Wireless LAN User's and Programmer's Guide

Agilent Technologies E4406A VSA Transmitter Tester

Special Option H17

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http://www.agilent.com/find/vsa (for VSA spectrum analyzers)

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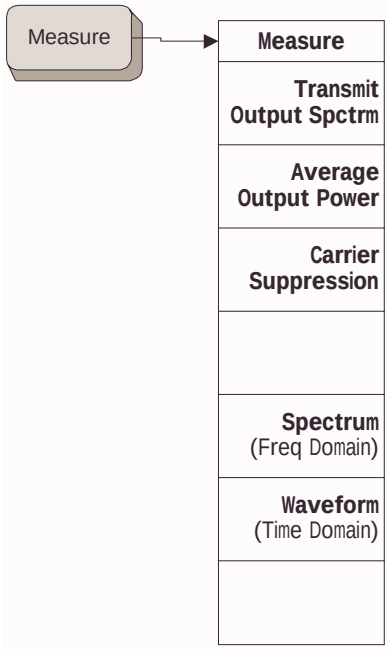
1 Mode Functionality

1.1 Mode Overview

The WLAN mode will include the following one-button measurements under the 'Measure' hardkey. These measurements will also be available remotely through SCPI.



- Transmit Output Spectrum
- Average Output Power
- Carrier Suppression
- Spectrum (Freq Domain)
- Waveform (Time Domain)

Providing this functionality is intended to:

- Optimize speed / throughput
- Simplify VSA programming and reduce required GPIB traffic
- Provide measurement integrity (i.e. verified measurement methods)
- Provide User & Remote Interfaces familiar to existing VSA users

The user will be required to specify 802.11b or 802.11g through the 'Mode Setup' hardkey (<Radio> softkey).

It is assumed that the DUT will operate in test modes and that these modes will be invoked independently.

Some of the functionality of this mode has been re-used from the E4406A Basic mode. Where this is the case, the detail will not be documented, but a reference to where the functionality originally exists. See VSA Series Programmer's Guide (E4406-90176) and VSA Series User's Guide (E4406-90177) for information on functionality that has not been documented.

1.1.1 Optimizing Speed

In order to minimize measurement times, and maximize device throughput, the following advice should be followed.

Note: This advice applies to all measurements.

1.1.1.1 Disable Display Updates (System, Disp Updates)

Display Updates can be disabled from front-panel by setting;

System -> Disp Updates -> Off.

This can greatly speed up all measurement operations, although is mostly appropriate for remote measurement operation.

When operating remotely from a measurement controller disable display updates by sending SCPI command "DISPlay:ENABle 0", for duration of the measurement, then send "DISPlay:ENABle 1" to re-enable at the end.

1.1.1.2 Input Range (Input Atten, Max Total Pwr)

RF Input Range can be set manually in two ways from front-panel, by setting either the Max Total Power or Input Atten from the Input hardkey menu (or Input Softkey under the Mode Setup hardkey).

When operating remotely from a measurement controller using known measurement test signal levels, disable the RF Input Range Autorange feature by either sending SCPI command "[:SENSe]:POWer[:RF]:RANGe[:UPPer] <power_val>", where power_val is the expected absolute maximum total mean power from device under test, or by sending SCPI command “[:SENSe]:POWer[:RF]:ATTenuation <rel_power>”, where <rel_power> value is the required amount of input attenuation for the given input test signal level.

1.2 Operations

1.2.1 Mode Selection

In order to avoid ambiguity when calling functions of the same name within different DLPs in the analyzer, the user must first set the instrument mode.

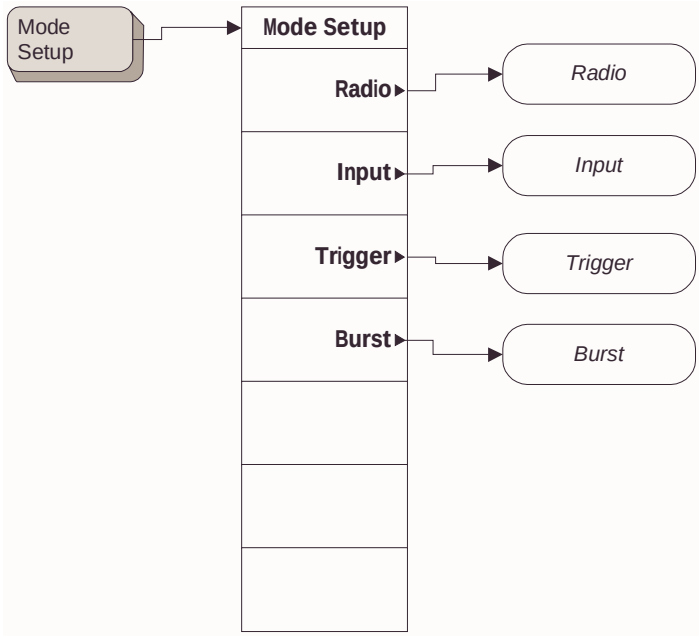
The available choices depend upon the applications that are installed in the analyzer.

Key Path:	**Mode, WLAN**
Remote Command:	**INSTrument[:SELect] WLAN | BASIC**
	INSTrument[:SELect]?
Factory Preset:	WLAN
State Saved:	Saved in instrument state.
SCPI Remarks	Dependant on the applications that are installed in the analyzer, you can have more available choices than: WLAN
	BASIC

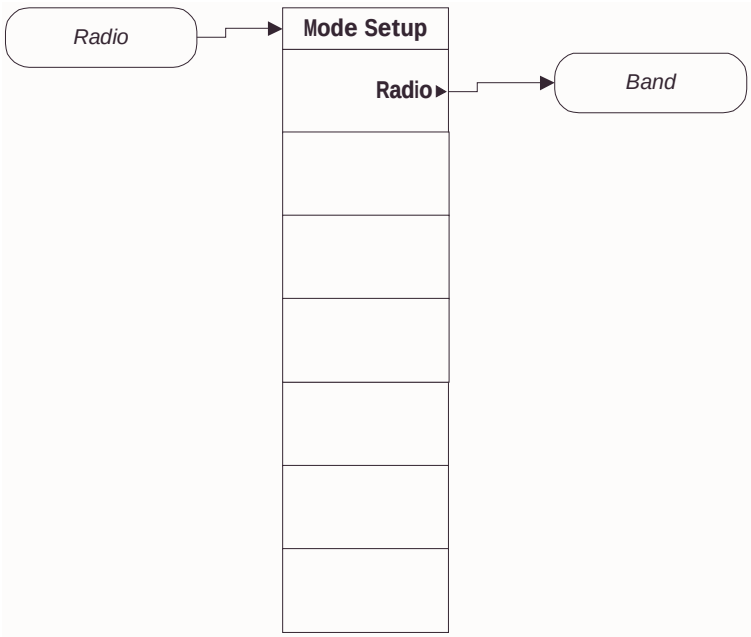
Alternatively, a numeric can be used to access the WLAN mode.

Remote Command:	**INSTrument:NSELect 16 | 8**
	INSTrument:NSELect?
Factory Preset:	16
State Saved:	Saved in instrument state.
SCPI Remarks	Dependant on the applications that are installed in the analyzer, you can have more available choices than: 16 (WLAN)
	8 (BASIC)

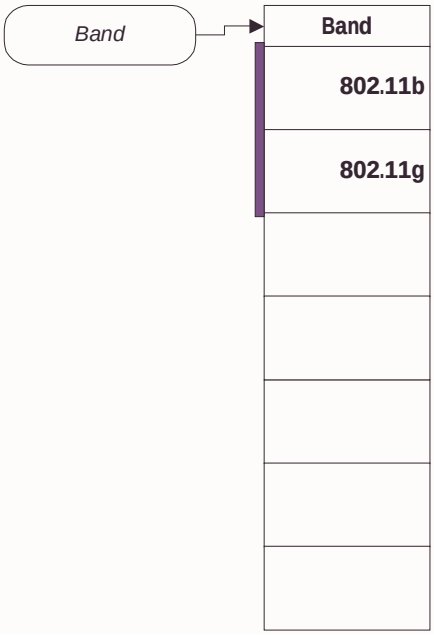
1.2.2 Mode Setup



1.2.2.1 Radio



1.2.2.1.1 Band



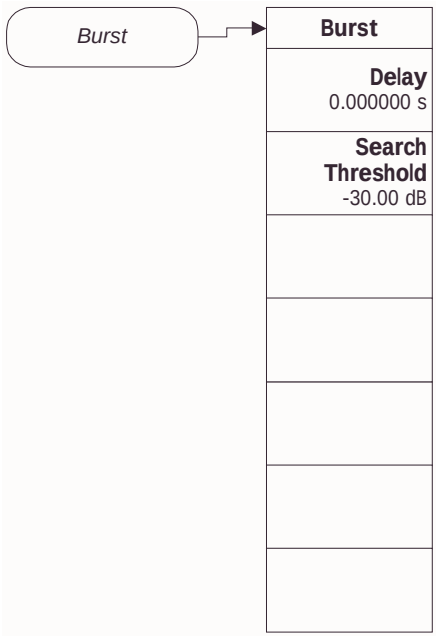
Allows the user to select the WLAN standard to be used.

Key Path:	**Mode Setup, Radio**
Remote Command:	`[:SENSe]:RADio:STANdard:BAND WLANB | WLANG` `[:SENSe]:RADio:STANdard:BAND?`
Factory Preset:	WLANB
State Saved:	Saved in instrument state.
Range:	802.11b | 802.11g
Force Restart	Yes

1.2.2.2 Trigger

As per Basic Mode

1.2.2.3 Burst



1.2.2.3.1 Burst Delay

Allows the user to set the burst delay

Key Path:	**Mode Setup, Burst**
Remote Command:	**[:SENSe]:SYNC:BURSt:DELay <time>**
	[:SENSe]:SYNC:BURSt:DELay?
Preset/Default	0 s
State Saved	Yes
Min	-500 ms
Max	500 ms
SCPI Resolution	0.1 us
Force Restart	Yes
RPG	10 us
Step (Front Panel)	10 us

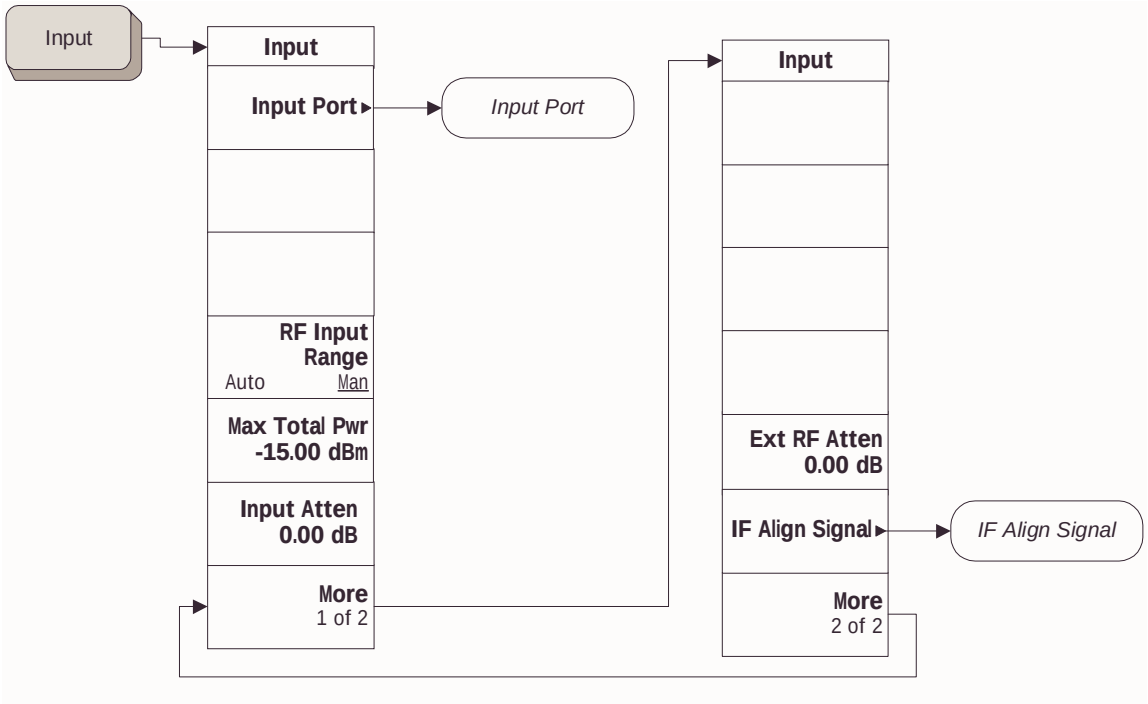
1.2.2.3.2 Burst Search Threshold

Allows the user to enter the value, relative to the peak power, that should be used to determine the of the burst.

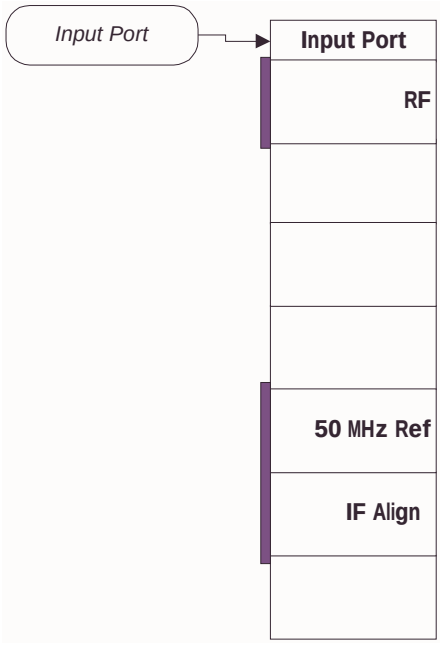
Key Path:	**Mode Setup, Burst**

Remote Command:	**[:SENSe]:SYNC:BURSt:STHReshold <rel ampl>** **[:SENSe]:SYNC:BURSt:STHReshold?**
Unit/Terminator Keys	dB
Preset/Default	-30.0
State Saved	Yes
Min	-200.0
Max	-0.01
SCPI Resolution	0.01
Force Restart	Yes
RPG	0.1
Step (Front Panel)	1.0

1.2.2.4 Input



1.2.2.4.1 Input Port



As per Basic Mode

1.2.2.4.2 RF Input Range

Allows you to toggle the input range control for the RF signal between Auto and Man (manual). If Auto is chosen the instrument automatically sets the attenuator and reference level based on the carrier power level where the analyzer is tuned.

Key Path:	**Input, 4 | Mode Setup, Input**
Remote Command:	**`[:SENSe]:POWer[:RF]:RANGe:AUTO ON | OFF | 1 | 0`** **`[:SENSe]:POWer[:RF]:RANGe:AUTO?`**
Factory Preset:	ON
State Saved:	Saved in instrument state.
Range:	Auto | Man
Dependencies and Couplings:	If 'Auto' is selected the instrument automatically sets the attenuator and reference level based on the power level of the tuned carrier.
Force Restart	Yes

1.2.2.4.3 Max Total Power

Allows you to set the maximum total power level from the UUT (Unit Under Test).

Key Path:	**Mode Setup, Input, 5 | Input**
Remote Command:	**`[:SENSe]:POWer[:RF]:RANGe <real>`** **`[:SENSe]:POWer[:RF]:RANGe?`**
Front Panel Unit/Terminator Keys	dBm
Preset/Default	-15.00 dBm
State Saved	Yes
Min	-200 dBm
Max	50 dBm
SCPI Resolution	0.01 dB
SCPI Resolution Max	0.01 dB
Coupling	When RF Input Range = Auto, the Max Total Power is measured and the displayed value updated at the start of each measurement. When RF Input Range = Man, the current value of Max Total Power is used directly to calculate the Input Atten (…and so the actual internal hardware attenuation value) required to ensure a safe/optimum level at the input to the 1st mixer. In this case, it is up to the user to ensure the actual signal power present at the input to the measurement setup, does NOT exceed the stated Max Total Power. Setting the Max Total Power value manually, forces the RF Input Range to Manual mode, and also updates the Input Atten value to reflect the new signal level at input.
Restriction and Notes	DEFINITION: The input to the measurement setup is defined to be the input to the SA RF Input, unless any External Gain/Atten blocks are in use, in which case the input to the measurement setup is defined to be the input to the External Gain/Atten blocks.
Force Restart	Yes
RPG	1.00 dB
Step (Front Panel)	5.00 dB

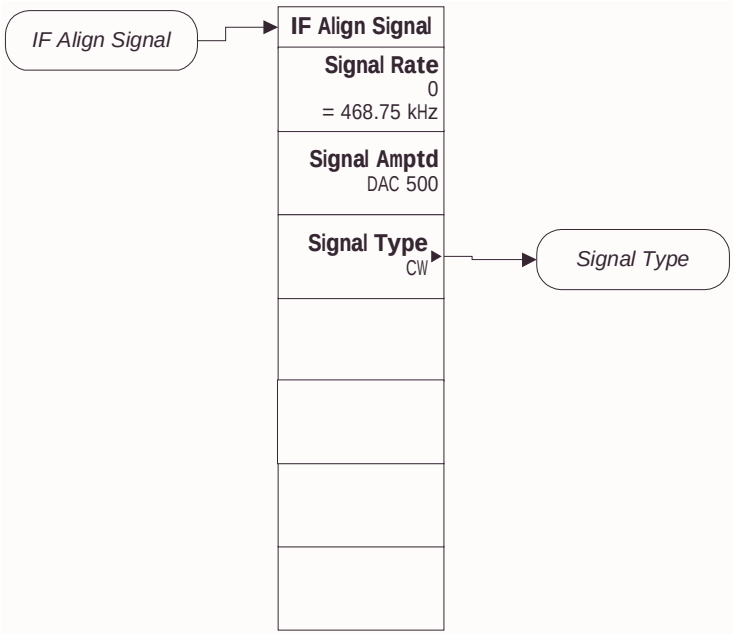
1.2.2.4.4 Input Atten

As per Basic Mode

1.2.2.4.5 Ext RF Attenuation

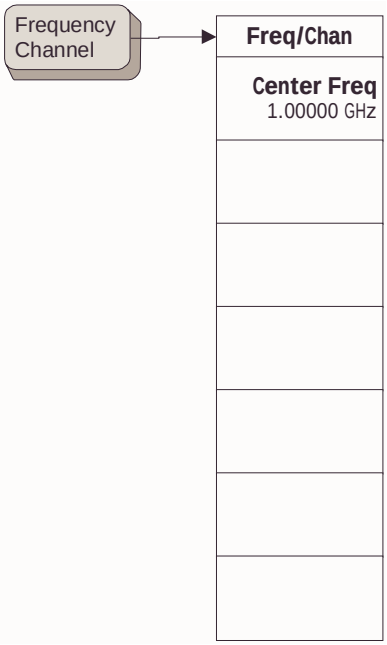
As per Basic Mode

1.2.2.4.6 IF Align Signal



As per Basic Mode

1.2.3 Center Frequency



Allows the user to set the Center Freq for the mode. This is used by all measurements.

Key Path:	**Frequency/Channel**
Remote Command:	**[:SENSe]:FREQuency[:CENTer] <freq>** **[:SENSe]:FREQuency[:CENTer]?**
Preset/Default	1 GHz
State Saved	Yes
Min	1 kHz
Max	4.3214 GHz
SCPI Resolution	100 Hz
Force Restart	Yes
RPG	25 kHz
Step (Front Panel)	25 kHz

1.2.4 Marker

As per Basic Mode

2 Average Output Power Measurement Definition

2.1 Measurement Overview

The measurement is intended to support 802.11b/g signals. The input signals may be single or repeating bursts or repeating sequences of bursts such as calibration power level staircase sequences.

Given the E4406A VSA instrument is limited to 10MHz maximum capture BW, and the Average Output Power measurement is implemented in the time domain, it is necessary to perform 2 separate 10 MHz signal data acquisitions (Lower 10MHz bandwidth portion centered at Center Freq – 5MHz, Upper 10MHz bandwidth portion centered at Center Freq + 5MHz), then sum the results of each to calculate the average power in the overall 20MHz of the 802.11b/g signal bandwidths.

The measurement supports all instrument trigger modes, and also supports a burst RF Amptd synchronization feature, allowing operation in Free Run trigger mode. The measurement also allows the user to setup the measurement start offset time relative to either the trigger event (Burst Sync = None) or the rising burst edge (Burst Sync = RF Amptd) along with the measurement interval length in time. Also the measurement supports measurement of special test signal power level staircases by allowing the user to define the staircase burst repeat offset time, and the number of staircase bursts contained within the repeating staircase sequence (Up to 12 staircase bursts are supported).

Numeric average output power results are displayed for each of the 12 staircase power levels. Supported displays include the Signal Envelope, which displays the averaged trace data summation of both the Lower 10MHz and Upper 10MHz bandwidth acquisitions. Also the Lower & Upper Envelope display shows the un-averaged separate Lower 10MHz and Upper 10MHz bandwidth acquisitions, and is useful when configuring the signal measurement setup parameters, trigger or synchronization settings.

As stated above the Average Output Power measurement supports two modes of burst synchronization, both of which are described here.

2.2 Measurement Algorithm

As stated above the Average Output Power measurement supports two modes of burst synchronization, both of which are described here.

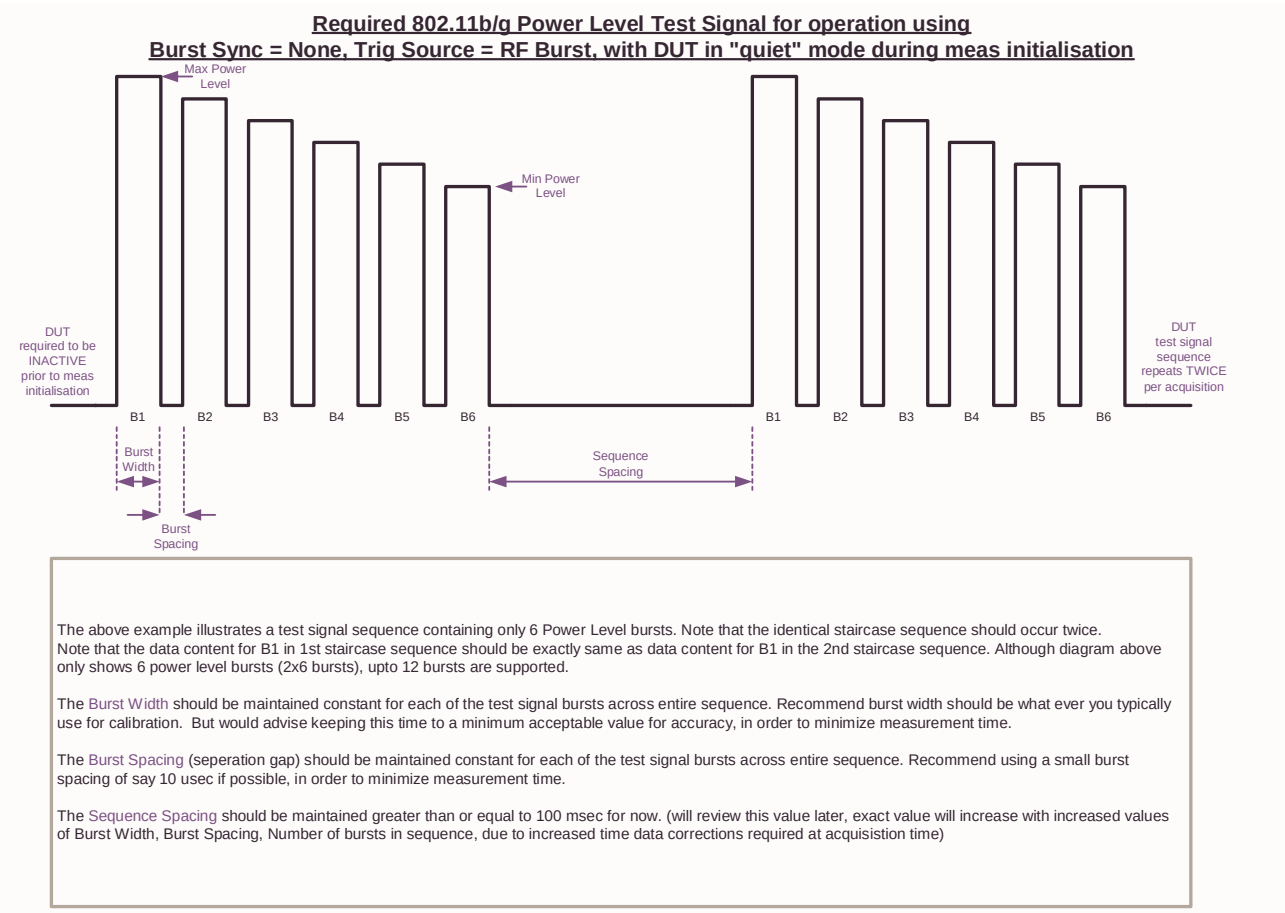
2.2.1 Burst Sync = None

If Burst Sync = None, the burst measurement region is specified to start from the trigger event plus the Start Offset time value, and the measurement interval is determined by the Meas Length time value.

If a single repeating burst signal is being used then an appropriate trigger of either RF Burst trigger (with appropriate Peak Level setting of approximately –30dB) or External trigger (with appropriate Level setting) can be used to achieve stable/reliable triggering.

If a staircase power level test signal is being used, External trigger (with appropriate Level setting) can still be used to achieve stable/reliable triggering. Also RF Burst triggering can still be used, as long as the DUT is placed into an inactive, quiet state, prior to measurement initialization. This allows RF Burst trigger Peak Level of approximately –6dB or so to be used, which will force acquisition to hold off and wait till the 1st active burst rising edge occurs from DUT. But in this mode of operation with a staircase power level test signal, it becomes the responsibility of the measurement controller software to control the DUT Sequence Spacing time delay between the end of the 1st stair sequence and the start of the 2nd stair sequence.

WARNING: If this test signal Sequence Spacing delay is too short, then the measurement acquisition may miss the start of the 2nd stair sequence, and end up triggering on a subsequent burst within the sequence, giving erroneous results (this extra measurement controller consideration can be avoided by using Burst Sync = RF Amptd. The following diagram better illustrates the input signal requirements when measuring a staircase power level test signal with Burst Sync = None.



2.2.2 Burst Sync = RF Amptd

If Burst Sync = RF Amptd, the burst measurement region is specified to start from the test signals burst rising edge (as determined by Mode Setup, Burst, Search Threshold) plus the Start Offset time value, and the measurement interval spans Meas Length time value.

No matter the test signal being used (i.e. either a single repeating burst signal or a staircase power level test signal) all trigger methods are supported including Free Run. Note that Free Run will gives fastest operation in Burst Sync = RF Amptd mode.

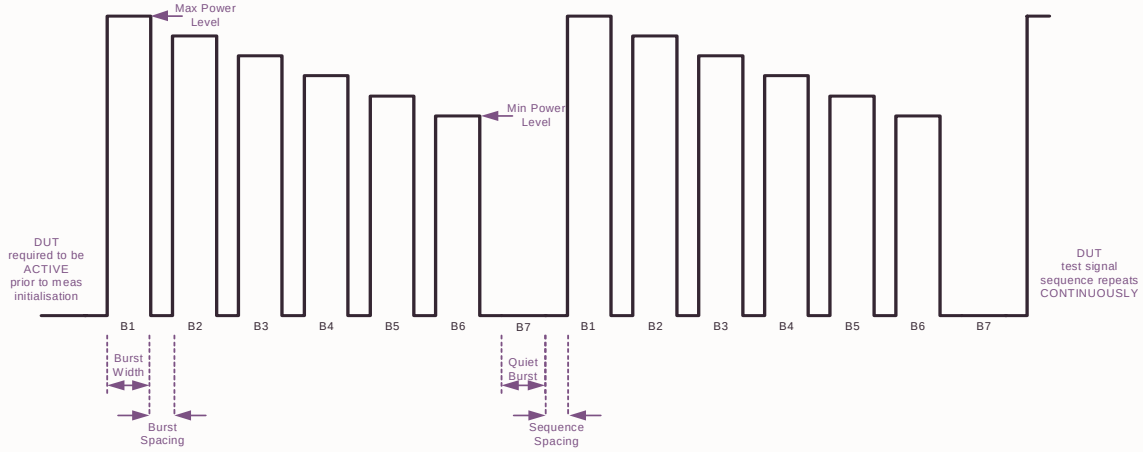
The RF Amptd burst synchronization algorithm will first synchronize to the rising burst edge of the test signal, and measure the output power over the user specified burst measurement regions of each burst. Then if more than 1 burst is being measured (i.e. a staircase power level test signal), the algorithm will locate and use the lowest power burst as a reference burst. This reference burst is used when combining results from both the Lower 10MHz BW and Upper 10MHz BW acquisitions to ensure the correct bursts are time aligned between each acquisition. Note that the displayed output power result metrics and also the displayed trace data are both reordered to start from the burst following the reference burst (that is, the results and displayed trace data will start from the burst following the lowest powered burst in the test signal).

Note that the DUT is required to be active prior to measurement initialization when

Free Run trigger is used. (not essential if RF Burst trigger is used), and must remain active long enough for completion of the two separate acquisitions (Lower 10MHz BW and Upper 10MHz BW).

WARNING: It is very important in RF Amptd burst synchronization mode of operation that the input signal is properly defined by all four of the Meas Setup parameters Start Offset, Meas Length, Repeat Offset, Repeat Number. Also it is important that the test signal staircase sequence (or even single burst sequence) to be measured should continuously loop at the stated signal repeat time interval of (Repeat Offset * Repeat Number). If this input signal constraint is not met, then the reordered results and displayed trace data, will be erroneous. The following diagram better illustrates the input signal requirements when measuring a staircase power level test signal with Burst Sync = RF Amptd.

Required 802.11b/g Power Level Test Signal for operation using
Burst Sync = RF Amptd, Trig Source = Free Run, with DUT in "continuous loop mode" mode prior to initialisation



The above example illustrates a test signal sequence containing only 6 Power Level bursts. Note that the identical staircase sequence should repeat in a continuous loop prior to and during the measurement acquisition. Note that the data content for B1 in 1st staircase sequence should be exactly same as data content for B1 in the 2nd staircase sequence. Although diagram above only shows 6 power level bursts (2x6 bursts), upto 12 bursts are supported.

The Burst Width should be maintained constant for each of the test signal bursts across entire sequence, even for the Quiet Burst (if required). Recommend burst width should be what ever you typically use for calibration. But would advise keeping this time to a minimum acceptable value for accuracy, in order to minimize measurement time.

The Burst Spacing (seperation gap) should be maintained constant for each of the test signal bursts across entire sequence. Recommend using a small burst spacing of say 10 usec if possible, in order to minimize measurement time.

The Sequence Spacing in this mode of operation is just the Burst Spacing value. Note that the above signal sequence illustrates the case where a known inactive Quiet Burst is inserted within the power level test signal in order to provide the burst synchronisation algorithm with a reliable known reference point (ie. lowest average power burst) within the test signal. Syncronised results are always displayed in time order starting from the 1st burst after the lowest average power burst.

2.2.3 Optimizing Speed

In order to minimize measurement times, and maximize device throughput, the following advice should be followed.

2.2.3.1 Minimize Burst Widths and Separation (Meas Setup, Meas Length & Repeat Offset)

By minimizing the test signal burst widths and burst separation, the resulting measurement capture length is reduced, and so the measurement processing time is reduced. Recommend minimizing the test signal burst widths and burst separations to

appropriate values for the given WLAN input signal format, whilst still maintaining adequate burst widths for measurement repeatability/accuracy, plus real world signal representation.

2.2.3.2 Use Decimation (Meas Setup, Advanced, Decimation)

For a given signal burst width and measurement length, it is still possible to further reduce measurement processing time by enabling the Decimation feature. Recommend enabling the decimation feature where burst lengths are long, whilst still maintaining adequate number of measurement samples to maintain measurement repeatability/accuracy.

When operating remotely from a measurement controller using known measurement test signal levels, enable Decimation by sending SCPI command “[:SENSe]:AOPower:DECimate:STATe ON”, and select decimation factor by sending SCPI command “[:SENSe]:AOPower:DECimate[:FACTor] <integer>”, where integer is the desired decimation factor.

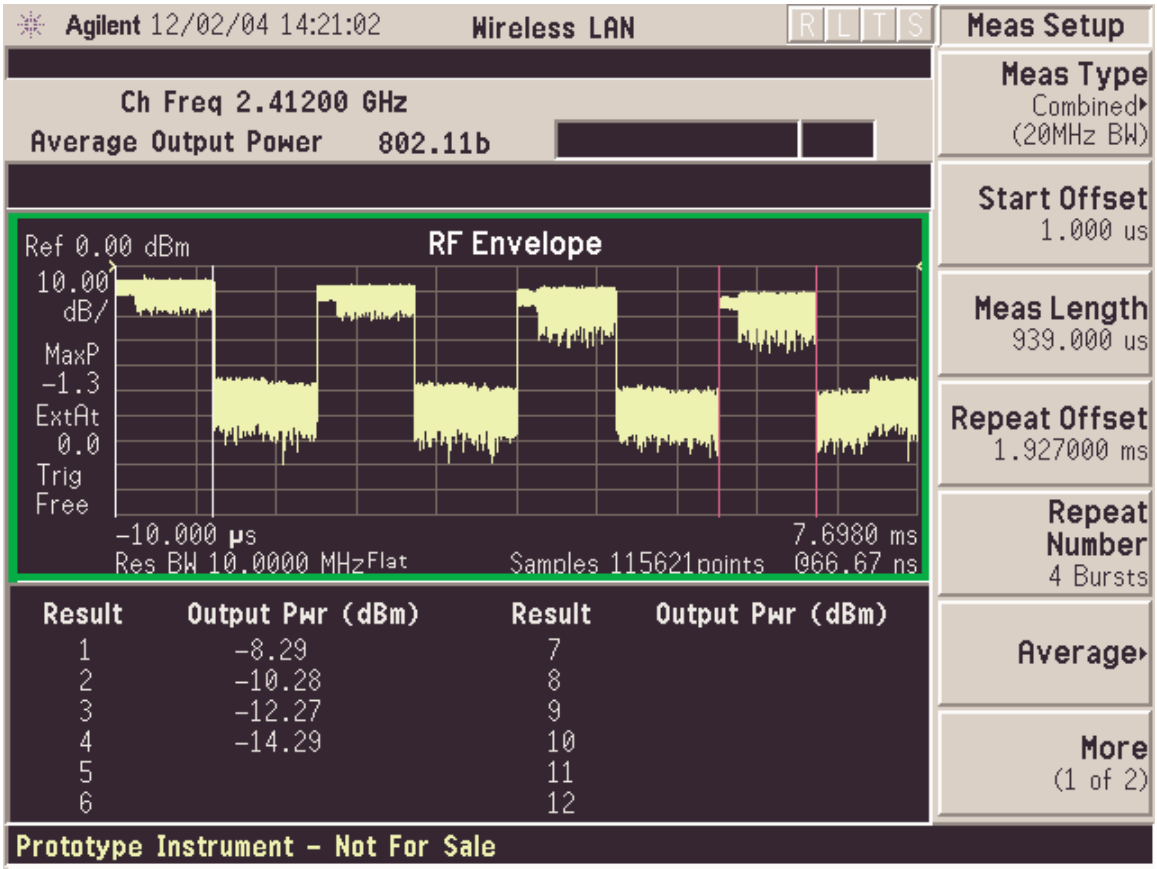
2.2.3.3 Averaging Approach

If to improve result repeatability, averaging is required, then instead of using the supported Meas Setup Average features, it may be faster to simply increase the test signal burst width to achieve better repeatability if this is still a valid approach to measurement requirement.

2.3 Measurement Results

2.3.1 Front Panel Views & Results

2.3.1.1 Signal Envelope View



This is the default view and displays both the captured signal RF Envelope trace data in the upper window, and the Output Power numeric results in the lower window.

If Meas Type = Combined (20MHz BW), RF Envelope trace data represents the combined averaged trace data summation of both the Lower 10MHz and Upper 10Mhz bandwidth acquisitions.

If Meas Type = Lower (10MHz BW), RF Envelope trace data represents only the averaged trace data of the Lower 10MHz bandwidth acquisitions

If Meas Type = Upper (10MHz BW), RF Envelope trace data represents only the averaged trace data of the Upper 10MHz bandwidth acquisitions

2.3.1.1.1 Output Pwr (dBm)

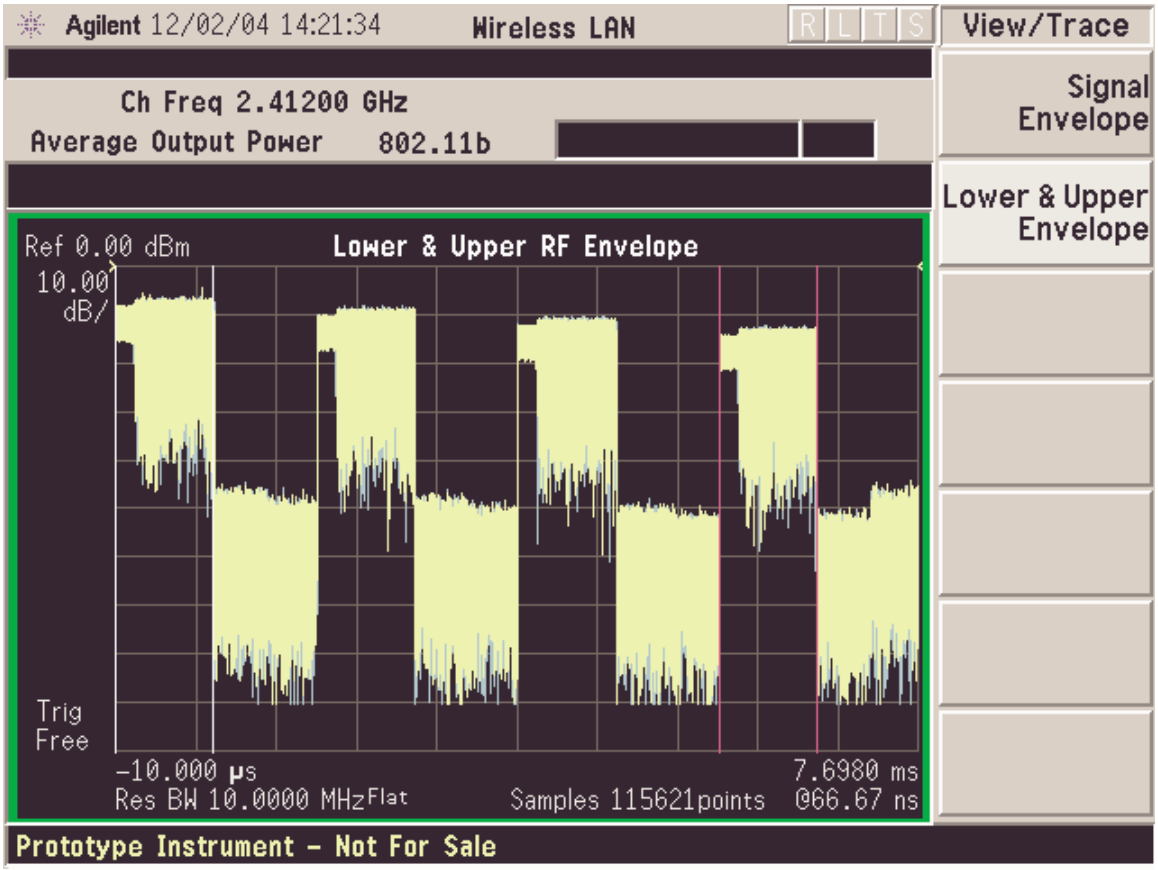
This numeric result represents the averaged mean output power measured over each of the specified burst measurement regions (in dBm). There are N valid scalar results displayed, where N is the value of Repeat Number parameter setting under Meas Setup menu.

If Meas Type = Combined (20MHz BW), power result values represent the combined averaged mean output power summation of both the Lower 10MHz and Upper 10Mhz bandwidth acquisitions.

If Meas Type = Lower (10MHz BW), power result values represent the averaged mean output power of only the Lower 10MHz bandwidth acquisitions.

If Meas Type = Upper (10MHz BW), power result values represent the averaged mean output power of only the Upper 10MHz bandwidth acquisitions.

2.3.1.2 Lower & Upper Envelope View



This view displays both the Lower 10MHz and Upper 10MHz captured signal RF Envelope traces separately, but overlaid in the same window. These traces are un-averaged, and only data from the last acquisition is displayed. This is particularly useful when setting up the measurement parameters like Repeat Offset, Repeat Number, Trig Source and Burst Sync to ensure proper burst synchronization is achieved.

If Meas Type = Combined (20MHz BW), both the Lower 10MHz (Yellow) and Upper 10MHz (Blue) un-averaged RF Envelope traces are displayed overlaid in single window.

If Meas Type = Lower (10MHz BW), only the Lower 10MHz (Yellow) un-averaged RF Envelope trace is displayed.

If Meas Type = Upper (10MHz BW), only the Upper 10MHz (Blue) un-averaged RF Envelope trace is displayed.

2.3.2 Remote SCPI Results

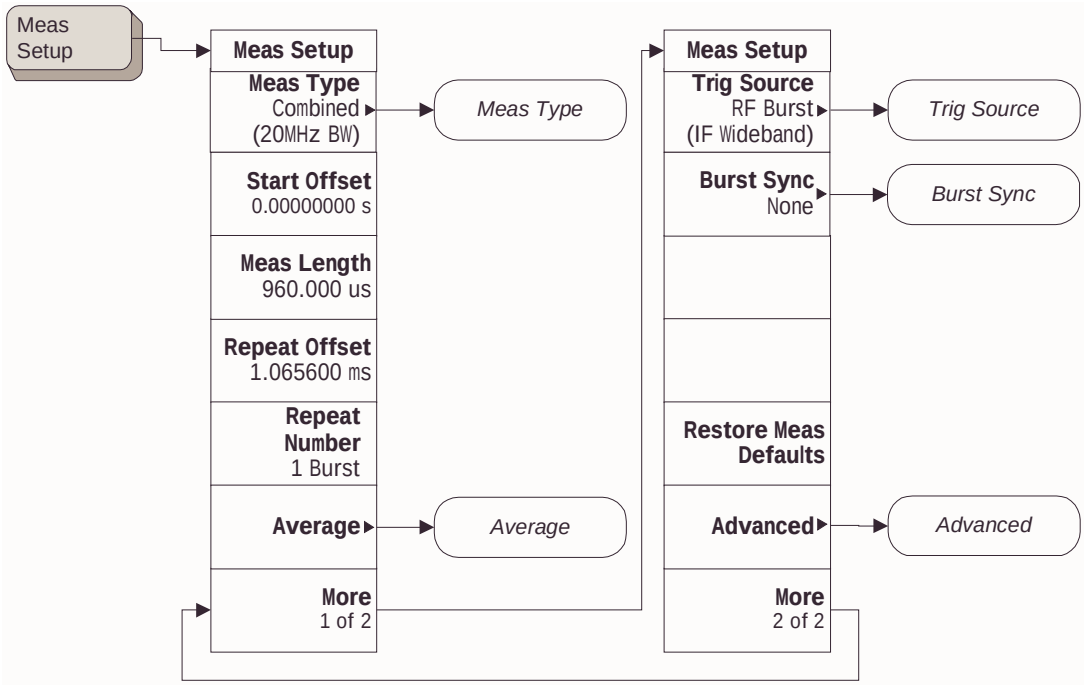
Command	Return Value
CONFigure:AOPower	N/A
FETCh:AOPower[n]? MEASure:AOPower[n]? READ:AOPower[n]?	

n	Return Value
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.
1 (or not supplied)	Returns the following scalar results: 1. Sample time is a floating point number representing the time between samples when using the trace queries (n=0,2,etc). 2. Number of samples is the number of data points in the captured signal. This number is useful when performing a query on the signal (i.e. when n=0,2,etc.).

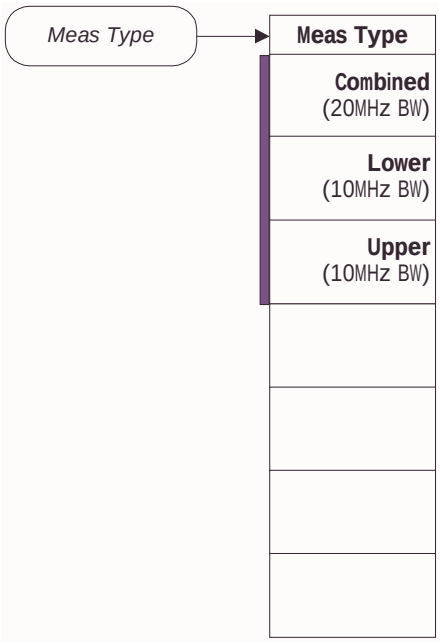
2	If Meas Type = Combined (20MHz BW), returns trace point values of the entire captured signal RF Envelope, representing the combined averaged trace data summation of both the Lower 10MHz and Upper 10Mhz bandwidth acquisitions. If Meas Type = Lower (10MHz BW), returns trace point values of the entire captured signal RF Envelope, representing only the averaged trace data of the Lower 10MHz bandwidth acquisitions If Meas Type = Upper (10MHz BW), returns trace point values of the entire captured signal RF Envelope, representing only the averaged trace data of the Upper 10MHz bandwidth acquisitions These data points are floating point numbers representing the average power of the signal (in dBm). There are N data points, where N is the Number of samples. The period between the samples is defined by the Sample time.
3	If Meas Type = Combined (20MHz BW) or Lower (10MHz BW), returns trace point values of the entire captured signal RF Envelope, representing the un-averaged (i.e. always returns data from last data acquisition) trace data of the Lower 10MHz bandwidth acquisitions
4	If Meas Type = Combined (20MHz BW) or Upper (10MHz BW), returns trace point values of the entire captured signal RF Envelope, representing the un-averaged (i.e. always returns data from last data acquisition) trace data of the Upper 10MHz bandwidth acquisitions
8	Returns up to 12 scalar results representing the averaged mean output power measured over each of the specified RF Envelope burst measurement regions (in dBm). There are N valid data points returned, where N is the value of Repeat Number parameter setting under Meas Setup menu.

2.4 Operations

2.4.1 Meas Setup



2.4.1.1 Meas Type



Allows the user to enter the Meas Type.

Key Path:	**Meas Setup**
Remote Command:	**[:SENSe]:AOPower:TYPE COMBined|LOWer|UPPer**
	[:SENSe]:AOPower:TYPE?
Factory Preset:	COMBined
State Saved:	Saved in instrument state.
Range:	Combined (20MHz BW) | Lower (10MHz BW) | Upper (10MHz BW)

2.4.1.2 Start Offset

Allows the user to offset where burst measurement region begins.

Key Path:	**Meas Setup**
Remote Command:	**[:SENSe]:AOPower:SWEep:SOFFset <time>**
	[:SENSe]:AOPower:SWEep:SOFFset?

Preset/Default	0.0 ms
State Saved	Yes
Min	0.0 us
Max	10.0 ms
SCPI Resolution	100 ns
Coupling	If Burst Sync = None, the burst measurement region is specified to start from the trigger event plus the start offset time value. If Burst Sync = RF Amptd, the burst measurement region is specified to start from the rising edge of the test signal's burst (as determined by Mode Setup, Burst, Search Threshold) plus the start offset time value
Force Restart	Yes

2.4.1.3 Meas Length

Allows the user to enter the Meas Length, which is time over which the measurement is made. This is also referred to as the burst width

Key Path:	**Meas Setup**
Remote Command:	**`[:SENSe]:AOPower:SWEep:MLENgth <time>`** **`[:SENSe]:AOPower:SWEep:MLENgth?`**
Preset/Default	960 us
State Saved	Yes
Min	100 ns
Max	10.0 ms
SCPI Resolution	100 ns
Force Restart	Yes

2.4.1.4 Repeat Offset

Allows the user to specify the duration between the start of one burst and the start of the next burst. This is also referred to as the burst separation.

Key Path:	**Meas Setup**

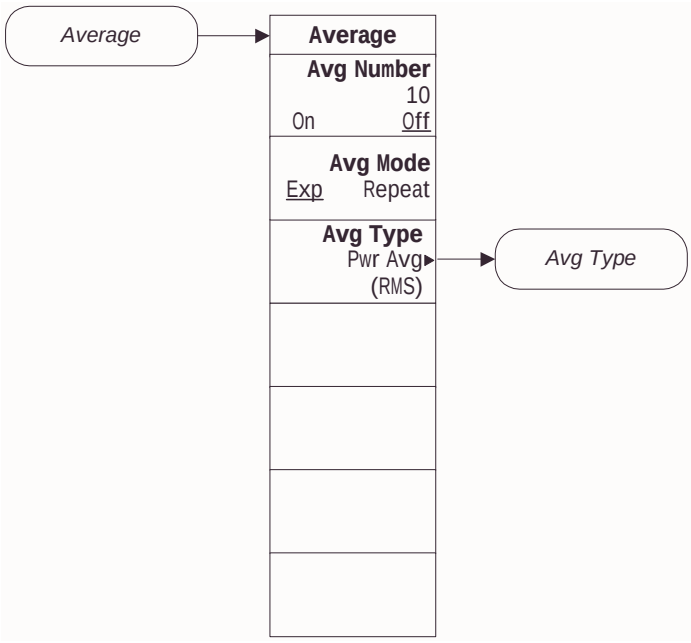
Remote Command:	**[:SENSe]:AOPower:SWEep:ROFFset <time>** **[:SENSe]:AOPower:SWEep:ROFFset?**
Preset/Default	1.0656 ms
State Saved	Yes
Min	100 ns
Max	10.0 ms
SCPI Resolution	100 ns
Force Restart	Yes

2.4.1.5 Repeat Number

Allows the user to specify the number of bursts to be measured.

Key Path:	**Meas Setup**
Remote Command:	**[:SENSe]:AOPower:SWEep:RNUMber <integer>** **[:SENSe]:AOPower:SWEep:RNUMber?**
Front Panel Unit/Terminator Keys	Burst
Preset/Default	1
State Saved	Yes
Min	1
Max	12
SCPI Resolution	1
Force Restart	Yes

2.4.1.6 Average



2.4.1.6.1 Avg Number

Average number sets the number of data acquisitions that will be averaged.

Average state turns averaging on or off.

Key Path:	**Meas Setup, Average**
Remote Command:	**[:SENSe]:AOPower:AVERage:COUNt <integer>**
	[:SENSe]:AOPower:AVERage:COUNt?
	[:SENSe]:AOPower:AVERage[:STATe] OFF|ON| 0|1
	[:SENSe]:AOPower:AVERage[:STATe]?
Preset/Default	10
State Saved	Yes
Min	1
Max	10000
SCPI Resolution	1
Force Restart	Yes
RPG	1
Step (Front Panel)	10

BAF Parameter Name	Average State
BAF Range	On | Off
BAF Preset/Default	0

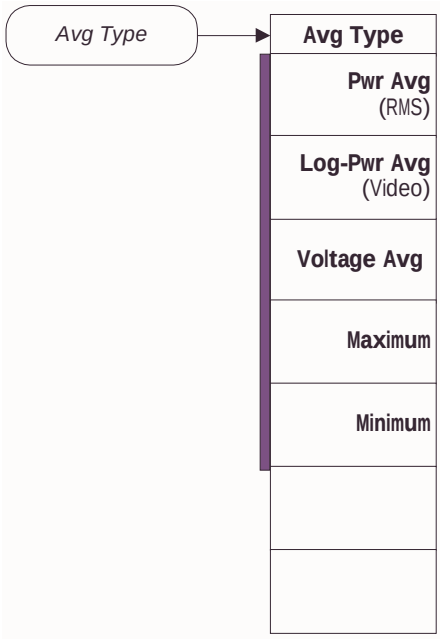
2.4.1.6.2 Avg Mode Select the type of termination control used for averaging. This determines the averaging action after the specified number of data acquisitions (average count) is reached.

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.

Key Path:	**Meas Setup, Average**
Remote Command:	**[:SENSe]:AOPower:AVERage:TCONtrol EXPonential | REPeat**
	[:SENSe]:AOPower:AVERage:TCONtrol?
Preset/Default	EXPonential
State Saved	Yes
Range	Exp | Repeat
Coupling	None
Force Restart	Yes
Soft Key Label	Avg Mode

2.4.1.6.3 Avg Type



Select the type of averaging to be performed.

Pwr Avg (RMS) - The power is averaged to provide a voltage rms value.

Log-Pwr Avg (Video) - The log of the power is averaged. (This is also known as video averaging.)

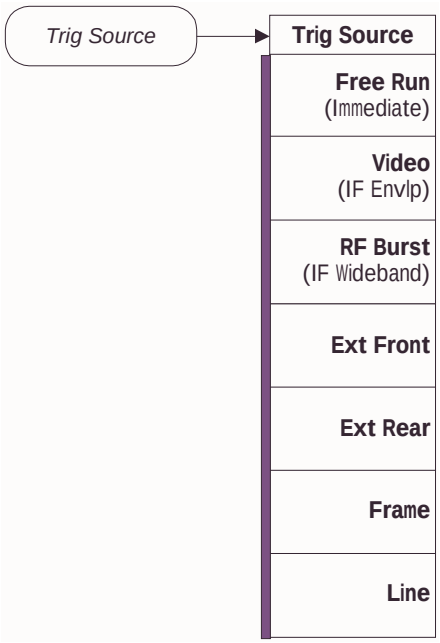
Voltage Avg - The amplitude level of power is averaged to provide a voltage value.

Maximum - The maximum values are retained.

Minimum - The minimum values are retained.

Key Path:	**Meas Setup, Average**
Remote Command:	**[:SENSe]:AOPower:AVERage:TYPE RMS|LOG|SCALar|MAXimum|MINimum**
	[:SENSe]:AOPower:AVERage:TYPE?
Preset/Default	RMS
State Saved	Yes
Range	Pwr Avg (RMS) | Log-Pwr Avg (Video) | Voltage Avg | Maximum | Minimum
Coupling	None
Force Restart	Yes

2.4.1.7 Trig Source



Select the trigger source used to control the data acquisitions.

Trigger sources that are available are;

Free Run - the next data acquisition is immediately taken.

Video - internal IF envelope (video) trigger.

RF Burst - wideband RF burst envelope trigger that has automatic level control for periodic burst signals.

Ext Front - front panel external trigger input.

Ext Rear - rear panel external trigger input.

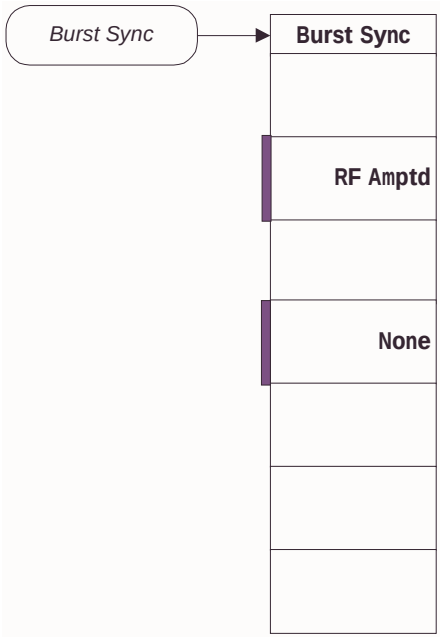
Frame - internal frame timer from front panel input.

Line - internal line trigger.

Key Path:	**Meas Setup, More (1 of 2)**
Remote Command:	**`[:SENSe]:AOPower:TRIGger:SOURce IMMediate|IF|RFBurst|EXTernal|EXT2|FRAMe|LINE`**
	`[:SENSe]:AOPower:TRIGger:SOURce?`
Factory Preset:	RFBurst
State Saved:	Saved in instrument state.

Range: Free Run (Immediate) | Video (IF Envlp) | RF Burst (IF Wideband) | Ext Front | Ext Rear | Frame | Line

2.4.1.8 Burst Sync



Allows the user to set the Burst Sync.

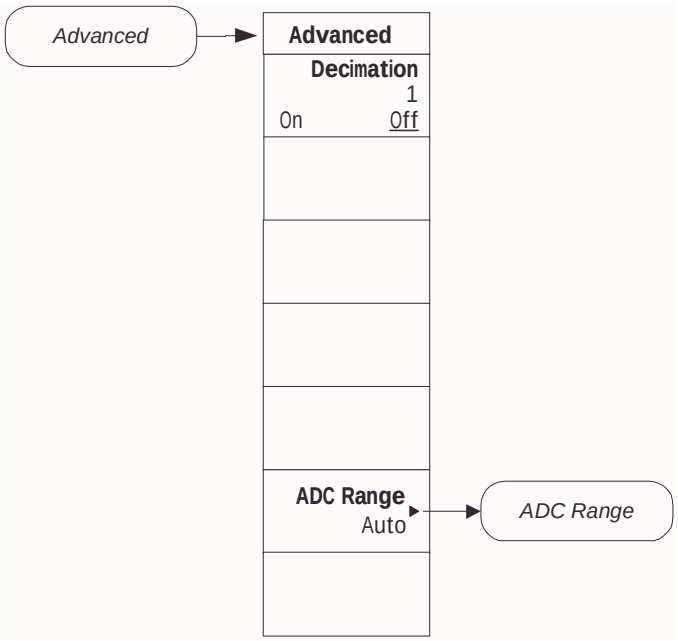
Key Path:	**Meas Setup, More (1 of 2)**
Remote Command:	**`[:SENSe]:AOPower:BSYNc:SOURce RFBurst|NONE`**
	`[:SENSe]:AOPower:BSYNc:SOURce?`
State Saved	Yes
Range	RF Amptd | None
Force Restart	Yes

2.4.1.9 Restore Meas Defaults

Allows you to preset only the settings that are specific to this measurement.

Key Path:	**Meas Setup, More (1 of 2)**

2.4.1.10 Advanced



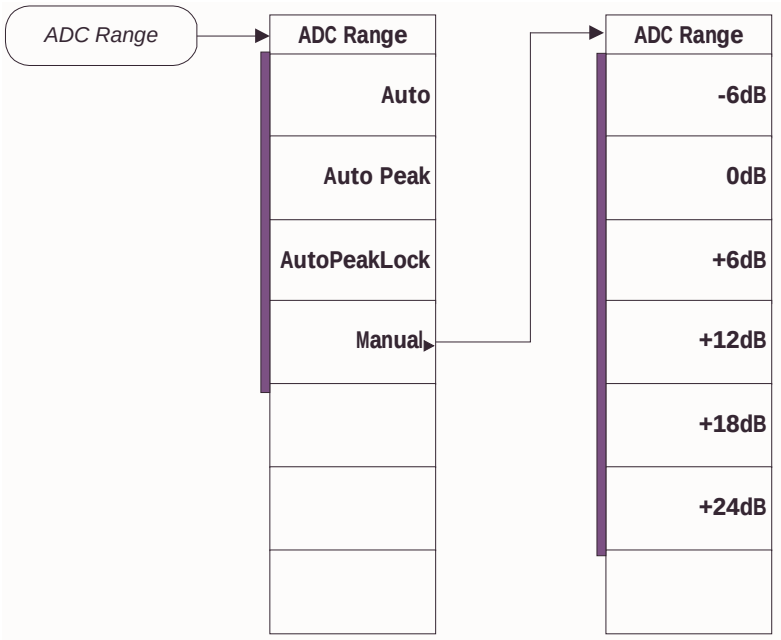
2.4.1.10.1 Decimation

Sets the amount of data decimation done by the hardware and/or the software. Decimation by n keeps every nth sample, throwing away each of the remaining samples in the group of n. For example, decimation by 3 keeps every third sample, throwing away the two in between. Similarly, decimation by 5 keeps every fifth sample, throwing away the four in between.

Key Path:	**Meas Setup, More (1 of 2), Advanced**
Remote Command:	**[:SENSe]:AOPower:DECimate[:FACTor] <integer>**
	[:SENSe]:AOPower:DECimate[:FACTor]?
	[:SENSe]:AOPower:DECimate:STATe OFF|ON| 0|1
	[:SENSe]:AOPower:DECimate:STATe?
Preset/Default	1
State Saved	Yes
Min	1
Max	20
SCPI Resolution	1
Force Restart	Yes

RPG	1
Step (Front Panel)	1
BAF Parameter Name	Decimation State
BAF Range	On | Off
BAF Preset/Default	0

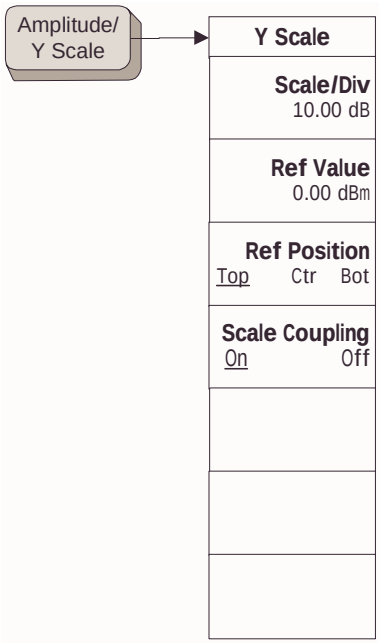
2.4.1.10.2 ADC Range



Select the range for the gain-ranging that is done in front of the ADC. This is an Advanced control that normally does not need to be changed.

Key Path:	**Meas Setup, More (1 of 2), Advanced**
Remote Command:	**[:SENSe]:AOPower:ADC:RANGe AUTO|APEak|APLock|GROund|M6|P0|P6|P12|P18|P24** **[:SENSe]:AOPower:ADC:RANGe?**
Factory Preset:	AUTO
State Saved:	Saved in instrument state.
Range:	Auto | Auto Peak | AutoPeakLock | -6dB | 0dB | +6dB | +12dB | +18dB | +24dB

2.4.2 AMPLITUDE Y Scale (Signal Envelope View, plus Lower & Upper Envelope View)



2.4.2.1 Scale/Div

Allows you to enter a numeric value to change the vertical display sensitivity.

Key Path:	**AMPLITUDE Y Scale,1**
Annotation:	<value>\ndB/ (Top left hand corner of graph display)
Factory Preset:	10.00 dB
State Saved:	Saved in instrument state.

2.4.2.2 Ref Value

Allows you to set the absolute power reference value.

Key Path:	**AMPLITUDE Y Scale**
Annotation:	Ref <value> dBm - top left hand corner of display
Factory Preset:	0.00 dBm
State Saved:	Saved in instrument state.

2.4.2.3 Ref Position

Allows the user to set the reference position.

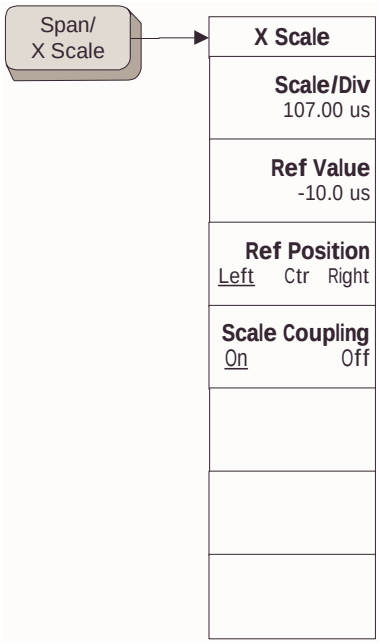
Key Path:	**AMPLITUDE Y Scale**
Annotation:	The current reference position is indicated by white indicators (> and <) either side of the graticule.
Range:	Top | Ctr | Bot
Factory Preset:	Top
State Saved:	Saved in instrument state.

2.4.2.4 Scale Coupling

Allows you to toggle the scale coupling function between On and Off. When On, upon pressing the Restart front-panel key or Restart softkey under the Meas Control menu, this function automatically determines the scale per division and reference values based on the measurement results. When you set a value to either Scale/Div or Ref Value manually, Scale Coupling automatically changes to Off.

Key Path:	**AMPLITUDE Y Scale**
Range:	On | Off
Factory Preset:	On
State Saved:	Saved in instrument state.

2.4.3 SPAN X Scale (Signal Envelope View, plus Lower & Upper Envelope View)



2.4.3.1 Scale/Div

Allows you to set the horizontal scale by changing a time value per division.

Key Path:	**SPAN X Scale,1**
Factory Preset:	107.00 us
State Saved:	Saved in instrument state.

2.4.3.2 Ref Value

Allows you to set the reference value.

Key Path:	**SPAN X Scale**
Annotation:	<value> - bottom left hand corner of display
Factory Preset:	-10.00 us
State Saved:	Saved in instrument state.

2.4.3.3 Ref Position

Allows you to set the reference position.

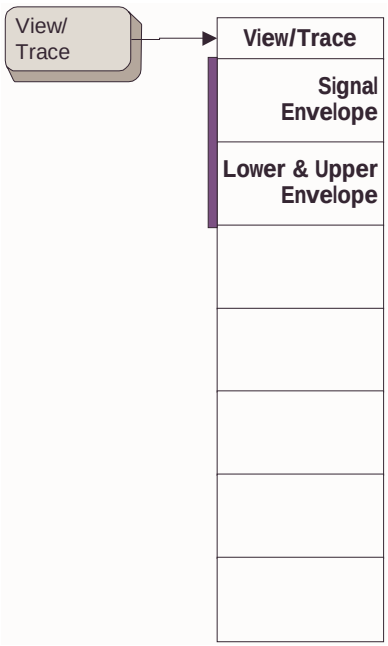
Key Path:	**SPAN X Scale**
Range:	Left | Ctr | Right
Factory Preset:	Left
State Saved:	Saved in instrument state.

2.4.3.4 Scale Coupling

Allows you to toggle the scale coupling function between On and Off. The default setting is On. Upon pressing the Restart front-panel key or Restart softkey under the Meas Control menu, this function automatically determines the scale per division and reference values based on the measurement results. When you set a value to either Scale/Div or Ref Value manually, Scale Coupling automatically changes to Off.

Key Path:	**SPAN X Scale**
Dependencies and Couplings:	When Auto, Res BW = Channel Integ BW / 50
Range:	On | Off
Factory Preset:	On
State Saved:	Saved in instrument state.

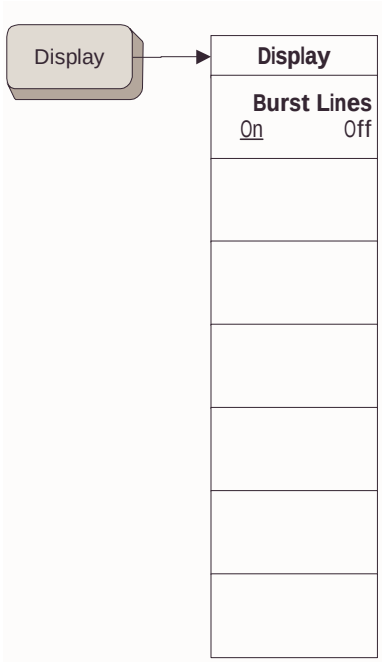
2.4.4 View / Trace



Allows the user to change the view.

Key Path:	**View/Trace**
Range:	Signal Envelope | Lower & Upper Envelope
Factory Preset:	Signal Envelope
State Saved:	Saved in instrument state.

2.4.5 Display



2.4.5.1 Burst Lines

Allows the user to turn the burst lines On or Off.

Key Path:	**Display**
Remote Command:	**`[:SENSe]:AOPower:BLINes[:STATe] OFF|ON|0|1`** **`[:SENSe]:AOPower:BLINes[:STATe]?`**
Factory Preset:	On
State Saved:	Saved in instrument state.
Range:	On | Off
Restriction and Notes	None

Force Restart	No
Soft Key Label	Burst Lines

2.5 Status Bar Messages

Status Bar Text	Meaning	ID (SCPI #)	Type
Valid WLAN burst not found	No active WLAN bursts have been detected in the RF Input signal. Please verify Repeat Offset parameter value is large enough for input signal type, and also verify the Burst Search Threshold value is appropriate for input signal type.	801	Error

3 Carrier Suppression Measurement Definition

3.1 Measurement Overview

With the DUT in Carrier Suppression test mode we expect to see:

- Signal @ Carrier Frequency - 250kHz
- Spur due to Carrier Leakage @ Carrier Frequency
- Spur due to DC Offset @ Carrier Frequency + 250kHz

The Carrier Suppression result is the difference, expressed in dBc between the Signal and the Carrier Leakage spur. The IQ Balance result is the difference, expressed in dBc between the Signal and the DC Offset spur.

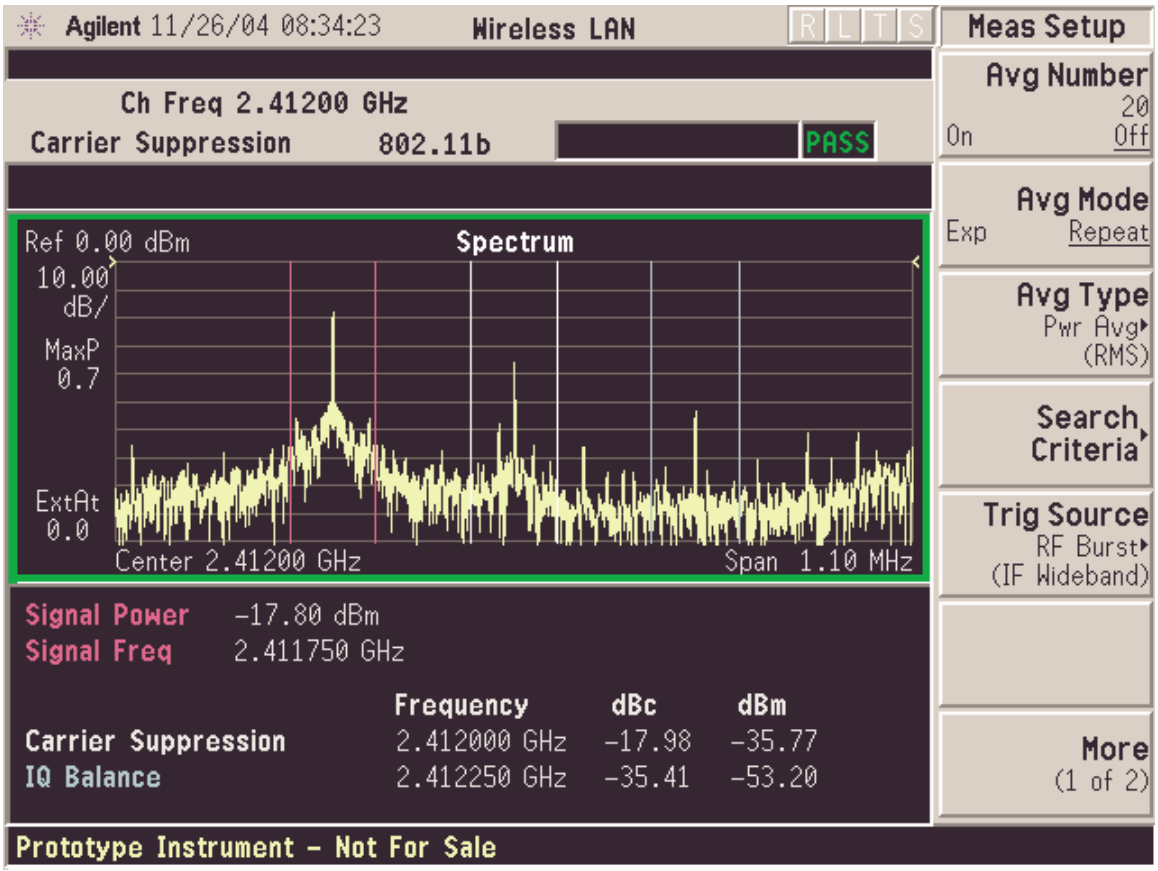
3.2 Measurement Algorithm

To measure the signal and each of the spurs, the measurement takes a single sweep with a span set to capture the Signal Measurement Bandwidth and the DC Offset Measurement Bandwidth.

The measurement searches the Signal, Carrier Leakage and DC Offset Bandwidths in turn to find the peak signal within each bandwidth.

3.3 Measurement Results

3.3.1 Front Panel Results & Views



3.3.1.1 Signal

The frequency and amplitude of the peak of the signal found in the signal measurement bandwidth at the carrier freq + signal offset frequency.

3.3.1.2 Carrier Suppression (Carrier Leakage)

The frequency and amplitude of the peak of the signal found in the carrier suppression measurement bandwidth at the carrier frequency. Also displays the amplitude relative to the signal power.

3.3.1.3 IQ Balance (DC Offset)

The frequency and amplitude of the peak of the signal found in the DC offset suppression measurement bandwidth at the carrier freq + DC offset frequency. Also displays the amplitude relative to the signal power.

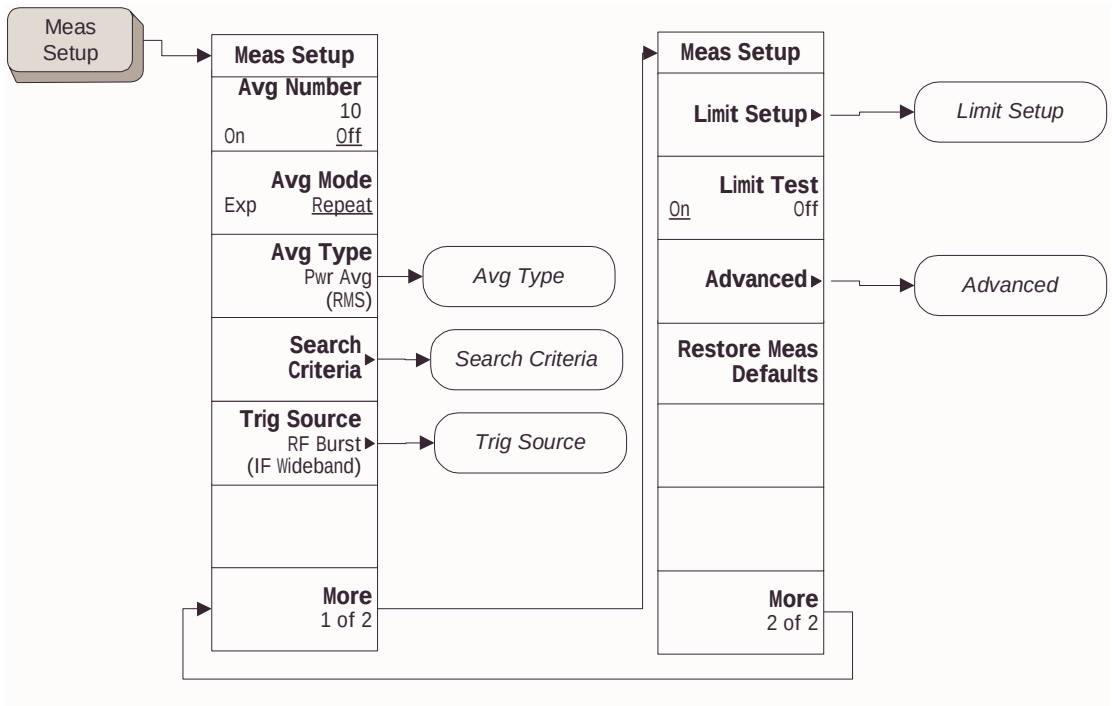
3.3.2 Remote SCPI Results

Command	Return Value
CONFigure:CSUPpression	N/A
FETCh:CSUPpression[n]? MEASure:CSUPpression[n]? READ:CSUPpression[n]?	

n	Return Value
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.
n=1 (or not specified)	Returns the following scalar results: 1. Signal Peak Power (dBm) 2. Signal Peak Frequency (Hz) 3. Carrier Suppression (dBc) 4. Carrier Leakage Peak Power (dBm) 5. Carrier Leakage Peak Frequency (Hz) 6. IQ Balance (dBc) 7. DC Offset Peak Power (dBm) 8. DC Offset Peak Frequency (Hz) 9. Pass/Fail Flag (0 = Pass, 1 = Fail)
2	Returns spectrum trace data. That is, the trace of log-magnitude versus frequency. (The trace is computed using a FFT.) The default number of trace points returned is 2405.

3.4 Operations

3.4.1 Meas Setup



3.4.1.1 Average Number

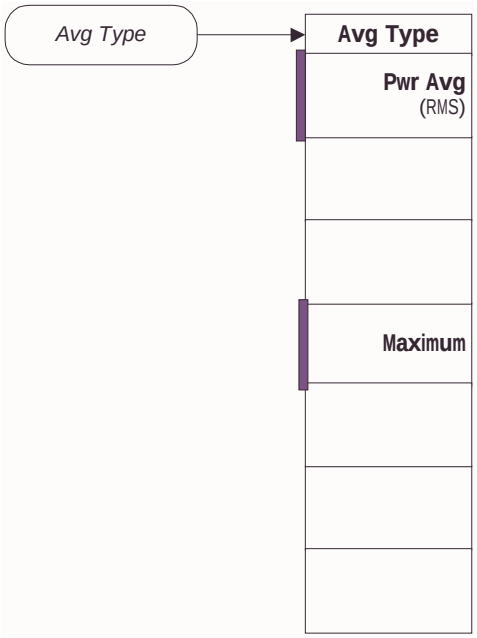
Average number sets the number of data acquisitions that will be averaged.

Average state turns averaging on or off.

Key Path:	**Meas Setup**
Remote Command:	**[:SENSe]:CSUPpression:AVERage:COUNt <integer>**
	[:SENSe]:CSUPpression:AVERage:COUNt?
	[:SENSe]:CSUPpression:AVERage[:STATe] OFF|ON| 0|1
	[:SENSe]:CSUPpression:AVERage[:STATe]?
Preset/Default	20
State Saved	Yes
Min	1
Max	10000

SCPI Resolution	1
Force Restart	Yes
RPG	1
Step (Front Panel)	10
BAF Parameter Name	Average State
BAF Range	On | Off
BAF Preset/Default	0
BAF State Saved	Yes

3.4.1.2 Average Type



Select the type of averaging to be performed.

Pwr Avg (RMS) - The power is averaged to provide a voltage rms value.

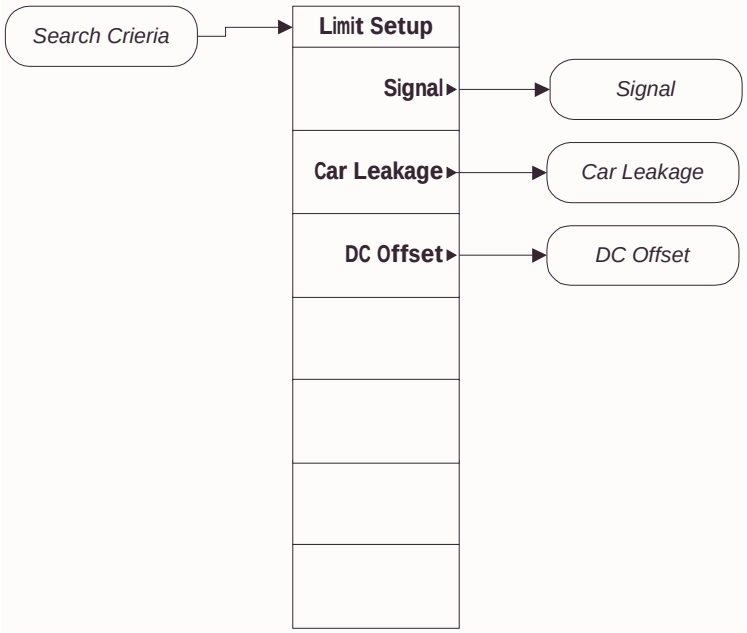
Maximum - The maximum values are retained.

Key Path:	**Meas Setup**
Remote Command:	**[:SENSe]:CSUPpression:AVERage:TYPE RMS | MAXimum**
	[:SENSe]:CSUPpression:AVERage:TYPE?
Factory Preset:	RMS

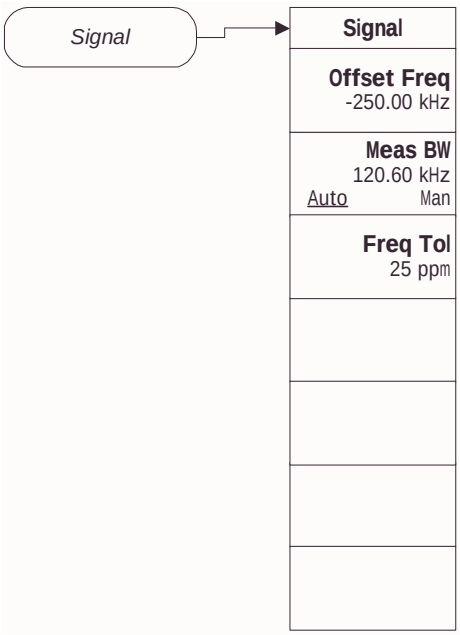
State Saved: Saved in instrument state.

Range: RMS | MAXimum

3.4.1.3 Search Criteria



3.4.1.3.1 Signal



3.4.1.3.1.1 Offset Frequency

Allows the user to enter the frequency, relative to the mode center frequency, where the Signal search is to be carried out.

Key Path:	**Meas Setup, Search Criteria, Signal**
Remote Command:	**[:SENSe]:CSUPpression:SIGNal:FREQuency <freq>**
	[:SENSe]:CSUPpression:SIGNal:FREQuency?
Preset/Default	-250 kHz
State Saved	Yes
Min	-500 kHz
Max	0 kHz
SCPI Resolution	1 Hz
Force Restart	Yes
RPG	1 kHz
Step (Front Panel)	50 kHz

3.4.1.3.1.2 Measurement Bandwidth

Allows the user to enter the bandwidth in which the measurement will search for the signal. When Meas Bandwidth mode is set to Auto, the Bandwidth is calculated using the Freq Tolerance parameter.

Key Path:	**Meas Setup, Search Criteria, Signal**
Remote Command:	**[:SENSe]:CSUPpression:SIGNal:BANDwidth:MEASurement <freq>**
	[:SENSe]:CSUPpression:SIGNal:BANDwidth:MEASurement?
	[:SENSe]:CSUPpression:SIGNal:BANDwidth:MEASurement:AUTO OFF|ON|0|1
	[:SENSe]:CSUPpression:SIGNal:BANDwidth:MEASurement:AUTO?
Preset/Default	50 kHz
State Saved	Yes
Min	300 Hz
Max	500 kHz
SCPI Resolution	1 Hz
Force Restart	Yes
RPG	Third most significant digit

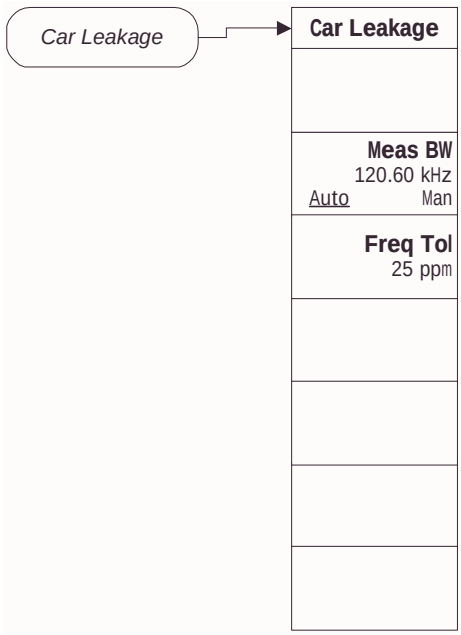
Step (Front Panel)	6 ppd
BAF Range	Auto | Man
BAF Preset/Default	1
BAF State Saved	Yes
BAF SCPI Remarks	Auto => Meas BW = ((Freq Tol / 1e6) * Center Freq) * 2

3.4.1.3.1.3 Frequency Tolerance

Allows the user to enter the Frequency Tolerance which refers to the frequency range, expressed in ppm, which the measurement searches to find the Signal.

Key Path:	**Meas Setup, Search Criteria, Signal**
Remote Command:	**`[:SENSe]:CSUPpression:SIGNal:FTOLerance <integer>`** **`[:SENSe]:CSUPpression:SIGNal:FTOLerance?`**
Front Panel Unit/Terminator Keys	ppm
Preset/Default	25
State Saved	Yes
Min	1
Max	500
SCPI Resolution	1
Force Restart	Yes
RPG	1
Step (Front Panel)	1

3.4.1.3.2 Carrier Leakage



3.4.1.3.2.1 Measurement Bandwidth

Allows the user to enter the bandwidth in which the measurement will search for the Carrier Leakage Spur. When Meas Bandwidth mode is set to Auto, the Bandwidth is calculated using the Freq Tolerance parameter.

Key Path:	**Meas Setup, Search Criteria, Car Leakage**
Remote Command:	**[:SENSe]:CSUPpression:CLEakage:BANDwidth:MEASurement <freq>**
	[:SENSe]:CSUPpression:CLEakage:BANDwidth:MEASurement?
	[:SENSe]:CSUPpression:CLEakage:BANDwidth:MEASurement:AUTO OFF|ON|0|1
	[:SENSe]:CSUPpression:CLEakage:BANDwidth:MEASurement:AUTO ?
Preset/Default	50 kHz
State Saved	Yes
Min	300 Hz
Max	500 kHz
SCPI Resolution	1 Hz
Force Restart	Yes
RPG	Third most significant digit

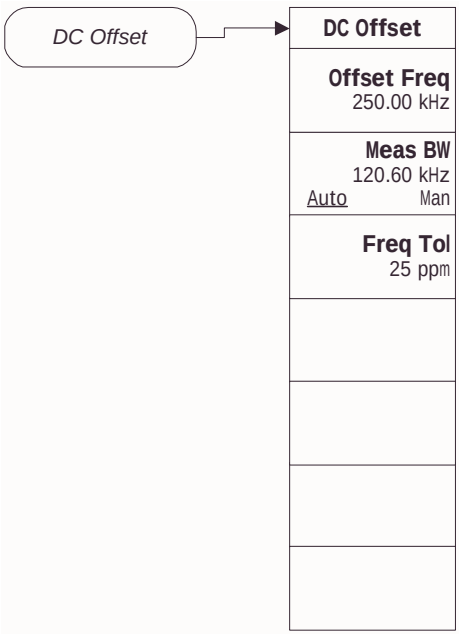
Step (Front Panel)	6 ppd
BAF Range	Auto | Man
BAF Preset/Default	1
BAF State Saved	Yes
BAF SCPI Remarks	Auto => Meas BW = ((Freq Tol / 1e6) * Center Freq) * 2

3.4.1.3.2.2 Frequency Tolerance

Allows the user to enter the Frequency Tolerance which refers to the frequency range, expressed in ppm, which the measurement searches to find the Carrier Leakage peak.

Key Path:	**Meas Setup, Search Criteria, Car Leakage**
Remote Command:	**`[:SENSe]:CSUPpression:CLEakage:FTOLerance <integer>`** **`[:SENSe]:CSUPpression:CLEakage:FTOLerance?`**
Front Panel Unit/Terminator Keys	ppm
Preset/Default	25
State Saved	Yes
Min	1
Max	500
SCPI Resolution	1
Force Restart	Yes
RPG	1
Step (Front Panel)	1

3.4.1.3.3 DC Offset



3.4.1.3.3.1 Offset Frequency

Allows the user to enter the frequency, relative to the mode center frequency, where the DC Offset peak search is to be carried out.

Key Path:	**Meas Setup, Search Criteria, DC Offset**
Remote Command:	**`[:SENSe]:CSUPpression:DCOFfset:FREQuency <freq>`**
	`[:SENSe]:CSUPpression:DCOFfset:FREQuency?`
Preset/Default	250 kHz
State Saved	Yes
Min	0 kHz
Max	500 kHz
SCPI Resolution	1 Hz
Force Restart	Yes
RPG	1 kHz
Step (Front Panel)	100 kHz

3.4.1.3.3.2 Measurement Bandwidth

Allows the user to enter the bandwidth in which the measurement will search for the DC Offset Spur. When Meas Bandwidth mode is set to Auto, the Bandwidth is calculated using the Freq Tolerance parameter.

Key Path:	**Meas Setup, Search Criteria, DC Offset**
Remote Command:	**[:SENSe]:CSUPpression:DCOFfset:BANDwidth:MEASurement <freq>**
	[:SENSe]:CSUPpression:DCOFfset:BANDwidth:MEASurement?
	[:SENSe]:CSUPpression:DCOFfset:BANDwidth:MEASurement:AUTO OFF|ON|0|1
	[:SENSe]:CSUPpression:DCOFfset:BANDwidth:MEASurement:AUTO ?
Preset/Default	50 kHz
State Saved	Yes
Min	300 Hz
Max	500 kHz
SCPI Resolution	1 Hz
Force Restart	Yes
RPG	Third most significant digit
Step (Front Panel)	6 ppd
BAF Range	Auto | Man
BAF Preset/Default	1
BAF State Saved	Yes
BAF SCPI Remarks	Auto => Meas BW = ((Freq Tol / 1e6) * Center Freq) * 2

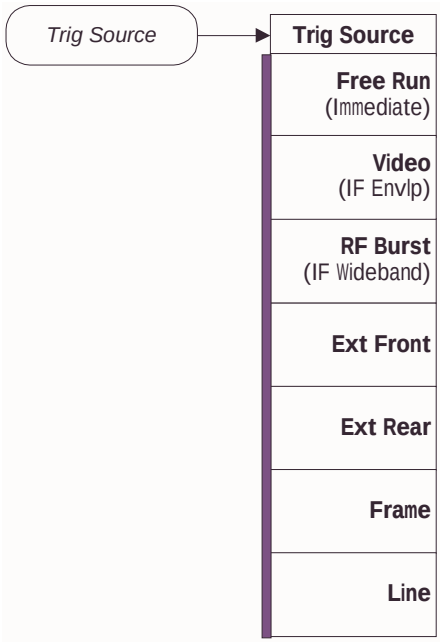
3.4.1.3.3.3 Frequency Tolerance

Allows the user to enter the Frequency Tolerance which refers to the frequency range, expressed in ppm, which the measurement searches to find the DC Offset peak.

Key Path:	**Meas Setup, Search Criteria, DC Offset**
Remote Command:	**[:SENSe]:CSUPpression:DCOFfset:FTOLerance**
	[:SENSe]:CSUPpression:DCOFfset:FTOLerance?
Front Panel Unit/Terminator Keys	ppm
Preset/Default	25
State Saved	Yes
Min	1
Max	500

SCPI Resolution	1
Force Restart	Yes
RPG	1
Step (Front Panel)	1

3.4.1.4 Trigger Source



Select the trigger source used to control the data acquisitions.

Trigger sources that are available are;

Free Run - the next data acquisition is immediately taken.

Video - internal IF envelope (video) trigger.

RF Burst - wideband RF burst envelope trigger that has automatic level control for periodic burst signals.

Ext Front - front panel external trigger input.

Ext Rear - rear panel external trigger input.

Frame - internal frame timer from front panel input.

Line - internal line trigger.

Key Path: **Meas Setup**

Remote Command:	**[:SENSe]:CSUPpression:TRIGger:SOURce IMMediate|IF|RFBurst|EXTernal|EXTernal2|FRAMe|LINE**
	[:SENSe]:CSUPpression:TRIGger:SOURce?
Factory Preset:	RFBurst
State Saved:	Saved in instrument state.
Range:	Free Run (Immediate) | Video (IF Envlp) | RF Burst (IF Wideband) | Ext Front | Ext Rear | Frame | Line

3.4.1.5 Limit Setup

3.4.1.5.1 Carrier Suppression Limit

Allows the user to enter the Carrier Suppression limit. This is the upper limit, expressed in dBc, between the Signal and the Carrier Leakage spur.

Key Path:	**Meas Setup, More, Limit Setup**
Remote Command:	**[:SENSe]:CSUPpression:CSLimit <rel_ampl>**
	[:SENSe]:CSUPpression:CSLimit?
Front Panel Unit/Terminator Keys	dBc
Preset/Default	-15.00
State Saved	Yes

Min	-150.00
Max	50.00
SCPI Resolution	0.01
Force Restart	Yes
RPG	0.1
Step (Front Panel)	10.0

3.4.1.5.2 IQ Balance Limit

Allows the user to enter the IQ Balance limit. This is the upper limit, expressed in dBc between the Signal and the IQ Balance spur.

Key Path:	**Meas Setup, More, Limit Setup**
Remote Command:	**[:SENSe]:CSUPpression:IQBLimit <rel_ampl>**
	[:SENSe]:CSUPpression:IQBLimit?
Front Panel Unit/Terminator Keys	dBc
Preset/Default	-30.00
State Saved	Yes
Min	-150.00
Max	50.00
SCPI Resolution	0.01
Force Restart	Yes
RPG	0.1
Step (Front Panel)	10.0

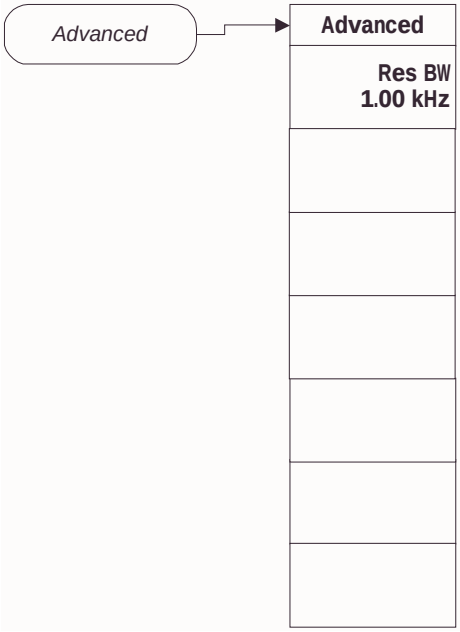
3.4.1.6 Limit Test

Allows the user to turn the limit test on or off.

Key Path:	**Meas Setup, More**
Remote Command:	**CALCulate:CSUPpression:LIMit:STATe OFF|ON|0|1**
	CALCulate:CSUPpression:LIMit:STATe?
Factory Preset:	On
State Saved:	Saved in instrument state.
Range:	On | Off

Restriction and Notes	None
Force Restart	No

3.4.1.7 Advanced

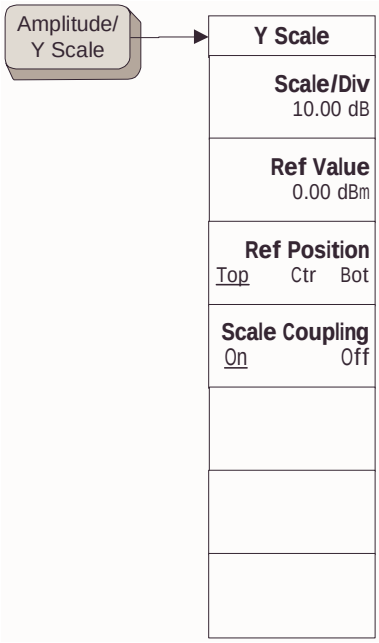


3.4.1.7.1 Resolution Bandwidth

Used to set the Res BW for the measurement.

Key Path:	**Meas Setup, Advanced**
Remote Command:	**[:SENSe]:CSUPpression:BANDwidth|BWIDth:RESolution <freq>**
	[:SENSe]:CSUPpression:BANDwidth|BWIDth:RESolution?
Preset/Default	1 kHz
State Saved	Yes
Min	1 kHz
Max	7.5 MHz
SCPI Resolution	1 Hz
Force Restart	Yes
RPG	Third most significant digit
Step (Front Panel)	6 ppd

3.4.2 Amplitude / Y Scale



3.4.2.1 Scale/Div

Allows you to enter a numeric value to change the vertical display sensitivity.

Key Path:	**AMPLITUDE Y Scale**
Factory Preset:	107.00 us
State Saved:	Saved in instrument state.

3.4.2.2 Ref Value

Allows you to set the absolute power reference value.

Key Path:	**AMPLITUDE Y Scale**
Annotation:	<value> - bottom left hand corner of display
Factory Preset:	-10.00 us
State Saved:	Saved in instrument state.

3.4.2.3 Ref Position

Allows you to set the reference position.

Key Path:	**AMPLITUDE Scale**
Range:	Left | Ctr | Right
Factory Preset:	Left
State Saved:	Saved in instrument state.

3.4.2.4 Scale Coupling

Allows you to toggle the scale coupling function between On and Off. When On, upon pressing the Restart front-panel key or Restart softkey under the Meas Control menu, this function automatically determines the scale per division and reference values based on the measurement results. When you set a value to either Scale/Div or Ref Value manually, Scale Coupling automatically changes to Off.

Key Path:	**AMPLITUDE Y Scale**
Range:	On | Off
Factory Preset:	On
State Saved:	Saved in instrument state.

3.5 Status Bar Messages

Status Bar Text	Meaning	ID (SCPI #)	Type
802.11g not supported by this measurement	802.11g was the selected band when this measurement was entered and as this measurement does not support 802.11g, the band will be forced to 802.11b. 802.11g will be greyed out and this error message will be displayed.	802	Error
Adjust Meas BW and Res BW to complete measurement.	The Meas BW of either the Signal, Carrier Leakage or DC Offset is too low or the Res BW is to high to allow a valid trace to be generated. The measurment cannot complete until the parameters are changed.	803	Error

4 Transmit Output Spectrum Measurement Definition

4.1 Measurement Overview

Transmit Output Spectrum measurement includes the in-band and out-of-band spectrum emissions. The measurement is based on ISO/IEC 802-11:1999, section 15.4.7.4 and IEEE Std 802.11a-1999, 17.3.9.2 which states that the measurement should test the power contained in a specified frequency bandwidth at certain offsets relative to the total carrier power.

4.2 Measurement Algorithm

The measurement will take the carrier and each of the active upper and lower offsets in turn and, using the currently selected trigger, find the peak point in each segment. The frequency and amplitude of this point is recorded. This is achieved using Averaging. Average Type defaults to Maximum and 200 Averages are taken. This ensures the peak of the segment is found.

4.2.1 Optimizing Speed

In order to minimize measurement time, and maximize device throughput, the following advice should be followed.

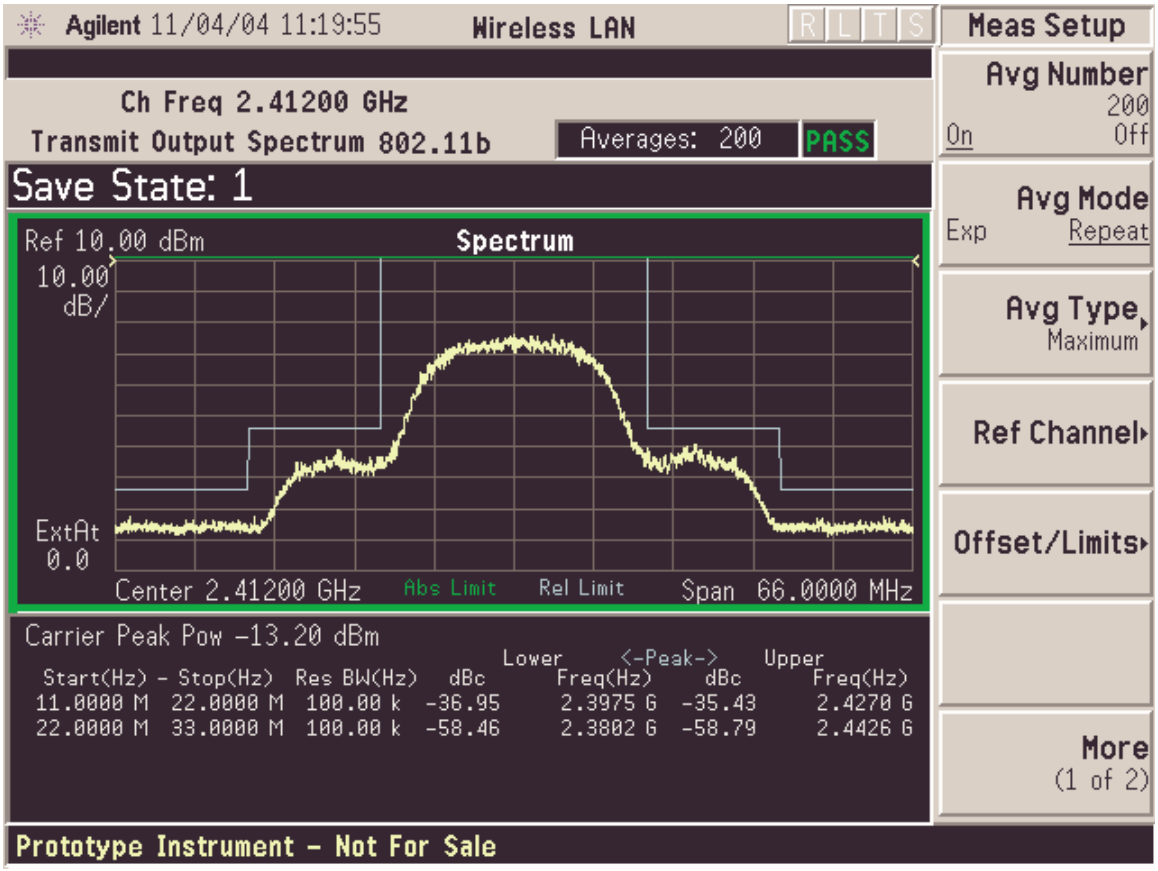
4.2.1.1 Triggering and Averaging

The default trigger setting for this measurement is Freerun. To ensure that the peak of the ref channel and offsets are found, it is necessary to use 200 maximum averages, with Average Type set to Maximum. This is because typically a WLAN burst is 1ms in duration, but when using a 100 kHz RBW (as specified in the test specifications), the VSA can only capture ~38µs of data. It is therefore likely that as well as capturing portions of the burst you also capture rising edge, falling edge and dead time. 200 averages was found to give repeatable results (and is the Agilent recommended setting for free-run trigger).

To optimize this measurement, it is possible to use an RF Burst trigger then use trigger delay to start the capture at the data portion of the burst. This assumes that the burst is non-repeating. By doing this the number of averages can be reduced as each trigger ensures you are always measuring the useful part of the burst. Averaging is still required as you still only capture ~38µs, but if it is a non-repeating signal the peak power in the burst will occur at different times.

4.3 Measurement Results

4.3.1 Front Panel Results



4.3.1.1 Carrier Peak Power

The peak power value (in dBm) found in the Ref Channel

4.3.1.2 Peak Power per Segment

The peak power value (in dBc) found in each active upper and lower offset

4.3.1.3 Pass/Fail

A red 'F' will be appended to each offset result that does not comply with the fail mask. Any failures result in the fail flag being set in the measurement bar.

4.3.2 Remote SCPI Results

Command	Return Value

CONFigure:TOSPectrum	N/A
FETCh:TOSPectrum[n]? MEASure:TOSPectrum[n]? READ:TOSPectrum[n]?	

n	Return Value
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.

1 (or not specified)	Returns 60 scalar results, in the following order: 1. Reserved for future use, returns –999.0 2. Reserved for future use, returns –999.0 3. Reserved for future use, returns –999.0 4. Absolute Peak power at the center frequency (reference) area (dBm) 5. Peak frequency in the center frequency (reference) area (Hz) 6. Reserved for future use, returns –999.0 7. Reserved for future use, returns –999.0 8. Reserved for future use, returns –999.0 9. Reserved for future use, returns –999.0 10. Reserved for future use, returns –999.0 11. Reserved for future use, returns –999.0 12. Reserved for future use, returns –999.0 13. Relative peak power on the negative offset A (dBc) 14. Absolute peak power on the negative offset A (dBm) 15. Peak frequency in the negative offset A (Hz) 16. Reserved for future use, returns –999.0 17. Reserved for future use, returns –999.0 18.Relative peak power on the positive offset A (dBc) 19. Absolute peak power on the positive offset A (dBm) 20. Peak frequency in the positive offset A (Hz) 21. Reserved for future use, returns –999.0 22. Reserved for future use, returns –999.0 23. Relative peak power on the negative offset B (dBc) 24. Absolute peak power on the negative offset B (dBm) . . . 58.Relative peak power on the positive offset E (dBc) 59. Absolute peak power on the positive offset E (dBm) 60. Peak frequency in the positive offset E (Hz)
2	Returns the displayed frequency domain spectrum trace data as a 2001 point comma separated list. .

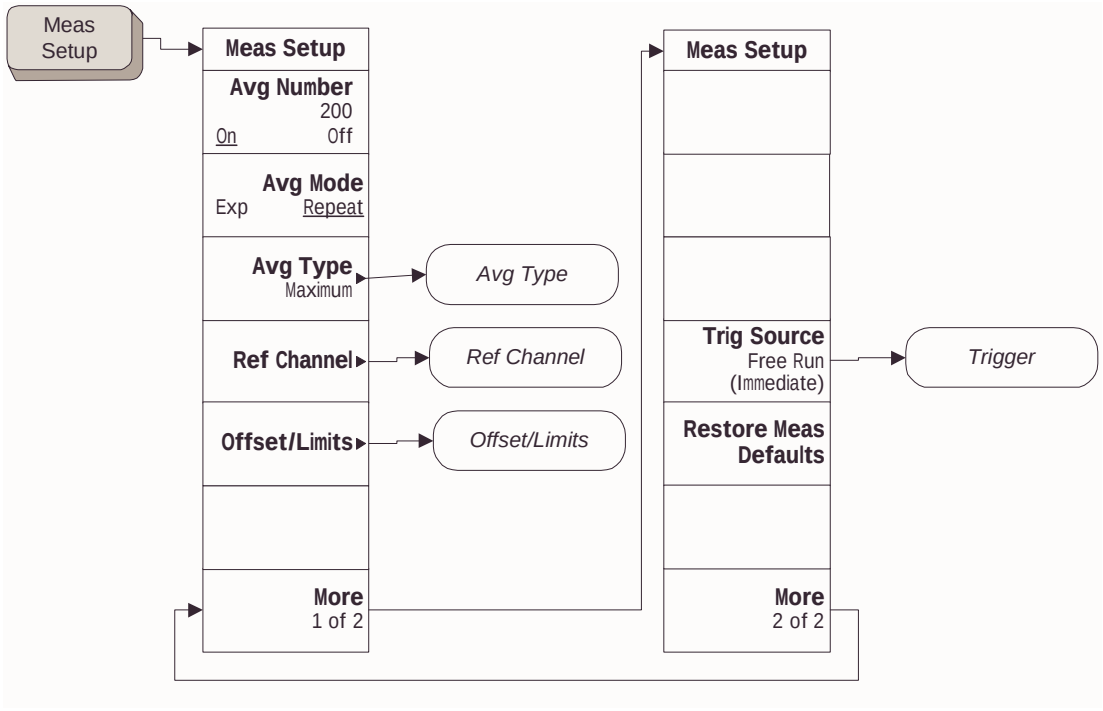
3	Returns the displayed frequency domain absolute limit trace data as a a 2001 point comma separated list.
4	Returns the displayed frequency domain relative limit trace data as a a 2001 point comma separated list.
7	Returns 12 pass/fail test results (0 = passed, or 1 = failed) determined by testing the absolute power of the offset frequencies: 1. Reserved for future use, returns –999.0 2. Reserved for future use, returns –999.0 3. Negative offset frequency (A) 4. Positive offset frequency (A) . . . 11. Negative offset frequency (E) 12. Positive offset frequency (E)
8	Returns 12 scalar values of the pass/fail (0=passed, or 1=failed) results determined by testing the power relative to the offset frequencies: 1. Reserved for future use, returns –999.0 2. Reserved for future use, returns –999.0 3. Negative offset frequency (A) 4. Positive offset frequency (A) . . . 11. Negative offset frequency (E) 12. Positive offset frequency (E)

9	Returns 12 scalar values of frequency (in Hz) at the peak power in each offset: 1. Reserved for future use, returns –999.0 2. Reserved for future use, returns –999.0 3. Negative offset frequency (A) 4. Positive offset frequency (A) . . . 11. Negative offset frequency (E) 12. Positive offset frequency (E)
10	Returns 12 scalar values (in dBm) of the absolute peak power of the offset frequencies: 1. Reserved for future use, returns –999.0 2. Reserved for future use, returns –999.0 3. Negative offset frequency (A) 4. Positive offset frequency (A) . . . 11. Negative offset frequency (E) 12. Positive offset frequency (E)
11	Returns 12 scalar values (in dBc) of the peak power relative to the carrier at the offset frequencies: 1. Reserved for future use, returns –999.0 2. Reserved for future use, returns –999.0 3. Negative offset frequency (A) 4. Positive offset frequency (A) . . . 11. Negative offset frequency (E) 12. Positive offset frequency (E)

12	Returns the following 10 scalar values: 1. Carrier Peak Power (dBm) 2. Lower Offset A Peak Power (dBc) 3. Lower Offset A Margin to Mask (dB) 4. Upper Offset A Peak Power (dBc) 5. Upper Offset A Margin to Mask (dB) 6. Lower Offset B Peak Power (dBc) 7. Lower Offset B Margin to Mask (dB) 8. Upper Offset B Peak Power (dBc) 9. Upper Offset B Margin to Mask (dB) 10. Lower Offset C Peak Power (dBc) 11. Lower Offset C Margin to Mask (dB) 12. Upper Offset C Peak Power (dBc) 13. Upper Offset C Margin to Mask (dB) 14. Pass/Fail Flag (0 = Pass, 1 = Fail) When Radio Band is set to 802.11b, results 11 to 13 will be –999.0

4.4 Operations

4.4.1 Meas Setup



4.4.1.1 Average Number

Average number sets the number of data acquisitions that will be averaged.

Average state turns averaging on or off.

Key Path:	**Meas Setup**
Remote Command:	**[:SENSe]:TOSPectrum:AVERage:COUNt <integer>**
	[:SENSe]:TOSPectrum:AVERage:COUNt?
	[:SENSe]:TOSPectrum:AVERage[:STATe] OFF|ON| 0|1
	[:SENSe]:TOSPectrum:AVERage[:STATe]?
Preset/Default	200
State Saved	Yes
Min	1
Max	10000

SCPI Resolution	1
SCPI Resolution Max	1
Force Restart	Yes
RPG	1
Step (Front Panel)	10
BAF Parameter Name	Average State
BAF Range	On | Off
BAF Preset/Default	1
BAF State Saved	Yes

4.4.1.2 Avg Mode

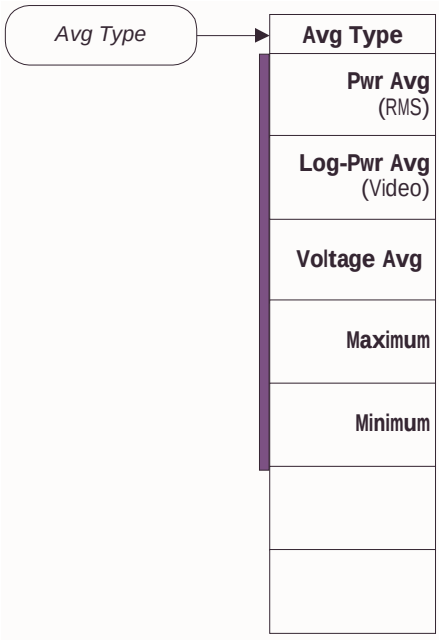
Select the type of termination control used for averaging. This determines the averaging action after the specified number of data acquisitions (average count) is reached.

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.

Key Path:	**Meas Setup**
Remote Command:	**`[:SENSe]:TOSPectrum:AVERage:TCONtrol EXPonential | REPeat`**
	`[:SENSe]:TOSPectrum:AVERage:TCONtrol?`
Preset/Default	REPeat
State Saved	Yes
Range	Exp | Repeat
Coupling	None
Force Restart	Yes
Soft Key Label	Avg Mode

4.4.1.3 Avg Type



Select the type of averaging to be performed.

Pwr Avg (RMS) - The power is averaged to provide a voltage rms value.

Log-Pwr Avg (Video) - The log of the power is averaged. (This is also known as video averaging.)

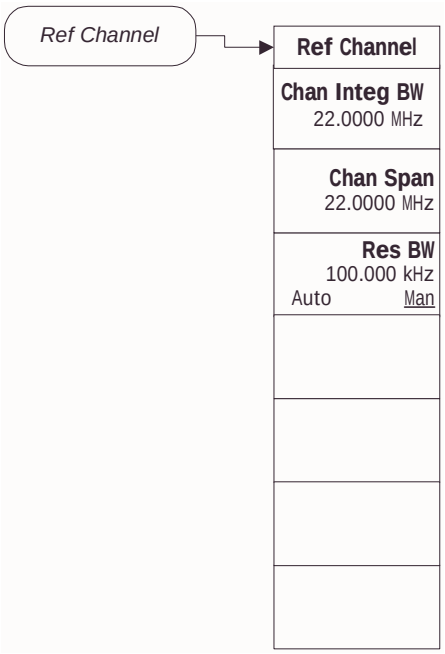
Voltage Avg - The amplitude level of power is averaged to provide a voltage value.

Maximum - The maximum values are retained.

Minimum - The minimum values are retained.

Key Path:	**Meas Setup**
Remote Command:	**`[:SENSe]:TOSPectrum:AVERage:TYPE RMS|LOG|SCALar|MAXimum|MINimum`**
	`[:SENSe]:TOSPectrum:AVERage:TYPE?`
Preset/Default	MAXimum
State Saved	Yes
Range	Pwr Avg (RMS) | Log-Pwr Avg (Video) | Voltage Avg | Maximum | Minimum
Coupling	None
Force Restart	Yes

4.4.1.4 Ref



4.4.1.4.1 Channel Integration Bandwidth

Set the integration bandwidth that will be used for the reference channel.

Key Path:	**Meas Setup, Ref Channel**
Remote Command:	**`[:SENSe]:TOSPectrum:BANDwidth[1]|2:INTegration <freq>`** **`[:SENSe]:TOSPectrum:BANDwidth[1]|2:INTegration?`**
Preset/Default	22 MHz | 22 MHz
State Saved	Yes
Min	100 kHz
Max	22 MHz
SCPI Resolution	100 Hz
Force Restart	Yes
RPG	Third most significant digit
Step (Front Panel)	6 ppd
SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g

4.4.1.4.2 Channel Span

Enter a frequency value to set the channel frequency span for the reference channel integration.

Key Path:	**Meas Setup, Ref Channel**
Remote Command:	**[:SENSe]:TOSPectrum:FREQuency[1]|2:SPAN <freq>**
	[:SENSe]:TOSPectrum:FREQuency[1]|2:SPAN?
Preset/Default	22 MHz | 22 MHz
State Saved	Yes
Min	100 kHz
Max	22 MHz
SCPI Resolution	100 Hz
Force Restart	Yes
RPG	Third most significant digit
Step (Front Panel)	6 ppd
SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore;
	1 = 802.11b
	2 = 802.11g

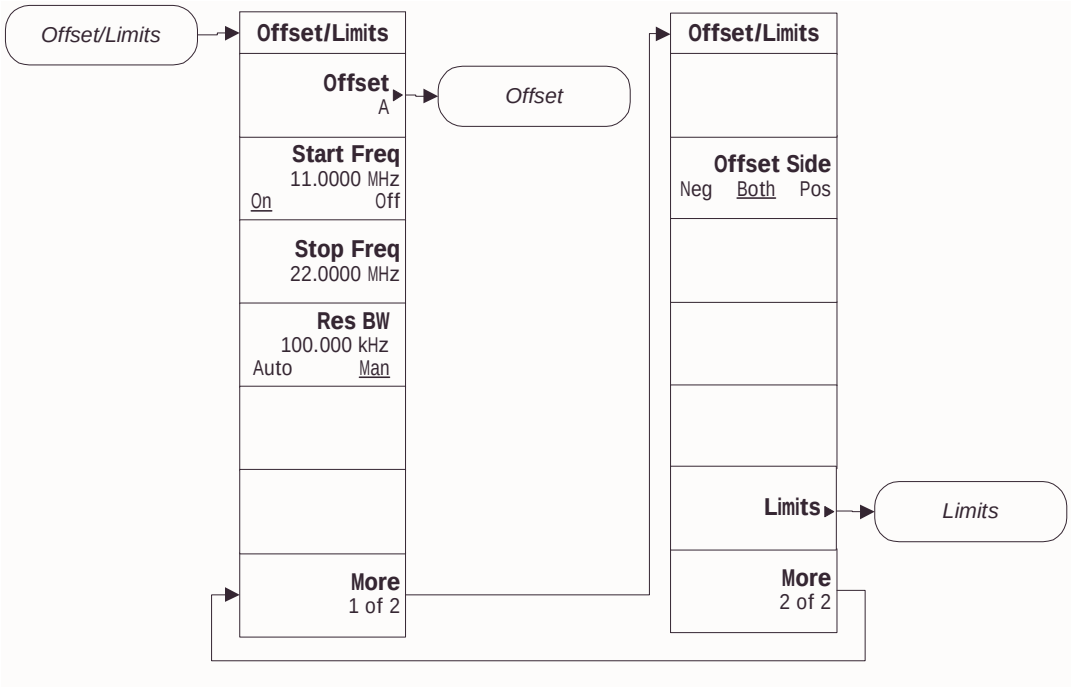
4.4.1.4.3 Resolution Bandwidth

Set the resolution bandwidth for the reference channel.

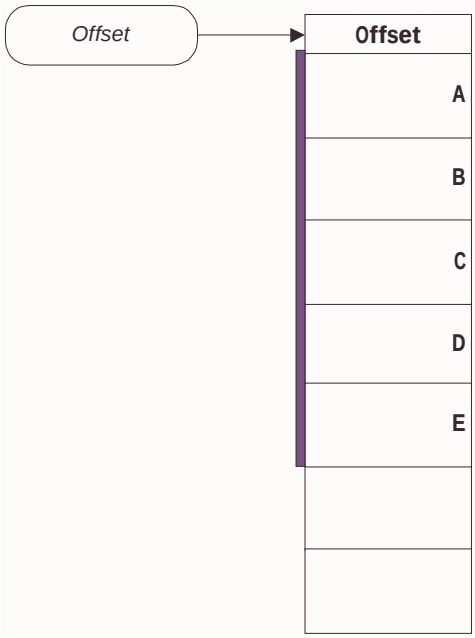
Key Path:	**Meas Setup, Ref Channel**
Remote Command:	**[:SENSe]:TOSPectrum:BANDwidth[1]|2:RESolution <freq>**
	[:SENSe]:TOSPectrum:BANDwidth[1]|2:RESolution?
	[:SENSe]:TOSPectrum:BANDwidth[1]|2:RESolution:AUTO OFF|ON| 0|1
	[:SENSe]:TOSPectrum:BANDwidth[1]|2:RESolution:AUTO?
Preset/Default	100 kHz | 100 kHz
State Saved	Yes
Min	1 kHz
Max	7.5 MHz
SCPI Resolution	1 Hz

Force Restart	Yes
RPG	Third most significant digit
Step (Front Panel)	6 ppd
SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g
BAF Range	Auto | Man
BAF Preset/Default	0 | 0
BAF State Saved	Yes
BAF SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g
BAF Coupling	When Auto, Res BW = Channel Integ BW / 50

4.4.1.5 Offset/Limits



4.4.1.5.1 Offset



To allow the user to select a specific offset.

Key Path:	**Meas Setup, Offset/Limits**
Array Length:	5
Range:	A | B | C | D | E
Factory Preset:	A
State Saved:	Saved in instrument state.

4.4.1.5.2 Start Frequency

Used to set the start frequency of each offset. Start Freq state defines whether or not a particular offset is active. When On the offset will be measured and included in the pass/fail tests.

Key Path:	**Meas Setup, Offset/Limits**
Remote Command:	`[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:FREQuency:STARt <freq>,…`
	`[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:FREQuency:STARt?`
	`[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STATe OFF|ON|1|0`
	`[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STATe?`

Preset/Default	11 MHz, 22 MHz, 33 MHz, 44 MHz, 55 MHz | 9 MHz, 11 MHz, 20 MHz, 30 MHz, 50.0 MHz
State Saved	Yes
Min	10 kHz
Max	100 MHz
SCPI Resolution	100 Hz
Force Restart	Yes
RPG	1 kHz
Step (Front Panel)	100 kHz
Array Length	5
SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g
BAF Parameter Name	Offset State
BAF Range	On | Off
BAF Preset/Default	1,1,0,0,0 | 1,1,1,0,0
BAF State Saved	Yes
BAF SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g

4.4.1.5.3 Stop Frequency

Used to set the stop frequency for each offset.

Key Path:	**Meas Setup, Offset/Limits**
Remote Command:	**[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:FREQuency:STOP <freq>,…** **[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:FREQuency:STOP?**
Preset/Default	22 MHz, 33 MHz, 44 MHz, 55 MHz, 66 MHz | 11 MHz, 20 MHz, 30 MHz, 50 MHz, 70 MHz
State Saved	Yes
Min	10 kHz
Max	100 MHz
SCPI Resolution	100 Hz

Force Restart	Yes
RPG	1 kHz
Step (Front Panel)	100 kHz
Array Length	5
SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g

4.4.1.5.4 Resolution Bandwidth

Used to set the Res BW for each offset. When Res BW mode is auto, the analyzer determines the optimum setting. When Res BW mode is set to man the user determines the setting.

Key Path:	**Meas Setup, Offset/Limits**
Remote Command:	**[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:BANDwidth|BWIDth <freq>,…** **[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:BANDwidth|BWIDth?** **[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:BANDwidth|BWIDth:AUTO OFF|ON|0|1** **[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:BANDwidth|BWIDth:AUTO?**
Preset/Default	100 kHz, 100 kHz, 100 kHz, 100 kHz, 100 kHz | 100 kHz, 100 kHz, 100 kHz, 100 kHz, 100 kHz
State Saved	Yes
Min	300 Hz
Max	22 MHz
SCPI Resolution	1 Hz
Restriction and Notes	When BAF is set to Auto, the RBW is calculated using Chan Integ BW / 50
Force Restart	Yes
RPG	Third most significant digit
Step (Front Panel)	6 ppd
Array Length	5

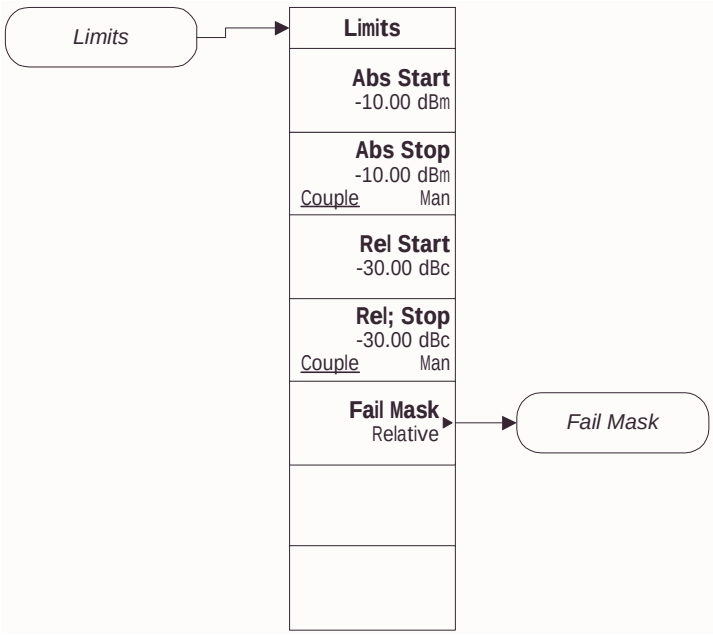
SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g
BAF SCPI Command	[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:BANDwidth|BWIDth:AUTO OFF|ON|0|1 [:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:BANDwidth|BWIDth:AUTO?
BAF Range	Auto | Man
BAF Preset/Default	0,0,0,0,0 | 0,0,0,0,0
BAF State Saved	Yes
BAF SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g

4.4.1.5.5 Offset Side

Specify which sideband will be measured for each offset.

Key Path:	**Meas Setup, Offset/Limits, More**
Remote Command:	**[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:SIDE NEGative | BOTH | POSitive** **[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:SIDE?**
Factory Preset:	BOTH, BOTH, BOTH, BOTH, BOTH | BOTH, BOTH, BOTH, BOTH, BOTH
State Saved:	Saved in instrument state.
Range:	Neg | Both | Pos
Array Length	5
SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g

4.4.1.5.6 Limits



4.4.1.5.6.1 Absolute Start

Sets an absolute power level for each offset start limit.

Key Path:	**Meas Setup, Offset/Limits, More, Limits**
Remote Command:	**`[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STARt:ABSolute <real>,…`**
	`[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STARt:ABSolute?`
Front Panel Unit/Terminator Keys	dBm
Preset/Default	-10.0, -30.0, -30.0, -30.0, -30.0 | 16.0, -4.0, -12, -24, -24
State Saved	Yes
Min	-200.0
Max	50.0
SCPI Resolution	0.01
Force Restart	Yes
RPG	0.01
Step (Front Panel)	10.0
Array Length	5

SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g

4.4.1.5.6.2 Absolute Stop

Set a absolute power level for each offset stop limit.

Absolute Stop Mode defines whether or not to couple the offset stop absolute power limit to the offset start absolute power limit for each offset channel.

Key Path:	**Meas Setup, Offset/Limits, More, Limits**
Remote Command:	**[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STOP:ABSolute <real>,…** **[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STOP:ABSolute?** **[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STOP:ABSolute:COUPle OFF|ON|0|1** **[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STOP:ABSolute:COUPle ?**
Front Panel Unit/Terminator Keys	dBm
Preset/Default	-10.0, -30.0, -30.0, -30.0, -30.0 | -4, -12, -24, -24, -24
State Saved	Yes
Min	-200.0
Max	50.0
SCPI Resolution	0.01
Restriction and Notes	If Abs Stop State is set to Couple, Abs Start Limit and Abs Stop Limit are coupled to make a flat limit line. If set to Man, Abs Start and Abs Stop can take different values to make a sloped limit line.
Force Restart	Yes
RPG	0.01
Step (Front Panel)	10.0
Array Length	5
SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g
BAF Parameter Name	Abs Stop Mode

BAF SCPI Command	[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STOP:ABSolute:COUPle OFF|ON|0|1 [:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STOP:ABSolute:COUPle?
BAF Range	Couple | Man
BAF Preset/Default	1,1,1,1,1 | 0,0,0,1,1
BAF State Saved	Yes
BAF SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g When Coupled, Start and Stop limit will be the same

4.4.1.5.6.3 Relative Start

Set a relative power level for each offset start limit. This power level is relative to the peak power in the reference channel.

Key Path:	**Meas Setup, Offset/Limits, More Limits**
Remote Command:	**[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STARt:RCARrier <real>,…** **[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STARt:RCARrier?**
Front Panel Unit/Terminator Keys	dBc
Preset/Default	-30.0, -50.0, -50.0, -50.0, -50.0 | 0, -20, -28, -40, -40
State Saved	Yes
Min	-150.0
Max	50.0
SCPI Resolution	0.01
Force Restart	Yes
RPG	0.1
Step (Front Panel)	10.0
Array Length	5
SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g

4.4.1.5.6.4 Relative Stop

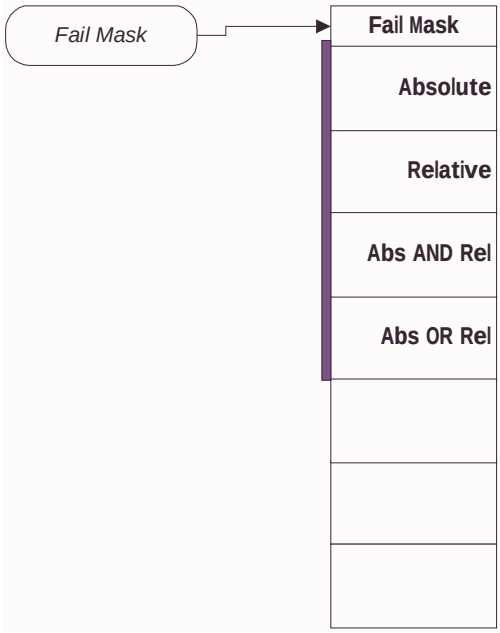
Set a relative power level for each offset stop limit. This power level is relative to the peak power in the reference channel.

Relative Stop Mode defines whether or not to couple the offset stop relative power limit to the offset start relative power limit for each offset channel.

Key Path:	**Meas Setup, Offset/Limits, More, Limits**
Remote Command:	**[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STOP:RCARrier <real>,…**
	[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STOP:RCARrier?
	[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STOP:RCARrier:COUPle OFF|ON|0|1
	[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STOP:RCARrier:COUPle ?
Front Panel Unit/Terminator Keys	dBc
Preset/Default	-30.0, -50.0, -50.0, -50.0, -50.0 | -20, -28, -40, -40, -40
State Saved	Yes
Min	-150.0
Max	50.0
SCPI Resolution	0.01
Restriction and Notes	If Rel Stop State is set to Couple, Rel Start Limit and Rel Stop Limit are coupled to make a flat limit line. If set to Man, Rel Start and Rel Stop can take different values to make a sloped limit line.
Force Restart	Yes
RPG	0.1
Step (Front Panel)	10.0
Array Length	5
SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore;
	1 = 802.11b
	2 = 802.11g
BAF Parameter Name	Rel Stop Mode
BAF SCPI Command	[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STOP:RCARrier:COUPle OFF|ON|0|1
	[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:STOP:RCARrier:COUPle?
BAF Range	Couple | Man

BAF Preset/Default	1,1,1,1,1 | 0,0,0,1,1
BAF State Saved	Yes
BAF SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g When Coupled, Start and Stop limit will be the same

4.4.1.5.6.5 Fail Mask



Define one of the fail conditions for each offset limit test to be done.

The fail condition that can be set for each offset are:

Abs AND Rel - Tests the measurement result for an offset against both the absolute power limit and the relative power limit. If it fails, then returns a failure for that measurement test.

ABSolute - Tests the measurement result for an offset against the absolute power limit. If it fails, then returns a failure for that measurement test.

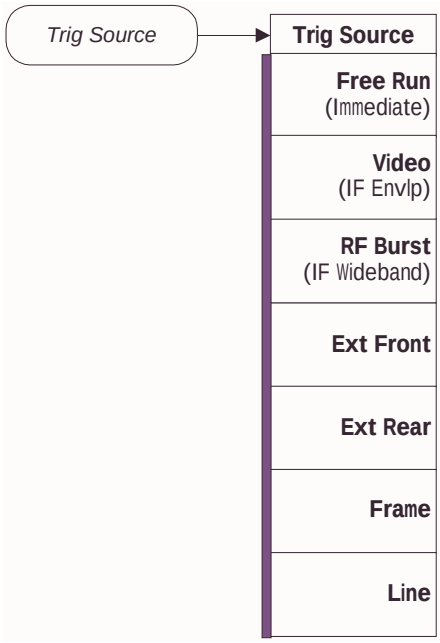
Abs OR Rel - Tests the measurement result for an offset against the absolute power limit OR the relative power limit. If either test fails, then returns a failure for that measurement test.

RELative - Tests the measurement result for an offset against the relative power limit. If it fails, then returns a failure for that measurement test.

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

Remote Command:	**[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:TEST ABSolute|AND|RELative|OR** **[:SENSe]:TOSPectrum:OFFSet[1]|2:LIST:TEST?**
Factory Preset:	REL, REL, REL, REL, REL | REL, REL, REL, REL, REL
State Saved:	Saved in instrument state.
Range:	Absolute | Relative | Abs AND Rel | Abs OR Rel
Array Length	5
SCPI Remarks	Sub Op Code Values relate to the Radio Bands, therefore; 1 = 802.11b 2 = 802.11g

4.4.1.6 Trigger Source



Select the trigger source used to control the data acquisitions.

Trigger sources that are available are;

Free Run - the next data acquisition is immediately taken.

Video - internal IF envelope (video) trigger.

RF Burst - wideband RF burst envelope trigger that has automatic level control for periodic burst signals.

Ext Front - front panel external trigger input.

Ext Rear - rear panel external trigger input.

Frame - internal frame timer from front panel input.

Line - internal line trigger.

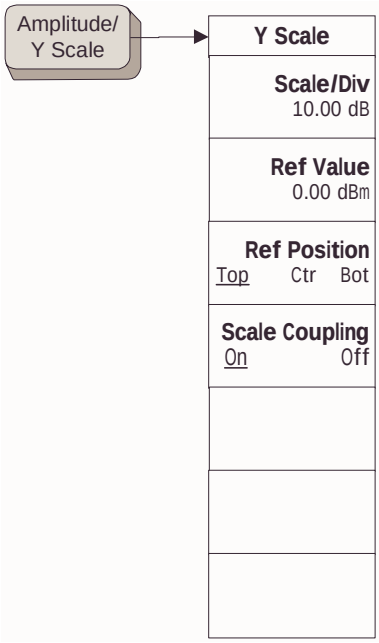
Key Path:	**Meas Setup**
Remote Command:	**[:SENSe]:TOSPectrum:TRIGger:SOURce IMMediate|IF|RFBurst|EXTernal|EXTernal2|FRAMe|LINE**
	[:SENSe]:TOSPectrum:TRIGger:SOURce?
Factory Preset:	IMMediate
State Saved:	Saved in instrument state.
Range:	Free Run (Immediate) | Video (IF Envlp) | RF Burst (IF Wideband) | Ext Front | Ext Rear | Frame | Line

4.4.1.7 Restore Meas Defaults

Allows you to preset all the parameters that are specific to this measurement.

Key Path:	**Meas Setup, More**

4.4.2 Amplitude/Y Scale



4.4.2.1 Scale/Div

Allows you to enter a numeric value to change the vertical display sensitivity.

Key Path:	**AMPLITUDE Y Scale**
Factory Preset:	107.00 us
State Saved:	Saved in instrument state.

4.4.2.2 Ref Value

Allows you to set the absolute power reference value.

Key Path:	**AMPLITUDE Y Scale**
Annotation:	<value> - bottom left hand corner of display
Factory Preset:	-10.00 us
State Saved:	Saved in instrument state.

4.4.2.3 Ref Position

Allows you to set the reference position.

Key Path:	**AMPLITUDE Y Scale**
Range:	Left | Ctr | Right
Factory Preset:	Left
State Saved:	Saved in instrument state.

4.4.2.4 Scale Coupling

Allows you to toggle the scale coupling function between On and Off. When On, upon pressing the Restart front-panel key or Restart softkey under the Meas Control menu, this function automatically determines the scale per division and reference values based on the measurement results. When you set a value to either Scale/Div or Ref Value manually, Scale Coupling automatically changes to Off.

Key Path:	**AMPLITUDE Y Scale**
Range:	On | Off
Factory Preset:	On
State Saved:	Saved in instrument state.