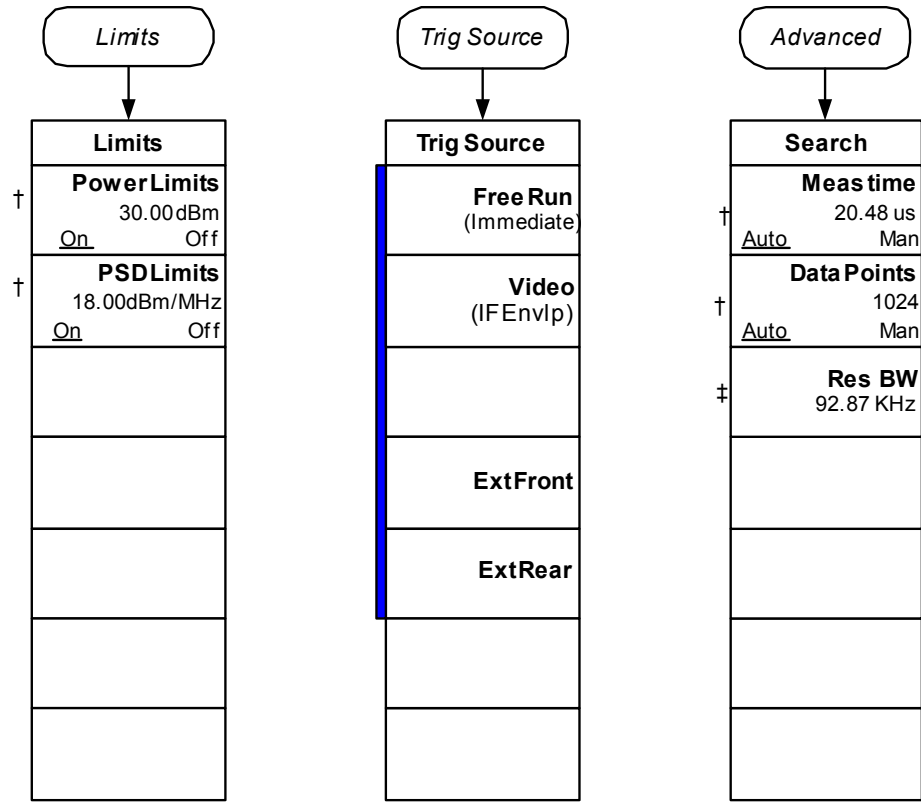


< Meas\_Setup\_TxPower\_1 >

Figure 5-53 Transmit Power Measurement Setup Key Flow (2 of 3)



**Figure 5-54 Transmit Power Measurement Setup Key Flow (3 of 3)**



< Meas\_Setup\_TxPower\_3 >

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